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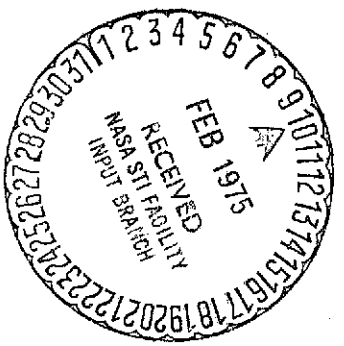
# PRECISION SELENODESY AND LUNAR LIBRATION THROUGH VLBI OBSERVATIONS OF ALSEPS

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## Summary

Data from 500 observation series, each one representing about 5 hours' continuous observation of a pair of ALSEPs by differential VLBI, have been compiled on magnetic tape. The theoretical models which we use to calculate the rotation of the earth, the orbit of the moon, the libration of the moon, and the basic VLBI observable have been improved substantially: We are now able to fit a four-year span of lunar laser ranging observations with post-fit residuals of 5.5 nsec rms (~ 80 cm in distance), and a 12-day span of VLBI observations with residuals of 15° rms (~ 1 m on the lunar surface). Further work may be required, however, to ensure that uncertainty in the lunar libration model does not degrade the determination of the relative coordinates of the ALSEPs. We are just beginning to analyze the data from long spans of VLBI observations.

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## I. OBSERVATIONS AND DATA PROCESSING

Differential very-long-baseline-interferometer (VLBI) observations of Apollo Lunar Surface Experiments Package (ALSEP) S-band radio transmitters continued through 1974[1]. These observations were made at stations of the NASA Spacecraft Tracking and Data Network (STDN), using the STDN "Unified S-Band" (USB) receivers in conjunction with the MIT Differential Doppler Receivers (DDRs) which we continued to maintain. Every observation was directed by an MIT experimenter via telephone connections with the participating stations. A list of all of the observations obtained through October 1974 is appended to this report.

The data from these observations were transmitted from the stations to NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. At Goddard, the data were accumulated and sent at approximately one-month intervals to MIT for analysis. We are indebted to James W. Ryan (Code 920, GSFC) for arranging the data-transmission system. Mr. Ryan, with the important assistance of Mr. H. Wade Stonesifer, has been responsible for all aspects of MIT's liaison with GSFC and the STDN.

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[1]This and subsequent references are listed in Section III.

At MIT the raw VLBI data, together with essential information from the MIT test director's and the station operators' logs, were sorted, collated, and edited, and collected on a number of observation library tapes (see Appendix)*. In the latter form, the observations are ready to be analyzed by MIT's Planetary Ephemeris Program (PEP)[2] in order to determine the selenodetic coordinates of the ALSEP transmitters, etc., as we describe in the following section.

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*Most of our data-processing effort during 1974 was actually devoted to clearing up the enormous backlog of data which had been accumulated during 1973 and early 1974, before this data-analysis grant was received. This job was complicated by the fact that these data had been sent from the tracking stations to MIT on punched paper tape. A thousand rolls of paper tape had to be transcribed onto magnetic tape, and a thousand pages of hand-logged data had to be keypunched. These tasks occupied one full-time data technician, four approximately half-time undergraduates, and four graduate-student research assistants for several months.

## II. ANALYSIS

The initial objectives of this grant, namely the determination of the selenodetic coordinates of the five ALSEPs and the determination of parameters influencing the moon's libration, require accurate theoretical-numerical models

(1) of the lunar orbit and the rotation of the earth;

(2) of the libration of the moon; and

(3) of the differential VLBI observable as a function of (1), (2), and other factors.

During 1974 we made significant advances, and/or we were able to use important results of other investigators, in all three of these areas.

### II. 1 Lunar Orbit and Rotation of the Earth

The numerically-integrated model of the lunar orbit which we are using was originally incorporated into PEP[2] by M. A. Slade in his thesis research[3]. Our model of the earth's rotation is basically that described in the Explanatory Supplement to the Astronomical Ephemeris[4], and uses the polar motion data published by the Bureau International de l'Heure[5], and the UT.1 data published by the U.S. Naval Observatory[6].* The basic coordinate system

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*Recently, programming changes in PEP were completed by A. Forni at MIT Lincoln Laboratory to use UT.1 data from the B.I.H.[5] instead of those from the U.S.N.O. However, we have not yet used this modification.

(sometimes called the "equator and equinox") to which the earth's rotation (and everything else) is referred in PEP is nominally defined by the mean equator and equinox of 1950.0, and is in practice defined by the PEP planetary ephemeris tape number 311[7]. Since our observable is sensitive to the relative orientations of the earth and moon, and since the orientation of the moon is sensitive, primarily through the very strong perturbations which the sun exerts on the moon's geocentric orbit, to the orientations of the heliocentric orbits of the earth and other planets, it is necessary for us to model accurately all of these systems: the earth, the moon, and the remainder of the solar system.

We have not made any changes to the PEP planetary ephemerides. Thus, these ephemerides serve to define our basic coordinate system. However, we have found it necessary to make adjustments to our earth-rotation model and to our lunar ephemeris in order to eliminate systematic errors which would have degraded the results obtainable from the analysis of the VLBI observations of the ALSEPs. For this purpose, the lunar laser ranging experiment (LURE) team made available to us laser ranging observations made at McDonald Observatory from March 1970 to July 1974. (These data were provided in the form of "normal points"[8].) R. W. King of MIT and Air Force Cambridge Research Laboratory then used

PEP to adjust the two angles which determine the plane of the earth's equator, the six elements of the moon's geocentric orbit, and the mass of the earth-moon system to fit the laser observations. The geocentric coordinates of McDonald Observatory, the selenocentric coordinates of the lunar retroreflectors, and parameters in the lunar libration model were adjusted simultaneously. (We describe the lunar libration model which we used in Section II. 2.) The r.m.s. of the post-fit residuals for these four years of laser observations was 5.5 nsec in delay -- approximately 80 cm in "range" or distance*. We conclude that our models of the rotation of the earth and the orbit** of the moon are now accurate enough that they will probably not degrade the determinations of the relative positions of the ALSEP transmitters at the level of 1-3 m uncertainty, and of the libration of the moon at the level of 0.5 second of selenocentric arc, from VLBI observations.

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*Detailed inspection of these residuals suggests that the most serious defect in our models is now in the representation of variations of UT.1. It is possible that the fit will improve significantly when we begin to use the B.I.H. data for UT.1.

**as opposed to the libration

## II. 2 Lunar Libration

Although we intend eventually to integrate the equations of motion for the rotation of the moon directly in PEP, we have not completed the new coding necessary to do this. Instead, R. W. King has adapted PEP to use either the semi-analytic model of the moon's libration developed by D. H. Eckhardt[9] at Air Force Cambridge Research Laboratory, or the numerically-integrated model of W. S. Sinclair and J. G. Williams[10] of the Jet Propulsion Laboratory. In our analysis of lunar laser ranging data to determine the lunar orbit and corrections to the earth's orientation, we used the JPL libration ephemeris tape number LLB-3[11], and we adjusted $\beta$, $\gamma$, all third-degree harmonic coefficients except $S_{33}$, and the six initial conditions of the integration*. Further work may be still required to ensure that the lunar libration model does not constitute the greatest source of uncertainty in the determination of the relative coordinates of the ALSEPs.

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*This parameter set, combined with the full set of retroreflector coordinates, is somewhat degenerate. Further discussions with the LURE team are required in order to reach agreement on a reduced parameter set, for example one which has certain coordinates of laser retroreflectors fixed to define the system of selenodetic coordinates.

## II. 3 VLBI Observable

Until December 1974, the algorithm which we used in PEP for the theoretical calculation of the doubly-differenced (between ALSEPs, between stations), or differential VLBI observable was basically the same as that which we developed originally for the tracking of the Apollo lunar roving vehicles[12]. An essential feature of this algorithm was the use of concurrently measured values of the two transmitters' frequencies in order to convert the changes of the transmitter-to-receiver propagation time delays over short (~ 1 minute) time intervals, from delay increments to phase increments. The value of frequency used for a particular receive-time interval was the average value of the received frequency over that interval, transformed to the frame of the transmitter to account for the Doppler shift. This procedure involves approximations which become less exact if the transmitter's frequency is rapidly time-varying. The most serious error involved in these approximations is proportional to the first time-derivative of the transmitted frequency and to the length of the time interval used in the calculation, and reflects the simple fact that if the derivative is positive (or negative), then the instantaneous value of the frequency is systematically lower

at the beginning of the interval, and higher at the end (or vice versa), than the average value over the interval. We have long been aware of the existence of such effects, but we had miscalculated the size of the error involved in ignoring them. In December we re-did the calculation (hopefully this time correctly), and immediately modified the algorithm in PEP to account for the main effect of the frequency time-derivative. This modification appears now to have eliminated systematic errors which were as large as several tens of degrees of phase in some of our VLBI observations, where the ALSEP transmitters were rapidly drifting in frequency. The remaining errors due to frequency drifts are now believed to be smaller than a few degrees of phase in all but a few rare cases. These cases are easily identified and can be excluded from future analyses of the VLBI observations.

II. 4 Results from Fitting VLBI Observations

At the October 1974 GEOP Conference on Lunar Dynamics and Selenodesy we reported that by adjusting ALSEP coordinates we could obtain satisfactory fits at the 1-meter

level* to VLBI observations taken one day at a time, but that a serious discrepancy between observed and computed values of the VLBI observable, equivalent to tens of meters in ALSEP position*, accumulated over a month.

A demonstration of the progress which we have made since October 1974 in improving our theoretical models is provided by Figure 1, which shows postfit residuals from observations spanning 12 days in July 1973, on 8 different interferometer baselines. The earth-rotation, lunar-orbit, lunar-libration, and basic VLBI-observable models used for this fit have been described in Sections II. 1 through II. 3. The r.m.s. of these postfit residuals is 15°, close to the noise level. Systematic error is evident (look at the ACN-MIL points on JD 2441877 and the ACN-GDS points on JD 2441881) at the level of a few meters, whereas previously the level was several tens of meters. It is to be

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*The high-frequency "noise" level of most of the VLBI data is approximately 10-15° of phase, r.m.s. Roughly speaking, a 1-meter ALSEP position error will introduce a slope of ~6°/hour in the residuals [(O-C)'s]. This slope, for a typical 5-hour observation series, would lead to an r.m.s. value of the residuals, exclusive of the "noise", of ~10°. Therefore, a position error of 1 meter or less will not significantly increase the r.m.s. of the residuals. However, the systematic slope of the residuals produced by a 1-meter error is quite obvious to the eye.

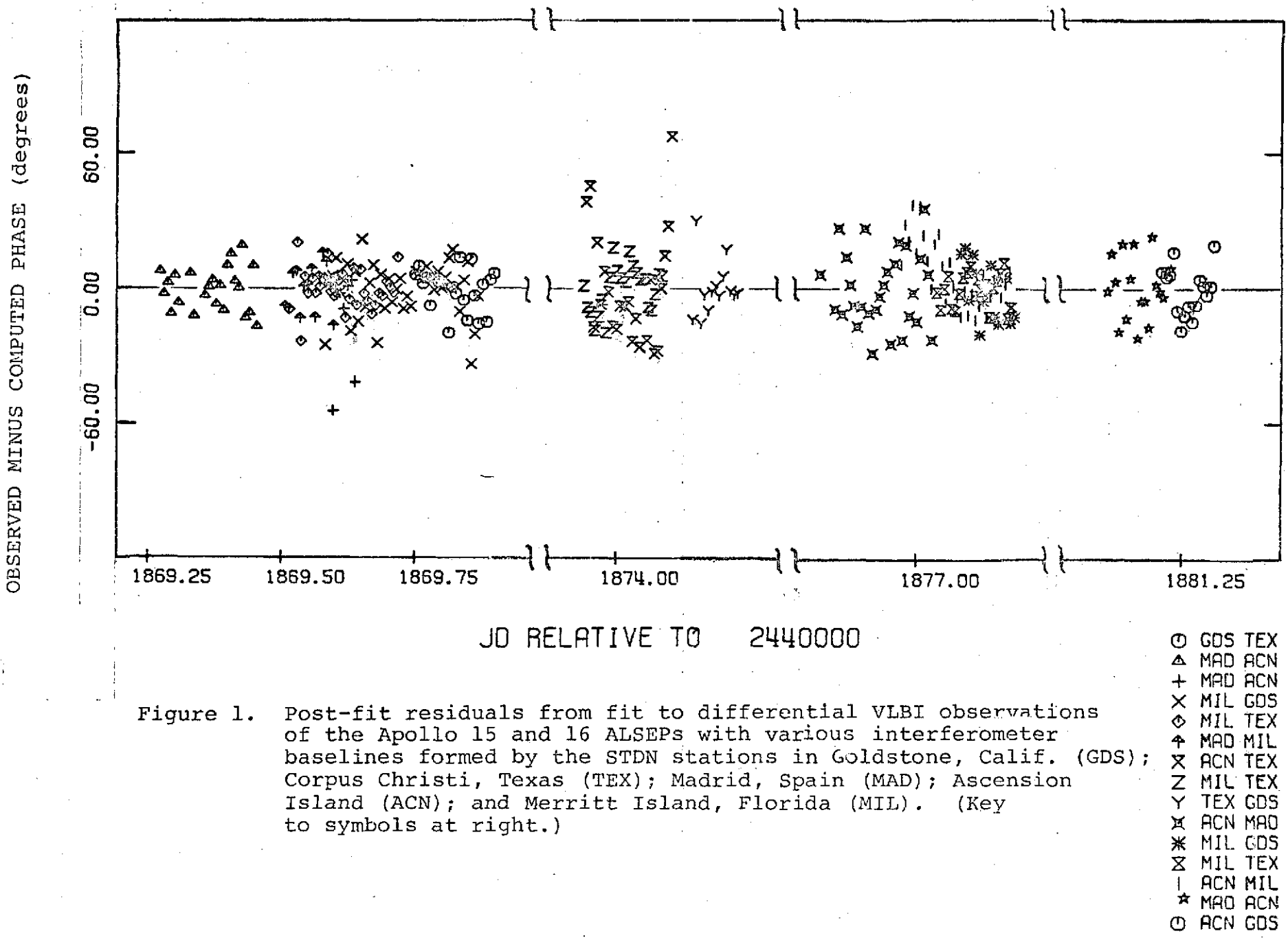


Figure 1. Post-fit residuals from fit to differential VLBI observations of the Apollo 15 and 16 ALSEPs with various interferometer baselines formed by the STDN stations in Goldstone, Calif. (GDS); Corpus Christi, Texas (TEX); Madrid, Spain (MAD); Ascension Island (ACN); and Merritt Island, Florida (MIL). (Key to symbols at right.)

expected, of course, that residuals from fits over time intervals much longer than two weeks will exhibit larger systematic trends, reflecting longer-period errors in the libration model. We are just now beginning to process long spans of VLBI data.

## III. References and Notes


1. Counselman III, C. C., H. F. Hinteregger, R. W. King and I. I. Shapiro, Lunar Baselines and Libration from Differential VLBI Observations of ALSEPs, The Moon, 8, 484-489 (1973).

2. Ash, M. E., Determination of Earth Satellite Orbits, M.I.T. Lincoln Laboratory Technical Note 1972-5 (1972). [This report documents the Planetary Ephemeris Program, its method of parameter estimation, units and coordinate systems used, models for the rotation of the earth, formulation of observables, numerical techniques, etc.]

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4. H. M. Nautical Almanac Office, Explanatory Sup- Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac, London (1961).

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6. United States Naval Observatory, Time Signals Bulletin, published periodically, Washington, D.C.

7. Ash, M. E., Planetary Ephemeris Program, Tape 311, M.I.T. Lincoln Laboratory (1972). [This heliocentric ephemeris of the earth and other planets is based on a combination of optical and modern radar observations. See, for example, M. E. Ash, I. I. Shapiro, and W. B. Smith, The System of Planetary Masses, Science, 174, 551-556 (1971).]

8. Abbot, R. E., P. J. Shelus, J. D. Mulholland and E. C. Silverberg, Laser Observations of the Moon: Identification and Construction of Normal Points for 1969-1971, Astron. J., 78, 784 (1973). [We are indebted to the entire LURE team for making their most up-to-date results available. P. J. Shelus, in particular, provided these in machine-readable form.]

9. Eckhardt, D. H., Lunar Libration Tables, The Moon, 1, 264 (1970); -- , Physical Librations due to the Third and Fourth Degree Harmonics of the Lunar Gravity Potential, ibid., 6, 127 (1973).

10. Williams, J. G., D. H. Eckhardt, W. M. Kaula and M. A. Slade, Lunar Physical Librations and Laser Ranging, The Moon, 8, 469 (1973).

11. Sinclair, W. S., JPL, provate communication, 1974.

12. Counselman III, C. C., H. F. Hinteregger and I. I. Shapiro, Astronomical Applications of Differential VLBI, Science, 178, 607 (1972); -- , "MIT Lunar Rover Tracking VLBI Algorithm," Appendix E, in STDN Metric Tracking Performance Apollo 16 Final Report No. X-832-72-203 (1972).

## APPENDIX

### Differential VLBI Observations of ALSEPs, 1972-1974*

The following list shows all of the differential VLBI observations of ALSEP transmitters which have been made with MIT differential Doppler receivers at NASA Spacecraft Tracking and Data Network (STDN) stations, and from which apparently valid data have been obtained. Date is the UTC date of the start of a continuous series of observations, that is, a series within which the differential Doppler counts are uninterrupted at both stations. The times are the UTC start and stop times; if the listed stop time of a series is numerically less than the start time, it is understood that the series stopped on the following UTC day. Stations are: GDS: the 85' "Apollo" station at Goldstone, California; TEX: the 30' station, now closed, at Corpus Christi, Texas; MIL: the original 30' station on Merritt Island, Florida; ETC: the original 30' station at Greenbelt, Maryland; MAD: the 85' station at Madrid, Spain; and ACN: the 30' station on Ascension Island in the South Atlantic Ocean. The first ALSEP listed is the "reference" ALSEP, that is, the one to whose carrier signal the S-band receiver was phase-locked. The second ALSEP is the one to whose carrier signal the DDR was locked. The ALSEPs are designated by their Apollo mission numbers. A number in the Obs. Lib. Tape column identifies

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*through 10/25/74

the MIT observation library tape on which the data from a series is written. The absence of any number in this column indicates that the raw data from the observation series has not yet been sorted, roughly edited, and written onto an observation library tape.

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs.Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 1972 | | | | | | |
| 10/28 | 0634-1330 | MIL-GDS | 12-14 | 10 | 302A | |
| 1973 | | | | | | |
| 03/7 | 1350-2045 | MAD-ETC | 15-14 | 11 | 066G | |
| 03/8 | 1352-2048 | ACN-ETC | 15-14 | 11 | 067G | |
| | 1130-2048 | ACN-MAD | 15-14 | 11 | 067H | |
| | 1352-2214 | ETC-MAD | 15-14 | 11 | 067I | |
| | 1352-2048 | ACN-ETC | 15-12 | 12 | 067J | |
| | 1130-2048 | ACN-MAD | 15-12 | 12 | 067K | |
| | 1352-2214 | ETC-MAD | 15-12 | 12 | 067L | |
| 03/15 | 2038-0335 | MAD-MIL | 15-14 | 11 | 074G | |
| | 0146-0330 | MAD-ACN | 15-14 | 11 | 075H | |
| | 0146-0330 | MIL-ACN | 15-14 | 11 | 075I | |
| | 2045-0335 | MAD-MIL | 15-12 | 12 | 075J | |
| | 2045-0335 | MAD-ACN | 15-12 | 12 | 075K | |
| | 2045-0335 | MIL-ACN | 15-12 | 12 | 075L | |
| 03/22 | 2348-0404 | ACN-MAD | 15-14 | 11 | 081B | |
| 03/24 | 0215-0545 | ACN-MAD | 15-14 | 11 | 083B | |
| | 0215-0447 | ACN-MAD | 15-17 | 13 | 083A | |
| 03/28 | 1115-1915 | GDS-TEX | 15-14 | 11 | 087B | |
| 03/30 | 1135-1415 | ACN-MAD | 15-14 | 11 | 089D | |
| | 1135-1415 | ACN-MAD | 15-17 | 13 | 089B | |
| 04/3 | 1336-1639 | TEX-MAD | 15-14 | 11 | 093G | |
| 04/4 | 1454-1627 | MAD-TEX | 15-14 | 11 | 094G | |
| 04/9 | 1815-2330 | ACN-TEX | 15-17 | 13 | 099A | |
| | 2351-0400 | ETC-TEX | 15-17 | 13 | 099B | |
| 04/12 | 2115-0059 | MAD-ACN | 15-14 | 11 | 102A | |
| | 2110-0059 | MAD-TEX | 15-14 | 11 | 102B | |
| 04/13 | 1925-0245 | ACN-MAD | 15-14 | 49 | 103A | |
| | 1635-0245 | ACN-MAD | 15-16 | 48 | 103B | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 04/17 | 2040-0300 | ACN-MAD | 15-14 | 11 | 107A | |
| | 0228-0520 | MAD-TEX | 15-14 | 11 | 107B | |
| | 0435-1215 | TEX-GDS | 15-14 | 11 | 107C | |
| 04/18 | 2100-0300 | ACN-MAD | 15-14 | 11 | 108D | |
| | 2100-0300 | ACN-MAD | 15-17 | 13 | 108A | |
| | 0230-0545 | MAD-TEX | 15-17 | 13 | 108B | |
| | 0435-1300 | TEX-GDS | 15-17 | 13 | 108C | |
| 07/2 | 1450-2035 | ACN-TEX | 15-14 | 21 | 183A | |
| | 1600-2030 | TEX-GDS | 15-14 | 21 | 183B | |
| | 2035-2335 | TEX-GDS | 15-14 | 21 | 183D | |
| | 2335-0305 | TEX-GDS | 15-14 | 21 | 183E | |
| | 2115-2330 | GDS-MIL | 15-17 | 22 | 183C | |
| 07/3 | 1815-0200 | MIL-GDS | 15-14 | 21 | 184A | |
| | 2015-0200 | MIL-TEX | 15-14 | 21 | 184B | |
| | 1530-2000 | TEX-MAD | 15-14 | 21 | 184C | |
| | 2005-0345 | TEX-GDS | 15-14 | 21 | 184D | |
| | 1815-0200 | MIL-GDS | 15-17 | 22 | 184E | |
| 07/5 | 1230-1600 | MAD-ACN | 15-17 | 22 | 186A | |
| | 1955-0315 | MIL-GDS | 15-12 | 24 | 186B | |
| | 0000-0500 | GDS-TEX | 15-16 | 23 | 186C | |
| | 1230-1700 | MAD-ACN | 15-16 | 25 | 186D | |
| | 1830-2200 | MAD-ACN | 15-16 | 25 | 186H | |
| | 1645-2200 | MAD-MIL | 15-16 | 25 | 186E | |
| | 1955-0315 | MIL-GDS | 15-16 | 25 | 186F | |
| | 1800-2315 | MIL-TEX | 15-16 | 25 | 186G | |
| 07/6 | 1410-2140 | ACN-MAD | 14-15 | 21 | 187A | |
| | 1715-0015 | ACN-MIL | 14-15 | 21 | 187B | |
| | 2050-0245 | MIL-GDS | 14-15 | 21 | 187C | |
| | 1410-2140 | ACN-MAD | 14-12 | 23 | 187D | |
| | 1715-0015 | ACN-MIL | 14-12 | 23 | 187E | |
| | 2050-0245 | MIL-GDS | 14-12 | 23 | 187F | |
| 07/9 | 2145-0245 | ACN-TEX | 15-16 | 25 | 190A | |
| | 2225-0315 | MIL-TEX | 15-16 | 25 | 190B | |
| | 0325-0730 | TEX-GDS | 15-16 | 25 | 190C | |
| | 0245-0545 | MIL-GDS | 15-17 | 22 | 190D | |
| | 2225-0235 | ACN-MIL | 15-17 | 22 | 190E | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 07/10 | 2100-0115 | MAD-MIL | 15-14 | 11 | 191A | |
| | 0015-0330 | MIL-GDS | 15-14 | 11 | 191B | |
| | 2100-0115 | MAD-MIL | 15-16 | 25 | 191C | |
| | 0015-0600 | MIL-GDS | 15-16 | 25 | 191D | |
| | 0015-0600 | TEX-GDS | 15-16 | 25 | 191E | |
| 07/11 | 2200-0145 | MAD-MIL | 15-17 | 22 | 192A | |
| | 0200-0600 | MIL-TEX | 15-17 | 22 | 192B | |
| | 0115-0600 | MIL-GDS | 15-17 | 22 | 192C | |
| | 0115-0600 | MIL-GDS | 15-12 | 24 | 192D | |
| 07/12 | 1845-0050 | ACN-MAD | 15-16 | 25 | 193A | |
| | 2245-0515 | ACN-MIL | 15-16 | 25 | 193B | |
| | 0200-0630 | MIL-GDS | 15-16 | 25 | 193C | |
| | 0000-0430 | MIL-TEX | 15-16 | 25 | 193D | |
| | 0115-0515 | ACN-MIL | 15-12 | 24 | 193E | |
| | 1845-0050 | ACN-MAD | 15-12 | 24 | 193F | |
| | 0150-0630 | MIL-GDS | 15-12 | 24 | 193G | |
| 07/13 | 1946-0330 | ACN-MAD | 15-17 | 22 | 194A | |
| | 2355-0300 | ACN-MIL | 15-17 | 22 | 194B | |
| | 0240-0553 | ACN-GDS | 15-17 | 22 | 194C | |
| | 1946-0330 | ACN-MAD | 15-12 | 24 | 194D | |
| | 2355-0300 | ACN-MIL | 15-12 | 24 | 194E | |
| | 0240-0600 | ACN-GDS | 15-12 | 24 | 194F | |
| 07/17 | 0220-0630 | MAD-ACN | 15-17 | 22 | 198A | |
| | 0230-0730 | ACN-TEX | 15-17 | 22 | 198B | |
| | 0415-0730 | ACN-GDS | 15-17 | 22 | 198C | |
| | 0415-1030 | TEX-GDS | 15-17 | 22 | 198D | |
| | 0220-0630 | MAD-ACN | 15-16 | 25 | 198E | |
| | 0415-0730 | ACN-GDS | 15-16 | 25 | 198F | |
| 07/18 | 0315-0735 | TEX-MAD | 15-12 | 24 | 199A | |
| | 0452-1415 | TEX-MAD | 15-12 | 24 | 199B | |
| | 0500-0735 | GDS-MAD | 15-17 | 22 | 199C | |
| 07/19 | 0345-0810 | MAD-TEX | 15-12 | 24 | 200A | |
| | 0530-1205 | TEX-GDS | 15-12 | 24 | 200B | |
| | 0530-0810 | MAD-GDS | 15-16 | 25 | 200C | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 07/20 | 0000-0700 | MAD-ACN | 15-14 | 49 | 201A | |
| | 0620-0930 | ACN-GDS | 15-14 | 49 | 201B | |
| | 0620-0930 | ACN-GDS | 15-16 | 48 | 201C | |
| | 0000-0700 | MAD-ACN | 15-16 | 48 | 201D | |
| 07/23 | 0615-1150 | TEX-ACN | 12-17 | 26 | 204A | |
| | 1425-1850 | GDS-TEX | 12-17 | 26 | 204B | |
| | 0930-1225 | ACN-GDS | 12-14 | 21 | 204C | |
| 07/24 | 0230-0730 | ACN-MAD | 12-17 | 26 | 205A | |
| | 0820-1400 | MAD-GDS | 12-17 | 26 | 205B | |
| | 0820-1745 | TEX-GDS | 12-17 | 26 | 205C | |
| | 0230-0730 | ACN-MAD | 12-14 | 23 | 205D | |
| | 0820-1400 | MAD-GDS | 12-14 | 23 | 205E | |
| 07/25 | 0745-0912 | MAD-TEX | 12-17 | 26 | 206A | |
| | 0850-1700 | GDS-TEX | 12-17 | 26 | 206C | |
| | 1000-1515 | MAD-GDS | 12-14 | 23 | 206D | |
| 08/6 | 2315-0415 | GDS-MIL | 12-14 | 23 | 218A | |
| | 2318-0415 | TEX-GDS | 12-14 | 23 | 218B | |
| | 2315-0415 | GDS-MIL | 12-17 | 26 | 218C | |
| 08/8 | 0015-0500 | MIL-GDS | 15-17 | 22 | 220A | |
| | 0015-0500 | TEX-GDS | 15-17 | 22 | 220B | |
| | 0015-0500 | MIL-GDS | 15-16 | 25 | 220C | |
| | 0000-0330 | MIL-GDS | 15-17 | 22 | 220D | |
| | 2213-0330 | MIL-TEX | 15-16 | 25 | 220E | |
| | 0000-0330 | TEX-GDS | 15-16 | 25 | 220F | |
| 08/9 | 1800-2055 | MAD-ACN | 12-17 | 26 | 221A | |
| | 0055-0630 | MIL-GDS | 12-17 | 26 | 221B | |
| | 2330-0500 | MIL-TEX | 12-15 | 24 | 221C | |
| | 0240-0630 | MIL-GDS | 12-15 | 24 | 221F | |
| | 1800-2055 | MAD-ACN | 12-15 | 24 | 221E | |
| 08/14 | 0105-0600 | MIL-ACN | 12-15 | 24 | 226A | |
| | 0105-0600 | MIL-ACN | 12-14 | 23 | 226B | |
| 08/17 | 0240-0700 | MIL-ACN | 12-15 | 24 | 229A | |
| | 0240-0700 | MIL-ACN | 12-14 | 23 | 229B | |
| 08/21 | 0600-1305 | MAD-MIL | 12-14 | 23 | 233A | |
| | 1435-1730 | MIL-GDS | 12-15 | 24 | 233B | |
| | 0600-1100 | MAD-MIL | 12-17 | 26 | 233C | |
| | 1405-1800 | GDS-TEX | 12-17 | 26 | 233D | |
| | 1325-1730 | MIL-TEX | 12-17 | 26 | 233E | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 08/22 | 0603-1400 | MAD-MIL | 16-17 | 47 | 234A | |
| | 1300-1830 | MIL-GDS | 16-17 | 47 | 234B | |
| | 0603-1400 | MAD-MIL | 16-15 | 25 | 234C | |
| | 1300-1830 | MIL-GDS | 16-15 | 25 | 234D | |
| | 1316-2000 | GDS-TEX | 16-15 | 25 | 234E | |
| 08/23 | 1440-1620 | TEX-GDS | 12-17 | 26 | 235A | |
| | 1700-2115 | TEX-GDS | 12-17 | 26 | 235B | |
| 08/24 | 0932-1440 | ACN-MIL | 12-15 | 24 | 236A | |
| | 1300-1945 | MIL-GDS | 12-15 | 24 | 236B | |
| | 0932-1440 | ACN-MIL | 12-14 | 23 | 236C | |
| | 1300-1945 | MIL-GDS | 12-14 | 23 | 236D | |
| 08/27 | 1502-2200 | MIL-GDS | 12-14 | 23 | 239A | |
| | 1502-2200 | MIL-GDS | 12-17 | 26 | 239B | |
| | 1502-2028 | GDS-TEX | 12-17 | 26 | 239C | |
| 08/28 | 1508-2300 | MIL-GDS | 12-14 | 23 | 240A | |
| | 1508-2300 | MIL-GDS | 12-15 | 24 | 240B | |
| | 1508-2130 | TEX-GDS | 12-15 | 24 | 240C | |
| 08/29 | 1600-2230 | MIL-GDS | 12-14 | 23 | 241A | |
| | 1600-2230 | MIL-GDS | 12-15 | 24 | 241B | |
| | 1600-2100 | TEX-GDS | 12-15 | 24 | 241C | |
| 08/30 | 1633-2130 | MIL-GDS | 12-17 | 26 | 242A | |
| | 1636-2130 | MIL-GDS | 12-16 | 34 | 242B | |
| | 1508-2000 | MIL-TEX | 12-16 | 34 | 242C | |
| 09/3 | 1830-2400 | ACN-MIL | 12-15 | 24 | 246A | |
| | 1830-2400 | ACN-MIL | 12-14 | 23 | 246B | |
| 09/10 | 0005-0400 | MIL-MAD | 15-16 | 48 | 253A | |
| | 2352-0400 | MIL-MAD | 15-14 | 49 | 253B | |
| 09/11 | 2345-0450 | MAD-MIL | 15-16 | 48 | 254A | |
| | 0600-1015 | MIL-GDS | 15-16 | 48 | 254B | |
| | 0605-1200 | TEX-GDS | 15-16 | 48 | 254C | |
| | 2345-0445 | MAD-MIL | 15-17 | 46 | 254D | |
| | 0600-1015 | MIL-GDS | 15-17 | 46 | 254E | |
| 09/13 | 0015-0530 | MAD-MIL | 15-17 | 46 | 256A | |
| | 0500-1030 | MIL-TEX | 15-17 | 46 | 256B | |
| | 0630-1255 | GDS-TEX | 15-17 | 46 | 256C | |
| | 0015-0530 | MAD-MIL | 15-14 | 49 | 256D | |
| | 0620-1030 | MIL-GDS | 15-14 | 49 | 256E | |

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|---|---|---|---|---|---|---|
| 09/14 | 0125-0550 | MAD-ACN | 12-15 | 32 | 257A | |
| | 0034-0630 | MIL-MAD | 12-15 | 32 | 257B | |
| | 0605-1200 | MIL-GDS | 12-15 | 32 | 257C | |
| | 0125-0550 | MAD-ACN | 12-14 | 33 | 257D | |
| | 0100-0630 | MIL-MAD | 12-14 | 33 | 257E | |
| | 0605-1200 | MIL-GDS | 12-14 | 33 | 257F | |
| 09/15 | 0115-0700 | ACN-MAD | 12-16 | 34 | 258A | |
| | 0115-0700 | ACN-MAD | 12-17 | 31 | 258B | |
| 09/17 | 0640-1200 | MIL-TEX | 12-15 | 32 | 260A | |
| | 0858-1330 | GDS-TEX | 12-15 | 32 | 260B | |
| | 0858-1200 | MIL-GDS | 12-14 | 33 | 260C | |
| 09/18 | 0510-1200 | MIL-TEX | 12-17 | 31 | 261A | |
| 09/19 | 0540-0930 | MIL-TEX | 12-17 | 31 | 262A | |
| | 0935-1500 | MIL-GDS | 12-17 | 31 | 262B | |
| | 0630-1500 | MIL-GDS | 12-14 | 33 | 262C | |
| 09/20 | 1126-1340 | MIL-GDS | 12-15 | 32 | 263A | |
| | 1013-1230 | MIL-GDS | 12-16 | 34 | 263B | |
| | 1235-1430 | MIL-GDS | 12-16 | 34 | 263C | |
| 09/24 | 0930-1530 | ACN-MIL | 12-15 | 32 | 267A | |
| | 0930-1530 | ACN-MIL | 12-17 | 31 | 267B | |
| 09/26 | 1230-1645 | MAD-MIL | 12-17 | 31 | 269A | |
| | 1352-2200 | MIL-TEX | 12-17 | 31 | 269B | |
| | 1230-1645 | MAD-MIL | 12-15 | 32 | 269C | |
| 09/27 | 0830-1730 | ACN-MAD | 12-17 | 31 | 270A | |
| | 1350-1900 | ACN-MIL | 12-17 | 31 | 270B | |
| | 0830-1730 | ACN-MAD | 12-16 | 34 | 270C | |
| | 1350-1900 | ACN-MIL | 12-16 | 34 | 270D | |
| 09/28 | 0916-1800 | ACN-MAD | 12-16 | 34 | 271A | |
| | 1402-2000 | ACN-MIL | 12-16 | 34 | 271B | |
| | 0916-1800 | ACN-MAD | 12-14 | 33 | 271C | |
| | 1402-2000 | ACN-MIL | 12-14 | 33 | 271D | |
| 10/1 | 1720-2245 | ACN-MIL | 12-16 | 34 | 274A | |
| | 2235-0130 | MIL-TEX | 12-16 | 34 | 274B | |
| | 1720-2245 | ACN-MIL | 12-15 | 32 | 274C | |
| 10/2 | 1720-2100 | MIL-MAD | 12-15 | 32 | 275A | |
| | 2100-0230 | MIL-TEX | 12-15 | 32 | 275B | |
| | 1720-2100 | MIL-MAD | 12-16 | 34 | 275C | |

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|---|---|---|---|---|---|---|
| 10/3 | 1820-2200 | MIL-MAD | 12-15 | 32 | 276A | |
| | 2010-0300 | MIL-TEX | 12-15 | 32 | 276B | |
| | 1835-2200 | MIL-MAD | 12-14 | 33 | 276C | |
| 10/4 | 1930-2300 | ACN-MAD | 12-16 | 34 | 277A | |
| | 1930-2300 | ACN-MIL | 12-16 | 34 | 277B | |
| | 0025-0400 | MIL-TEX | 12-16 | 34 | 277C | |
| | 1930-2300 | ACN-MAD | 12-14 | 33 | 277D | |
| | 1930-2300 | ACN-MIL | 12-14 | 33 | 277E | |
| 10/5 | 1730-2200 | ACN-MAD | 12-17 | 31 | 278A | |
| | 1923-2400 | MAD-MIL | 12-17 | 31 | 278B | |
| | 1730-2200 | ACN-MAD | 12-14 | 33 | 278C | |
| | 1923-2400 | MAD-MIL | 12-14 | 33 | 278D | |
| 10/16 | 0300-0700 | ACN-MIL | 12-15 | 32 | 289A | |
| | 0300-0700 | ACN-MIL | 12-14 | 33 | 289B | |
| 10/22 | 0950-1430 | ACN-MIL | 12-17 | 31 | 295A | |
| | 0950-1430 | ACN-MIL | 12-16 | 34 | 295B | |
| 10/25 | 1140-1600 | MAD-MIL | 12-15 | 32 | 298A | |
| | 1140-1600 | MAD-MIL | 12-14 | 33 | 298B | |
| 11/2 | 1500-2200 | MAD-ACN | 12-17 | 31 | 306A | |
| | 1905-2230 | MAD-MIL | 12-17 | 31 | 306B | |
| | 1500-2200 | MAD-ACN | 12-14 | 33 | 306C | |
| | 1905-2230 | MAD-MIL | 12-14 | 33 | 306D | |
| 11/5 | 2320-0600 | MIL-GDS | 16-17 | 47 | 309A | |
| | 2325-0600 | MIL-GDS | 16-15 | 48 | 309B | |
| 11/7 | 0000-0700 | MIL-GDS | 16-17 | 47 | 311A | |
| | 0000-0700 | MIL-GDS | 16-15 | 48 | 311B | |
| | 2130-0300 | MAD-MIL | 12-17 | 31 | 311C | |
| | 0030-0550 | MIL-GDS | 12-17 | 31 | 311D | |
| | 2130-0300 | MAD-MIL | 12-14 | 33 | 311E | |
| | 0030-0800 | MIL-GDS | 12-14 | 33 | 311F | |
| 11/8 | 1832-0415 | MAD-ACN | 12-15 | 32 | 312A | |
| | 2150-0500 | MAD-MIL | 12-15 | 32 | 312B | |
| | 0030-0700 | MIL-GDS | 12-15 | 32 | 312C | |
| | 1832-0415 | MAD-ACN | 12-14 | 33 | 312D | |
| | 2150-0500 | MAD-MIL | 12-14 | 33 | 312E | |
| | 0030-0700 | MIL-GDS | 12-14 | 33 | 312F | |

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|---|---|---|---|---|---|---|
| 11/9 | 1934-0500 | MAD-ACN | 12-16 | 34 | 313A | |
| | 2202-0400 | MAD-MIL | 12-16 | 34 | 313B | |
| | 0045-0600 | MAD-GDS | 12-16 | 34 | 313C | |
| | 1945-0500 | MAD-ACN | 12-15 | 32 | 313D | |
| | 2202-0400 | MAD-MIL | 12-15 | 32 | 313E | |
| | 0045-0600 | MAD-GDS | 12-15 | 32 | 313F | |
| 11/27 | 0500-1830 | MAD-MIL | 12-15 | 44 | 331A | |
| | 1500-1830 | MAD-MIL | 12-14 | 42 | 331B | |
| 11/28 | 1545-1945 | MAD-MIL | 12-17 | 41 | 332A | |
| | 1545-1940 | MAD-MIL | 12-16 | 43 | 332B | |
| 11/29 | 1700-2000 | MAD-ACN | 12-17 | 41 | 333A | |
| | 1700-2200 | MIL-ACN | 12-17 | 41 | 333B | |
| | 2155-0115 | MIL-GDS | 12-17 | 41 | 333C | |
| | 1756-2000 | MAD-ACN | 12-16 | 43 | 333D | |
| | 1756-2115 | MIL-ACN | 12-16 | 43 | 333E | |
| | 2155-0115 | MIL-GDS | 12-16 | 43 | 333F | |
| 11/30 | 1750-2130 | MAD-MIL | 12-15 | 44 | 334A | |
| | 2145-0230 | MIL-GDS | 12-15 | 44 | 334B | |
| | 1745-2130 | ACN-MAD | 12-14 | 42 | 334C | |
| | 1715-2130 | MAD-MIL | 12-14 | 42 | 334D | |
| | 2145-0230 | MIL-GDS | 12-14 | 42 | 334E | |
| 12/1 | 1645-2100 | ACN-MAD | 12-15 | 44 | 335A | |
| | 1645-2100 | ACN-MAD | 12-14 | 42 | 335B | |
| 12/3 | 2305-0400 | MIL-GDS | 15-17 | 46 | 337A | |
| | 2305-0400 | MIL-GDS | 15-16 | 45 | 337B | |
| 12/4 | 1915-0030 | MIL-MAD | 15-17 | 46 | 338A | |
| | 2315-0600 | MIL-GDS | 15-17 | 46 | 338B | |
| | 1915-0030 | MIL-MAD | 15-16 | 45 | 338C | |
| | 2309-0600 | MIL-GDS | 15-16 | 45 | 338D | |
| 12/6 | 0218-0650 | MIL-GDS | 15-16 | 45 | 340A | |
| | 0218-0650 | MIL-GDS | 15-16 | 45 | 340B | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 12/7 | 0230-0645 | MIL-GDS | 12-17 | 41 | 340C | |
| | 0230-0645 | MIL-GDS | 12-14 | 42 | 340D | |
| 12/20 | 1426-1830 | MIL-GDS | 12-17 | 41 | 354A | |
| | 1426-1830 | MIL-GDS | 12-14 | 42 | 354B | |
| 12/21 | 1330-1915 | MIL-GDS | 12-15 | 44 | 355A | |
| | 1321-1915 | MIL-GDS | 12-16 | 43 | 355B | |
| 1974 | | | | | | |
| 01/9 | 0345-1515 | MAD-MIL | 12-17 | 41 | 009M | |
| | 0345-1515 | MAD-MIL | 12-17 | 41 | 009N | |
| | 0530-1200 | MIL-GDS | 12-17 | 41 | 009P | |
| | 0530-1200 | MIL-GDS | 12-17 | 41 | 009Q | |
| 01/10 | 0215-0600 | MAD-MIL | 15-16 | 45 | 010M | |
| | 0455-1100 | MIL-GDS | 15-16 | 45 | 010N | |
| | 0215-0600 | MAD-MIL | 15-12 | 44 | 010P | |
| | 0500-1100 | MIL-GDS | 15-12 | 44 | 010Q | |
| 01/11 | 0200-0600 | MAD-MIL | 14-12 | 42 | 011M | |
| | 0605-1100 | MIL-GDS | 14-12 | 42 | 011N | |
| | 0200-0600 | MAD-MIL | 14-12 | 42 | 011P | |
| | 0605-1100 | MIL-GDS | 14-12 | 42 | 011Q | |
| 01/28 | 2215-0230 | MIL-GDS | 12-16 | 43 | 028M | |
| | 2215-0230 | MIL-GDS | 12-14 | 42 | 028N | |
| 01/30 | 1800-2400 | MAD-MIL | 12-17 | 41 | 030M | |
| | 2112-0400 | MIL-GDS | 12-17 | 41 | 030N | |
| | 1800-2400 | MAD-MIL | 12-14 | 42 | 030P | |
| | 2112-0400 | MIL-GDS | 12-14 | 42 | 030Q | |
| 02/1 | 1850-2400 | MAD-MIL | 16-17 | 47 | 032M | |
| | 2100-0145 | MIL-GDS | 16-17 | 47 | 032N | |
| | 2100-0145 | MIL-GDS | 16-15 | 45 | 032P | |
| 02/2 | 1746-2200 | MAD-ACN | 16-17 | 47 | 033M | |
| | 1900-2200 | MAD-ACN | 16-15 | 45 | 033N | |
| 02/15 | 0515-1000[1] | ACN-MAD | 12-17 | 41 | 046M | |
| | 0447-1000 | ACN-MAD | 12-16 | 43 | 046N | |
| 02/16 | 0430-1000 | ACN-MAD | 15-17 | 46 | 047M | |
| | 0425-1000 | ACN-MAD | 15-16 | 45 | 047N | |

[1]Possible offset at MAD

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|---|---|---|---|---|---|---|
| 02/20 | 1405-1710 | MIL-GDS | 12-15 | 44 | 051N | |
| 02/21 | 1015-1700 | MAD-ACN | 12-17 | 41 | 052M | |
| | 1400-1800 | ACN-MIL | 12-17 | 41 | 052N | |
| | 1500-2200 | MIL-GDS | 12-17 | 41 | 052P | |
| | 1135-1700 | MAD-ACN | 12-16 | 43 | 052Q | |
| | 1352-1800 | ACN-MIL | 12-16 | 43 | 052R | |
| | 1454-2200 | MIL-GDS | 12-16 | 43 | 052S | |
| 02/22 | 1200-1745 | ACN-MAD | 12-15 | 44 | 053M | |
| | 1400-1800 | ACN-MIL | 12-15 | 44 | 053N | |
| | 1509-2200 | MIL-GDS | 12-15 | 44 | 053P | |
| | 1200-1745 | ACN-MAD | 12-14 | 42 | 053Q | |
| | 1400-1800 | ACN-MIL | 12-14 | 42 | 053R | |
| | 1500-2200 | MIL-GDS | 12-14 | 42 | 053S | |
| 02/23 | 1200-1830 | ACN-MAD | 12-17 | 41 | 054M | |
| | 1200-1830 | ACN-MAD | 12-14 | 42 | 054N | |
| 02/25 | 1348-2030 | ACN-MIL | 12-17 | 41 | 056M | |
| | 1700-0100 | MIL-GDS | 12-17 | 41 | 056N | |
| | 1348-2030 | ACN-MIL | 12-16 | 43 | 056P | |
| | 1700-0100 | MIL-GDS | 12-16 | 43 | 056Q | |
| 02/26 | 2317-0200 | MIL-GDS | 12-15 | 44 | 057M | |
| | 2317-0200 | MIL-GDS | 12-16 | 43 | 057N | |
| 02/27 | 1745-0300 | MIL-GDS | 12-15 | 44 | 058M | |
| | 1745-0300 | MIL-GDS | 12-14 | 42 | 058N | |
| 02/28 | 1615-2007 | ACN-MIL | 12-17 | 41 | 059M | |
| | 2010-0300 | MIL-GDS | 12-17 | 41 | 059N | |
| | 1615-2100 | ACN-MIL | 12-14 | 42 | 059P | |
| | 1824-0300 | MIL-GDS | 12-14 | 42 | 059Q | |
| 03/4 | 2235-0300[1] | MIL-GDS | 15-17 | 46 | 063M | |
| | 2235-0300 | MIL-GDS | 15-16 | 45 | 063N | |
| 03/15 | 0240-0745 | ACN-MAD | 12-17 | 50 | 074M | |
| | 0240-0910 | ACN-MAD | 12-14 | 51 | 074N | |

[1] A5 hi bit rate

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 03/22 | 1300-1630 | MAD-MIL | 12-15 | 52 | 081M | |
| | 1300-1630 | MAD-MIL | 12-16 | 53 | 081P | |
| 03/26 | 0955-1425 | ACN-MAD | 16-17 | 54 | 085M | |
| | 1315-1715 | MAD-MIL | 16-17 | 54 | 085N | |
| | 0955-1425 | ACN-MAD | 16-15 | 55 | 085P | |
| | 1315-1715 | MAD-MIL | 16-15 | 55 | 085Q | |
| 03/27 | 1720-2200 | MAD-MIL | 15-14 | 56 | 086M | |
| | 1110-1630 | MAD-ACN | 15-16 | 55 | 086N | |
| | 1400-2200 | MAD-MIL | 15-16 | 55 | 086P | |
| 04/1 | 2136-0200 | ACN-MAD | 16-17 | 54 | 091M | |
| | 2040-0200 | ACN-MIL | 16-17 | 54 | 091N | |
| | 2136-0200 | ACN-MAD | 16-15 | 55 | 091P | |
| | 2040-0200 | ACN-MIL | 16-15 | 55 | 091Q | |
| 04/2 | 2010-0200 | MAD-ACN | 16-17 | 54 | 092M | |
| | 2010-0200 | MAD-MIL | 16-17 | 54 | 092N | |
| | 2010-0200 | MAD-ACN | 16-15 | 55 | 092P | |
| | 2010-0200 | MAD-MIL | 16-15 | 55 | 092Q | |
| 04/9 | 0000-0630 | ACN-MAD | 14-12 | 51 | 099M | |
| | 0000-0630 | ACN-MAD | 14-15 | 56 | 099N | |
| | 2300-0415 | ACN-MAD | 12-14 | 51 | 099P | |
| | 2315-0415 | ACN-MAD | 12-17 | 50 | 099Q | |
| 04/16 | 0400-1230 | MAD-ACN | 17-16 | 54 | 106M | |
| | 0400-1230 | MAD-ACN | 17-15 | 57 | 106N | |
| 04/22 | 1320-1845 | MAD-MIL | 17-15 | 57 | 112M | |
| | 1250-1845 | MAD-MIL | 17-16 | 54 | 112N | |
| 04/23 | 1445-2330 | GDS-MIL | 15-12 | 52 | 113M | |
| | 1445-2330 | GDS-MIL | 15-14 | 56 | 113N | |
| 04/24 | 1500-1930 | ACN-MAD | 17-15 | 57 | 114M | |
| | 1455-1904 | ACN-MAD | 17-16 | 54 | 114N | |
| 04/29 | 1845-2312 | ACN-MAD | 16-12 | 53 | 119M | |
| | 1845-2400 | MAD-MIL | 16-12 | 53 | 119N | |
| | 1845-2312 | ACN-MAD | 16-17 | 54 | 119P | |
| | 1845-2400 | MAD-MIL | 16-17 | 54 | 119Q | |

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|---|---|---|---|---|---|---|
| 04/30 | 1715-2300 | ACN-MAD | 16-12 | 53 | 120M | |
| | 1715-2300 | ACN-MAD | 16-17 | 54 | 120N | |
| 05/1 | 1955-2400 | MAD-MIL | 16-15 | 55 | 121M | |
| | 1955-2400 | MAD-MIL | 16-17 | 54 | 121N | |
| 05/11 | 0128-0800 | ACN-MAD | 14-12 | 51 | 131M | |
| | 0128-0800 | ACN-MAD | 14-15 | 56 | 131N | |
| 05/12 | 0145-0800 | ACN-MAD | 12-15 | 52 | 132M | |
| | 0150-0800 | ACN-MAD | 12-17 | 50 | 132N | |
| 05/13 | 0126-0700 | ACN-MAD | 12-14 | 51 | 133M | |
| | 0126-0700 | ACN-MAD | 12-17 | 50 | 133N | |
| 05/15 | 0228-0850 | ACN-MAD | 16-15 | 55 | 135M | |
| | 0228-0850 | ACN-MAD | 16-17 | 54 | 135N | |
| 05/17 | 1300-1845 | GDS-MIL | 12-15 | 52 | 137M | |
| | 1627-1845 | GDS-MIL | 12-17 | 50 | 137N | |
| 05/20 | 1155-1600[1] | MAD-ACN | 16-17 | 54 | 140M | |
| | 1830-2200[1] | MIL-GDS | 16-17 | 54 | 140N | |
| | 1155-1600[1] | MAD-ACN | 16-12 | 53 | 140P | |
| | 1830-2200[1] | MIL-GDS | 16-12 | 53 | 140Q | |
| 05/21 | 1908-2315 | MIL-GDS | 15-16 | 55 | 141M | |
| | 1908-2315 | MIL-GDS | 15-14 | 56 | 141N | |
| 05/22 | 1115-1800 | MAD-ACN | 15-16 | 55 | 142M | |
| | 1115-1800 | MAD-ACN | 15-14 | 56 | 142N | |
| 05/27 | 1240-2000 | MAD-ACN | 12-14 | 51 | 147M | |
| | 1245-2000 | MAD-ACN | 12-15 | 52 | 147N | |
| 05/28 | 1830-2200 | MAD-MIL | 12-14 | 51 | 148M | |
| | 1830-2200 | MAD-MIL | 12-16 | 53 | 148N | |
| 05/30 | 2100-0100 | MAD-MIL | 16-15 | 55 | 150M | |
| | 2210-0210 | MIL-ACN | 16-15 | 55 | 150N | |
| | 2100-0100 | MAD-MIL | 16-17 | 54 | 150P | |
| | 2210-0210 | MIL-ACN | 16-17 | 54 | 150Q | |

[1]Mil gap 1854-1942

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 06/5 | 0110-0400 | ACN-MAD | 16-15 | 55 | 156M | |
| | 0110-0400 | ACN-MAD | 16-15 | 55 | 156N | |
| 06/7 | 0005-0600 | ACN-MAD | 16-15 | 55 | 158M | |
| | 0005-0600 | ACN-MAD | 16-12 | 53 | 158N | |
| 06/11 | 0215-0935 | MAD-ACN | 12-15 | 52 | 162M | |
| | 0215-0935 | MAD-ACN | 12-14 | 51 | 162N | |
| 06/13 | 0215-1115 | ACN-MAD | 12-17 | 50 | 164M | |
| | 0215-1115 | ACN-MAD | 12-16 | 53 | 164N | |
| 06/17 | 1300-2000 | MIL-GDS | 16-17 | 54 | 168M | |
| | 1300-2000 | MIL-GDS | 16-12 | 53 | 168N | |
| 06/18 | 0725-1430 | MAD-ACN | 16-17 | 54 | 169M | |
| | 0725-1430 | MAD-ACN | 16-12 | 53 | 169N | |
| 06/19 | 0700-1335 | MAD-ACN | 15-14 | 56 | 170M | |
| | 0700-1330 | MAD-ACN | 15-17 | 57 | 170N | |
| 06/20 | 1830-2230 | MIL-GDS | 15-14 | 56 | 171M | |
| | 1830-2230 | MIL-GDS | 15-17 | 57 | 171N | |
| 06/24 | 1615-2115 | MAD-MIL | 15-16 | 60 | 175M | |
| | 1615-2115 | MAD-MIL | 15-14 | 61 | 175N | |
| 06/25 | 1800-2200 | MAD-MIL | 12-16 | 62 | 176M | |
| | 1800-2200 | MAD-MIL | 12-14 | 63 | 176N | |
| 06/28 | 2000-0200 | MIL-ACN | 12-17 | 64 | 179M | |
| | 2000-0200 | MIL-ACN | 12-16 | 62 | 179N | |
| 07/1 | 1910-0224 | ACN-MAD | 12-17 | 64 | 182M | |
| | 2224-0224 | MAD-MIL | 12-17 | 64 | 182N | |
| | 1910-0224 | ACN-MAD | 12-14 | 63 | 182P | |
| | 2224-0224 | MAD-MIL | 12-14 | 63 | 182Q | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 07/2 | 1920-0230 | ACN-MAD | 12-15 | 65 | 183M | |
| | 1920-0230 | ACN-MAD | 12-14 | 63 | 183N | |
| 07/13 | 0800-1222 | ACN-GDS | 15-16 | 60 | 194M | |
| | 0800-1222 | ACN-GDS | 15-17 | 67 | 194N | |
| 07/14 | 0837-1258 | ACN-GDS | 16-15 | 60 | 195M | |
| | 0837-1258 | ACN-GDS | 16-17 | 66 | 195N | |
| 07/15 | 1300-1815 | GDS-MIL | 16-17 | 66 | 196M | |
| | 1300-1815 | GDS-MIL | 16-15 | 60 | 196N | |
| 07/16 | 1100-1500 | ACN-GDS | 16-17 | 66 | 197M | |
| | 1100-1500 | ACN-GDS | 16-15 | 60 | 197N | |
| 07/17 | 1310-1700 | MIL-MAD | 12-14 | 63 | 198M | |
| | 1310-1700 | MIL-MAD | 12-17 | 64 | 198N | |
| 07/19 | 1526-1844 | MIL-ACN | 12-15 | 65 | 200M | |
| | 1526-1844 | MIL-ACN | 12-14 | 63 | 200N | |
| 07/22 | 1205-2000 | ACN-MAD | 16-17 | 66 | 203M | |
| | 1205-2000 | ACN-MAD | 16-12 | 62 | 203N | |
| 07/23 | 2100-0200 | GDS-MIL | 16-12 | 62 | 204N | |
| 07/24 | 1400-2100 | MAD-ACN | 12-15 | 65 | 205M | |
| | 1400-2100 | MAD-ACN | 12-14 | 63 | 205N | |
| 07/25 | 2115-0300 | GDS-MIL | 12-15 | 65 | 206M | |
| | 2115-0300 | GDS-MIL | 12-14 | 63 | 206N | |
| 07/29 | 1740-0100 | MAD-ACN | 16-17 | 66 | 210M | |
| | 1740-0100 | MAD-ACN | 16-15 | 60 | 210N | |
| 07/30 | 1940-0200 | MAD-ACN | 16-17 | 66 | 211M | |
| | 1940-0200 | MAD-ACN | 16-15 | 60 | 211N | |
| 07/31 | 1830-0300 | MAD-ACN | 15-14 | 61 | 212M | |
| | 1830-0300 | MAD-ACN | 15-12 | 65 | 212N | |
| 08/2 | 2100-0320 | MAD-ACN | 15-14 | 61 | 214M | |
| | 2100-0320 | MAD-ACN | 15-12 | 65 | 214N | |
| 08/5 | 0000-0430 | ACN-MAD | 12-17 | 64 | 217M | |
| | 0000-0430 | ACN-MAD | 12-14 | 63 | 217N | |
| | 2200-0300 | ACN-MAD | 16-15 | 60 | 217P | |
| | 2200-0300 | ACN-MAD | 16-12 | 62 | 217Q | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 08/14 | 0822-1200 | MAD-ACN | 17-15 | 67 | 226M | |
| | 0822-1200 | MAD-ACN | 17-12 | 64 | 226N | |
| 08/15 | 1330-2100 | MIL-GDS | 17-15 | 67 | 227M | |
| | 1330-2100 | MIL-GDS | 17-12 | 64 | 227N | |
| 08/16 | 1000-1630 | ACN-MAD | 15-16 | 60 | 228M | |
| | 1000-1630 | ACN-MAD | 15-14 | 61 | 228N | |
| 08/19 | 1318-1718 | ACN-MIL | 12-16 | 62 | 231N | |
| | 1318-1718 | ACN-MIL | 12-15 | 65 | 231Q | |
| 08/20 | 1423-1950 | ACN-MAD | 12-14 | 63 | 232M | |
| | 1423-1950 | MAD-MIL | 12-14 | 63 | 232N | |
| | 1423-1950 | ACN-MAD | 12-17 | 64 | 232P | |
| | 1423-1950 | MAD-MIL | 12-17 | 64 | 232Q | |
| 09/6 | 0330-0800 | ACN-MAD | 16-17 | 66 | 249M | |
| | 0330-0900 | ACN-MAD | 16-12 | 62 | 249N | |
| 09/7 | 0300-0845 | ACN-MAD | 15-14 | 61 | 250M | |
| | 0300-0845 | ACN-MAD | 15-12 | 65 | 250N | |
| 09/9 | 0130-1050 | ACN-MAD | 12-17 | 64 | 252M | |
| | 0130-1050 | ACN-MAD | 12-14 | 63 | 252N | |
| 09/10 | 0400-0955 | ACN-MAD | 12-17 | 62 | 253M | |
| | 0400-0955 | ACN-MAD | 12-17 | 64 | 253N | |
| 09/16 | 1235-1730 | MAD-MIL | 12-16 | 62 | 259M | |
| | 1235-1730 | MAD-MIL | 12-15 | 65 | 259N | |
| 09/19 | 1520-2100 | ACN-MIL | 15-17 | 67 | 262M | |
| | 1520-2100 | ACN-MIL | 15-14 | 61 | 262N | |
| 09/23 | 1900-0100 | ACN-MIL | 12-14 | 63 | 266M | |
| | 1900-0100 | ACN-MIL | 12-17 | 64 | 266N | |
| 09/27 | 2215-0230 | ACN-MAD | 15-16 | 60 | 270M | |
| | 2215-0230 | MIL-MAD | 15-16 | 60 | 270N | |
| | 2215-0230 | ACN-MAD | 15-17 | 67 | 270P | |
| | 2215-0230 | MIL-MAD | 15-17 | 67 | 270Q | |
| 09/30 | 2300-0300 | ACN-MAD | 15-16 | 60 | 273M | |
| | 2300-0300 | MIL-MAD | 15-16 | 60 | 273N | |
| | 2300-0300 | ACN-MAD | 15-17 | 67 | 273P | |
| | 2300-0300 | MIL-MAD | 15-17 | 67 | 273Q | |

| Date (mm/dd) | Times (hhmm) | Stations | ALSEPS | Obs. Lib. Tape | Series Name | Notes |
|---|---|---|---|---|---|---|
| 10/1 | 2148-0609 | ACN-MAD | 15-16 | | 274M | |
| | 2148-0609 | ACN-MAD | 15-17 | | 274N | |
| 10/7 | 0545-1000 | ACN-GDS | 15-12 | | 280M | |
| | 0545-1000 | ACN-GDS | 15-14 | | 280N | |
| 10/8 | 0645-1100 | GDS-ACN | 12-14 | | 281M | |
| | 0645-1100 | GDS-ACN | 12-17 | | 281N | |
| | 1322-1700 | GDS-MIL | 12-14 | | | |
| | 1322-1700 | GDS-MIL | 12-17 | | | |
| 10/14 | 1300-1700 | ACN-MIL | 15-14 | | 287M | |
| | 1300-1700 | ACN-MIL | 15-12 | | 287N | |
| 10/18 | 1710-2115 | ACN-MIL | 16-15 | | 291M | |
| | 1710-2115 | ACN-MIL | 16-17 | | 291N | |
| 10/24 | | | 12-14 | | 297M | |
| | | | 12-14 | | 297N | |
| | | | 12-17 | | 297P | |
| | | | 12-17 | | 297Q | |
| 10/25 | 2057-2355 | MAD-MIL | 15-16 | | 298M | |
| | 2000-2355 | MAD-MIL | 15-17 | | 298N | |