Speed Letter. 44-912 GrayLine. SNAP-A-WAY FORM

VLB ARRAY MEMO No. 174

Speed Letter.

To: Craig R. Moore
NRAO
PO Box 2
Greenbank, West Virginia - 24944

From: William W. Ward
MIT Lincoln Laboratory, Room C-270
PO Box 73
Lexington, Massachusetts - 02173

Subject

MESSAGE

Date 1982 June 21 19

(1) Lincoln Laboratory telephone numbers are changing. From now on, call us via (617) 863-5500, repeat (617) 863-5500. My new extension is 7680 repeat 7680. Harold Hoover's new extension (in LESOC) is 4050 repeat 4050.

(2) I'm forwarding Michael Balister's letter of 1982 June 17 to the Air Force for approval of NRAO's use of LES-8/9. I expect no problems on that score.

(3) I may have oversold you on the virtues of LES-8/9. I enclose excerpts from your memo of 1982 June 15.

(4) As far as on-board power is concerned, we haven't yet perfected our perpetual-motion turboencabulator (but we're working on it!). The radioisotope thermoelectric generators have undeniably fallen off in power output (from about 300 W for a pair of them at launch in 1976 to perhaps 265 W for a pair of them today). What we do is to juggle the loads, turning things OFF to make power available for turning things ON. We can still do this, and we expect to be able to do this for many years to come. If you ask for K-band support in 2001 AD, we may be a little hard put to get everything needed fired up at once, but we anticipate no problem for some time to come.

(5) Similarly, we do have to use propulsion fuel, not only for attitude control (the daily-integrated distribution of solar-radiation pressure induces a net increment of angular momentum that must ultimately be bled off by thrusting with the cold-gas ammonia system) but also for orbit control (fighting the triaxiality of the Earth). We're very stingy with the fuel insofar as changing station is concerned. We have more than 60 lb (mass) fuel left on each satellite out of about 75 lb (mass) initially.

Signed

(6) When I say that LES-8/9 will last indefinitely long, I don't mean infinitely long. With continued good luck, they will last longer than I, which is one definition of eternity. Call me if you have any questions.

(continued)

REPLY

Date 19

Signed

Speed Letter. 44-912 GrayLine. SNAP-AWAY FORM

Speed Letter.

To Craig R. Moore

From William W. Ward

Subject (continued)

No. 9 & 10 FOLD

MESSAGE

Date 1982 June 21 19

(7) Although I'll not be able to study your memo of 1982 June 15 exhaustively, I have taken a look at the LES-8/9 numbers, just to check (p. 4).

I may have sent you the attached sheet from LM-98, Vol. 4. It represents our best pre-launch estimate of the EIRP for each satellite. The post-launch testing gave values as follows (by two methods):

LES-8: 38.3 ± 1.0 dBW, 39.4 ± 1.0 dBW, 38.8 dBW common value (average of the 2)

LES-9: 37.4 ± 1.0 dBW, 38.6 ± 1.0 dBW, 38.0 dBW common value (average of the 2).

All the numbers hang together fairly well. I believe you have a typographical error in the LES-9 EIRP on p. 4 of your memo. Perhaps you're not concerned to track down fractional-dB signal-level differences. We've not measured the EIRP with care for several years.

No. 9 FOLD

No. 10 FOLD

Signed

REPLY

Date 19

No. 9 & 10 FOLD

Signed

Table 2.2.1-3

Detailed Performance of the LES-8/9 K-band Dish Transmitters and Antenna Systems

LES-8 (see LL dwg G-69705 for details of unit interconnections)

P_{TX} = Power at TX Output Coupler (A27C)			+27.6 dBmW (Nominal) = -2.4 dBW
Losses from TX Output Coupler to Polarizer Input			1.43 dB
WG #15	(C67059)	0.10 dB	
	(D67064)	0.10 dB	
WG #8	(C67058-G1)	0.16 dB	
TX Filter	(C61442)	0.61 dB	
TX Isolator	(C67456)	0.20 dB	
WG Assy	(C61482)	0.26 dB	
		1.43 dB	
Dish-Antenna Gain (from Polarizer Input)			+42.6 dBI
EIRP (LHCP)			+38.8 dBW (7.6 kW)

$$EIRP\ (dBW) = P_{TX}\ (dBW) - 1.4\ dB + G_{ANT}\ (dBI)$$

LES-9 (See LL dwg G-69704 for details of unit interconnections)

P_{TX} - Power at TX Output Coupler (A27C)			+27.3 dBmW (Nominal) = -2.7 dBW
Losses from TX Output Coupler to Polarizer Input			1.35 dB
WG #15	(C67059)	0.10 dB	
	(D67064)	0.10 dB	
WG #8	(C67058-G2)	0.16 dB	
TX Filter	(C61440)	0.58 dB	
TX Isolator	(C67456)	0.20 dB	
WG Assy	(C61482)	0.21 dB	
		1.35 dB	
Dish-Antenna Gain (from Polarizer Input)			+42.6 dBI
EIRP (RHCP)			+38.6 dBW (7.2 kW)

$$EIRP\ (dBW) = P_{TX}\ (dBW) - 1.4\ dB + G_{ANT}\ (dBI)$$

Japanese domestic satellites have been launched with frequencies between 19.5 GHz (CS) and 34.5 GHz (ECS and ETSII). These have spot beam earth coverage over Japan and are thus not visible from Kitt Peak. The ATS-6 satellite had 20 GHz and 30 GHz beacons for propagation experiments, but this satellite has been turned off due to old age. It is noted in passing that this was the satellite that interfered with the Green Bank interferometer at 2695 MHz some years ago. The four Comstar satellites have propagation experiment beacons of 19.04 GHz and 28.56 GHz. The D3 satellite was used about 12 months ago in an attempt at a holographic measurement of the NRAO 140-ft antenna. Dr. Peter Arnold of Bell Laboratories (201-949-5293) informed us that the beacons on all four satellites have been turned off due to deteriorating DC power on the satellites. Since these birds are used for commercial communications, there is no chance of the beacons being activated and thus jeaprodizing commerical operations.

The LES-8 and LES-9 military satellites each have a spot beam down link covering North America of 38.04 GHz and 36.84 GHz, respectively. These satellites were built by Lincoln Laboratories for the USAF and are used for military communications. However, it is possible for non-DOD U.S. Government-sponsored agencies to obtain time on these satellites for scientific purposes. Read Predmore of U. Massachusetts has used LES-8 for beam shape measurements of the Five College Radio Observatory antenna. Dr. William Ward of Lincoln Labs (617-862-5500, x7236) is the contact person for these requests. He advises us that there has been no degradation in performance in either of these satellites over the past several years and that none is expected over the next several years. The DC power is derived from a radio isotope thermoelectric generator instead of the conventional solar cell panels. Three axis stabilization is by a gimballed momentum wheel instead of the usual hydrogen peroxide control jets.

For these reasons the design life is indefinitely long. In order to obtain time on these satellites Dr. Ward suggested that we write a letter to him detailing our interest, scientific purpose and relationship with the NSF. He would then write to the military scheduling office outlining our need and qualifications. Following approval of our application we could then deal directly with the scheduling office when we wanted time. Dr. Ward further stated that they like to do this kind of thing on an occasional basis as it broadens the scope of the satellite program. There is no charge for any services as we are a U.S. Government-sponsored organization. This appears to be a good long-term signal source for holographic measurements and is also the highest frequency satellite down link that the author has been able to identify.

<u>The LES-8 and LES-9 Parameters</u>

The LES-8 and -9 satellites combine UHF and K-band transmit/receive capabilities for earth/space/earth and earth/space/space/earth communications links. The K-band down link is available on a 9.5° beamwidth horn or a 1.2° beamwidth steerable dish. The latter provides about 18 dB more effective isotropically radiated power (EIRP) and is updated in pointing every 20 minutes; but this can be done more often if needed. The LES-8 antenna has been easier to get time on up to now, but we should provide enough flexibility in our design to receive either satellite. The important parameters for the dish antenna are:

	LES-8	LES-9
Frequency	38.04 GHz	36.84 GHz
Polarization ...	LHCP	RHCP
EIRP	38.8 dBW	36.6 dBW
Longitude	109° West	106° West

The frequency is derived from an ovenized crystal oscillator having a stability of $\pm 1 \times 10^{-11}$ per day. The spectrum of the unmodulated K-band carrier is thought to be less than 200 Hz wide. (from p. 5)