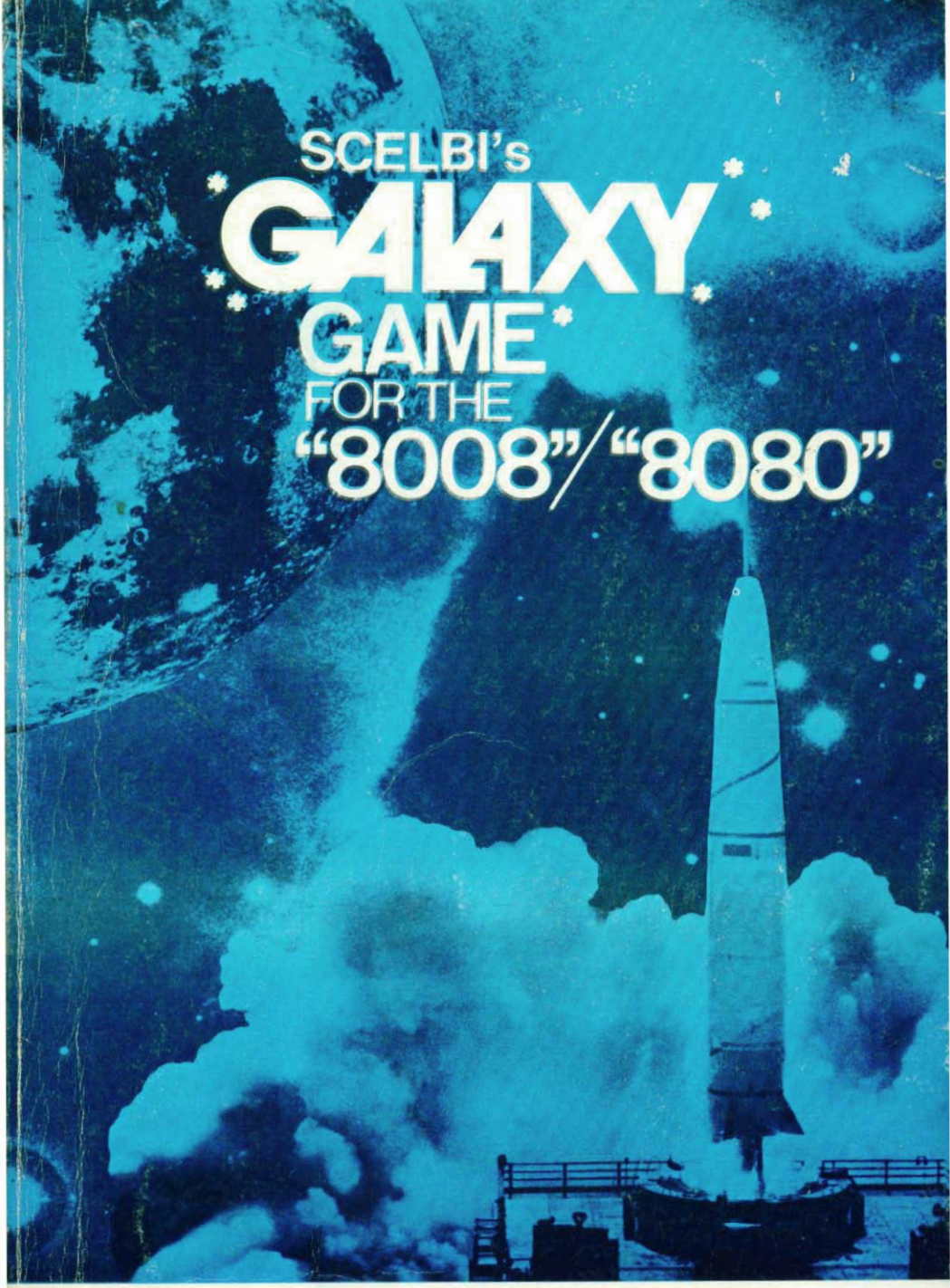

SCELBI COMPUTER
CONSULTING INC.

SCELBI'S GALAXY GAME

FOR THE '8008/8080'

Author:

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SCELBI'S GALAXY GAME

FOR THE '8008/8080'

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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 tor-

pedo 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.

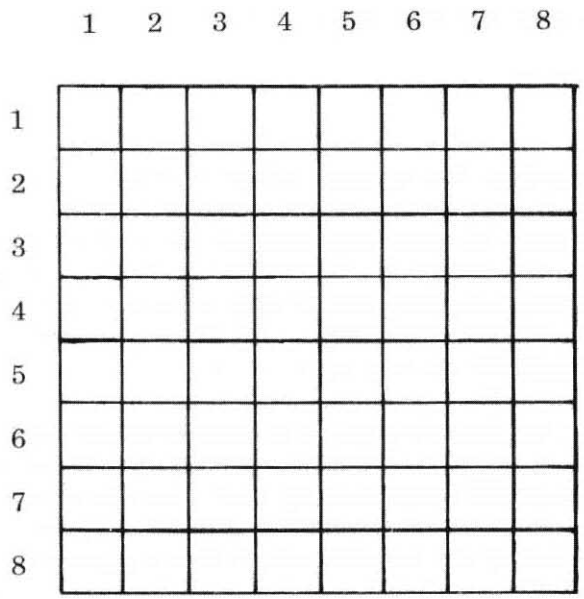
OPERATION OF THE GALAXY PROGRAM

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.



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

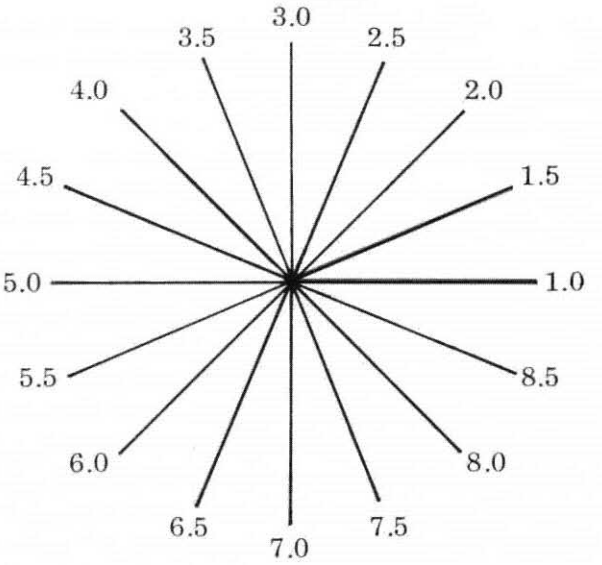
COMMAND 0 - SPACE SHIP MOVEMENT

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.

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

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

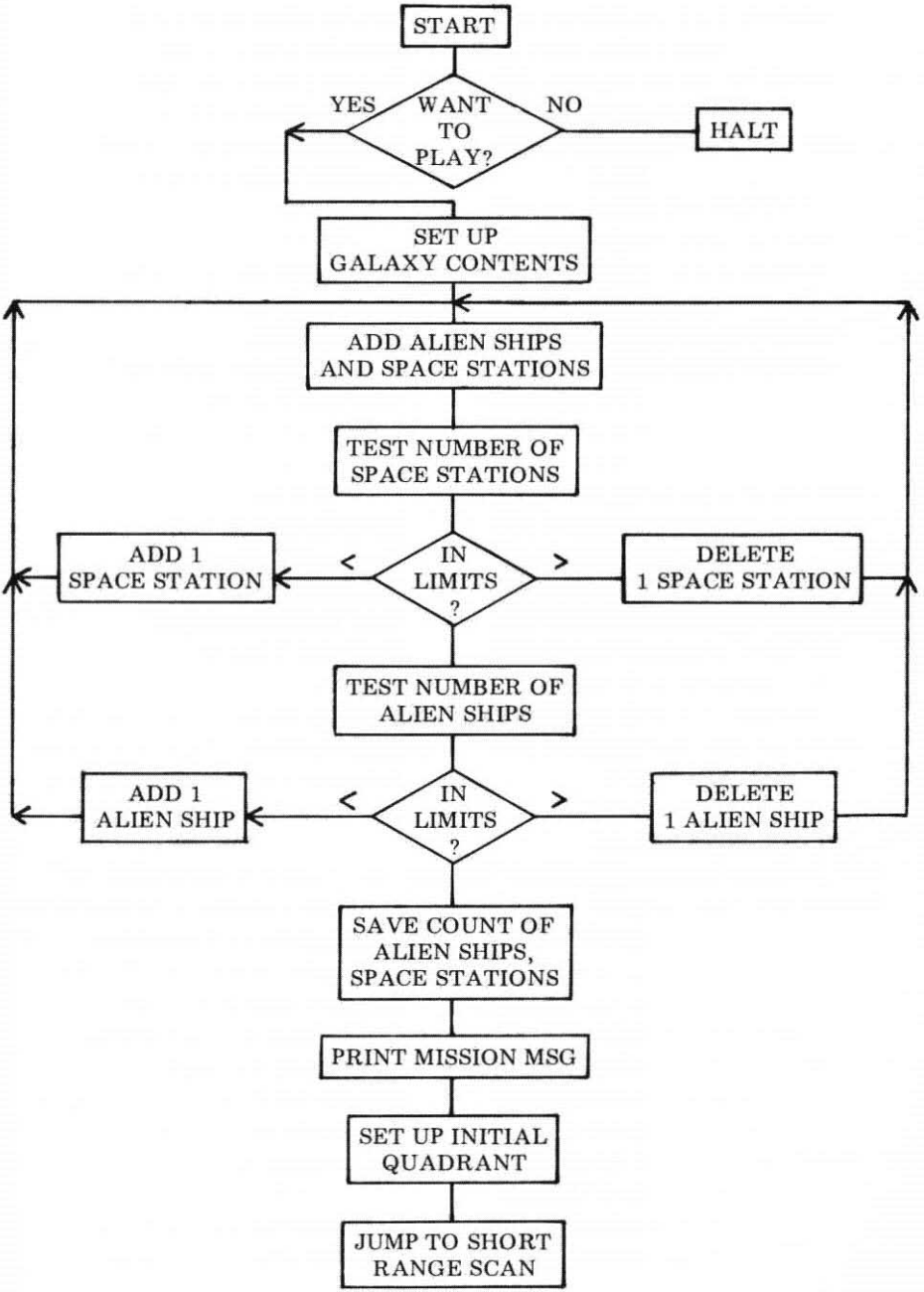
The main portion of the Galaxy program consists of nine major functional routines. The first of these routines provides the initial galaxy setup. The contents of each quadrant are randomly selected from the galaxy setup table which consists of many possible quadrant content arrangements. The selected 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
```

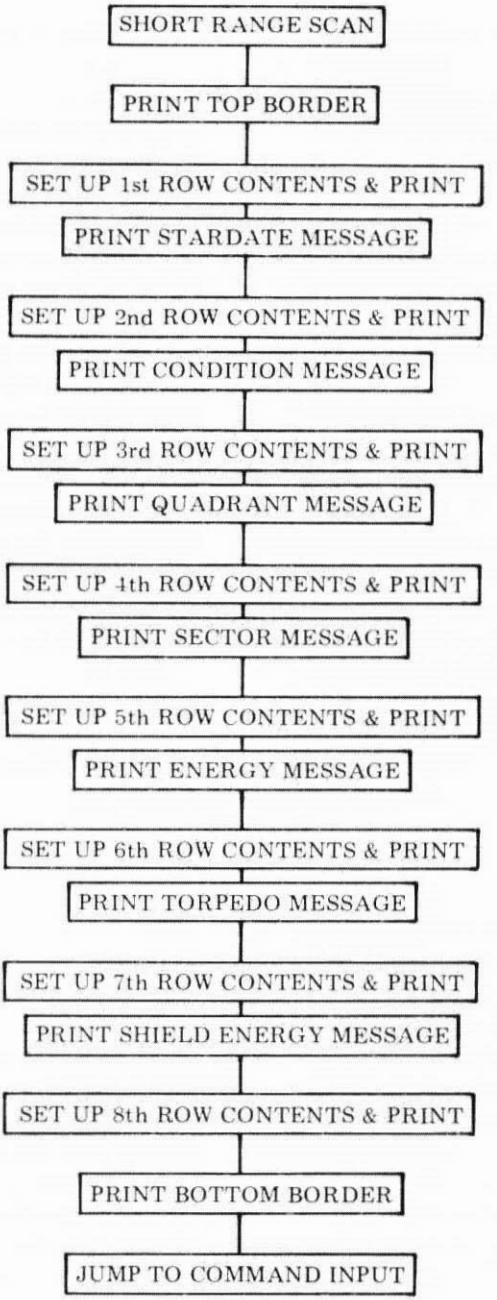
The following routines are part of the Galaxy setup routine, but do not follow directly after the above listing. Instead, they are stored in the same portion of memory as the subroutines.

```
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
```

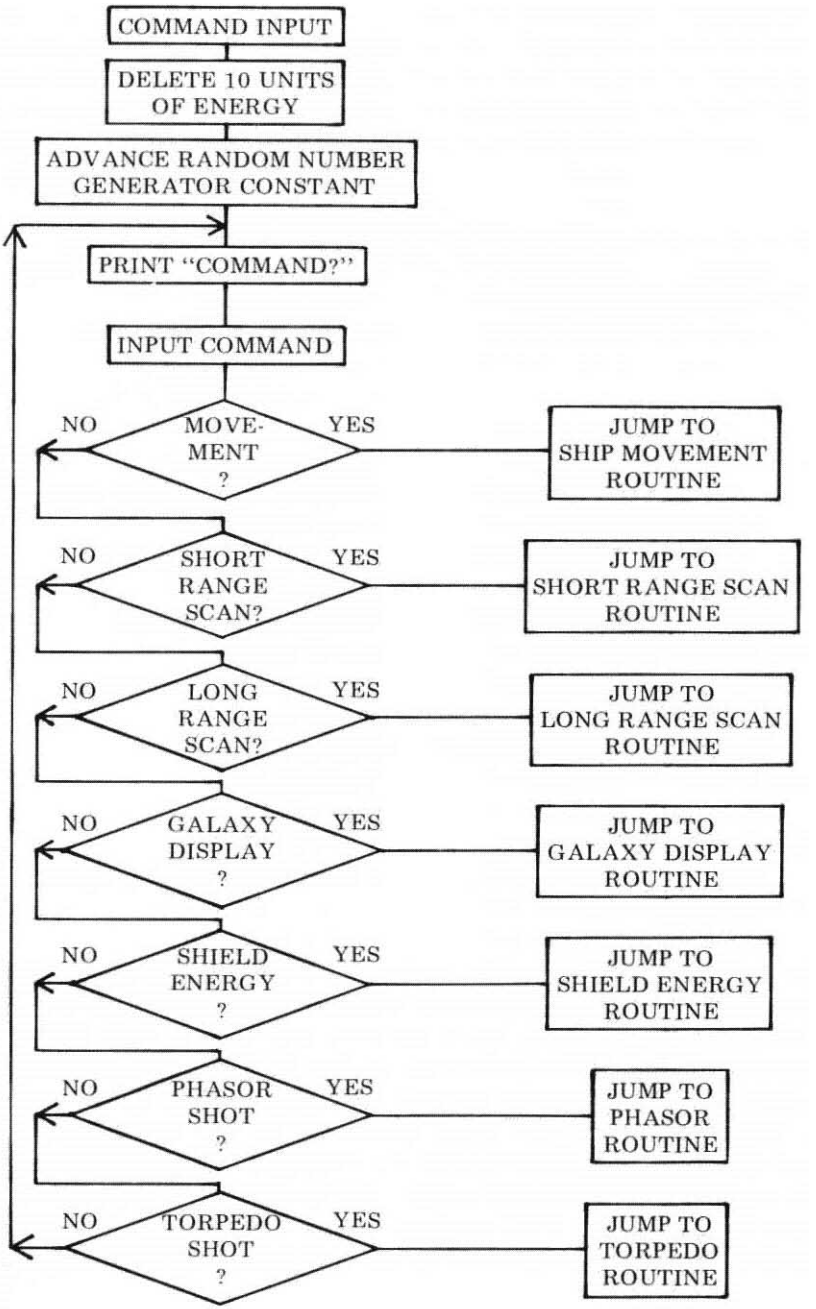
```
LEI 343          Set digit code storage
IND
CAL TWO          Put two digits in message
LLI 330          Set pointer to sector message
CAL MSG          Print sector message
LCI 005          Set row number 5
CAL ROWSET       Set up row for printout
LLI 117          Set pointer to energy storage
LBI 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.

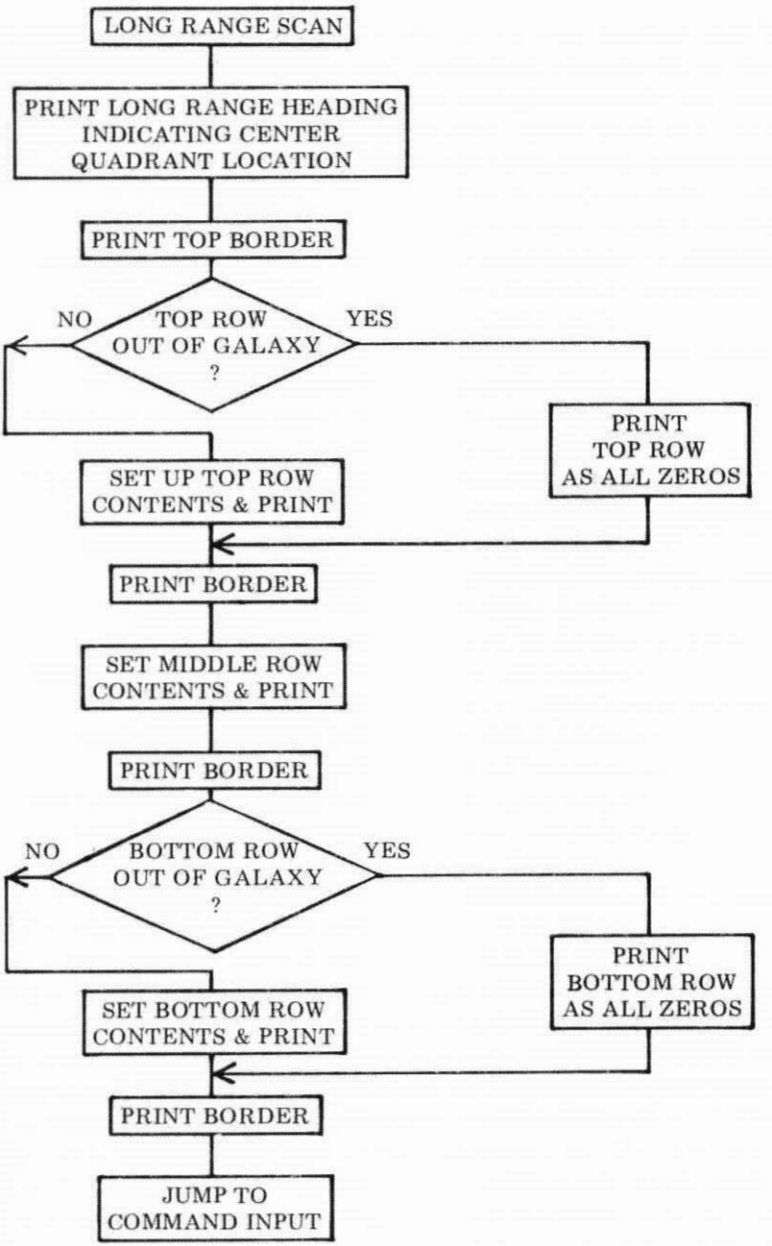

COMMAND INPUT
DELETE 10 UNITS OF ENERGY
ADVANCE RANDOM NUMBER GENERATOR CONSTANT
PRINT "COMMAND?"
INPUT COMMAND
NO
MOVE-MENT ?
YES
JUMP TO SHIP MOVEMENT ROUTINE
NO
SHORT RANGE SCAN?
YES
JUMP TO SHORT RANGE SCAN ROUTINE
NO
LONG RANGE SCAN?
YES
JUMP TO LONG RANGE SCAN ROUTINE
NO
GALAXY DISPLAY ?
YES
JUMP 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 quad-

rant. 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
```

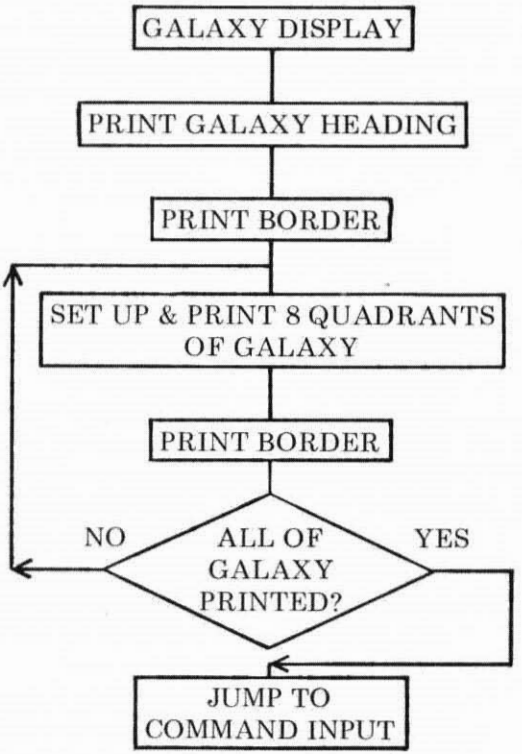

LONG RANGE SCAN
PRINT LONG RANGE HEADING INDICATING CENTER QUADRANT LOCATION
PRINT TOP BORDER
NO
TOP ROW OUT OF GALAXY ?
YES
PRINT TOP ROW AS ALL ZEROS
SET UP TOP ROW CONTENTS & PRINT
PRINT BORDER
SET MIDDLE ROW CONTENTS & PRINT
PRINT BORDER
NO
BOTTOM ROW OUT OF GALAXY ?
YES
PRINT BOTTOM ROW AS ALL ZEROS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

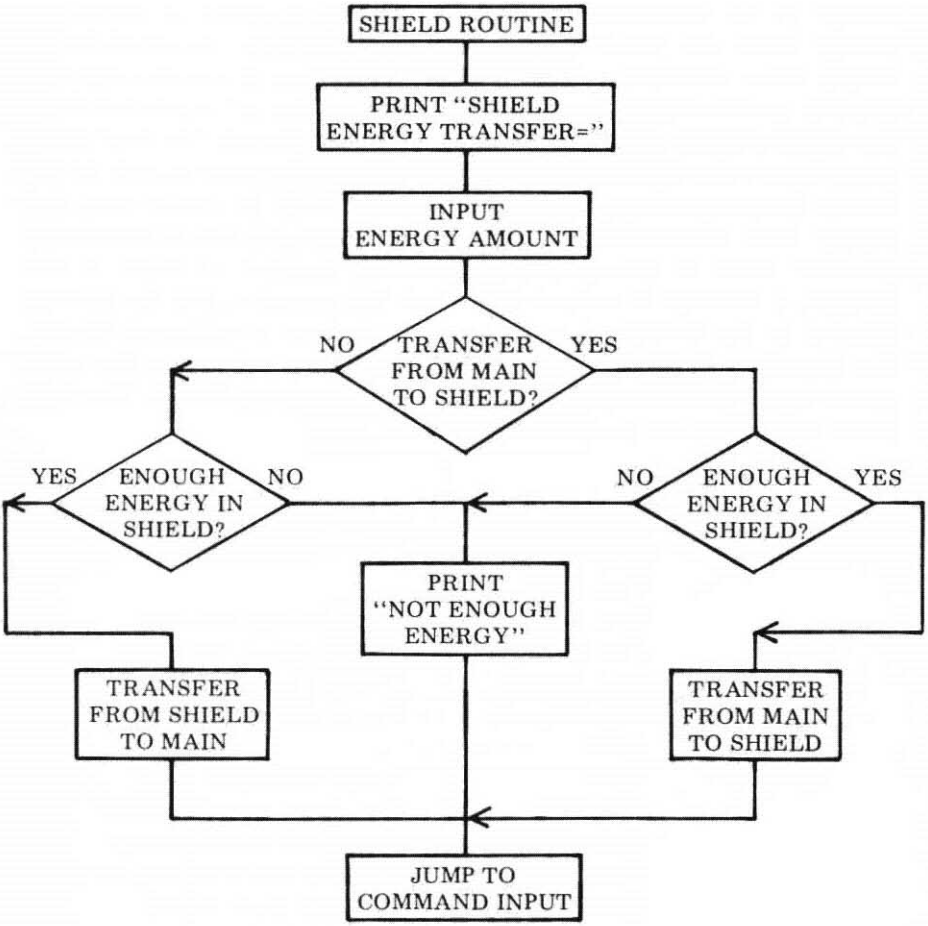
```
GXPRT,  LLI 042
        LHI 004     Print galaxy display
        CAL MSG
        LHI 061
        CAL NT1     Print border
        LLI 300     Set pointer to galaxy
GL1,    LDH         Set printout pointer
        LEI 204
GL2,    LAM         Fetch quadrant contents
        CAL SWITCH  Set message 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
NO
TRANSFER FROM MAIN TO SHIELD?
YES
YES
ENOUGH ENERGY IN SHIELD?
NO
NO
ENOUGH ENERGY IN SHIELD?
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.

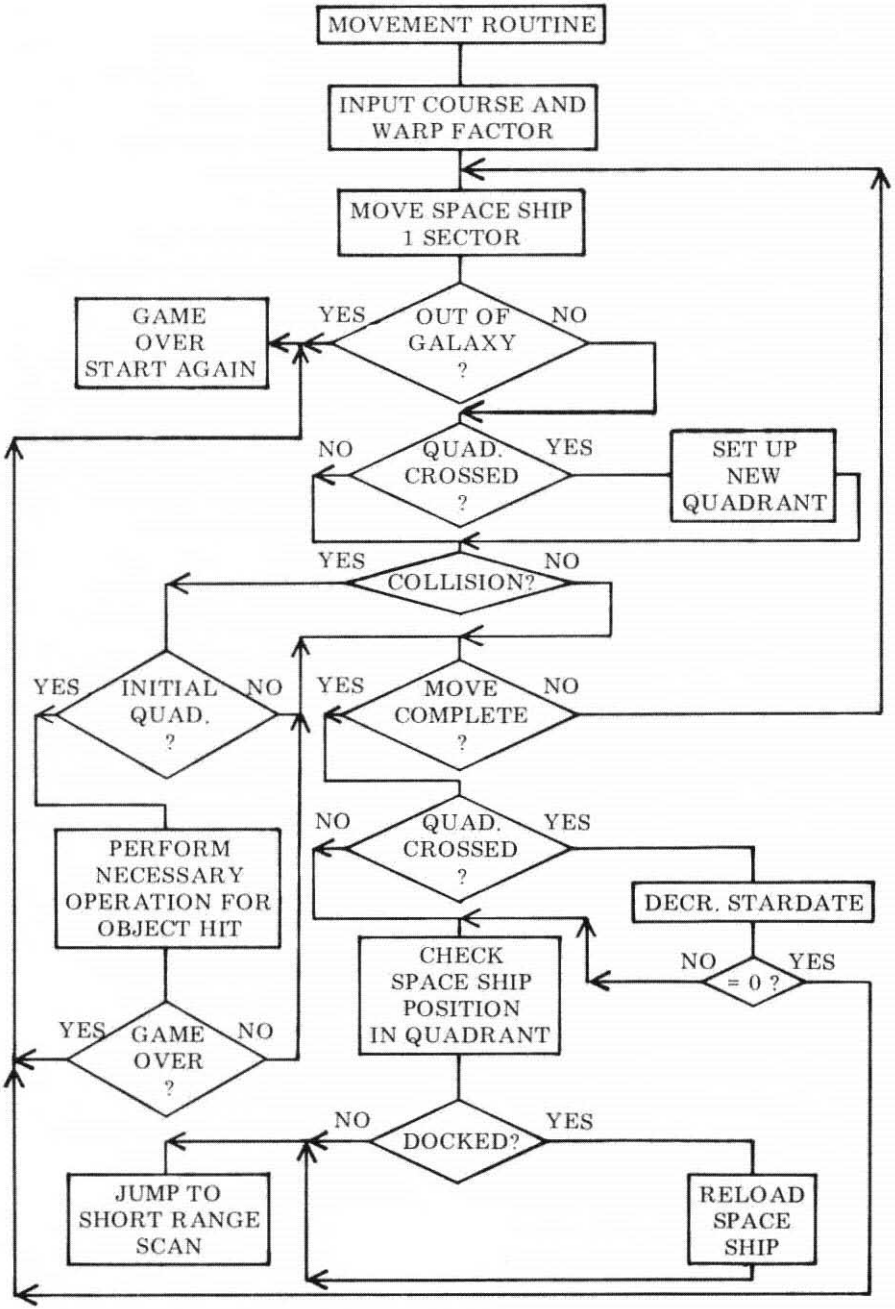
The final operation of this routine is to check for a docking with a space station. This can only occur when the space ship completes its move by residing in a sector on either side of the space station. The space ship is not docked when it is in the sector above or below the space station. If the space 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?
```

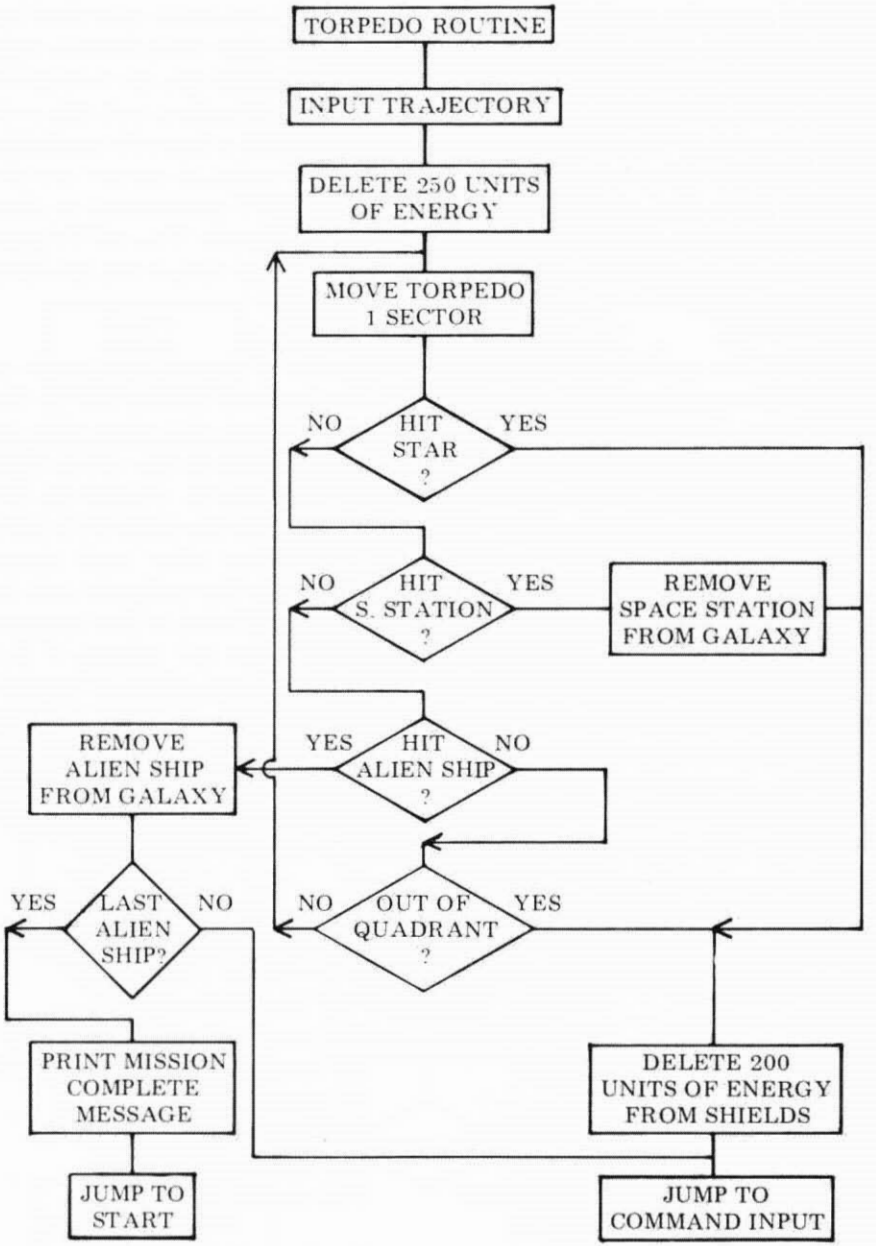
```
        JFZ MVDN        No, no loss
        LLB             Yes, delete alien ship
        CAL DLET
        LEI 334         Delete 1500 units of
        LDI 005         Energy from space ship
        JMP SSO1        And finish move

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
OUT OF GALAXY ?
YES
NO
GAME OVER START AGAIN
QUAD. CROSSED ?
NO
YES
SET UP NEW QUADRANT
COLLISION?
YES
NO
INITIAL QUAD. ?
YES
NO
MOVE COMPLETE ?
YES
NO
QUAD. CROSSED ?
NO
YES
PERFORM NECESSARY OPERATION FOR OBJECT HIT
DECR. STARDATE
= 0 ?
NO
YES
CHECK SPACE SHIP POSITION IN QUADRANT
GAME OVER ?
YES
NO
DOCKED?
NO
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
NO
HIT STAR ?
YES
NO
HIT S. STATION ?
YES
REMOVE SPACE STATION FROM GALAXY
YES
HIT ALIEN SHIP ?
NO
REMOVE ALIEN SHIP FROM GALAXY
YES
LAST ALIEN SHIP?
NO
NO
OUT OF QUADRANT ?
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.
```

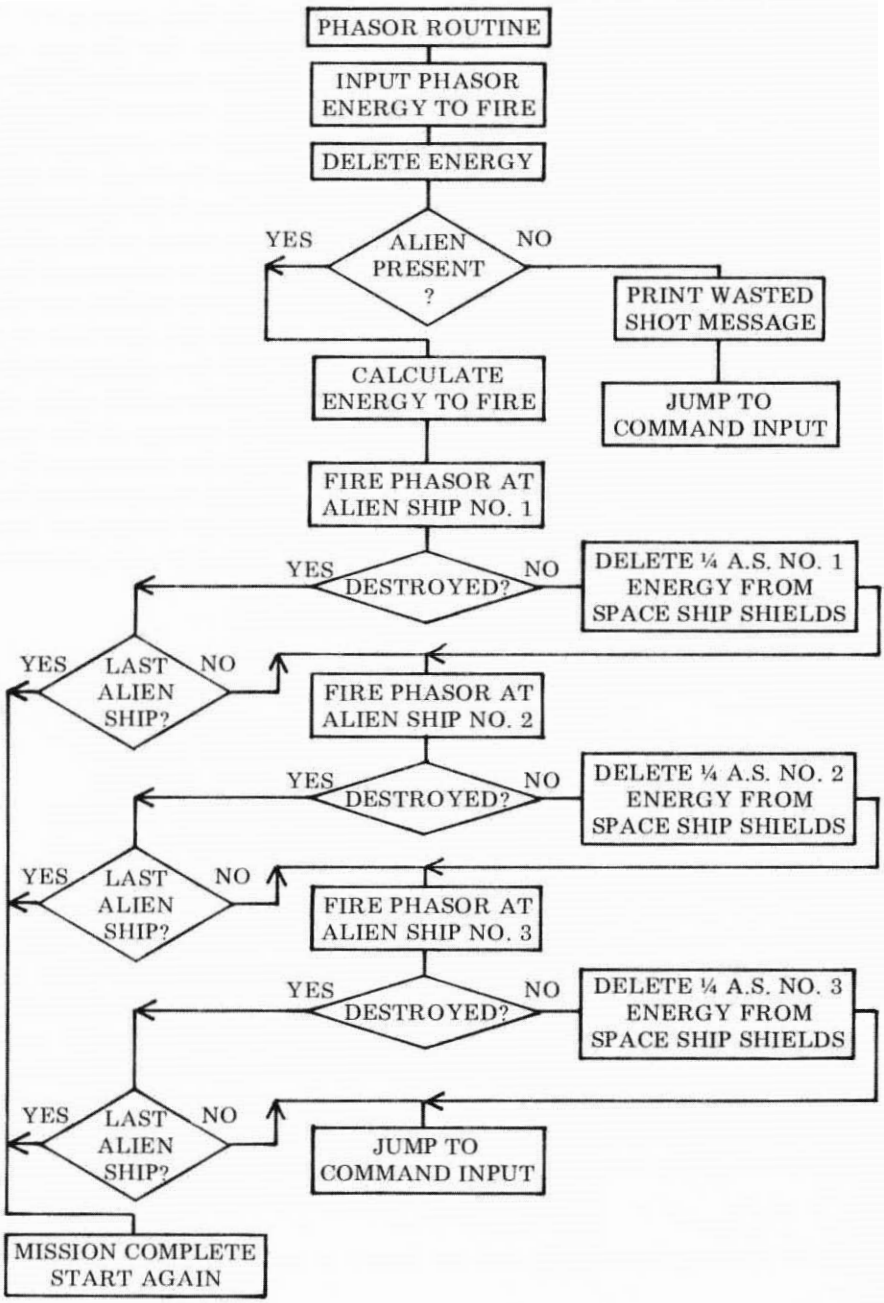
```
        CAL DLET        No, delete alien ship
        LLI 177         Print alien ship hit message
        LHI 003
        CAL MSG
        JMP CMND        Input new command

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

```
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
```

```
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
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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
```

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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
```

```
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
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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,
```

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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