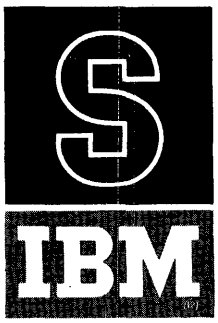

7000 AND 1400 DATA PROCESSING SYSTEMS BULLETIN

PRELIMINARY BULLETIN

IBM 1401 PERIPHERAL INTEGRATED PROCESSING SYSTEM FOR USE WITH 7000 SERIES DATA PROCESSING SYSTEMS

This bulletin describes the external specifications for the IBM 1401 Peripheral Integrated Processing System. In order to make this information available rapidly, it is issued in preliminary form.

The Peripheral Integrated Processing System includes among its supervised peripheral programs the D-programs of the 7000/1400 Output Editing System (see the IBM bulletin, IBM 7000/1400 Output Editing System, Form J28-6173). The reader of this bulletin, however, need not have a knowledge of that system, but should have a general knowledge of data processing systems and input/output devices.

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Functional Specifications

The Peripheral Integrated Processing System (PIPS) permits the consecutive execution of peripheral programs which are independent of each other both in their operations and in the data upon which they act. Such features as label processing, program restart, and variations in the sequence of program execution are also provided for. Any peripheral processing programs which conform to the rules given below can participate in the monitored system operation.

The Systems Tape

As long as PIPS is in control of 1401 operation, a Systems tape is kept mounted on tape unit 1. This tape contains, first, the Peripheral Monitor (PM), then the individual processors, and finally, the Librarian, which updates the Systems tape by adding or removing processors. The number and the order of processors are immaterial.

Selection of a Processor

A peripheral processor is activated by a flag which may be either a tape record or a control card, depending upon the setting of a sense switch. Thus, at a time when data files on both tape and cards are awaiting processing, the operator may give priority by setting a sense switch.

Restart

Processing of data which is on tape may, if interrupted, be restarted from a checkpoint, rather than from the beginning of the tape, as indicated by a sense switch.

Since all checkpoints are preserved, the program can be restarted, under operator option, from any checkpoint written.

Beginning and End of Reel Action

The Peripheral Monitor performs certain functions associated with the physical boundaries of the reels of an input tape file. Thus, label processing is performed by the Monitor, provided the presence of a tape label is indicated by the operator through the setting of a sense switch.

Priority Processing

Tape jobs need not be executed in the order in which they are stacked on the input tape. The setting of a sense switch will determine whether the next tape job is to be executed or skipped over. The operator may thus execute

jobs in order of some expressed priority, rather than the order in which the output of the large computer was written. The operator may also cause the next job to be input from the card reader.

Machine Requirements

The 1401 PIPS requires the following machine configuration:

1. Core Storage. A minimum of 4000 positions of core storage is required.

2. 1403 Printer. Either a model 1 or a model 2 may be used. With a model 1 printer, printing is restricted to a line of 100 positions only.

3. 1402 Card Read Punch.

4. Three tape units. The tape units may be of any model, not necessarily identical, and are assigned as follows:

   Unit 1 Systems tape

   Unit 2 Input tape

   Unit 3 Scratch tape for checkpoint writing

   Unit 4 Output tape

   (Since tape units 2, 3, and 4 are not usually active all at the same time, three units may suffice in a given application.)

5. Advanced Programming.

6. Expanded Print Edit.

7. High-Low-Equal Compare.

8. Print Storage.

The Systems tape and input tapes should be file-protected during running of PIPS.

Rules for Processors

Location on Systems Tape

Each processor must be completely relocatable on the Systems tape; that is, it must not in any way depend upon its position relative to the load point.

Each processor may be segmented, and should position the Systems tape only within its own segments, except when returning control to the peripheral monitor (see page 16).

Input/Output Capabilities

Unlike some monitored systems, in PIPS no routines of the Peripheral Monitor share storage with those of the processors. Hence, each processor must provide for its own input and output; that is, each processor must contain routines for moving magnetic tape and/or cards. These routines must recognize and act upon terminal conditions such as:

End of Reel

End of Deck

End of Data File

The terminal indicators shall be specified separately for each data file type and for its associated processor. However, an end of reel occurring between complete data files must be indicated by a single tape mark.

Normal Execution of Processing

In the normal mode of execution, the processor reads input data from its indicated medium and produces output in accordance with its specifications and the format of the input. The processor continues sequentially until it senses an appropriate terminal indicator, in which case it executes the corresponding terminal procedure.

Skipping Over the Entire Data File

In addition to the normal execution of processing, all processors utilizing tape input data must have a second mode of spacing over the data, namely, non-process skipping.

When running in this mode, the processor reads the input data from tape but does not produce any output. The processor continues sequentially until it senses an appropriate terminal indicator, in which case it executes the corresponding terminal procedure.

If the terminal indicator sensed while skipping is that of end-of-reel, the processor should initialize a location which will be recorded in its checkpoint record and which will inform the restart routine that the end-of-reel-while-skipping condition occurred and that it motivated the writing of that checkpoint record.

Checkpoint

All processors utilizing tape input must have checkpoint and restart facilities. The checkpoint records are images of important areas of core storage and are used to record on the checkpoint tape such information as is necessary to restore the system to the status which it had at the time the checkpoint was written.

The checkpoint tape consists of alternating Checkpoint Records A and B, where Checkpoint Record B is an image of the first 333 positions of 1401 storage, and Checkpoint Record A contains any other information the processor needs for restart. A tape mark follows the latest Checkpoint Record B. Thus, the sequence for writing a checkpoint is:

1. Write Checkpoint Record A.
2. Write Checkpoint Record B.
3. Write tape mark.
4. Backspace checkpoint tape.

The frequency with which checkpoints are written may be a function of the input or of the processor itself, with the exception of the cases specified below.

End-of-Reel Procedure

Upon discovering an end-of-reel condition within a data file, the processor must:

1. Perform functions peculiar to the particular processor.
2. Rewind and unload the input tape.
3. Halt.
4. Rewind the checkpoint tape.
5. Initialize certain locations to communicate with the Peripheral Monitor (see page 13).
6. Write the flag of the processor on the checkpoint tape.
7. Write checkpoint records.
8. Call in, and return control to, the Peripheral Monitor.

End-of-Data-File Procedure

Upon discovering an end-of-data-file condition, the processor must:

1. Perform functions peculiar to the particular processor.

2. If the processor utilizes tape input:

   a. Initialize a location which will be recorded in a checkpoint record and which will inform the restart routine that an end-of-data-file condition occurred and motivated the writing of that checkpoint record.

   b. Write checkpoint records.

3. Initialize certain locations to communicate with the peripheral monitor (see page 13).

4. Call in, and return control to, the Peripheral Monitor.

Restart

Restart facilities are used to minimize the time lost through the interruption of a processor before the completion of processing a data file. Also, since the Peripheral Monitor is activated on an end-of-reel condition, the restart facility is used to restore core storage to the status that it had when the processor relinquished control.

When the Peripheral Monitor informs the processor that it should execute its restart routine, Checkpoint Record B has already been read into storage. The checkpoint tape is thus positioned after the checkpoint records which pertain to that restart. Hence, if the restart routine determines that Checkpoint Record A is needed for restart, the checkpoint tape must be backspaced twice, Checkpoint Record A must be read in, and the checkpoint tape must be advanced past Checkpoint Record B again, to position it correctly for writing further checkpoints.

The input tape will normally be positioned for routine processing, i.e., between the flag which activated the processor and the first data record. However, if the checkpoint had been written on an end-of-reel condition, the input tape will be positioned before the first data record of the new reel.

Hence, the restart routine should:

1. Interrogate locations to determine if the checkpoint was written on an end-of-data-file or end-of-reel-while-skipping condition, and, if so, relinquish control to the skipping routine.

2. Determine if the checkpoint was written on an end-of-reel condition, and if not, position the input tape at the point at which the checkpoint was written.

3. Determine if Checkpoint Record A is needed, and, if so, bring it in and space the checkpoint tape past Checkpoint Record B.

4. Complete the restoration of storage and input/output devices and resume normal processing.

The Peripheral Monitor

The Peripheral Monitor is in control of 1401 operation between complete input data files and at the physical boundaries of the reels of an input tape file.

The Peripheral Monitor is initially activated at the beginning of a machine run by loading the Systems tape. Thereafter, control is returned to the Peripheral Monitor whenever the processor completes the processing of a data file or discovers an end-of-reel condition.

Processing of Labels

When the Peripheral Monitor is informed through Sense Switch D that the next reel of the input tape file begins with a header label, it reads the input tape until a tape mark is sensed, indicating that the header labels have been bypassed. The user may modify the PM to process header labels in any manner which he desires. Future versions of the Peripheral Monitor may provide linkages to a program written by the user which would perform the desired label processing. Trailer labels are ignored.

Selecting the Processor

Upon its initial activation, and thereafter upon each end-of-data file return to the Peripheral Monitor, the program halts to permit the operator to set Sense Switches C and E, if necessary.

When restarted, the PM interrogates Sense Switch E and reads the flag for the next input data file, which may be either a control card or a tape record of between 13 and 150 characters in length. The flag should conform to the format

bPIPSbPROCESSORbNAME‡

and the processor name must not exceed 23 characters.

The flag is then compared against a table of the names of the processors on the Systems tape. After initializing certain communication words, the PM reads in the named processor and transfers control to it (see page 15).

Determination of Processor Mode of Execution

Following the programmed halt described above, the Peripheral Monitor interrogates Sense Switch C and, depending upon its setting, sets a

communication word to indicate to the processor that it shall run in either the normal processing mode or the skipping mode. This same word is set by the Peripheral Monitor on a restart run, its setting depending upon whether or not the input tape is positioned at the data file at which restart is to occur (see page 16 below).

Positioning the Input Tape

With the exception of the end-of-reel condition, when the peripheral monitor transfers control to the processor the input tape is positioned between the flag and the first record of the data file upon which the processor is to act.

On the end-of-reel condition, the input tape is positioned at the first data record on that reel.

During a non-restart run, the input tape is advanced past the records of a data file by the processor which acts upon that file, either in the normal processing or in the skipping mode.

During a restart run, if the Peripheral Monitor finds that the input tape is not positioned at the data file at which restart is to occur, it calls upon the processor corresponding to the data file at which the input tape is currently positioned to space past that data file in the skipping mode. Processors are repeatedly activated and are instructed to run in the skipping mode until the input tape is properly positioned for restart.

The Output Tape

In its initial availability version, the Peripheral Monitor will never act upon the output tape (tape unit 4). Thus, the individual processors must provide for label, restart, and end-of-reel routines for this tape. A communication word, however, is provided to enable a processor to determine how many processors have previously referenced the output tape (see page 15).

Selection of Checkpoint for Restart

When the operator indicates to the Peripheral Monitor, by means of Sense Switch B, that it is to initiate a restart run, the PM reads the checkpoint tape until a tape mark is sensed. The checkpoint tape is then backspaced two records, to position it at the last written Checkpoint Record B. Sense Switch C is then interrogated; if it is ON, indicating that restart shall occur at a previous checkpoint, the machine halts. When restarted, the Peripheral Monitor backspaces the checkpoint tape twice (to position it at the previous checkpoint record B) and again interrogates Sense Switch C.

The backspacing, interrogating, and halting sequence is repeated until Sense Switch C is set to OFF, at which time Checkpoint Record B is read into storage. The Peripheral Monitor then completes its restart procedure.

1401 Sense Switches

The sense switches on the 1401 console are used by the operator to communicate the selection of certain options to the Peripheral Monitor.

Sense Switch	Status	Meaning
B	OFF	Machine run is a prime run.
	ON	Machine run is a restart run.
C	OFF	If Sense Switch B is OFF, the next data file will be processed in the normal processing mode. If Sense Switch B is ON, the restart shall occur at the last checkpoint written.
	ON	If Sense Switch B is OFF, the next data file will be processed in the skipping mode. If Sense Switch B is ON, the checkpoint tape is backspaced to the preceding checkpoint, and the machine will stop. Upon restart, the machine will repeat this action if Sense Switch C is still ON. If Sense Switch C is set to OFF, however, restart will commence from this checkpoint.
D	OFF	Input tape reel is unlabeled.
	ON	Input tape reel is labeled.
E	OFF	The flag for the next data file shall be read from tape.
	ON	The flag for the next data file shall be read from a card.

Sense Switches F and G are available for use by the particular processor. If additional switches are needed, a halt may be executed at the start of the processor and Switches B to E may be reset. However, they must be restored to their previous settings before the processor returns control to the Peripheral Monitor.

Sense Switch B is tested at the beginning of the run; hence, it must be set before loading the Systems tape.

Sense Switch C is tested:

1. At the beginning of the run, if Sense Switch B is ON; hence, it must be set before loading the Systems tape. If the setting chosen is ON, Sense Switch C should be set OFF at the appropriate programmed halt, (i.e., when the checkpoint tape is sufficiently backspaced.

2. At the beginning of each data file, if Sense Switch B is OFF; hence, it must be set at the appropriate programmed halt.

Sense Switch D is tested at the beginning of reel; hence, it must be set both before loading the Systems tape and before restarting after an end-of-reel halt.

Sense Switch E is tested at the beginning of each data file; hence, it must be set at the appropriate programmed halt.

Communication Between Processor and Monitor

Reserved Storage

The Peripheral Monitor reserves certain areas of lower storage for its own uses, as well as for communicating with the individual processors. The reserved 1401 locations are 082-086, 090, 091, 095, 096, 100-129, and 182-199.

If a processor needs to use any of these locations, it must save their contents and restore them before returning control to the Peripheral Monitor.

Communication Cells

The storage locations used for communication between the Peripheral Monitor and the processors follow.

FILCNT (1401 storage locations 082-084). This is a counter which contains the number of tape data files completed since the start of the current input reel. The processor acts upon FILCNT only as part of its

end-of-reel procedure, when it sets FILCNT to zero with the instruction

```
S    FILCNT          S084
```

RUNTYP (1401 storage location 085). This is a switch which indicates to the processor whether it is called in for a prime run or a restart run. RUNTYP contains the digit 0 if it is prime run and 1 if it is a restart run. This switch should be interrogated after SKIPSW. If RUNTYP is set to restart, the processor should, before completing its restart procedure, set RUNTYP to prime run with the instruction

```
MN   aaa    RUNTYP        Daaa085
```

where aaa is the address of a constant which has the value zero.

SKIPSW (1401 storage location 085). This switch, if ON, indicates to the processor that it should execute in its skipping mode. The ON condition is indicated by the presence of a word mark, the OFF condition by its absence. The processor should interrogate SKIPSW before RUNTYP. The processor never sets SKIPSW.

EORLSW (1401 storage location 086). This switch is used by the processor to communicate to the Peripheral Monitor that it has discovered an end-of-reel condition on the input tape. The ON condition is indicated by the presence of a word mark, the OFF condition by its absence. The processor acts upon EORLSW as part of its end-of-reel procedure, when it must set EORLSW to ON with the instruction

```
SW   EORLSW          ,086
```

The processor also utilizes EORLSW in its restart procedure, where the ON condition indicates to the processor that it is already at the correct position for the resumption of processing. The restart routine must guarantee that EORLSW is set to OFF with the instruction

```
CW   EORLSW               ¤086
```

CNTDSW (1401 storage location 086). This switch indicates to the Peripheral Monitor that the data file is continued on a new reel. The ON condition is a digit 1, and the OFF condition is a zero. The processor acts upon CNTDSW only as part of its end-of-reel procedure, when it sets CNTDSW to ON with the instruction

```
MN   aaa    CNTDSW        Daaa086
```

where aaa is the address of a constant which has the value one.

RETCOD (1401 storage location 090). This switch indicates to the Peripheral Monitor that the last processor called advanced the input tape. The digit 0 in this position is equivalent to ON, and the digit 1 is equivalent to OFF. The processor should, as part of its end-of-data-file procedure, set this switch with the instruction

```
MN  aaa   RETCOD        Daaa090
```

where aaa is the address of a constant which has the value zero if the processor advanced the input tape, and of a constant which has the value one if it did not.

OUTTAP (1401 storage locations 197-198). This is a counter which contains the number of processors which have referenced the output tape since the start of the current output reel. The processor using the output tape must, before returning control to the PM, increment this counter with the instruction

```
A  aaa  OUTTAP          Aaaa198
```

where aaa is the address of a constant which has the value one. The processor must, at end of output reel, set the counter to zero with the instruction

```
S  OUTTAP          S198
```

Transferring Control to the Processor

The Peripheral Monitor transfers control to a processor by reading the first segment of that processor into 1401 storage location 334 and branching to the instruction located at 337.

The segmentation scheme of the processor may be based entirely upon considerations peculiar to that processor, with the restrictions that:

1. The first segment must be assembled with origin at storage location 334.

2. The first executable instruction of the first segment must be located at storage location 337.

3. No segment of the processor may exceed

   k - 1500

   characters in length, where k is the number of positions in 1401 storage.

Upon receiving control from the Peripheral Monitor, the initial sequence of the processor must:

1. Interrogate SKIPSW and, if it is ON, execute the skipping routine; otherwise,

2. Interrogate RUNTYP and, if it is set to restart, execute the restart routine; otherwise,

3. Begin normal processing.

Returning Control to the Peripheral Monitor

Before relinquishing control to the Peripheral Monitor on an end-of-reel or end-of-data-file condition, the processor must initialize the appropriate communication words, as described above. The processor must then:

1. Rewind the Systems tape.

2. Read the first record of the Systems tape.

3. Read the second record of the Systems tape into storage location 334.

4. Branch to location 337.

Following this branch, the Peripheral Monitor is activated.

The Librarian

General

The Librarian program is a processor of PIPS which will operate on the Systems tape itself. It will enable the user to update the Systems tape by adding, deleting, replacing, or rearranging the processors or, by replacing the Peripheral Monitor.

Operations

The Librarian is capable of performing the following operations.

1.	ADD	Adds the named processor to the PIPS Systems tape.
2.	DELETE	Removes the named processor from the PIPS Systems tape.
3.	REPLACE	Combines items 1 and 2, replacing the named processor by an updated version of some processor.
4.	COPY	Copies the PIPS Systems tape onto a scratch tape.

5. PRINT — Prints out a list of the names of all processors currently on the PIPS Systems tape.

Flag

The Librarian, like any other PIPS processor, is activated by a flag; the flag is

bPIPSbLIBRARIAN≠

and is always supplied to the Peripheral Monitor as a card punched in columns 1-16. This card is always followed by a control card specifying the operation required.

Control Card Format

Constant information is underlined in the following outline.

Column 1	9	41	48
ADD	DUMP I-STRING≠	AFTER	PRINT/PUNCH DPROGRAM≠
DELETE	PRINT ONLY DPROGRAM≠		
REPLACE	DUMP I-STRING≠	BY	DUMP I-STRING≠
REPLACE	MONITOR≠		
COPY			
PRINT			

Columns 9 and 48, where applicable, identify the processor by giving its name followed by a record mark. The Peripheral Monitor is indicated by MONITOR≠.

Column 9 of the ADD and DELETE operations may not contain MONITOR≠. Since the Peripheral Monitor may only be replaced by a Peripheral Monitor, the second operand of such a REPLACE operation may be omitted.

Messages and Halts

The Librarian , in the table of processor names kept in the Peripheral Monitor, makes a revision corresponding to the changes produced on the Systems Tape.

This table provides space for a minimum of 80 processor names, each 23 characters in length; shorter names increase the number of names permitted. In the event that the Librarian attempts an ADD operation and discovers that the table is filled, a message is printed and the program halts. The program also prints a message and halts on an ADD operation which would result in duplicate names in the table.

If the control card is in error or the processor named and expected on the current Systems tape is not found, a message will be printed and the program will halt. The operator may correct and reinsert the control card. Upon restarting, the Librarian program will resume processing.

The program will also halt upon discovering any unrecoverable input/output error and at the end of job.

Procedures

In all operations in which a processor is added to, or replaced on, the Systems tape, it must be in final assembled and segmented form on tape unit 2, and its last segment must be followed by a tape mark.

The current Systems tape must be mounted on tape unit 1. The updated Systems tape will be produced on the scratch tape mounted on tape unit 3.

The Librarian flag card, followed by the appropriate control card, is placed in the card reader. The Systems tape is loaded and, at the Peripheral Monitor halt, Sense Switches A and E are set ON to indicate that the flag shall be read from cards.

The Librarian Program assumes control until the new Systems tape is produced and the end-of-job halt is reached. At this time, control can be returned to the updated PIPS peripheral monitor by setting tape unit 1 to 3, and tape unit 3 to 1 and then pressing START.

To achieve multiple modifications of the Systems tape, the new processors should all be on tape unit 2, each one immediately following the terminal tape mark of the one before. The deck of control cards, each preceded by a Librarian flag and signaling new processors in the same order in which they appear on the input tape, should be placed in the card reader. The Systems tape should then be loaded as described above. At each end-of-job halt, the operator should replace the previous Systems tape with a scratch tape, reset the tape unit numbers, and press START. At the PM halt, the operator should press START only if control cards remain to be read.

There will always be at least two programs on any Systems tape, namely, the Peripheral Monitor and the Librarian. Between them they have the ability to modify the tape in any manner required.

Once the processor which has been named on the control card by PROCESSOR+ has been placed on the Systems tape, it may be called with

the flag

bPIPSbPROCESSOR≠

either on card or tape, in any successive run.

APPENDIX 1: PERIPHERAL MONITOR HALTS

In the table of programmed halts below, the column headings are defined as follows:

Halt number - for reference purposes only.

Address - the number displayed in the storage address register on the 1401 console when the program comes to a halt.

Record - the number stored in 1401 storage locations 00334-00336 when the program comes to a halt.

Cause - the condition which produced the programmed halt.

Procedure - the operator action following the halt.

START - depress the Start key on the 1401 console.

SRS - depress the Start Reset key and then the Start key on the 1401 console.

Number	Address	Record	Cause	Procedure
001	00076		Maximum number of unsuccessful attempts to read Systems tape performed.	START to try again a maximum number of times.
002	00372	007	Ready to process next data file.	If next data file is on tape, set Sense Switch E to OFF; if in the card reader, to ON. If tape data file is to be skipped, set Sense Switch C to ON; otherwise, to OFF. Set Sense Switches F and G as needed by processor and START.
003	00404	009	The checkpoint tape is ready to be backspaced to a previous checkpoint.	To backspace one checkpoint, START. If no further backspacing is required, set Sense Switch C to OFF and START.
004	00450	007	Failure to recognize flag.	Examine the record beginning at the address which is stored in locations 00958-00960. If it is a flag and the first six characters are in error, manually enter 00450 into the I-address register and SRS. If the record is not a flag, manually enter 00388 into the I-address register and SRS.
005	00514	005	Same as Halt 001.	
006	00528	007	Failure to find processor.	Examine flag beginning at the address which is stored in locations 00958-00960. If the processor name is in error, correct it, store 01 in locations 00884-00885, and manually enter 00464 into the I-address register and SRS.
007	00537	009	Maximum number of unsuccessful attempts to read checkpoint tape performed.	START to try again a maximum number of times. (If repeated attempts fail, repeat the entire restart procedure, requesting a restart at a previous checkpoint).
008	00591	002	Same as Halt 001.	
009	00682	007	Same as Halt 001.	
010	00734	007	End of reel on input tape immediately following end of data file. (Possibly end of job)	If not end of job, verify that restart is not needed. (Once the program is continued, ability to restart before this point is lost.)

Number	Address	Record	Cause	Procedure
				If labeled input tapes are being used, rewind the tape on units 1 and 3, mount the next reel of the input file, set Sense Switch D to ON, and press the Tape Load key. If unlabeled input tapes are being used, mount the next reel of the input file and SRS.
011	00818	007	Restart initiated.	Set Sense Switch B to OFF and START.
012	00919	007	Maximum number of unsuccessful attempts to read input tape performed.	START to try again a maximum number of times.
013	03553		Program in improper instruction sequence.	Utilize restart facilities.
014	03630		Same as Halt 001.	
015	03662		Same as Halt 001.	
016	03713		Noise record discovered on Systems tape.	START to ignore noise record.
017	03798		Same as Halt 016.	
018	03905		Same as Halt 001.	
019	07553		Same as Halt 013.	
020	07630		Same as Halt 001.	
021	07662		Same as Halt 001.	
022	07713		Same as Halt 016.	
023	07798		Same as Halt 016.	
024	07905		Same as Halt 001.	
025	11553		Same as Halt 013.	
026	11630		Same as Halt 001.	

Number	Address	Record	Cause	Procedure
027	11662		Same as Halt 001.	
028	11713		Same as Halt 016.	
029	11798		Same as Halt 016.	
030	11905		Same as Halt 001.	
031	15553		Same as Halt 013.	
032	15630		Same as Halt 001.	
033	15662		Same as Halt 001.	
034	15713		Same as Halt 016.	
035	15798		Same as Halt 016.	
036	15905		Same as Halt 001.	

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