GLINT NO. 390
November 4, 1970

HOUR ANGLE DRIVE POWER EXPECTATIONS

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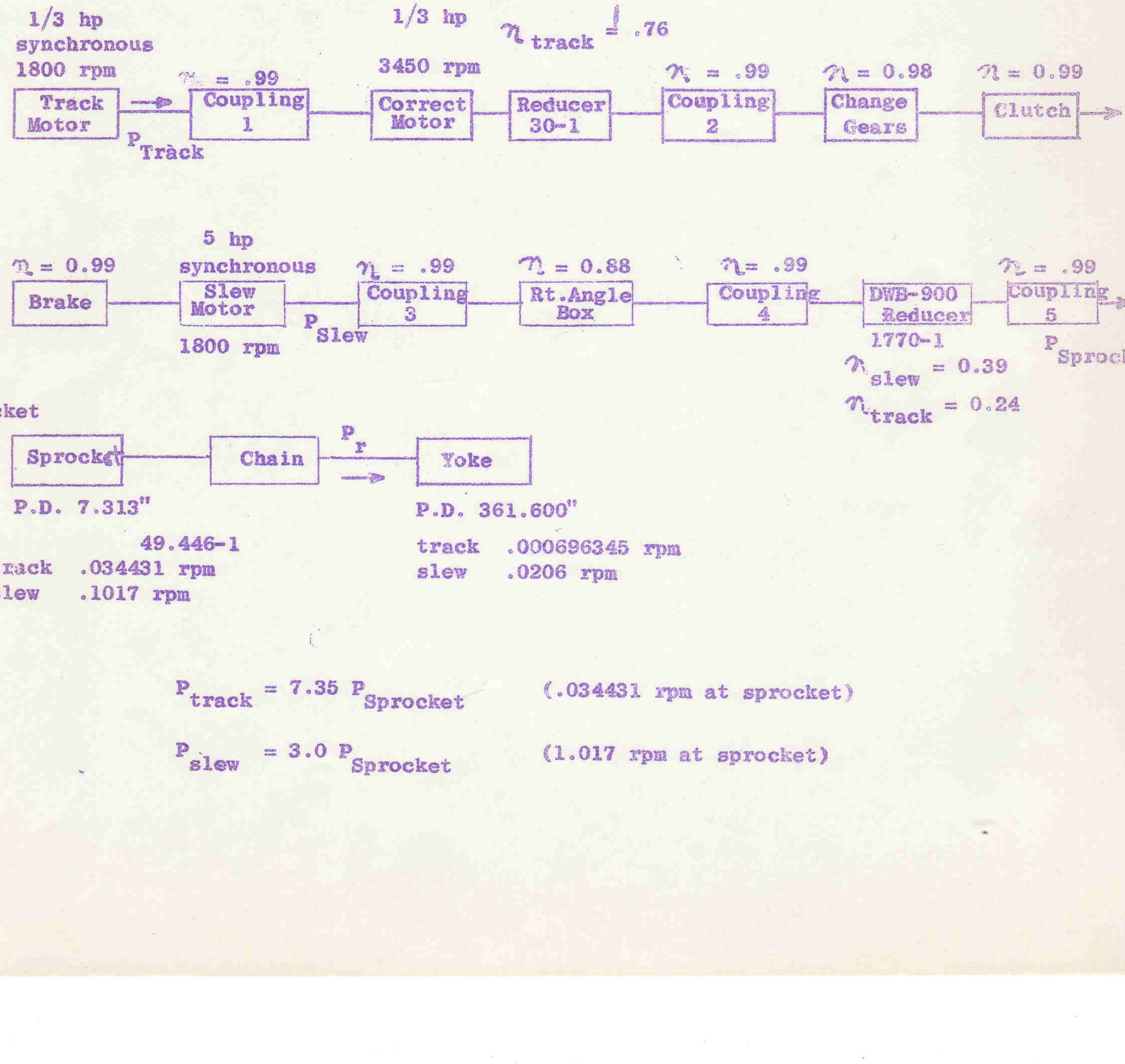
References:

Glint No.	293	Centroid Calculations
	295	Pointing Errors due to Chain Stretch
	366	Antenna Jacking Experiment
	368	Summary of Worm Reducer Testing
	384	Change in Elastomer Boxes
	391	Note on Motor Efficiency
RA-219		Hour Angle Gear Loads
RB-659		Hour Angle Drive Schematic



$P_{track} = 7.35\ P_{Sprocket}$ (.034431 rpm at sprocket)

$P_{slew} = 3.0\ P_{Sprocket}$ (1.017 rpm at sprocket)

The jacking experiment of Appendix I observed that at $\delta = -5^{\circ}$ HA = -50°, to raise the antenna in hour angle

Chain pull to overcome weight load	12,500 lbs.
" " " friction load	7,500
Total Chain Pull	20,000 lbs.

$$\therefore \quad P_{Track} = 0.29 \text{ hp}$$

$$P_{Slew} = 3.54 \text{ hp}$$

Weight-Centroid calculations (see Appendix II) predict 11,000 lbs. of chain pull is required to overcome the weight load only. If the reflector weight were 22,800 lbs (instead of the 20,000 lbs. assumed) or if the reflector C.G. were 13% further away, calculation would agree with the jacking experiment.

Observed motor power measurements of Appendix III at $\delta = -5^{\circ}$, HA -50°,* are

$$P_{Track} = 0.36 \text{ hp}$$

$$P_{Slew} = 4.70 \text{ hp}$$

Since the DWD-900 reducer efficiency is well known (Glint No. 368), this discrepancy between measured motor power and measured jacking force most probably lies either in the right angle box efficiency or the motor efficiency (Glint No. 391).

The effect of a 50 mph wind at $\delta = -5^{\circ}$, HA = 50° is to add 12,000 lbs. chain pull** to overcome wind. This approximately equals the weight chain pull (= 12,000 lbs.) so a 50 mph wind could double the motor hp required. Using the observed motor hp of 4.7 hp - no wind; 9.4 hp is expected at 50 mph.

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*This combination of declination and hour angle give the highest weight loads.

**See Dwg. Nos. RA-218 thru RA-221. 14,000 lbs. will be added at lower declinations, but restrictions in HA motion will decrease the weight load more. As a matter of interest, all wind directions are equally bad except an east (west) wind blowing into the dish when the antenna is at the east (west) limits driving west (east).

APPENDIX I. HOUR ANGLE JACKING EXPERIMENT

A hydraulic jack with gage was put on the hour angle rim** of TERTIO and the antenna raised and lowered in hour angle at a constant rate (similar to Glint No. 366, Antenna Jacking Experiment-Declination). Results are below:

$\delta = -5^{\circ}$

$HA = -50^{\circ}$

jacking force up 20,000 lbs.

jacking force down 5,000 lbs.

$\therefore$ friction force = 7,500 lbs.

$\therefore$ weight force = 12,500 lbs.

$$\text{chain sprocket friction coefficient} = \frac{7,500}{12,500 + 14,000^{*}} = 0.28$$

Since $P = \frac{7.313}{24} (2\pi) \frac{LOAD}{33,000}$ (rpm); 20,000 lbs. jacking force corresponds to

$$P_{Sprocket} = 1.18 \text{ hp slewing}$$

$$P_{Sprocket} = 0.040 \text{ hp tracking}$$

at $\delta = -5^{\circ}$ $HA = -50^{\circ}$.

*Chain pretension = 14,000 lbs. Glint No. 384.

**Effective jacking distance from the polar axis was 179 inches, compared to the chain radius of 181.5 inches.

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APPENDIX II. EXPECTED POWER TO LIFT HOUR ANGLE WEIGHT LOAD

Glint No. 293 calculates centroid positions.

Reflector	Weight	20,000 lbs.
	r	7.6 ft.
	Mr	152,000 lb.ft.
Yoke*	Weight	17,000 lbs
	Z_2	-1.8 ft.
	Mz	-30,500 lb.ft.

The expression for hour angle chain tension (weight loads only) derived on p. 4 of Glint No. 293 is incorrect and should read as follows:

$$\text{Tension} = \frac{[(20{,}000)(8.5 - 7.6(\sin \delta - 52^\circ)) - (17{,}000)(1.8)](\cos 37^\circ)(\sin HA)}{15}$$

$$= [7500 - 8100\ (\sin \delta - 52^\circ)] \sin HA$$

$$= 11{,}000 \text{ lbs.} \quad \text{for} \quad \delta = -5^\circ$$
$$HA = -50^\circ$$

*Revised figures.

APPENDIX III. HOUR ANGLE MOTOR POWER MEASUREMENTS*

δ	HA	Motor & Direction	amps	kw	P_{Track}**	P_{Slew}**
+80°	0	Track West	2.1	0.32	0.27 hp	---
	0	Slew E or W	12.0	2.3		2.40 hp
	-75°	Slew E	12.2	2.4		2.51
	-75°	Slew W	14.5	3.3		3.45
+18°	0	Slew E or W	12.6	2.6		2.71
	-70°	Track W	2.2	0.4	0.33 hp	---
	-70°	Slew E	12.3	2.3		2.40
	-70°	Slew W	17.5	4.1		4.28
-5°	-50°	Slew E	12.3	2.4		2.51
	-50°	Slew W	18.5	4.5		4.70
-20°	-37°	Slew E	11.6	2.1		2.19
	-37°	Slew W	17.0	3.9		4.08

*Made on Tertio with DWB-900B reducer warm, chain tension per specs, no wind, on 10-29-70, p. 39 Notebook 1970-6.

**Computed using $\eta_{slew\ motor} = 0.78$, $\eta_{track\ motor} = 0.62$ (see Glint 391).