

September 30, 1983

VLBA ELEMENT OPERATING PROBABILITY

USING REVISED ACCESS TIME DATA

JACK CAMPBELL

In VLB Array Memo No. 80 "VLBA Element Operating Probability Using VLA Reliability Data" we related VLBA average access time (T_A) for two possible VLBA sites to the probability of $>N$ Antennas operational. This memo includes all of the sites listed in VLB Array Memo No. 205 "Final Configuration" by R.C. Walker and the following suggested Central Maintenance Station (CMS) locations.

- A. Charlottesville, VA.
- B. Albuquerque, N.M.
- C. Socorro, N.M.
- D. VLA Site, N.M.
- E. Tucson, Ariz.
- F. Pasadena, CA.

In order to provide a base for calculating an access time the following assumptions were set up.

1. A typical failure occurring at 0500 and 1700 CMS Local time.
2. That only two shipments per day will be made from the CMS to the Airport. One at 0830 and one at 1730 local time.
3. When a module arrives at the site airport between 0800 and 1700 local site time it will be picked up when it arrives and the repair completed. When a module arrives at the site airport between 1700 and 0800 local site time it will be picked up at 0800 and the repair completed.

4. Transit times from the CMS to the Airport are shown in Table IV and transit time from the site airport to the site are shown in Table V.
5. Total transit times are shown in the following tables for the various CMS:

- a. For the 10 Element Array

Charlottesville - Table VI

Albuquerque - VII

Socorro VIII

VLA Site IX

Tucson X

Pasadena XI

- b. For the 13 Element Array

Charlottesville XII

Albuquerque XIII

Socorro XIV

VLA Site XV

Tucson XVI

Pasadena XVII

Using the above assumptions and the data from 5 above an access time (T_A) was estimated as shown in Table I.

Table I

CMS	Estimated Access Time (T_A)			
	10 Element Array		13 Element Array	
	Transit Time Total	Avg.	Transit Time Total	Avg.
Charlottesville	455	22.7	550	21.2
Albuquerque	341	17	412	15.9
Socorro	368	18.4	434	16.7
VLA Site	376	18.8	444	17.1
Tucson	387	19.4	475	18.3
Pasadena	319	16	410	15.8

The estimated average access time for the 10 element array is 18.7 hours with a maximum of 22.7 hours and a minimum of 16 hours and for the 13 element array 17.5 hours with a maximum of 21.2 hours and a minimum of 15.8 hours. Figure 1 relates T_A and Probability of failure in Percent. These access times lead to a probability of Failure in percent of 5% for total system operation and 2.4% for critical modules (system will be operational but not at all frequencies) for the 10 element array and 4.7% for the total system operation and 2.25% for critical modules for the 13 element array.

The probability of $>N$ antennas operational is presented in Table II and in Figure 2 for the 10 element array and in Table II and Figure 3 for the 13 Element Array.

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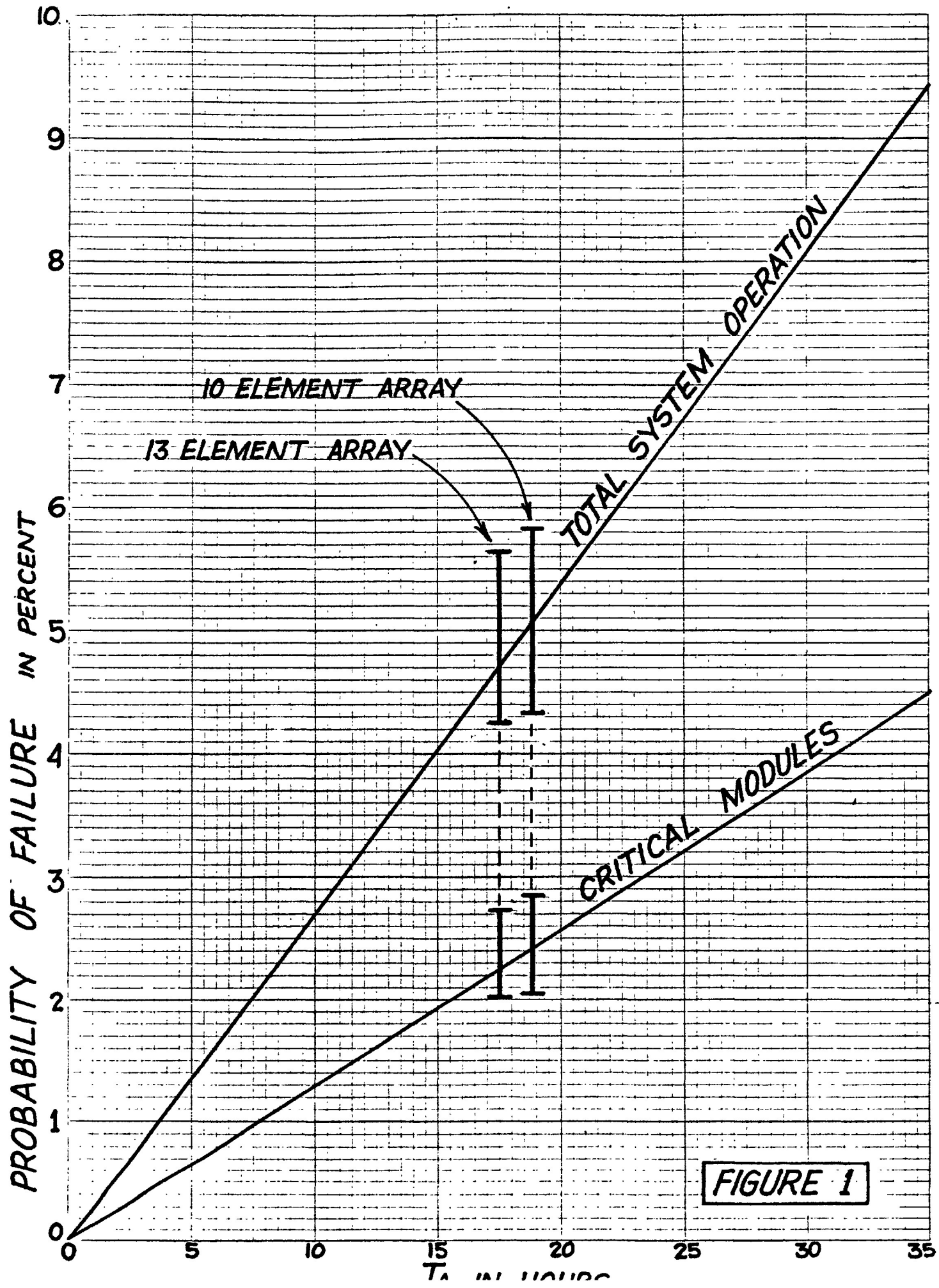


FIGURE 1

Table II

Probability in Percent of >N Antennas

Operational

N	10 Element Array		13 Element Array	
	Some Degradation ¹	Complete System	Some Degradation ¹	Complete System
13	NA	NA	74	53
12	NA	NA	96.3	88
11	NA	NA	99.7	98
10	78	60	99.99	99.74
9	97.6	91.5	>99.99	99.99
8	99.85	98.8	>99.99	>99.99
7	>99.99	98.89	>99.99	>99.99

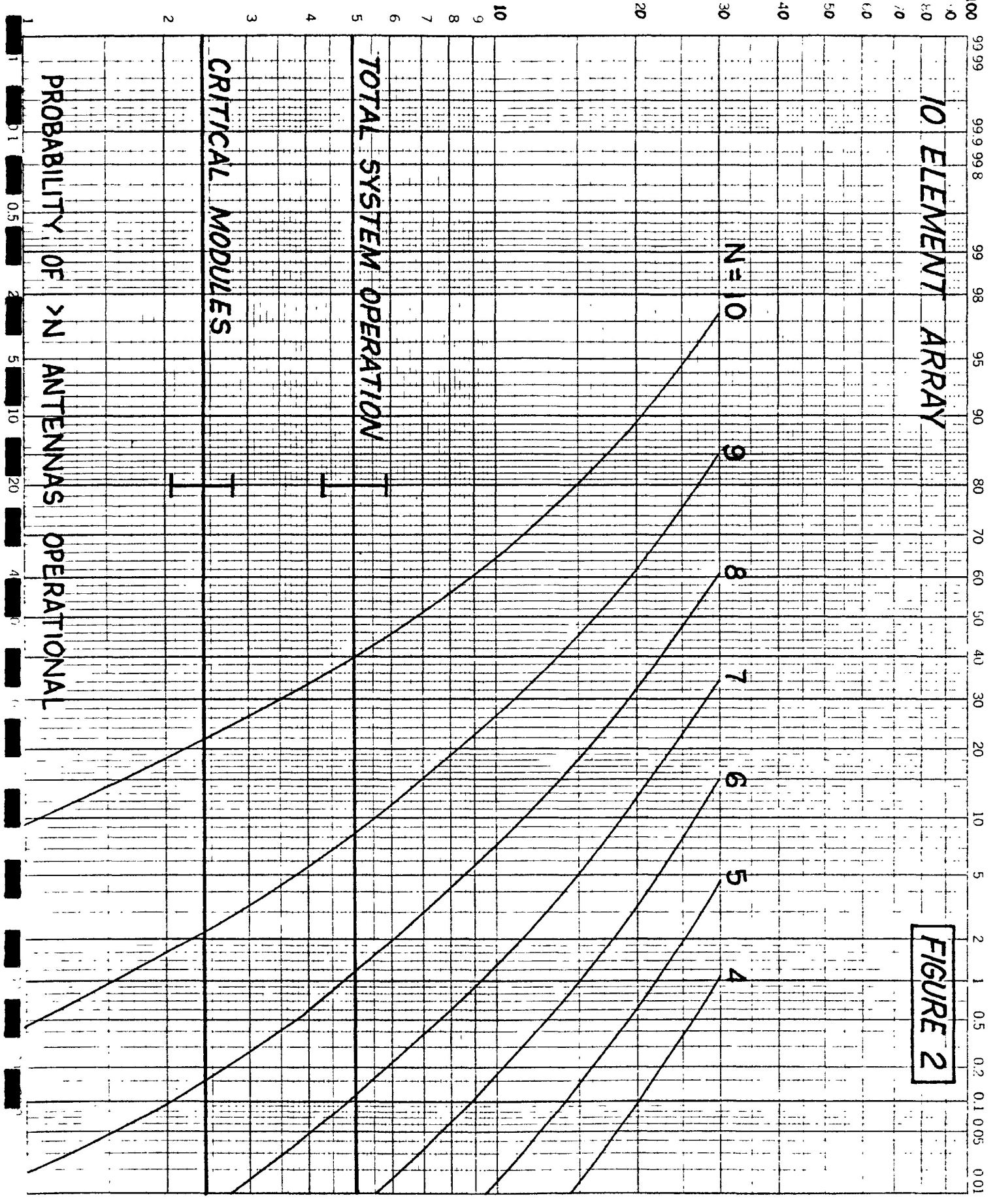
¹ System will be operational but not on all frequencies

Summary

This cursory estimate did not make any attempt to optimize flight schedules, procedures, or working hours at either the CMS or the various sites. For example it may be that at the CMS the working hours for the remote diagnostic personnel and their schedule may be set to optimize air transit times, or changes of site schedules and/or overtime to provide for more prompt repair.

The estimate of T_A shown here is two times better than that estimated in VLB Array Memo No. 80 and that an average T_A of less than a day will be possible.

PROBABILITY OF FAILURES IN PERCENT



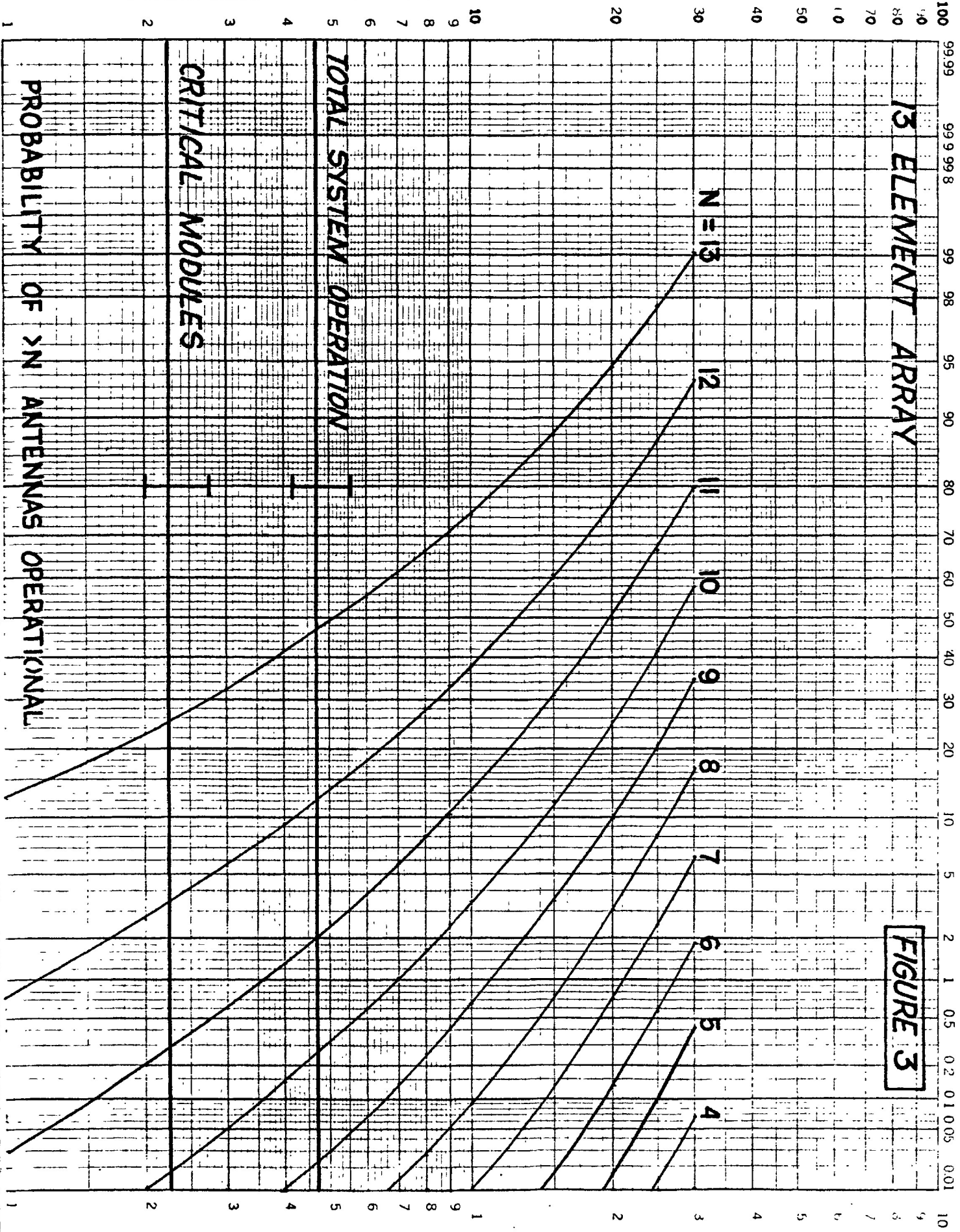
PROBABILITY OF $>N$ ANTENNAS OPERATIONAL

CRITICAL MODULES

TOTAL SYSTEM OPERATION

FIGURE 2

PROBABILITY OF FAILURE IN PERCENT



This estimate of T_A also shows that with the sites separated as they are that the location of the CMS will not have a great effect on T_A so long as it is near a reasonable air transportation center.

Table IV

Transit Time from CMS to Airport

CMS	Time to Airport
Charlottesville	0:30
Albuquerque	0:30
Socorro	1:15
VLA Site	2:15
Tucson	1:00
Pasadena	1:30

Table V

Transit Time from Site Airport to Site

Site	Site Airport	Time to Site From			
		Airport	Alb	Socorro	VLA
Maui	Haleakala	1:30			
Arecibo	San Juan	3:00			
Haystack	Boston	2:00			
Oroville	Penticton, B.C.	1:30			
Owens Valley	Inyokern	2:00			
North Liberty	Cedar Rapids	1:30			
Fort Davis	El Paso	4:00			
Kitt Peak	Tucson	1:30			
Bernal	Albuquerque	2:00	2:00	3:00	4:00
Winston	Albuquerque	4:00	4:00	3:00	2:30
Pie Town	Albuquerque	3:00	3:00	2:00	1:00
Bernardo	Albuquerque	1:00	1:00	1:00	1:30
Roswell	Albuquerque	4:00	4:00	3:00	4:00

Table VI

Average Access Time (T_A) to VLBA Site with
Charlottesville as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	1035	1442	0930	28.5
	1700	1730	2125	0926	1300	20.0
Kitt Peak	0500	0830	1035	1323	1500	35.0
	1700	1730	2125	1035	1200	19.0
Bernal, N.M.	0500	0830	1035	1442	0830	27.5
	1700	1730	2125	0926	1200	19.0
Fort Davis, Tex	0500	0830	1035	1540	1100	30.0
	1700	1730	2125	1057	1500	22.0
North Liberty, Iowa	0500	0830	1035	1457	1630	11.0
	1700	1730	2125	0935	1100	18.0
Owens Valley, Calif.	0500	0830	1035	1650	0700	28.0
	1700	1730	2125	1650	0700	38.0
Haystack, Mass.	0500	0830	1035	1326	1530	10.5
	1700	1730	2125	2435	1000	17.0
Oroville - Wash	0500	0830	1035	0441	0630	25.5
	1700	1730	2125	1351	1530	22.5
Maui - Hawaii	0500	0830	1035	1317	1500	10.0
	1700	1730	2125	1317	1500	22.0
Puerto Rico	0500	0830	1035	1905	1000	29.0
	1700	1730	2125	1208	1500	22.0

All Time EDT

Table VII

Average Access Time (T_A) to VLBA Site with
Albuquerque as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1200	7.0
	1700	1730	NA	NA	1130	18.5
Kitt Peak	0500	0830	1525	1645	1830	13.5
	1700	1730	1905	2003	0930	16.5
Bernal, N.M.	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	0930	16.5
Fort Davis, Tex	0500	0830	0930	1020	1430	9.5
	1700	1730	2001	2051	1200	19.0
North Liberty, Iowa	0500	0830	0931	1411	1600	11.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1930	14.5
	1700	1730	0800	0940	1200	19.0
Haystack, Mass.	0500	0830	0925	1440	1700	12.0
	1700	1730	1850	2212	1000	17.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	1145	1557	0730	22.5
	1700	1730	2230	0915	1100	18.0
Puerto Rico	0500	0830	0939	2135	0800	27
	1700	1730	1730	1250	1600	23

All Time MDT

Table VIII

Average Access Time (T_A) to VLBA Site with
Socorro as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1100	6.0
	1700	1730	NA	NA	1100	18.0
Kitt Peak	0500	0830	1525	1645	1830	13.5
	1700	1730	1905	2000	0930	16.5
Bernal, N.M.	0500	0830	NA	NA	1100	6.0
	1700	1730	NA	NA	1100	18.0
Fort Davis, Tex	0500	0830	1205	1255	1700	12.0
	1700	1730	2130	2220	1200	19.0
North Liberty, Iowa	0500	0830	1055	1512	1700	12.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1930	14.5
	1700	1730	0800	1250	1500	22.0
Haystack, Mass.	0500	0830	1230	1842	0930	28.5
	1700	1730	0550	1100	1500	20.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	1145	1557	0730	22.5
	1700	1730	2030	0915	1100	18.0
Puerto Rico	0500	0830	1120	2410	0800	27
	1700	1730	2000	1250	1600	23

All Times MDT

Table IX

Average Access Time (T_A) To VLBA Site with

VLA Site As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1030	5.5
	1700	1730	NA	NA	1030	17.5
Kitt Peak	0500	0830	1525	1645	1830	13.5
	1700	1730	0815	0835	1000	19.0
Bernal, N.M.	0500	0830	NA	NA	1230	7.5
	1700	1730	NA	NA	1230	19.5
Fort Davis, Tex	0500	0830	1205	1255	1700	12.0
	1700	1730	2130	2220	1200	19.0
North Liberty, Iowa	0500	0830	1055	1512	1700	12.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1930	14.5
	1700	1730	0800	1250	1500	22.0
Haystack, Mass.	0500	0830	1230	1842	0930	28.5
	1700	1730	0550	1108	1300	20.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	1145	1557	0730	26.5
	1700	1730	2030	0915	1100	18.0
Puerto Rico	0500	0830	1128	2410	0800	27.0
	1700	1730	2000	1250	1600	23.0

All Time MDT

Table X

Average Access Time (T_A) to VLBA Site With
Tucson As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	0930	1250	1600	11.0
	1700	1730	0615	0911	1230	19.0
Kitt Peak	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	0930	16.5
Bernal, N.M.	0500	0830	0930	1250	1430	9.5
	1700	1730	0615	0911	1100	18.0
Fort Davis, Tex	0500	0830	1206	1256	1700	12.0
	1700	1730	0725	0831	1230	19.5
North Liberty, Iowa	0500	0830	1300	1814	0930	28.5
	1700	1730	0739	1511	1700	24.0
Owens Valley, Calif.	0500	0830	1035	1655	1900	14.0
	1700	1730	1835	2410	1000	17.0
Haystack, Mass.	0500	0830	0955	1920	0930	28.5
	1700	1730	2145	0827	1030	17.5
Oroville - Wash	0500	0830	1000	1915	0930	28.5
	1700	1730	0615	1430	1600	23.0
MauI - Hawaii	0500	0830	0945	1615	0930	28.5
	1700	1730	2145	1205	1330	20.5
Puerto Rico	0500	0830	1350	2336	0800	27.0
	1700	1730	2145	0735	1030	19.5

All Time MST

Table XI

Average Access Time (T_A) to VLBA Site With
Pasadena As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	1045	1530	1900	14.0
	1700	1730	2115	2455	1000	18.0
Kitt Peak	0500	0830	1035	1055	1200	7.0
	1700	1730	2130	2130	0930	16.5
Bernal, N.M.	0500	0830	1045	1530	1700	12.0
	1700	1730	2115	2455	0930	16.5
Fort Davis, Tex	0500	0830	1015	1230	1630	11.5
	1700	1730	2030	1010	1000	17.0
North Liberty, Iowa	0500	0830	1025	1421	1600	11.0
	1700	1730	2420	0641	0830	16.5
Owens Valley, Calif.	0500	0830	1040	1150	1400	9.0
	1700	1730	1925	2030	1000	17
Haystack, Mass.	0500	0830	1020	1720	0700	26.0
	1700	1730	1920	0500	0700	14.0
Oroville - Wash	0500	0830	1215	1615	1800	13.0
	1700	1730	0830	1511	1700	24.0
Maui - Hawaii	0500	0830	1100	1417	1600	11.0
	1700	1730	0645	0915	1100	18.0
Puerto Rico	0500	0830	1300	2159	0700	26.0
	1700	1730	2135	1036	1400	21.0

All Time PDT

Table XII

Average Access Time (T_A) to VLBA Site with
Charlottesville as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	1035	1442	0915	28.5
	1700	1730	2125	0926	1245	20.0
Kitt Peak	0500	0830	1035	1323	1500	35.0
	1700	1730	2125	1035	1200	19.0
Bernal, N.M.	0500	0830	1035	1442	0815	27.5
	1700	1730	2125	0926	1145	19.0
Fort Davis, Tex	0500	0830	1035	1540	1100	30.0
	1700	1730	2125	1057	1500	22.0
North Liberty, Iowa	0500	0830	1035	1457	1630	11.0
	1700	1730	2125	0935	1100	18.0
Owens Valley, Calif.	0500	0830	1035	1650	0700	28.0
	1700	1730	2125	1155	1400	38.0
Haystack, Mass.	0500	0830	1035	1326	1530	10.5
	1700	1730	2125	2435	1000	17.0
Oroville - Wash	0500	0830	1035	0441	0630	25.5
	1700	1730	2125	1351	1530	22.5
Maui - Hawaii	0500	0830	1035	1317	1500	10.0
	1700	1730	2125	1317	1500	22.0
Puerto Rico	0500	0830	1035	1905	1200	29.0
	1700	1730	2125	1445	1745	22.0
Pie Town, NM	0500	0830	1035	1442	1800	13.0
	1700	1730	2125	0926	1230	19.5
Bernardo, NM	0500	0830	1035	1442	1600	11.0
	1700	1730	2125	0926	1030	17.5
Roswell, NM	0500	0830	1035	1442	1900	14.0
	1700	1730	2125	0926	1330	20.5

All Time EDT

Table XIII

Average Access Time (T_A) to VLBA Site with
Albuquerque as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1200	7.0
	1700	1730	NA	NA	1200	18.5
Kitt Peak	0500	0830	1525	1645	1830	13.5
	1700	1730	1905	2003	0930	16.5
Bernal, N.M.	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	1000	16.5
Fort Davis, Tex	0500	0830	0930	1020	1430	9.5
	1700	1730	2001	2051	1200	19.0
North Liberty, Iowa	0500	0830	0931	1411	1600	11.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1100	14.5
	1700	1730	0800	1250	1450	19.0
Haystack, Mass.	0500	0830	0920	1120	1330	12.0
	1700	1730	1850	2212	1000	17.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	0735	1717	1900	22.5
	1700	1730	0735	1717	1900	18.0
Puerto Rico	0500	0830	0939	2135	0800	27
	1700	1730	1900	1250	1600	23
Pie Town, NM	0500	0830	NA	NA	1130	6.5
	1700	1730	NA	NA	1100	18.0
Bernardo, NM	0500	0830	NA	NA	0930	4.5
	1700	1730	NA	NA	0900	16.0
Roswell, NM	0500	0830	NA	NA	1230	7.5
	1700	1730	NA	NA	1200	19.0

All Time MDT

Table XIV

Average Access Time (T_A) to VLBA Site with
Socorro as Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1100	6.0
	1700	1730	NA	NA	1100	18.0
Kitt Peak	0500	0830	1525	1645	1930	13.5
	1700	1730	1905	2000	0930	16.5
Bernal, N.M.	0500	0830	NA	NA	1100	6.0
	1700	1730	NA	NA	1100	18.0
Fort Davis, Tex	0500	0830	1205	1255	1700	12.0
	1700	1730	2130	2220	1200	19.0
North Liberty, Iowa	0500	0830	1055	1512	1700	12.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1100	14.5
	1700	1730	0800	1250	1450	22.0
Haystack, Mass.	0500	0830	1230	1842	2100	28.5
	1700	1730	1850	1250	1450	20.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	0735	1717	1900	22.5
	1700	1730	0735	1717	1900	18.0
Puerto Rico	0500	0830	1128	2410	0800	27
	1700	1730	2000	1250	1600	23
Pie Town, NM	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	0930	16.5
Bernardo, NM	0500	0830	NA	NA	0930	4.5
	1700	1730	NA	NA	0900	16.0
Roswell, NM	0500	0830	NA	NA	1130	6.5
	1700	1730	NA	NA	1100	18.0

All Times MDT

Table XV

Average Access Time (T_A) To VLBA Site with

VLA Site As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	NA	NA	1030	5.5
	1700	1730	NA	NA	1030	17.5
Kitt Peak	0500	0830	1525	1645	1830	13.5
	1700	1730	0815	0835	1000	19.0
Bernal, N.M.	0500	0830	NA	NA	1230	7.5
	1700	1730	NA	NA	1230	19.5
Fort Davis, Tex	0500	0830	1205	1255	1700	12.0
	1700	1730	2130	2220	1200	19.0
North Liberty, Iowa	0500	0830	1055	1512	1700	12.0
	1700	1730	0550	1050	1300	20.0
Owens Valley, Calif.	0500	0830	1200	1725	1100	14.5
	1700	1730	0800	1250	1450	22.0
Haystack, Mass.	0500	0830	1230	1842	2100	28.5
	1700	1730	0550	1108	1300	20.0
Oroville - Wash	0500	0830	1200	0841	1030	29.5
	1700	1730	0720	1303	1430	21.5
Maui - Hawaii	0500	0830	0735	1717	1900	26.5
	1700	1730	0735	1717	1900	18.0
Puerto Rico	0500	0830	1128	2410	0800	27.0
	1700	1730	2000	1250	1600	23.0
Pie Town, NM	0500	0830	NA	NA	0930	4.5
	1700	1730	NA	NA	0900	16.0
Bernardo, NM	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	0930	16.5
Roswell, NM	0500	0830	NA	NA	1230	7.5
	1700	1730	NA	NA	1200	19.0

All Time MDT

Table XVI

Average Access Time (T_A) to VLBA Site With
Tucson As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	0930	1250	1600	11.0
	1700	1730	0615	0911	1230	19.0
Kitt Peak	0500	0830	NA	NA	1000	5.0
	1700	1730	NA	NA	0930	16.5
Bernal, N.M.	0500	0830	0930	1250	1430	9.5
	1700	1730	0615	0911	1100	18.0
Fort Davis, Tex	0500	0830	1206	1256	1700	12.0
	1700	1730	0725	0831	1230	19.5
North Liberty, Iowa	0500	0830	1300	1814	0930	28.5
	1700	1730	0739	1511	1700	24.0
Owens Valley, Calif.	0500	0830	1035	1655	1855	14.0
	1700	1730	1835	2410	1000	17.0
Haystack, Mass.	0500	0830	0955	0720	0930	28.5
	1700	1730	0945	0827	1030	17.5
Oroville - Wash	0500	0830	1000	1915	0930	28.5
	1700	1730	0615	1430	1600	23.0
Maui - Hawaii	0500	0830	0945	1615	0930	28.5
	1700	1730	2145	1205	1330	20.5
Puerto Rico	0500	0830	1350	1436	0800	27.0
	1700	1730	2145	0935	1230	19.5
Pie Town, NM	0500	0830	0930	1250	1550	10.5
	1700	1730	0615	0911	1200	19.0
Bernardo, NM	0500	0830	0930	1250	1400	9.0
	1700	1730	0615	0911	1030	17.5
Roswell, NM	0500	0830	0930	1250	1700	12.0
	1700	1730	0615	0911	1300	20.0

All Time MST

Table XVII

Average Access Time (T_A) to VLBA Site With
Pasadena As Central Maintenance Station

Site Location	Trouble Occurs	Lv CMS	Lv Airport	Arr Airport	Installed At Site	Access Time
Winston, N.M.	0500	0830	1045	1530	1900	14.0
	1700	1730	2115	2455	1000	18.0
Kitt Peak	0500	0830	1035	1055	1155	7.0
	1700	1730	2130	2130	0930	16.5
Bernal, N.M.	0500	0830	1045	1530	1700	12.0
	1700	1730	2115	2455	0930	16.5
Fort Davis, Tex	0500	0830	1015	1230	1630	11.5
	1700	1730	2030	1010	1000	17.0
North Liberty, Iowa	0500	0830	1215	0950	1130	11.0
	1700	1730	1215	0950	1130	16.5
Owens Valley, Calif.	0500	0830	NA	NA	1200	9.0
	1700	1730	NA	NA	1130	17
Haystack, Mass.	0500	0830	1020	1720	0700	26.0
	1700	1730	1920	0500	0700	14.0
Oroville - Wash	0500	0830	1215	1615	1800	13.0
	1700	1730	0830	1511	1700	24.0
MauI - Hawaii	0500	0830	1100	1417	1600	11.0
	1700	1730	0645	0915	1100	18.0
Puerto Rico	0500	0830	1300	2159	0700	26.0
	1700	1730	2135	1036	1400	21.0
Pie Town, NM	0500	0830	1045	1530	1830	13.5
	1700	1730	2115	2455	1100	18.0
Bernardo, NM	0500	0830	1045	1530	1430	9.5
	1700	1730	2115	2455	0900	16.0
Roswell, NM	0500	0830	1045	1530	1930	14.5
	1700	1730	2115	2455	1200	19.0

All Time PDT