(TICKLER)

NRL SPECIAL PROJECTS CONTROL NUMBER

NRL B-289-75

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DATE: 19DEC75

ORIGINATOR: PME 106-543		SERIAL NO.: BYE 59,621-75	ENCLOSURES: (1)AGENDA(2) LIST OF ATTENDEES (3) MISSION 7107 STATUS(4) MISSION 7107 PHASE X ENGINEERING EVALUATION (5) COLLECTION HIGHLIGHTS(6) GROUND SITE STATUS
DATE/REC'D: 12/19	TICKLER DATE:	COPY NO.: 11	RECEIPT NO.: WA 80,765

SUBJECT: POPPY TECHNICAL OPS GRP(TOG): MEETING REPORT OF

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WA 80,765

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NAVY SPACE PROJECT OFFICE
~~(S)~~ NATIONAL RECONNAISSANCE OFFICE, PROGRAM C
WASHINGTON, D.C.

OFFICE OF THE DIRECTOR

PME-106-543/1c
19 DEC 1975

MEMORANDUM FOR THE COMMANDER, NAVAL SECURITY GROUP COMMAND (G54, POCG)
DIRECTOR, NATIONAL SECURITY AGENCY (A81, R24, W2, W34)
DIRECTOR, NATIONAL RECONNAISSANCE OFFICE (SS4, SS4A, SS7)
DIRECTOR, NAVAL RESEARCH LABORATORY (1000, 7030)
CHIEF OF NAVAL OPERATIONS (OP955)

Subj: POPPY Technical Operations Group (TOG) Meeting; report of

Encl: (1) Agenda
(2) List of Attendees
(3) Mission 7107 Status
(4) Mission 7107 Phase X Engineering Evaluation
(5) Collection Highlights
(6) Ground Site Status

1. The POPPY Technical Operations Group met at 0830 on 25 November 1975 at the National Security Agency. The meeting agenda is forwarded as enclosure (1). A list of attendees is forwarded as enclosure (2).

2. The Naval Research Laboratory representative presented a report on the status of Mission 7107, which is forwarded as enclosure (3). A detailed report of the November engineering evaluation, including a statement of current operational capabilities and an estimate of the future performance of Mission 7107, was also submitted by the Naval Research Laboratory representative and is forwarded as enclosure (4). A copy of the engineering evaluation was provided to the National Reconnaissance Office (SS4A) representative for immediate consideration of the recommendations for measures to reduce the collection tasking of 7107A during the present period of low sunlight. Two additional action items were taken with respect to Mission 7107 as follows:

a. The Naval Research Laboratory representative will submit a message recommendation that one of the 7107A data transmitters be shut off as a power conservation measure. A statement of the power savings will be included in the recommendation.

b. The National Reconnaissance Office (SS4A) representative will examine collection tasking requirements to determine whether or not band 1 on 7107D can be dropped from tasking in order to prevent data regeneration in other bands.

Warning Notice - Sensitive Intelligence Sources and Methods Involved

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Subj: POPPY Technical Operations Group (TOG) Meeting; report of

3. November collection highlights were reported by the Naval Security Group Command (POCG) representative and are forwarded as enclosure (5). The report includes operational highlights of ocean surveillance, technical intelligence and electronic order of battle reporting.

4. The Naval Security Group Command (POCG) representative reported on the status of POPPY ground sites as provided in enclosure (6).

5. The next TOG meeting is scheduled for 0930 on Thursday, 18 December at the Naval Security Station.

R. T. DARCY

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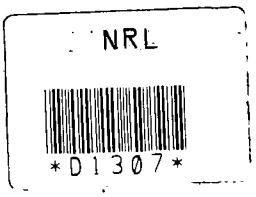
AGENDA



Mission 7107 Status

Mission 7107 Phase X
Engineering Evaluation

Collection Highlights

Processing Highlights

Ground Site Status

Enclosure (1) to BYE- 59,621-75

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LIST OF ATTENDEES

NSA [redacted]

NRO [redacted]

LCDR Potts (NSPO)

NRL Mr. Lawton (7030)

CNO [redacted]

NSGC LCDR Morgan (POCG)

[redacted]

Enclosure (2) to BYE-59,621-75

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MINIMUM DAILY

171

172

173

174

14 13 12 11 10 14 13 12 11 10 14 13 12 11 10 14 13 12 11 10

300 310 320 330 340 350 360 365

MISSION 7107 STATUS

Since the last TOG meeting, the 7107 vehicles have continued to be in a period of diminishing sunlight and are now in minimum sunlight. They will remain in minimum sunlight another week, will not reach eighty percent sunlight until 12 December and will reach one hundred percent sunlight on 15 December.

Since the vehicles are in minimum sunlight, there are a lot of passes which are in darkness. The current restrictions on tasking in darkness include "low yield" task groups on 7107A and 7107B and alternate pass collection for [redacted] field sites on 7107C "dark passes." [redacted] collects on odd numbered passes, [redacted] on even numbered passes). There are no tasking restrictions on 7107D.

There has been a problem with 7107D with data links 1, 2 and 3 which have caused processing difficulties. Initial observations with task group C82 indicated that data links 1 and 2 together cause cross talk which makes [redacted] This problem was examined during the engineering evaluation. It was determined that data link 1 or 2 could be tasked separately through the use of the adjustable threshold, option two.

The problem of regeneration with data link 3 on 7107D was also examined during the evaluation. Intermittent regenerative noise in data link 3 on 7107D did not appear with the use of adjustable threshold option 2, level 2. The results are inconclusive and the site [redacted] will try this solution the next time the problem occurs.

7107B was thrusted on the 4th of November and was thrusted again on 22 November. This should produce the desired spacing for [redacted] 7107A/B.

The spacing is as follows:

7107A/B - [redacted]

7107C/D - [redacted]

Enclosure (3) to

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MISSION 7107 PHASE X

ENGINEERING EVALUATION

Enclosure (4) to BYE-59,621-75

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1.0 Introduction

Since launch on 14 December 1971, the four Mission 7107 POPPY satellites have been in continuous operation. They are currently being tasked to collect ELINT data for [redacted] Satellite non-ELINT (housekeeping) functions are monitored from the engineering site located at [redacted] The purposes of this report are to summarize the current operational capabilities of the satellites; and to project, as well as can be projected, likely degradations which may be expected during the continuing life time of the satellites.

2.0 Spacecraft Operations

2.1 Command and Control Subsystems

The command and control of 7107 spacecraft are currently 100 percent operational on 7107A, 7107B, and 7107C. The ability to command 7107D has been degraded since January 1974. The redundancy of the 7107 command system design usually provides several alternate means of commanding which will attain the same or similar tasking objectives. This command flexibility has been of benefit in extending the operational life of the mission. 7107D spacecraft command system experienced a failure of the third address position in the "one" state. This prohibits commanding any address which requires a change to the third position of the address. The result of this condition is the inability to activate some ELINT bands and other functions. These are summarized below.

2.2 Telemetry Subsystem

The PCM telemetry subsystems on 7107A, 7107B, 7107C, and 7107D are currently 100 percent operational. The function of the telemetry system is:

1. Verification of the commanded ELINT collection configuration at the field sites.

2. Selective monitoring of satellite health at field sites.

3. Complete monitoring of satellite health at [redacted]. In order to conserve energy, the back-up (analog) telemetry subsystem has been turned off since 1973 and will be used only in the event of a PCM telemetry failure.

The store-and-dump mode of telemetry collection allows the [redacted] station to collect time histories of such functions as satellite attitude, temperatures, solar cell currents, etc. The satellite attitude measurements are necessary for use of the system signal level measurement option (SLM). The monitoring of health functions have been invaluable in tailoring the power consumption to the available battery and solar cell capacity.

2.3 Power Subsystem

Each satellite's power supply system consists of a solar array power source and eighteen rechargeable, nickel-cadmium cells wired in series. Each satellite has two battery packs, primary and secondary. All satellites are now operating on the primary battery pack. The 7107A secondary battery failed early in the mission. The secondary batteries on 7107B, 7107C, and 7107D are recharged periodically from [redacted]. However, the secondary batteries are not instrumented for individual cell voltage monitoring and

therefore cannot be switched as carefully as the primary batteries. Further they have not been switched on-line since 1973, an action that must be considered risky at this time. The batteries show the normal effects of four years of operation. There is considerable evidence of battery cell wearout. The wide dispersion of cell voltage indicates either partially shorted cells or cells drying out through slow leakage or both. Theoretical projection of the future capability of these batteries is speculative. However, close monitoring of individual cell voltages over the last ten months has minimized the aging process of the batteries. To continue operating with minimum detriment to the batteries, both over-discharge and excessive overcharge must be carefully avoided. A cell voltage below 1.0 volts (or battery voltage below 10.0 volts) is evidence that the battery's limit has been reached. One or more days without operational tasking should restore the battery. The preferred mode of reducing battery loading would be to decrease or eliminate, to the extent necessary, operational tasking during solar eclipse periods. This will tend to minimize depth of discharge and thus extend life. Overcharge is evidenced by cell voltages in excess of 1.5 volts and can be rectified by increasing operational tasking.

The solar arrays consist of body mounted solar array panels and one extended paddle. Ninety-two series strings of 1 cm x 1 cm cells and twenty series strings of 2 cm x 2 cm solar cells develop the satellite power. The solar arrays are arranged to provide, at beginning of life, 14.76 watts of electrical energy to the +12 volt bus and 11.76 watts to the -12 volt bus during sunlight portions of a maximum eclipse orbit. Typical design loads for housekeeping were 383 ma on the +12 volt bus and 283 ma on the -12 volt bus. To determine each satellite's present solar array capability, an

examination of solar array average current during minimum sun orbits since launch was performed. The raw average currents were corrected for solar intensity variations. Data between the 128th day of 1972 and the 216th day of 1975 was used and projected through the sixth year of satellite life (December 1977). Between launch and April 1973, a larger than nominal degradation of solar array capacity was experienced on all satellites. This difficulty was probably due to a mechanical separation of epoxy glue bonds on the satellites' solar paddles. At that time, energy conservation measures included turning off the reaction wheels (which provided third-axis stability) and analog telemetry. Nominal degradation is primarily electron and proton radiation damage and is occurring at a rate in good agreement with theoretical predictions. Typical load values for passes during a recent thirty day period were evaluated to determine actual loading levels. The solar array currents were projected through 1977. The arrays will support housekeeping loads at present levels through 1977. For 7107C and 7107D sufficient solar cell capacity is projected to exist through 1977 to support housekeeping and operational tasking. The combined operational and housekeeping loads for 7107A and 7107B exceed average array capability, and battery support is required to supplement the array. For 7107A and 7107B, a predicted allowable operational duty cycle has been forecasted.

Predicated Allowable Operational Duty Cycle

	Year 4 (CY 75)		Year 5 (CY 76)		Year 6 (CY 77)	
	Max Eclipse	Full Sunlight	Max Eclipse	Full Sunlight	Max Eclipse	Full Sunlight
Satellite						
7107A	.11	.44	.05*	.34	<.01	.27
7107B	.20	.51	.17	.46	.12	.40

*For example, the .05 duty cycle translates to 72 minutes per day of combined collection for [redacted]

These projections are based on present loadings. Reduction of loading would allow a proportionally higher duty cycle. It is clear the 7107A is in the most critical condition and its ability to operate in maximum eclipse (minimum sunlight) conditions will become nil unless actions discussed later in paragraph 3.6.1 are implemented.

2.4 Stabilization Subsystem

The satellites are stabilized in two axes (pitch and roll) by means of a gravity gradient boom and mass. This subsystem is currently operational on 7107A, 7107B, and 7107D. The gravity gradient boom on 7107C could not be deployed after launch; therefore, the spacecraft is not stable. The spacecraft third-axis stability (yaw) was provided by a angular momentum wheel. Since early 1973, when power problems arose, the wheels were turned off as a conservation measure. The lack of third-axis stability on the spacecraft has not diminished their collection capability significantly. Because of the unstable condition of 7107C, some collection passes are marginally processable. However, in the northern hemisphere most passes produce much useable data and often no degradation is noticeable. It is not expected that the stability of the

spacecraft will change throughout the remainder of the mission. For situations in which satellite aspect is important, a time history of pitch, roll and yaw is available from telemetry.

2.5 Microthruster Subsystem

Ammonia-vapor microthrusters are used to maintain desired separation between satellites [redacted]. The spacing between 7107A and 7107B can be adjusted by thrusting either satellite. The spacing between 7107C and 7107D can be adjusted only by thrusting 7107C due to the partial command malfunction on 7107D. Satellite aspect must be available in real time in order to align the thrust axis for all spacecraft. It is expected that station keeping will be possible throughout the remainder of the mission.

3.0 ELINT Data Collection Systems

3.1 Data Bands

3.1.1 7107A and 7107B

Operational collection bands - all bands are operational and were installed as follows:

1. Data bands on both 7107A and 7107B have the following RF coverages: 154-200 MHz, 550-970 MHz, 1800-4850 MHz, 5250-6725 MHz, and 9200-9600 MHz (COMB FILTER).

2. Data band 17.0-18.0 GHz on 7107A.

3. Data band 12.5-14.5 GHz on 7107B.

4. This coverage equates to full ELINT design capability.

3.1.2 7107C and 7107D

Operational collection bands:

1. Data bands operational on both 7107C and 7107D have the following RF coverages: 200-550 MHz, 815-1205 MHz, 2100-2580 MHz, 2680-2930 MHz, 4850-5250 MHz, 6400-9600 MHz, 14.8-15.1 GHz, and 34.7-35.0 GHz.

2. Data bands operational on 7107C are: 1205-1800 MHz, 9600-10500 MHz, 14.5-14.8 GHz, and 15.0-16.0 GHz.

3. This coverage equates to full ELINT design capability on 7107C.

4. Data band 16.0-17.0 GHz on 7107D.

5. Data bands 6 (1205-1800 MHz), 17 (9600-10500 MHz) and 18 (14.5-14.8 GHz) are not operational on 7107D.

3.2 Band Options

ELINT data bands are assigned to one of three data transmitters on each satellite. The option to switch that band to another transmitter on the satellite is referred to as band option. Option one advances the band output assignment to the next transmitter. Option two advances the band output assignment to the second transmitter in order. These options are used to (1) design task groups which are more convenient to work; (2) avoid assigning the same transmitter and pulse width to two or more bands; and (3) work around mulfunction conditions.

3.2.1 7107A and 7107B

There are 16 bands with two options each on 7107A and 7107B which are all operational.

3.2.2 7107C and 7107D

3.2.2.1 The following band options are operable on 7107C:

band 1 opt 1 + 2, band 2 opt 1 + 2, band 3 opt 1 + 2
band 5 opt 2, band 6 opt 1 + 2, band 7 opt 1 + 2
band 8 opt 2, band 9 opt 1 + 2, band 11 opt 1 + 2,
band 12 opt 1 + 2, band 15 opt 1, band 16 opt 1 + 2,
band 17 opt 1 + 2, band 19 opt 1, and band 21 opt 2.

3.2.2.2 The following band options have been intermittent on 7107C:

band 4 opt 2, band 13 opt 2, band 14 opt 2,
band 19 opt 2, and band 20 opt 1 + 2.

3.2.2.3 The following band options are operable on 7107D:

band 1 opt 1, band 2 opt 1 + 2, band 3 opt 1,
band 4 opt 2, band 5 opt 2, band 7 opt 1,
band 9 opt 1, band 11 opt 2, band 12 opt 1, band 13 opt 1 + 2,
band 14 opt 1, band 15 opt 2, band 16 opt 1, and band 19 opt 1.

3.2.2.4 The following band options have been intermittent on 7107D:

band 8 opt 2, band 10 opt 2, band 20 opt 2, and band 21 opt 2.

3.3 Location Capability

The system has continuous geolocation coverage over the 154-1205 MHz, 1800-9600 MHz, 14.8-15.1 GHz and 34.7-35.0 GHz frequency ranges.

3.3.1 7107A and 7107B

15 bands plus 20 comb filter bands common to 7107A and 7107B with RF coverage as listed in paragraph 3.1.1.1 above, capable of providing [redacted] locations.

3.3.2 7107C and 7107D

17 bands common to 7107C and 7107D with RF coverage, as listed in paragraph 3.1.2.1 above, capable of providing [redacted] locations.

3.4 SLM Capability

3.4.1 7107A and 7107B

SLM capability exists on all three transmitters for 7107A and 7107B.

3.4.2 7107C and 7107D

SLM capability exists on transmitters B and C for 7107C. 7107D has no SLM capability.

3.5 Adjustable Threshold

The adjustable threshold option was designed to be an engineering tool to be used to extend the useful life on all ELINT bands.

3.5.1 7107A and 7107B

The adjustable threshold option capability exists on all three transmitters of 7107A and 7107B.

3.5.2 7107C and 7107D

The adjustable threshold option capability exists on transmitters B and C of 7107C and on transmitter D of 7107D.

3.6 Collection Capability

An analysis has been conducted of the collection capability at the existing and proposed ground stations. The average number of minutes per day of collection for a northern site [redacted] or [redacted] is approximately 117 minutes per day. The proportion

of sunlight and darkness operation varies with the sun cycle. A sixteen day period during minimum sunlight was examined. Approximately 65 minutes of sunlight collection and 52 minutes of darkness collection per day exists at each site. One hundred and seventeen minutes per site represents a duty cycle of .08 per site or .16 if two sites are operating.

3.6.1 Minimum Sunlight Conditions

The allowable duty cycle for max eclipse, from paragraph 2.3.2 above, drops from .11 to .05 between Year 4 (CY 75) and Year 5 (CY 76) for 7107A. The allowable duty cycle for 7107B for max eclipse drops from .20 to .17 between Year 4 (CY 75) and Year 5 (CY 76). The duty cycle for 7107C and 7107D presents no problem between Years 4 (CY 75) and 6 (CY 77). The main concern for 7107C is maintaining the proper equilibrium between darkness and sunlight collection to sustain the battery health.

It will be necessary to lower the duty cycle for 7107A or lower the load or both. To obtain a duty cycle of .05 a total of 72 minutes per day of collection at two sites is allowable. There are eight revs a day which pass within the collection horizon of each northern site. A reduction in the number of minutes of collection at each site would reduce the overall collection drain, and hence the duty cycle. Resetting the satellites several minutes earlier on each rev would have the added benefit of reducing the probability that the satellite would leave the station's collection horizon without being reset.

The 72 minutes of collection per day must therefore be apportioned among sixteen site passes for two sites. It is recommended that this be done in conjunction with tasking authority in order to maximize collection benefits. However, certain guidelines may be helpful.

1. Since the power on 7107B can sustain present normal collection, it should be interrogated before 7107A.

2. Early reset will serve the dual purposes of reducing the duty cycle and diminishing the probability of leaving a station without reset.

3.6.2 High Sunlight Conditions

Above 80 percent sunlight, the satellites are able to sustain the loads from two sites tasking through Year 5 (CY 76) at the present load levels. Present calculations indicate that satellites should have the ability to operate through Year 6 (CY 77). A more valid projection of possible operational capabilities in Year 6 (CY 77) should be made as Year 5 (CY 76) progresses.

3.6.3 Effects of Failure to Reset Satellites

The failure to reset a satellite when it leaves a site's horizon has been examined for collection at [redacted] providing backup to reset. There are no cases where a satellite will go more than one rev without being seen. However, there are many instances in which 70-85 minutes will have elapsed, a severe hazard to these satellites. It is therefore imperative that all possible precautions be taken to reset the satellites before leaving a site's horizon.

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Failure to Reset Time Gaps

EQX	Site Collecting	Site Resetting	Time Gap (Approx)
19E-2W			10 70
2W-160W			85 or 70
160W-175E			10 70
175E-96E			5
96E-45E			85
45E-19E			70

4.0 Summary and Conclusions

At this time, it seems likely that the 7107 satellites will continue to operate through December 1976 providing that no unforeseen malfunctions occur. While the projections beyond Year 5 (CY 76) indicate that the system will continue to operate, it is deemed advisable to make an assessment following an evaluation next year. In order to achieve this objective, the satellites must be treated with care and the tasking on 7107A must be reduced during periods of low sunlight. The ground rules upon which this project is based are:

1. Two sites collecting data
2. Attention by site personnel in avoiding potentially hazardous operating conditions.
3. Continued careful monitoring of spacecraft health by and Naval Research Laboratory analysts.

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COLLECTION HIGHLIGHTS

OCEAN SURVEILLANCE:

A total of 1483 [redacted] items were reported, 339 of which were equated to major combatants or auxiliaries and 133 of which were major combatant associated but could not be correlated to a specific unit. Fifteen [redacted] intercepts and 996 merchant intercepts were reported. Activity was moderate from the Mediterranean and Black Sea and relatively light from all other fleet areas. [redacted] were intercepted from the Sea of Japan on 29 October and on 21 November. Of the fifteen [redacted] intercepts two were located out of area, one on 5 November north of the Gulf of Hammamet in the central Mediterranean Sea and the other, a possible [redacted] from south of the British Isles on 21 November. [redacted] emitters were isolated in the Black Sea during the report period. One exhibits a very highly stable pulse train and is believed to be emanating from the fourth Black Sea Construction Kara. The other does not exhibit the high degree of stability and is believed to be emanating from the new third Black Sea Krivak. The Kashin PROVORNYY was also noted in operation (after an extended yard period for conversion from DLG to DLGM).

Fifty intercepts were accomplished of the KRESTA II CLGM MAKAROV and ISACHENKOV as they monitored allied Ocean Safari operations in the North Atlantic and Norwegian Sea. The ISACHENKOV returned to the North Fleet while the MAKAROV continues to linger off the British Isles (monitoring the remaining NATO vessels).

TRANSITS/TRANSFERS:

Primorye AGI KAVKAZ returned to the Black Sea after deployment off Cyprus.

Moskva CHG LENINGRAD returned to the Black Sea after a Mediterranean deployment. (The vessel was relieved in the Med Squadron by the Kynda ADM GOLOVKO of the Black Sea Fleet).

Kashin DLG OGNEVOY returned to the Mediterranean Sea after a stay in Conakry, Guinea.

The Kresta I ADM ZOZULYA and the Kresta II ADM ISAKOV have departed the Mediterranean Sea and are presently northbound in the Atlantic. (Vessels are apparently returning to the North Fleet).

The Desna AGM CHUMIKAN was intercepted during operations on the 52 degree earth trace and return to Petropavlovsk.

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TECHNICAL INTELLIGENCE AND EOB:

Unident [ ] intercepted on 24 October by [ ] displayed occasional double pulsing with two different intervals. At times a pulse triplet was noted. The emitter was also noted occasionally being transponded in the [ ] This may have been due to narrow pulse group activity or a wide emitted pulse width.

A [ ] intercepted on 27 October b[ ] was geolocated to 37-34N/019-58E. A max amplitude level (binary word) of fifteen was noted in 7107A and twelve in 7107B. A max sidelobe level of two was noted. The HBW calculated to be 4.1 degrees. The emitter displayed a high degree of PRI stability with burst to burst PRI variations of 0.1 nsec or less. This reported PRF is the resultant of basic 124.1 PPS PRF as intercepted in the five RF mode.

[ ] was intercepted on 5 November by [ ] and geolocated to 51-06N/022-03E and displayed a PRF of 416.4426 PPS. Its PRI legs of 2334.6 and 2467.8 usec equate to the 175th and the 185th countdowns respectively of a 74.95967 kHz 2 KM crystal.

Enclosure (5) to BYE-59,621-75

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GROUND SITE STATUS

[redacted] 24 November - 19 December

Operations remain in ready condition

Completed Phase X Engineering Evaluation

IPA is installed and on site training by HRB-Singer representatives has been completed.

Conditions normal although some recent problems with the fixed head disc have been encountered

Terminated operations 31 October 1975

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