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ATARS/ATC SIMULATION TESTS WITH SITE-ADAPTATION LOGIC.(U)
JAN 79 J R WINDLE, G MORFITT, P J DEVINE

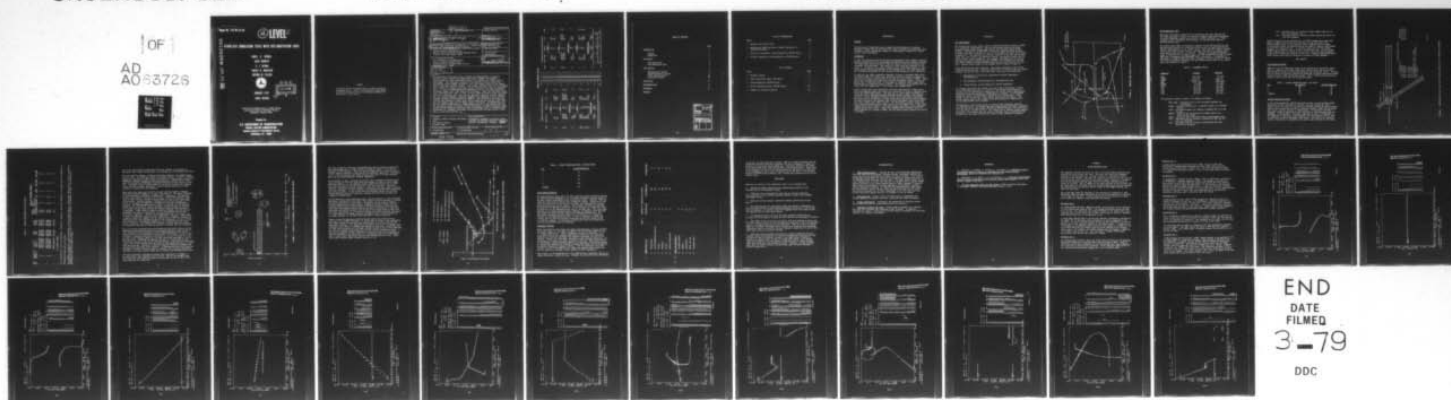
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ATARS/ATC SIMULATION TESTS WITH SITE-ADAPTATION LOGIC

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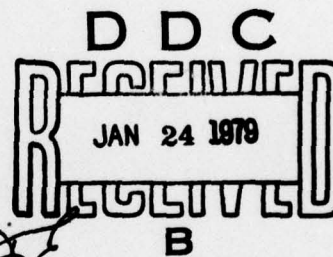
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JANUARY 1979

FINAL REPORT



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| 16. Abstract The objective of this project was to assess the effectiveness of proposed Automatic Traffic Advisory and Resolution Service (ATARS) site-adapted logic designed to reduce unnecessary alarms in a terminal air traffic control environment. The tests were conducted at the National Aviation Facilities Experimental Center (NAFEC) at Atlantic City, New Jersey, using the Air Traffic Control Simulation Facility (ATCSF). Test results indicated that the site-adapted logic reduced the numerous unnecessary alarms experienced in previous simulation tests. In fact, no ATARS alarms were generated in any of the tests involving instrument flight rules (IFR) separation procedures. Under IFR and/visual flight rules (VFR) separation rules, a total of seven ATARS controller alerts was issued over four 1-hour data runs. One aircraft received a positive vertical command, and four received negative horizontal commands; the remaining aircraft received flashing proximity warning indicators (FPWI's). The majority of the eight controllers participating in these tests favored ATARS use and indicated that ATARS with site-adapted logic did not impact control procedures. Recommendations are made for further improvements in ATARS desensitization in the terminal ATC area, for additional studies to improve tracker performance and ATARS performance under reduced VFR ATC separation criteria, and for additional tests to evaluate ATARS performance in a terminal environment with uncontrolled aircraft flying in proximity to controlled aircraft. | | | | | |
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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|----------------------------|------------------------|----------------------------|---------------------|-----------------|
| LENGTH | | | | |
| in | inches | 2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| AREA | | | | |
| in ² | square inches | 6.5 | square centimeters | cm ² |
| ft ² | square feet | 0.09 | square meters | m ² |
| yd ² | square yards | 0.8 | square meters | m ² |
| mi ² | square miles | 2.6 | square kilometers | km ² |
| | acres | 0.4 | hectares | ha |
| MASS (weight) | | | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| VOLUME | | | | |
| teaspoon | teaspoons | 5 | milliliters | ml |
| fluid ounce | fluid ounces | 15 | milliliters | ml |
| cup | cups | 0.24 | liters | l |
| quart | quarts | 0.47 | liters | l |
| gallon | gallons | 0.95 | liters | l |
| cubic foot | cubic feet | 3.8 | cubic meters | m ³ |
| | | 0.03 | cubic meters | m ³ |
| | | 0.76 | cubic meters | m ³ |
| TEMPERATURE (exact) | | | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |

*1 in = 2.54 exactly. For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10.286.

| Approximate Conversions from Metric Measures | | | | |
|---|-----------------------------------|-------------------|------------------------|-----------------|
| Symbol | When You Know | Multiply by | To Find | Symbol |
| LENGTH | | | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| AREA | | | | |
| cm ² | square centimeters | 0.16 | square inches | in ² |
| m ² | square meters | 1.2 | square yards | yd ² |
| km ² | square kilometers | 0.4 | square miles | mi ² |
| ha | hectares (10,000 m ²) | 2.5 | acres | ac |
| MASS (weight) | | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | short tons |
| VOLUME | | | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| m ³ | cubic meters | 35 | cubic feet | ft ³ |
| m ³ | cubic meters | 1.3 | cubic yards | yd ³ |
| TEMPERATURE (exact) | | | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |

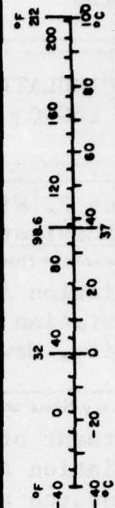


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|---------------------------------|---|
| ACCESSION for | |
| NTIS | White Section <input checked="" type="checkbox"/> |
| DDC | Buff Section <input type="checkbox"/> |
| UNANNOUNCED | <input type="checkbox"/> |
| JUSTIFICATION | |
| | |
| REGISTRATION/AVAILABILITY CODES | |
| Dist. | AVAIL. INTD. or SPECIAL |
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INTRODUCTION

PURPOSE.

The objective of these tests was to assess the effectiveness of proposed Automatic Traffic Advisory and Resolution Service (ATARS) site-adaptation logic designed to reduce unnecessary alarms in a high-density terminal air traffic control (ATC) environment.

BACKGROUND.

In 1975, the National Aviation Facilities Experimental Center (NAFEC) conducted dynamic simulation tests to investigate the operational and procedural problems that might exist when Intermittent Positive Control (IPC) was introduced into a terminal ATC environment. The results of those tests were reported in reference 1. In general, the results indicated that an excessive number of unnecessary alarms were being generated in the terminal area. The high alarm rate was considered intolerable by the controllers participating in the simulation.

In addition, the MITRE Corporation analyzed 11 hours of Automated Radar Terminal System (ARTS III) traffic data collected from four different terminals to quantify the alarm rates generated by the same IPC logic tested at NAFEC. MITRE tests also concluded that there were too many unnecessary alarms. It was suggested that a concerted effort be undertaken to eliminate false alarms while maintaining the necessary margin of safety. The program to accomplish this was called "IPC Site Adaptation." The IPC was later renamed ATARS.

Based on Monte Carlo type simulations and tests using ARTS III traffic data, three site-adapted logics were found to be effective in terms of reducing false alarms and maintaining safety. The first was to reduce alarm thresholds for controller alert, Flashing Proximity Warning Indicator (FPWI), and commands relative to those thresholds initially tested in the 1975 NAFEC simulations. The second was to incorporate a uniform logic which applied the same thresholds uniformly throughout the terminal area for both instrument flight rules (IFR) and visual flight rules (VFR) aircraft. The third was to further refine the final approach desensitization logic used in the 1975 NAFEC tests so that ATARS commands would not be issued to aircraft already established on the instrument landing system (ILS) course. These three changes were introduced into the ATARS algorithm for testing at NAFEC, and the report herein presents the results of testing.

DISCUSSION

TEST ENVIRONMENT.

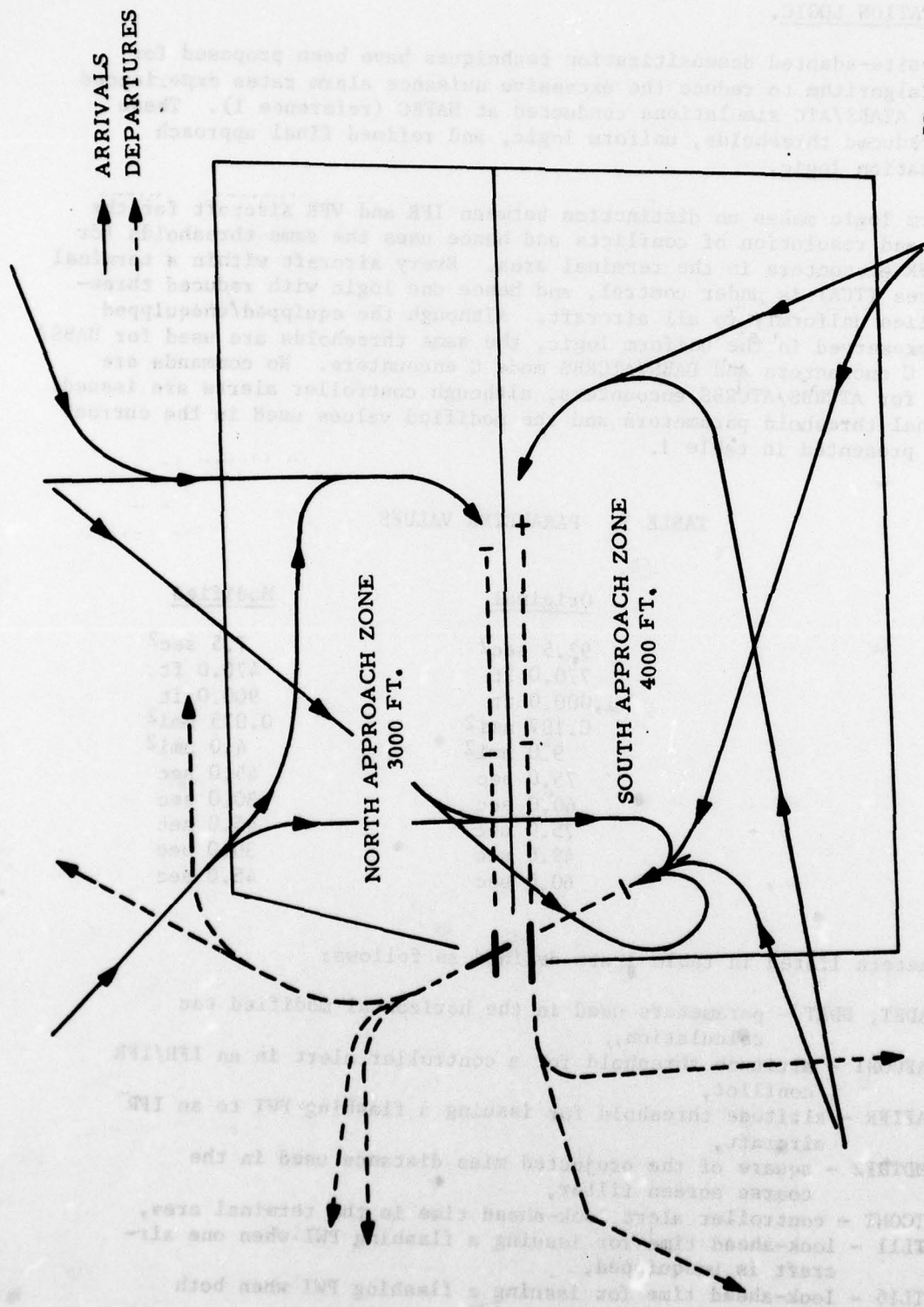
The testing used the Air Traffic Control Simulation Facility (ATCSF) at NAFEC in a stand-alone configuration. The test environment simulated a single Discrete Address Beacon System (DABS) sensor site serving a terminal ATC facility. Testing was accomplished utilizing the ATARS algorithm provided by MITRE Corporation (reference 2) with new site-adaptation logic incorporated (reference 3). The simulated ATC facility consisted of six ATC control positions; one local control, one departure control, two arrival control, and two enroute feeder control positions. The terminal environment was the same as that used in previous IPC/ATC testing at NAFEC. The terminal area included all traffic within a 30-nautical-mile (nmi) radius of the center of the airport. Typical traffic flows in the terminal area are shown in figure 1.

Three series of tests were conducted. Each series consisted of four 1-hour 15-minute simulation runs. The first 15 minutes of a run were used for traffic buildup, and the last hour as the data base. The three test series were:

1. High-density, all-arrival, simultaneous parallel approaches, IFR separation;
2. Medium-density, arrival-departure, IFR separation; and
3. Medium-density, arrival-departure, IFR/VFR separation.

All aircraft were under the control of an air traffic controller. In both of the IFR-separation series, 75 percent of the aircraft were DABS/mode C equipped, and the remaining 25 percent were Air Traffic Control Radar Beacon System with altitude transponder (ATCRBS/mode C) equipped. In the IFR/VFR separation series, the percentages were 60 and 40, respectively. Twelve percent of the 150 aircraft in the IFR/VFR series were VFR flights. The traffic samples used in the current tests were identical to those used in the previous IPC/ATC tests at NAFEC.

IFR separation criteria used by the controllers were 1,000-feet vertical or 3-nmi horizontal. ATC separations used under assumed VFR weather conditions were 500 feet or 1.0 nmi between IFR/VFR and VFR/VFR aircraft, and 1,000 feet or 3 nmi between IFR/IFR aircraft. The purpose was to simulate visual approach procedures. No consideration was given to variable types of separation used between heavy and light aircraft as a result of wake turbulence avoidance.



78-42-1

FIGURE 1. TERMINAL AREA TRAFFIC FLOW

SITE-ADAPTATION LOGIC.

Three new site-adapted desensitization techniques have been proposed for the ATARS algorithm to reduce the excessive nuisance alarm rates experienced in earlier ATARS/ATC simulations conducted at NAFEC (reference 1). These included reduced thresholds, uniform logic, and refined final approach desensitization logic.

The uniform logic makes no distinction between IFR and VFR aircraft for the detection and resolution of conflicts and hence uses the same thresholds for IFR and VFR encounters in the terminal area. Every aircraft within a terminal control area (TCA) is under control, and hence one logic with reduced thresholds applies uniformly to all aircraft. Although the equipped/unequipped logic is preserved in the uniform logic, the same thresholds are used for DABS/DABS mode C encounters and DABS/ATCRBS mode C encounters. No commands are generated for ATCRBS/ATCRBS encounters, although controller alerts are issued. The original threshold parameters and the modified values used in the current tests are presented in table 1.

TABLE 1. PARAMETER VALUES

| <u>Parameter</u> | <u>Original</u> | <u>Modified</u> |
|------------------|------------------------|------------------------|
| ADET | 92.5 sec ² | 7.5 sec ² |
| AFCONI | 770.0 ft | 470.0 ft |
| AFIFR | 1,000.0 ft | 900.0 ft |
| BDET | 0.107 nmi ² | 0.025 nmi ² |
| MDTHF2 | 9.0 nmi ² | 4.0 nmi ² |
| TCONT | 75.0 sec | 45.0 sec |
| TL6 | 60.0 sec | 30.0 sec |
| TL11 | 75.0 sec | 45.0 sec |
| TL15 | 49.0 sec | 30.0 sec |
| TL16 | 60.0 sec | 45.0 sec |

The parameters listed in table 1 are defined as follows:

- ADET, BDET - parameters used in the horizontal modified tau calculation,
- AFCONI - altitude threshold for a controller alert in an IFR/IFR conflict,
- AFIFR - altitude threshold for issuing a flashing PWI to an IFR aircraft,
- MDTHF2 - square of the projected miss distance used in the coarse screen filter,
- TCONT - controller alert look-ahead time in the terminal area,
- TL11 - look-ahead time for issuing a flashing PWI when one aircraft is unequipped,
- TL16 - look-ahead time for issuing a flashing PWI when both aircraft are equipped,

- TL6 - look-ahead time for issuing an ATARS command when one aircraft is unequipped, and
 TL15 - look-ahead time for issuing an ATARS command when both aircraft are equipped.

With the exception of one modification, the ATARS desensitized areas (see figure 2) used in these tests were identical to the ones used in the previous NAFEC tests. In the previous tests, commands were not issued to an aircraft inside the desensitization zone when in conflict with another aircraft also inside the zone. An aircraft inside the zone was issued commands if in conflict with an aircraft outside the zone. In the current tests, commands were not issued to any aircraft inside the zone regardless of where the intruder was relative to the zone. Proximity Warning Indicator (PWI) service would still be provided to aircraft on final approach.

TEST RESULTS

IFR SEPARATION SERIES.

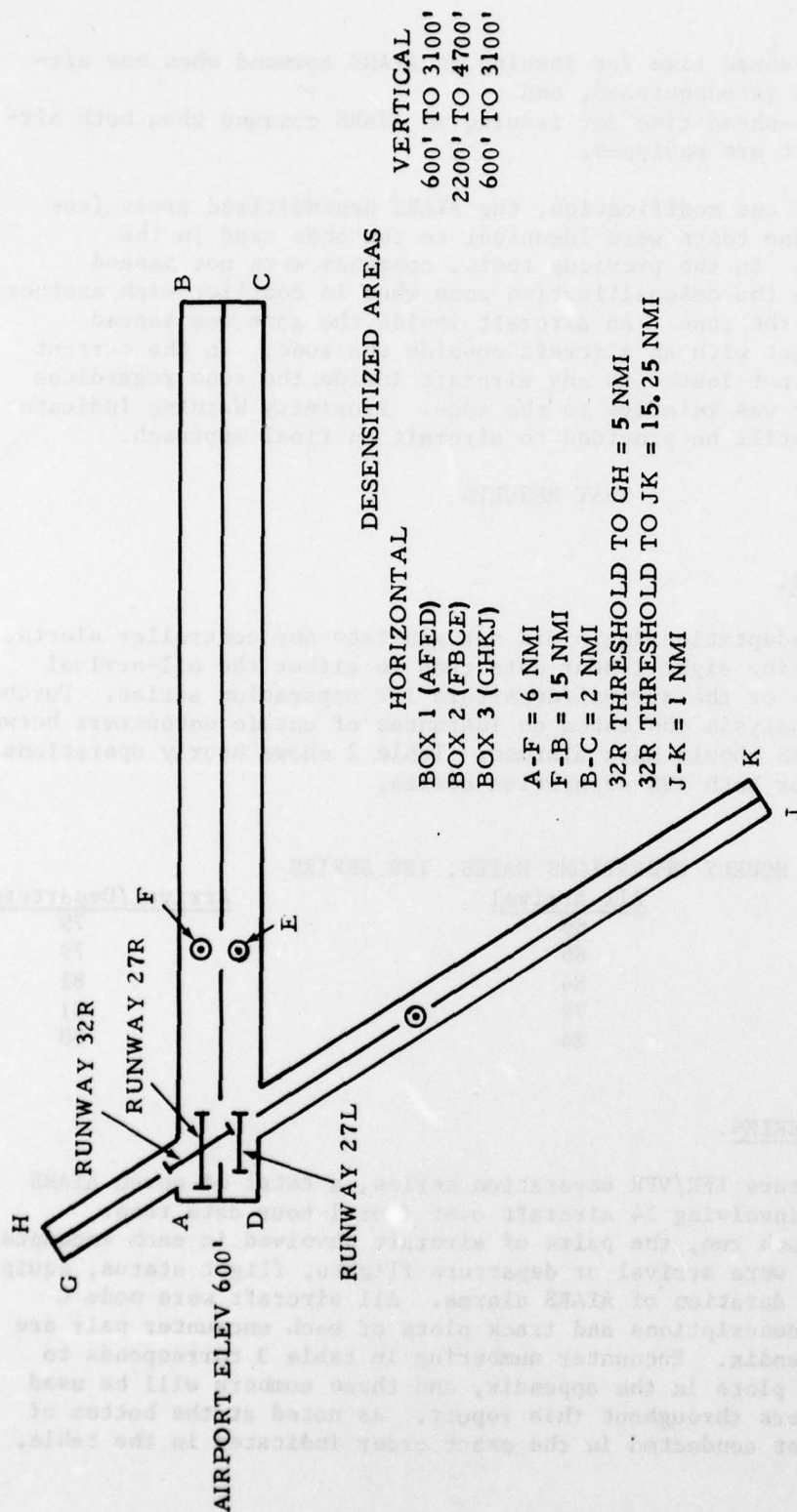
ATARS with the site-adaptation logic did not generate any controller alerts, FPWI, or commands during eight 1-hour data runs in either the all-arrival IFR separation series or the arrival/departure IFR separation series. Furthermore, a run-by-run analysis indicated no instances of unsafe encounters between aircraft wherein ATARS should have alarmed. Table 2 shows hourly operations rates for each run for both IFR separation series.

TABLE 2. HOURLY OPERATIONS RATES, IFR SERIES

| <u>Run</u> | <u>All Arrival</u> | <u>Arrival/Departure</u> |
|------------|--------------------|--------------------------|
| 1 | 86 | 79 |
| 2 | 86 | 79 |
| 3 | 84 | 81 |
| 4 | 79 | 81 |
| AVERAGE | 84 | 80 |

IFR/VFR SEPARATION SERIES.

In the arrival/departure IFR/VFR separation series, a total of seven ATARS encounters occurred involving 14 aircraft over four 1-hour data runs. Table 3 lists, for each run, the pairs of aircraft involved in each encounter, whether the aircraft were arrival or departure flights, flight status, equipment status, and the duration of ATARS alarms. All aircraft were mode C equipped. Detailed descriptions and track plots of each encounter pair are presented in the appendix. Encounter numbering in table 3 corresponds to the numbering on the plots in the appendix, and these numbers will be used to reference encounters throughout this report. As noted at the bottom of table 3, runs were not conducted in the exact order indicated in the table.



78-42-2

FIGURE 2. DESENSITIZED ATARS AREA USED IN NAFEC SIMULATION FOR CONTROLLED AIRCRAFT

TABLE 3. ARRIVAL/DEPARTURE IFR/VFR SERIES

| Run* No. | Encounter Number | Aircraft Ident | ARR/ DEP | Flight Status | Equip D-DABS A-ATCRBS | NO. OF 4-SECOND SCANS** | | | | |
|-------------|---------------------|-------------------|-------------|------------------|-----------------------------|--------------------------------|----|------|---------|---------|
| | | | | | | Total Encounter Duration | CA | FPWI | NEG CMD | POS CMD |
| | | | | | | | | | | |
| 1 | 1 | NW604/PA318 | ARR/ARR | IFR/IFR | D/D | 4 | 3 | 4 | 0 | 0 |
| | 2 | AA317/CO128 | ARR/ARR | IFR/IFR | D/D | 2 | 1 | 2 | 0 | 0 |
| | 3 | AA241/AA887 | ARR/DEP | IFR/IFR | D/D | 5 | 4 | 1 | 4 | 0 |
| 2 | 4 | A30924/N5303 | ARR/DEP | IFR/VFR | A/A | 4 | 4 | 0 | 0 | 0 |
| | 5 | AA241/N5316 | ARR/DEP | IFR/VFR | D/A | 11 | 10 | 5 | 1 | 5 |
| | 6 | A30454/TW97 | ARR/ARR | IFR/IFR | A/D | 4 | 3 | 1 | 3 | 0 |
| 3 | 7 | OZ967/N5164W | ARR/ARR | IFR/VFR | D/A | 9 | 8 | 6 | 3 | 0 |
| 4 | | NO ATARS ALARMS | | | | | | | | |

*For convenience, runs are tabulated 1 through 4; however, runs were conducted in random order in simulation.

**Tabulated data read as follows:

For example, encounter 5; total duration 11 scans consisting of 5 scans FPWI alone, plus 1 scan of a negative command, accompanied by FPWI, plus 5 scans of a positive command, accompanied by FPWI. The controller was alerted for 10 of these 11 scans.

Two of the runs involved three encounters each, another run involved one encounter, and a fourth run had none. The average was 1.8 encounters per hour.

Only one positive command, a climb of 20-seconds duration, was issued during all four runs. The climb was issued in encounter number 5, in which a positive command was required to safely resolve the conflict. This encounter involved a DABS/mode C equipped arrival aircraft descending from 10,000 feet to 6,000 feet altitude and an ATCRBS/mode C equipped departure aircraft level at 7,000 feet. The ATARS issued a climb command to the arrival aircraft and satisfactorily resolved an unsafe situation. A more detailed description of this encounter is contained in the appendix.

There were three encounters in which aircraft received negative commands. These were encounters number 3, 6, and 7 (see table 3). Encounter 3 involved an arrival/departure DABS/mode C equipped pair of aircraft. The departure aircraft was cleared to pass over the arrival. ATARS issued negative right turns to both aircraft, and the aircraft passed 1.7 nmi of each other when at altitude. Encounter number 6 involved an arrival/arrival pair of aircraft, one of which was DABS/mode C equipped and the other ATCRBS/mode C equipped. The DABS-equipped aircraft failed to intercept the ILS approach course on the controller's initial clearance, crossed through the parallel ILS courses, and was being vectored for another approach (see encounter 6 in appendix). ATARS issued a negative right-turn command, and the aircraft approached each other no closer than 1.37 nmi horizontally and 115 feet vertically. Encounter 7 involved an arrival/arrival pair of aircraft, one of which was DABS/mode C and the other ATCRBS/mode C equipped. ATARS issued a negative right-turn command, and the closest point of approach between the aircraft was 0.91 nmi horizontally and 425 feet vertically. In all of these three encounters, the negative commands did not interfere with the intent of the controller. The commands were advisory in nature and did not impact the controller adversely or cause an aircraft to deviate from its flightpath.

Four of the seven encounters occurred between arrival/arrival pairs, and the remaining three encounters between arrival/departure pairs. With one exception, arrival/arrival encounters occurred between opposite-side arrivals being vectored to final approach to the parallel ILS courses. As can be seen in figure 3, opposite-side arrival encounters 1, 2, and 6 occurred 23 to 28 nmi east of the runways, which is 3 to 8 nmi beyond the east edge of the desensitized zone. Extending the desensitized zone to 28 nmi would not have affected the outcome in any of the three encounters. Even though in encounters 1 and 2 one of the aircraft would have been in the desensitized zone, no commands were involved. Encounter 6 occurred laterally outside an extended desensitized zone and would not be affected. A desensitized zone could have been developed to include encounter number 6; however, this would have increased the size of the zone, and the intent was to minimize the desensitization area.

The fourth encounter involving an arrival pair, encounter 7 in figure 3, occurred about 8 nmi northeast of the airport. This is the downwind area for runway 27R, where small aircraft are transiting the area to get to the final approach for runway 32R.

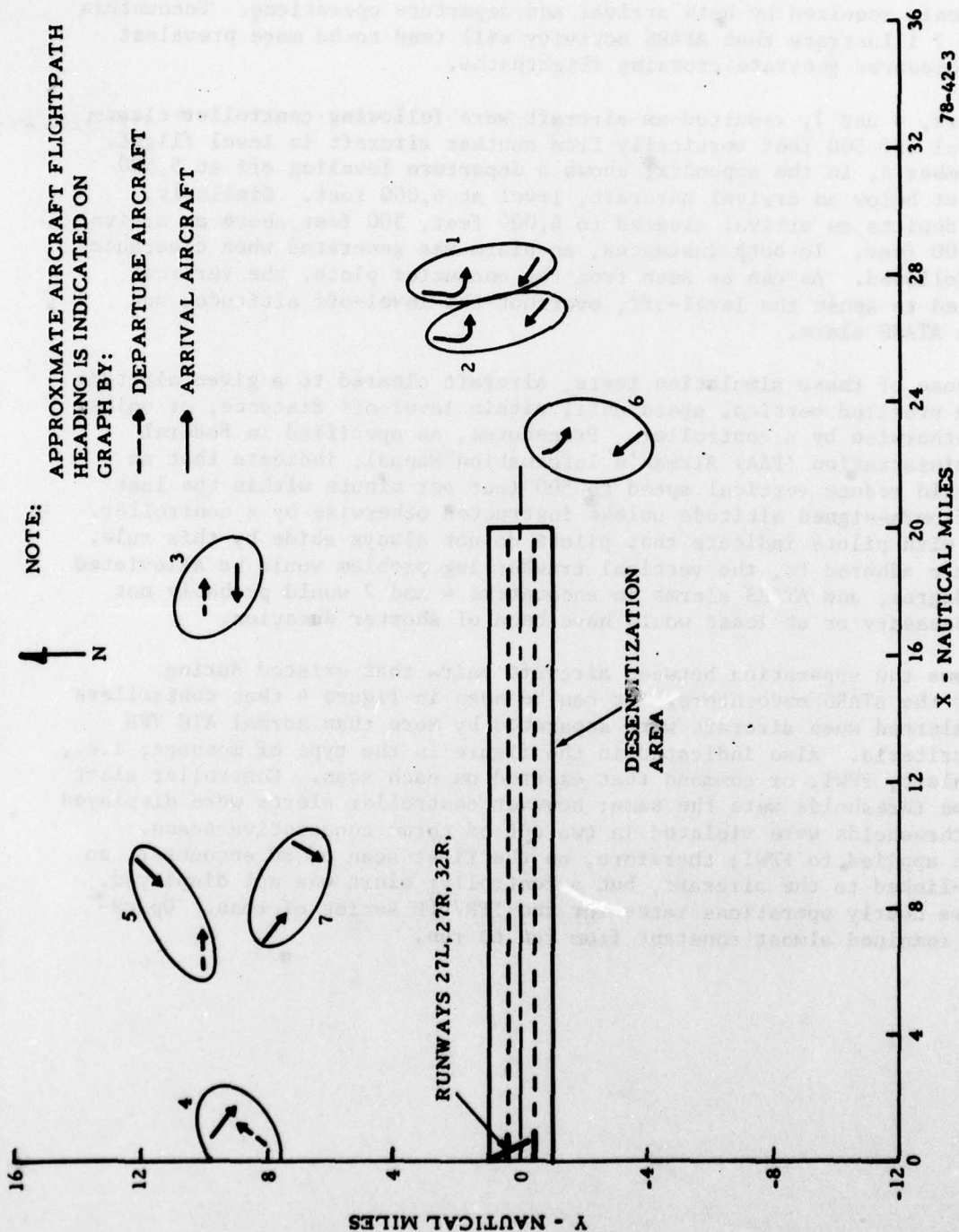


FIGURE 3. LOCATION OF ENCOUNTERS, ARRIVAL/DEPARTURE IFR/VFR SERIES

The three encounters involving arrival/departure pairs occurred as departures were being passed over or under arrivals as shown in figure 3 (8 to 12 nmi northeast of the airport). This area can be categorized as a transition environment commonly required by both arrival and departure operations. Encounters 3, 4, 5, and 7 illustrate that ATARS activity will tend to be more prevalent where ATC procedures generate crossing flightpaths.

Two encounters, 4 and 7, resulted as aircraft were following controller clearances to level off 500 feet vertically from another aircraft in level flight. Encounter number 4, in the appendix, shows a departure leveling off at 5,500 feet, 500 feet below an arrival aircraft, level at 6,000 feet. Similarly, encounter 7 depicts an arrival cleared to 4,000 feet, 500 feet above an arrival level at 3,500 feet. In both instances, an alarm was generated when clearances were being followed. As can be seen from the encounter plots, the vertical tracker failed to sense the level-off, overshoot the level-off altitude, and triggered an ATARS alarm.

For the purpose of these simulation tests, aircraft cleared to a given altitude maintained a profiled vertical speed until within level-off distance, or unless instructed otherwise by a controller. Procedures, as specified in Federal Aviation Administration (FAA) Airman's Information Manual, indicate that an aircraft should reduce vertical speed to 500 feet per minute within the last 1,000 feet from assigned altitude unless instructed otherwise by a controller. Discussions with pilots indicate that pilots do not always abide by this rule. Were this rule adhered to, the vertical tracker lag problem would be alleviated to a great degree, and ATARS alarms in encounters 4 and 7 would probably not have been necessary or at least would have been of shorter duration.

Figure 4 shows the separation between aircraft pairs that existed during each scan of the ATARS encounters. It can be seen in figure 4 that controllers were being alerted when aircraft were separated by more than normal ATC VFR separation criteria. Also indicated in the figure is the type of message; i.e., controller alert, FPWI, or command that existed on each scan. Controller alert and FPWI time thresholds were the same; however controller alerts were displayed only after thresholds were violated in two out of three consecutive scans. No such rule applied to FPWI; therefore, on the first scan of an encounter, an FPWI was up-linked to the aircraft, but a controller alert was not displayed. Table 4 shows hourly operations rates for the IFR/VFR series of runs. Operations rates remained almost constant from run to run.

CONTROLLER ALERT (CA) ATCRBS/ATCRBS ENCOUNTER

FPWI WITHOUT CA

CA = 45 SEC

FPWI WITH CA

FPWI = 45 SEC

NEGATIVE COMMAND WITH CA

CMD = 30 SEC

POSITIVE COMMAND WITH CA

ENCOUNTER

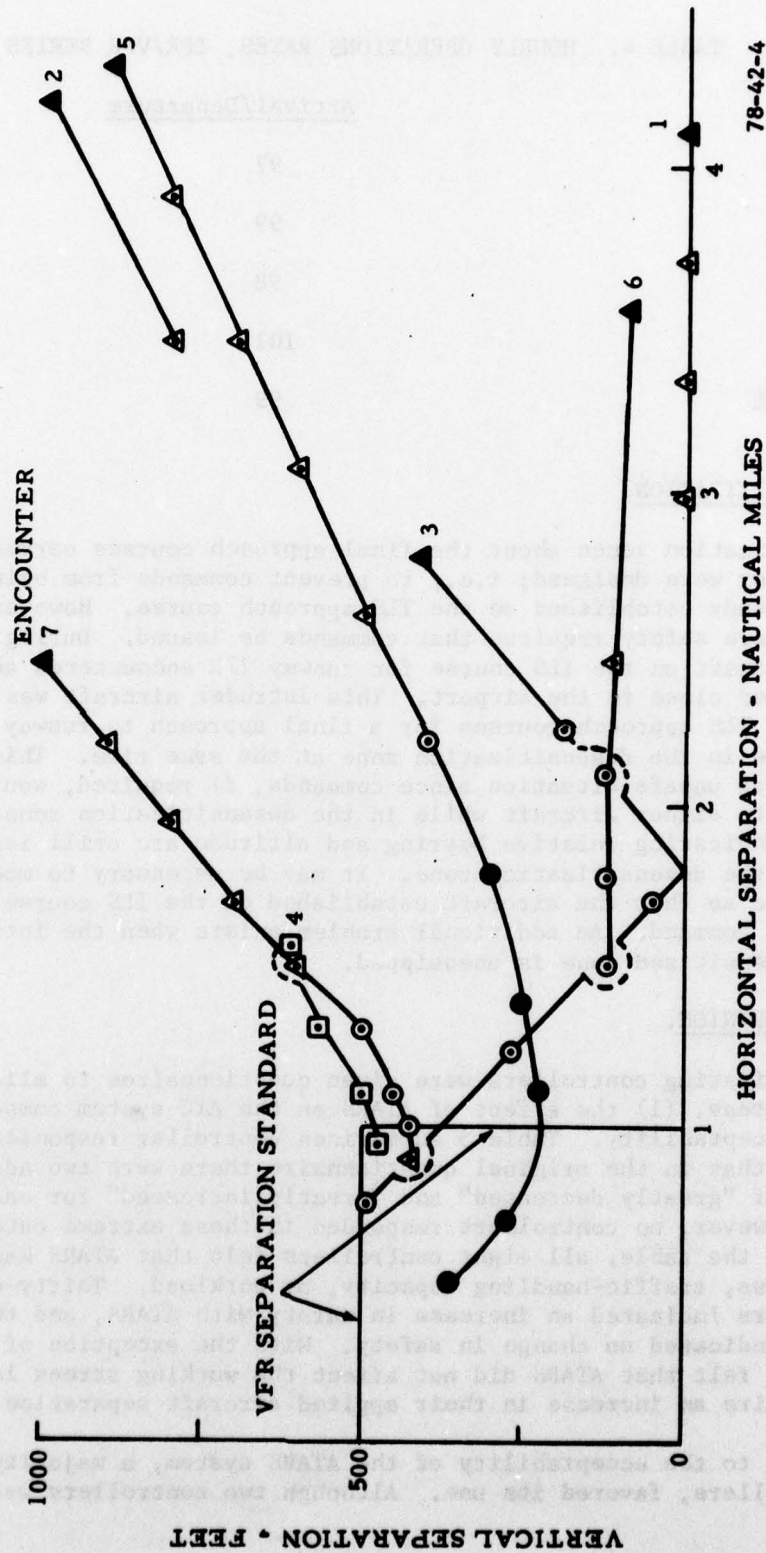


FIGURE 4. AIRCRAFT SEPARATION, ARRIVAL/DEPARTURE IFR/VFR SERIES

TABLE 4. HOURLY OPERATIONS RATES, IFR/VFR SERIES

| <u>Run</u> | <u>Arrival/Departure</u> |
|------------|--------------------------|
| 1 | 97 |
| 2 | 99 |
| 3 | 98 |
| 4 | 101 |
| AVERAGE | 99 |

ATARS DESENSITIZATION.

The desensitization zones about the final approach courses served the purpose for which they were designed; i.e., to prevent commands from being issued to aircraft already established on the ILS approach course. However, there are instances where safety requires that commands be issued. During one of the runs, an aircraft on the ILS course for runway 27R encountered an aircraft being vectored close to the airport. This intruder aircraft was crossing the parallel ILS approach courses for a final approach to runway 32R. Both aircraft were in the desensitization zone at the same time. This could have resulted in an unsafe situation since commands, if required, would not have been issued to either aircraft while in the desensitization zone. PWI advisories indicating relative bearing and altitude are still issued to aircraft in the desensitization zone. It may be necessary to modify the current logic so that the aircraft established on the ILS course is able to receive a command. An additional problem exists when the intruder outside the desensitized zone is unequipped.

CONTROLLER OPINION.

Eight participating controllers were given questionnaires to elicit opinions in two key areas, (1) the effect of ATARS on the ATC system components and (2) ATARS acceptability. Table 5 summarizes controller responses. It is to be noted that in the original questionnaire there were two additional categories of "greatly decreased" and "greatly increased" for each of the factors. However, no controllers responded in these extreme categories. As indicated in the table, all eight controllers felt that ATARS had no effect on orderliness, traffic-handling capacity, or workload. Thirty-eight percent of controllers indicated an increase in safety with ATARS, and the remaining 62 percent indicated no change in safety. With the exception of one controller, all felt that ATARS did not affect the working stress levels and did not require an increase in their applied aircraft separation.

With respect to the acceptability of the ATARS system, a majority, six out of eight controllers, favored its use. Although two controllers were indifferent

TABLE 5. SUMMARY OF CONTROLLER OPINION

| <u>I. ATARS Affect On:</u> | | <u>Decrease (%)</u> | <u>No Change (%)</u> | <u>Increase (%)</u> |
|---------------------------------|---------------------------|---------------------|----------------------|---------------------|
| A. | Orderliness | 0 | 100 | 0 |
| B. | Traffic-Handling Capacity | 0 | 100 | 0 |
| C. | Safety | 0 | 62 | 38 |
| D. | Workload | 0 | 100 | 0 |
| E. | Stress | 0 | 88 | 12 |
| F. | Applied Separation | 0 | 88 | 12 |
| <u>II. ATARS Acceptability:</u> | | | | |
| A. | Strongly Oppose | 0 | | |
| B. | Oppose | 0 | | |
| C. | Indifferent | 25 | | |
| D. | Favor its use | 75 | | |
| E. | Strongly favor | 0 | | |

to its use, no controllers were opposed. This is in direct contrast with the controller opinions expressed in previous IPC tests (reference 1) where the majority of controllers opposed ATARS use. Controller opposition was based on the ATARS high alarm rates experienced in the previous tests. These alarm rates averaged 7 per hour in the arrival/departure IFR series to 12 per hour in the high-density all-arrival IFR series, and 10 per hour in the arrival/departure IFR/VFR series; whereas, only 7 alarms were generated in all of the current tests.

CONCLUSIONS

Based on the results of the simulation tests, it is concluded that:

1. Unnecessary ATARS alarms have been significantly reduced by the introduction of site-adaptation logic.
2. ATARS with the site-adaptation logic did not interact adversely with controllers, and controller opinion favored its use in the terminal environment tested.
3. ATARS did provide adequate separation between conflicting aircraft pairs.
4. The algorithm does not adequately handle the special circumstances of controlled VFR traffic in which minimum separation criteria of 1 nmi or 500 feet are employed. Controller alerts and commands still occur when aircraft are separated by more than these minima.
5. The desensitization zone about the final approach courses did not provide protection against crossing intruder aircraft and unequipped intruders.
6. When ATARS alarms occurred in the tests, they were located at vector and altitude crossover points for arrival/departure pairs and in the final approach area for converging opposite-side arrival pairs. There is a need to evaluate ATARS in a terminal environment which contains more crossover and converging flightpaths than the relatively few that existed in these tests to see if such areas would present any serious problems.
7. ATARS did provide adequate protection in vertical conflicts; however, nuisance alarms were generated for aircraft following ATC clearance to level off 500 feet away from another aircraft. The ATARS vertical tracker's inability to quickly sense a level-off caused such alarms. This problem would be alleviated to a great degree if aircraft were to reduce vertical speed when 1,000 feet from assigned altitude. Similarly, tracker problems exist with the ATARS horizontal tracker which lags the actual heading of aircraft during turns.

RECOMMENDATIONS

1. ATARS desensitization. Develop and test a final approach desensitization zone which protects against crossing aircraft, unequipped intruder aircraft, and aircraft inadvertently straying off the ILS course. This could be accomplished by modifying the logic and by reshaping and reducing the size of the desensitization zone used in these tests. The logic should include an aircraft heading check to ensure that aircraft not aligned with or within a small angular deviation of the runway heading would be issued commands if required. Logic should be introduced to provide commands to ILS aircraft to protect against unequipped intruders. In addition, the desensitization zone should be reconfigured to extend 200 feet above and 200 feet below the ILS course. This would be adequate for aircraft established on the ILS course and also provide protection against aircraft in proximity to the ILS course.
2. Controlled VFR. Further refine the ATARS logic to accommodate the reduced separation standards used under controlled VFR flight procedures.
3. Tracker Performance. Investigate the possibility of reducing tracker lag by improving turn and climb/descent/level-off detection.
4. Additional terminal ATC tests. Assess ATARS performance in a terminal area with more crossover and converging flight patterns. In addition, determine the impact of uncontrolled aircraft flying in proximity to controlled aircraft in a terminal environment.

REFERENCES

1. Rossiter, S., Windle, J., Strack, R., and Mullen, W., Simulation Study of Intermittent Positive Control in a Terminal Area Air Traffic Control Environment, Report No. FAA-RD-76-193, January 1977
2. McFarland, A. L., Patel, K. R., and Roberts, D. L., Multi-Site Intermittent Positive Control Algorithm for the Discrete Address Beacon System, Report FAA-EM-74-4, Change 2, May 1976
3. IPC Site Adaptation Logic for DSF Testing, MITRE Corporation Memorandum to Dan Hopson, ARD-250, from Chen-Chung Hsin, August 8, 1977

APPENDIX

ATARS ENCOUNTER PLOTS

This appendix contains two plots for each of the seven ATARS encounters that occurred over four 1-hour data runs. The first plot shows the flightpath position in the horizontal (x, y) plane relative to a coordinate system centered at the airport. The right ILS course is located at 0.40 nmi, and the left ILS course is at -0.40 nmi on the vertical axis. Direction of flight of an aircraft proceeds from the point where the aircraft identification is listed on the plot. The "+" symbol is the radar position of the aircraft, and the short vector is the ATARS 4-second tracker-projected position and heading. The tabulated data on each plot are the values of the ATARS variables computed for each scan.

The second plot shows the altitude of each aircraft as a function of time. Additional ATARS variables applicable to the vertical dimension are tabulated to the right of this plot. A brief description of each encounter is given below along with comments concerning ATARS performance.

Encounter No. 1

Two DABS-equipped aircraft, NW604 and PA318, being vectored for ILS approach to 27R received four scans of FPWI. The closest separation during the FPWI was 2.97 nmi. The controller had instructed NW604 to fly heading 090° about 4 seconds prior to the first scan of FPWI, indicating his intent to sequence NW604 behind PA318 for an ILS approach to 27R.

A curve drawn through each of the aircraft position coordinates, indicated by the symbol "+" on the plots, would represent the actual flightpath of the aircraft. The short 4-second vectors located on each coordinate are the predicted track of the aircraft computed by the ATARS tracker. A comparison of the heading of the ATARS-predicted track with the heading of a tangent to the curve would show that the tracker lags the actual heading of the aircraft during turns. For example, the tracker heading lags the heading of NW604 by up to eight scans in the turn. This lag tends to trigger ATARS alarms unnecessarily and extends the duration of alarms.

Encounter No. 2

Two DABS-equipped aircraft, AA317 and CO128, being vectored for ILS approach, momentarily received two nonconsecutive 4-second scans of FPWI. Based on controller intent and a separation of 3.46 nmi and 800 feet, there appears to be no need for an alarm in this situation. These momentary FPWI are due to the tracker-predicted heading lagging the turn of aircraft CO128.

Encounter No. 3

A DABS-equipped North arrival aircraft, AA241, level at 6,000 feet, encountered a DABS-equipped departure aircraft, AA887, which had been cleared through 6,000 feet to 15,000 feet. Both received negative right-turn commands and approached within 1.7 nmi of each other before diverging in altitude.

Encounter No. 4

An ATCRBS/mode C equipped arrival, A30924, level at 6,000 feet, encountered an ATCRBS/mode C equipped departure, N5303. The departure aircraft had been cleared to altitude 5,500 feet which would provide 500 feet vertical separation, adequate under VFR operations. It can be seen in the vertical profile plot that the ATARS tracker failed to sense the level-off of N5303, and the tracker overshoot resulted in a controller alert of four scans duration. Subsequent versions of these plots are being modified to automatically indicate on the plots when a controller alert was issued.

Encounter No. 5

A DABS-equipped arrival, AA241, being vectored for approach to 27R, was cleared to descend to 6,000 feet. An ATCRBS/mode C equipped departure was level at the wrong altitude of 7,000 feet. The arrival controller expected the departure to be level at 5,000 feet. Clearly the coordinator controller should have made him aware of the situation. ATARS issued a climb command to the arrival aircraft and satisfactorily resolved an unsafe situation.

Encounter No. 6

TW97, a DABS/mode C equipped North arrival, crossed through the parallel ILS course to the south side, then turned to a heading of 300°, and was cleared for an ILS approach to runway 27R. The clearance was not taken, and the pilot again proceeded through the ILS courses, circling to the right.

The controller then put TW97 on a heading of 90° and subsequently sequenced it behind A30454. The ATARS issued two scans of FPWI and three scans of negative right. The closest point of approach between the aircraft was 1.37 nmi and 115 feet.

Encounter No. 7

A DABS-equipped arrival aircraft, OZ967, being vectored to an approach to 27R has been cleared to 4,000 feet altitude. This altitude is 500 feet above an ATCRBS/mode C equipped arrival, N5164W, which is being vectored for an approach to runway 32R. The vertical plot clearly shows that the ATARS tracker failed to sense the level-off of OZ967 and, as a result, triggered a negative turn command for three scans. The controller was aware of the situation, since he had four scans of controller alert starting at scan 508 prior to the command. His intent, however, was to level off OZ967 at 500 feet above N5164W, and he saw no need to alter its course.

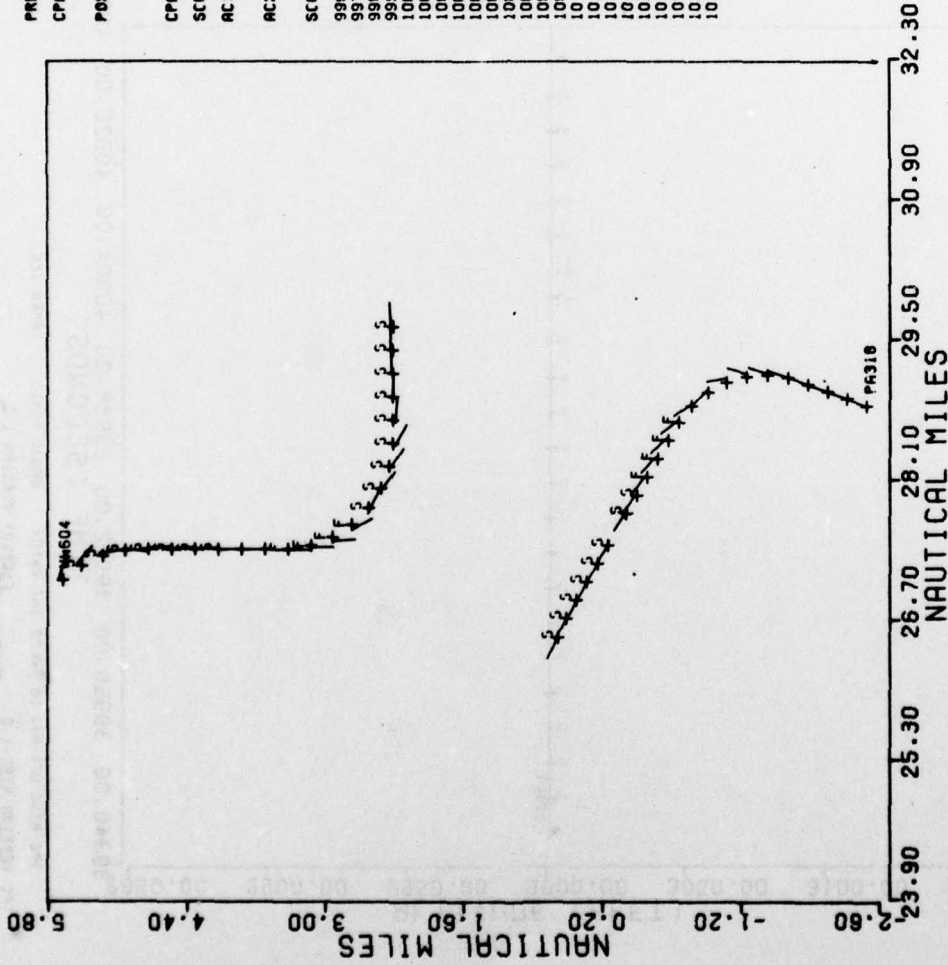
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ENCOUNTER NUMBER 1

START TIME = 11 5 44 END TIME = 11 7 12 ST SCAN = 995 END SCAN = 1019
NPTS FT AC1 = 23 NPTS FT AC2 = 23

PRES =
CPAN = 14222.359 CPANV = 0.000
POSCMD= 0 AT SCAN 0 MD= 0.0
ALT= 0.0 XANG= 0.00
CPA ON SCAN 1013 SCPA = 14222.355
SCPAN = 14222.359 SCPANV = 0.003
AC1 ID = NM604 CON DABS
AC2 ID = PA318 CON DABS

| SCAN | AC1 | AC2 | POS | TH | RANGE | MD | TV | RZ |
|------|-----|-----|-----|------|-------|-------|-----|----|
| 995 | | | | 115 | 9.25 | 99.00 | 4 | -0 |
| 997 | | | | 87 | 7.88 | 99.00 | -0 | 0 |
| 998 | | | | 74 | 7.46 | 99.00 | -3 | 0 |
| 999 | | | | 71 | 7.04 | 99.00 | -5 | 0 |
| 1000 | | | | 64 | 6.63 | 99.00 | -7 | 0 |
| 1001 | | | | 60 | 6.21 | 99.00 | -9 | 0 |
| 1002 | | | | 56 | 5.79 | 99.00 | -14 | 0 |
| 1003 | | | | 49 | 5.35 | 99.00 | -27 | 0 |
| 1004 | | | | 47 | 4.93 | 99.00 | 132 | 0 |
| 1005 | | | | 42 | 4.51 | 0.24 | 12 | 0 |
| 1006 | F | F | | 39 | 4.10 | 0.96 | 3 | 0 |
| 1007 | F | F | | 35 | 3.71 | 0.20 | -0 | -0 |
| 1008 | F | F | | 32 | 3.33 | 0.52 | -3 | -0 |
| 1009 | F | F | | 31 | 2.97 | 1.39 | -5 | -0 |
| 1010 | S | S | | 41 | 2.67 | 2.18 | -7 | -0 |
| 1011 | S | S | | 42 | 2.45 | 2.09 | -9 | -0 |
| 1012 | S | S | | 52 | 2.39 | 99.00 | -14 | -0 |
| 1013 | S | S | | 161 | 2.34 | 99.00 | -32 | -0 |
| 1014 | S | S | | 2129 | 2.45 | 99.00 | 56 | -0 |
| 1015 | S | S | | 2520 | 2.66 | 99.00 | 9 | -0 |
| 1016 | S | S | | 3018 | 2.91 | 99.00 | 3 | -0 |
| 1017 | S | S | | 3535 | 3.19 | 99.00 | 0 | -0 |
| 1018 | S | S | | 4418 | 3.51 | 99.00 | -4 | 0 |



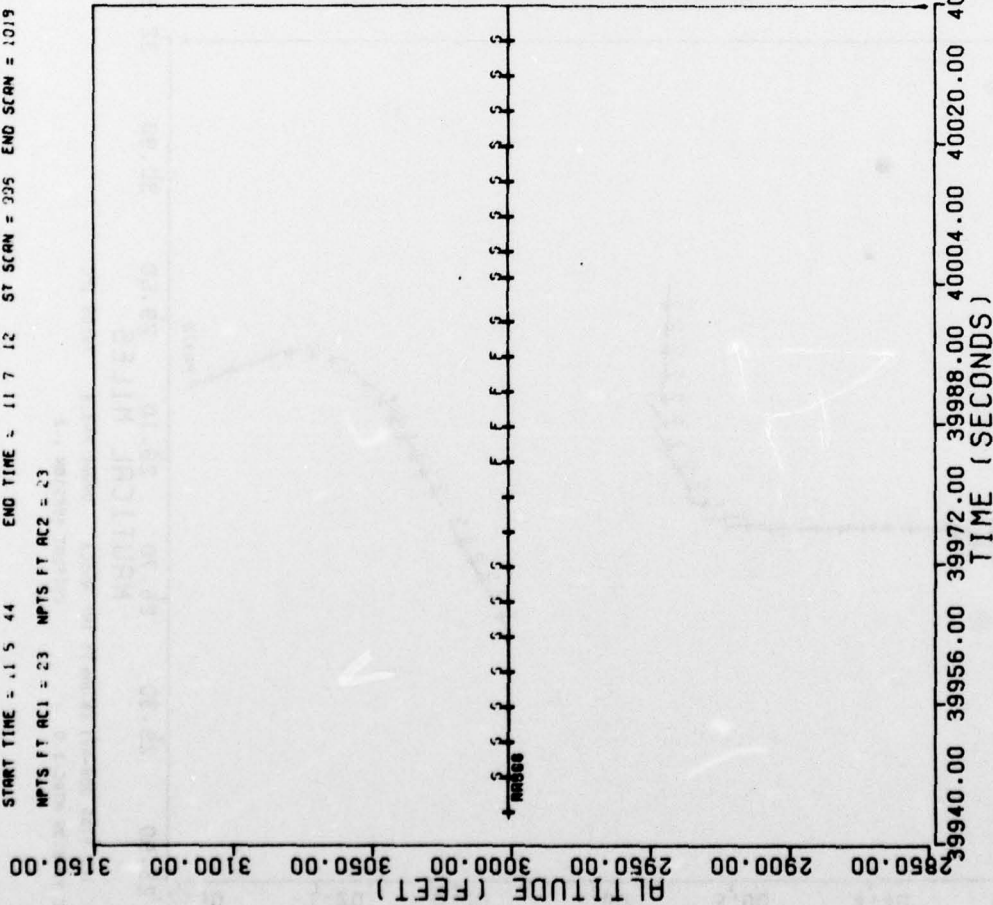
IPC NISS DDB-RV1 18 JAN 78 INT NM604 DRONE PA318 TAPES IPC
IPC VERSION NTRAC-1.0 CSCPLOT VERSION 1.2

78-42-A-1

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START TIME = 11 5 44 END TIME = 11 7 12 ST SCAN = 205 END SCAN = 1019
MPTS FT AC1 = 23 MPTS FT AC2 = 23

ENCOUNTER NUMBER 1



| SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|------|-----|-----|----|------|-----|-------|-------|
| 995 | | | -0 | 3.0 | 0.0 | -2135 | 30 |
| 997 | | | 0 | 3.0 | 0.0 | -2557 | 30 |
| 998 | | | 0 | 2.5 | 2.4 | -2715 | 30 |
| 999 | | | 0 | 1.9 | 1.9 | -2502 | 30 |
| 1000 | | | 0 | 1.3 | 1.2 | -2449 | 30 |
| 1001 | | | 0 | 0.9 | 0.7 | -2293 | 30 |
| 1002 | | | 0 | 0.4 | 0.3 | -2137 | 30 |
| 1003 | | | 0 | 0.1 | 0.0 | -2099 | 30 |
| 1004 | | | 0 | -0.4 | 0.0 | -1841 | 30 |
| 1005 | | | 0 | -0.1 | 0.0 | -1753 | 30 |
| 1006 | | | 0 | -0.1 | 0.0 | -1592 | 30 |
| 1007 | | | 0 | -0.1 | 0.1 | -1409 | 30 |
| 1008 | | | 0 | -0.1 | 0.1 | -1233 | 30 |
| 1009 | | | 0 | -0.1 | 0.1 | -1027 | 30 |
| 1010 | | | 0 | -0.1 | 0.1 | -812 | 30 |
| 1011 | | | 0 | 0.0 | 0.0 | -510 | 30 |
| 1012 | | | 0 | 0.0 | 0.0 | -370 | 30 |
| 1013 | | | 0 | 0.0 | 0.0 | -121 | 99999 |
| 1014 | | | 0 | -0.0 | 0.0 | 301 | 99999 |
| 1015 | | | 0 | -0.0 | 0.0 | 525 | 99999 |
| 1016 | | | 0 | -0.0 | 0.0 | 729 | 99999 |
| 1017 | | | 0 | -0.0 | 0.0 | 912 | 99999 |
| 1019 | | | 0 | -0.0 | 0.0 | 1091 | 99999 |

78-42-A-2

IPC MISS DOG-RV1 18 JAN 78 INT NR504 DRONE PR319 TAPES IPC
IPC VERSION NTRAC-1.0 CSCPILOT VERSION 1.2

START TIME = 11 24 END TIME = 11 24 ST SCAN = 1021 END SCAN = 1045
 NPTS FT AC1 = 25 NPTS FT AC2 = 25

ENCOUNTER NUMBER 2.

PRES =

CPAM = 13052.054 CPAY = 0.001

POSCMD = 0 AT SCAN 0 MD = 0.0

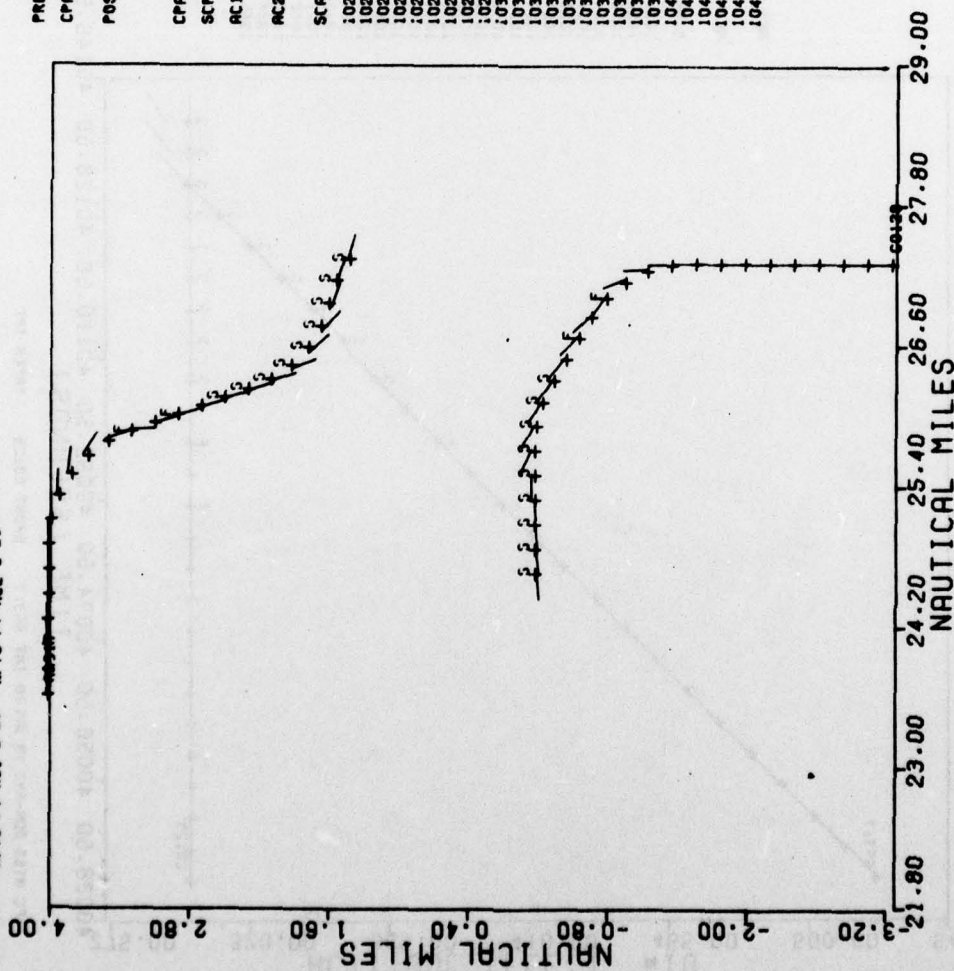
ALT = 0.0 XANG = 0.00

CPR ON SCAN 1040 SCPR = 13055.500

SCPRM = 13052.054 SCPRV = 300.041

AC1 ID = R9317 CON DABS

AC2 ID = C0128 CON DABS



IPC MISS DOB-RV1 18 JAN 76 INT R9317 DROME C0128 TAPES IPC
 IPC VERSION RTNC-1.0 CSCPLT VERSION 1.2

78-42-A-3

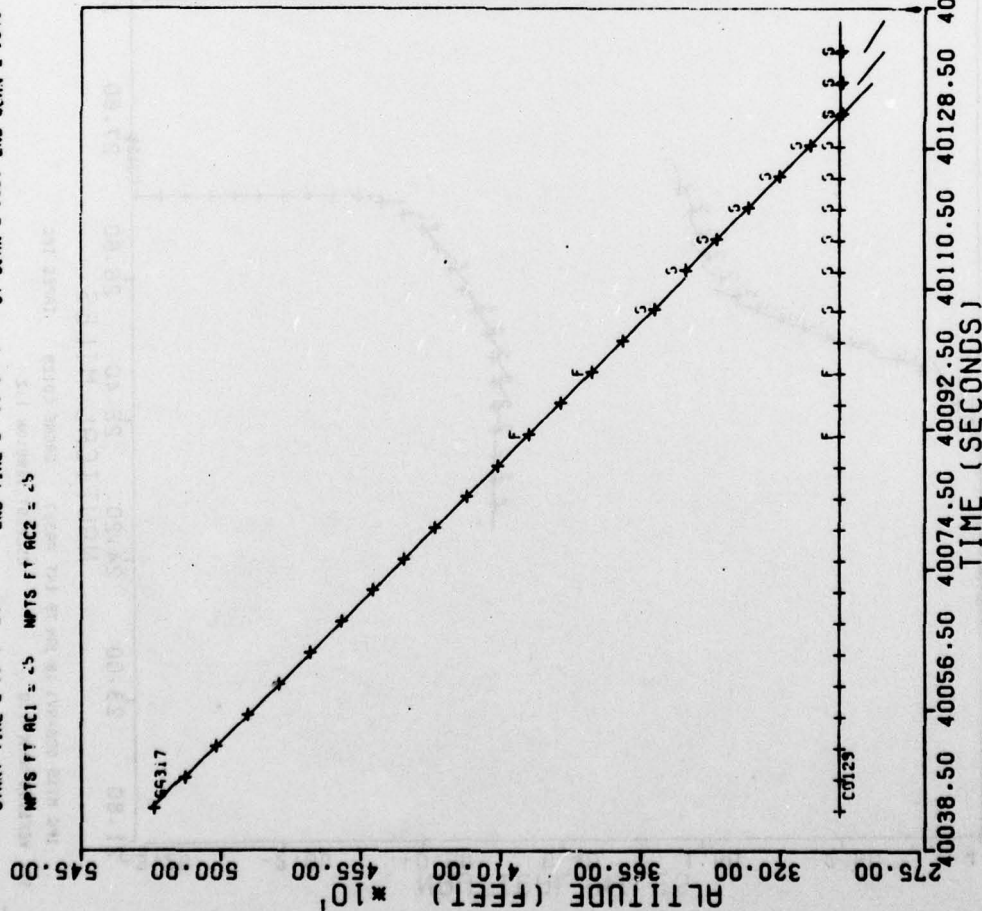
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| SCAN | AC1 | AC2 | POS | TH | RANGE | MD | TV | AZ |
|------|-----|-----|-----|-----|-------|-------|----|-------|
| 1021 | | | | 117 | 8.09 | 99.00 | 86 | -2211 |
| 1022 | | | | 113 | 7.81 | 99.00 | 81 | -2104 |
| 1023 | | | | 109 | 7.52 | 99.00 | 77 | -2000 |
| 1024 | | | | 105 | 7.24 | 99.00 | 73 | -1899 |
| 1025 | | | | 101 | 6.96 | 99.00 | 70 | -1797 |
| 1026 | | | | 97 | 6.68 | 99.00 | 67 | -1697 |
| 1027 | | | | 93 | 6.41 | 99.00 | 63 | -1597 |
| 1028 | | | | 89 | 6.12 | 99.00 | 60 | -1498 |
| 1029 | | | | 85 | 5.84 | 99.00 | 56 | -1398 |
| 1030 | | | | 81 | 5.56 | 99.00 | 52 | -1299 |
| 1031 | | | | 77 | 5.28 | 99.00 | 48 | -1200 |
| 1032 | | | | 73 | 5.00 | 99.00 | 44 | -1100 |
| 1033 | | | | 69 | 4.72 | 99.00 | 40 | -1000 |
| 1034 | | | | 65 | 4.44 | 99.00 | 36 | -900 |
| 1035 | | | | 61 | 4.16 | 99.00 | 32 | -800 |
| 1036 | | | | 57 | 3.88 | 99.00 | 28 | -700 |
| 1037 | | | | 53 | 3.60 | 99.00 | 24 | -600 |
| 1038 | | | | 49 | 3.32 | 99.00 | 20 | -500 |
| 1039 | | | | 45 | 3.04 | 99.00 | 16 | -400 |
| 1040 | | | | 41 | 2.76 | 99.00 | 12 | -300 |
| 1041 | | | | 37 | 2.48 | 99.00 | 8 | -200 |
| 1042 | | | | 33 | 2.20 | 99.00 | 4 | -100 |
| 1043 | | | | 29 | 1.92 | 99.00 | 0 | 0 |
| 1044 | | | | 25 | 1.64 | 99.00 | -3 | 54 |
| 1045 | | | | 21 | 1.36 | 99.00 | -5 | 75 |

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ENCOUNTER NUMBER 2

START TIME = 11 7 24 END TIME = 11 9 1 ST SCAN = 1021 END SCAN = 1045
MPTS FT AC1 = 45 MPTS FT AC2 = 45



| SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|------|-----|-----|------------|--------|-------|-------|-------|
| 1021 | | | -2211550.3 | 1435.1 | -2006 | 30 | |
| 1022 | | | -2104567.5 | 1320.5 | -1939 | 30 | |
| 1023 | | | -2000555.9 | 1216.4 | -1870 | 30 | |
| 1024 | | | -1899557.0 | 1119.0 | -1901 | 30 | |
| 1025 | | | -1797543.5 | 1024.9 | -1729 | 30 | |
| 1026 | | | -1697530.0 | 931.7 | -1655 | 30 | |
| 1027 | | | -1597518.4 | 837.9 | -1579 | 30 | |
| 1028 | | | -1498509.6 | 743.0 | -1510 | 30 | |
| 1029 | | | -1398503.4 | 646.8 | -1459 | 30 | |
| 1030 | | | -1293493.7 | 549.2 | -1424 | 30 | |
| 1031 | | | -1203437.7 | 450.7 | -1644 | 30 | |
| 1032 | | | -1100437.0 | 351.3 | -1739 | 30 | |
| 1033 | F | | -1000437.0 | 251.5 | -1415 | 30 | |
| 1034 | F | | -900437.5 | 151.4 | -1398 | 30 | |
| 1035 | F | | -800437.1 | 51.1 | -1237 | 30 | |
| 1036 | | | -700439.2 | 0.0 | -1067 | 30 | |
| 1037 | S | | -600439.2 | 0.0 | -995 | 30 | |
| 1038 | S | | -500439.5 | 939.5 | -725 | 30 | |
| 1039 | S | | -400439.9 | 1099.8 | -555 | 30 | |
| 1040 | S | | -300439.0 | 1200.0 | -377 | 30 | |
| 1041 | S | | -200439.1 | 1300.1 | 60 | 99999 | |
| 1042 | S | | -100439.1 | 1400.1 | 253 | 99999 | |
| 1043 | S | | 0 | 1500.1 | 0.0 | 539 | 99999 |
| 1044 | S | | 54 | 1294.1 | 0.0 | 789 | 99999 |
| 1045 | S | | 75 | -983.4 | 0.0 | 946 | 99999 |

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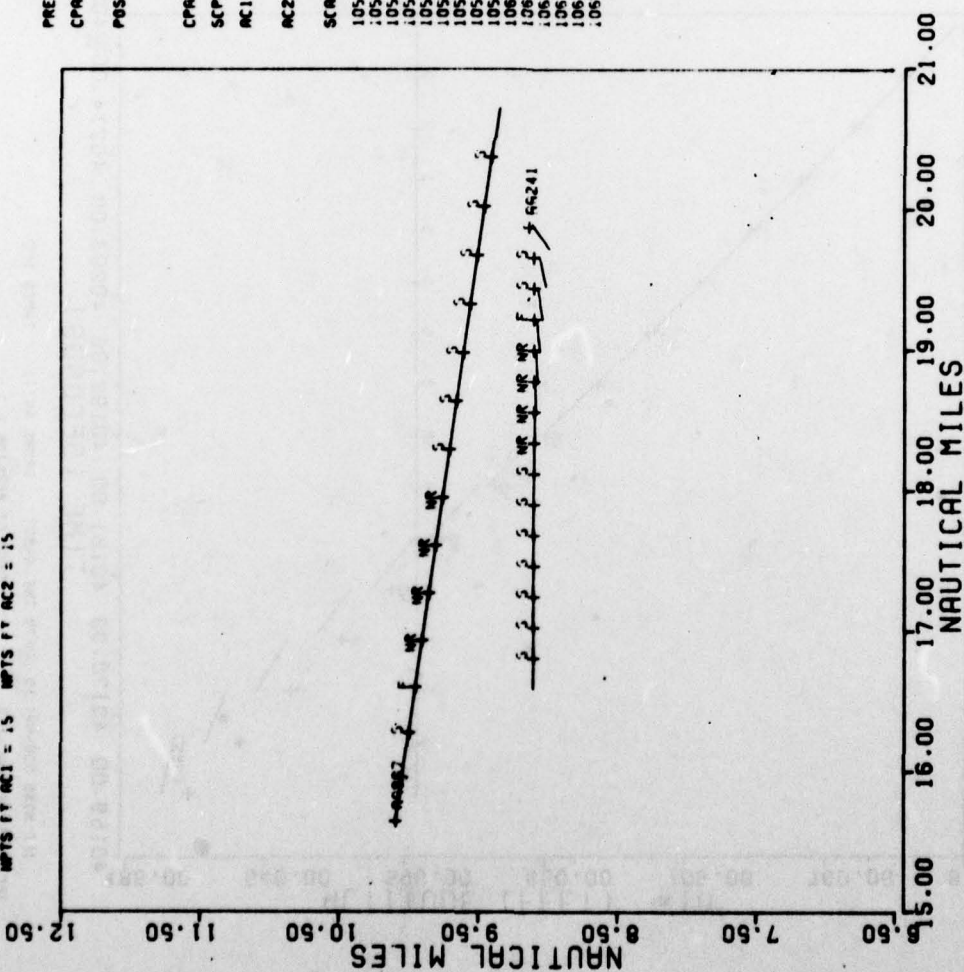
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ENCOUNTER NUMBER 3

START TIME = 11 0 24 END TIME = 11 10 20 ST SCAN = 1051 END SCAN = 1055
MPTS FT AC1 = 15 MPTS FT AC2 = 15

PRES =
CPRM = 3759.255 CPMV = 41.143
POSCMD = 0 AT SCAN 0 MD = 0.0
ALT = 0.0 XANG = 0.00
CPR OM SCAN 1051 SCPR = 3921.762
SCPRM = 3759.255 SCPMV = 693.319
AC1 10 = 66957 CON CABS
AC2 10 = 66241 CON CABS

| SCAN | AC1 | AC2 | PBS | TH | RANGE | MD | TV | RZ |
|------|-----|-----|-----|------|-------|-------|----|------|
| 1051 | | | | 39 | 4.35 | 93.00 | 92 | 1008 |
| 1052 | | | | 31 | 3.95 | 1.01 | 39 | 839 |
| 1053 | | | | 26 | 3.31 | 0.95 | 21 | 635 |
| 1054 | | | | 21 | 2.77 | 0.76 | 11 | 414 |
| 1055 | | | | 17 | 2.23 | 0.59 | 4 | 186 |
| 1056 | | | | 13 | 1.70 | 0.64 | 1 | 41 |
| 1057 | | | | 9 | 1.19 | 0.62 | 5 | 264 |
| 1058 | | | | 8 | 0.76 | 0.00 | 9 | 482 |
| 1059 | | | | 101 | 0.62 | 0.00 | 13 | 694 |
| 1060 | | | | 253 | 0.91 | 0.00 | 17 | 901 |
| 1061 | | | | 645 | 1.35 | 0.00 | 21 | 1105 |
| 1062 | | | | 1293 | 1.90 | 0.00 | 25 | 1306 |
| 1063 | | | | 2114 | 2.44 | 0.00 | 30 | 1506 |
| 1064 | | | | 3197 | 3.00 | 0.00 | 34 | 1705 |
| 1065 | | | | 4515 | 3.55 | 0.00 | 39 | 1904 |



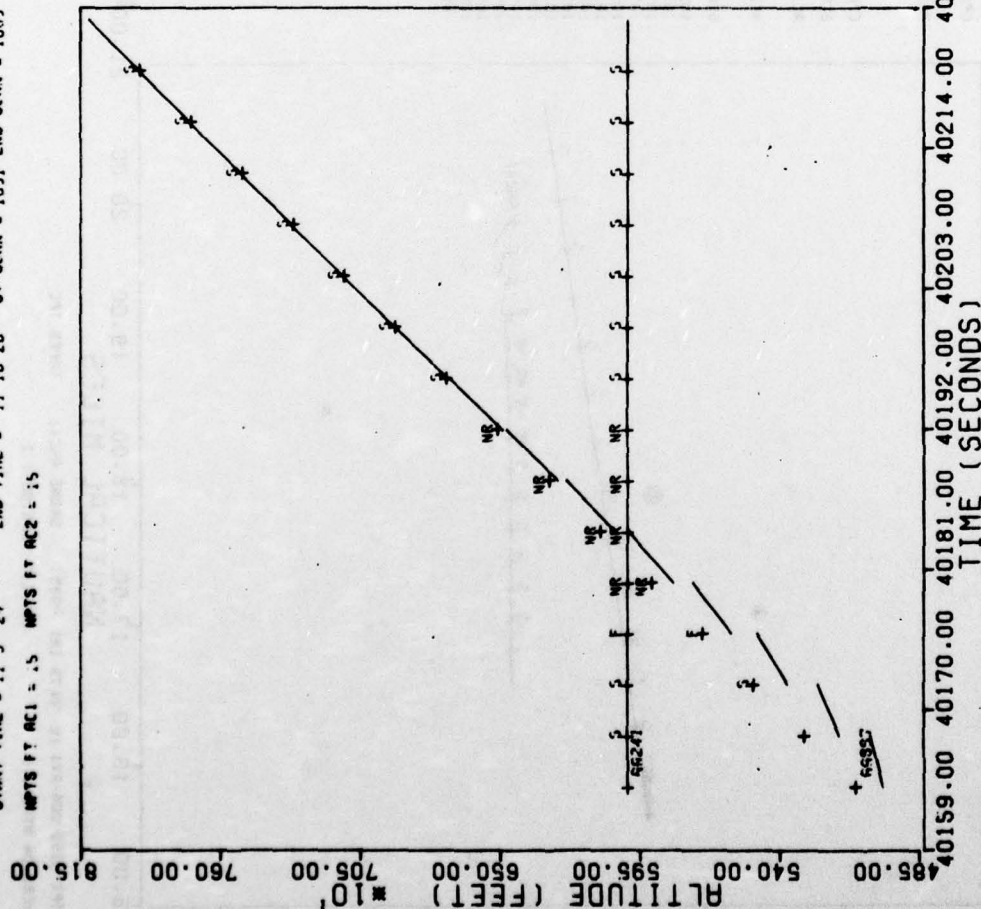
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IPC VERSION INTRC-1.0 CSXPLT VERSION 1.2

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ENCOUNTER NUMBER 3

START TIME = 11 0 21 END TIME = 11 10 20 ST SCAN = 105, END SCAN = 1065
MPTS FT AC1 = .5 MPTS FT AC2 = .5



| SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|------|-----|-----|-------|---------|--------|-------|-------|
| 1051 | | | 1009 | -734.9 | 540.3 | -1749 | 30 |
| 1052 | | | 937 | -1293.5 | 191.9 | -1724 | 30 |
| 1053 | S | | 635 | -1939.9 | 0.0 | -1510 | 30 |
| 1054 | F | | 414 | -2298.4 | 0.0 | -1278 | 30 |
| 1055 | NR | NR | 196 | -2645.7 | 0.0 | -1031 | 30 |
| 1056 | NR | NR | -41 | -2892.8 | 2841.7 | -772 | 30 |
| 1057 | NR | NR | -264 | -3026.9 | 2762.6 | -504 | 30 |
| 1058 | NR | NR | -882 | -3100.2 | 2618.4 | -229 | 30 |
| 1059 | S | S | -894 | -3125.1 | 2431.2 | 52 | 99999 |
| 1060 | S | S | -901 | -3120.4 | 2219.3 | 337 | 99999 |
| 1061 | S | S | -1105 | -3100.6 | 1995.7 | 623 | 99999 |
| 1062 | S | S | -1306 | -3075.5 | 1769.2 | 912 | 99999 |
| 1063 | S | S | -1506 | -3051.2 | 1545.1 | 1202 | 99999 |
| 1064 | S | S | -1705 | -3030.8 | 1325.7 | 1494 | 99999 |
| 1065 | S | S | -1904 | -3015.4 | 1111.6 | 1786 | 99999 |

78-42-A-6

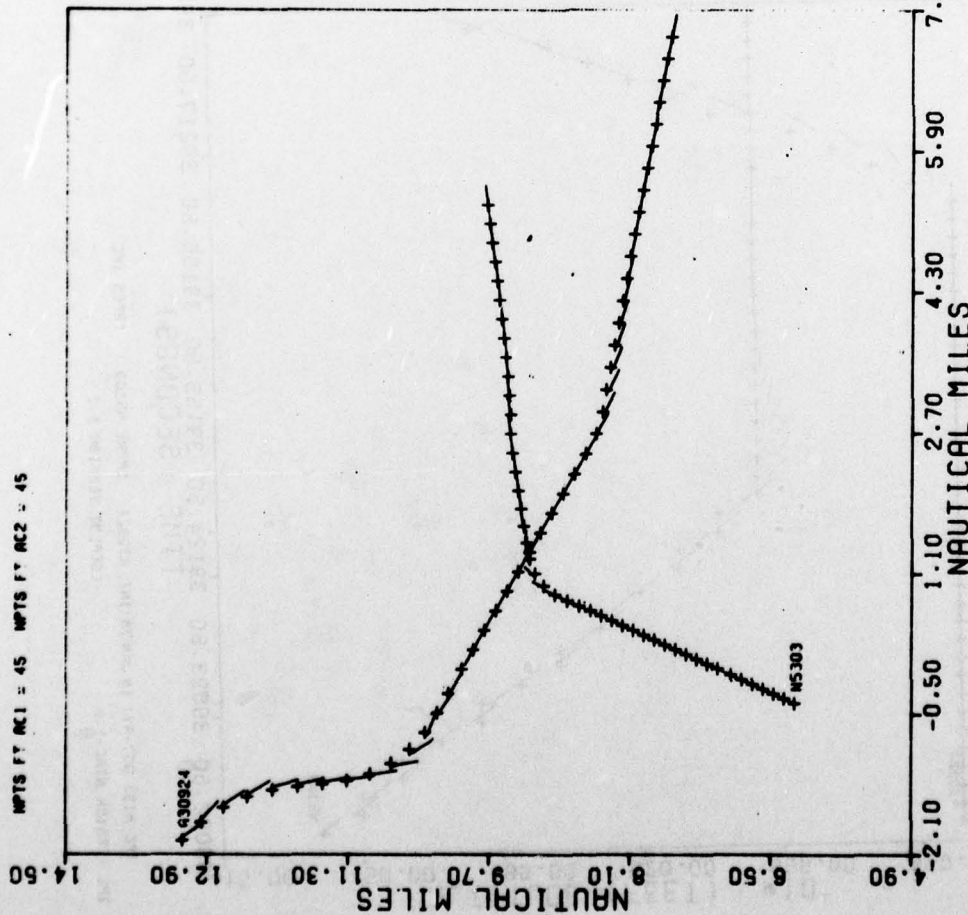
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IPC VERSION WTRAC-1.0 CSCELOT VERSION 1.2

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START TIME = 10 51.7 END TIME = 10 54.4 ST SCAN = 777 END SCAN = 821
NPTS FT AC1 = 45 NPTS FT AC2 = 45

ENCOUNTER NUMBER 4

PRES =
CPRM = 5042.848 CPMV = 3.182
POSCMD = 0 AT SCAN 0 MD = 0.0
ALT = 0.0 XANG = 0.00
CPA ON SCAN 798 SCRA = 5083.304
SCPM = 5042.848 SCPMV = 456.937
AC1 ID = R30924 CON ATCB
AC2 ID = W5303 CON ATCB



IPC MISS 007-0V1 19 JAN 78 INT R30924 DRONE W5303 TAPES IPC
IPC VERSION NTMC-1.0 CSCPLT VERSION 1.2

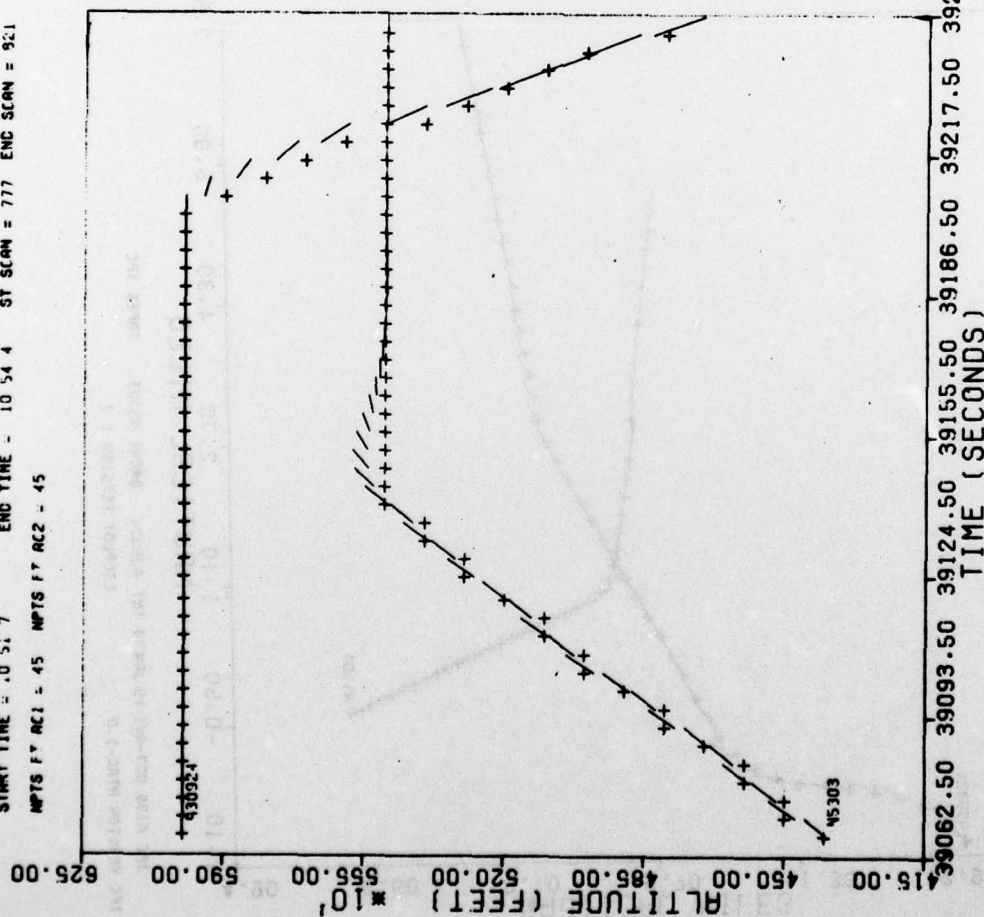
| SCAN | AC1 | AC2 | POS | TN | RANGE | MD | TV | RZ |
|------|-----|-----|-----|------|-------|-------|--------|-------|
| 777 | | | | 74 | 7.15 | 99.00 | 112 | -1809 |
| 778 | | | | 76 | 6.77 | 99.00 | 94 | -1528 |
| 779 | | | | 65 | 5.39 | 99.00 | 99 | -1480 |
| 780 | | | | 60 | 5.38 | 99.00 | 90 | -1411 |
| 781 | | | | 54 | 5.57 | 99.00 | 100 | -1372 |
| 782 | | | | 50 | 5.18 | 99.00 | 91 | -1309 |
| 783 | | | | 47 | 4.79 | 99.00 | 76 | -1228 |
| 784 | | | | 44 | 4.39 | 99.00 | 79 | -1180 |
| 785 | | | | 41 | 4.02 | 99.00 | 71 | -1111 |
| 786 | | | | 39 | 3.55 | 99.00 | 59 | -1026 |
| 787 | | | | 35 | 3.30 | 99.00 | 62 | -977 |
| 788 | | | | 42 | 2.97 | 99.00 | 55 | -907 |
| 789 | | | | 34 | 2.68 | 99.00 | 61 | -869 |
| 790 | | | | 31 | 2.40 | 99.00 | 55 | -806 |
| 791 | | | | 30 | 2.05 | 0.84 | 44 | -726 |
| 792 | | | | 28 | 1.81 | 0.80 | 45 | -679 |
| 793 | | | | 26 | 1.55 | 0.80 | 39 | -610 |
| 794 | | | | 24 | 1.32 | 0.80 | 42 | -572 |
| 795 | | | | 22 | 1.11 | 0.81 | 35 | -509 |
| 796 | | | | 26 | 0.93 | 0.82 | 39 | -474 |
| 797 | | | | 61 | 0.83 | 99.00 | 47 | -459 |
| 798 | | | | 226 | 0.83 | 99.00 | 66 | -457 |
| 799 | | | | 289 | 0.93 | 99.00 | 105 | -462 |
| 800 | | | | 402 | 1.09 | 99.00 | 195 | -470 |
| 801 | | | | 539 | 1.25 | 99.00 | 484 | -479 |
| 802 | | | | 665 | 1.39 | 99.00 | 5743 | -487 |
| 803 | | | | 779 | 1.49 | 99.00 | -1195 | -493 |
| 804 | | | | 896 | 1.59 | 99.00 | -802 | -497 |
| 805 | | | | 990 | 1.68 | 99.00 | -779 | -500 |
| 806 | | | | 1093 | 1.76 | 99.00 | -694 | -501 |
| 807 | | | | 1195 | 1.84 | 99.00 | -1150 | -502 |
| 808 | | | | 1293 | 1.92 | 99.00 | -1634 | -502 |
| 809 | | | | 1377 | 1.99 | 99.00 | -2590 | -502 |
| 810 | | | | 1480 | 2.05 | 99.00 | -4778 | -501 |
| 811 | | | | 1566 | 2.10 | 99.00 | -11855 | -501 |
| 812 | | | | 1663 | 2.17 | 99.00 | 126 | -454 |
| 813 | | | | 1771 | 2.24 | 99.00 | 43 | -375 |
| 814 | | | | 1859 | 2.31 | 99.00 | 20 | -275 |
| 815 | | | | 2013 | 2.39 | 99.00 | 9 | -165 |
| 816 | | | | 2144 | 2.46 | 99.00 | 0 | -3 |
| 817 | | | | 2278 | 2.53 | 99.00 | -5 | 145 |

78-42-A-7

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ENCOUNTER NUMBER 4

START TIME = 05:17 END TIME = 10:54 ST SCAN = 777 ENC SCAN = 921
NPTS F1 AC1 = 45 NPTS F1 AC2 = 45



IPC MISS DDT-RV1 15 JAN 78 INT R30924 DRONE NS303 TAPES IPC
IPC VERSION NTAC-1.0 CSCLPLOT VERSION 1.2

AC1 ID = 430924 CON ATCB

AC2 ID = 45303 CON ATCB

| SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|------|-----|-----|-------------|-----|--------|-------|-------|
| 777 | | | -1603965.2 | | 1176.6 | -2471 | -17 |
| 778 | | | -1529076.5 | | 1039.4 | -2153 | -17 |
| 779 | | | -1490305.5 | | 1032.2 | -2248 | -17 |
| 780 | | | -1411039.2 | | 941.3 | -2140 | -17 |
| 781 | | | -1372827.3 | | 959.5 | -2073 | -17 |
| 782 | | | -1309864.2 | | 877.0 | -1918 | -17 |
| 783 | | | -1229075.5 | | 730.8 | -1752 | -17 |
| 784 | | | -1180904.8 | | 732.8 | -1594 | -17 |
| 785 | | | -1111039.5 | | 541.6 | -1420 | -17 |
| 786 | | | -10281042.9 | | 504.4 | -1264 | -17 |
| 787 | | | -977349.7 | | 502.3 | -1104 | -17 |
| 788 | | | -807377.6 | | 419.4 | -748 | -17 |
| 789 | | | -869852.3 | | 442.9 | -762 | -17 |
| 790 | | | -806379.4 | | 357.3 | -555 | -17 |
| 791 | | | -726381.0 | | 234.7 | -493 | -17 |
| 792 | | | -570396.0 | | 230.7 | -409 | -17 |
| 793 | | | -610395.9 | | 141.7 | -372 | -17 |
| 794 | | | -572323.3 | | 252.0 | -253 | -17 |
| 795 | | | -509350.7 | | 351.6 | -187 | -17 |
| 796 | | | -474755.5 | | 282.4 | -113 | -17 |
| 797 | | | -459591.7 | | 132.6 | -37 | -17 |
| 798 | | | -457419.2 | | 39.9 | 42 | 93333 |
| 799 | | | -462264.9 | | 197.0 | 123 | 93333 |
| 800 | | | -470144.7 | | 325.5 | 193 | 93333 |
| 801 | | | -47050.4 | | 419.5 | 220 | 93333 |
| 802 | | | -4875.1 | | 481.4 | 173 | 93333 |
| 803 | | | -49324.7 | | 480.2 | 155 | 93333 |
| 804 | | | -19737.2 | | 478.7 | 189 | 93333 |
| 805 | | | -50035.5 | | 480.4 | 185 | 93333 |
| 806 | | | -50133.5 | | 484.4 | 180 | 93333 |
| 807 | | | -50228.2 | | 483.7 | 173 | 93333 |
| 808 | | | -50216.4 | | 492.7 | 168 | 93333 |
| 809 | | | -50211.6 | | 496.9 | 161 | 93333 |
| 810 | | | -5016.3 | | 498.2 | 151 | 93333 |
| 811 | | | -5012.5 | | 499.7 | 142 | 93333 |
| 812 | | | -454215.3 | | 239.3 | 139 | 93333 |
| 813 | | | -375517.8 | | 142.9 | 137 | 93333 |
| 814 | | | -275921.1 | | 545.9 | 140 | 93333 |
| 815 | | | -1651081.4 | | 016.8 | 145 | 93333 |
| 816 | | | -31407.2 | | 1404.1 | 152 | 93333 |
| 817 | | | 1451720.5 | | 0.0 | 160 | 93333 |

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START TIME = 11 0 24 END TIME = 11 4 16 ST SCAN = 916 END SCAN = 974
NPTS FT AC1 = 39 NPTS FT AC2 = 39

ENCOUNTER NUMBER 8

CPAN = 3302.321 CNAV = 225.208

POS(MD) = 1 AT SCAN 920 MD = 860.9

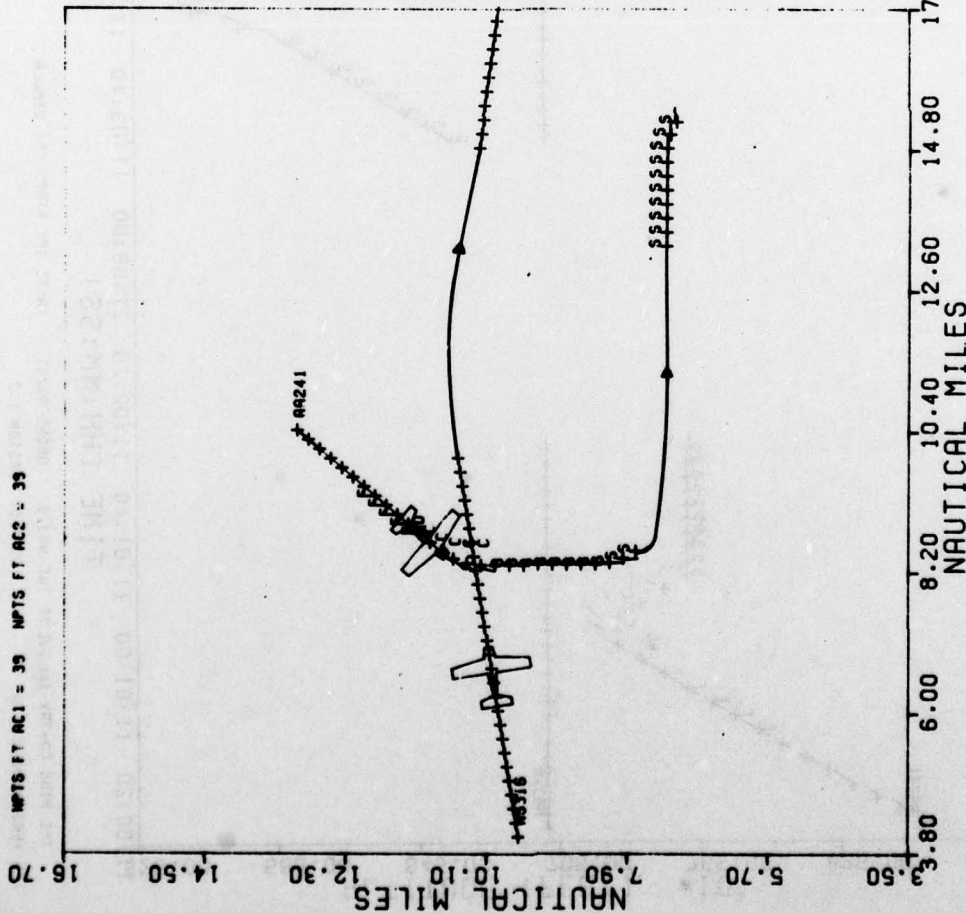
ALT = 398.4 XANG = 139.20

CPA ON SCAN 933 SCPA = 3321.985

SCPAN = 3302.321 SCNAV = 360.917

AC1 ID = NS316 CON ATCB

AC2 ID = AR241 CON DRBS



IPC MISS DD-74V-111 JUL 78 INT NS316 DRONE AR241 TAPES IPC ATARS CHI SIMULA
IPC VERSION NTRAC-1.0 CSCPLOT VERSION 1.2

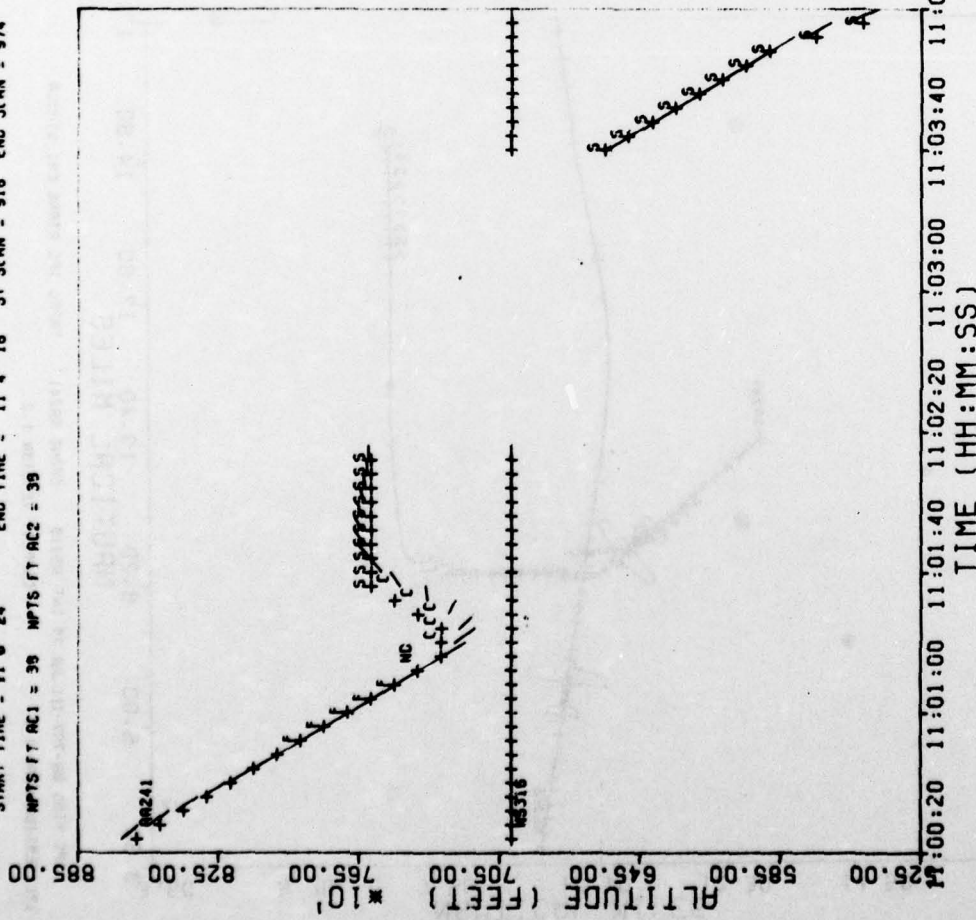
| SCAN | AC1 | AC2 | POS | TH | RANGE | MD | TV | RZ |
|------|-----|-----|-----|-----|-------|-------|------|-------|
| 916 | | | | 70 | 7.25 | 99.00 | 93 | 1867 |
| 917 | | | | 65 | 6.82 | 99.00 | 73 | 1551 |
| 918 | | | | 61 | 6.40 | 99.00 | 61 | 1435 |
| 919 | | | | 57 | 5.98 | 99.00 | 53 | 1322 |
| 920 | | | | 52 | 5.55 | 99.00 | 47 | 1211 |
| 921 | | | | 48 | 5.13 | 99.00 | 42 | 1104 |
| 922 | | | | 44 | 4.71 | 99.00 | 38 | 1000 |
| 923 | | | | 40 | 4.29 | 99.00 | 35 | 987 |
| 924 | F | | | 36 | 3.87 | 99.00 | 31 | 787 |
| 925 | F | | | 33 | 3.45 | 99.00 | 27 | 697 |
| 926 | F | | | 29 | 3.03 | 99.00 | 24 | 587 |
| 927 | F | | | 25 | 2.61 | 99.00 | 20 | 488 |
| 928 | MD | | | 21 | 2.19 | 99.00 | 16 | 398 |
| 929 | C | | | 17 | 1.78 | 99.00 | 12 | 299 |
| 930 | C | | | 13 | 1.37 | 99.00 | 12 | 248 |
| 931 | C | | | 9 | 1.01 | 99.00 | 14 | 225 |
| 932 | C | | | 5 | 0.70 | 99.00 | 35 | 271 |
| 933 | C | | | 58 | 0.54 | 99.00 | -219 | 361 |
| 934 | S | | | 92 | 0.57 | 99.00 | -47 | 475 |
| 935 | S | | | 178 | 0.75 | 99.00 | -42 | 555 |
| 936 | S | | | 345 | 1.01 | 99.00 | -47 | 604 |
| 937 | S | | | 594 | 1.31 | 99.00 | -58 | 629 |
| 938 | S | | | 926 | 1.63 | 99.00 | -78 | 699 |
| 939 | S | | | 999 | 1.95 | 99.00 | -114 | 699 |
| 940 | S | | | 999 | 2.28 | 99.00 | -185 | 633 |
| 941 | S | | | 999 | 2.60 | 99.00 | -358 | 625 |
| 942 | S | | | 999 | 2.90 | 99.00 | 999 | 617 |
| 943 | S | | | 999 | 3.16 | 99.00 | 999 | 610 |
| 944 | S | | | 483 | 3.30 | 99.00 | -15 | -400 |
| 945 | S | | | 490 | 3.28 | 99.00 | -19 | -502 |
| 946 | S | | | 496 | 3.25 | 99.00 | -23 | -603 |
| 947 | S | | | 498 | 3.22 | 99.00 | -28 | -703 |
| 948 | S | | | 500 | 3.20 | 99.00 | -32 | -803 |
| 949 | S | | | 501 | 3.17 | 99.00 | -36 | -902 |
| 950 | S | | | 501 | 3.15 | 99.00 | -40 | -1002 |
| 951 | S | | | 512 | 3.13 | 99.00 | -44 | -1101 |
| 952 | S | | | 512 | 3.13 | 99.00 | -44 | -1247 |
| 953 | S | | | 635 | 3.14 | 99.00 | -44 | -1428 |
| 954 | S | | | 999 | 3.18 | 99.00 | -42 | -1428 |

78-42-A-9

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ENCOUNTER NUMBER 5

START TIME = 11 01 24 END TIME = 11 04 16 ST SCAN = 916 END SCAN = 974
NPTS FT AC1 = 39 NPTS FT AC2 = 39



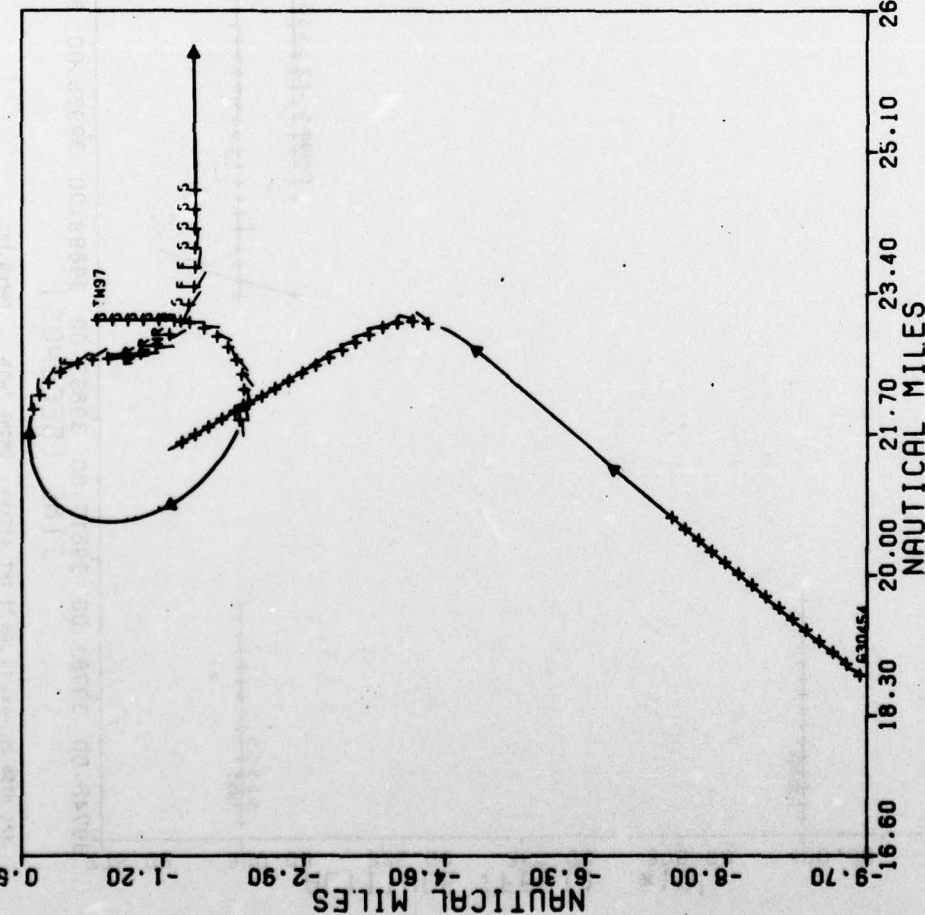
| SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|------|-----|-----|-------|---------|--------|-------|------|
| 916 | C | C | 1667 | -1070.1 | 1131.7 | -2694 | 30 |
| 917 | C | C | 1551 | -1276.1 | 813.1 | -2561 | 30 |
| 918 | C | C | 1435 | -1418.0 | 726.0 | -2419 | 30 |
| 919 | C | C | 1322 | -1508.9 | 568.4 | -2288 | 30 |
| 920 | C | C | 1211 | -1553.2 | 434.9 | -2114 | 30 |
| 921 | C | C | 1104 | -1570.3 | 319.1 | -1956 | 30 |
| 922 | C | C | 1000 | -1589.4 | 215.1 | -1785 | 30 |
| 923 | C | C | 897 | -1599.9 | 117.9 | -1634 | 30 |
| 924 | C | C | 797 | -1544.8 | 24.1 | -1472 | 30 |
| 925 | C | C | 697 | -1530.8 | 0.0 | -1310 | 30 |
| 926 | C | C | 597 | -1518.9 | 0.0 | -1149 | 30 |
| 927 | C | C | 498 | -1509.7 | 0.0 | -989 | 30 |
| 928 | C | C | 398 | -1503.4 | 0.0 | -829 | 30 |
| 929 | C | C | 298 | -1499.5 | 0.0 | -669 | 30 |
| 930 | C | C | 246 | -1281.6 | 0.0 | -513 | 30 |
| 931 | C | C | 225 | -986.2 | 0.0 | -362 | 30 |
| 932 | C | C | 271 | -461.5 | 40.6 | -179 | 30 |
| 933 | C | C | 351 | 88.0 | 261.9 | -14 | 30 |
| 934 | C | C | 475 | 601.2 | 125.9 | 61 | 30 |
| 935 | C | C | 555 | 763.7 | 229.0 | 159 | 30 |
| 936 | C | C | 604 | 768.7 | 219.4 | 259 | 30 |
| 937 | C | C | 829 | -650.0 | 304.5 | 359 | 30 |
| 938 | C | C | 839 | -482.7 | 392.7 | 461 | 30 |
| 939 | C | C | 839 | -337.5 | 469.8 | 564 | 30 |
| 940 | C | C | 833 | -205.7 | 529.9 | 668 | 30 |
| 941 | C | C | 825 | -105.4 | 572.2 | 768 | 30 |
| 942 | C | C | 817 | -95.5 | 598.9 | 848 | 30 |
| 943 | C | C | 810 | 5.7 | 604.9 | 785 | 30 |
| 944 | C | C | 803 | 1518.5 | 43.6 | -73 | 30 |
| 945 | C | C | -802 | 1509.6 | 147.4 | -72 | 30 |
| 946 | C | C | -1002 | 1503.5 | 249.8 | -71 | 30 |
| 947 | C | C | -1101 | 1489.7 | 351.1 | -68 | 30 |
| 948 | C | C | -1247 | 1713.7 | 390.0 | -55 | 30 |
| 949 | C | C | -1426 | 2013.7 | 418.7 | -24 | 30 |

78-42-A-10

IPC MISS DO-78V-111 JUL 78 INT NS316 DRONE AR241 TAPES IPC ATARS CHI SIMULA
IPC VERSION NTRAC-1.0 CSCPLOT VERSION 1.2

START TIME = 11 2 20 END TIME = 11 5 57 ST SCAN = 047 ENC SCAN = 900
 MPTS FT AC1 = 34 MPTS FT AC2 = 34

ENCOUNTER NUMBER 8



PRES =
 CPAM = 9307.673 CPAY = 0.133
 POSCHD = 0 AT SCAN 0 MD = 0.0
 ALT = 0.0 XANG = 0.00
 CPA ON SCAN 932 SCPR = 9308.472
 SCPRM = 9307.673 SCPRV = 115.017
 AC1 ID = 930454 CON ATB
 AC2 ID = TH97 CON DABG

| SCAN | AC1 | AC2 | POS | TH | RANGE | MD | TV | RZ |
|------|-----|-----|-----|------|-------|-------|--------------|----|
| 947 | | | | 114 | 10.18 | 99.00 | -12630756000 | |
| 948 | | | | 109 | 9.90 | 99.00 | 19496751000 | |
| 949 | | | | 103 | 9.42 | 99.00 | 19496751000 | |
| 950 | | | | 98 | 9.04 | 99.00 | 19496751000 | |
| 951 | | | | 93 | 8.67 | 99.00 | 19496751000 | |
| 952 | | | | 89 | 8.29 | 99.00 | 19496751000 | |
| 953 | | | | 84 | 7.91 | 99.00 | 19496751000 | |
| 954 | | | | 79 | 7.54 | 99.00 | 19496751000 | |
| 955 | | | | 76 | 7.13 | 99.00 | 19496751000 | |
| 956 | | | | 69 | 6.33 | 99.00 | 19496751000 | |
| 957 | | | | 67 | 6.05 | 99.00 | 19496751000 | |
| 958 | | | | 77 | 5.75 | 99.00 | 19496751000 | |
| 959 | | | | 91 | 5.51 | 99.00 | 19496751000 | |
| 960 | | | | 87 | 5.32 | 99.00 | 19496751000 | |
| 961 | | | | 119 | 4.91 | 99.00 | 19496751000 | |
| 962 | | | | 83 | 4.63 | 99.00 | 19496751000 | |
| 963 | | | | 56 | 4.31 | 99.00 | 19496751000 | |
| 964 | | | | 42 | 3.95 | 0.60 | 19496751000 | |
| 965 | | | | 37 | 3.55 | 1.14 | 19496751000 | |
| 966 | | | | 34 | 3.18 | 1.13 | 19496751000 | |
| 967 | | | | 23 | 2.82 | 0.61 | 19496751000 | |
| 968 | | | | 26 | 2.46 | 0.59 | 19496751000 | |
| 969 | | | | 22 | 2.10 | 0.65 | 19496751000 | |
| 970 | | | | 20 | 1.78 | 0.78 | 19496751000 | |
| 971 | | | | 23 | 1.51 | 1.14 | 19496751000 | |
| 972 | | | | 125 | 1.37 | 99.00 | 19496751000 | |
| 973 | | | | 669 | 1.39 | 99.00 | 19496751000 | |
| 974 | | | | 624 | 1.53 | 99.00 | 19496751000 | |
| 975 | | | | 1114 | 1.78 | 99.00 | 19496751000 | |
| 976 | | | | 1623 | 2.08 | 99.00 | 19496751000 | |
| 977 | | | | 2032 | 2.33 | 99.00 | 19496751000 | |
| 978 | | | | 2627 | 2.71 | 99.00 | 19496751000 | |
| 979 | | | | 3315 | 3.05 | 99.00 | 19496751000 | |

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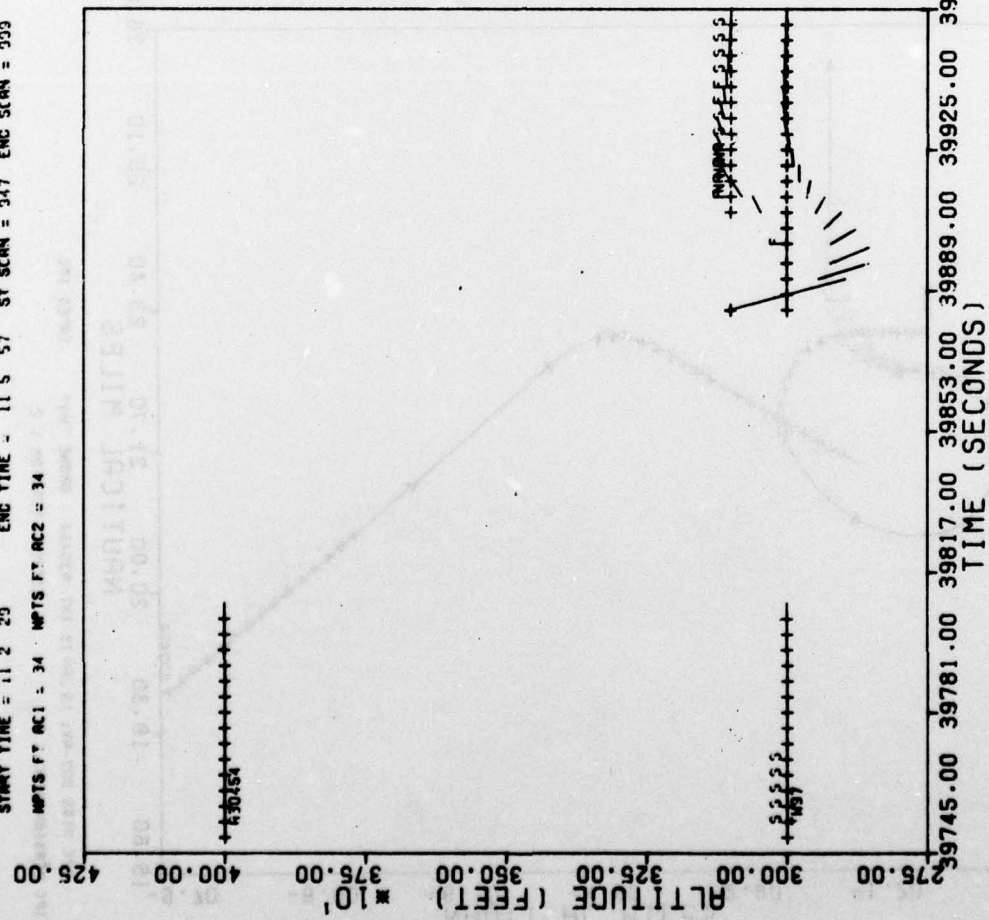
IPC MISS 007-AVI 19 JUN 79 INT 930454 DROME TH97 TAPES IPC
 IPC VERSION NTAC-1.0 CSCPLT VERSION 1.2

78-42-A-11

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ENCOUNTER NUMBER 6

START TIME = 11 2 20 END TIME = 11 5 57 ST SCAN = 347 ENC SCAN = 309
MPTS F' AC1 = 34 MPTS F' AC2 = 34



| AC1 ID = A30454 | CON RYCB | AC2 ID = T497 | CON DRBS | SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCMD |
|-----------------|----------|---------------|----------|------|------|------|------|------|------|------|------|
| 947 | -1000.0 | -1000.0 | -1000.0 | 947 | 947 | 947 | 947 | 947 | 947 | 947 | 947 |
| 948 | -1000.0 | -1000.0 | -1000.0 | 948 | 948 | 948 | 948 | 948 | 948 | 948 | 948 |
| 949 | -1000.0 | -1000.0 | -1000.0 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 |
| 950 | -1000.0 | -1000.0 | -1000.0 | 950 | 950 | 950 | 950 | 950 | 950 | 950 | 950 |
| 951 | -1000.0 | -1000.0 | -1000.0 | 951 | 951 | 951 | 951 | 951 | 951 | 951 | 951 |
| 952 | -1000.0 | -1000.0 | -1000.0 | 952 | 952 | 952 | 952 | 952 | 952 | 952 | 952 |
| 953 | -1000.0 | -1000.0 | -1000.0 | 953 | 953 | 953 | 953 | 953 | 953 | 953 | 953 |
| 954 | -1000.0 | -1000.0 | -1000.0 | 954 | 954 | 954 | 954 | 954 | 954 | 954 | 954 |
| 955 | -1000.0 | -1000.0 | -1000.0 | 955 | 955 | 955 | 955 | 955 | 955 | 955 | 955 |
| 956 | -1000.0 | -1000.0 | -1000.0 | 956 | 956 | 956 | 956 | 956 | 956 | 956 | 956 |
| 957 | -1000.0 | -1000.0 | -1000.0 | 957 | 957 | 957 | 957 | 957 | 957 | 957 | 957 |
| 958 | -1000.0 | -1000.0 | -1000.0 | 958 | 958 | 958 | 958 | 958 | 958 | 958 | 958 |
| 959 | -1000.0 | -1000.0 | -1000.0 | 959 | 959 | 959 | 959 | 959 | 959 | 959 | 959 |
| 960 | -1000.0 | -1000.0 | -1000.0 | 960 | 960 | 960 | 960 | 960 | 960 | 960 | 960 |
| 961 | -1000.0 | -1000.0 | -1000.0 | 961 | 961 | 961 | 961 | 961 | 961 | 961 | 961 |
| 962 | -1000.0 | -1000.0 | -1000.0 | 962 | 962 | 962 | 962 | 962 | 962 | 962 | 962 |
| 963 | -1000.0 | -1000.0 | -1000.0 | 963 | 963 | 963 | 963 | 963 | 963 | 963 | 963 |
| 964 | -1000.0 | -1000.0 | -1000.0 | 964 | 964 | 964 | 964 | 964 | 964 | 964 | 964 |
| 965 | -1000.0 | -1000.0 | -1000.0 | 965 | 965 | 965 | 965 | 965 | 965 | 965 | 965 |
| 966 | -1000.0 | -1000.0 | -1000.0 | 966 | 966 | 966 | 966 | 966 | 966 | 966 | 966 |
| 967 | -1000.0 | -1000.0 | -1000.0 | 967 | 967 | 967 | 967 | 967 | 967 | 967 | 967 |
| 968 | -1000.0 | -1000.0 | -1000.0 | 968 | 968 | 968 | 968 | 968 | 968 | 968 | 968 |
| 969 | -1000.0 | -1000.0 | -1000.0 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 |
| 970 | -1000.0 | -1000.0 | -1000.0 | 970 | 970 | 970 | 970 | 970 | 970 | 970 | 970 |
| 971 | -1000.0 | -1000.0 | -1000.0 | 971 | 971 | 971 | 971 | 971 | 971 | 971 | 971 |
| 972 | -1000.0 | -1000.0 | -1000.0 | 972 | 972 | 972 | 972 | 972 | 972 | 972 | 972 |
| 973 | -1000.0 | -1000.0 | -1000.0 | 973 | 973 | 973 | 973 | 973 | 973 | 973 | 973 |
| 974 | -1000.0 | -1000.0 | -1000.0 | 974 | 974 | 974 | 974 | 974 | 974 | 974 | 974 |
| 975 | -1000.0 | -1000.0 | -1000.0 | 975 | 975 | 975 | 975 | 975 | 975 | 975 | 975 |
| 976 | -1000.0 | -1000.0 | -1000.0 | 976 | 976 | 976 | 976 | 976 | 976 | 976 | 976 |
| 977 | -1000.0 | -1000.0 | -1000.0 | 977 | 977 | 977 | 977 | 977 | 977 | 977 | 977 |
| 978 | -1000.0 | -1000.0 | -1000.0 | 978 | 978 | 978 | 978 | 978 | 978 | 978 | 978 |
| 979 | -1000.0 | -1000.0 | -1000.0 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 |
| 980 | -1000.0 | -1000.0 | -1000.0 | 980 | 980 | 980 | 980 | 980 | 980 | 980 | 980 |
| 981 | -1000.0 | -1000.0 | -1000.0 | 981 | 981 | 981 | 981 | 981 | 981 | 981 | 981 |
| 982 | -1000.0 | -1000.0 | -1000.0 | 982 | 982 | 982 | 982 | 982 | 982 | 982 | 982 |
| 983 | -1000.0 | -1000.0 | -1000.0 | 983 | 983 | 983 | 983 | 983 | 983 | 983 | 983 |
| 984 | -1000.0 | -1000.0 | -1000.0 | 984 | 984 | 984 | 984 | 984 | 984 | 984 | 984 |
| 985 | -1000.0 | -1000.0 | -1000.0 | 985 | 985 | 985 | 985 | 985 | 985 | 985 | 985 |
| 986 | -1000.0 | -1000.0 | -1000.0 | 986 | 986 | 986 | 986 | 986 | 986 | 986 | 986 |
| 987 | -1000.0 | -1000.0 | -1000.0 | 987 | 987 | 987 | 987 | 987 | 987 | 987 | 987 |
| 988 | -1000.0 | -1000.0 | -1000.0 | 988 | 988 | 988 | 988 | 988 | 988 | 988 | 988 |
| 989 | -1000.0 | -1000.0 | -1000.0 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 |
| 990 | -1000.0 | -1000.0 | -1000.0 | 990 | 990 | 990 | 990 | 990 | 990 | 990 | 990 |
| 991 | -1000.0 | -1000.0 | -1000.0 | 991 | 991 | 991 | 991 | 991 | 991 | 991 | 991 |
| 992 | -1000.0 | -1000.0 | -1000.0 | 992 | 992 | 992 | 992 | 992 | 992 | 992 | 992 |
| 993 | -1000.0 | -1000.0 | -1000.0 | 993 | 993 | 993 | 993 | 993 | 993 | 993 | 993 |
| 994 | -1000.0 | -1000.0 | -1000.0 | 994 | 994 | 994 | 994 | 994 | 994 | 994 | 994 |
| 995 | -1000.0 | -1000.0 | -1000.0 | 995 | 995 | 995 | 995 | 995 | 995 | 995 | 995 |
| 996 | -1000.0 | -1000.0 | -1000.0 | 996 | 996 | 996 | 996 | 996 | 996 | 996 | 996 |
| 997 | -1000.0 | -1000.0 | -1000.0 | 997 | 997 | 997 | 997 | 997 | 997 | 997 | 997 |
| 998 | -1000.0 | -1000.0 | -1000.0 | 998 | 998 | 998 | 998 | 998 | 998 | 998 | 998 |
| 999 | -1000.0 | -1000.0 | -1000.0 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 |
| 1000 | -1000.0 | -1000.0 | -1000.0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |

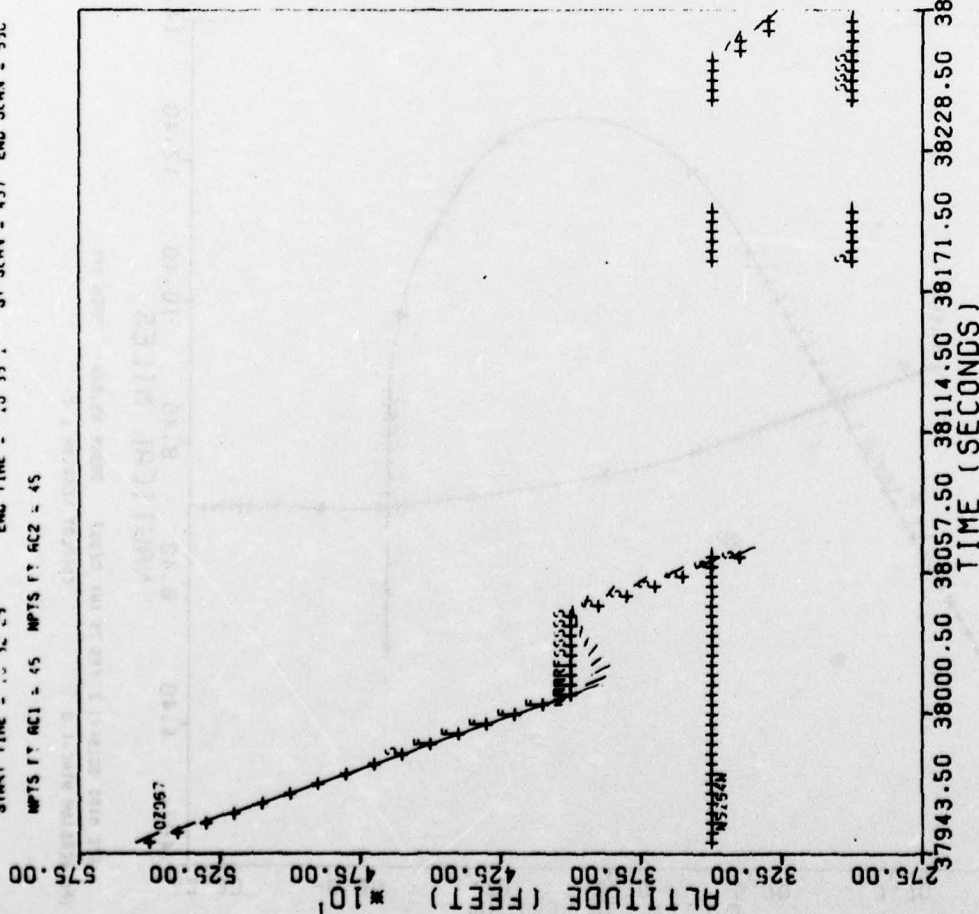
10
78-42-A-12

IPC MISS 007-6V1 19 JUN 78 INT A30454 DRONE T497 TAPES IPC
IPC VERSION WING-1.0 CSEPLLOT VERSION 1.2

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

ENCOUNTER NUMBER 7

START TIME = 10 34 29 ENG TIME = 10 39 : ST SCAN = 437 END SCAN = 550
MPTS FT AC1 = 45 MPTS FT AC2 = 45



IPC MISS 00164V1 2 FEB 79 INT 02957 DRONE WS,54M TAPES IPC
IPC VERSION NTRC-1.0 CSE PLOT VERSION 1.2

| AC1 ID = 02957 | CON DRG | AC2 ID = WS,54M | CON R7C6 | SCAN | AC1 | AC2 | RZ | VRZ | VND | DOT | TCNO |
|----------------|---------|-----------------|----------|------|-----|-----|-------------|--------|-------|-----|------|
| 437 | | | | | | | -20501279.7 | 1409.9 | -1241 | 30 | 30 |
| 439 | | | | | | | -19341419.7 | 1225.1 | -1172 | 30 | 30 |
| 439 | | | | | | | -19211504.0 | 1069.0 | -1103 | 30 | 30 |
| 500 | | | | | | | -17111550.3 | 736.1 | -1034 | 30 | 30 |
| 501 | | | | | | | -16041567.5 | 920.5 | -964 | 30 | 30 |
| 502 | | | | | | | -15001566.0 | 718.4 | -896 | 30 | 30 |
| 503 | | | | | | | -13791557.0 | 619.0 | -827 | 30 | 30 |
| 504 | | | | | | | -12371543.5 | 524.0 | -753 | 30 | 30 |
| 505 | | | | | | | -11371530.0 | 431.7 | -691 | 30 | 30 |
| 506 | | | | | | | -10371518.4 | 337.0 | -623 | 30 | 30 |
| 507 | | | | | | | -9391500.5 | 243.0 | -556 | 30 | 30 |
| 509 | | | | | | | -9391503.4 | 146.9 | -490 | 30 | 30 |
| 509 | | | | | | | -7931400.7 | 40.2 | -423 | 30 | 30 |
| 510 | | | | | | | -7001497.7 | 0.0 | -355 | 30 | 30 |
| 511 | | | | | | | -5001497.0 | 0.0 | -230 | 30 | 30 |
| 512 | | | | | | | -5001497.0 | 0.0 | -224 | 30 | 30 |
| 513 | | | | | | | -4471291.5 | 0.0 | -153 | 30 | 30 |
| 514 | | | | | | | -4251291.4 | 0.0 | -93 | 30 | 30 |
| 515 | | | | | | | -4251291.4 | 95.4 | -29 | 30 | 30 |
| 516 | | | | | | | -4351410.5 | 16.1 | 37 | 30 | 30 |
| 517 | | | | | | | -4501410.9 | 230.6 | 102 | 30 | 30 |
| 519 | | | | | | | -4681412.2 | 394.4 | 188 | 30 | 30 |
| 520 | | | | | | | -4701419.9 | 476.2 | 233 | 30 | 30 |
| 521 | | | | | | | -493150.3 | 453.5 | 228 | 30 | 30 |
| 522 | | | | | | | -4401448.6 | 500.7 | 333 | 30 | 30 |
| 523 | | | | | | | -3751440.9 | 75.1 | 427 | 30 | 30 |
| 524 | | | | | | | -2781762.5 | 494.3 | 431 | 30 | 30 |
| 525 | | | | | | | -1691095.3 | 949.4 | 555 | 30 | 30 |
| 526 | | | | | | | -531240.9 | 1195.9 | 619 | 30 | 30 |
| 526 | | | | | | | 631400.3 | 0.0 | 692 | 30 | 30 |
| 555 | | | | | | | 50010.1 | 500.0 | -669 | 30 | 30 |
| 557 | | | | | | | 50010.1 | 500.0 | -641 | 30 | 30 |
| 559 | | | | | | | 50010.1 | 400.0 | -615 | 30 | 30 |
| 561 | | | | | | | 50010.1 | 400.0 | -593 | 30 | 30 |
| 561 | | | | | | | 50010.1 | 400.0 | -569 | 30 | 30 |
| 561 | | | | | | | 50010.1 | 400.0 | -552 | 30 | 30 |
| 572 | | | | | | | 50010.0 | 500.0 | -105 | 30 | 30 |
| 573 | | | | | | | 50010.0 | 500.0 | -52 | 30 | 30 |
| 574 | | | | | | | 50010.0 | 500.0 | -10 | 30 | 30 |
| 575 | | | | | | | 50010.0 | 500.0 | 50 | 30 | 30 |
| 576 | | | | | | | 50010.0 | 500.0 | 100 | 30 | 30 |

78-42-A-14