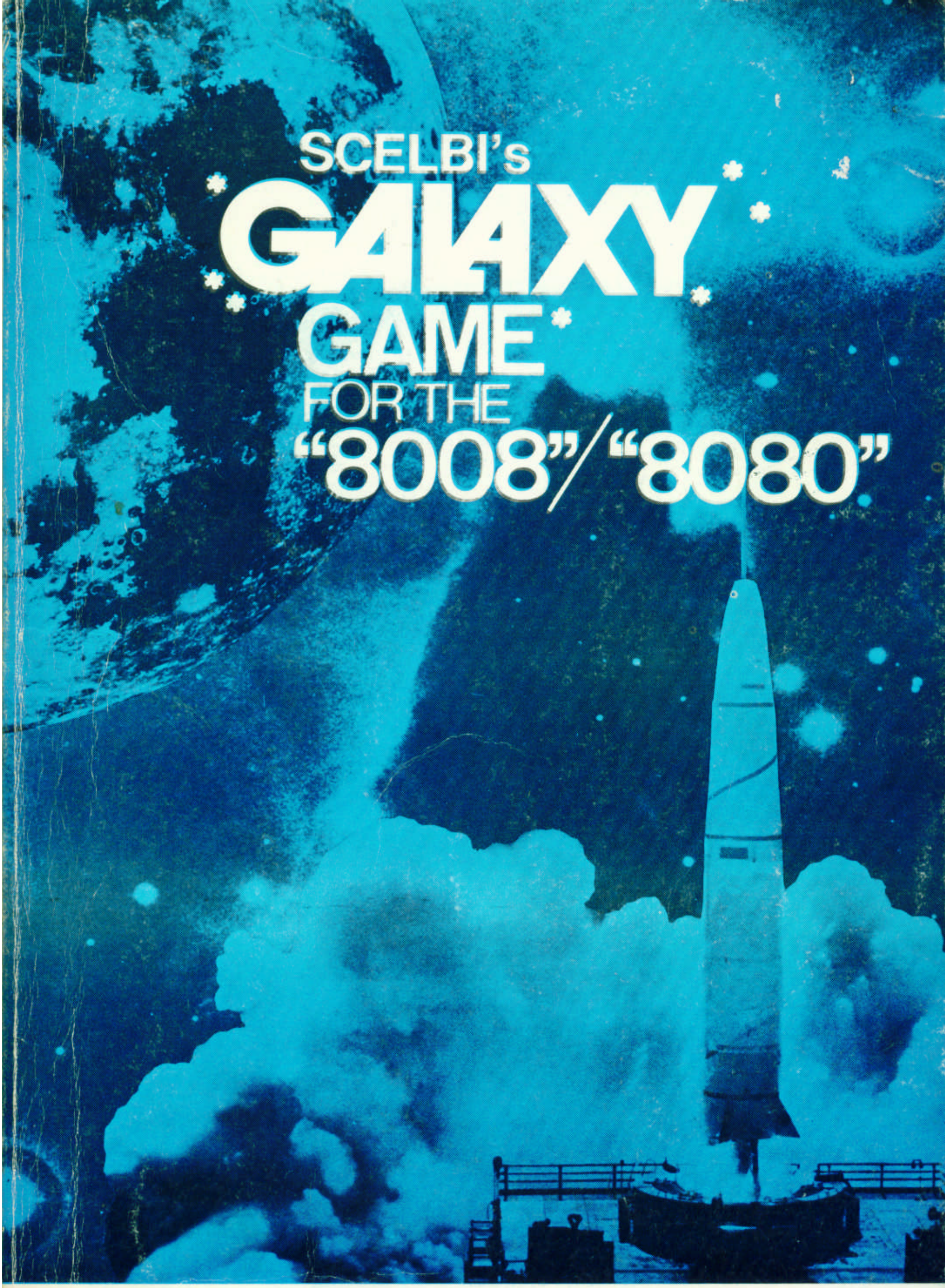

SCELBI's

GALAXY GAME

FOR THE

"8008"/"8080"

SCELBI COMPUTER CONSULTING INC.

SCELBI'S GALAXY GAME

FOR THE '8008/8080'

Author:

Robert Findley

Scelbi Computer Consulting, Inc.
1322 Rear - Boston Post Road
Milford, CT 06460

IMPORTANT NOTICE

The information in this publication has been carefully reviewed and is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies or for the success or failure of various applications to which the information herein might be applied.

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SCELBI'S GALAXY GAME

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INTRODUCTION

Imagine yourself as captain of a space ship traveling throughout the galaxy. Your mission is to seek and destroy all alien ships to make the galaxy safe so that other ships from your planet may journey into outer space. Due to the urgency of the mission it must be completed within a given time. If the mission is not completed within the time allotted, the safety of all future voyages is in jeopardy. Your space ship is supplied with a limited amount of fuel and weapons so you must choose your course and attack strategy carefully. Mission control has placed space stations at various points in the galaxy for refueling. A space station contains a limitless amount of fuel and weapons. However, don't get caught too far from a space station with your energy low or you may end up drifting endlessly through space.

As an aid in searching the galaxy, the space ship is equipped with a galaxy scanner which is capable of displaying three different degrees of detail. The short range scan provides an accurate picture of the immediate quadrant through which the space ship is currently traveling. Your location and that of any alien ships, stars, and space stations in the quadrant are defined by exact sector coordinates. The long range scan displays the contents of the eight quadrants surrounding the quadrant you presently reside in. The wide angle scanner provides a view of the total galaxy from which you can plot your course.

The space ship is equipped with two types of weapons. The PHASOR is an energy discharge device which homes in on all enemy ships in the immediate area and directs specified amounts of energy at each. This energy, if enough to destroy, will completely eliminate the alien ship. However, should the alien ship survive the attack, it will retaliate by shooting back at your ship. It is important that you keep the energy in your ship's protective shields at sufficient levels to withstand any possible retaliation from the enemy. The other weapon available is the TORPEDO. It is capable of destroying any alien ship on impact. The target must be in direct line of sight of the space ship for the torpedo to reach its destination. A missed torpedo shot results in immediate retaliation by the alien ship. Also, be careful when there is a space station in the area. If the torpedo hits it, the space station is destroyed.

Now, turn your imagination into the realm of reality by transforming your small computer system into the control station of the space ship. Each move by the space ship is controlled by the computer operator and the responsibility of the total mission is placed on the operator's shoulders. The GALAXY program presented here will allow one to make this transformation by loading the program as presented, and simply adding the appropriate I/O routines for one's specific I/O setup. Or, it can be expanded by revising the command operations or adding new commands to make the game more complex, and modifying it to take advantage of special I/O devices which the reader may have associated with one's computer system. The number of possible variations are limitless. The operation of this program is explained in detail to aid those that desire to make revisions and additions to its operation.

OPERATION OF THE GALAXY PROGRAM

Before getting into the specifics of the SCELBI GALAXY program, it is important that the reader understands the general operation of the program. As one might imagine, the programming will be a bit intricate at times, so a good general knowledge of its operation will help keep things in perspective. This section is also written so that it may be used as an operating guide which may be referred to when playing the game.

The object of the Galaxy game is to destroy all the alien ships in the galaxy. The exact number of alien ships which must be destroyed is defined in the initial message along with the number of stardates one has to complete the mission, and the number of space stations available in the galaxy for refueling. Each time a game is started, the entire galaxy is set up in a random manner so that no two games will be the same. The number of alien ships and space stations, and their respective locations in the galaxy will also be different for each game.

The galaxy is made up of 64 quadrants arranged in an eight-by-eight matrix. The quadrants are identified by the row number and column number of its location in the matrix. The row numbers run from one to eight starting with the top row. The column numbers go from one to eight starting with the left-hand column. Within each quadrant there are 64 sectors arranged in the exact same format as the quadrants in the galaxy. There can exist only one galactic object in a sector at any one time. An illustration of the matrix is shown on the following page.

The space ship used to traverse the galaxy in search of enemy vessels contains several integral parts which allow it to carry out its mission. First, there is the main storage bank which contains the main supply of energy for the space ship. This energy is used to move the ship through the galaxy, supply the power to fire the phasors and torpedoes, and transfer energy to the protective shields. The maximum energy capacity in the main storage bank is 5000 units.

	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
6								
7								
8								

The master control panel is used to enter commands to direct the ship's movement, request scanner displays, fire phasors and torpedoes, and transfer energy to the protective shields. It also displays status reports to inform the operator of various conditions which arise during the course of the mission. The master control panel requires 10 units of energy for each command entered. It is also a positive action panel which means that once a command mode is entered, the command sequence must be completed. The physical arrangement of the master control panel will depend on the I/O facilities of the individual computer system.

The alien ships which are to be destroyed have the following properties. First, a protective shield, similar to the space ship's shields, surrounds the alien ship. This shield can contain from 0 to 1023 units of energy. This supply of energy is depleted by a phasor shot from the space ship in direct proportion to the amount of phasor energy which reaches the shield. Next, the alien ship has an endless supply of energy to fire back at the space ship. This energy is fired only in retaliation for an attack by the space ship. If a torpedo shot misses, the alien ship responds with a phasor of 200 units of energy. If a phasor does not destroy the alien ship, a phasor with 1/4 of the amount of energy left in the shields of the alien ship is fired at the space ship. The alien ship is destroyed by the direct hit of a torpedo, by a phasor which removes all of its shield energy, or by the space ship colliding with the alien ship.

Space stations are scattered throughout the galaxy to provide the space ship with refueling locations. In order for the space ship to refuel, it must maneuver to a sector alongside the space station where it is considered "docked." When the space ship is docked, its energy supply is replenished to its maximum capacity, and the torpedo tubes are refilled to their capacity of 10 torpedoes. The energy and torpedoes are transferred to the space ship only on the initial move to dock with the space station. Remaining docked while using energy to fire phasors and torpedoes will not provide the space ship with an endless supply. To replenish its supply after attacking from a docked position, the space ship must move away from, and then return to, the space station. Also, when docking, if the space ship collides with the space station, the space station will be destroyed.

The ship's weapons arsonal consists of a phasor, which discharges high levels of concentrated energy, and a torpedo launcher. The phasor "homes in" on all alien ships in the quadrant in which the space ship is residing. The actual amount of energy fired is selected by the operator. The torpedo must proceed in a straight line to the object that it is to destroy. The maximum number of torpedoes, and the amount of energy used for each, will be covered shortly.

The protective shields are the ship's defense against any attack by an alien ship, or it's protection from damage should it accidently collide with a space station or alien ship. The shields are capable of absorbing an amount of energy equal to the amount of energy they contain. It is important that the shield energy level be maintained high enough to withstand any possible attack, since severe energy losses occur if the shield energy goes to zero.

The stars, which are scattered throughout the galaxy, serve as possible obstructions for the space ship when moving about in a quadrant, and by blocking the direct line of fire of a torpedo. The space ship must also be very careful in maneuvering around a star because colliding with one means instant destruction.

When a command is to be input to the program, the following message will be displayed:

COMMAND?

The operator must then enter a number from zero to six to initiate one of the following command modes.

0 - SPACE SHIP MOVEMENT COMMAND
1 - SHORT RANGE SCAN COMMAND
2 - LONG RANGE SCAN COMMAND
3 - GALAXY DISPLAY COMMAND
4 - SHIELD COMMAND
5 - PHASOR COMMAND
6 - TORPEDO COMMAND

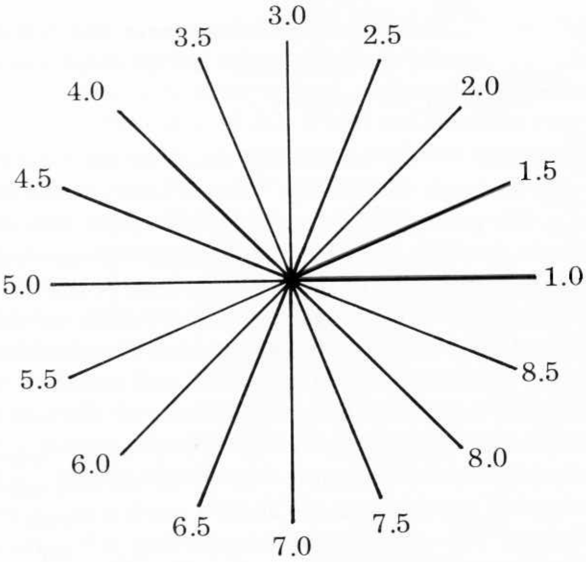
COMMAND 0 - SPACE SHIP MOVEMENT

The movement of the space ship is controlled by designating both course direction and distance. Movement within a quadrant requires only the energy required for the command, which is 10 units. If the move crosses one or more quadrant boundaries, 25 units are used for each quadrant crossed. When the completion of any move results in the space ship residing in a new quadrant, one stardate is used up.

When a movement command is entered, the course direction is requested by the following message being displayed:

COURSE (1-8.5)?

Course direction is entered by specifying a two digit number as indicated in the request of the value 1.0 to 8.5. This number indicates the direction the space ship is to move according to the compass on the following page.



From this diagram, one can see that the possible directions start to the right with a value of 1.0 and move around in a counterclockwise manner with assignments made every 22½ degrees. If one desired to move to the left and slightly down, the course would be entered as 5.5. This direction assignment is also used to define the trajectory of a torpedo fired from the space ship, as will be discussed shortly.

After the direction has been entered, the distance, or warp factor, is requested by the following message being displayed:

```
WARP FACTOR (0.1-7.7)?
```

As indicated, the warp factor is entered by specifying a two digit value. The space ship will move a distance of one sector for each 0.1 designated in the input. The maximum value for either digit is seven. Thus, to move to the same sector in the quadrant to the right of one's current position, the course direction would be 1.0, and the warp factor would be 1.0, not 0.8. This setup creates a one-to-one relationship between the distance entered, and the number of quadrants and sectors moved through, since the quadrants are broken up into an 8 x 8 matrix for the sectors.

There are several moves which one must be very careful to avoid while traveling through the galaxy. One is that of moving out of the boundaries of the galaxy. If this occurs, the space ship is lost forever in outer space. Another move of equivalent consequence is a move which causes the space ship to crash into a star. A star is considerably larger than the space ship, and a collision results in the space ship becoming completely engulfed in the gaseous composition of the star and destroyed. The third move to avoid is a collision with a space station. The force of the collision will result in the loss of 600 units of energy from the space ship. Of a greater consequence, however, is the aspect that the space station is wiped out on impact, since it contains no defensive mechanism to absorb such a collision. This may seriously damage the chances of completing a mission. The final move is a "kami-kazi" move against an alien ship. This gives the desired affect of destroying the enemy, but the space ship will sustain a loss of 1500 units of energy which may leave it with very little power. The possibility of colliding with another object is only present while traveling in the quadrant that the space ship is in at the time the movement command was entered. Once the ship moves outside the initial quadrant, the automatic guidance control takes over and safely steers the space ship to its destination.

COMMAND 1 - SHORT RANGE SCAN

The short range scan provides a detailed picture of the contents of the quadrant in which the space ship currently resides. A short range scan uses only the energy required for the command, which is 10 units. The precise sector location of the space ship, stars, alien ships, and space stations are displayed for examination by the operator. The following symbols are used to define each of the possible objects.

<*>	- SPACE SHIP
+++	- ALIEN SHIP
*	- STAR
>1<	- SPACE STATION

A sample of a short range scan display is shown below. The display also provides the basic status information for the ship to the left of the scan. The stardate will always start with a 30, and the last two digits will approach the value of 50. When the stardate reaches 3050, the space ship has run out of stardates and the mission has failed. The condition status will be red if an alien ship is present in the current quadrant, and green if there are no alien ships in the quadrant. The quadrant and sector values refer to the current position of the space ship. The first digit indicates the row number, and the second digit indicates the column of the respective position in the galaxy. The energy is the amount of energy currently contained in the main storage bank. This energy will be a maximum value of 5000 units. The next entry provides a count of the number of torpedoes available on the space ship. The final status entry indicates the amount of energy in the protective shields.

```
 -1--2--3--4--5--6--7--8-
1          *                  STARDATE     3023
2                             CONDITION    RED
3               +++           QUADRANT     6,5
4    *                        SECTOR       5,3
5      <*>                    ENERGY       5000
6                             TORPEDOES    10
7         >1<        *        SHIELDS      0000
8
 -1--2--3--4--5--6--7--8-
```

EXAMPLE OF A SHORT RANGE SCAN

COMMAND 2 - LONG RANGE SCAN

The long range scan command gives an overall view of the eight quadrants which surround the quadrant currently occupied by the space ship. The 10 units of energy needed for a command are all that is required to display a long range scan. The presence of alien ships, space stations and stars are indicated for each quadrant. The contents are indicated by a three digit number in each square. The left hand digit indicates the number of alien ships in the quadrant: the center digit indicates the number of space stations, and the right hand digit indicates the number of stars. A sample of a long range scan is presented below.

```
L.R. SCAN FOR QUADRANT 6,5
-------------------------------------
1 112 1 001 1 006 1
-------------------------------------
1 001 1 113 1 104 1
-------------------------------------
1 203 1 007 1 004 1
-------------------------------------
```

COMMAND 3 - GALAXY DISPLAY

The contents of the entire galaxy may be displayed by requesting a galaxy display. The display requires only the 10 units of energy necessary for the command. The contents of each quadrant are shown in the same form as that used in the long range scan. From this display the operator may plan a long range course to successfully complete a mission. The following is a sample of a galaxy display. The reader may note the location of the long range scan quadrants as pre-

```
-----------------------------------------------------------------
1 105 1 002 1 003 1 000 1 000 1 105 1 000 1 000 1
-----------------------------------------------------------------
1 117 1 000 1 304 1 106 1 005 1 003 1 107 1 002 1
-----------------------------------------------------------------
1 105 1 007 1 003 1 006 1 000 1 000 1 000 1 000 1
-----------------------------------------------------------------
1 005 1 003 1 000 1 000 1 000 1 000 1 003 1 004 1
-----------------------------------------------------------------
1 001 1 000 1 000 1 112 1 001 1 006 1 203 1 105 1
-----------------------------------------------------------------
1 000 1 103 1 000 1 001 1 113 1 104 1 002 1 117 1
-----------------------------------------------------------------
1 000 1 103 1 000 1 203 1 007 1 004 1 000 1 002 1
-----------------------------------------------------------------
1 000 1 000 1 003 1 000 1 000 1 001 1 102 1 107 1
-----------------------------------------------------------------
```

sented in the previous illustration.

COMMAND 4 - SHIELD CONTROL

The shield control command provides a means of transferring energy between the main energy storage bank and the protective shields. The shields must contain energy to protect the space ship from attacks by the alien ships or from possible collisions with either an alien ship or a space station. The energy required to make the transfer is simply the 10 units required for the command. The amount of energy transferred is specified by the operator in response to the following message being displayed:

```
SHIELD ENERGY TRANSFER =
```

The operator then enters a four digit number indicating the amount of energy desired to be transferred. When a four digit number is entered, the energy is transferred from the main storage bank to the shield. If a four digit number is preceeded by a minus sign, the energy is transferred from the protective shield back to the main storage bank.

It is important that the amount of energy in the shields be maintained at sufficient levels to withstand any possible attack. If the shield energy should become too low to absorb the energy of an attack, the additional energy needed will be taken from the main supply, and an additional 25 percent of the total energy loss will be depleted from the main storage bank as a penalty. This 25 percent loss is the amount of energy required to make repairs to the portions of the space ship damaged by the energy that was not absorbed by the shields.

COMMAND 5 - PHASOR CONTROL

The phasor control directs the phasor's energy at the alien ships that reside in the immediate quadrant. The amount of energy that is to be fired is specified by the operator in response to the following message being displayed.

PHASOR ENERGY TO FIRE:

A four digit number is then entered and the phasor shots are fired at the alien ships in the quadrant. The result of the phasor energy shot at each alien ship is reported by the following message being displayed:

```
ALIEN SHIP AT SECTOR X,Y:  ENERGY = ZZZZ
                       or  DESTROYED
```

The values of X and Y indicate the sector location of the alien ship, and the message after the colon will indicate either the amount of energy (ZZZZ) remaining in the alien ship, or that the alien ship has been destroyed. If the alien ship is not destroyed by the phasor, one quarter of its energy will be shot back at the space ship in retaliation. This retaliation will be indicated by the following message:

```
LOSS OF ENERGY   XXXX
```

Before specifying the amount of energy, the operator must be aware of several properties of phasor energy. First, the amount of energy to be fired is divided equally between the alien ships in the quadrant. If there are two alien ships in the quadrant, and the operator indicates 500 units of energy, 250 units will be fired at each alien ship. Next, the amount of phasor energy that reaches the target is governed by the distance the energy must travel. The distance is figured by adding up the number of sectors in the horizontal and vertical direction between the space ship and the alien ship. This distance is then divided by four and the fraction is discarded; this value is used as the distance factor. The distance factor is the number of times the amount of energy fired at an alien ship is to be divided by two. The distance between the space ship and the alien ship is therefore critical to the amount of phasor energy to reach the alien ship. For example, if the space ship is at sector 2,4 and the alien ship is at sector 6,6, the total number of sectors is equal to two in the horizontal direction (6-4=2) plus four in the vertical direction (6-2=4). This distance of six is divided by four and the whole number one is used as the distance factor. This distance factor divides the energy to be fired at the alien ship by 2. It is important that the space ship be as close to the alien ship(s) as possible to achieve the maximum effectiveness of a phasor shot.

COMMAND 6 - TORPEDO CONTROL

The torpedo control fires a torpedo in the direction specified by the operator. Each torpedo requires 250 units of energy to fire, and must be in the direct line of fire of the target. The trajectory of the torpedo is entered by the operator in response to the following message being displayed:

```
TORPEDO TRAJECTORY:
```

The trajectory is defined in the same format as the course specification when entering a movement command. A two digit number is entered indicating the direction in which the torpedo is to travel. The track of the torpedo is then traced, and reported to the operator as it moves from one sector to another. This is reported by a series of tracking messages displayed in the following format:

```
TRACKING: X,Y
TRACKING: U,V
TRACKING: S,T
```

The values of X,Y, U,V, and S,T are the row and column of the sectors through which the torpedo is passing. When the torpedo either reaches the boundary of the quadrant or hits an object, an advisory message is displayed. If the torpedo misses the alien ship and reaches the boundary of the quadrant, or if the torpedo hits a star, the following message will be displayed:

```
YOU MISSED!  ALIEN SHIP RETALIATES
LOSS OF ENERGY = 200
```

Missing the alien ship causes it to retaliate by firing back 200 units of energy at the space ship. If the torpedo hits a space station, not only is the alien ship going to retaliate, but the space station is destroyed since it has no defense against a torpedo. The following message is displayed to inform the operator of this serious disaster.

```
SPACE STATION DESTROYED
YOU MISSED!  ALIEN SHIP RETALIATES
LOSS OF ENERGY = 200
```

If all goes well, and the trajectory is right on target, the alien ship will be destroyed and the following message will inform the operator of the successful hit:

```
ALIEN SHIP DESTROYED
```

SYSTEM REQUIREMENTS

MEMORY USAGE FOR THE GALAXY PROGRAM

The Galaxy program presented in the book requires 4096 bytes of RAM memory to operate in an 8008 based micro-computer system. The 8080 version listed in the back is slightly shorter but also requires a 4K system to operate in. The program is broken down into the following blocks of memory. Page 00 is used to store the course table, temporary data, the galaxy display line, and the galaxy content table. Pages 01 through 04 contain the messages used by the program. The subroutines reside on pages 05 through 11, and the major program routines run from page 12 to page 16. The lower half of page 17 contains the galaxy setup table and the upper half of page 17 is reserved for the user supplied input/output routines. If more than 128 bytes are required by the user for the I/O routines, and the user's system does not have more than 4K of memory, the length of several of the messages can be cut down to provide the additional memory space needed for I/O routines.

INPUT/OUTPUT REQUIREMENTS

The input/output requirements for the galaxy program presented herein allow the reader to tailor the I/O portion of the program to the specific devices which are available for use on one's computer system. The character code used in this program is the 7 bit ASCII code with the 8th bit, or parity bit, assumed to be at a "1." The game uses the full alphanumeric character set plus several punctuation marks. A table of the ASCII code required by this program is presented next.

CHARACTERS SYMBOLIZED	BINARY CODE	OCTAL REP
A	11 000 001	301
B	11 000 010	302

CHARACTERS SYMBOLIZED	BINARY CODE	OCTAL REP
C	11 000 011	303
D	11 000 100	304
E	11 000 101	305
F	11 000 110	306
G	11 000 111	307
H	11 001 000	310
I	11 001 001	311
J	11 001 010	312
K	11 001 011	313
L	11 001 100	314
M	11 001 101	315
N	11 001 110	316
O	11 001 111	317
P	11 010 000	320
Q	11 010 001	321
R	11 010 010	322
S	11 010 011	323
T	11 010 100	324
U	11 010 101	325
V	11 010 110	326
W	11 010 111	327
X	11 011 000	330
Y	11 011 001	331
Z	11 011 010	332
[	11 011 011	333
\	11 011 100	334
]	11 011 101	335
↑	11 011 110	336
←	11 011 111	337
SPACE	10 100 000	240
!	10 100 001	241
“	10 100 010	242
#	10 100 011	243
$	10 100 100	244
%	10 100 101	245
&	10 100 110	246
’	10 100 111	247

CHARACTERS SYMBOLIZED	BINARY CODE	OCTAL REP
(	10 101 000	250
)	10 101 001	251
*	10 101 010	252
+	10 101 011	253
,	10 101 100	254
-	10 101 101	255
.	10 101 110	256
/	10 101 111	257
0	10 110 000	260
1	10 110 001	261
2	10 110 010	262
3	10 110 011	263
4	10 110 100	264
5	10 110 101	265
6	10 110 110	266
7	10 110 111	267
8	10 111 000	270
9	10 111 001	271
:	10 111 010	272
;	10 111 011	273
<	10 111 100	274
=	10 111 101	275
>	10 111 110	276
?	10 111 111	277
@	11 000 000	300
LINE FEED	10 001 010	212
CAR-RET	10 001 101	215

There are two input routines required by the galaxy program. The first is one which simply tests the status of the input device to determine whether the device has a character input available and returns to the calling program. This routine can use whatever registers are required to perform the status check. The only requirement is that the SIGN flag be set to a "1" if the character input is available, and reset to a "0" if the character input is not available. This routine should be as brief as possible. It is called once in the program at the start of the operating portion by the instruction CAL INPCK. The purpose of this check is to allow the random number generator to run while waiting for the operator to enter the first response. The purpose of the random number generator will be explained later.

The other input routine must input a character from the system input device, such as a keyboard, and return to the calling program with the ASCII code for the character entered in the accumulator. The input routine, labeled INPUT, can use registers A and B to input the character. If the CPU registers must be used, the input routine must save and then restore the contents of those registers before returning. If the input device is not connected in some way to the display device to provide automatic printout of the characters entered, the INPUT routine should provide some means of outputting the character received to the output device. This may be achieved by echoing the character in the input routine, or by calling the print routine to perform the output. The INPUT routine is called in the subroutines labeled DRCT and EIN, and in the major routines labeled GALAXY, CMND, and CRSE.

The output routine is required to output the character whose ASCII code is contained in the accumulator when the output routine is called. The output routine can use only registers A and B in outputting the character to the output device. If the other registers are used, their contents must be saved and then restored before returning to the calling program. The output routine is referred to by the label PRINT. This routine is called by the subroutines MSG, NTN, and DRCT, and the major routine CRSE.

DATA TABLE, MESSAGES, and SUBROUTINES

DESCRIPTION OF THE GALAXY DATA ON PAGE 00

The major portion of the operation of the Galaxy game concerns itself with the contents and manipulation of the data stored on page 00 from location 100 to 135. This table area is reserved for the storage of information, such as the location of the space ship, stars, alien ships, and space stations within the current quadrant, the amount of energy contained in the main energy storage, the shields of the space ship, and the energy in the shields of the alien ships. The count of the number of torpedoes, space stations, alien ships, and stardates remaining is also stored here. The format of the data in this table is summarized below with a description of each following the summary.

LOCATIONS	FORMAT	DEFINITION
100, 101	XXXXXXXX	Random number storage
102	00AASTTT	Current quadrant contents
103	00RRRCCC	Sector location of space ship
104 - 112	00RRRCCC	Sector location of stars
113	00RRRCCC	Sector location of space station
114	00RRRCCC	Sector location of alien ship No. 1
115	00RRRCCC	Sector location of alien ship No. 2
116	00RRRCCC	Sector location of alien ship No. 3
117, 120	XXXXXXXX	Dbl precision value of main energy
121, 122	XXXXXXXX	Dbl precision val. of shield energy
123, 124	XXXXXXXX	D.P. val. of alien ship No. 1 energy
125, 126	XXXXXXXX	D.P. val. of alien ship No. 2 energy
127, 130	XXXXXXXX	D.P. val. of alien ship No. 3 energy
131	00RRRCCC	Crnt. quad. location of space ship
132	0000PPPP	Number of torpedoes remaining
133	00000XXX	Number of space stations
134	000XXXXX	Number of alien ships
135	00XXXXXX	Number of stardates remaining

LOCATIONS 100 and 101

The random number routine uses the contents of these two locations to generate and store the next random number.

LOCATION 102

The contents of the current quadrant in which the space ship is located are stored in this byte. The bits indicated by TTT provide a count of the number of stars in the quadrant, the S indicates a space station present when set to "1," and the bits AA indicate the number of alien ships in the quadrant. Each time a new quadrant is entered, this location is loaded with its contents. This is done to provide the program with a convenient reference location for the contents of the quadrant. All of the quadrants are set up at the start of the game, and stored in the galaxy content table on the upper quarter of page 00.

LOCATION 103

The row and column numbers for the current sector location of the space ship are indicated by the RRR and CCC bits, respectively, in this byte. The row and column numbers are represented by the binary values zero through seven in this location. However, they represent the row and column numbers one through eight when presented in the output to the display device. This row and column representation is used in the next 11 locations to indicate the location of the stars, space stations, and alien ships in the quadrant. This provides the program with a convenient means of checking for a strike by a torpedo, or a collision of the space ship with another object in the quadrant. The initial value stored in this location is set up using the random number generator. After that time, the location of the space ship is controlled by the operator.

LOCATIONS 104 through 112

The location of the stars in the current quadrant is indicated by the row and column numbers contained in this portion of the table. The values RRR and CCC are of the same format as that presented for the space ship. If there are less than seven stars in the current quadrant, the unused locations in this table are set to octal 200. If there are no stars in the quadrant all of these locations will contain 200. The location of the stars are set using the random number generator each time a new quadrant is entered.

LOCATION 113

The location of the space station in the current quadrant is stored here. The row and column numbers are represented in the same format as the space ship and stars; they are set by use of the random number generator each time a new quadrant is entered. If a space station does not reside in the current quadrant, this location will contain 200. At the completion of a move by the space ship, this location is used in determining whether the space ship has docked with the space station.

LOCATIONS 114 through 116

This portion of the table is used for the storage of the location of the alien ships. The row and column representation is the same as that presented for the previous nine locations. If less than three alien ships are in the current quadrant, the unused locations will contain 200. When an alien ship is destroyed, the corresponding location in this table will be set to 200 as part of the process of eliminating it from the galaxy.

LOCATIONS 117 and 120

The binary value of the amount of energy in the main storage bank is maintained in this location pair. The least significant half is saved in location 117, and the most significant half in location 120. The maximum value stored in this location is 5000, which is set up at the start of a game and each time the space ship docks.

LOCATIONS 121 and 122

This location pair is used to store the binary value of the energy contained in the space ship's protective shields. As with the main energy storage, the least significant half is stored in location 121, and the most significant half in location 122. The amount of energy stored in this location is set up by a command entry and is depleted by attacks by alien ships.

LOCATIONS 123 through 130

The binary value of the energy levels of the alien ships protective shields are contained in this portion of the table. The least significant half is in the odd numbered byte, and the most significant half in the even numbered byte. The energy level for each alien ship is set up using the random number generator when a space ship enters a quadrant. The energy indicated in these locations is the only defense an alien ship has against a phasor attack.

LOCATION 131

This location contains the row and column numbers of the space ship's current quadrant location within the galaxy. The format is the same as that for the sector location of the space ship defined previously. The quadrant location is set up initially by use of the random number generator, and is then controlled by the operator as the space ship is moved throughout the galaxy. The contents of this location are used to fetch the quadrant contents by setting the two most significant bits to "1," and using this as a pointer to the galaxy content table.

LOCATION 132

A count of the number of torpedoes remaining in the space ship is maintained here. This location is set to 10 at the start of each game and each time the space ship docks with the space station. When a torpedo is fired, this count is decremented by one until it reaches zero which indicates there are no torpedoes left.

LOCATION 133

This location maintains a count of the number of space stations in the galaxy. If a space station is destroyed by collision or torpedo, the count is decremented by one. When the count goes to zero, a warning message is displayed to inform the operator that the last space station has been destroyed.

LOCATION 134

A count of the number of alien ships remaining is maintained in this location. Each time an alien ship is destroyed, this location is decremented by one. When it reaches zero, the mission is completed by the successful destruction of all the alien ships.

LOCATION 135

This location indicates the number of stardates left in the game. A stardate is used up when a move results in the space ship residing in a new quadrant. This location will be decremented by one each time this occurs. When this count goes to zero, the operator has run out of time and the game is over. This count is initially set to five more than the number of alien ships.

IMPORTANT NOTE

The presence of the data table on page zero means that when dealing with these tables, register H is set to zero. This fact is often used to load memory locations and other registers with a value of zero by simply loading them with the contents of register H. If the contents of page zero are to be relocated to another page in memory, the entire program must be examined and corrected at the locations where this technique has been employed.

TEXT MESSAGES USED IN THE GALAXY PROGRAM

The Galaxy program uses a number of messages to inform the player of the current status of the game in progress, and to request information from the player about the move that is to be made next. These messages are stored in a large block of memory on pages 01 through 04. Each message is stored as a string of ASCII characters with a zero byte as the terminator for the message. There are a number of these messages that require the addition of variable information before the message is to be printed. These messages indicate the current status of the space ship which the player must keep watch over, the position of the objects in the galaxy, and the current progress of a specific move, such as the energy used or the tracking of a torpedo as it moves through a quadrant. The text of these messages is presented next with the location of the variable data indicated by X's.

"DO YOU WANT TO GO ON A SPACE VOYAGE?"

"YOU MUST DESTROY XX ALIEN SHIPS IN XX STARDATES
WITH X SPACE STATIONS"

" - 1 - - 2 - - 3 - - 4 - - 5 - - 6 - - 7 - - 8 -"

"X   " (Short Range Scan Row)

"STARDATE 30XX"

"CONDITION XXXXX" (Green or Red)

"QUADRANT X,X"

"SECTOR X,X"

"ENERGY XXXX"

"TORPEDOES XX"

"SHIELDS XXXX"

"COMMAND?"

"COURSE (1-8.5)?"

"WARP FACTOR (0.1-7.7)?"

"L.R. SCAN FOR"

"1 XXX 1 XXX 1 XXX 1" (Long Range Scan Row)

"1 XXX 1 XXX 1 XXX 1 XXX 1 XXX 1 XXX 1 XXX 1 XXX 1"
(Galaxy Display Row)

"MISSION FAILED, YOU HAVE RUN OUT OF STARDATES"

"KA-BOOM, YOU CRASHED INTO A STAR.
YOUR SHIP IS DESTROYED."

"YOU MOVED OUT OF THE GALAXY.
YOUR SHIP IS LOST. . .LOST"

"ABANDON SHIP! NO ENERGY LEFT!"

"CONGRATULATIONS, YOU HAVE ELIMINATED ALL OF
THE ALIEN SHIPS"

"LOSS OF ENERGY XXXX"

"DANGER - SHIELD ENERGY 000"

"SHIELD ENERGY TRANSFER = "

"NOT ENOUGH ENERGY"

"TORPEDO TRAJECTORY: "

"ALIEN SHIP DESTROYED"

"YOU MISSED! ALIEN SHIP RETALIATES"

"SPACE STATION DESTROYED"

"TRACKING: X,X"

"GALAXY DISPLAY"

"PHASOR ENERGY TO FIRE = "

"ALIEN SHIP AT SECTOR X,X:"

"ENERGY = XXXX"

"NO ALIEN SHIPS! WASTED SHOT"

"NO TORPEDOES"

"LAST SPACE STATION DESTROYED"

"CHICKEN!"

These messages require 1K bytes of memory to store one byte at a time. The text of many of these messages can be changed by the reader to indicate varying degrees of emotion if desired. Or, if the user provided I/O routines require more than the amount of memory allocated, several of the messages can be shortened, or, if necessary, deleted, to make room for the I/O programming. If the messages are changed, the addresses in the program that refer to them must also be changed. These locations in the program will be indicated when the operating portion of the program is presented.

SUBROUTINES FOR THE GALAXY PROGRAM

There are many subroutines in this program. They are written to perform various tasks common to many of the routines throughout the Galaxy program. Among the types of functions they perform are outputting messages to the printer device, converting binary numbers to decimal (and vice-versa), setting up message contents with data to be displayed, controlling the movement of objects in the galaxy, and controlling the transfer of energy within the space ship. The subroutines of the Galaxy program reside in 1¼K bytes of memory on pages 05 through 11. This is equal to the amount of memory the operating portion of the program requires. Thus, one can see that the Galaxy program relies heavily on the subroutines to allow it to fit within 4K of memory. This section provides the details on the purpose and operation of the subroutines used in the Galaxy program.

The majority of the messages in the Galaxy program are output by means of the subroutine labeled MSG. This routine, presented below, outputs a string of ASCII characters stored in memory to the output device. MSG output begins with the character pointed to by the memory pointer registers H and L. It will continue to output characters by calling the PRINT routine until a zero byte is encountered in the character string. The routine then returns to the calling program.

```
MSG,      LAM              Fetch character
          NDA              End of message?
          RTZ              Yes, return
          CAL PRINT        No, print character
          CAL INMEM        Increment message pointer
          JMP MSG          Continue printout
```

The next group of subroutines are general purpose routines which are the type used in many programs. These subroutines perform such operations as incrementing and decrementing the memory pointer registers H and L, switching the register pairs H and L with D and E, respectively, and rotating the accumulator right. The first three subroutines are replaced in the 8080 version by the instructions of the 8080 instruction set which perform the same functions. The listings of these subroutines are presented next.

```
   INMEM,      INL              Increment low address
               RFZ              If non-zero, return
               INH              Else, increment page address
               RET

  DCMEM,       DCL
               INL              Low address = 0?
               JFZ LODCR        No, decr. low address only
               DCH              Yes, decrement page address
   LODCR,      DCL              Decrement low address
               RET

  SWITCH,      LCL              Save low address No. 1
               LLE              Move low address No. 2
               LEC              Save low address No. 1
               LCH              Save page address No. 1
               LHD              Move page address No. 2
               LDC              Save page address No. 1
               RET

   ROTR4,      RRC              Rotate accumulator right
   ROTR3,      RRC
               RRC
               RRC
               RET
```

The next subroutine is a random number generator used to provide random locations for the initial galaxy setup. It is also used in the placement of the alien ships, stars, and space stations each time a quadrant is entered by the space ship. The amount of energy an alien ship contains is also set up by calling on the random number subroutine. This random number routine provides a variation of numbers sufficient for use in the Galaxy program, and it can be applied to other programs requiring random number selection. The listing for this routine is presented next.

```
      RN,      LLI 100          Set random number pointer
               LHI 000
```

```
          LAM             The random number
          LBA             Is generated by performing
          RLC             The series of arithmetic
          XRB             Operations presented
          RRC
          INL
          LBM
          INB
          LMB
          ADB
          DCL
          LMA             Save random number
          RET
```

The Galaxy program performs a number of operations involving the conversion of numbers from binary to decimal and vice-versa for inputting and outputting numbers. The next trio of subroutines performs the conversion of double precision binary whole numbers to and from decimal, and also checks that digits entered on the keyboard fall within the range of the ASCII code for digits, namely 260 through 271. The binary-to-decimal routine converts a single or double precision binary number to its decimal equivalent up to five digits long, and stores the result in locations 140 through 144 on page 00. Register B is set to 001 for a single precision number, and 002 for a double precision number, and the memory pointer is set to the least significant byte of the number to be converted before the BINDEC subroutine is called. The decimal-to-binary subroutine, labeled DCBN, converts the decimal values stored in locations 140 through 143 on page 00 to the equivalent double precision binary number which is saved in locations 136 for the least significant half, and 137 on page 00 for the most significant half of the binary value. The listing for these subroutines is presented next.

```
BINDEC,   CAL SWITCH      Save binary pointer
          LLI 140         Set pointer to digit storage
          LHI 000
          LMH             Clear digit table
          INL
          LMH
```

```
            INL
            LMH
            INL
            LMH
            INL
            LMH
            CAL SWITCH     Set pointer to binary number
            LEM            Fetch least significant half
            DCB            Single precision?
            JTZ BNDC       Yes, most significant half = 0
            INL            No, advance pointer
            LDM            Fetch most significant half
BNDC,       LLI 144        Set pointer to 5th digit
            LHI 000
            LCI 020        Least significant half of 10000
            LBI 047        Most significant half of 10000
            CAL BD         Calculate 5th digit
            DCL            Set pointer to 4th digit
            LCI 350        Least significant half of 1000
            LBI 003        Most significant half of 1000
            CAL BD         Calculate 4th digit
            DCL            Set pointer to 3rd digit
            LCI 144        Least significant half of 100
            LBI 000        Most significant half of 100
            CAL BD         Calculate 3rd digit
            DCL            Set pointer to 2nd digit
            LCI 012        Least significant half of 10
            CAL BD         Calculate 2nd digit
            DCL            Set pointer to 1st digit
            LME            Store 1st digit
            RET            Return to calling program

BD,         LAM            Fetch decimal digit
            ADI 001        Increment and
            LMA            Save new digit
            LAE            Fetch least significant half
            SUC            Subtract least signif. constant
            LEA            Save least significant half
            LAD            Fetch most significant half
            SBB            Subtract most signif. constant
            LDA             Save most significant half
            JFC BD          If greater than 0, continue calc.
            LAE             Else, restore bin. & dec. value
            ADC             Add least significant constant
            LEA             Save least significant half
            LAD             Fetch most significant half
            ACB             Add most significant constant
            LDA             Save most significant half
            LCM             Fetch digit
            DCC             Decrement digit stored
            LMC             Save digit in table
            RET             Return

DCBN,       LLI 140         Fetch unit's digit
            LAM
            DCL             Move pointer to temp. storage
            LMH             Set temporary storage to
            DCL             Value of units digit
            LMA
            LLI 141         Fetch ten's digit
            LAM
            NDA             Is ten's digit = 0?
            JTZ DC1         Yes, do 100's digit
            LBA             Save ten's digit
            LEI 012         Set up binary value
            LDH             Of 10 in 'E' and 'D'
            CAL TOBN        Add 10 X digit
  DC1,      LLI 142         Fetch 100's digit
            LAM
            NDA             Is 100's digit = 0?
            JTZ DC2         Yes, finish
            LBA             Save 100's digit
            LEI 144         Set up binary value
            LDH             Of 100 in 'E' and 'D'
            CAL TOBN        Add 100 X digit
  DC2,      LLI 143         Fetch 1000's digit
            LAM
            NDA             Is 1000's digit = 0?
            JTZ DC3         Yes, set bn val in 'E' & 'D'
            LBA             Save 1000's digit
```

```
           LEI 350        Set up binary value of
           LDI 003        1000 in 'E' and 'D'
           CAL TOBN       Add 1000 X digit
   DC3,    LLI 136        Set pointer to binary value
           LEM            Fetch least significant half
           INL
           LDM            Fetch most significant half
           RET

  FNUM,    LAM            Fetch number
           CPI 260        Is number valid?
           RTS            No, return with 'S' flag set
           SUI 272        Yes, return with 'S' flag reset
           ADI 200
           RET
```

Setting up the sector location of the stars, alien ships, and space station within a quadrant each time the space ship enters a new quadrant is performed by use of the following group of subroutines. When a game is started, the galaxy contents are set up in the last 64 bytes of page 00. The initial quadrant location of the space ship is then set and the quadrant contents are moved from the galaxy content table to location 102 on page 00 by the QCNT subroutine. The NWQD subroutine is then called to set the location of the stars, space station and alien ships in the quadrant. NWQD begins by clearing the sector locations of the galactic objects by storing 200 in locations 104 through 116 on page 00. It then determines how many of each object is contained in the quadrant, and calls on LOCSET to set the exact sector location of each. As each location is set, it is checked against the locations of the other objects in the quadrant by the MATCH subroutine. If the new location is already assigned to another object, LOCSET selects a new location. As the final step in the NWQD subroutine, the energy in the shields of the alien ships is set to random levels from 0 to 1023 in the data table. After the game is underway, these same subroutines are called to set up the quadrant each time a new quadrant is entered. The LOAD subroutine is called at the start of the game and each time the space ship docks with the space station to restore it's energy and set the torpedo count to ten. The listings of these subroutines are presented next.

```
NWQD,    LLI 104         Set pointer to star table
         LEI 013         Set number of entries
  CLR,   LMI 200         Store terminate entry
         INL             To clear table
         DCE             Table cleared?
         JFZ CLR         No, clear more
         LLI 102         Set pointer to quad. contents
         LAM             Fetch quadrant contents
         NDI 007         Fetch number of stars
         LCA             Save in "C"
         LEI 104         Set pointer to star table
         CFZ LOCSET      Set up star locations
         LLI 102         Pointer to quadrant contents
         LAM             Fetch quadrant contents
         CAL ROTR3       Move to space station position
         NDI 001         Isolate space station entry
         LCA             Save in "C"
         LEI 113         Set pointer to space station tbl
         CFZ LOCSET      If S.S. present, set position
         LLI 102         Pointer to quadrant contents
         LAM             Fetch quadrant contents
         CAL ROTR4       Move to alien ship position
         NDI 003         Isolate alien ship entry
         LCA             Save in "C"
         LEI 114         Set pointer to alien ship table
         CFZ LOCSET      If A. ship present, set position
 LDAS,   CAL RN          Fetch ran. no. for A.S. energy
         LLI 123         Set pntr to A.S. no. 1 energy
         CAL LAS         Store A.S. number 1 energy
         LLI 125         Set pointer to alien ship no. 2
         CAL LAS         Store A.S. number 2 energy
         LLI 127         Set pointer to alien ship no. 3
         JMP LAS         Store A.S. No. 3 nrgy & RET

  LAS,   LMA             Store least significant half
         NDI 003         Form most significant half
         INL
         LMA             Store most significant half
         JMP RN          Fetch nxt ran. num. & Return
```

```
LOCSET,   CAL RN        Fetch random location
          NDI 077       Mask off most significant bits
          LBA           Save location
          CAL MATCH     New location match others?
          JTZ LOCSET    Yes, find new location
          LLE           Set pointer to storage location
          LMB           Save indicated loc. in table
          INE           Advance table pointer
          DCC           Last entry filled?
          JFZ LOCSET    No, find next location
          RET           Yes, return

 MATCH,   LLI 104       Set pointer to star table
   SCK,   LAM           Fetch first star location
          NDA           Is location stored here?
          JTS NS        No, check S.S. location
          CPB           Are locations equal?
          RTZ           Yes, return
          INL           No, increment pointer
          LAI 113       Check for end of star table
          CPL           End of star table?
          JFZ SCK       No, check next star location
    NS,   LLI 113       Set pointer to S.S. location
          LAM           Fetch S.S. location
          CPB           Locations equal?
          RTZ           Yes, return
   ACK,   INL           Advance pointer to A.S. table
          LAM           Fetch alien ship location
          CPB           Are locations equal?
          RTZ           Yes, return
          LAL           No, ck for end of A.S. table
          CPI 116       End of alien ship table?
          JFZ ACK       No, try next location
          NDA           Yes, reset 'Z' flag to 0
          RET           Return

  QCNT,   LHI 000       Set pointer to current quad.
          LLI 131       Row & column storage
          LAM           Fetch current quadrant
          ADI 300       Form pointer to galaxy
```

```
            LLA             Set up pointer
            LAM             Fetch quadrant contents
            LLI 102         Set pointer to quad. contents
            LMA             And store new contents
            RET

LOAD,       LLI 117         Space ship energy storage
            LMI 210         Least signif. half of 5000 units
            INL
            LMI 023         Most signif. half of 5000 units
            INL             Advance to shield energy
            LMH             Initial shield energy = 0
            INL
            LMH             Most signif. half of shield nrgy
            LLI 132         Set pointer to torpedo storage
            LMI 012         Initial amount = 10 torpedoes
            RET
```

The next group of subroutines are called to indicate to the operator that the game has ended due to the occurance of one of the following problems. Either the stardate time has run out (TIME), or the space ship has moved out of the known galaxy (LOST), or the space ship has smashed into a star (WPOUT), or the space ship has run out of energy (EOUT). These subroutines print an advisory message, and then jump to the beginning of the program to inquire whether the operator desires to try again. The listings for these subroutines are presented below.

```
TIME,       LLI 135         Stardate's time has run
            LHI 002         Out.  Player loses.
DONE,       CAL MSG         Print message and start
            JMP GALAXY      A new game.

LOST,       LLI 310         Moved out of known galaxy
            LHI 002         Player loses
            JMP DONE        Print message & start again

WPOUT,      LLI 215         Smashed into star
```

```
            LHI 002          Space ship destroyed
            JMP DONE         Print message & start again

EOUT,       LLI 227          Out of energy
            LHI 004          Abandon ship
            JMP DONE         Print message & start again
```

The next group of subroutines deals with setting up various messages for the output to the display device. The first subroutine, DIGPRT, fetches a digit stored in memory, forms the ASCII equivalent, and stores the ASCII code in the message to be printed. The digit storage is indicated by registers H and L beginning with the units digit and the message pointer is set up in registers D and E with register B containing a binary count of the number of digits to place in the message. The listing for this subroutine is now presented.

```
DIGPRT,     LAM              Fetch digit
            ADI 260          Form ASCII code
            CAL INMEM        Increment digit table pointer
            CAL SWITCH       Set pointer to message area
            LMA              Put digit in message
            CAL DCMEM        Move message pointer
            DCB              Last digit in message?
            RTZ              Yes, return
            CAL SWITCH       No, set pointer to digit table
            JMP DIGPRT       Move more digits
```

ROWSET is used by the short range scan routine to set up the contents of each row before it is printed. ROWSET first clears the row message by filling it with space characters. It then stores the ASCII code for the row number at the beginning of the message. The location of all of the objects contained in the quadrant is then checked to determine whether they are present in the row being prepared for output. If one or more of the objects are located in the row, the ASCII code for the symbolic representation of each is stored in the row message at the proper column location. The subroutine RWPNT is used to check for the location of each object, and to set a pointer to the column location within the row message for storage of the object's ASCII representation. When ROWSET is called, register 'C' must contain the binary value of the row number minus one. When the row message is set up, the MSG subroutine is called to print it. The listings for these two subroutines are given below.

```
ROWSET,   LLI 217        Pointer to row message
          LHI 001
  RCLR,   LMI 240        Store a space character
          INL            Advance message pointer
          LAI 247
          CPL            Message cleared?
          JFZ RCLR       No, continue clearing
          LAC            Set up row No. for message
          ADI 260
          LLI 216        Pointer to row number char.
          LMA            Store row number in message
          DCC            Set row number for check out
          LHI 000        Restore page pointer
          LLI 103        Set pointer to location table
          CAL RWPNT      Fetch space ship location
          JFZ STR        In this row? No
          LMI 274        Yes, store space ship code
          INL
          LMI 252
          INL
          LMI 276
   STR,   LLI 104        Set pointer to star table
  STR1,   LHI 000
          CAL RWPNT      Fetch star location
          JFZ NXSTR      Star here? No, try next star
          INL            Set pointer to store star
          LMI 252        Store star code
          LLE            Set pointer to star table
 NXSTR,   INL            Advance star table pointer
          LAI 113        End of table?
          CPL
          JFZ STR1       No, check next star
```

```
           LHI 000      Restore page pointer
           CAL RWPNT    Fetch S.S. location
           JFZ AS       S.S. here? No, try A.S.
           LMI 276      Store S.S. code
           INL
           LMI 261
           INL
           LMI 274
    AS,    LLI 114      Pointer to A.S. table
   AS1,    LHI 000
           CAL RWPNT    Fetch A.S. location
           JFZ NXAS     A.S. here? No, try next
           LMI 253      Yes, store A.S. code
           INL
           LMI 253
           INL
           LMI 253
           LLE          Fetch A.S. table pointer
  NXAS,    INL          Advance A.S. pointer
           LAI 117      End of table?
           CPL
           JFZ AS1      No, try next A.S. location
           LHI 001      Set up to print
           LLI 214      Short range scan line
           JMP CMSG     Print and return

RWPNT,     LAM          Fetch entry location
           NDA          Anything here?
           RTS          No, return
           CAL ROTR3    Position row value
           NDI 007      Separate row entry
           CPC          Is row equal current row?
           RFZ          No, return
           LAM          Yes, fetch column location
           NDI 007      Separate column location
           LBA          Save column
           RLC          Multiply by two
           ADB          Form pointer to row message
           ADI 217
           LEL          Save table pointer
           LLA              Set pointer to row message
           LHI 001
           XRA              Set Zero flag
           NDA
           RET              Return with 'Z' flag set
```

The subroutine labeled QUAD is used to place the row and column location of the current quadrant into the QUADRANT R,C message. The quadrant message is used in the short range scan and in the heading for the long range scan. It fetches the quadrant location from the data table and stores the ASCII code for the row and column numbers in the message. It then calls MSG to print it. The subroutine TWO is called to separate the row and column numbers and store them in the proper locations in the message. TWO is also used to place the row and column location of the current sector in the SECTOR R,C message, which is part of the short range scan routine. The listings for QUAD and TWO are presented next.

```
QUAD,      LLI 131          Pointer to quadrant location
           LHI 000
           LEI 324          Pointer to quadrant message
           LDI 001
           CAL TWO          Put two digits in message
           LLI 311          Pointer to quadrant message
           JMP MSG          Print quadrant message

 TWO,      LAM              Fetch row and column
           LBA              Save row and column
           CAL SWITCH       Set pointer to message
  T1,      CAL ROTR3        Position row number
           NDI 007          Mask off other bits
           ADI 261          Form ASCII digit
           LMA              Save ASCII code in message
           LAB              Fetch column number
           NDI 007          Separate column number
           ADI 261          Form ASCII digit
           CAL INMEM        Advance message pointer
```

```
            CAL INMEM
            LMA               Store digit in message
            RET               Return
```

The final three subroutines of this group are used in the preparation and output of the long range scan and the galaxy display. The NTN subroutine prints the dividing line between rows for each of the printouts mentioned. It first outputs a carriage return/line feed combination, and then prints as many hyphens as are defined in register H. QDSET takes the quadrant contents stored in register 'C' and forms the ASCII code for the digits indicating the number of alien ships, space stations, and stars in the quadrant, and stores them in the message indicated by the memory pointer registers H and L. QDSET is called by the galaxy display routine and LRR. LRR is a subroutine of the long range scan routine that sets up each row of the scan for printout. The quadrant location in the center of the long range row being prepared is contained in the accumulator when LRR is called. If the left hand quadrant is outside the galaxy, it is set up to be printed as all zeroes. When the long range row is completed, the MSG routine is called to output the row to the display device. The listing for these subroutines is presented below.

```
    NTN,    LHI 023           Set counter to 19 dashes
    NT1,    LAI 215           Print carriage return
            CAL PRINT
            LAI 212           Print line feed
            CAL PRINT
    NT2,    LAI 255           ASCII code for dash
            CAL PRINT         Print " - "
            DCH               Decrement counter =0?
            JFZ NT2           No, print more dashes
            RET

   QDS1,    LHI 004           Set message pointer
  QDSET,    LCA               Save quadrant contents
            CAL ROTR4         Position alien ship number
            NDI 003           Mask alien ship number
            ORI 260           Form ASCII digit
```

```
        LMA             Store in message
        CAL INMEM       Increment message pointer
        LAC             Fetch quadrant contents
        CAL ROTR3       Position space ship number
        NDI 001         Mask space ship number
        ORI 260         Form ASCII digit
        LMA             Store space ship in message
        CAL INMEM       Increment message pointer
        LAC             Fetch quadrant contents
        NDI 007         Mask star number
        ORI 260         Form ASCII digit
        LMA             Store in message
        RET

CLC1,   XRA             Clear column contents
        JMP LR3         Print 000 quadrant

CLC2,   XRA             Clear column contents
        JMP LR4         Print 000 quadrant

 LRR,   ADI 300         Set pointer to galaxy
        LBA             Save pointer
        NDI 007         First column?
        JTZ CLC1        Yes, first column zero
        LAB             Fetch galaxy pointer
        SUI 001         No, back up one column
        LLA             Pointer to quadrant in galaxy
        LAM             Fetch quadrant contents
 LR3,   LLI 311         Set pointer to left quadrant
        CAL QDS1        Set quadrant contents
        LLB             Pointer to quadrant in galaxy
        LHI 000
        LAM             Fetch quadrant contents
        LLI 317         Pointer to middle quadrant
        CAL QDS1        Set quadrant contents
        LAB             Fetch quadrant location
        NDI 007         Is quadrant in last column?
        CPI 007
        JTZ CLC2        Yes, right column zero
        LAB             No, fetch quadrant location
```

```
            ADI 001          Set location to right quadrant
            LLA              Set pointer to right quadrant
            LHI 000
            LAM              Fetch quadrant contents
LR4,        LLI 325          Pointer to right quadrant
            CAL QDS1         Set quadrant contents
LRP,        LLI 305          Set pntr. to L.R. row message
            LHI 004
            JMP MSG          Print L.R. scan row and return
```

The depletion of energy from the space ship's main storage bank and its shields is an important function in this program. The following group of subroutines is called to delete the energy from the ship, and to check the energy level of the ship. The subroutine labeled ELOS deletes the amount of energy contained in registers D and E, which indicate the most and least significant halves of a double precision value, respectively, from the ship's protective shields. The amount of energy deleted is first output to the display device to inform the operator of the loss. The shield energy level is checked, and if sufficient, the energy is removed from the shield. If the level is not high enough to absorb the loss, the remaining shield energy is transferred to the main supply and the loss is taken from the main storage bank. If at this time the main supply is not enough, the ship is out of energy, and the game is over. Otherwise, since the shield energy is zero, the warning message is output and an additional 25 percent of the energy loss is depleted from the main supply as a penalty. The listing of ELOS and its supporting subroutines is shown next.

```
ELOS,       LLI 062          Pointer to temporary storage
            LME              Put energy amount in
            INL              Temporary storage
            LMD
            DCL              Pointer to energy loss
            LBI 002          Number of bytes for BINDEC
            CAL BINDEC       Convert energy amount
            LDI 003          Set pointer to energy message
            LEI 023
            LBI 004       Counter to number of digits
            CAL DIGPRT    Put digits in message
            LLI 377       Set pointer to energy loss msg
            LHI 002
            CAL CMSG      Print loss message
            LLI 062       Put energy amount back to
            LEM           Allow the energy to be
            INL           Removed from the shields
            LDM
   ELS1,    CAL CKSD      Is shield energy sufficient?
            JFC FMSD      Yes, delete from shield & RET
            LEM           No, move shield energy to
            INL           Main supply
            LDM
            CAL FMSD      Set shield energy to 0
            CAL TOMN
            LLI 062       Then fetch energy loss
            LEM           From temporary storage
            INL
            LDM
    SD0,    CAL CKMN      Enough energy?
            JTC EOUT      No, ship out of energy
            CAL FMMN      Yes, take from main
            LLI 025       Print warning
            LHI 003       'Danger - Shield Energy 000'
            CAL CMSG
            LBI 002       Divide energy loss by 4
            CAL DVD
            CAL CKMN      Delete from main as a
            JTC EOUT      Penalty for no energy
            JMP FMMN      In shields

   CKSD,    LLI 122       Check shield energy level
            JMP CK1       Against requested level

   CKMN,    LLI 120       Set pointer to main energy
    CK1,    LAM           Fetch most significant half
            DCL           Set pointer to least signif. half
            CPD           Is most significant half = 0?
            RFZ           No, return with flags set up
```

```
  CK2,    LAM         If greater than or =, ret. with
          CPE         'C' flag reset, if less than
          RET         Return with 'C' flag set

 FMSD,    LLI 121     Set pointer to shield energy
          JMP FM1     Subtr. 'E' & 'D' fm. shld ener.

 FMMN,    LLI 117     Set pointer to main energy
  FM1,    LAM         Fetch least significant half
          SUE         Subtract 'E'
          LMA         Save new least significant half
          INL         Advance pntr. to most signif.
          LAM         Fetch most significant half
          SBD         Subtract 'D' with carry
          LMA         Save new most significant half
          RET

 TOSD,    LLI 121     Set pointer to shield energy
          JMP TO1     Add 'E' & 'D' to shield

 TOMN,    LLI 117     Set pointer to main energy
  TO1,    LAM         Fetch least significant half
          ADE         Add 'E'
          LMA         Save new least significant half
          INL         Advance pntr. to most signif.
          LAM         Fetch most significant half
          ACD         Add 'D' with carry
          LMA         Save new most significant half
          RET

  DVD,    NDA         Divide the double
          LAD         Precision value
          RAR         By two by the number
          LDA         Of times indicated
          LAE         In 'B'
          RAR
          LEA
          DCB         Finished divide?
          JFZ DVD     No, continue
          RET         Yes, return
```

```
TOBN,      LLI 136         Pointer to binary storage
           CAL TO1         Add value in 'E' and 'D'
           DCB             Multiplier = 0?
           RTZ             Yes, return
           JMP TOBN        No, add again
```

The removal of energy from the main supply for the execution of commands, firing phasors and torpedoes, and moving through the galaxy, is provided by the ELOM subroutine. The amount of energy to be removed is stored in registers D and E (as described in the ELOS subroutine) when the ELOM subroutine is called. If the main energy bank contains enough energy, the energy is deleted and the subroutine returns to the calling program. If there is not enough energy, the shield energy is transferred to the main storage bank in an effort to provide for the loss. If this does not provide sufficient energy, the game is over. However, if the transfer does produce the energy needed in the main supply, the energy will be removed, and since the shield energy has been reduced to zero, an additional 25 percent of the energy loss will be deleted from the main supply as a penalty. The listing for ELOM is presented next.

```
ELOM,      CAL CKMN        Enough energy in main?
           JFC FMMN        Yes, take from main and return
           LCE             No, save energy loss
           LBD
           LLI 121         Fetch shield energy
           LEM
           INL
           LDM
           CAL FMSD        Remove all shield energy
           CAL TOMN        And put in main supply
           LEC             Restore energy loss
           LDB
           JMP SD0         Take energy from main
```

The amount of energy transferred to or from the shields and the energy to be fired by the phasor is entered by the operator. The EIN subroutine is called to input these energy values. The first entry is checked to determine whether it is a minus sign, used in the shield entry. Location 144 on page 00 will be all zeros if the value is to be positive, and non-zero for a negative entry. Each digit entered is checked for validity and then the ASCII code is masked off, resulting in the binary digits being stored in locations 143 through 140. The units digit is stored in location 140. Four digits must be entered by the operator when this routine is called. If the input is found to be invalid, the routine returns with the SIGN flag set to '1.' If the input is valid, the SIGN flag is reset upon returning to the calling program. The listing for this routine is presented below.

```
EIN,    LHI 000       Set pointer to sign indicator
        LLI 144
        LMH           Clear sign indicator
        LLI 143       Set pointer to input table
        CAL INPUT     Input 1st character
        CPI 255       Negative sign?
        JFZ EN2       No, check digit
        INL           Yes, advance pntr to sign ind.
        LML           Set sign indicator to non-zero
        DCL           Reset table pointer
EN1,    CAL INPUT     Input digit
EN2,    LMA           Save digit in table
        CAL FNUM      Valid digit?
        RTS           No, return with S flag set
        LAM           Yes, fetch digit
        NDI 017       Mask off ASCII code
        LMA           Save binary value
        DCL           Move table pointer
        LAI 137       Is the table pointer
        CPL           Indicating table full?
        RTZ           Yes, return with S flag reset
        JMP EN1       No, input more digits
```

When the space ship destroys an alien ship or space station, the result is the elimination of the alien ship or space station from the galaxy. The subroutine DLET is called to perform this function.

First, the sector location of the object is cleared by storing a 200 in the data table at the location indicated by registers H and L. From this location, the identity of the object to be deleted is ascertained. A pointer is then formed indicating the location of the quadrant in the galaxy content table from which the object is to be removed. If the object was a space station, it is removed from the galaxy and the number of space stations is decremented. If this value goes to zero, a warning message is output to inform the operator that the last space station has been destroyed. If an alien ship is destroyed, it is removed from the galaxy and its count is decremented. When the number of alien ships reaches zero, the game is over and the operator has successfully completed the mission. The listing of DLET is shown below

```
DLET,     LMI 200        Remove from quadrant table
          LBL            Save table pointer
          LLI 131        Fetch current quad. location
          LAM
          ADI 300        Form pntr. to galaxy location
          LLA            Set galaxy pointer
          LAB            Fetch table pointer
          CPI 113        Space station hit?
          JFZ DLAS       No, delete alien ship
          LAM            Fetch location in galaxy
          NDI 067        Delete space station
          LMA            Restore in galaxy
          LLI 102        Set pntr. to quad. contents
          LMA            Save new contents
          LLI 133        Set pointer to number of S.S.
          LBM            Fetch number space stations
          DCB            Decrement number of S.S.
          LMB
          RFZ            If number not 0, return
          LLI 333        If number of space stations=0,
          LHI 004        Print warning message
CMSG,     CAL MSG
          LHI 000        Reset pointer to page 000
          RET

DLAS,     LAM            Fetch location in galaxy
```

```
SUI 020         Delete 1 alien ship from quad.
LMA             Restore in galaxy
LLI 102         Fetch current quad. contents
LMA             Save new contents
LLI 134
LBM             Fetch number of A.S. counter
DCB             Subtract 1 from number
LMB             Save new alien ship counter
RFZ             If counter not = 0, return
LLI 324         If counter = 0, game over
LHI 003         Print CONGRATULATIONS!
JMP DONE        And start again
```

The short routine of DLET, which begins at the label CMSG, is used by many other routines to call the MSG subroutine. Since most subroutine messages reside on pages other than zero, it is often required to reset register H to zero upon returning from the MSG subroutine. To save memory space and provide a common means of resetting register H, this short routine has been set up.

The final group of subroutines to be presented deals with the movement of the space ship through the galaxy, and the tracking of the torpedo within the quadrant. Moving an object through the galaxy is performed with the use of a table referred to as the COURSE TABLE. The course table, presented on the following page, is located at the beginning of page 00, and contains 16 pairs of row and column displacement values. There is one pair of displacement values for each possible direction of movement. The first value of each pair is the column displacement and the second value is the row displacement. The entries in the course table are made up of the binary values 2, 1, 0, -1, and -2. A displacement of 1 advances the object one half of a sector for each sector move made. So, for example, if the course was chosen as 8.5, the displacement value for the column is two, and for the row is one. This means that for every column moved to the right, the object would move one half of a row down. A move is made by the program by separating the row and column location of the object to be moved, rotating each to the left once, and using the adjusted values to calculate the move. Then for each sector move made, the row and column displacement is added to the adjusted row and column location. When the move is completed, the adjusted values are rotated to the right once, and then combined to give a new sector location to the object. By using this method it is possible for the direction of travel to be broken down to every 22½ degrees.

DISPLACEMENT	COURSE
VALUES	SELECTED
002	1.0
000	
002	1.5
377	
002	2.0
376	
001	2.5
376	
000	3.0
376	
377	3.5
376	
376	4.0
376	
376	4.5
377	
376	5.0
000	
376	5.5
001	
376	6.0
002	
377	6.5
002	
000	7.0
002	
001	7.5
002	
002	8.0
002	
002	8.5
001	

The subroutine DRCT is called to input the course direction from the operator through the input device. The two digits defining the move are checked for validity when entered, and then used to form a pointer to the course table. If the input is valid, the routine returns with the ZERO flag reset and the pointer stored in location 136 on page 00. If invalid, the ZERO flag is set before returning. The ACTV subroutine is then called to fetch the displacement values from the course table, and store the column displacement in register C and the row displacement in register D. It then sets up the adjusted row and column values and stores them in locations 136 and 137 respectively.

The subroutine labeled TRK is called to make the individual sector moves. First, location 60 on page 00 is cleared to be used as a quadrant crossing flag. The column displacement is then added to the adjusted column location, and a quadrant crossing to the left or right is checked. If the crossing did occur, the crossing flag is set and the adjusted column is corrected to indicate the new column value. The crossing is then checked for a move out of the galaxy, which would be indicated by the TRK subroutine returning with the ZERO flag set. If the move is not out of the galaxy, the new quadrant location is stored at location 131 on page 00. The row displacement is then added to the adjusted row location, and a quadrant crossing up and down is checked. If a quadrant is crossed, the crossing flag is set and a move out of the galaxy is checked. If the crossing is out of the galaxy, the routine returns with the ZERO flag set. Otherwise, the new quadrant location is stored at location 131 and the routine returns with the ZERO flag reset. The final subroutine of this group is called RWCM, and is called to restore the adjusted row and column locations to the single byte used to define the final location of the object moved. The listings for these subroutines are presented next.

```
DRCT,     CAL INPUT      Input first course number
          LLI 136        Pointer to temporary storage
          LHI 000
          CPI 261        Is input less than 1?
          JTC ZRET       Yes, illegal input
          CPI 271        Is input greater than 8?
          JFC ZRET       Yes, illegal input
          NDI 017        No, mask off ASCII code
          RLC               If good, times 2
          LMA               And save in temporary storage
          LAI 256           Print a decimal point
          CAL PRINT
          CAL INPUT         Input 2nd course number
          CPI 260           Is digit = 0?
          JTZ CR1           Yes, continue process
          CPI 265           No, is digit = 5?
          JFZ ZRET          No, return with Z flag set
   CR1,   NDI 001           Mask all but least signif. bit
          ADM               Add 1st number input
          RLC               And form pointer to course
          SUI 004           Table
          LMA               Save pointer in temp. storage
          RFZ               Return with Z flag reset
          ADI 001           If not reset, reset it
          RET

  ZRET,   XRA               Set Z flag
          RET               And return

  ACTV,   LLI 136           Fetch course pointer
          LLM
          LCM               Fetch column movement
          INL               Advance pointer
          LDM               Fetch row movement
          LLI 103           Pointer to current sector
          LAM               Fetch current sector
          LBA               Save in 'B'
          NDI 007           Mask off row
          LLI 136           Pointer to temporary storage
          RLC               Multiply times 2
          LMA               Save adjusted column
          INL               Advance storage pointer
          LAB               Fetch current sector
          NDI 070           Mask off column
          RRC               Set up times 2 value
          RRC
          LMA               Save adjusted row
          RET
```

```
TRK,    LLI 060      Set pointer to crossing flag
        LMH          Clear quadrant crossing flag
        LLI 136
        LAM          Fetch adjusted column
        ADC          Add column move
        LMA          Temp. save current column
        JFS NOBK     If not left crossing, jump
        NDI 017      Left crossing, correct and
        LMA          Save new adjusted column
        LLI 060      Indicate left crossing in
        LML          Crossing flag by non-zero
        LLI 131      And decrement current quad.
        LAM          Column entry
        NDI 007      Is current quad. column = 0?
        RTZ          Yes, return with Z flag set
        LBM          No, fetch current quadrant
        DCB          Decrement current quad. clmn
        LMB          Restore current quadrant
        JMP RMV      Do row move

NOBK,   CPI 020      Quadrant crossing right?
        JTC RMV      No, do row move
        NDI 017      Yes, correct and
        LMA          Save new adjusted column
        LLI 060      Indicate right crossing in
        LML          Crossing flag by non-zero
        LLI 131      Then incr. current quad. clmn
        LAM
        NDI 007      Separate column entry
        ADI 001      Increment column entry
        CPI 010      Move out of galaxy?
        RTZ          Yes, return with Z flag set
        LBM          No, the increment quad. clmn
        INB
        LMB

RMV,    LLI 137
        LAM          Fetch adjusted row
        ADD          Add row move
        LMA          Save new adjusted row
```

```
            JFS NOUP      If not up, jump
            NDI 017       Move up 1 quadrant, correct
            LMA           And save new adjusted row
            LLI 060       Then indicate crossing in
            LML           Crossing flag by non-zero
            LLI 131       And decrement quadrant row
            LAM           Fetch current quadrant entry
            NDI 070       Is quadrant row = 0?
            RTZ           Yes, return with Z flag set
            LAM           No, decr. current quad. row
            SUI 010
            LMA           Save new current quadrant
            JMP CKX       The perform crossing logic

NOUP,       CPI 020       Quadrant crossing down?
            JTC CKX       No, check for crossing flag
            NDI 017       Yes, correct and
            LMA           Save new adjusted row
            LLI 060       Then indicate down crossing
            LML           In crossing flag by non-zero
            LLI 131       Then incr. current quad. row
            LAM
            NDI 070       Separate row entry
            ADI 010       Increment row entry
            CPI 100       Move out of galaxy?
            RTZ           Yes, return with Z flag set
            LAM           No, then incr. crnt. quad. row
            ADI 010
            LMA           Save new current quadrant

CKX,        LLI 050       Set pointer to register storage
            LME           Save registers 'E' 'D' and 'C'
            INL
            LMD
            INL
            LMC
            RFZ           Return with Z flag reset
            LAI 001       If not reset
            NDA           Reset it and return
            RET
```

```
RWCM,      LLI 136          Pointer to adjusted column
           LAM              Fetch adjusted column
           RRC              Adjust position
           NDI 007          Form column value
           LBA              Save column
           INL              Advance pointer
           LAM              Fetch adjusted row
           RLC              Position row value
           RLC
           NDI 070          Form row value
           ADB              Form row and column byte
           LBA              Save in 'B'
           RET              Return
```

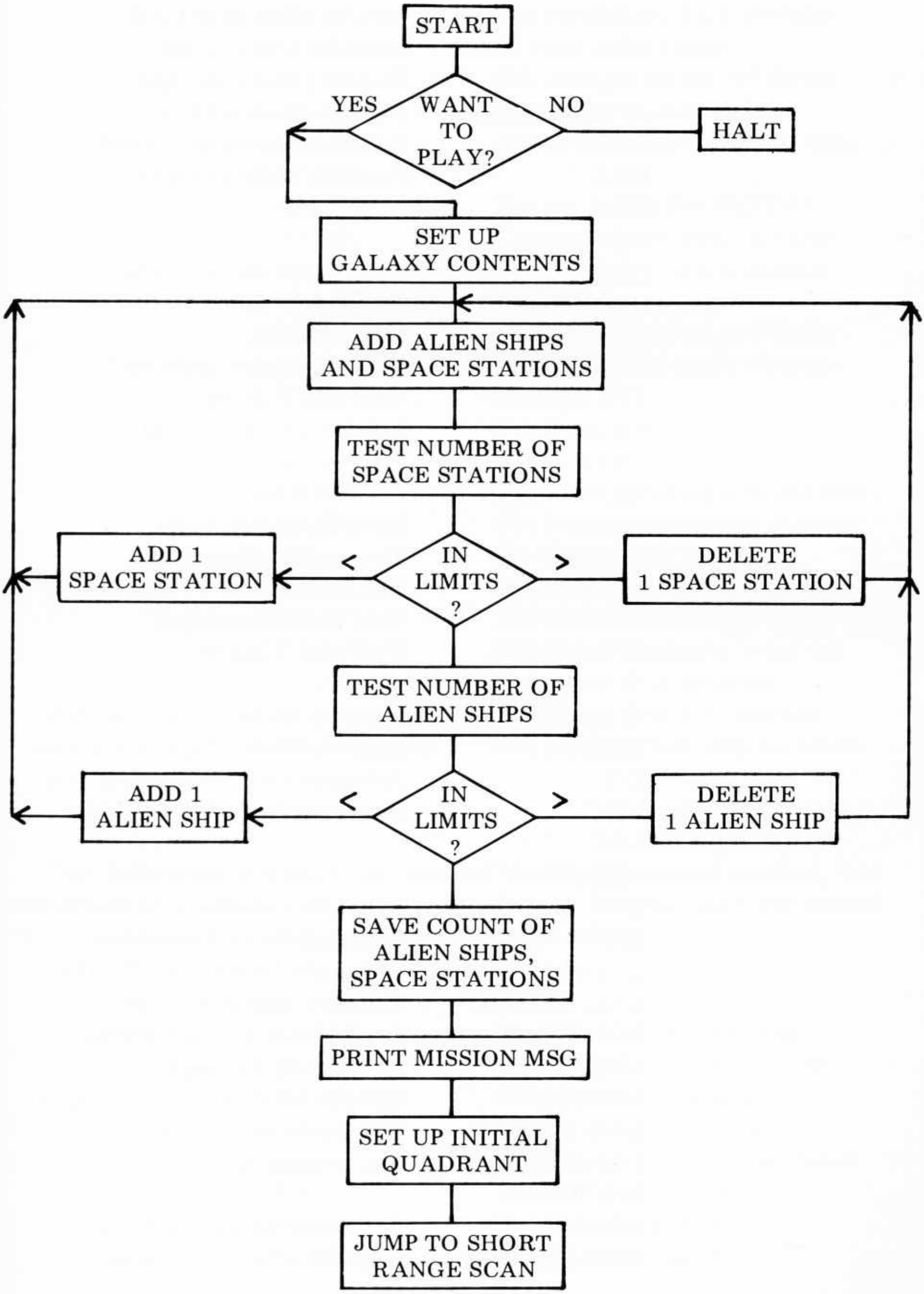
MAJOR ROUTINES OF THE GALAXY PROGRAM

The main portion of the Galaxy program consists of nine major functional routines. The first of these routines provides the initial galaxy setup. The contents of each quadrant are randomly selected from the galaxy setup table which consists of many possible quadrant content arrangements. The selected quadrant arrangements are then stored in the galaxy content table. This random selection provides a different game for the operator each time GALAXY is played.

This routine, labeled GALAXY, is the starting point of the entire program. It begins by posing the question, "DO YOU WANT TO GO ON A SPACE VOYAGE?" While waiting for the response from the operator, the program goes into a loop which advances the random number generator and then checks the input status for a character available. The program remains in this loop until the INPCK routine returns with the SIGN flag set to '1.' The character is then read in from the input device. If the response is "N," the program outputs the message "CHICKEN!" and halts. For any other input, the program will proceed to form the galaxy contents to be used for this game.

With the use of the random number generator, various locations in the galaxy setup table are selected and stored in the galaxy content table. When the galaxy content table is filled, the number of alien ships and space stations in the newly formed galaxy is calculated. If the count is not within the limits desired, the contents of the galaxy are revised until the proper limits are met. The number of alien ships must be between 10 and 31, and the number of space stations must be between 2 and 6. These limits may be revised by the reader by simply changing the binary values in the compare instructions which set the limits. Once the galaxy is completed, the values indicating the number of space stations and alien ships are stored in the data table. The number of stardates is then set to a value of five greater than the number of alien ships, and is also stored in the data table. The message stating the mission assigned for this game is then prepared by storing the ASCII code for the number of alien ships, stardates, and space stations in the body of the message, and calling the MSG subroutine to output it. This routine finishes by selecting the starting quadrant, loading the initial energy and torpedoes for the space ship, setting up the locations of the quadrant contents, and setting the start location of the space ship within the quadrant. The flow chart and program listing of this routine is presented next.

```
  GALAXY,    LLI 000
             LHI 001
             CAL MSG        Print introduction
   START,    CAL RN         Increment random number
             CAL INPCK      Input yet?
             JFS START      No, continue wait
             CAL INPUT      Input character
             CPI 316        No, stop game?
             JTZ OVER       Yes, vanish from galaxy
             LEI 300        Set pointer to galaxy storage
  GLXSET,    CAL RN         Fetch random number
             NDI 177
             LLA
             LHI 017        Set pointer to galaxy table
             LAM            Fetch galaxy entry
             LLE
             LHI 000        Set pntr. to galaxy content tbl
             LMA            Store quadrant contents
             INE            Galaxy storage complete?
             JFZ GLXSET     No, fetch more sectors

   GLXCK,    LDH            Space station count = 0
             LCH            Alien ship count = 0
             LLI 300        Set pntr. to galaxy content tbl
  GLXCK1,    LAM            Fetch quadrant contents
             NDI 010        Mask space station
             ADD            Add to space station total
             LDA            Save space station total
             LAM            Fetch quadrant contents
             NDI 060        Mask alien ship
             RRC
             RRC
```


START
YES
WANT TO PLAY?
NO
HALT
SET UP GALAXY CONTENTS
ADD ALIEN SHIPS AND SPACE STATIONS
TEST NUMBER OF SPACE STATIONS
ADD 1 SPACE STATION
<
IN LIMITS ?
>
DELETE 1 SPACE STATION
TEST NUMBER OF ALIEN SHIPS
ADD 1 ALIEN SHIP
<
IN LIMITS ?
>
DELETE 1 ALIEN SHIP
SAVE COUNT OF ALIEN SHIPS, SPACE STATIONS
PRINT MISSION MSG
SET UP INITIAL QUADRANT
JUMP TO SHORT RANGE SCAN

```
ADC             Add to alien ship total
LCA             Save alien ship total
INL             End of galaxy storage?
JFZ GLXCK1      No, continue adding
LAD             Fetch space station total
RRC             Position total to right
RRC
RRC
LDA             Save space station total
CPI 007         Too many space stations?
JFC SSPLS       Yes, delete 1
CPI 002         Too few space stations?
JTC SSMNS       Yes, add 1 more
LAC             Fetch alien ship total
RRC
RRC
LCA             Save alien ship total
CPI 040         Too many alien ships?
JFC ASPLS       Yes, delete 1
CPI 012         Too few alien ships?
JTC ASMNS       Yes, add 1 more

LLI 133         Set pntr to store number S.S.
LMD             Save number of space stations
INL             Advance pntr to number A.S.
LMC             Save number of alien ships
LAC
ADI 005
INL             Adv. pntr to nmbr of stardates
LMA             Save number of stardates
LBI 001         Set nmbr bytes for BINDEC
CAL BINDEC      Convert stardate value
LDI 001         Set pointer to digit storage
LEI 116         In starting message
LBI 002         Set counter to nmbr of digits
CAL DIGPRT      Put digits in message
LLI 134         Set pointer to number A.S.
LHI 000
LBI 001         Set nmbr bytes for BINDEC
CAL BINDEC      Convert alien ship value
```

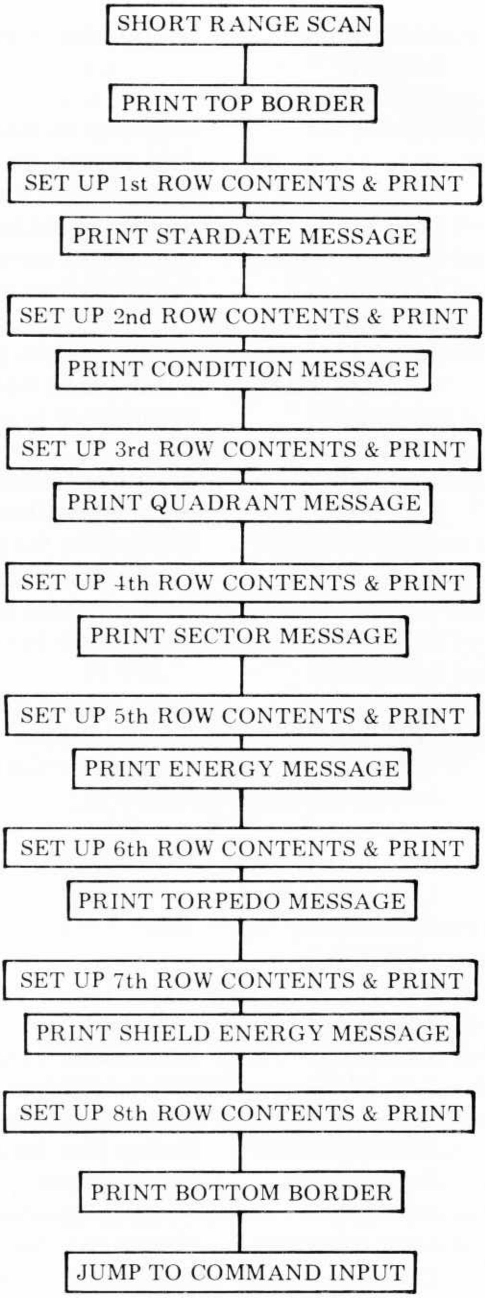
```
            LDI 001          Set pointer to digit storage
            LEI 074          In starting message
            LBI 002          Set counter to no. of digits
            CAL DIGPRT       Put digits in message
            LLI 133          Set pointer to no. space stat.
            LHI 000
            LAM              Set no. bytes for BINDEC
            ORI 260          Convert space station value
            LHI 001          Set pointer to digit storage
            LLI 137          In starting message
            LMA              Set counter to no. of digits
            LLI 050          Set pointer to start message
            LHI 001
            CAL MSG          Print starting message
            CAL RN           Fetch start quadrant
            NDI 077          Mask off most significant bits
            LLI 131          Set pntr. to quadrant storage
            LMA              Save quadrant location
            CAL QCNT         Fetch current quad. contents
            CAL LOAD         Set initial conditions
            CAL NWQD         Set quad. contents location
            LCI 001          Set space ship counter
            LEI 103          Set space ship loc. storage
            CAL LOCSET       Set initial space ship location
```

The following routines are part of the Galaxy setup routine, but do not follow directly after the above listing. Instead, they are stored in the same portion of memory as the subroutines.

```
   ASPLS,   LEI 317          Mask to delete alien ship
     PLS,   CAL RN           Fetch random low address
            ORI 300          Set to point to galaxy
            LLA              Set up galaxy pointer
            LAE              Load mask into accumulator
            NDM              Delete from galaxy
            LMA              Put back in galaxy
            JMP GLXCK        Check galaxy again
   SSPLS,     LEI 367          Mask to delete space station
              JMP PLS          Delete excess space station

  ASMNS,      LEI 020          Mask to add alien ship
    MNS,      CAL RN           Fetch random low address
              ORI 300          Set to point to galaxy
              LLA              Set up galaxy pointer
              LAE              Load mask into accumulator
              ORM              Add to galaxy
              LMA              Put back in galaxy
              JMP GLXCK        Check galaxy again

   SSMNS,     LEI 010          Mask to add space station
              JMP MNS          Add a space station

    OVER,     LLI 342
              LHI 004          Print "CHICKEN"
              CAL MSG
              HLT              Halt
```

The next routine, which immediately follows the galaxy setup routine, is the short range scan. The location of each of the objects contained in the current quadrant is displayed as illustrated in the sample short range scan in Chapter One. By the use of the ROWSET, BINDEC, DIGPRT, and MSG subroutines, each line of the scan is prepared and output to the display device. This routine is entered following the galaxy setup to display the initial quadrant; then after each move by the space ship either within the quadrant or when a new quadrant is entered, and in response to a command to display a short range scan. The flow chart and listing for this routine, which begins at the label SRSCN, is presented next.

```
   SRSCN,     LLI 160          Set pntr. for short range scan
              LHI 001
              CAL MSG          Print initial row
              LCI 001          Set row number
              CAL ROWSET       Set up row for printout
```


SHORT RANGE SCAN
PRINT TOP BORDER
SET UP 1st ROW CONTENTS & PRINT
PRINT STARDATE MESSAGE
SET UP 2nd ROW CONTENTS & PRINT
PRINT CONDITION MESSAGE
SET UP 3rd ROW CONTENTS & PRINT
PRINT QUADRANT MESSAGE
SET UP 4th ROW CONTENTS & PRINT
PRINT SECTOR MESSAGE
SET UP 5th ROW CONTENTS & PRINT
PRINT ENERGY MESSAGE
SET UP 6th ROW CONTENTS & PRINT
PRINT TORPEDO MESSAGE
SET UP 7th ROW CONTENTS & PRINT
PRINT SHIELD ENERGY MESSAGE
SET UP 8th ROW CONTENTS & PRINT
PRINT BOTTOM BORDER
JUMP TO COMMAND INPUT

```
          LLI 135          Set pointer to stardate
          LHI 000
          LAI 062
          SUM              Calculate number used
          INL              Adv pntr to temporary storage
          LMA              Save number used
          LBI 001          Set no. bytes for BINDEC
          CAL BINDEC       Convert to current stardate
          LDI 001          Set pointer to stardage msg.
          LEI 266
          LBI 002          Set counter to no. of digits
          CAL DIGPRT       Put digits in stardate message
          LLI 250          Set pointer to message
          LHI 001
          CAL MSG          Print stardate message
          LCI 002          Set row number 2
          CAL ROWSET       Set up row for printout
          LLI 102          Set pntr to current quadrant
          LAM              Fetch current contents
          LLI 303          Set pointer to condition msg
          LHI 001
          NDI 060          Alien ship in quadrant?
          JFZ RED          Yes, condition "RED"
          LMI 307          Condition "GREEN"
          INL
          LMI 322
          INL
          LMI 305
          INL
          LMI 305
          INL
          LMI 316
CND,      LLI 270          Set pointer to condition msg
          CAL MSG          Print condition message
          LCI 003          Set row number 3
          CAL ROWSET       Set up row for printout
          CAL QUAD         Print current quadrant
          LCI 004          Set row number 4
          CAL ROWSET       Set up row for printout
          LLI 103          Pointer to current sector
```

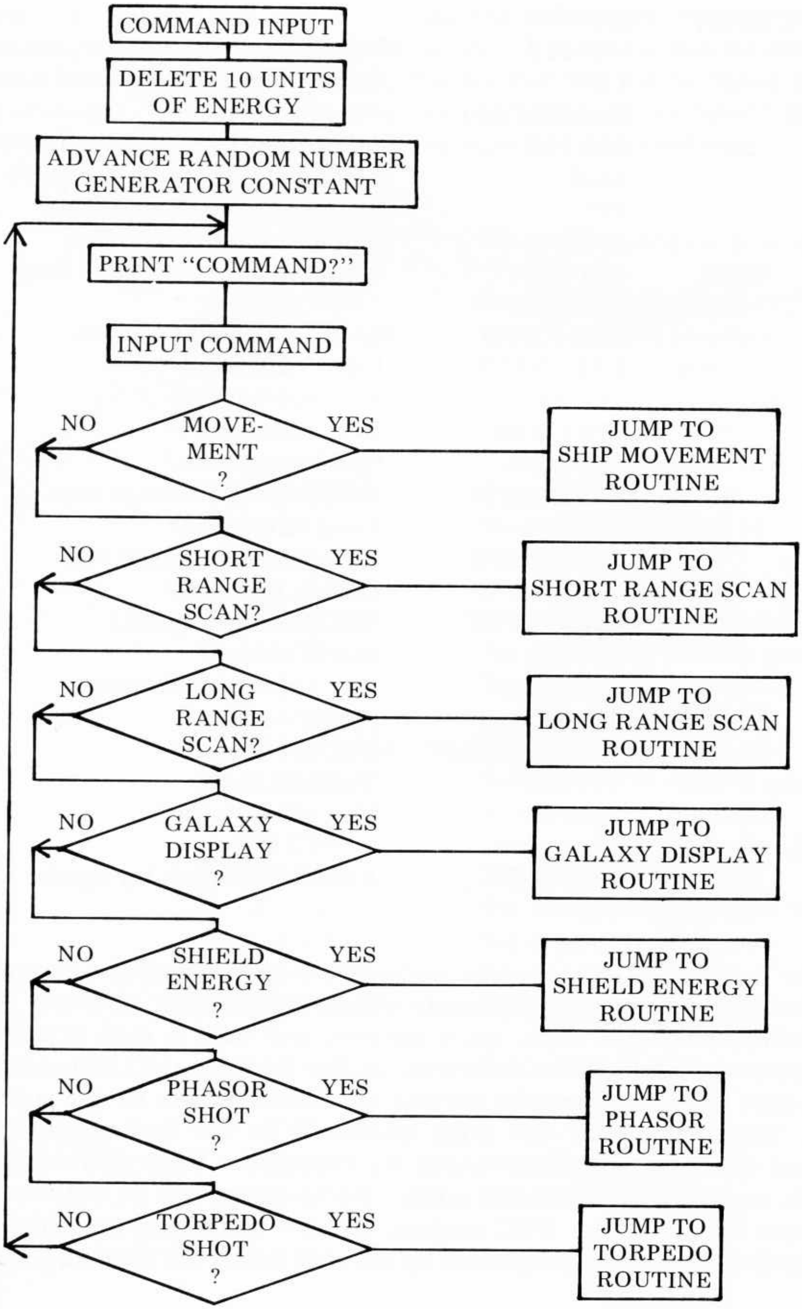
```
LEI 343         Set digit code storage
IND
CAL TWO         Put two digits in message
LLI 330         Set pointer to sector message
CAL MSG         Print sector message
LCI 005         Set row number 5
CAL ROWSET      Set up row for printout
LLI 117         Set pointer to energy storage
LBI 002         Number of bytes for BINDEC
CAL BINDEC      Convert to energy stored
LDI 001         Set pointer to energy message
LEI 365
LBI 004         Set counter to no. of digits
CAL DIGPRT      Put digits in message
LLI 347         Set pointer to energy message
LHI 001
CAL MSG         Print current energy message
LCI 006         Set row number 6
CAL ROWSET      Set up row for printout
LLI 132         Set pointer to no. torpedoes
LBI 001         Number of bytes for BINDEC
CAL BINDEC      Convert number of torpedoes
LDI 002         Set pointer to torpedo msg
LEI 003
LBI 002         Set counter to no. of digits
CAL DIGPRT      Put no. torpedoes in message
LLI 367         Set pointer to torpedo msg
LHI 001
CAL MSG         Print torpedo message
LCI 007         Set row number 7
CAL ROWSET      Set up row for printout
LLI 121         Set pointer to shield energy
LBI 002         Number of bytes for BINDEC
CAL BINDEC      Convert shield energy
LDI 002         Set pointer to shield message
LEI 023
LBI 004         Set counter for no. of digits
CAL DIGPRT      Put shield energy in message
LLI 005         Set pointer to shield message
LHI 002
```

```
          CAL MSG         Print shield message
          LCI 010         Set row number 8
          CAL ROWSET      Set up row for printout
          LLI 160         Set pointer to final row
          LHI 001
          CAL MSG         Print final row of S.R. scan
```

This next portion of the short range scan routine is stored with the subroutines in memory, since it does not fall in the direct sequence of the program.

```
RED,      LMI 322         Condition "RED"
          INL
          LMI 305
          INL
          LMI 304
          INL
          LMI 000
          JMP CND         Return to short range scan
```

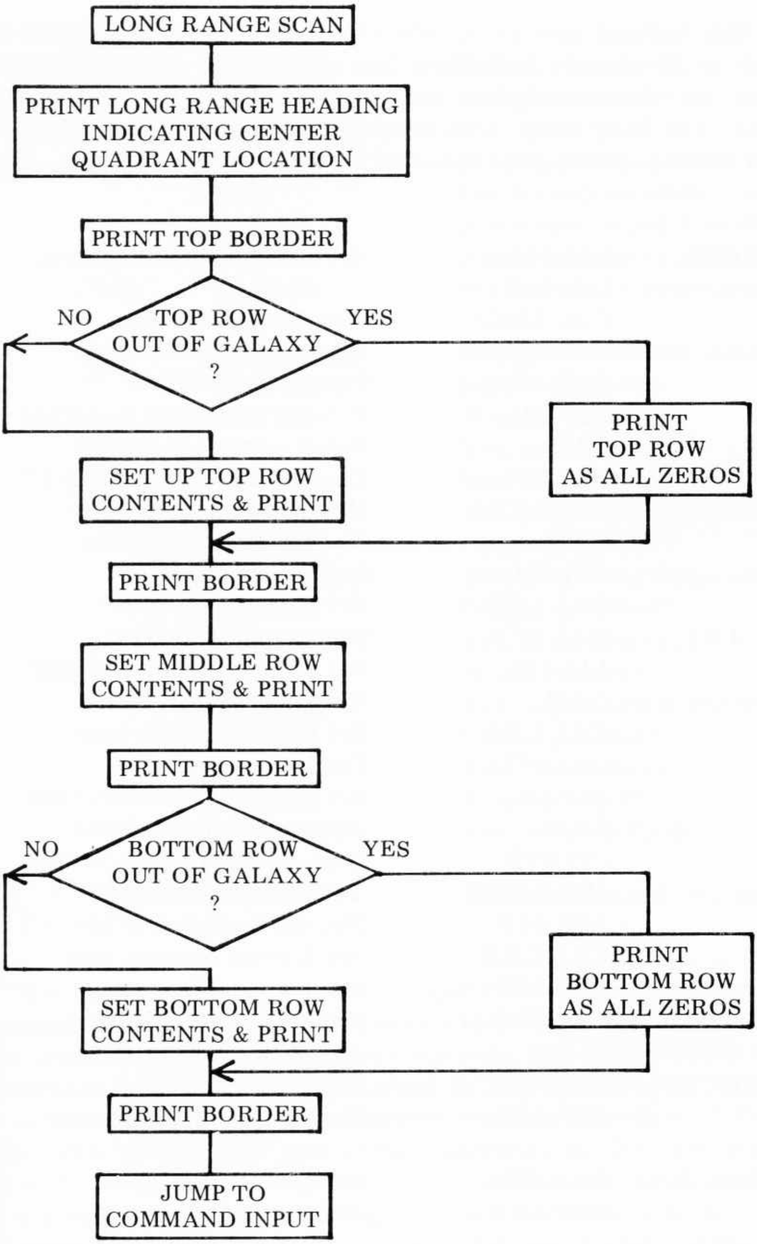
The commands, input by the operator to direct the operation of the space ship, are controlled by the COMMAND INPUT routine, labeled CMND. This routine (which immediately follows the short range scan) begins by deleting ten units of energy from the main storage bank to simulate the loss of energy resulting from the operation of the ship's control panel. The second byte of the random number storage is then incremented to increase the random number generator's overall randomness. The command request message is then output to the display device followed by a call to the input routine to receive the command from the input device. If the character input matches one of the ASCII codes, indicating a valid command, the proper routine is entered to perform the command. If the character is not a valid command entry, the program simply requests the command input again. The flow chart and listing for the command input routine is presented next.


COMMAND INPUT
DELETE 10 UNITS OF ENERGY
ADVANCE RANDOM NUMBER GENERATOR CONSTANT
PRINT "COMMAND?"
INPUT COMMAND
NO
MOVEMENT ?
YES
JUMP TO SHIP MOVEMENT ROUTINE
NO
SHORT RANGE SCAN?
YES
JUMP TO SHORT RANGE SCAN ROUTINE
NO
LONG RANGE SCAN?
YES
JUMP TO LONG RANGE SCAN ROUTINE
NO
GALAXY DISPLAY ?
YES
JUMP TO GALAXY DISPLAY ROUTINE
NO
SHIELD ENERGY ?
YES
JUMP TO SHIELD ENERGY ROUTINE
NO
PHASOR SHOT ?
YES
JUMP TO PHASOR ROUTINE
NO
TORPEDO SHOT ?
YES
JUMP TO TORPEDO ROUTINE

```
CMND,   LHI 000
        LEI 012         Delete 10 units of
        LDH             Energy for each command
        CAL ELOM
        LLI 101         Set pointer to random number
        LEM             Fetch random nmbr. constant
        INE             Increment to aid in making
        LME             Random number random
CMD,    LLI 025         Set pointer to command msg
        LHI 002
        CAL CMSG        Request command input
        CAL INPUT       Input command
        CPI 260         Ship movement?
        JTZ CRSE        Yes, input course
        CPI 261         Short range scan?
        JTZ SRSCN       Yes, print short range scan
        CPI 262         Long range scan?
        JTZ LRSCN       Yes, print long range scan
        CPI 263         Galaxy printout?
        JTZ GXPRT       Yes, print galaxy
        CPI 264         Shield energy?
        JTZ SHEN        Yes, adjust shield energy
        CPI 265         Phasor control?
        JTZ PHSR        Yes, fire phasors
        CPI 266         Torpedo shot?
        JTZ TRPD        Yes, shoot torpedo

        JMP CMD         Illegal command, try again
```

The long range scan routine outputs the contents of the current quadrant and the eight quadrants which immediately surround it. The number of alien ships, space stations, and stars in each of these quadrants is displayed as described in the first chapter. A message is output first indicating the current quadrant location of the space ship. The contents of the three quadrants in the row above the current quadrant are then output by calling the LRR subroutine. If this top row is outside the galaxy, the contents will be output as all zeros by use of the RWC routine. The row containing the current quadrant is then output followed by the row below the current quadrant. If this bottom row is outside the galaxy, its contents will be displayed as all zeros. A dividing line of dashes is output between each row. At the completion, the routine returns to input a new command. The long range scan routine begins at the label LRSCN. The flow chart and listing for this routine are presented next.

```
    LRSCN,    LLI 115        Set pntr to long range msg
              LHI 002
              CAL MSG        Print long range scan
              CAL QUAD       Print quadrant location
              CAL NTN        Print row of dashes
              LLI 131        Pointer to current quadrant
              LAM            Fetch current quadrant
              NDI 070        Current quadrant in row 1?
              JTZ RWC1       Yes, top row clear
              LAM            No, set up quadrant to
              SUI 010        Indicate row - 1
              CAL LRR        Set & print top row
      LR1,    CAL NTN        Print separating row
              LLI 131        Set pointer to current quad.
              LAM            Fetch current quadrant
              CAL LRR        Set & print middle row
              CAL NTN        Print separating row
              LLI 131        Set pointer to current quad.
              LAM            Fetch current quadrant
              CPI 070        Current quadrant in row 8?
              JFC RWC2       Yes, bottom row clear
              ADI 010        No, set quadrant to row + 1
              CAL LRR        Set & print bottom row
      LR2,    CAL NTN        Print separating row
              JMP CMND       Input next command

     RWC1,    CAL RWC        Print clear row
              JMP LR1        Continue long range scan

     RWC2,    CAL RWC        Print clear row
              JMP LR2        Finish long range scan

      RWC,    LLI 311        Set pointer to left quadrant
```

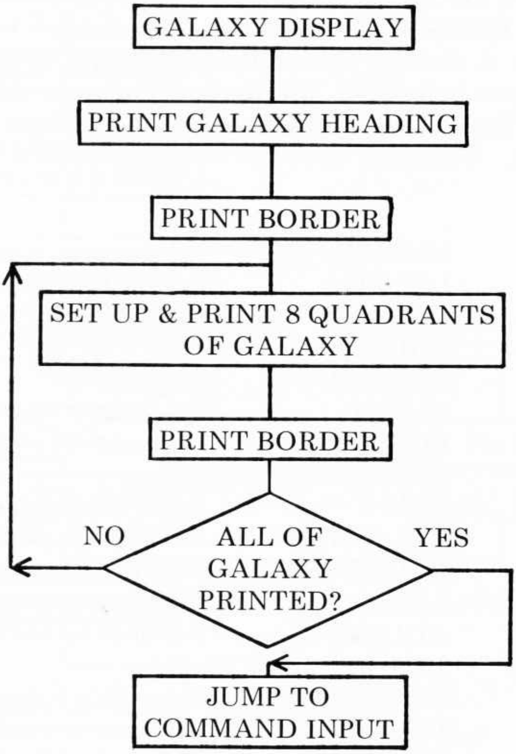

LONG RANGE SCAN
PRINT LONG RANGE HEADING INDICATING CENTER QUADRANT LOCATION
PRINT TOP BORDER
NO
TOP ROW OUT OF GALAXY ?
YES
PRINT TOP ROW AS ALL ZEROS
SET UP TOP ROW CONTENTS & PRINT
PRINT BORDER
SET MIDDLE ROW CONTENTS & PRINT
PRINT BORDER
NO
BOTTOM ROW OUT OF GALAXY ?
YES
PRINT BOTTOM ROW AS ALL ZEROS
SET BOTTOM ROW CONTENTS & PRINT
PRINT BORDER
JUMP TO COMMAND INPUT

```
            XRA             Set zero entry
            CAL QDS1        Set quadrant contents
            LLI 317         Set pointer to middle quad.
            XRA             Set zero entry
            CAL QDS1        Set quadrant contents
            LLI 325         Set pointer to right quadrant
            XRA             Set zero contents
            CAL QDS1        Set quadrant contents
            JMP LRP         Print long range row
```

The galaxy display routine produces an output of the entire galaxy contents to the display device in a format similar to that of the long range scan. The display is used to provide the operator with a map from which a course may be charted for the mission. The contents of a complete row are set up in the galaxy printout message on page 00 by calling the QDSET subroutine, and then the row is output to the display device. A dividing line of dashes is output between each row. When the output is finished, the routine returns to the command input routine. The galaxy display routine flow chart and listing is presented next.

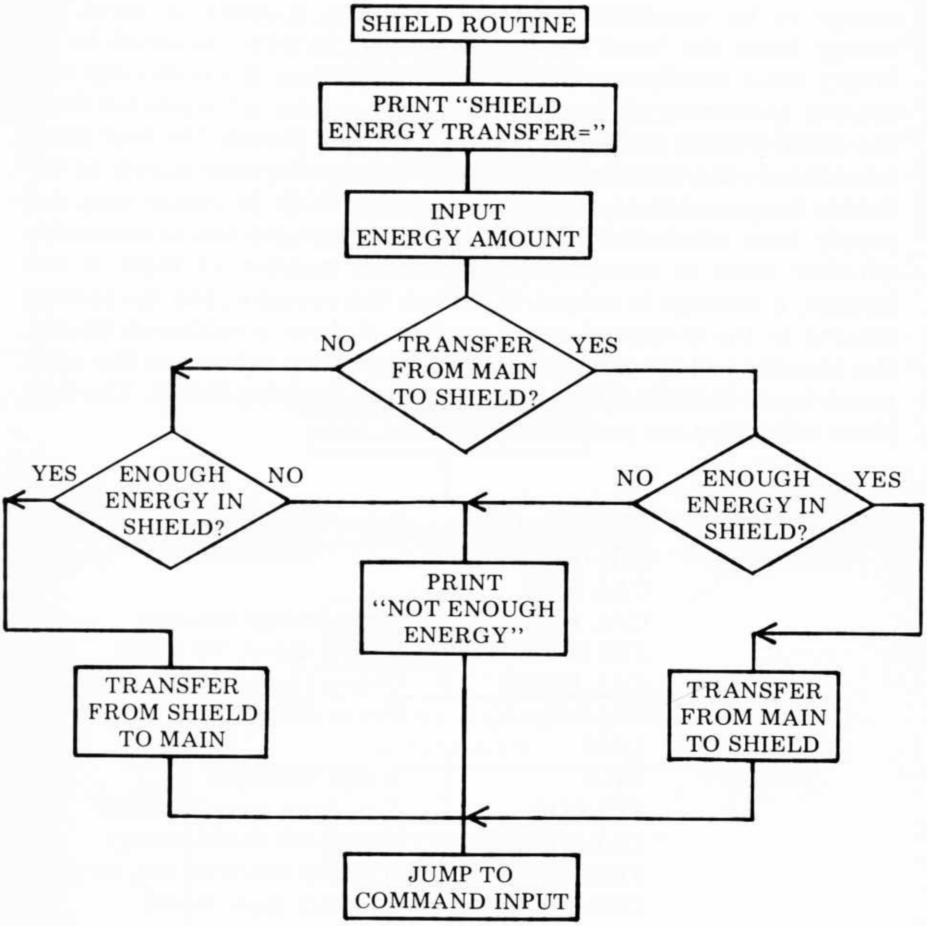
```
GXPRT,      LLI 042
            LHI 004         Print galaxy display
            CAL MSG
            LHI 061
            CAL NT1         Print border
            LLI 300         Set pointer to galaxy
  GL1,      LDH             Set printout pointer
            LEI 204
  GL2,      LAM             Fetch quadrant contents
            CAL SWITCH      Set message pointer
            CAL QDSET       Set quad. contents in message
            LAL             Fetch message pointer
            ADI 004         Advance to next quad. in msg
            LLA
            CAL SWITCH      Set galaxy pointer
            INL             Advance to next quad. in glxy
            CPI 264         This end of line?
```

```
JFZ GL2           No, set next quad. in msg
CAL SWITCH        Save galaxy pointer
LLI 200           Print current line of galaxy
CAL MSG
LHI 061
CAL NT1           Print dividing line
LAE               Fetch galaxy pointer
CPH               End of galaxy printed? =0?
JTZ CMND          Yes, return to command input
CAL SWITCH        No, set up galaxy pointer
JMP GL1           Continue printout
```



The shield routine transfers energy between the main energy supply and the protective shields as designated by the operator. The routine begins by requesting the operator to enter the amount of energy to be transferred. The EIN routine is called to input the energy from the input device. The input is then converted to its binary value and the sign of the input is checked. If a minus sign was entered preceeding the energy input, the energy is transferred from the shield energy to the main energy storage. If only the four digits are entered, the transfer of energy goes from the main supply to the shields by jumping to the routine labeled POS. In either case, the supply from which the energy is to be taken is checked to determine whether there is enough energy for the transfer. If there is not enough, a message is output to inform the operator, and the routine returns to the command input routine. If there is sufficient energy, the transfer will be completed and the program returns to the command input routine. This routine begins at the label SHEN. The flow chart and listing are presented next.

```
SHEN,     LLI 060       Print "Shield Energy
          LHI 003                Transfer =  "
          CAL MSG
          CAL EIN       Input energy amount
          JTS SHEN      Invalid input, try again
          CAL DCBN      Convert to binary
          LLI 144       Fetch sign indicator
          LAM
          NDA           Is sign positive?
          JTZ POS       Yes, from main to shield
          CAL CKSD      No, check shield energy
          JTC NE        If shield less than req, no good
          CAL FMSD      Subtract from shield
          CAL TOMN      Add to main
          JMP CMND      Input new command

 POS,     CAL CKMN      Check main energy
          JTC NE        If main less than req, no good
          CAL FMMN      Subtract from main
          CAL TOSD      Add to shield energy
          JMP CMND      Input new command
```


SHIELD ROUTINE
PRINT "SHIELD ENERGY TRANSFER="
INPUT ENERGY AMOUNT
TRANSFER FROM MAIN TO SHIELD?
NO
YES
ENOUGH ENERGY IN SHIELD?
YES
NO
ENOUGH ENERGY IN SHIELD?
NO
YES
PRINT "NOT ENOUGH ENERGY"
TRANSFER FROM SHIELD TO MAIN
TRANSFER FROM MAIN TO SHIELD
JUMP TO COMMAND INPUT

```
NE,     LLI 114          Print “Not Enough
        LHI 003                Energy”
        CAL MSG
        JMP CMND         Input new command
```

The movement routine is called when it is desired to move the space ship within the galaxy. The course direction is input by calling the DRCT subroutine, which returns with the pointer to the course table stored in location 136 on page 00. The distance, or warp factor, is then entered, and the binary count of the number of sectors to be traversed is stored in register E. The ACTV subroutine is called to set up the adjusted row and column values used by the TRK subroutine in advancing the space ship. The crossing indicator is cleared before the routine begins the actual movement of the space ship. The crossing indicator is used at the end of the move to indicate whether one or more quadrant borders have been crossed.

Movement of the space ship begins at the label MOV which first calls TRK to move the space ship one sector. If the return from TRK indicates the space ship is outside the known galaxy, the LOST subroutine is called, which ends the current game. Otherwise, a quadrant crossing is checked by reading the crossing flag. If a crossing did not occur, the program checks for a possible collision. However, if the space ship did cross a quadrant border, the crossing indicator is set, 25 units of energy are deleted from the main supply, and the new quadrant is set up.

The routine then checks for a collision between the space ship and the other objects in the quadrant. If a collision occurs within the initial quadrant, the result will be one of the following. For a collision with a star, the game will end by jumping to the WPOUT subroutine. A collision with a space station results in the elimination of the space station and the loss of 600 units of energy from the ship's shields. Finally, a collision with an alien ship results in its elimination, and a loss of 1500 units of energy from the space ship's shields.

After a collision with a space station or alien ship, or if there was no collision, the move is continued by decrementing the warp factor and, if not zero, returning to MOV to move the space ship one more sector. When the warp factor reaches zero, the crossing indicator is checked and, if set, the stardate counter is decremented. When the stardate counter goes to zero, the operator has run out of time and the game ends by jumping to the TIME subroutine.

The location of the space ship is then checked against the location of the other objects in the quadrant. If the space ship is in the same sector as another object in the quadrant, the other object is moved. This coincidence may occur when the space ship moves into a new quadrant, since a collision outside the original quadrant is ignored in the collision routine.

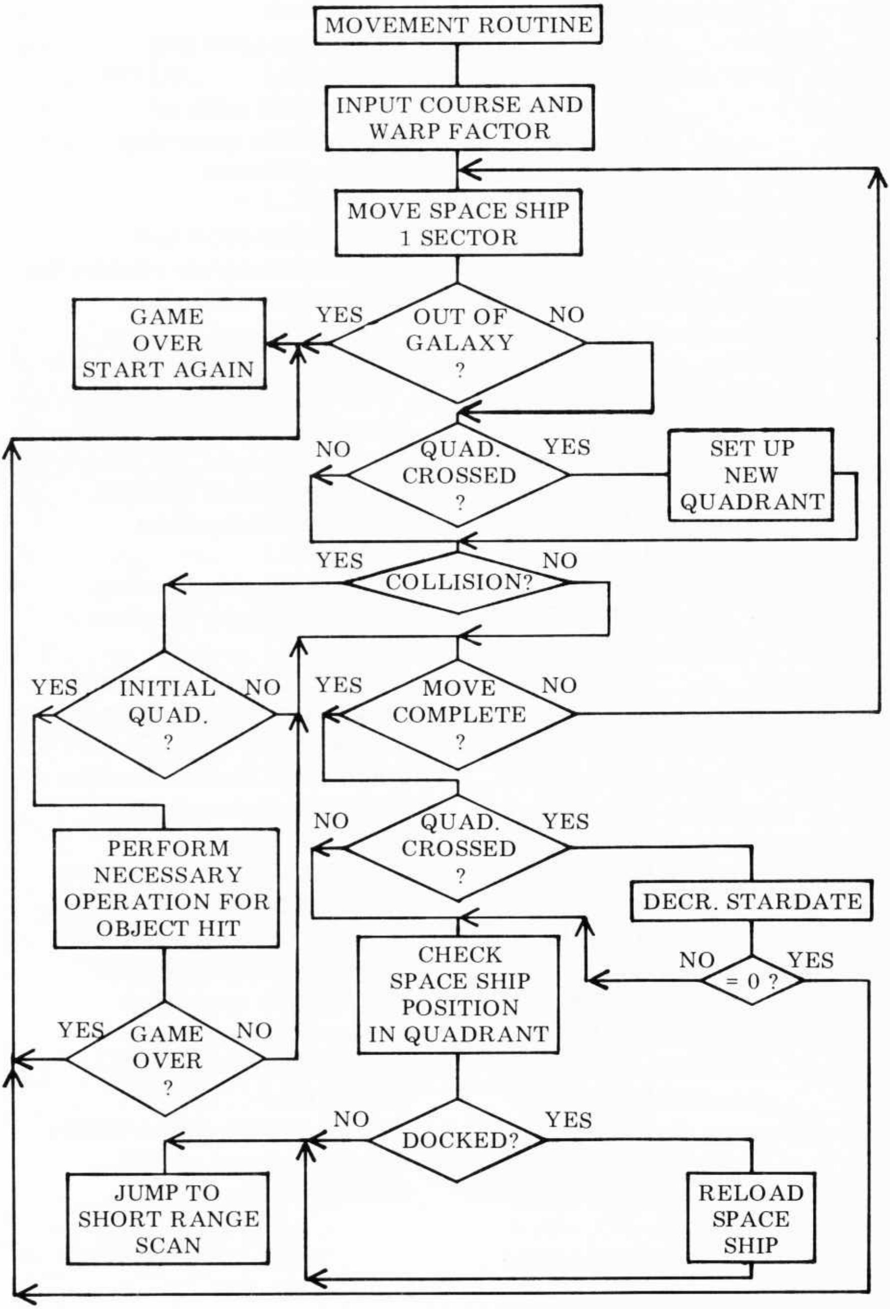
The final operation of this routine is to check for a docking with a space station. This can only occur when the space ship completes its move by residing in a sector on either side of the space station. The space ship is not docked when it is in the sector above or below the space station. If the space ship is docked, its energy banks and torpedo tubes are refilled. The flow chart and listing for the movement routine is now presented.

```
     CRSE,     LLI 040         Pointer to "Course" message
               LHI 002
               CAL MSG         Request course input
               CAL DRCT        Input course direction
               JTZ CRSE        Input error, try again
      WRP,     LLI 063         Pointer to "Warp" message
               LHI 002
               CAL CMSG        Request warp input
               LLI 137         Set pntr. to temporary storage
               CAL INPUT       Input warp factor number 1
               CPI 260         Is digit less than 0?
               JTC WRP         No, request input again
               CPI 270         Is digit greater than 7?
               JFC WRP         Yes, try again
               NDI 007         Mask off ASCII code
               RLC             Position to 3rd bit
               RLC
```

```
        RLC
        LMA           Save in temporary storage
        LAI 256       Print decimal point
        CAL PRINT
        CAL INPUT     Input 2nd warp factor number
        CPI 260       Is digit less than 0?
        JTC WRP       Yes, no good
        CPI 270       Is digit greater than 7?
        JFC WRP       Yes, no good
        NDI 007       Mask off ASCII code
        ADM           Add warp digit number 1
        JTZ WRP       If 0, no good
        LEA           Save warp factor in 'E'
        CAL ACTV      Fetch adjusted row & column
        LLI 061       Set pntr to crossing indicator
        LMH           Clear crossing indicator
MOV,    CAL TRK       Track 1 sector
        JTZ LOST      Out of galaxy? Yes, lost
        LLI 060       Fetch crossing flag
        LAM
        NDA           Quadrant crossed?
        JTZ CLSN      No, check collision
        INL           Advance to crossing indicator
        LML           Set crossing indicator to non-0
        LEI 031       Delete 25 units of
        LDH           Energy from main supply
        CAL ELOM
        CAL QCNT      Fetch new quadrant contents
        CAL NWQD      Set up new quadrant
CLSN,   CAL RWCM      Form row and column byte
        CAL MATCH     Collision?
        JFZ MVDN      No, complete move
        LBL           Yes, save object location
        LAB           Set flags to determine
        CPI 113       What was hit
        LLI 061       Pointer to crossing indicator
        LAM           Fetch crossing indicator
        JTZ SSOUT     Space station collision
        JFC ASOUT     Alien ship collision
        NDA           Star, initial quadrant?
```

```
          JTZ WPOUT       Yes, ship wiped out

MVDN,     LHI 000         Restore registers 'E' 'D' & 'C'
          LLI 050
          LEM
          INL
          LDM
          INL
          LCM
          DCE             Decrement warp factor
          JFZ MOV         Not 0, continue move

          LLI 061         Fetch crossing indicator
          LAM
          NDA             Quadrant crossing occurred?
          JTZ NOX         No, complete move
          LLI 135         Yes, fetch stardate
          LBM
          DCB             Decrement stardate counter
          JTZ TIME        If 0, end of game
          LMB             Else save new date

  NOX,    CAL RWCM        Form row and column byte
          LLI 103         Set pointer to current sector
          LMB             Save new sector
          CAL MATCH       Last move a collision?
          CTZ CHNG        Yes, change object location
          CAL DKED        Check for docking
          JMP SRSCN       Do short range scan

SSOUT,    NDA             Initial quadrant?
          JFZ MVDN        No, no loss
          LLB             Yes, set object pointer
          CAL DLET        Remove space station fm glxy
          LEI 130         Then delete 600 units
          LDI 002         Of energy from space ship
  SSO1,   CAL ELOS        Delete energy
          JMP MVDN        Finish move

ASOUT,    NDA             Initial quadrant?
```

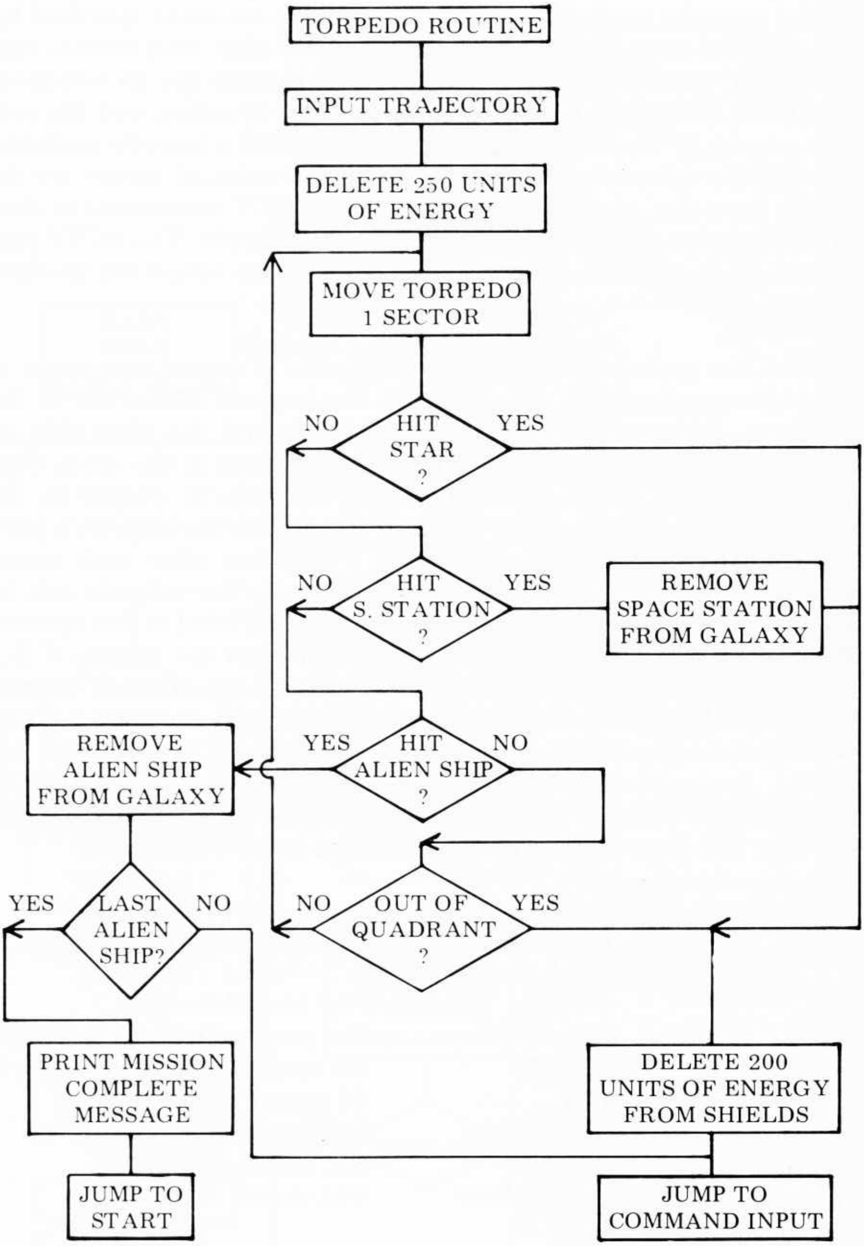
```
          JFZ MVDN      No, no loss
          LLB           Yes, delete alien ship
          CAL DLET
          LEI 334       Delete 1500 units of
          LDI 005       Energy from space ship
          JMP SSO1      And finish move

CHNG,     LEL           Set table location and
          LCI 001       Number of objects counter for
          JMP LOCSET    Move object and return

DKED,     LLI 113       Fetch space station byte
          LAM
          NDA           Space station in quadrant?
          RTS           No, return
          LAB           Fetch space ship location
          NDI 070       Separate row location
          LCA           Save in 'C'
          LAB           Fetch space ship location
          NDI 007       Separate column location
          LBA           Save in 'B'
          LAM           Fetch space ship location
          NDI 007       Separate space ship clmn loc
          LEA           Save in 'E'
          LAM           Fetch space station location
          NDI 070       Separate row location
          CPC           Same row as space ship?
          RFZ           No, return
          LAB           Fetch space ship column
          ADI 001       Advance one column
          CPE           Space station adjacent?
          JTZ LOAD      Yes, load up space ship
          SUI 002       No, try column to left
          CPE           Space station adjacent?
          RFZ           No, return
          JMP LOAD      Yes, load space ship & return
```


MOVEMENT ROUTINE
INPUT COURSE AND WARP FACTOR
MOVE SPACE SHIP 1 SECTOR
YES
OUT OF GALAXY ?
NO
GAME OVER START AGAIN
NO
QUAD. CROSSED ?
YES
SET UP NEW QUADRANT
YES
COLLISION?
NO
YES
INITIAL QUAD. ?
NO
YES
MOVE COMPLETE ?
NO
NO
QUAD. CROSSED ?
YES
DECR. STARDATE
PERFORM NECESSARY OPERATION FOR OBJECT HIT
NO
= 0 ?
YES
CHECK SPACE SHIP POSITION IN QUADRANT
YES
GAME OVER ?
NO
NO
DOCKED?
YES
JUMP TO SHORT RANGE SCAN
RELOAD SPACE SHIP

The torpedo routine fires a torpedo in the direction specified by the operator in an attempt to destroy an alien ship. This routine first checks the number of torpedoes available. If there are no torpedoes remaining, a message is output to inform the operator, and the routine returns to the command routine. If there is a torpedo available, the torpedo count is decremented, and 250 units of energy are depleted from the main storage bank. The DRCT subroutine is then called to input the direction of fire for the torpedo. The ACTV subroutine then sets the adjusted row and column values for tracking the torpedo.

Once the trajectory is set up, the torpedo is moved one sector at a time, using the TRK subroutine. If the torpedo moves out of the quadrant, it has missed its intended target and the alien ship retaliates by firing 200 units of phasor energy back at the space ship. Otherwise, the sector location of the torpedo is output in the tracking message so that the operator can follow the torpedo's path. The MATCH subroutine checks for a collision after each sector moved. If there is no collision at this sector, the torpedo will be tracked another sector by returning to the TR2 label in this routine. If an alien ship has been hit, it is removed from the galaxy. If it is the last alien ship, the mission is complete, and the program begins a new game. If a space station is hit, it is eliminated and the alien ship will retaliate as mentioned above. If a star is hit, the torpedo has missed its mark and the alien ship will again retaliate for the attempted attack. The program then returns to the command input routine. The torpedo flow chart and listing are presented next.

```
TRPD,     LLI 132        Fetch number of torpedoes
          LAM
          NDA            Any torpedoes left?
          JTZ NTPD       No, print no torpedo message
          LEI 372        Set up 250 units
          LDH            Of energy to delete
          CAL CKMN       Enough in main supply?
          JTC NE         No, report not enough
          CAL FMMN       Yes, delete from main
          LLI 132
          LAM            Fetch torpedo count
```


TORPEDO ROUTINE
INPUT TRAJECTORY
DELETE 250 UNITS OF ENERGY
MOVE TORPEDO 1 SECTOR
HIT STAR ?
NO
YES
HIT S. STATION ?
NO
YES
REMOVE SPACE STATION FROM GALAXY
HIT ALIEN SHIP ?
YES
NO
REMOVE ALIEN SHIP FROM GALAXY
LAST ALIEN SHIP?
YES
NO
OUT OF QUADRANT ?
NO
YES
PRINT MISSION COMPLETE MESSAGE
JUMP TO START
DELETE 200 UNITS OF ENERGY FROM SHIELDS
JUMP TO COMMAND INPUT

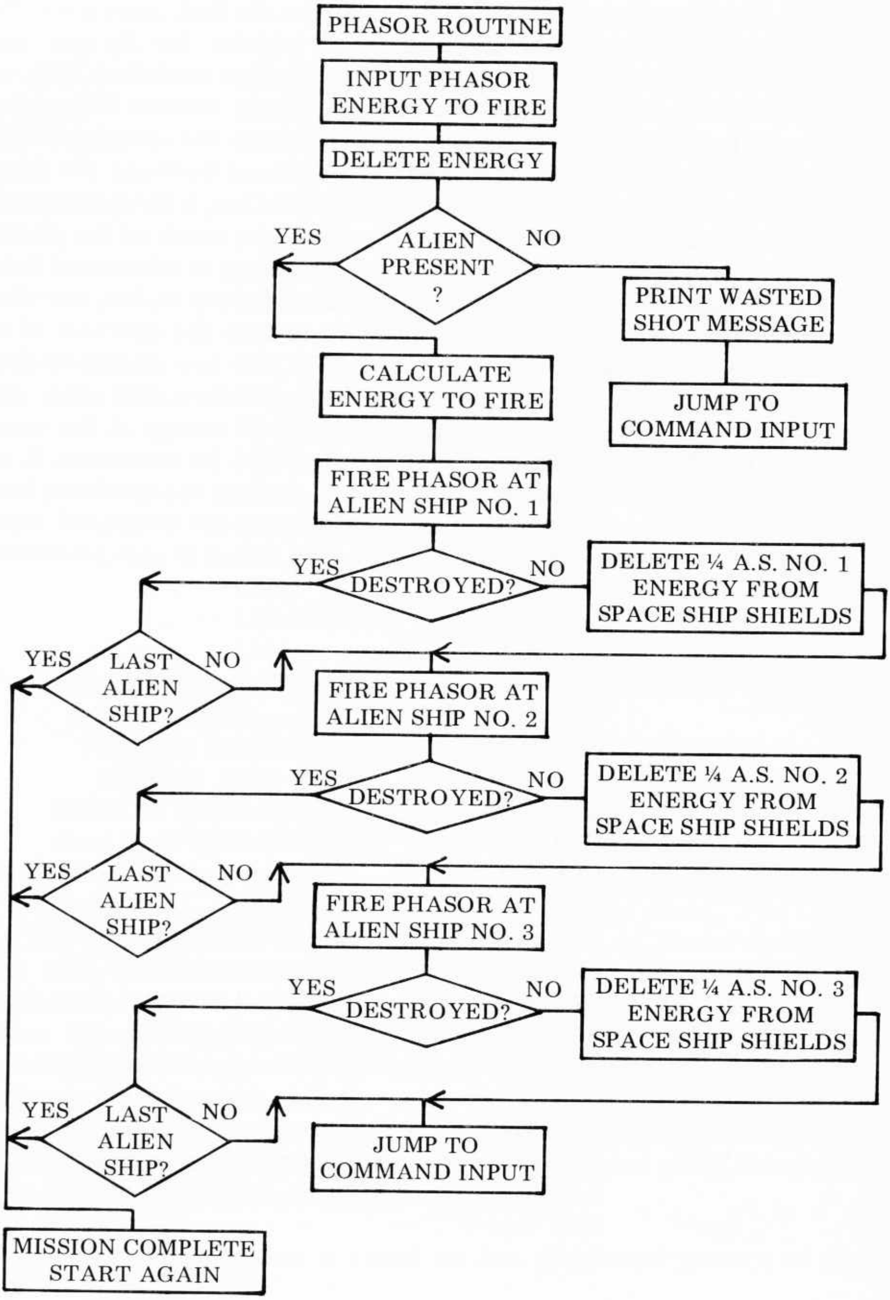
```
        SUI 001         Remove one torpedo
        LMA
TR1,    LLI 140         Print “Torpedo
        LHI 003                 Trajectory’
        CAL MSG
        CAL DRCT        Input direction
        JTZ TR1         Invalid input, try again
        CAL ACTV        Form adjusted row & column
        LLI 131         Save current quadrant location
        LAM             In temporary storage
        LLI 053
        LMA
TR2,    CAL TRK         Move torpedo one sector
        JTZ QOUT        Out of quadrant? Missed
        LLI 060         Fetch crossing flag
        LAM
        NDA             Crossed quadrant?
        JFZ QOUT        Yes, missed
        CAL RWCM        No, form row and column
        LCB             Save row and column byte
        LLI 036         Set up tracking message
        LHI 004         By inserting row and column
        CAL T1          In message
        LLI 022         Set pointer to message
        CAL CMSG        Print ‘Tracking:  R,C’
        LBC             Fetch row and column byte
        CAL MATCH       Torpedo hit anything?
        JTZ HIT         Yes, analyze
        LLI 050         No, restore registers
        LEM
        INL
        LDM
        INL
        LCM
        JMP TR2         Continue tracking

HIT,    LAL             What was hit?
        CPI 113         Was it a star?
        JTC QOUT        Yes, missed alien ship
        JTZ SSTA        Space stat.? Yes, delete S.S.
```

```
          CAL DLET       No, delete alien ship
          LLI 177        Print alien ship hit message
          LHI 003
          CAL MSG
          JMP CMND       Input new command

SSTA,     CAL DLET       Delete space station fm galaxy
          LLI 272        Print message of loss of
          LHI 003        Space station
          CAL MSG

QOUT,     LLI 226        Print missed message
          LHI 003
          CAL CMSG
          LEI 310        Set up loss of 200
          LDH            Units due to alien ship
          CAL ELOS       Retaliating
          LLI 053        Restore current quadrant
          LAM            Location
          LLI 131
          LMA
          JMP CMND       Input new command

NTPD,     LLI 266        Set pointer to No Torpedo
          LHI 004        Message
          CAL MSG        Print message
          JMP CMND       Jump to input command
```

The phasor routine fires a designated amount of phasor energy at the alien ships in the quadrant. The EIN subroutine is called to input the energy to be fired. The amount of energy entered is then deleted from the main storage bank. The number of alien ships in the immediate quadrant is then determined to calculate the amount of energy to be fired at each. If there are no alien ships, a message is output indicating the energy fired was wasted. The amount of phasor energy to be fired at the alien ships is calculated and saved for use by the ASHP subroutine.

The ASPH subroutine is called to fire the phasor at each of the three possible alien ships in the quadrant. It first ascertains the presence of the particular alien ship by looking for its row and column location in the data table. If this location contains a 200, no alien ship is located here and the routine simply returns. Otherwise, this row and column location is output to inform the operator which alien ship is about to be attacked. The distance between the space ship and the alien ship, as defined in Chapter One, is then calculated and the distance factor is used to determine how much of the phasor energy actually reaches the alien ship. This energy is subtracted from the alien ship's shield energy, and if the result is zero or less, the alien ship is destroyed. A message is output to inform the operator of its destruction. If the alien ship is not destroyed, the new energy level of the alien ship's shields is output and, in retaliation, the alien ship fires a phasor equal to one quarter of its shield energy at the space ship. When the ASPH subroutine has completed its operation, it returns to the phasor routine. After all alien ships in the quadrant have been fired upon, the phasor routine returns to the command input routine. The phasor routine flow chart and listing is now presented.

```
PHSR,    LLI 063
         LHI 004        Print 'Phasor Energy to Fire='
         CAL MSG
         CAL EIN        Input energy amount
         JTS PHSR       Input error, try again
         CAL DCBN       Convert energy to binary
         CAL ELOM       Delete energy from main
         LLI 102        Fetch current quad. contents
         LAM
         NDI 060        Any alien ships?
         JTZ WASTE      No, waste of energy
         CAL ROTR4      Position number of alien ship
         SUI 001        1 alien ship, full energy
         JTZ PH1        2 alien ships, half energy
         LBA            3 alien ships, quarter energy
         CAL DVD
PH1,     LLI 136        Set pointer to energy storage
         LME            Save energy amount
         INL
         LMD
```


PHASOR ROUTINE
INPUT PHASOR ENERGY TO FIRE
DELETE ENERGY
YES
ALIEN PRESENT ?
NO
PRINT WASTED SHOT MESSAGE
JUMP TO COMMAND INPUT
CALCULATE ENERGY TO FIRE
FIRE PHASOR AT ALIEN SHIP NO. 1
YES
DESTROYED?
NO
DELETE ¼ A.S. NO. 1 ENERGY FROM SPACE SHIP SHIELDS
YES
LAST ALIEN SHIP?
NO
FIRE PHASOR AT ALIEN SHIP NO. 2
YES
DESTROYED?
NO
DELETE ¼ A.S. NO. 2 ENERGY FROM SPACE SHIP SHIELDS
YES
LAST ALIEN SHIP?
NO
FIRE PHASOR AT ALIEN SHIP NO. 3
YES
DESTROYED?
NO
DELETE ¼ A.S. NO. 3 ENERGY FROM SPACE SHIP SHIELDS
YES
LAST ALIEN SHIP?
NO
JUMP TO COMMAND INPUT
MISSION COMPLETE START AGAIN

```
            LLI 050         Save energy in temp. storage
            LME
            INL
            LMD
            INL             Save loc. of alien ship in table
            LMI 114
            CAL ASPH        Calc. phsr dmg to A.S. No. 1
            LLI 052         Set pntr to A.S. loc. storage
            LMI 115         Save location of A.S. in table
            CAL ASPH        Calc. phsr dmg to A.S. No. 2
            LLI 052         Set pntr to A.S. loc. storage
            LMI 116         Save location of 3rd alien ship
            CAL ASPH        Calc. phsr dmg to A.S. No. 3
            JMP CMND        Input new command

ASPH,       LLM             Set pntr to alien ship in table
            LAM             Fetch alien ship location
            NDA             Alien ship in this location?
            RTS             No, return
            LEI 145         Set pointer to sector
            LDI 004         Storage in message
            CAL TWO         Set sector coordinates
            LLI 116         Print 'A.S. at sector X,Y:'
            CAL CMSG
            LLI 103         Fetch space ship location
            CAL SPRC        Separate row and column
            LLE             Save space ship row & column
            LHD
            LEC
            LDB
            CAL SPRC        Separate A.S. row & column
            LAB             Fetch alien ship row
            SUD             Subtract space ship row
            JFS PH2         To calculate distance between
            XRI 377         Alien ship and space ship
            ADI 001
 PH2,       LBA             Save row distance
            LAC             Fetch alien ship column
            SUE             Subtract space ship column
            JFS PH3         To calculate column distance
```

```
        XRI 377         Between A. ship & S. ship
        ADI 001
PH3,    ADB             Add row distance
        RRC             Form distance factor
        RRC             To be used to calculate
        NDI 003         Energy that reaches alien ship
        LBA             Save in 'B'
        LCL             Save pointer in 'C'
        LLI 050         Fetch phasor energy
        LEM
        INL
        LDM
        DCB             Divide energy by
        INB
        CFZ DVD         Distance factor
        LAC             Fetch table pointer
        NDI 003
        RLC             And set pointer to alien ship
        ADI 123         Energy storage
        LLI 053         Save energy pointer
        LMA
        LLA             Set pntr. to alien ship energy
        CAL FM1         Delete energy fm alien ship
        JTS DSTR        If negative, A. ship destroyed
        JFZ ALOS        If non-0, print A. ship energy
        DCL             Check 2nd half of alien ship
        LAM             Energy to see if zero.
        INL
        NDA             Alien ship energy = 0?
        JTZ DSTR        Yes, remove from galaxy
ALOS,   DCL             Set pntr to alien ship energy
        LBI 002         Set number for BINDEC
        CAL BINDEC      Convert A.S. enrgy to decimal
        LEI 167
        LDI 004
        LBI 004         Set number of digits
        CAL DIGPRT      Put energy in message
        LLI 153         Print energy of alien ship
        LHI 004
        CAL CMSG
```

```
            LLI 053        Fetch alien ship energy
            LLM
            LEM            Fetch alien ship energy
            INL
            LDM
            LBI 002        Divide alien ship energy
            CAL DVD        By 4 as retaliation by A.S.
            JMP ELOS       Remove fm shld nrgy & ret

  DSTR,     LLI 312        Print "Destroyed"
            LHI 003
            CAL CMSG
            LLI 052        Fetch alien ship location in tbl
            LLM
            JMP DLET       Remove A.S. fm glxy & ret

  SPRC,     LAM            Fetch row and column
            NDI 007        Separate column
            LCA            Save column in 'C'
            LAM            Fetch row
            CAL ROTR3      Position row to right
            NDI 007        Separate row
            LBA            Save row in 'B'
            RET

 WASTE,     CAL ELOM       Delete power from main
            LLI 171
            LHI 004        Print 'No A.S.! Wasted shot'
            CAL MSG
            JMP CMND       Input new command
```

8008 ASSEMBLED LISTING

This chapter contains the assembled listing for the 8008 version of the Galaxy program. The assembled listing provides the memory addresses and machine code for the mnemonics which make up the Galaxy program. All that is required is to add the reader provided I/O driver routines for the specific devices available on one's system. These routines must follow the guidelines described in Chapter Two.

The first portion of the listing indicates the usage of page 00 for the course table, temporary data storage, the galaxy display message, and the galaxy content table. The galaxy display message on page 00, the messages of page 01 through 04, and the galaxy setup table on page 17 are presented as octal dumps.

The start of execution address for the Galaxy program as presented herein is page 12 location 000.

```
000 000    002                                      Course 1.0
000 001    000
000 002    002                                      Course 1.5
000 003    377
000 004    002                                      Course 2.0
000 005    376
000 006    001                                      Course 2.5
000 007    376
000 010    000                                      Course 3.0
000 011    376
000 012    377                                      Course 3.5
000 013    376
000 014    376                                      Course 4.0
000 015    376
000 016    376                                      Course 4.5
000 017    377
000 020    376                                      Course 5.0
000 021    000
```

```
000 022    376                              Course 5.5
000 023    001
000 024    376                              Course 6.0
000 025    002
000 026    377                              Course 6.5
000 027    002
000 030    000                              Course 7.0
000 031    002
000 032    001                              Course 7.5
000 033    002
000 034    002                              Course 8.0
000 035    002
000 036    002                              Course 8.5
000 037    001


000 050    000                              Register storage
000 051    000                              Register storage
000 052    000                              Register storage
000 053    000                              Temporary storage

000 060    000                              Crossing flag
000 061    000                              Crossing indicator
000 062    000                              Temporary storage
000 063    000                              Temporary storage

000 100    000                              Random number
000 101    000                              Ran. num. constant
000 102    000                              Quadrant contents
000 103    000                              Sec. loc. of S. ship
000 104    000                              Sector loc. of star
000 105    000                              Sector loc. of star
000 106    000                              Sector loc. of star
000 107    000                              Sector loc. of star
000 110    000                              Sector loc. of star
000 111    000                              Sector loc. of star
000 112    000                              Sector loc. of star
000 113    000                              Sec. loc. of space st.
000 114    000                              S. loc. of A.S. No. 1
000 115    000                              S. loc. of A.S. No. 2
```

```
000 116    000                                    S. loc. of A.S. No. 3
000 117    000                                    Main nrgy L.S. half
000 120    000                                    Main nrgy M.S. half
000 121    000                                    Shld nrgy L.S. half
000 122    000                                    Shld nrgy M.S. half
000 123    000                                    A.S. 1 nrgy L.S. half
000 124    000                                    A.S. 1 nrgy MS half
000 125    000                                    A.S. 2 nrgy L.S. half
000 126    000                                    A.S. 2 nrgy MS half
000 127    000                                    A.S. 3 nrgy L.S. half
000 130    000                                    A.S. 3 nrgy MS half
000 131    000                                    Quad. loc. of S. ship
000 132    000                                    Number torpedoes
000 133    000                                    Num. space stations
000 134    000                                    Num. alien ships
000 135    000                                    Num. stardates
000 136    000                                    Temporary storage
000 137    000                                    Temporary storage
000 140    000                                    Digit storage
000 141    000                                    Digit storage
000 142    000                                    Digit storage
000 143    000                                    Digit storage
000 144    000                                    Digit storage
```

```
000 200     215 212 261 240 240 240 240 240
000 210     261 240 240 240 240 240 261 240
000 220     240 240 240 240 261 240 240 240
000 230     240 240 261 240 240 240 240 240
000 240     261 240 240 240 240 240 261 240
000 250     240 240 240 240 261 240 240 240
000 260     240 240 261
```

000 300 through 377 reserved for Galaxy content table

```
001  000     215  212  304  317  240  331  317  325
001  010     240  327  301  316  324  240  324  317
001  020     240  307  317  240  317  316  240  301
001  030     240  323  320  301  303  305  240  326
001  040     317  331  301  307  305  277  240  000
001  050     215  212  331  317  325  240  315  325
001  060     323  324  240  304  305  323  324  322
001  070     317  331  240  240  240  240  301  314
001  100     311  305  316  240  323  310  311  320
001  110     323  240  311  316  240  240  240  240
001  120     323  324  301  322  304  301  324  305
001  130     323  240  327  311  324  310  240  240
001  140     240  323  320  301  303  305  240  323
001  150     324  301  324  311  317  316  323  000
001  160     215  212  240  255  261  255  255  262
001  170     255  255  263  255  255  264  255  255
001  200     265  255  255  266  255  255  267  255
001  210     255  270  255  000  215  212  260  240
001  220     240  240  240  240  240  240  240  240
001  230     240  240  240  240  240  240  240  240
001  240     240  240  240  240  240  240  240  000
001  250     240  323  324  301  322  304  301  324
001  260     305  240  240  263  260  260  260  000
001  270     240  303  317  316  304  311  324  311
001  300     317  316  240  307  322  305  305  316
001  310     000  240  321  325  301  304  322  301
001  320     316  324  240  240  240  254  240  000
001  330     240  323  305  303  324  317  322  240
001  340     240  240  240  240  254  240  000  240
001  350     305  316  305  322  307  331  240  240
001  360     240  240  240  240  240  240  000  240
001  370     324  317  322  320  305  304  317  305
002  000     323  240  240  240  000  240  323  310
002  010     311  305  314  304  323  240  240  240
002  020     240  240  240  240  000  215  212  303
002  030     317  315  315  301  316  304  277  000
002  040     215  212  303  317  325  322  323  305
002  050     240  250  261  255  270  256  265  251
002  060     277  240  000  215  212  327  301  322
002  070     320  240  306  301  303  324  317  322
```

```
002  100     240  250  260  256  261  255  267  256
002  110     267  251  277  240  000  215  212  314
002  120     256  322  256  240  323  303  301  316
002  130     240  306  317  322  000  215  212  315
002  140     311  323  323  311  317  316  240  306
002  150     301  311  314  305  304  254  240  331
002  160     317  325  240  310  301  326  305  240
002  170     322  325  316  240  317  325  324  240
002  200     317  306  240  323  324  301  322  304
002  210     301  324  305  323  000  215  212  313
002  220     301  255  302  317  317  315  254  240
002  230     331  317  325  240  303  322  301  323
002  240     310  305  304  240  311  316  324  317
002  250     240  301  240  323  324  301  322  256
002  260     240  331  317  325  322  240  323  310
002  270     311  320  240  311  323  240  304  305
002  300     323  324  322  317  331  305  304  000
002  310     215  212  331  317  325  240  315  317
002  320     326  305  304  240  317  325  324  240
002  330     317  306  240  324  310  305  240  307
002  340     301  314  301  330  331  254  240  331
002  350     317  325  322  240  323  310  311  320
002  360     240  311  323  240  314  317  323  324
002  370     256  256  314  317  323  324  000  215
003  000     212  314  317  323  323  240  317  306
003  010     240  305  316  305  322  307  331  240
003  020     240  240  240  240  000  215  212  304
003  030     301  316  307  305  322  255  323  310
003  040     311  305  314  304  240  305  316  305
003  050     322  307  331  240  260  260  260  000
003  060     215  212  323  310  311  305  314  304
003  070     240  305  316  305  322  307  331  240
003  100     324  322  301  316  323  306  305  322
003  110     240  275  240  000  215  212  316  317
003  120     324  240  305  316  317  325  307  310
003  130     240  305  316  305  322  307  331  000
003  140     215  212  324  317  322  320  305  304
003  150     317  240  324  322  301  312  305  303
003  160     324  317  322  331  250  261  255  270
003  170     256  265  251  240  272  240  000  215
```

```
003  200     212  301  314  311  305  316  240  323
003  210     310  311  320  240  304  305  323  324
003  220     322  317  331  305  304  000  215  212
003  230     331  317  325  240  315  311  323  323
003  240     305  304  241  240  301  314  311  305
003  250     316  240  323  310  311  320  240  322
003  260     305  324  301  314  311  301  324  305
003  270     323  000  215  212  323  320  301  303
003  300     305  240  323  324  301  324  311  317
003  310     316  240  304  305  323  324  322  317
003  320     331  305  304  000  215  212  303  317
003  330     316  307  322  301  324  325  314  301
003  340     324  311  317  316  323  254  240  331
003  350     317  325  240  310  301  326  305  240
003  360     305  314  311  315  311  316  301  324
003  370     305  304  240  301  314  314  240  317
004  000     306  240  324  310  305  240  301  314
004  010     311  305  316  240  323  310  311  320
004  020     323  000  215  212  324  322  301  303
004  030     313  311  316  307  272  240  240  254
004  040     240  000  215  212  307  301  314  301
004  050     330  331  240  304  311  323  320  314
004  060     301  331  000  215  212  320  310  301
004  070     323  317  322  240  305  316  305  322
004  100     307  331  240  324  317  240  306  311
004  110     322  305  240  275  240  000  215  212
004  120     301  314  311  305  316  240  323  310
004  130     311  320  240  301  324  240  323  305
004  140     303  324  317  322  240  240  254  240
004  150     272  240  000  305  316  305  322  307
004  160     331  240  275  240  240  240  240  240
004  170     000  215  212  316  317  240  301  314
004  200     311  305  316  240  323  310  311  320
004  210     323  241  240  327  301  323  324  305
004  220     304  240  323  310  317  324  000  215
004  230     212  301  302  301  316  304  317  316
004  240     240  323  310  311  320  241  240  316
004  250     317  240  305  316  305  322  307  331
004  260     240  314  305  306  324  000  215  212
004  270     316  317  240  324  317  322  320  305
```

```
     004 300     304 317 305 323 000 215 212 261
     004 310     240 240 240 240 240 261 240 240
     004 320     240 240 240 261 240 240 240 240
     004 330     240 261 000 215 212 314 301 323
     004 340     324 000 215 212 303 310 311 303
     004 350     313 305 316 241 000


005 000    307                           MSG,    LAM
005 001    240                                   NDA
005 002    053                                   RTZ
005 003    106 300 017                           CAL PRINT
005 006    106 014 005                           CAL INMEM
005 011    104 000 005                           JMP MSG

005 014    060                         INMEM,    INL
005 015    013                                   RFZ
005 016    050                                   INH
005 017    007                                   RET

005 020    066 100                        RN,    LLI 100
005 022    056 000                               LHI 000
005 024    307                                   LAM
005 025    310                                   LBA
005 026    002                                   RLC
005 027    251                                   XRB
005 030    012                                   RRC
005 031    060                                   INL
005 032    317                                   LBM
005 033    010                                   INB
005 034    371                                   LMB
005 035    201                                   ADB
005 036    061                                   DCL
005 037    370                                   LMA
005 040    007                                   RET

005 041    046 367                     SSPLS,    LEI 367
005 043    104 055 005                           JMP PLS

005 046    046 010                     SSMNS,    LEI 010
```

```
005 050    104 073 005                  JMP MNS

005 053    046 317              ASPLS,  LEI 317
005 055    106 020 005            PLS,  CAL RN
005 060    064 300                      ORI 300
005 062    360                          LLA
005 063    304                          LAE
005 064    247                          NDM
005 065    370                          LMA
005 066    104 053 012                  JMP GLXCK

005 071    046 020              ASMNS,  LEI 020
005 073    106 020 005            MNS,  CAL RN
005 076    064 300                      ORI 300
005 100    360                          LLA
005 101    304                          LAE
005 102    267                          ORM
005 103    370                          LMA
005 104    104 053 012                  JMP GLXCK

005 107    307                 DIGPRT,  LAM
005 110    004 260                      ADI 260
005 112    106 014 005                  CAL INMEM
005 115    106 144 005                  CAL SWITCH
005 120    370                          LMA
005 121    106 134 005                  CAL DCMEM
005 124    011                          DCB
005 125    053                          RTZ
005 126    106 144 005                  CAL SWITCH
005 131    104 107 005                  JMP DIGPRT

005 134    061                  DCMEM,  DCL
005 135    060                          INL
005 136    110 142 005                  JFZ LODCR
005 141    051                          DCH
005 142    061                 LODCR,   DCL
005 143    007                          RET

005 144    326                SWITCH,   LCL
005 145    364                          LLE
```

```
005 146    342                               LEC
005 147    325                               LCH
005 150    353                               LHD
005 151    332                               LDC
005 152    007                               RET

005 153    106 144 005             BINDEC,   CAL SWITCH
005 156    066 140                           LLI 140
005 160    056 000                           LHI 000
005 162    375                               LMH
005 163    060                               INL
005 164    375                               LMH
005 165    060                               INL
005 166    375                               LMH
005 167    060                               INL
005 170    375                               LMH
005 171    060                               INL
005 172    375                               LMH
005 173    106 144 005                       CAL SWITCH
005 176    347                               LEM
005 177    011                               DCB
005 200    150 205 005                       JTZ BNDC
005 203    060                               INL
005 204    337                               LDM
005 205    066 144                   BNDC,   LLI 144
005 207    056 000                           LHI 000
005 211    026 020                           LCI 020
005 213    016 047                           LBI 047
005 215    106 251 005                       CAL BD
005 220    061                               DCL
005 221    026 350                           LCI 350
005 223    016 003                           LBI 003
005 225    106 251 005                       CAL BD
005 230    061                               DCL
005 231    026 144                           LCI 144
005 233    016 000                           LBI 000
005 235    106 251 005                       CAL BD
005 240    061                               DCL
005 241    026 012                           LCI 012
005 243    106 251 005                       CAL BD
```

```
005 246    061                                  DCL
005 247    374                                  LME
005 250    007                                  RET

005 251    307                           BD,    LAM
005 252    004 001                              ADI 001
005 254    370                                  LMA
005 255    304                                  LAE
005 256    222                                  SUC
005 257    340                                  LEA
005 260    303                                  LAD
005 261    231                                  SBB
005 262    330                                  LDA
005 263    100 251 005                          JFC BD
005 266    304                                  LAE
005 267    202                                  ADC
005 270    340                                  LEA
005 271    303                                  LAD
005 272    211                                  ACB
005 273    330                                  LDA
005 274    327                                  LCM
005 275    021                                  DCC
005 276    372                                  LMC
005 277    007                                  RET

005 300    066 117                     LOAD,    LLI 117
005 302    076 210                              LMI 210
005 304    060                                  INL
005 305    076 023                              LMI 023
005 307    060                                  INL
005 310    375                                  LMH
005 311    060                                  INL
005 312    375                                  LMH
005 313    066 132                              LLI 132
005 315    076 012                              LMI 012
005 317    007                                  RET

005 320    012                       ROTR4,     RRC
005 321    012                       ROTR3,     RRC
005 322    012                                  RRC
```

```
005 323   012                          RRC
005 324   007                          RET

005 325   106 020 005         LOCSET,  CAL RN
005 330   044 077                      NDI 077
005 332   310                          LBA
005 333   106 237 007                  CAL MATCH
005 336   150 325 005                  JTZ LOCSET
005 341   364                          LLE
005 342   371                          LMB
005 343   040                          INE
005 344   021                          DCC
005 345   110 325 005                  JFZ LOCSET
005 350   007                          RET

005 351   066 217             ROWSET,  LLI 217
005 353   056 001                      LHI 001
005 355   076 240               RCLR,  LMI 240
005 357   060                          INL
005 360   006 247                      LAI 247
005 362   276                          CPL
005 363   110 355 005                  JFZ RCLR
005 366   302                          LAC
005 367   004 260                      ADI 260
005 371   066 216                      LLI 216
005 373   370                          LMA
005 374   021                          DCC
005 375   056 000                      LHI 000
005 377   066 103                      LLI 103
006 001   106 125 006                  CAL RWPNT
006 004   110 017 006                  JFZ STR
006 007   076 274                      LMI 274
006 011   060                          INL
006 012   076 252                      LMI 252
006 014   060                          INL
006 015   076 276                      LMI 276
006 017   066 104                STR,  LLI 104
006 021   056 000               STR1,  LHI 000
006 023   106 125 006                  CAL RWPNT
006 026   110 035 006                  JFZ NXSTR
```

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006 031   060                                        INL
006 032   076 252                                    LMI 252
006 034   364                                        LLE
006 035   060                              NXSTR,    INL
006 036   006 113                                    LAI 113
006 040   276                                        CPL
006 041   110 021 006                                JFZ STR1
006 044   056 000                                    LHI 000
006 046   106 125 006                                CAL RWPNT
006 051   110 064 006                                JFZ AS
006 054   076 276                                    LMI 276
006 056   060                                        INL
006 057   076 261                                    LMI 261
006 061   060                                        INL
006 062   076 274                                    LMI 274
006 064   066 114                              AS,   LLI 114
006 066   056 000                             AS1,   LHI 000
006 070   106 125 006                                CAL RWPNT
006 073   110 107 006                                JFZ NXAS
006 076   076 253                                    LMI 253
006 100   060                                        INL
006 101   076 253                                    LMI 253
006 103   060                                        INL
006 104   076 253                                    LMI 253
006 106   364                                        LLE
006 107   060                              NXAS,     INL
006 110   006 117                                    LAI 117
006 112   276                                        CPL
006 113   110 066 006                                JFZ AS1
006 116   056 001                                    LHI 001
006 120   066 214                                    LLI 214
006 122   104 112 010                                JMP CMSG

006 125   307                              RWPNT,    LAM
006 126   240                                        NDA
006 127   063                                        RTS
006 130   106 321 005                                CAL ROTR3
006 133   044 007                                    NDI 007
006 135   272                                        CPC
006 136   013                                        RFZ
```

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006 137   307                    LAM
006 140   044 007                NDI 007
006 142   310                    LBA
006 143   002                    RLC
006 144   201                    ADB
006 145   004 217                ADI 217
006 147   346                    LEL
006 150   360                    LLA
006 151   056 001                LHI 001
006 153   250                    XRA
006 154   240                    NDA
006 155   007                    RET

006 156   076 322          RED,  LMI 322
006 160   060                    INL
006 161   076 305                LMI 305
006 163   060                    INL
006 164   076 304                LMI 304
006 166   060                    INL
006 167   076 000                LMI 000
006 171   104 372 012            JMP CND

006 174   066 131         QUAD,  LLI 131
006 176   056 000                LHI 000
006 200   046 324                LEI 324
006 202   036 001                LDI 001
006 204   106 214 006            CAL TWO
006 207   066 311                LLI 311
006 211   104 000 005            JMP MSG

006 214   307              TWO,  LAM
006 215   310                    LBA
006 216   106 144 005            CAL SWITCH
006 221   106 321 005       T1,  CAL ROTR3
006 224   044 007                NDI 007
006 226   004 261                ADI 261
006 230   370                    LMA
006 231   301                    LAB
006 232   044 007                NDI 007
006 234   004 261                ADI 261
```

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006 236    106 014 005                     CAL INMEM
006 241    106 014 005                     CAL INMEM
006 244    370                             LMA
006 245    007                             RET

006 246    307                    FNUM,    LAM
006 247    074 260                         CPI 260
006 251    063                             RTS
006 252    024 272                         SUI 272
006 254    004 200                         ADI 200
006 256    007                             RET

006 257    056 023                 NTN,    LHI 023
006 261    006 215                 NT1,    LAI 215
006 263    106 300 017                     CAL PRINT
006 266    006 212                         LAI 212
006 270    106 300 017                     CAL PRINT
006 273    006 255                 NT2,    LAI 255
006 275    106 300 017                     CAL PRINT
006 300    051                             DCH
006 301    110 273 006                     JFZ NT2
006 304    007                             RET

006 305    004 300                 LRR,    ADI 300
006 307    310                             LBA
006 310    044 007                         NDI 007
006 312    150 034 007                     JTZ CLC1
006 315    301                             LAB
006 316    024 001                         SUI 001
006 320    360                             LLA
006 321    307                             LAM
006 322    066 311                 LR3,    LLI 311
006 324    106 373 006                     CAL QDS1
006 327    361                             LLB
006 330    056 000                         LHI 000
006 332    307                             LAM
006 333    066 317                         LLI 317
006 335    106 373 006                     CAL QDS1
006 340    301                             LAB
006 341    044 007                         NDI 007
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006 343   074 007                   CPI 007
006 345   150 040 007               JTZ CLC2
006 350   301                       LAB
006 351   004 001                   ADI 001
006 353   360                       LLA
006 354   056 000                   LHI 000
006 356   307                       LAM
006 357   066 325             LR4,  LLI 325
006 361   106 373 006               CAL QDS1
006 364   066 305             LRP,  LLI 305
006 366   056 004                   LHI 004
006 370   104 000 005               JMP MSG

006 373   056 004            QDS1,  LHI 004
006 375   320               QDSET,  LCA
006 376   106 320 005               CAL ROTR4
007 001   044 003                   NDI 003
007 003   064 260                   ORI 260
007 005   370                       LMA
007 006   106 014 005               CAL INMEM
007 011   302                       LAC
007 012   106 321 005               CAL ROTR3
007 015   044 001                   NDI 001
007 017   064 260                   ORI 260
007 021   370                       LMA
007 022   106 014 005               CAL INMEM
007 025   302                       LAC
007 026   044 007                   NDI 007
007 030   064 260                   ORI 260
007 032   370                       LMA
007 033   007                       RET

007 034   250                CLC1,  XRA
007 035   104 322 006               JMP LR3

007 040   250                CLC2,  XRA
007 041   104 357 006               JMP LR4

007 044   066 136            RWCM,  LLI 136
007 046   307                       LAM
```

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007 047   012                          RRC
007 050   044 007                      NDI 007
007 052   310                          LBA
007 053   060                          INL
007 054   307                          LAM
007 055   002                          RLC
007 056   002                          RLC
007 057   044 070                      NDI 070
007 061   201                          ADB
007 062   310                          LBA
007 063   007                          RET

007 064   066 135              TIME,   LLI 135
007 066   056 002                      LHI 002
007 070   106 000 005          DONE,   CAL MSG
007 073   104 000 012                  JMP GALAXY

007 076   066 310              LOST,   LLI 310
007 100   056 002                      LHI 002
007 102   104 070 007                  JMP DONE

007 105   066 215             WPOUT,   LLI 215
007 107   056 002                      LHI 002
007 111   104 070 007                  JMP DONE

007 114   066 227              EOUT,   LLI 227
007 116   056 004                      LHI 004
007 120   104 070 007                  JMP DONE

007 123   066 104              NWQD,   LLI 104
007 125   046 013                      LEI 013
007 127   076 200               CLR,   LMI 200
007 131   060                          INL
007 132   041                          DCE
007 133   110 127 007                  JFZ CLR
007 136   066 102                      LLI 102
007 140   307                          LAM
007 141   044 007                      NDI 007
007 143   320                          LCA
007 144   046 104                      LEI 104
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007 146   112 325 005              CFZ LOCSET
007 151   066 102                  LLI 102
007 153   307                      LAM
007 154   106 321 005              CAL ROTR3
007 157   044 001                  NDI 001
007 161   320                      LCA
007 162   046 113                  LEI 113
007 164   112 325 005              CFZ LOCSET
007 167   066 102                  LLI 102
007 171   307                      LAM
007 172   106 320 005              CAL ROTR4
007 175   044 003                  NDI 003
007 177   320                      LCA
007 200   046 114                  LEI 114
007 202   112 325 005              CFZ LOCSET
007 205   106 020 005         LDAS,  CAL RN
007 210   066 123                  LLI 123
007 212   106 227 007              CAL LAS
007 215   066 125                  LLI 125
007 217   106 227 007              CAL LAS
007 222   066 127                  LLI 127
007 224   104 227 007              JMP LAS

007 227   370                  LAS,  LMA
007 230   044 003                  NDI 003
007 232   060                      INL
007 233   370                      LMA
007 234   104 020 005              JMP RN

007 237   066 104            MATCH,  LLI 104
007 241   307                  SCK,  LAM
007 242   240                      NDA
007 243   160 257 007              JTS NS
007 246   271                      CPB
007 247   053                      RTZ
007 250   060                      INL
007 251   006 113                  LAI 113
007 253   276                      CPL
007 254   110 241 007              JFZ SCK
007 257   066 113                NS,  LLI 113
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007 261   307                       LAM
007 262   271                       CPB
007 263   053                       RTZ
007 264   060               ACK,    INL
007 265   307                       LAM
007 266   271                       CPB
007 267   053                       RTZ
007 270   306                       LAL
007 271   074 116                   CPI 116
007 273   110 264 007               JFZ ACK
007 276   240                       NDA
007 277   007                       RET

007 300   066 062           ELOS,   LLI  062
007 302   374                       LME
007 303   060                       INL
007 304   373                       LMD
007 305   061                       DCL
007 306   016 002                   LBI 002
007 310   106 153 005               CAL BINDEC
007 313   036 003                   LDI 003
007 315   046 023                   LEI 023
007 317   016 004                   LBI 004
007 321   106 107 005               CAL DIGPRT
007 324   066 377                   LLI 377
007 326   056 002                   LHI 002
007 330   106 112 010               CAL CMSG
007 333   066 062                   LLI 062
007 335   347                       LEM
007 336   060                       INL
007 337   337                       LDM
007 340   106 332 011       ELS1,   CAL CKSD
007 343   100 314 011               JFC FMSD
007 346   347                       LEM
007 347   060                       INL
007 350   337                       LDM
007 351   106 314 011               CAL FMSD
007 354   106 263 011               CAL TOMN
007 357   066 062                   LLI 062
007 361   347                       LEM
```

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007 362   060                     INL
007 363   337                     LDM
007 364   106 321 011       SD0,  CAL CKMN
007 367   140 114 007             JTC EOUT
007 372   106 302 011             CAL FMMN
007 375   066 025                 LLI 025
007 377   056 003                 LHI 003
010 001   106 112 010             CAL CMSG
010 004   016 002                 LBI 002
010 006   106 062 011             CAL DVD
010 011   106 321 011             CAL CKMN
010 014   140 114 007             JTC EOUT
010 017   104 302 011             JMP FMMN

010 022   106 321 011      ELOM,  CAL CKMN
010 025   100 302 011             JFC FMMN
010 030   324                     LCE
010 031   313                     LBD
010 032   066 121                 LLI 121
010 034   347                     LEM
010 035   060                     INL
010 036   337                     LDM
010 037   106 314 011             CAL FMSD
010 042   106 263 011             CAL TOMN
010 045   342                     LEC
010 046   331                     LDB
010 047   104 364 007             JMP SD0

010 052   076 200          DLET,  LMI 200
010 054   316                     LBL
010 055   066 131                 LLI 131
010 057   307                     LAM
010 060   004 300                 ADI 300
010 062   360                     LLA
010 063   301                     LAB
010 064   074 113                 CPI 113
010 066   110 120 010             JFZ DLAS
010 071   307                     LAM
010 072   044 067                 NDI 067
010 074   370                     LMA
```

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010 075   066 102                  LLI 102
010 077   370                      LMA
010 100   066 133                  LLI 133
010 102   317                      LBM
010 103   011                      DCB
010 104   371                      LMB
010 105   013                      RFZ
010 106   066 333                  LLI 333
010 110   056 004                  LHI 004
010 112   106 000 005      CMSG,   CAL MSG
010 115   056 000                  LHI 000
010 117   007                      RET

010 120   307              DLAS,   LAM
010 121   024 020                  SUI 020
010 123   370                      LMA
010 124   066 102                  LLI 102
010 126   370                      LMA
010 127   066 134                  LLI 134
010 131   317                      LBM
010 132   011                      DCB
010 133   371                      LMB
010 134   013                      RFZ
010 135   066 324                  LLI 324
010 137   056 003                  LHI 003
010 141   104 070 007              JMP DONE

010 144   106 210 017      DRCT,   CAL INPUT
010 147   066 136                  LLI 136
010 151   056 000                  LHI 000
010 153   074 261                  CPI 261
010 155   140 226 010              JTC ZRET
010 160   074 271                  CPI 271
010 162   100 226 010              JFC ZRET
010 165   044 017                  NDI 017
010 167   002                      RLC
010 170   370                      LMA
010 171   006 256                  LAI 256
010 173   106 300 017              CAL PRINT
010 176   106 210 017              CAL INPUT
```

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010 201   074 260                   CPI 260
010 203   150 213 010               JTZ CR1
010 206   074 265                   CPI 265
010 210   110 226 010               JFZ ZRET
010 213   044 001             CR1,  NDI 001
010 215   207                       ADM
010 216   002                       RLC
010 217   024 004                   SUI 004
010 221   370                       LMA
010 222   013                       RFZ
010 223   004 001                   ADI 001
010 225   007                       RET

010 226   250                ZRET,  XRA
010 227   007                       RET

010 230   056 000            QCNT,  LHI 000
010 232   066 131                   LLI 131
010 234   307                       LAM
010 235   004 300                   ADI 300
010 237   360                       LLA
010 240   307                       LAM
010 241   066 102                   LLI 102
010 243   370                       LMA
010 244   007                       RET

010 245   066 136            ACTV,  LLI 136
010 247   367                       LLM
010 250   327                       LCM
010 251   060                       INL
010 252   337                       LDM
010 253   066 103                   LLI 103
010 255   307                       LAM
010 256   310                       LBA
010 257   044 007                   NDI 007
010 261   066 136                   LLI 136
010 263   002                       RLC
010 264   370                       LMA
010 265   060                       INL
010 266   301                       LAB
```

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010 267    044 070                          NDI 070
010 271    012                              RRC
010 272    012                              RRC
010 273    370                              LMA
010 274    007                              RET

010 275    066 060                  TRK,    LLI 060
010 277    375                              LMH
010 300    066 136                          LLI 136
010 302    307                              LAM
010 303    202                              ADC
010 304    370                              LMA
010 305    120 332 010                      JFS NOBK
010 310    044 017                          NDI 017
010 312    370                              LMA
010 313    066 060                          LLI 060
010 315    376                              LML
010 316    066 131                          LLI 131
010 320    307                              LAM
010 321    044 007                          NDI 007
010 323    053                              RTZ
010 324    317                              LBM
010 325    011                              DCB
010 326    371                              LMB
010 327    104 362 010                      JMP RMV
010 332    074 020                 NOBK,    CPI 020
010 334    140 362 010                      JTC RMV
010 337    044 017                          NDI 017
010 341    370                              LMA
010 342    066 060                          LLI 060
010 344    376                              LML
010 345    066 131                          LLI 131
010 347    307                              LAM
010 350    044 007                          NDI 007
010 352    004 001                          ADI 001
010 354    074 010                          CPI 010
010 356    053                              RTZ
010 357    317                              LBM
010 360    010                              INB
010 361    371                              LMB
```

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010 362   066 137                  RMV,   LLI 137
010 364   307                             LAM
010 365   203                             ADD
010 366   370                             LMA
010 367   120 015 011                     JFS NOUP
010 372   044 017                         NDI 017
010 374   370                             LMA
010 375   066 060                         LLI 060
010 377   376                             LML
011 000   066 131                         LLI 131
011 002   307                             LAM
011 003   044 070                         NDI 070
011 005   053                             RTZ
011 006   307                             LAM
011 007   024 010                         SUI 010
011 011   370                             LMA
011 012   104 046 011                     JMP CKX
011 015   074 020                 NOUP,   CPI 020
011 017   140 046 011                     JTC CKX
011 022   044 017                         NDI 017
011 024   370                             LMA
011 025   066 060                         LLI 060
011 027   376                             LML
011 030   066 131                         LLI 131
011 032   307                             LAM
011 033   044 070                         NDI 070
011 035   004 010                         ADI 010
011 037   074 100                         CPI 100
011 041   053                             RTZ
011 042   307                             LAM
011 043   004 010                         ADI 010
011 045   370                             LMA
011 046   066 050                  CKX,   LLI 050
011 050   374                             LME
011 051   060                             INL
011 052   373                             LMD
011 053   060                             INL
011 054   372                             LMC
011 055   013                             RFZ
011 056   006 001                         LAI 001
```

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011 060   240                             NDA
011 061   007                             RET

011 062   240                       DVD,  NDA
011 063   303                             LAD
011 064   032                             RAR
011 065   330                             LDA
011 066   304                             LAE
011 067   032                             RAR
011 070   340                             LEA
011 071   011                             DCB
011 072   110 062 011                     JFZ DVD
011 075   007                             RET

011 076   106 022 010             WASTE,  CAL ELOM
011 101   066 171                         LLI 171
011 103   056 004                         LHI 004
011 105   106 000 005                     CAL MSG
011 110   104 171 013                     JMP CMND

011 113   056 000                   EIN,  LHI 000
011 115   066 144                         LLI 144
011 117   375                             LMH
011 120   066 143                         LLI 143
011 122   106 210 017                     CAL INPUT
011 125   074 255                         CPI 255
011 127   110 140 011                     JFZ EN2
011 132   060                             INL
011 133   376                             LML
011 134   061                             DCL
011 135   106 210 017               EN1,  CAL INPUT
011 140   370                       EN2,  LMA
011 141   106 246 006                     CAL FNUM
011 144   063                             RTS
011 145   307                             LAM
011 146   044 017                         NDI 017
011 150   370                             LMA
011 151   061                             DCL
011 152   006 137                         LAI 137
011 154   276                             CPL
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011 155    053                              RTZ
011 156    104 135 011                      JMP EN1

011 161    066 140                  DCBN,   LLI 140
011 163    307                              LAM
011 164    061                              DCL
011 165    375                              LMH
011 166    061                              DCL
011 167    370                              LMA
011 170    066 141                          LLI 141
011 172    307                              LAM
011 173    240                              NDA
011 174    150 206 011                      JTZ DC1
011 177    310                              LBA
011 200    046 012                          LEI 012
011 202    335                              LDH
011 203    106 251 011                      CAL TOBN
011 206    066 142                   DC1,   LLI 142
011 210    307                              LAM
011 211    240                              NDA
011 212    150 224 011                      JTZ DC2
011 215    310                              LBA
011 216    046 144                          LEI 144
011 220    335                              LDH
011 221    106 251 011                      CAL TOBN
011 224    066 143                   DC2,   LLI 143
011 226    307                              LAM
011 227    240                              NDA
011 230    150 243 011                      JTZ DC3
011 233    310                              LBA
011 234    046 350                          LEI 350
011 236    036 003                          LDI 003
011 240    106 251 011                      CAL TOBN
011 243    066 136                   DC3,   LLI 136
011 245    347                              LEM
011 246    060                              INL
011 247    337                              LDM
011 250    007                              RET

011 251    066 136                  TOBN,   LLI 136
```

```
011 253    106 265 011                          CAL TO1
011 256    011                                  DCB
011 257    053                                  RTZ
011 260    104 251 011                          JMP TOBN

011 263    066 117                     TOMN,    LLI 117
011 265    307                          TO1,    LAM
011 266    204                                  ADE
011 267    370                                  LMA
011 270    060                                  INL
011 271    307                                  LAM
011 272    213                                  ACD
011 273    370                                  LMA
011 274    007                                  RET

011 275    066 121                     TOSD,    LLI 121
011 277    104 265 011                          JMP TO1

011 302    066 117                     FMMN,    LLI 117
011 304    307                          FM1,    LAM
011 305    224                                  SUE
011 306    370                                  LMA
011 307    060                                  INL
011 310    307                                  LAM
011 311    233                                  SBD
011 312    370                                  LMA
011 313    007                                  RET

011 314    066 121                     FMSD,    LLI 121
011 316    104 304 011                          JMP FM1

011 321    066 120                     CKMN,    LLI 120
011 323    307                          CK1,    LAM
011 324    061                                  DCL
011 325    273                                  CPD
011 326    013                                  RFZ
011 327    307                          CK2,    LAM
011 330    274                                  CPE
011 331    007                                  RET
```

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011 332   066 122                  CKSD,   LLI 122
011 334   104 323 011                      JMP CK1

011 337   066 342                  OVER,   LLI 342
011 341   056 004                          LHI 004
011 343   106 000 005                      CAL MSG
011 346   000                              HLT

011 347   307                      SPRC,   LAM
011 350   044 007                          NDI 007
011 352   320                              LCA
011 353   307                              LAM
011 354   106 321 005                      CAL ROTR3
011 357   044 007                          NDI 007
011 361   310                              LBA
011 362   007                              RET

012 000   066 000                GALAXY,   LLI 000
012 002   056 001                          LHI 001
012 004   106 000 005                      CAL MSG
012 007   106 020 005             START,   CAL RN
012 012   106 200 017                      CAL INPCK
012 015   120 007 012                      JFS START
012 020   106 210 017                      CAL INPUT
012 023   074 316                          CPI 316
012 025   150 337 011                      JTZ OVER
012 030   046 300                          LEI 300
012 032   106 020 005            GLXSET,   CAL RN
012 035   044 177                          NDI 177
012 037   360                              LLA
012 040   056 017                          LHI 017
012 042   307                              LAM
012 043   364                              LLE
012 044   056 000                          LHI 000
012 046   370                              LMA
012 047   040                              INE
012 050   110 032 012                      JFZ GLXSET

012 053   335                     GLXCK,   LDH
012 054   325                              LCH
```

```
012 055   066 300                        LLI 300
012 057   307                  GLXCK1,   LAM
012 060   044 010                        NDI 010
012 062   203                            ADD
012 063   330                            LDA
012 064   307                            LAM
012 065   044 060                        NDI 060
012 067   012                            RRC
012 070   012                            RRC
012 071   202                            ADC
012 072   320                            LCA
012 073   060                            INL
012 074   110 057 012                    JFZ GLXCK1
012 077   303                            LAD
012 100   012                            RRC
012 101   012                            RRC
012 102   012                            RRC
012 103   330                            LDA
012 104   074 007                        CPI 007
012 106   100 041 005                    JFC SSPLS
012 111   074 002                        CPI 002
012 113   140 046 005                    JTC SSMNS
012 116   302                            LAC
012 117   012                            RRC
012 120   012                            RRC
012 121   320                            LCA
012 122   074 040                        CPI 040
012 124   100 053 005                    JFC ASPLS
012 127   074 012                        CPI 012
012 131   140 071 005                    JTC ASMNS
012 134   066 133                        LLI 133
012 136   373                            LMD
012 137   060                            INL
012 140   372                            LMC
012 141   302                            LAC
012 142   004 005                        ADI 005
012 144   060                            INL
012 145   370                            LMA
012 146   016 001                        LBI 001
012 150   106 153 005                    CAL BINDEC
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012 153    036 001                           LDI 001
012 155    046 116                           LEI 116
012 157    016 002                           LBI 002
012 161    106 107 005                       CAL DIGPRT
012 164    066 134                           LLI 134
012 166    056 000                           LHI 000
012 170    016 001                           LBI 001
012 172    106 153 005                       CAL BINDEC
012 175    036 001                           LDI 001
012 177    046 074                           LEI 074
012 201    016 002                           LBI 002
012 203    106 107 005                       CAL DIGPRT
012 206    066 133                           LLI 133
012 210    056 000                           LHI 000
012 212    307                               LAM
012 213    064 260                           ORI 260
012 215    056 001                           LHI 001
012 217    066 137                           LLI 137
012 221    370                               LMA
012 222    066 050                           LLI 050
012 224    056 001                           LHI 001
012 226    106 000 005                       CAL MSG
012 231    106 020 005                       CAL RN
012 234    044 077                           NDI 077
012 236    066 131                           LLI 131
012 240    370                               LMA
012 241    106 230 010                       CAL QCNT
012 244    106 300 005                       CAL LOAD
012 247    106 123 007                       CAL NWQD
012 252    026 001                           LCI 001
012 254    046 103                           LEI 103
012 256    106 325 005                       CAL LOCSET
012 261    066 160                 SRSCN,    LLI 160
012 263    056 001                           LHI 001
012 265    106 000 005                       CAL MSG
012 270    026 001                           LCI 001
012 272    106 351 005                       CAL ROWSET
012 275    066 135                           LLI 135
012 277    056 000                           LHI 000
012 301    006 062                           LAI 062
```

```
012 303   227                    SUM
012 304   060                    INL
012 305   370                    LMA
012 306   016 001                LBI 001
012 310   106 153 005            CAL BINDEC
012 313   036 001                LDI 001
012 315   046 266                LEI 266
012 317   016 002                LBI 002
012 321   106 107 005            CAL DIGPRT
012 324   066 250                LLI 250
012 326   056 001                LHI 001
012 330   106 000 005            CAL MSG
012 333   026 002                LCI 002
012 335   106 351 005            CAL ROWSET
012 340   066 102                LLI 102
012 342   307                    LAM
012 343   066 303                LLI 303
012 345   056 001                LHI 001
012 347   044 060                NDI 060
012 351   110 156 006            JFZ RED
012 354   076 307                LMI 307
012 356   060                    INL
012 357   076 322                LMI 322
012 361   060                    INL
012 362   076 305                LMI 305
012 364   060                    INL
012 365   076 305                LMI 305
012 367   060                    INL
012 370   076 316                LMI 316
012 372   066 270          CND,  LLI 270
012 374   106 000 005            CAL MSG
012 377   026 003                LCI 003
013 001   106 351 005            CAL ROWSET
013 004   106 174 006            CAL QUAD
013 007   026 004                LCI 004
013 011   106 351 005            CAL ROWSET
013 014   066 103                LLI 103
013 016   046 343                LEI 343
013 020   030                    IND
013 021   106 214 006            CAL TWO
```

```
013 024    066 330                        LLI 330
013 026    106 000 005                    CAL MSG
013 031    026 005                        LCI 005
013 033    106 351 005                    CAL ROWSET
013 036    066 117                        LLI 117
013 040    016 002                        LBI 002
013 042    106 153 005                    CAL BINDEC
013 045    036 001                        LDI 001
013 047    046 365                        LEI 365
013 051    016 004                        LBI 004
013 053    106 107 005                    CAL DIGPRT
013 056    066 347                        LLI 347
013 060    056 001                        LHI 001
013 062    106 000 005                    CAL MSG
013 065    026 006                        LCI 006
013 067    106 351 005                    CAL ROWSET
013 072    066 132                        LLI 132
013 074    016 001                        LBI 001
013 076    106 153 005                    CAL BINDEC
013 101    036 002                        LDI 002
013 103    046 003                        LEI 003
013 105    016 002                        LBI 002
013 107    106 107 005                    CAL DIGPRT
013 112    066 367                        LLI 367
013 114    056 001                        LHI 001
013 116    106 000 005                    CAL MSG
013 121    026 007                        LCI 007
013 123    106 351 005                    CAL ROWSET
013 126    066 121                        LLI 121
013 130    016 002                        LBI 002
013 132    106 153 005                    CAL BINDEC
013 135    036 002                        LDI 002
013 137    046 023                        LEI 023
013 141    016 004                        LBI 004
013 143    106 107 005                    CAL DIGPRT
013 146    066 005                        LLI 005
013 150    056 002                        LHI 002
013 152    106 000 005                    CAL MSG
013 155    026 010                        LCI 010
013 157    106 351 005                    CAL ROWSET
```

```
013 162    066 160                          LLI 160
013 164    056 001                          LHI 001
013 166    106 000 005                      CAL MSG

013 171    056 000                  CMND,   LHI 000
013 173    046 012                          LEI 012
013 175    335                              LDH
013 176    106 022 010                      CAL ELOM
013 201    066 101                          LLI 101
013 203    347                              LEM
013 204    040                              INE
013 205    374                              LME
013 206    066 025                   CMD,   LLI 025
013 210    056 002                          LHI 002
013 212    106 112 010                      CAL CMSG
013 215    106 210 017                      CAL INPUT
013 220    074 260                          CPI 260
013 222    150 021 014                      JTZ CRSE
013 225    074 261                          CPI 261
013 227    150 261 012                      JTZ SRSCN
013 232    074 262                          CPI 262
013 234    150 266 013                      JTZ LRSCN
013 237    074 263                          CPI 263
013 241    150 266 016                      JTZ GXPRT
013 244    074 264                          CPI 264
013 246    150 007 015                      JTZ SHEN
013 251    074 265                          CPI 265
013 253    150 343 015                      JTZ PHSR
013 256    074 266                          CPI 266
013 260    150 106 015                      JTZ TRPD

013 263    104 206 013                      JMP CMD

013 266    066 115                 LRSCN,   LLI 115
013 270    056 002                          LHI 002
013 272    106 000 005                      CAL MSG
013 275    106 174 006                      CAL QUAD
013 300    106 257 006                      CAL NTN
013 303    066 131                          LLI 131
013 305    307                              LAM
```

```
013 306   044 070                   NDI 070
013 310   150 360 013               JTZ RWC1
013 313   307                       LAM
013 314   024 010                   SUI 010
013 316   106 305 006               CAL LRR
013 321   106 257 006        LR1,   CAL NTN
013 324   066 131                   LLI 131
013 326   307                       LAM
013 327   106 305 006               CAL LRR
013 332   106 257 006               CAL NTN
013 335   066 131                   LLI 131
013 337   307                       LAM
013 340   074 070                   CPI 070
013 342   100 366 013               JFC RWC2
013 345   004 010                   ADI 010
013 347   106 305 006               CAL LRR
013 352   106 257 006        LR2,   CAL NTN
013 355   104 171 013               JMP CMND

013 360   106 374 013       RWC1,   CAL RWC
013 363   104 321 013               JMP LR1

013 366   106 374 013       RWC2,   CAL RWC
013 371   104 352 013               JMP LR2

013 374   066 311            RWC,   LLI 311
013 376   250                       XRA
013 377   106 373 006               CAL QDS1
014 002   066 317                   LLI 317
014 004   250                       XRA
014 005   106 373 006               CAL QDS1
014 010   066 325                   LLI 325
014 012   250                       XRA
014 013   106 373 006               CAL QDS1
014 016   104 364 006               JMP LRP

014 021   066 040           CRSE,   LLI 040
014 023   056 002                   LHI 002
014 025   106 000 005               CAL MSG
014 030   106 144 010               CAL DRCT
```

```
014 033   150 021 014          JTZ CRSE
014 036   066 063        WRP,  LLI 063
014 040   056 002              LHI 002
014 042   106 112 010          CAL CMSG
014 045   066 137              LLI 137
014 047   106 210 017          CAL INPUT
014 052   074 260              CPI 260
014 054   140 036 014          JTC WRP
014 057   074 270              CPI 270
014 061   100 036 014          JFC WRP
014 064   044 007              NDI 007
014 066   002                  RLC
014 067   002                  RLC
014 070   002                  RLC
014 071   370                  LMA
014 072   006 256              LAI 256
014 074   106 300 017          CAL PRINT
014 077   106 210 017          CAL INPUT
014 102   074 260              CPI 260
014 104   140 036 014          JTC WRP
014 107   074 270              CPI 270
014 111   100 036 014          JFC WRP
014 114   044 007              NDI 007
014 116   207                  ADM
014 117   150 036 014          JTZ WRP
014 122   340                  LEA
014 123   106 245 010          CAL ACTV
014 126   066 061              LLI 061
014 130   375                  LMH
014 131   106 275 010    MOV,  CAL TRK
014 134   150 076 007          JTZ LOST
014 137   066 060              LLI 060
014 141   307                  LAM
014 142   240                  NDA
014 143   150 164 014          JTZ CLSN
014 146   060                  INL
014 147   376                  LML
014 150   046 031              LEI 031
014 152   335                  LDH
014 153   106 022 010          CAL ELOM
```

```
014 156   106 230 010               CAL QCNT
014 161   106 123 007               CAL NWQD

014 164   106 044 007        CLSN,  CAL RWCM
014 167   106 237 007               CAL MATCH
014 172   110 216 014               JFZ MVDN
014 175   316                       LBL
014 176   301                       LAB
014 177   074 113                   CPI 113
014 201   066 061                   LLI 061
014 203   307                       LAM
014 204   150 274 014               JTZ SSOUT
014 207   100 316 014               JFC ASOUT
014 212   240                       NDA
014 213   150 105 007               JTZ WPOUT

014 216   056 000            MVDN,  LHI 000
014 220   066 050                   LLI 050
014 222   347                       LEM
014 223   060                       INL
014 224   337                       LDM
014 225   060                       INL
014 226   327                       LCM
014 227   041                       DCE
014 230   110 131 014               JFZ MOV

014 233   066 061                   LLI 061
014 235   307                       LAM
014 236   240                       NDA
014 237   150 252 014               JTZ NOX
014 242   066 135                   LLI 135
014 244   317                       LBM
014 245   011                       DCB
014 246   150 064 007               JTZ TIME
014 251   371                       LMB

014 252   106 044 007        NOX,   CAL RWCM
014 255   066 103                   LLI 103
014 257   371                       LMB
014 260   106 237 007               CAL MATCH
```

```
014 263    152 335 014                      CTZ CHNG
014 266    106 343 014                      CAL DKED
014 271    104 261 012                      JMP SRSCN

014 274    240                     SSOUT,   NDA
014 275    110 216 014                      JFZ MVDN
014 300    361                              LLB
014 301    106 052 010                      CAL DLET
014 304    046 130                          LEI 130
014 306    036 002                          LDI 002
014 310    106 300 007              SSO1,   CAL ELOS
014 313    104 216 014                      JMP MVDN

014 316    240                     ASOUT,   NDA
014 317    110 216 014                      JFZ MVDN
014 322    361                              LLB
014 323    106 052 010                      CAL DLET
014 326    046 334                          LEI 334
014 330    036 005                          LDI 005
014 332    104 310 014                      JMP SSO1

014 335    346                      CHNG,   LEL
014 336    026 001                          LCI 001
014 340    104 325 005                      JMP LOCSET

014 343    066 113                  DKED,   LLI 113
014 345    307                              LAM
014 346    240                              NDA
014 347    063                              RTS
014 350    301                              LAB
014 351    044 070                          NDI 070
014 353    320                              LCA
014 354    301                              LAB
014 355    044 007                          NDI 007
014 357    310                              LBA
014 360    307                              LAM
014 361    044 007                          NDI 007
014 363    340                              LEA
014 364    307                              LAM
014 365    044 070                          NDI 070
```

```
014 367   272                        CPC
014 370   013                        RFZ
014 371   301                        LAB
014 372   004 001                    ADI 001
014 374   274                        CPE
014 375   150 300 005                JTZ LOAD
015 000   024 002                    SUI 002
015 002   274                        CPE
015 003   013                        RFZ
015 004   104 300 005                JMP LOAD

015 007   066 060            SHEN,   LLI 060
015 011   056 003                    LHI 003
015 013   106 000 005                CAL MSG
015 016   106 113 011                CAL EIN
015 021   160 007 015                JTS SHEN
015 024   106 161 011                CAL DCBN
015 027   066 144                    LLI 144
015 031   307                        LAM
015 032   240                        NDA
015 033   150 055 015                JTZ POS
015 036   106 332 011                CAL CKSD
015 041   140 074 015                JTC NE
015 044   106 314 011                CAL FMSD
015 047   106 263 011                CAL TOMN
015 052   104 171 013                JMP CMND

015 055   106 321 011             POS,   CAL CKMN
015 060   140 074 015                JTC NE
015 063   106 302 011                CAL FMMN
015 066   106 275 011                CAL TOSD
015 071   104 171 013                JMP CMND

015 074   066 114                  NE,   LLI 114
015 076   056 003                    LHI 003
015 100   106 000 005                CAL MSG
015 103   104 171 013                JMP CMND

015 106   066 132            TRPD,   LLI 132
015 110   307                        LAM
```

```
015 111   240                          NDA
015 112   150 331 015                  JTZ NTPD
015 115   046 372                      LEI 372
015 117   335                          LDH
015 120   106 321 011                  CAL CKMN
015 123   140 074 015                  JTC NE
015 126   106 302 011                  CAL FMMN
015 131   066 132                      LLI 132
015 133   307                          LAM
015 134   024 001                      SUI 001
015 136   370                          LMA
015 137   066 140              TR1,    LLI 140
015 141   056 003                      LHI 003
015 143   106 000 005                  CAL MSG
015 146   106 144 010                  CAL DRCT
015 151   150 137 015                  JTZ TR1
015 154   106 245 010                  CAL ACTV
015 157   066 131                      LLI 131
015 161   307                          LAM
015 162   066 053                      LLI 053
015 164   370                          LMA
015 165   106 275 010          TR2,    CAL TRK
015 170   150 303 015                  JTZ QOUT
015 173   066 060                      LLI 060
015 175   307                          LAM
015 176   240                          NDA
015 177   110 303 015                  JFZ QOUT
015 202   106 044 007                  CAL RWCM
015 205   321                          LCB
015 206   066 036                      LLI 036
015 210   056 004                      LHI 004
015 212   106 221 006                  CAL T1
015 215   066 022                      LLI 022
015 217   106 112 010                  CAL CMSG
015 222   312                          LBC
015 223   106 237 007                  CAL MATCH
015 226   150 243 015                  JTZ HIT
015 231   066 050                      LLI 050
015 233   347                          LEM
015 234   060                          INL
```

```
015 235   337                    LDM
015 236   060                    INL
015 237   327                    LCM
015 240   104 165 015            JMP TR2

015 243   306              HIT,  LAL
015 244   074 113                CPI 113
015 246   140 303 015            JTC QOUT
015 251   150 271 015            JTZ SSTA
015 254   106 052 010            CAL DLET
015 257   066 177                LLI 177
015 261   056 003                LHI 003
015 263   106 000 005            CAL MSG
015 266   104 171 013            JMP CMND

015 271   106 052 010     SSTA,  CAL DLET
015 274   066 272                LLI 272
015 276   056 003                LHI 003
015 300   106 000 005            CAL MSG

015 303   066 226         QOUT,  LLI 226
015 305   056 003                LHI 003
015 307   106 112 010            CAL CMSG
015 312   046 310                LEI 310
015 314   335                    LDH
015 315   106 300 007            CAL ELOS
015 320   066 053                LLI 053
015 322   307                    LAM
015 323   066 131                LLI 131
015 325   370                    LMA
015 326   104 171 013            JMP CMND

015 331   066 266         NTPD,  LLI 266
015 333   056 004                LHI 004
015 335   106 000 005            CAL MSG
015 340   104 171 013            JMP CMND

015 343   066 063         PHSR,  LLI 063
015 345   056 004                LHI 004
015 347   106 000 005            CAL MSG
```

```
015 352     106 113 011                       CAL EIN
015 355     160 343 015                       JTS PHSR
015 360     106 161 011                       CAL DCBN
015 363     106 022 010                       CAL ELOM
015 366     066 102                           LLI 102
015 370     307                               LAM
015 371     044 060                           NDI 060
015 373     150 076 011                       JTZ WASTE
015 376     106 320 005                       CAL ROTR4
016 001     024 001                           SUI 001
016 003     150 012 016                       JTZ PH1
016 006     310                               LBA
016 007     106 062 011                       CAL DVD
016 012     066 136                   PH1,    LLI 136
016 014     374                               LME
016 015     060                               INL
016 016     373                               LMD
016 017     066 050                           LLI 050
016 021     374                               LME
016 022     060                               INL
016 023     373                               LMD
016 024     060                               INL
016 025     076 114                           LMI 114
016 027     106 053 016                       CAL ASPH
016 032     066 052                           LLI 052
016 034     076 115                           LMI 115
016 036     106 053 016                       CAL ASPH
016 041     066 052                           LLI 052
016 043     076 116                           LMI 116
016 045     106 053 016                       CAL ASPH
016 050     104 171 013                       JMP CMND

016 053     367                       ASPH,   LLM
016 054     307                               LAM
016 055     240                               NDA
016 056     063                               RTS
016 057     046 145                           LEI 145
016 061     036 004                           LDI 004
016 063     106 214 006                       CAL TWO
016 066     066 116                           LLI 116
```

```
016 070    106 112 010                          CAL CMSG
016 073    066 103                              LLI 103
016 075    106 347 011                          CAL SPRC
016 100    364                                  LLE
016 101    353                                  LHD
016 102    342                                  LEC
016 103    331                                  LDB
016 104    106 347 011                          CAL SPRC
016 107    301                                  LAB
016 110    223                                  SUD
016 111    120 120 016                          JFS PH2
016 114    054 377                              XRI 377
016 116    004 001                              ADI 001
016 120    310                           PH2,   LBA
016 121    302                                  LAC
016 122    224                                  SUE
016 123    120 132 016                          JFS PH3
016 126    054 377                              XRI 377
016 130    004 001                              ADI 001

016 132    201                           PH3,   ADB
016 133    012                                  RRC
016 134    012                                  RRC
016 135    044 003                              NDI 003
016 137    310                                  LBA
016 140    326                                  LCL
016 141    066 050                              LLI 050
016 143    347                                  LEM
016 144    060                                  INL
016 145    337                                  LDM
016 146    011                                  DCB
016 147    010                                  INB
016 150    112 062 011                          CFZ DVD
016 153    302                                  LAC
016 154    044 003                              NDI 003
016 156    002                                  RLC
016 157    004 123                              ADI 123
016 161    066 053                              LLI 053
016 163    370                                  LMA
016 164    360                                  LLA
```

```
016 165    106 304 011                        CAL FM1
016 170    160 251 016                        JTS DSTR
016 173    110 205 016                        JFZ ALOS
016 176    061                                DCL
016 177    307                                LAM
016 200    060                                INL
016 201    240                                NDA
016 202    150 251 016                        JTZ DSTR
016 205    061                        ALOS,   DCL
016 206    016 002                            LBI 002
016 210    106 153 005                        CAL BINDEC
016 213    046 167                            LEI 167
016 215    036 004                            LDI 004
016 217    016 004                            LBI 004
016 221    106 107 005                        CAL DIGPRT
016 224    066 153                            LLI 153
016 226    056 004                            LHI 004
016 230    106 112 010                        CAL CMSG
016 233    066 053                            LLI 053
016 235    367                                LLM
016 236    347                                LEM
016 237    060                                INL
016 240    337                                LDM
016 241    016 002                            LBI 002
016 243    106 062 011                        CAL DVD
016 246    104 300 007                        JMP ELOS

016 251    066 312                    DSTR,   LLI 312
016 253    056 003                            LHI 003
016 255    106 112 010                        CAL CMSG
016 260    066 052                            LLI 052
016 262    367                                LLM
016 263    104 052 010                        JMP DLET

016 266    066 042                    GXPRT,  LLI 042
016 270    056 004                            LHI 004
016 272    106 000 005                        CAL MSG
016 275    056 061                            LHI 061
016 277    106 261 006                        CAL NT1
016 302    066 300                            LLI 300
```

```
016 304    335                            GL1,  LDH
016 305    046 204                              LEI 204
016 307    307                            GL2,  LAM
016 310    106 144 005                          CAL SWITCH
016 313    106 375 006                          CAL QDSET
016 316    306                                  LAL
016 317    004 004                              ADI 004
016 321    360                                  LLA
016 322    106 144 005                          CAL SWITCH
016 325    060                                  INL
016 326    074 264                              CPI 264
016 330    110 307 016                          JFZ GL2
016 333    106 144 005                          CAL SWITCH
016 336    066 200                              LLI 200
016 340    106 000 005                          CAL MSG
016 343    056 061                              LHI 061
016 345    106 261 006                          CAL NT1
016 350    304                                  LAE
016 351    275                                  CPH
016 352    150 171 013                          JTZ CMND
016 355    106 144 005                          CAL SWITCH
016 360    104 304 016                          JMP GL1
```

```
017 000    000 001 004 043 012 003 007 000
017 010    000 032 043 005 003 024 026 022
017 020    000 000 000 000 000 005 004 027
017 030    005 001 024 000 000 004 005 000
017 040    007 002 021 011 000 004 000 000
017 050    043 000 002 044 000 000 003 007
017 060    000 025 000 005 014 000 002 006
017 070    025 000 003 002 023 000 064 003
017 100    007 001 000 000 000 003 025 000
017 110    000 004 000 037 004 001 003 002
017 120    003 024 000 000 000 026 015 000
017 130    000 004 023 003 000 000 000 024
017 140    013 001 025 023 000 000 004 003
017 150    007 000 000 000 035 004 000 026
017 160    000 023 025 000 000 004 006 002
017 170    003 025 000 000 026 000 047 000


017 200    INPCK,


017 210    INPUT,


017 300    PRINT,
```

8080 ASSEMBLED LISTING

The assembled listing for the 8080 version of the Galaxy program is now presented. It contains essentially the same logic as the 8008 version. The 8080 version, however, makes use of the extended instruction set of the 8080 CPU for setting up pointers, incrementing and decrementing register pairs and memory locations, and exchanging the contents of register pairs. The listing for the 8080 version also includes instructions for setting up the stack pointer, an operation not required for the 8008. The stack for this program is located in the upper portion of page 11 starting at location 377 and working down.

The memory usage of pages 00 through 04 and page 17 is exactly the same as that assigned for the 8008 version. These areas include the course table, temporary data storage, the galaxy content table, messages, and the galaxy set up table. Because they are the same as presented in the 8008 listing, they will not be repeated here. The reader should refer back to Chapter Five for the contents of these particular sections. The listing presented here contains the memory addresses and contents for the subroutines and major routines of the Galaxy program for operation in an 8080 based microcomputer. The reader simply adds the required I/O driver routines for the devices available on one's system, as described in Chapter Two, and the Galaxy program is ready to operate.

The start of execution address of this program, as listed, is on page 12 at location 000.

```
005 000    176                     MSG,   LAM
005 001    247                            NDA
005 002    310                            RTZ
005 003    315 300 017                    CAL PRINT
005 006    043                            INXH
005 007    303 000 005                    JMP MSG
```

```
005 012   041 100 000            RN,  LXH 100 000
005 015   176                         LAM
005 016   107                         LBA
005 017   007                         RLC
005 020   250                         XRB
005 021   017                         RRC
005 022   054                         INL
005 023   064                         INM
005 024   206                         ADM
005 025   055                         DCL
005 026   167                         LMA
005 027   311                         RET

005 030   036 367             SSPLS,  LEI 367
005 032   303 044 005                 JMP PLS

005 035   036 010             SSMNS,  LEI 010
005 037   303 062 005                 JMP MNS

005 042   036 317             ASPLS,  LEI 317
005 044   315 012 005           PLS,  CAL RN
005 047   366 300                     ORI 300
005 051   157                         LLA
005 052   173                         LAE
005 053   246                         NDM
005 054   167                         LMA
005 055   303 055 012                 JMP GLXCK

005 060   036 020             ASMNS,  LEI 020
005 062   315 012 005           MNS,  CAL RN
005 065   366 300                     ORI 300
005 067   157                         LLA
005 070   173                         LAE
005 071   266                         ORM
005 072   167                         LMA
005 073   303 055 012                 JMP GLXCK

005 076   176                DIGPRT,  LAM
005 077   306 260                     ADI 260
005 101   043                         INXH
```

```
005 102   353                           XCHG
005 103   167                           LMA
005 104   053                           DCXH
005 105   005                           DCB
005 106   310                           RTZ
005 107   353                           XCHG
005 110   303 076 005                   JMP DIGPRT

005 113   353               BINDEC,     XCHG
005 114   041 140 000                   LXH 140 000
005 117   164                           LMH
005 120   054                           INL
005 121   164                           LMH
005 122   054                           INL
005 123   164                           LMH
005 124   054                           INL
005 125   164                           LMH
005 126   054                           INL
005 127   164                           LMH
005 130   353                           XCHG
005 131   136                           LEM
005 132   005                           DCB
005 133   312 140 005                   JTZ BNDC
005 136   054                           INL
005 137   126                           LDM
005 140   041 144 000         BNDC,     LXH 144 000
005 143   001 020 047                   LXB 020 047
005 146   315 200 005                   CAL BD
005 151   055                           DCL
005 152   001 350 003                   LXB 350 003
005 155   315 200 005                   CAL BD
005 160   055                           DCL
005 161   001 144 000                   LXB 144 000
005 164   315 200 005                   CAL BD
005 167   055                           DCL
005 170   016 012                       LCI 012
005 172   315 200 005                   CAL BD
005 175   055                           DCL
005 176   163                           LME
005 177   311                           RET
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005 200    064                         BD,  INM
005 201    173                              LAE
005 202    221                              SUC
005 203    137                              LEA
005 204    172                              LAD
005 205    230                              SBB
005 206    127                              LDA
005 207    322 200 005                      JFC BD
005 212    173                              LAE
005 213    201                              ADC
005 214    137                              LEA
005 215    172                              LAD
005 216    210                              ACB
005 217    127                              LDA
005 220    065                              DCM
005 221    311                              RET

005 222    056 117                   LOAD,  LLI 117
005 224    066 210                          LMI 210
005 226    054                              INL
005 227    066 023                          LMI 023
005 231    054                              INL
005 232    164                              LMH
005 233    054                              INL
005 234    164                              LMH
005 235    056 132                          LLI 132
005 237    066 012                          LMI 012
005 241    311                              RET

005 242    017                      ROTR4,  RRC
005 243    017                      ROTR3,  RRC
005 244    017                              RRC
005 245    017                              RRC
005 246    311                              RET

005 247    315 012 005             LOCSET,  CAL RN
005 252    346 077                          NDI 077
005 254    107                              LBA
005 255    315 135 007                      CAL MATCH
005 260    312 247 005                      JTZ LOCSET
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005 263   153                              LLE
005 264   160                              LMB
005 265   034                              INE
005 266   015                              DCC
005 267   302 247 005                      JFZ LOCSET
005 272   311                              RET

005 273   041 217 001             ROWSET,  LXH 217 001
005 276   066 240                   RCLR,  LMI 240
005 300   054                              INL
005 301   076 247                          LAI 247
005 303   275                              CPL
005 304   302 276 005                      JFZ RCLR
005 307   171                              LAC
005 310   306 260                          ADI 260
005 312   056 216                          LLI 216
005 314   167                              LMA
005 315   015                              DCC
005 316   041 103 000                      LXH 103 000
005 321   315 044 006                      CAL RWPNT
005 324   302 337 005                      JFZ STR
005 327   066 274                          LMI 274
005 331   054                              INL
005 332   066 252                          LMI 252
005 334   054                              INL
005 335   066 276                          LMI 276
005 337   056 104                    STR,  LLI 104
005 341   046 000                   STR1,  LHI 000
005 343   315 044 006                      CAL RWPNT
005 346   302 355 005                      JFZ NXSTR
005 351   054                              INL
005 352   066 252                          LMI 252
005 354   153                              LLE
005 355   054                  NXSTR,      INL
005 356   076 113                          LAI 113
005 360   275                              CPL
005 361   302 341 005                      JFZ STR1
005 364   046 000                          LHI 000
005 366   315 044 006                      CAL RWPNT
005 371   302 004 006                      JFZ AS
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005 374    066 276                      LMI 276
005 376    054                          INL
005 377    066 261                      LMI 261
006 001    054                          INL
006 002    066 274                      LMI 274
006 004    056 114                 AS,  LLI 114
006 006    046 000                AS1,  LHI 000
006 010    315 044 006                  CAL RWPNT
006 013    302 027 006                  JFZ NXAS
006 016    066 253                      LMI 253
006 020    054                          INL
006 021    066 253                      LMI 253
006 023    054                          INL
006 024    066 253                      LMI 253
006 026    153                          LLE
006 027    054                   NXAS,  INL
006 030    076 117                      LAI 117
006 032    275                          CPL
006 033    302 006 006                  JFZ AS1
006 036    041 214 001                  LXH 214 001
006 041    303 002 010                  JMP CMSG

006 044    176                  RWPNT,  LAM
006 045    247                          NDA
006 046    370                          RTS
006 047    315 243 005                  CAL ROTR3
006 052    346 007                      NDI 007
006 054    271                          CPC
006 055    300                          RFZ
006 056    176                          LAM
006 057    346 007                      NDI 007
006 061    107                          LBA
006 062    007                          RLC
006 063    200                          ADB
006 064    306 217                      ADI 217
006 066    135                          LEL
006 067    157                          LLA
006 070    046 001                      LHI 001
006 072    257                          XRA
006 073    247                          NDA
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006 074   311                         RET

006 075   066 322              RED,   LMI 322
006 077   054                         INL
006 100   066 305                     LMI 305
006 102   054                         INL
006 103   066 304                     LMI 304
006 105   054                         INL
006 106   066 000                     LMI 000
006 110   303 361 012                 JMP CND

006 113   041 131 000         QUAD,   LXH 131 000
006 116   021 324 001                 LXD 324 001
006 121   315 131 006                 CAL TWO
006 124   056 311                     LLI 311
006 126   303 000 005                 JMP MSG

006 131   176                  TWO,   LAM
006 132   107                         LBA
006 133   353                         XCHG
006 134   315 243 005           T1,   CAL ROTR3
006 137   346 007                     NDI 007
006 141   306 261                     ADI 261
006 143   167                         LMA
006 144   170                         LAB
006 145   346 007                     NDI 007
006 147   306 261                     ADI 261
006 151   043                         INXH
006 152   043                         INXH
006 153   167                         LMA
006 154   311                         RET

006 155   176                 FNUM,   LAM
006 156   376 260                     CPI 260
006 160   370                         RTS
006 161   326 272                     SUI 272
006 163   306 200                     ADI 200
006 165   311                         RET

006 166   046 023              NTN,   LHI 023
```

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006 170   076 215                  NT1,   LAI 215
006 172   315 300 017                     CAL PRINT
006 175   076 212                         LAI 212
006 177   315 300 017                     CAL PRINT
006 202   076 255                  NT2,   LAI 255
006 204   315 300 017                     CAL PRINT
006 207   045                             DCH
006 210   302 202 006                     JFZ NT2
006 213   311                             RET

006 214   306 300                  LRR,   ADI 300
006 216   107                             LBA
006 217   346 007                         NDI 007
006 221   312 336 006                     JTZ CLC1
006 224   170                             LAB
006 225   326 001                         SUI 001
006 227   157                             LLA
006 230   176                             LAM
006 231   056 311                  LR3,   LLI 311
006 233   315 301 006                     CAL QDS1
006 236   150                             LLB
006 237   046 000                         LHI 000
006 241   176                             LAM
006 242   056 317                         LLI 317
006 244   315 301 006                     CAL QDS1
006 247   170                             LAB
006 250   346 007                         NDI 007
006 252   376 007                         CPI 007
006 254   312 342 006                     JTZ CLC2
006 257   170                             LAB
006 260   306 001                         ADI 001
006 262   157                             LLA
006 263   046 000                         LHI 000
006 265   176                             LAM
006 266   056 325                  LR4,   LLI 325
006 270   315 301 006                     CAL QDS1
006 273   041 305 004              LRP,   LXH 305 004
006 276   303 000 005                     JMP MSG

006 301   046 004                  QDS1,  LHI 004
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006 303    117                      QDSET,  LCA
006 304    315 242 005                      CAL ROTR4
006 307    346 003                          NDI 003
006 311    366 260                          ORI 260
006 313    167                              LMA
006 314    043                              INXH
006 315    171                              LAC
006 316    315 243 005                      CAL ROTR3
006 321    346 001                          NDI 001
006 323    366 260                          ORI 260
006 325    167                              LMA
006 326    043                              INXH
006 327    171                              LAC
006 330    346 007                          NDI 007
006 332    366 260                          ORI 260
006 334    167                              LMA
006 335    311                              RET

006 336    257                       CLC1,  XRA
006 337    303 231 006                      JMP LR3

006 342    257                       CLC2,  XRA
006 343    303 266 006                      JMP LR4

006 346    056 136                   RWCM,  LLI 136
006 350    176                              LAM
006 351    017                              RRC
006 352    346 007                          NDI 007
006 354    107                              LBA
006 355    054                              INL
006 356    176                              LAM
006 357    007                              RLC
006 360    007                              RLC
006 361    346 070                          NDI 070
006 363    200                              ADB
006 364    107                              LBA
006 365    311                              RET

006 366    041 135 002               TIME,  LXH 135 002
006 371    315 000 005               DONE,  CAL MSG
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006 374   303 000 012                     JMP GALAXY

006 377   041 310 002             LOST,   LXH 310 002
007 002   303 371 006                     JMP DONE

007 005   041 215 002            WPOUT,   LXH 215 002
007 010   303 371 006                     JMP DONE

007 013   041 227 004             EOUT,   LXH 227 004
007 016   303 371 006                     JMP DONE

007 021   056 104                 NXQD,   LLI 104
007 023   036 013                         LEI 013
007 025   066 200                  CLR,   LMI 200
007 027   054                             INL
007 030   035                             DCE
007 031   302 025 007                     JFZ CLR
007 034   056 102                         LLI 102
007 036   176                             LAM
007 037   346 007                         NDI 007
007 041   117                             LCA
007 042   036 104                         LEI 104
007 044   304 247 005                     CFZ LOCSET
007 047   056 102                         LLI 102
007 051   176                             LAM
007 052   315 243 005                     CAL ROTR3
007 055   346 001                         NDI 001
007 057   117                             LCA
007 060   036 113                         LEI 113
007 062   304 247 005                     CFZ LOCSET
007 065   056 102                         LLI 102
007 067   176                             LAM
007 070   315 242 005                     CAL ROTR4
007 073   346 003                         NDI 003
007 075   117                             LCA
007 076   036 114                         LEI 114
007 100   304 247 005                     CFZ LOCSET
007 103   315 012 005             LDAS,   CAL RN
007 106   056 123                         LLI 123
007 110   315 125 007                     CAL LAS
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007 113    056 125                             LLI 125
007 115    315 125  007                        CAL LAS
007 120    056 127                             LLI 127
007 122    303 125  007                        JMP LAS

007 125    167                           LAS,  LMA
007 126    346 003                             NDI 003
007 130    054                                 INL
007 131    167                                 LMA
007 132    303 012  005                        JMP RN

007 135    056 104                     MATCH,  LLI 104
007 137    176                           SCK,  LAM
007 140    247                                 NDA
007 141    372 155  007                        JTS NS
007 144    270                                 CPB
007 145    310                                 RTZ
007 146    054                                 INL
007 147    076 113                             LAI 113
007 151    275                                 CPL
007 152    302 137  007                        JFZ SCK
007 155    056 113                        NS,  LLI 113
007 157    176                                 LAM
007 160    270                                 CPB
007 161    310                                 RTZ
007 162    054                           ACK,  INL
007 163    176                                 LAM
007 164    270                                 CPB
007 165    310                                 RTZ
007 166    175                                 LAL
007 167    376 116                             CPI 116
007 171    302 162  007                        JFZ ACK
007 174    247                                 NDA
007 175    311                                 RET

007 176    056 062                      ELOS,  LLI 062
007 200    163                                 LME
007 201    054                                 INL
007 202    162                                 LMD
007 203    055                                 DCL
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007 204    006 002                            LBI 002
007 206    315 113 005                        CAL BINDEC
007 211    021 023 003                        LXD 023 003
007 214    006 004                            LBI 004
007 216    315 076 005                        CAL DIGPRT
007 221    041 377 002                        LXH 377 002
007 224    315 002 010                        CAL CMSG
007 227    056 062                            LLI 062
007 231    136                                LEM
007 232    054                                INL
007 233    126                                LDM
007 234    315 206 011                 ELS1,  CAL CKSD
007 237    322 170 011                        JFC FMSD
007 242    136                                LEM
007 243    054                                INL
007 244    126                                LDM
007 245    315 170 011                        CAL FMSD
007 250    315 137 011                        CAL TOMN
007 253    056 062                            LLI 062
007 255    136                                LEM
007 256    054                                INL
007 257    126                                LDM

007 260    315 175 011                 SD0,   CAL CKMN
007 263    332 013 007                        JTC EOUT
007 266    315 156 011                        CAL FMMN
007 271    041 025 003                        LXH 025 003
007 274    315 002 010                        CAL CMSG
007 277    006 002                            LBI 002
007 301    315 341 010                        CAL DVD
007 304    315 175 011                        CAL CKMN
007 307    332 013 007                        JTC EOUT
007 312    303 156 011                        JMP FMMN

007 315    315 175 011                 ELOM,  CAL CKMN
007 320    322 156 011                        JFC FMMN
007 323    113                                LCE
007 324    102                                LBD
007 325    056 121                            LLI 121
007 327    136                                LEM
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007 330   054                           INL
007 331   126                           LDM
007 332   315 170 011                   CAL FMSD
007 335   315 137 011                   CAL TOMN
007 340   131                           LEC
007 341   120                           LDB
007 342   303 260 007                   JMP SD0

007 345   066 200               DLET,   LMI 200
007 347   105                           LBL
007 350   056 131                       LLI 131
007 352   176                           LAM
007 353   306 300                       ADI 300
007 355   157                           LLA
007 356   170                           LAB
007 357   376 113                       CPI 113
007 361   302 010 010                   JFZ DLAS
007 364   176                           LAM
007 365   346 067                       NDI 067
007 367   167                           LMA
007 370   056 102                       LLI 102
007 372   167                           LMA
007 373   056 133                       LLI 133
007 375   065                           DCM
007 376   300                           RFZ
007 377   041 333 004                   LXH 333 004
010 002   315 000 005           CMSG,   CAL MSG
010 005   046 000                       LHI 000
010 007   311                           RET

010 010   176                   DLAS,   LAM
010 011   326 020                       SUI 020
010 013   167                           LMA
010 014   056 102                       LLI 102
010 016   167                           LMA
010 017   056 134                       LLI 134
010 021   065                           DCM
010 022   300                           RFZ
010 023   041 324 003                   LXH 324 003
010 026   303 371 006                   JMP DONE
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010 031    315 210 017          DRCT,  CAL INPUT
010 034    041 136 000                 LXH 136 000
010 037    376 261                     CPI 261
010 041    332 112 010                 JTC ZRET
010 044    376 271                     CPI 271
010 046    322 112 010                 JFC ZRET
010 051    346 017                     NDI 017
010 053    007                         RLC
010 054    167                         LMA
010 055    076 256                     LAI 256
010 057    315 300 017                 CAL PRINT
010 062    315 210 017                 CAL INPUT
010 065    376 260                     CPI 260
010 067    312 077 010                 JTZ CR1
010 072    376 265                     CPI 265
010 074    302 112 010                 JFZ ZRET
010 077    346 001               CR1.  NDI 001
010 101    206                         ADM
010 102    007                         RLC
010 103    326 004                     SUI 004
010 105    167                         LMA
010 106    300                         RFZ
010 107    306 001                     ADI 001
010 111    311                         RET

010 112    257                  ZRET,  XRA
010 113    311                         RET

010 114    041 131 000          QCNT,  LXH 131 000
010 117    176                         LAM
010 120    306 300                     ADI 300
010 122    157                         LLA
010 123    176                         LAM
010 124    056 102                     LLI 102
010 126    167                         LMA
010 127    311                         RET

010 130    056 136              ACTV,  LLI 136
010 132    156                         LLM
010 133    116                         LCM
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010 134   054                    INL
010 135   126                    LDM
010 136   056 103                LLI 103
010 140   176                    LAM
010 141   107                    LBA
010 142   346 007                NDI 007
010 144   056 136                LLI 136
010 146   007                    RLC
010 147   167                    LMA
010 150   054                    INL
010 151   170                    LAB
010 152   346 070                NDI 070
010 154   017                    RRC
010 155   017                    RRC
010 156   167                    LMA
010 157   311                    RET

010 160   056 060         TRK,   LLI 060
010 162   164                    LMH
010 163   056 136                LLI 136
010 165   176                    LAM
010 166   201                    ADC
010 167   167                    LMA
010 170   362 213 010            JFS NOBK
010 173   346 017                NDI 017
010 175   167                    LMA
010 176   056 060                LLI 060
010 200   165                    LML
010 201   056 131                LLI 131
010 203   176                    LAM
010 204   346 007                NDI 007
010 206   310                    RTZ
010 207   065                    DCM
010 210   303 241 010            JMP RMV
010 213   376 020        NOBK,   CPI 020
010 215   332 241 010            JTC RMV
010 220   346 017                NDI 017
010 222   167                    LMA
010 223   056 060                LLI 060
010 225   165                    LML
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010 226   056 131                    LLI 131
010 230   176                        LAM
010 231   346 007                    NDI 007
010 233   306 001                    ADI 001
010 235   376 010                    CPI 010
010 237   310                        RTZ
010 240   064                        INM
010 241   056 137              RMV,  LLI 137
010 243   176                        LAM
010 244   202                        ADD
010 245   167                        LMA
010 246   362 274 010                JFS NOUP
010 251   346 017                    NDI 017
010 253   167                        LMA
010 254   056 060                    LLI 060
010 256   165                        LML
010 257   056 131                    LLI 131
010 261   176                        LAM
010 262   346 070                    NDI 070
010 264   310                        RTZ
010 265   176                        LAM
010 266   326 010                    SUI 010
010 270   167                        LMA
010 271   303 325 010                JMP CKX
010 274   376 020             NOUP,  CPI 020
010 276   332 325 010                JTC CKX
010 301   346 017                    NDI 017
010 303   167                        LMA
010 304   056 060                    LLI 060
010 306   165                        LML
010 307   056 131                    LLI 131
010 311   176                        LAM
010 312   346 070                    NDI 070
010 314   306 010                    ADI 010
010 316   376 100                    CPI 100
010 320   310                        RTZ
010 321   176                        LAM
010 322   306 010                    ADI 010
010 324   167                        LMA
010 325   056 050              CKX,  LLI 050
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010 327    163                           LME
010 330    054                           INL
010 331    162                           LMD
010 332    054                           INL
010 333    161                           LMC
010 334    300                           RFZ
010 335    076 001                       LAI 001
010 337    247                           NDA
010 340    311                           RET

010 341    247                  DVD,     NDA
010 342    172                           LAD
010 343    037                           RAR
010 344    127                           LDA
010 345    173                           LAE
010 346    037                           RAR
010 347    137                           LEA
010 350    005                           DCB
010 351    302 341 010                   JFZ DVD
010 354    311                           RET

010 355    315 315 007        WASTE,     CAL ELOM
010 360    041 171 004                   LXH 171 004
010 363    315 000 005                   CAL MSG
010 366    303 153 013                   JMP CMND

010 371    041 144 000          EIN,     LXH 144 000
010 374    164                           LMH
010 375    056 143                       LLI 143
010 377    315 210 017                   CAL INPUT
011 002    376 255                       CPI 255
011 004    302 015 011                   JFZ EN2
011 007    054                           INL
011 010    165                           LML
011 011    055                           DCL
011 012    315 210 017          EN1,     CAL INPUT
011 015    167                  EN2,     LMA
011 016    315 155 006                   CAL FNUM
011 021    370                           RTS
011 022    176                           LAM
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011 023    346 017                             NDI 017
011 025    167                                 LMA
011 026    055                                 DCL
011 027    076 137                             LAI 137
011 031    275                                 CPL
011 032    310                                 RTZ
011 033    303 012 011                         JMP EN1

011 036    056 140                     DCBN,   LLI 140
011 040    176                                 LAM
011 041    055                                 DCL
011 042    164                                 LMH
011 043    055                                 DCL
011 044    167                                 LMA
011 045    056 141                             LLI 141
011 047    176                                 LAM
011 050    247                                 NDA
011 051    312 063 011                         JTZ DC1
011 054    107                                 LBA
011 055    036 012                             LEI 012
011 057    124                                 LDH
011 060    315 125 011                         CAL TOBN
011 063    056 142                      DC1,   LLI 142
011 065    176                                 LAM
011 066    247                                 NDA
011 067    312 101 011                         JTZ DC2
011 072    107                                 LBA
011 073    021 144 000                         LXD 144 000
011 076    315 125 011                         CAL TOBN
011 101    056 143                      DC2,   LLI 143
011 103    176                                 LAM
011 104    247                                 NDA
011 105    312 117 011                         JTZ DC3
011 110    107                                 LBA
011 111    021 350 003                         LXD 350 003
011 114    315 125 011                         CAL TOBN
011 117    056 136                      DC3,   LLI 136
011 121    136                                 LEM
011 122    054                                 INL
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011 123    126                               LDM
011 124    311                               RET

011 125    056 136                   TOBN,   LLI 136
011 127    315 141 011                       CAL TO1
011 132    005                               DCB
011 133    310                               RTZ
011 134    303 125 011                       JMP TOBN

011 137    056 117                   TOMN,   LLI 117
011 141    176                        TO1,   LAM
011 142    203                               ADE
011 143    167                               LMA
011 144    054                               INL
011 145    176                               LAM
011 146    212                               ACD
011 147    167                               LMA
011 150    311                               RET

011 151    056 121                   TOSD,   LLI 121
011 153    303 141 011                       JMP TO1

011 156    056 117                   FMMN,   LLI 117
011 160    176                        FM1,   LAM
011 161    223                               SUE
011 162    167                               LMA
011 163    054                               INL
011 164    176                               LAM
011 165    232                               SBD
011 166    167                               LMA
011 167    311                               RET

011 170    056 121                   FMSD,   LLI 121
011 172    303 160 011                       JMP FM1

011 175    056 120                   CKMN,   LLI 120
011 177    176                        CK1,   LAM
011 200    055                               DCL
011 201    272                               CPD
011 202    300                               RFZ
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011 203   176                         CK2,    LAM
011 204   273                                 CPE
011 205   311                                 RET

011 206   056 122                     CKSD,   LLI 122
011 210   303 177 011                         JMP CK1

011 213   056 342                     OVER,   LLI 342
011 215   046 004                             LHI 004
011 217   315 000 005                         CAL MSG
011 222   166                                 HLT

011 223   176                         SPRC,   LAM
011 224   346 007                             NDI 007
011 226   117                                 LCA
011 227   176                                 LAM
011 230   315 243 005                         CAL ROTR3
011 233   346 007                             NDI 007
011 235   107                                 LBA
011 236   311                                 RET

012 000   061 000 012               GALAXY,   LXS 000 012
012 003   041 000 001                         LXH 000 001
012 006   315 000 005                         CAL MSG
012 011   315 012 005                START,   CAL RN
012 014   315 200 017                         CAL INPCK
012 017   362 011 012                         JFS START
012 022   315 210 017                         CAL INPUT
012 025   376 316                             CPI 316
012 027   312 213 011                         JTZ OVER
012 032   036 300                             LEI 300
012 034   315 012 005               GLXSET,   CAL RN
012 037   346 177                             NDI 177
012 041   157                                 LLA
012 042   046 017                             LHI 017
012 044   176                                 LAM
012 045   153                                 LLE
012 046   046 000                             LHI 000
012 050   167                                 LMA
012 051   034                                 INE
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012 052    302 034 012                      JFZ GLXSET

012 055    124                      GLXCK,  LDH
012 056    114                              LCH
012 057    056 300                          LLI 300
012 061    176                     GLXCK1,  LAM
012 062    346 010                          NDI 010
012 064    202                              ADD
012 065    127                              LDA
012 066    176                              LAM
012 067    346 060                          NDI 060
012 071    017                              RRC
012 072    017                              RRC
012 073    201                              ADC
012 074    117                              LCA
012 075    054                              INL
012 076    302 061 012                      JFZ GLXCK1
012 101    172                              LAD
012 102    017                              RRC
012 103    017                              RRC
012 104    017                              RRC
012 105    127                              LDA
012 106    376 007                          CPI 007
012 110    322 030 005                      JFC SSPLS
012 113    376 002                          CPI 002
012 115    332 035 005                      JTC SSMNS
012 120    171                              LAC
012 121    017                              RRC
012 122    017                              RRC
012 123    117                              LCA
012 124    376 040                          CPI 040
012 126    322 042 005                      JFC ASPLS
012 131    376 012                          CPI 012
012 133    332 060 005                      JTC ASMNS

012 136    056 133                          LLI 133
012 140    162                              LMD
012 141    054                              INL
012 142    161                              LMC
012 143    171                              LAC
```

```
012 144    306 005                                  ADI 005
012 146    054                                      INL
012 147    167                                      LMA
012 150    006 001                                  LBI 001
012 152    315 113 005                              CAL BINDEC
012 155    021 116 001                              LXD 116 001
012 160    006 002                                  LBI 002
012 162    315 076 005                              CAL DIGPRT
012 165    041 134 000                              LXH 134 000
012 170    006 001                                  LBI 001
012 172    315 113 005                              CAL BINDEC
012 175    021 074 001                              LXD 074 001
012 200    006 002                                  LBI 002
012 202    315 076 005                              CAL DIGPRT
012 205    041 133 000                              LXH 133 000
012 210    176                                      LAM
012 211    366 260                                  ORI 260
012 213    041 137 001                              LXH 137 001
012 216    167                                      LMA
012 217    041 050 001                              LXH 050 001
012 222    315 000 005                              CAL MSG

012 225    315 012 005                              CAL RN
012 230    346 077                                  NDI 077
012 232    056 131                                  LLI 131
012 234    167                                      LMA
012 235    315 114 010                              CAL QCNT
012 240    315 222 005                              CAL LOAD
012 243    315 021 007                              CAL NWQD
012 246    016 001                                  LCI 001
012 250    036 103                                  LEI 103
012 252    315 247 005                              CAL LOCSET
012 255    041 160 001                   SRSCN,     LXH 160 001
012 260    315 000 005                              CAL MSG
012 263    016 001                                  LCI 001
012 265    315 273 005                              CAL ROWSET
012 270    041 135 000                              LXH 135 000
012 273    076 062                                  LAI 062
012 275    226                                      SUM
012 276    054                                      INL
```

```
012 277   167                         LMA
012 300   006 001                     LBI 001
012 302   315 113 005                 CAL BINDEC
012 305   021 266 001                 LXD 266 001
012 310   006 002                     LBI 002
012 312   315 076 005                 CAL DIGPRT
012 315   041 250 001                 LXH 250 001
012 320   315 000 005                 CAL MSG

012 323   016 002                     LCI 002
012 325   315 273 005                 CAL ROWSET
012 330   056 102                     LLI 102
012 332   176                         LAM
012 333   041 303 001                 LXH 303 001
012 336   346 060                     NDI 060
012 340   302 075 006                 JFZ RED
012 343   066 307                     LMI 307
012 345   054                         INL
012 346   066 322                     LMI 322
012 350   054                         INL
012 351   066 305                     LMI 305
012 353   054                         INL
012 354   066 305                     LMI 305
012 356   054                         INL
012 357   066 316                     LMI 316
012 361   056 270               CND,  LLI 270
012 363   315 000 005                 CAL MSG
012 366   016 003                     LCI 003
012 370   315 273 005                 CAL ROWSET
012 373   315 113 006                 CAL QUAD
012 376   016 004                     LCI 004
013 000   315 273 005                 CAL ROWSET
013 003   056 103                     LLI 103
013 005   036 343                     LEI 343
013 007   024                         IND
013 010   315 131 006                 CAL TWO
013 013   056 330                     LLI 330
013 015   315 000 005                 CAL MSG
013 020   016 005                     LCI 005
013 022   315 273 005                 CAL ROWSET
```

```
013 025   056 117                         LLI 117
013 027   006 002                         LBI 002
013 031   315 113 005                     CAL BINDEC
013 034   021 365 001                     LXD 365 001
013 037   006 004                         LBI 004
013 041   315 076 005                     CAL DIGPRT
013 044   041 347 001                     LXH 347 001
013 047   315 000 005                     CAL MSG
013 052   016 006                         LCI 006
013 054   315 273 005                     CAL ROWSET
013 057   056 132                         LLI 132
013 061   006 001                         LBI 001
013 063   315 113 005                     CAL BINDEC
013 066   021 003 002                     LXD 003 002
013 071   006 002                         LBI 002
013 073   315 076 005                     CAL DIGPRT
013 076   041 367 001                     LXH 367 001
013 101   315 000 005                     CAL MSG
013 104   016 007                         LCI 007
013 106   315 273 005                     CAL ROWSET
013 111   056 121                         LLI 121
013 113   006 002                         LBI 002
013 115   315 113 005                     CAL BINDEC
013 120   026 002                         LDI 002
013 122   021 023 002                     LXD 023 002
013 125   006 004                         LBI 004
013 127   315 076 005                     CAL DIGPRT
013 132   041 005 002                     LXH 005 002
013 135   315 000 005                     CAL MSG
013 140   016 010                         LCI 010
013 142   315 273 005                     CAL ROWSET
013 145   041 160 001                     LXH 160 001
013 150   315 000 005                     CAL MSG

013 153   046 000                 CMND,   LHI 000
013 155   061 000 012                     LXS 000 012
013 160   036 012                         LEI 012
013 162   124                             LDH
013 163   315 315 007                     CAL ELOM
013 166   056 101                         LLI 101
```

```
013 170    064                         INM
013 171    041 025 002          CMD,   LXH 025 002
013 174    315 002 010                 CAL CMSG
013 177    315 210 017                 CAL INPUT
013 202    376 260                     CPI 260
013 204    312 002 014                 JTZ CRSE
013 207    376 261                     CPI 261
013 211    312 255 012                 JTZ SRSCN
013 214    376 262                     CPI 262
013 216    312 250 013                 JTZ LRSCN
013 221    376 263                     CPI 263
013 223    312 222 016                 JTZ GXPRT
013 226    376 264                     CPI 264
013 230    312 363 014                 JTZ SHEN
013 233    376 265                     CPI 265
013 235    312 304 015                 JTZ PHSR
013 240    376 266                     CPI 266
013 242    312 060 015                 JTZ TRPD

013 245    303 171 013                 JMP CMD

013 250    041 115 002        LRSCN,   LXH 115 002
013 253    315 000 005                 CAL MSG
013 256    315 113 006                 CAL QUAD
013 261    315 166 006                 CAL NTN
013 264    056 131                     LLI 131
013 266    176                         LAM
013 267    346 070                     NDI 070
013 271    312 341 013                 JTZ RWC1
013 274    176                         LAM
013 275    326 010                     SUI 010
013 277    315 214 006                 CAL LRR
013 302    315 166 006          LR1,   CAL NTN
013 305    056 131                     LLI 131
013 307    176                         LAM
013 310    315 214 006                 CAL LRR
013 313    315 166 006                 CAL NTN
013 316    056 131                     LLI 131
013 320    176                         LAM
013 321    376 070                     CPI 070
```

```
013 323   322 347 013              JFC RWC2
013 326   306 010                  ADI 010
013 330   315 214 006              CAL LRR
013 333   315 166 006        LR2,  CAL NTN
013 336   303 153 013              JMP CMND

013 341   315 355 013       RWC1,  CAL RWC
013 344   303 302 013              JMP LR1

013 347   315 355 013       RWC2,  CAL RWC
013 352   303 333 013              JMP LR2

013 355   056 311            RWC,  LLI 311
013 357   257                      XRA
013 360   315 301 006              CAL QDS1
013 363   056 317                  LLI 317
013 365   257                      XRA
013 366   315 301 006              CAL QDS1
013 371   056 325                  LLI 325
013 373   257                      XRA
013 374   315 301 006              CAL QDS1
013 377   303 273 006              JMP LRP

014 002   041 040 002       CRSE,  LXH 040 002
014 005   315 000 005              CAL MSG
014 010   315 031 010              CAL DRCT
014 013   312 002 014              JTZ CRSE
014 016   041 063 002        WRP,  LXH 063 002
014 021   315 002 010              CAL CMSG
014 024   056 137                  LLI 137
014 026   315 210 017              CAL INPUT
014 031   376 260                  CPI 260
014 033   332 016 014              JTC WRP
014 036   376 270                  CPI 270
014 040   322 016 014              JFC WRP
014 043   346 007                  NDI 007
014 045   007                      RLC
014 046   007                      RLC
014 047   007                      RLC
014 050   167                      LMA
```

```
014 051    076 256                         LAI 256
014 053    315 300 017                     CAL PRINT
014 056    315 210 017                     CAL INPUT
014 061    376 260                         CPI 260
014 063    332 016 014                     JTC WRP
014 066    376 270                         CPI 270
014 070    322 016 014                     JFC WRP
014 073    346 007                         NDI 007
014 075    206                             ADM
014 076    312 016 014                     JTZ WRP
014 101    137                             LEA
014 102    315 130 010                     CAL ACTV
014 105    056 061                         LLI 061
014 107    164                             LMH
014 110    315 160 010           MOV,      CAL TRK
014 113    312 377 006                     JTZ LOST
014 116    056 060                         LLI 060
014 120    176                             LAM
014 121    247                             NDA
014 122    312 143 014                     JTZ CLSN
014 125    054                             INL
014 126    165                             LML
014 127    036 031                         LEI 031
014 131    124                             LDH
014 132    315 315 007                     CAL ELOM
014 135    315 114 010                     CAL QCNT
014 140    315 021 007                     CAL NWQD

014 143    315 346 006           CLSN,     CAL RWCM
014 146    315 135 007                     CAL MATCH
014 151    302 175 014                     JFZ MVDN
014 154    105                             LBL
014 155    170                             LAB
014 156    376 113                         CPI 113
014 160    056 061                         LLI 061
014 162    176                             LAM
014 163    312 252 014                     JTZ SSOUT
014 166    322 273 014                     JFC ASOUT
014 171    247                             NDA
014 172    312 005 007                     JTZ WPOUT
```

```
014 175   041 050 000             MVDN,  LXH 050 000
014 200   136                            LEM
014 201   054                            INL
014 202   126                            LDM
014 203   054                            INL
014 204   116                            LCM
014 205   035                            DCE
014 206   302 110 014                    JFZ MOV

014 211   056 061                        LLI 061
014 213   176                            LAM
014 214   247                            NDA
014 215   312 230 014                    JTZ NOX
014 220   056 135                        LLI 135
014 222   106                            LBM
014 223   005                            DCB
014 224   312 366 006                    JTZ TIME
014 227   160                            LMB

014 230   315 346 006              NOX,  CAL RWCM
014 233   056 103                        LLI 103
014 235   160                            LMB
014 236   315 135 007                    CAL MATCH
014 241   314 311 014                    CTZ CHNG
014 244   315 317 014                    CAL DKED
014 247   303 255 012                    JMP SRSCN

014 252   247                    SSOUT,  NDA
014 253   302 175 014                    JFZ MVDN
014 256   150                            LLB
014 257   315 345 007                    CAL DLET
014 262   021 130 002                    LXD 130 002
014 265   315 176 007             SSO1,  CAL ELOS
014 270   303 175 014                    JMP MVDN

014 273   247                    ASOUT,  NDA
014 274   302 175 014                    JFZ MVDN
014 277   150                            LLB
014 300   315 345 007                    CAL DLET
014 303   021 334 005                    LXD 334 005
```

```
014 306    303 265 014                 JMP SSO1

014 311    135                 CHNG,   LEL
014 312    016 001                     LCI 001
014 314    303 247 005                 JMP LOCSET

014 317    056 113             DKED,   LLI 113
014 321    176                         LAM
014 322    247                         NDA
014 323    370                         RTS
014 324    170                         LAB
014 325    346 070                     NDI 070
014 327    117                         LCA
014 330    170                         LAB
014 331    346 007                     NDI 007
014 333    107                         LBA
014 334    176                         LAM
014 335    346 007                     NDI 007
014 337    137                         LEA
014 340    176                         LAM
014 341    346 070                     NDI 070
014 343    271                         CPC
014 344    300                         RFZ
014 345    170                         LAB
014 346    306 001                     ADI 001
014 350    273                         CPE
014 351    312 222 005                 JTZ LOAD
014 354    326 002                     SUI 002
014 356    273                         CPE
014 357    300                         RFZ
014 360    303 222 005                 JMP LOAD

014 363    041 060 003         SHEN,   LXH 060 003
014 366    315 000 005                 CAL MSG
014 371    315 371 010                 CAL EIN
014 374    372 363 014                 JTS SHEN
014 377    315 036 011                 CAL DCBN
015 002    056 144                     LLI 144
015 004    176                         LAM
015 005    247                         NDA
```

```
015 006   312 030 015              JTZ POS
015 011   315 206 011              CAL CKSD
015 014   332 047 015              JTC NE
015 017   315 170 011              CAL FMSD
015 022   315 137 011              CAL TOMN
015 025   303 153 013              JMP CMND

015 030   315 175 011        POS,  CAL CKMN
015 033   332 047 015              JTC NE
015 036   315 156 011              CAL FMMN
015 041   315 151 011              CAL TOSD
015 044   303 153 013              JMP CMND

015 047   041 114 003         NE,  LXH 114 003
015 052   315 000 005              CAL MSG
015 055   303 153 013              JMP CMND

015 060   056 132           TRPD,  LLI 132
015 062   176                      LAM
015 063   247                      NDA
015 064   312 273 015              JTZ NTPD
015 067   036 372                  LEI 372
015 071   124                      LDH
015 072   315 175 011              CAL CKMN
015 075   332 047 015              JTC NE
015 100   315 156 011              CAL FMMN
015 103   056 132                  LLI 132
015 105   065                      DCM
015 106   041 140 003        TR1,  LXH 140 003
015 111   315 000 005              CAL MSG
015 114   315 031 010              CAL DRCT
015 117   312 106 015              JTZ TR1
015 122   315 130 010              CAL ACTV
015 125   056 131                  LLI 131
015 127   176                      LAM
015 130   056 053                  LLI 053
015 132   167                      LMA
015 133   315 160 010        TR2,  CAL TRK
015 136   312 246 015              JTZ QOUT
015 141   056 060                  LLI 060
```

```
015 143    176                               LAM
015 144    247                               NDA
015 145    302 246 015                       JFZ QOUT
015 150    315 346 006                       CAL RWCM
015 153    110                               LCB
015 154    041 036 004                       LXH 036 004
015 157    315 134 006                       CAL T1
015 162    056 022                           LLI 022
015 164    315 002 010                       CAL CMSG
015 167    101                               LBC
015 170    315 135 007                       CAL MATCH
015 173    312 210 015                       JTZ HIT
015 176    056 050                           LLI 050
015 200    136                               LEM
015 201    054                               INL
015 202    126                               LDM
015 203    054                               INL
015 204    116                               LCM
015 205    303 133 015                       JMP TR2

015 210    175                         HIT,  LAL
015 211    376 113                           CPI 113
015 213    332 246 015                       JTC QOUT
015 216    312 235 015                       JTZ SSTA
015 221    315 345 007                       CAL DLET
015 224    041 177 003                       LXH 177 003
015 227    315 000 005                       CAL MSG
015 232    303 153 013                       JMP CMND

015 235    315 345 007                SSTA,  CAL DLET
015 240    041 272 003                       LXH 272 003
015 243    315 000 005                       CAL MSG

015 246    041 226 003                QOUT,  LXH 226 003
015 251    315 002 010                       CAL CMSG
015 254    036 310                           LEI 310
015 256    124                               LDH
015 257    315 176 007                       CAL ELOS
015 262    056 053                           LLI 053
015 264    176                               LAM
```

```
015 265   056 131                 LLI 131
015 267   167                     LMA
015 270   303 153 013             JMP CMND

015 273   041 266 004      NTPD,  LXH 266 004
015 276   315 000 005             CAL MSG
015 301   303 153 013             JMP CMND

015 304   041 063 004      PHSR,  LXH 063 004
015 307   315 000 005             CAL MSG
015 312   315 371 010             CAL EIN
015 315   372 304 015             JTS PHSR
015 320   315 036 011             CAL DCBN
015 323   315 315 007             CAL ELOM
015 326   056 102                 LLI 102
015 330   176                     LAM
015 331   346 060                 NDI 060
015 333   312 355 010             JTZ WASTE
015 336   315 242 005             CAL ROTR4
015 341   326 001                 SUI 001
015 343   312 352 015             JTZ PH1
015 346   107                     LBA
015 347   315 341 010             CAL DVD
015 352   056 136          PH1,   LLI 136
015 354   163                     LME
015 355   054                     INL
015 356   162                     LMD
015 357   056 050                 LLI 050
015 361   163                     LME
015 362   054                     INL
015 363   162                     LMD
015 364   054                     INL
015 365   066 114                 LMI 114
015 367   315 013 016             CAL ASPH
015 372   056 052                 LLI 052
015 374   066 115                 LMI 115
015 376   315 013 016             CAL ASPH
016 001   056 052                 LLI 052
016 003   066 116                 LMI 116
016 005   315 013 016             CAL ASPH
```

```
016 010    303 153 013              JMP CMND

016 013    156               ASPH,  LLM
016 014    176                      LAM
016 015    247                      NDA
016 016    370                      RTS
016 017    021 145 004              LXD 145 004
016 022    315 131 006              CAL TWO
016 025    056 116                  LLI 116
016 027    315 002 010              CAL CMSG
016 032    056 103                  LLI 103
016 034    315 223 011              CAL SPRC
016 037    153                      LLE
016 040    142                      LHD
016 041    131                      LEC
016 042    120                      LDB
016 043    315 223 011              CAL SPRC
016 046    170                      LAB
016 047    222                      SUD
016 050    362 057 016              JFS PH2
016 053    356 377                  XRI 377
016 055    306 001                  ADI 001
016 057    107                PH2,  LBA
016 060    171                      LAC
016 061    223                      SUE
016 062    362 071 016              JFS PH3
016 065    356 377                  XRI 377
016 067    306 001                  ADI 001
016 071    200                PH3,  ADB
016 072    017                      RRC
016 073    017                      RRC
016 074    346 003                  NDI 003
016 076    107                      LBA
016 077    115                      LCL
016 100    056 050                  LLI 050
016 102    136                      LEM
016 103    054                      INL
016 104    126                      LDM
016 105    005                      DCB
016 106    004                      INB
```

```
016 107   304 341 010              CFZ DVD
016 112   171                      LAC
016 113   346 003                  NDI 003
016 115   007                      RLC
016 116   306 123                  ADI 123
016 120   056 053                  LLI 053
016 122   167                      LMA
016 123   157                      LLA
016 124   315 160 011              CAL FM1
016 127   372 206 016              JTS DSTR
016 132   302 144 016              JFZ ALOS
016 135   055                      DCL
016 136   176                      LAM
016 137   054                      INL
016 140   247                      NDA
016 141   312 206 016              JTZ DSTR
016 144   055              ALOS,   DCL
016 145   006 002                  LBI 002
016 147   315 113 005              CAL BINDEC
016 152   021 167 004              LXD 167 004
016 155   006 004                  LBI 004
016 157   315 076 005              CAL DIGPRT
016 162   041 153 004              LXH 153 004
016 165   315 002 010              CAL CMSG
016 170   056 053                  LLI 053
016 172   156                      LLM
016 173   136                      LEM
016 174   054                      INL
016 175   126                      LDM
016 176   006 002                  LBI 002
016 200   315 341 010              CAL DVD
016 203   303 176 007              JMP ELOS

016 206   041 312 003      DSTR,   LXH 312 003
016 211   315 002 010              CAL CMSG
016 214   056 052                  LLI 052
016 216   156                      LLM
016 217   303 345 007              JMP DLET

016 222   041 042 004      GXPRT,  LXH 042 004
```

```
016 225   315 000 005           CAL MSG
016 230   046 061               LHI 061
016 232   315 170 006           CAL NT1
016 235   056 300               LLI 300
016 237   124             GL1,  LDH
016 240   036 204               LEI 204
016 242   176             GL2,  LAM
016 243   353                   XCHG
016 244   315 303 006           CAL QDSET
016 247   175                   LAL
016 250   306 004               ADI 004
016 252   157                   LLA
016 253   353                   XCHG
016 254   054                   INL
016 255   376 264               CPI 264
016 257   302 242 016           JFZ GL2
016 262   353                   XCHG
016 263   056 200               LLI 200
016 265   315 000 005           CAL MSG
016 270   046 061               LHI 061
016 272   315 170 006           CAL NT1
016 275   173                   LAE
016 276   274                   CPH
016 277   312 153 013           JTZ CMND
016 302   353                   XCHG
016 303   303 237 016           JMP GL1


017 200                 INPCK,


017 210                 INPUT,


017 300                 PRINT,
```

SAMPLE OF GALAXY OPERATION

For those that may still be unsure of the operation of the Galaxy game, the following sample illustrates the initial moves that may be made in a typical game. The galaxy contents are assumed to be the same as that displayed on page 1-8. All operator entries are underlined. The comments in the parentheses are included to point out various facts one should watch as a game progresses, and to explain the reasoning behind each of the moves. The Galaxy game is initiated by jumping to the start address of page 12 location 000.

```
DO YOU WANT TO GO ON A SPACE VOYAGE?  Y

YOU MUST DESTROY 22 ALIEN SHIPS IN 27 STARDATES
WITH 4 SPACE STATIONS


 -1--2--3--4--5--6--7--8-
1          *                 STARDATE     3023
2                            CONDITION    RED
3               +++          QUADRANT     6,5
4    *                       SECTOR       5,3
5      <*>                   ENERGY       5000
6                            TORPEDOES    10
7         >1<       *        SHIELDS      0000
8
 -1--2--3--4--5--6--7--8-
```

(Before attacking the alien ship, energy should be transferred to the protective shields.)

```
COMMAND?  4

SHIELD ENERGY TRANSFER = 1000
```

(The alien ship is located three columns to the right and two rows up. A torpedo trajectory of 1.5 just might make it.)

```
COMMAND?  6

TORPEDO TRAJECTORY:  1.5

TRACKING 4,4

TRACKING 4,5

TRACKING 3,6

ALIEN SHIP DESTROYED
```

(Good shot. Now, a short range scan will indicate the loss of the alien ship and amount of energy remaining. The energy consumed was 10 units for each command entered plus 250 units to fire the torpedo.)

```
COMMAND?  1

  -1--2--3--4--5--6--7--8-
1           *                 STARDATE    3023
2                             CONDITION   GREEN
3                             QUADRANT    6,5
4     *                       SECTOR      5,3
5       <*>                   ENERGY      3720
6                             TORPEDOES   09
7          >1<       *        SHIELDS     1000
8
  -1--2--3--4--5--6--7--8-
```

(Before leaving this quadrant, docking with the space station will refill the energy banks and torpedo tubes.)

```
COMMAND?  0

COURSE (1 - 8.5)?  7.0

WARP FACTOR (0.1 - 7.7)?  0.2
```

```
 -1--2--3--4--5--6--7--8-
1          *                  STARDATE     3023
2                             CONDITION    GREEN
3                             QUADRANT     6,5
4    *                        SECTOR       7,3
5                             ENERGY       5000
6                             TORPEDOES    10
7      <*>>1<       *         SHIELDS      0000
8
 -1--2--3--4--5--6--7--8-
```

(A long range scan will display the surrounding quadrants.)

```
COMMAND?  2

LONG RANGE SCAN FOR QUADRANT 6,5

-------------------------
1  112  1  001  1  006  1
-------------------------
1  001  1  013  1  104  1
-------------------------
1  203  1  007  1  004  1
-------------------------
```

(Let's move into quadrant 7,4 to attack the two alien ships residing there. The stardate will increase by one, and the new quadrant location will be indicated. If the move is tracked one sector at a time it would be noted that two quadrant borders were crossed, resulting in the loss of 25 units of energy for each crossing.)

```
COMMAND?  0

COURSE (1 - 8.5)?  6.0

WARP FACTOR (0.1 - 7.7)?  1.0
```

```
 -1--2--3--4--5--6--7--8-
1                                STARDATE     3024
2                                CONDITION    RED
3       +++                      QUADRANT     7,4
4        *                       SECTOR       7,3
5                                ENERGY       4930
6 +++ *                          TORPEDOES    10
7     *  <*>                     SHIELDS      0000
8
 -1--2--3--4--5--6--7--8-
```

(Don't forget the shield energy before attacking.)

COMMAND? 4

SHIELD ENERGY TRANSFER = 1000

(The stars are blocking the path to both alien ships for the torpedoes. Instead of maneuvering to a position to fire a torpedo at each, a small phasor is fired to determine the size of the alien ships.)

COMMAND? 5

PHASOR ENERGY TO FIRE = 0100

ALIEN SHIP AT SECTOR 3,3: DESTROYED

ALIEN SHIP AT SECTOR 6,1: ENERGY = 0150

LOSS OF ENERGY 0037

(The alien ship at sector 3,3 was destroyed. The other alien ship fired back in retaliation. However, since its shield energy is only 150, and the distance factor (as defined on page 1 - 10) is zero, another phasor shot should take care of it.)

COMMAND? 5

PHASOR ENERGY TO FIRE = 0150

```
ALIEN SHIP AT SECTOR 6,1:  DESTROYED
```

(A short range scan will provide proof that the alien ships are destroyed, and also indicate how much energy is left.)

```
COMMAND?  1


 -1--2--3--4--5--6--7--8-
1                             STARDATE    3024
2                             CONDITION   GREEN
3                             QUADRANT    7,4
4       *                     SECTOR      7,3
5                             ENERGY      3640
6    *                        TORPEDOES   10
7    * <*>                    SHIELDS     0963
8
 -1--2--3--4--5--6--7--8-
```

(The game would be continued by maneuvering about to the other quadrants in the galaxy which contain alien ships. However, one must always be aware of the amount of energy in the space ship, and the number of stardates remaining as the game progresses. Allowing either of these to run out would be as disasterous as moving out of the known galaxy or making a fatal error such as the following attempt to move to quadrant 5,4.)

```
COMMAND?  0

COURSE (1 - 8.5)?  3.0

WARP FACTOR (0.1 - 7.7)?  2.1

KA-BOOM, YOU CRASHED INTO A STAR.
YOUR SHIP IS DESTROYED.
```

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