ASTRO CHALLENGER

A Nationals winner in electric competition!

by BOB BOUCHER

Type: Electric Sport and Competition
Span: 70 inches
Area: 630 square inches
Channels: 3

I BEGAN designing the Challenger right after our tenth annual Astro Championships in February 1984. At that contest Mike Regan amazed everybody with the fantastic climb of his electric Mirage sailplane. Mike used the new Astro* Challenger Cobalt geared motor with seven Sanyo 800-mAh nicads. I figured that with a model designed especially for the geared motor, I would have an unbeatable combination for the Reno Nats.

Using my IBM computer program I tried various combinations of wing area, wingspan, and airfoil sections. For these calculations I assumed that the model would weigh 38 ounces complete with motor, battery, and radio. The actual model weighed 39 ounces. The computer said that the model with the best still air time after a one-minute motor run would have an Eppler 193 airfoil, a span of 6 feet, and a wing chord between 8 and 9 inches.

The Challenger will do nice rudder rolls and fly inverted with just a bit of forward trim.

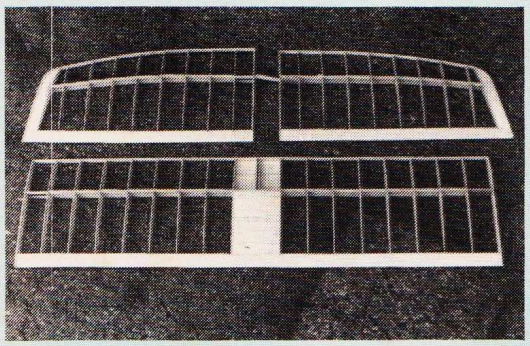
Using these parameters I began to lay out the model. I wanted to try a flat center section and an open frame wing for minimum weight and minimum work. In order to eliminate the requirement for wash-out to alleviate tip stall, I chose an elliptical planform for the wing tips. I matched this with an elliptical stab for a distinctive and pleasing appearance. This wing/tail combination really works. The glide is superb and the model just won't tip stall. Another bonus of eliminating wash-out is that with the power on, the Challenger will fly inverted and do nice rudder rolls. The Eppler 193 is thick enough so that the MonoKoted wing is torsionally stiff to resist flutter, even in steep descents.

The power train consists of the Astro Cobalt 05 geared motor and seven Sanyo 800-mAh fast charge nicad cells. I chose the small Geist prop (13x7) and the Astro electronic switch. The total power system weighs 19.6 ounces. My model with radio weighed 19.9 ounces.

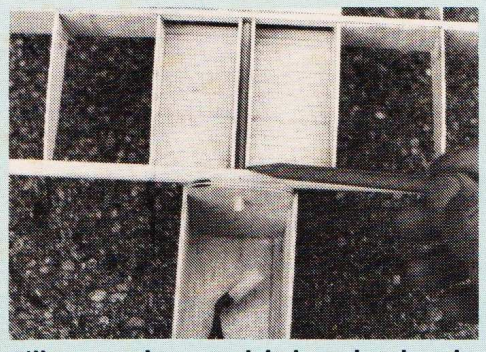
Using the computer simulation of the model glide polar combined with a simple model of the propeller characteristics, we can calculate expected climb altitude as a function of lift coefficient. Table 2 shows the results of these calculations and indicates that climb altitudes of almost 1,400 feet can be obtained with a one-minute motor run. Best altitudes are obtained when climb angle is held between 20° and 30°. From this altitude still air glide times of over 16 minutes can be expected.

Table 3 repeats the same computer simulation but with a direct-drive 8x4 propeller installed. The climb performance is a bit less dramatic, but nonetheless the Challenger can easily max in still air with a one-minute motor run.

CONSTRUCTION. The construction of the Challenger is straightforward. The wing and tail use conventional open frame construction. The wing has spar webs extending all the way to the wing tips for maximum strength. Both spars and the leading edge are bent backward to achieve the elliptical planform. I built the original wing dry, but if the bending



Completed framing shows attention to light, strong construction.



Fill space above and below the dowel, between the two center ribs.

Geist folding prop, note scoop.

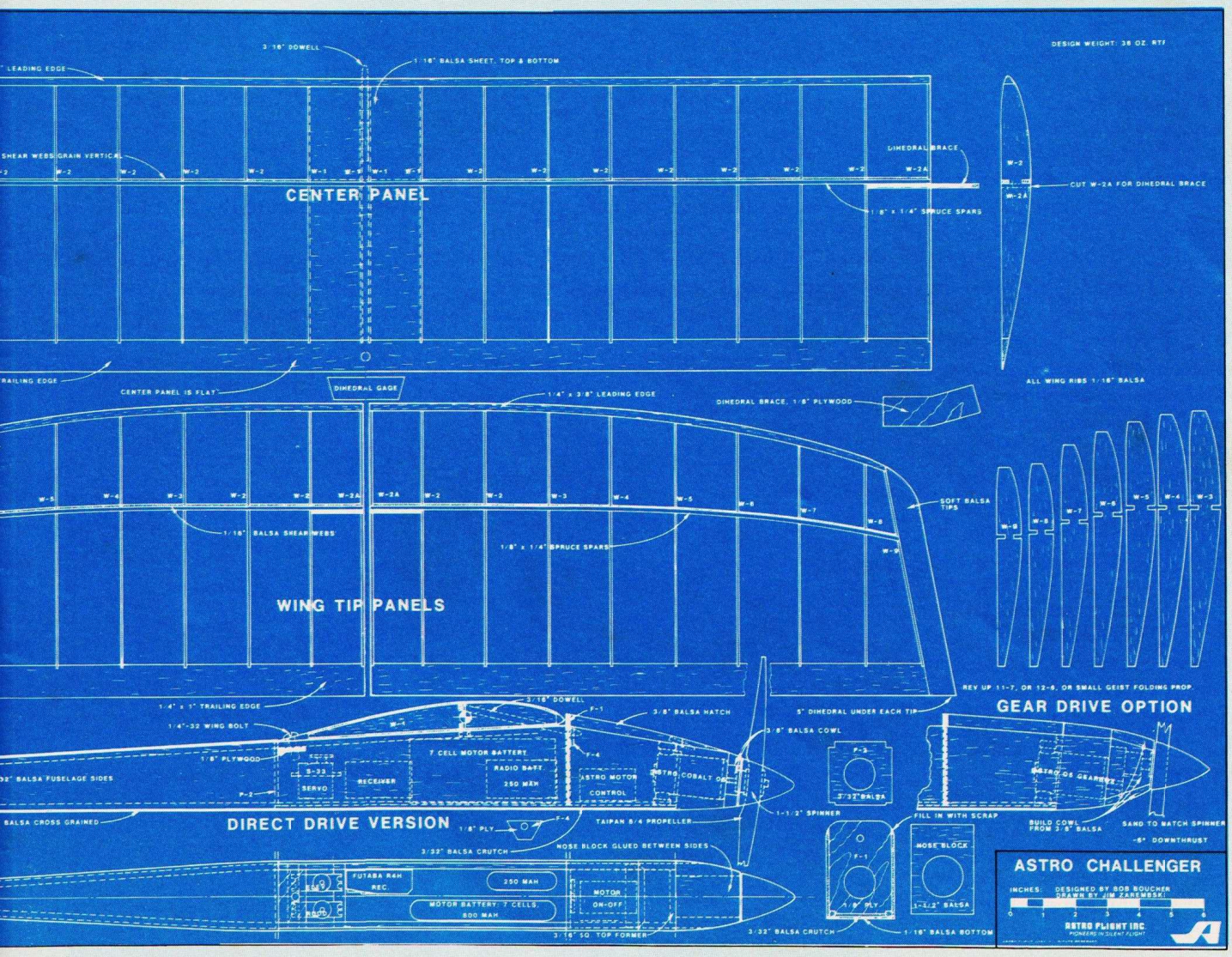
of the spars and leading edge seems difficult, then wet the spars and leading edge, towel dry, and you should have no trouble bending them. The wood should be left to dry a couple hours before gluing to the ribs.

The stab uses two pieces of balsa for the leading edge. Pin these to the plan, then Hot-Stuff them together. The photos should answer most of your questions.

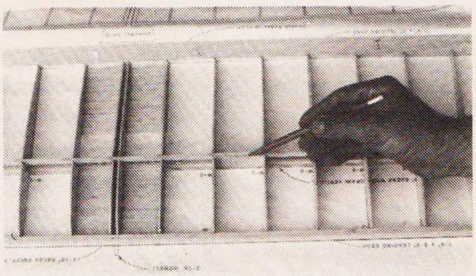
FLYING. Calculations are one thing, the real world is something else. I had the Challenger finished about two weeks before the Reno Nats and took it out to Malibu for the first flight tests. I balanced the model on the spar and set the control surfaces neutral with 15° of elevator throw and 30° of rudder throw. The wing is built flat with no wash-out.

On its first flight the Challenger climbed to about 500 feet in 15 seconds in light lift. The glide was very flat, this model will float with the best of them. Its stall was gentle and the model would bobble up and down without dropping a wing. The elliptical tips were working perfectly. In the glide the turns are slow and majestic. Power on the rudder is much more effective, the Challenger will do nice rudder rolls and will fly inverted with just a bit of forward trim. With the 6° of down thrust, you will need only a click or two of down trim to keep the nose down in the climb. On the first flight I got seven climbs on a battery charge, but there was light lift at all times. I landed after 45 minutes because I was carrying a 250-mAh receiver battery.

The next morning I went out early before any lift had developed and took



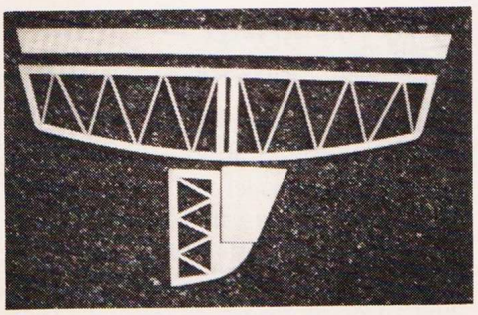
ASTRO CHALLENGER



Vertical grain shear web is essential.

three battery packs. To get some sort of calibration I climbed for 30 seconds, then glided until about 10 feet off the ground, then repeated the climb. I could get three solid climbs from a charged pack and averaged 24 minutes per flight. I knew I had a winner and packed up my stuff and headed for Reno.

The altitude in Reno is 6,500 feet and the temperature was nearly 100°. This meant that the density altitude was over 10,000 feet! I expected reduced performance in the thin air. To my pleasant surprise, the climb was even better than at sea level and the Challenger climbed almost twice as high as the nearest competitor. The sink rate was noticeably higher in the thin air, but I still got my 8-minute max. My nearest rival had only 2½ minutes.



Tailfeathers use geodetic structure.

In the second round some pilots switched their direct-drive models to 8x6 and 8x7 props to get more bite in the thin air. Now they were getting about two-thirds of my altitude and were also maxing most flights. My early lead prevailed, however, and after nearly 40 years in modeling I finally captured my first gold medal at the Nats!

If you're like me and need all the help you can get to challenge the experts, then maybe the Challenger is for you!

**The following is the address of the company mentioned in this article:*

Astro Flight, Inc., 13311 Beach Ave., Venice, CA 90291. ■

ASTRO CHALLENGER

GLIDE POLAR FOR AIRFOIL SELECTION

EXPECTED PERFORMANCE AT SEA LEVEL

DIRECT DRIVE COBALT 05 MOTOR WITH 8 X 4 PROP

airfoil	mean	wing	wing	aspect	total	wing	parasite	reynolds	speed	PROP DIAMETER	8.000	max eff	70.0%	CLIMB	35.62
eppler	chord	span	area	ratio	weight	loading	drag	number(k	cl=1.0	sink	pitch	4.000	pitch sp	66.672	
193.000	0.717	6.000	4.302	8.368	2.400	0.558	0.008	99.147	21.660	1.420	RPM K	12.000	POWER	116.000	RUN TIME 60

lift cl	profile drag	induced drag	total drag	total force	glide speed	reynolds number(k	sink speed	forward speed	L/D ratio	dive angle	prop eff.	gross climb	net climb	speed J/Jo	climb altitude	CLIMB ANGLE
1.000	0.019	0.038	0.065	1.002	21.64	99.29	1.41	21.59	15.30	3.74	38.1%	13.56	12.15	0.325	729	29.36
0.900	0.017	0.031	0.056	0.902	22.81	104.67	1.42	22.77	15.99	3.58	39.7%	14.14	12.72	0.342	763	29.20
0.800	0.015	0.024	0.047	0.801	24.20	111.03	1.43	24.15	16.91	3.38	41.6%	14.81	13.39	0.363	803	29.00
0.700	0.014	0.019	0.040	0.701	25.87	118.70	1.49	25.82	17.34	3.30	43.8%	15.60	14.11	0.388	846	28.65
0.600	0.012	0.014	0.034	0.601	27.94	128.22	1.59	27.90	17.56	3.26	46.4%	16.52	14.93	0.419	896	28.16
0.500	0.012	0.010	0.029	0.501	30.61	140.45	1.78	30.55	17.18	3.33	49.5%	17.64	15.86	0.459	952	27.43
0.400	0.011	0.006	0.025	0.401	34.22	157.01	2.13	34.15	16.04	3.57	53.4%	19.03	16.90	0.513	1014	26.33
0.350	0.011	0.005	0.023	0.351	36.57	167.82	2.43	36.49	15.05	3.80	55.7%	19.85	17.43	0.549	1046	25.53
0.300	0.010	0.003	0.022	0.301	39.49	181.23	2.88	39.39	13.70	4.18	58.4%	20.79	17.92	0.592	1075	24.46
0.250	0.010	0.002	0.021	0.251	43.25	198.45	3.57	43.10	12.06	4.74	61.4%	21.86	18.28	0.649	1097	22.99
0.200	0.010	0.002	0.020	0.201	48.32	221.73	4.69	48.09	10.26	5.57	64.7%	23.05	18.36	0.725	1101	20.89
0.150	0.012	0.001	0.021	0.152	55.65	255.36	7.83	55.09	7.03	8.09	68.1%	24.25	16.42	0.835	985	16.60
0.120	0.015	0.001	0.024	0.122	61.94	284.24	11.91	60.79	5.10	11.09	69.6%	24.81	12.90	0.929	774	11.98
0.085	0.015	.000	0.024	0.088	72.83	334.19	20.16	69.98	3.47	16.08	69.4%	24.72	4.56	1.092	273	3.73
.000	0.017	.000	0.025	0.025	135.74	622.86	135.73	0.53	.00	89.78	-5.1%	-1.82	-137.56	2.036	-8253	-89.78
CL	CD P	CD I	CD	FORCE	SPEED	RN (K)	SINK	FWD SPD	L/D	THETA	PROP EFF	CLIMB	NET CLIM	J/Jo	ALT	ANGLE

ALTITUDE CORRECTION		BEST CLIMB	1101 FEET	BEST L/D.....	17.56	MAX DISTANCE IN	2.0 MIN
ACTUAL ALTITUDE SEA LEVEL		LOWEST SINK RATE	1.41 FEET/SEC	MAX DISTANCE....	19340	REQUIRED SINK	9.178
DENSITY ALTITUDE	0	GLIDE TIME	13.00 MINUTES			FORWARD SPEED	58.000
DENSITY RATIO	1.000	TOTAL TIME	13.00 MINUTES	MAX LEVEL SPEED	69.98	DISTANCE feet	6950

ASTRO CHALLENGER

GLIDE POLAR FOR AIRFOIL SELECTION

EXPECTED PERFORMANCE AT 10,000 FEET DENSITY ALTITUDE

GEARED COBALT 05 MOTOR WITH 13 X 7 GEIST PROP

airfoil	mean	wing	wing	aspect	total	wing	parasite	reynolds	speed	PROP DIAMETER	13.000	max eff	75.0%	CLIMB	35.62
eppler	chord	span	area	ratio	weight	loading	drag	number(k	cl=1.0	sink	pitch	7.000	pitch sp	48.615	
193.000	0.717	6.000	4.302	8.368	2.400	0.558	0.008	99.147	21.660	1.420	RPM K	5.000	POWER	116.000	RUN TIME 60

lift cl	profile drag	induced drag	total drag	total force	glide speed	reynolds number(k	sink speed	forward speed	L/D ratio	dive angle	prop eff.	gross climb	net climb	speed J/Jo	climb altitude	CLIMB ANGLE
1.000	0.019	0.038	0.065	1.002	24.98	114.65	1.63	24.93	15.30	3.74	57.3%	20.40	18.77	0.514	1126	36.98
0.900	0.017	0.031	0.056	0.902	26.34	120.86	1.64	26.29	15.99	3.58	59.3%	21.11	19.46	0.542	1168	36.52
0.800	0.015	0.024	0.247	0.801	27.94	128.21	1.65	27.89	16.91	3.38	61.4%	21.88	20.23	0.575	1214	35.96
0.700	0.014	0.019	0.040	0.701	29.87	137.07	1.72	29.82	17.34	3.30	63.8%	22.74	21.02	0.614	1261	35.19
0.600	0.012	0.014	0.034	0.601	32.26	148.05	1.83	32.21	17.56	3.26	66.5%	23.69	21.86	0.664	1312	34.16
0.500	0.012	0.010	0.029	0.501	35.34	162.18	2.05	35.28	17.18	3.33	69.4%	24.72	22.67	0.727	1360	32.73
0.400	0.011	0.006	0.025	0.401	39.51	181.29	2.46	39.43	16.04	3.57	72.4%	25.78	23.32	0.813	1399	30.60
0.350	0.011	0.005	0.023	0.351	42.23	193.79	2.80	42.14	15.05	3.80	73.7%	26.26	23.45	0.869	1407	29.10
0.300	0.010	0.003	0.022	0.301	45.60	209.27	3.32	45.48	13.70	4.18	74.7%	26.61	23.29	0.938	1398	27.12
0.250	0.010	0.002	0.021	0.251	49.94	229.15	4.13	49.77	12.06	4.74	74.9%	26.70	22.57	1.027	1354	24.40
0.200	0.010	0.002	0.020	0.201	55.80	256.03	5.41	55.53	10.26	5.57	73.4%	26.13	20.72	1.148	1243	20.46
0.150	0.012	0.001	0.021	0.152	64.26	294.86	9.05	63.62	7.03	8.09	67.2%	23.95	14.90	1.322	894	13.19
0.120	0.015	0.001	0.024	0.122	71.52	328.21	13.76	70.19	5.10	11.09	58.3%	20.78	7.03	1.471	422	5.72
0.085	0.016	.000	0.024	0.088	84.09	385.89	23.28	80.81	3.47	16.08	35.1%	12.49	-10.80	1.730	-648	-7.61
.000	0.017	.000	0.025	0.025	156.73	719.22	156.73	0.62	.00	89.78	-296.0%	-105.43	-262.16	3.224	-15729	-89.87
CL	CD P	CD I	CD	FORCE	SPEED	RN (K)	SINK	FWD SPD	L/D	THETA	PROP EFF	CLIMB	NET CLIM	J/Jo	ALT	ANGLE

ALTITUDE CORRECTION		BEST CLIMB	1407 FEET	BEST L/D.....	17.56	MAX DISTANCE IN	2.0 MIN
ACTUAL ALTITUDE	6500	LOWEST SINK RATE	1.63 FEET/SEC	MAX DISTANCE....	24712	REQUIRED SINK	11.727
DENSITY ALTITUDE	10000	GLIDE TIME	14.39 MINUTES			FORWARD SPEED	65.000
DENSITY RATIO	0.750	TOTAL TIME	14.39 MINUTES	MAX LEVEL SPEED	80.81	DISTANCE feet	7800

ASTRO CHALLENGER

GLIDE POLAR FOR AIRFOIL SELECTION

EXPECTED PERFORMANCE AT SEA LEVEL

GEARED COBALT 05 MOTOR AND GEIST 13 X 7 PROP

airfoil	mean	wing	wing	aspect	total	wing	parasite	reynolds	speed	PROP DIAMETER	13.000	max eff	75.0%	CLIMB	35.62
eppler	chord	span	area	ratio	weight	loading	drag	number(k	cl=1.0	sink	pitch	7.000	pitch sp	48.615	
193.000	0.717	6.000	4.302	8.368	2.400	0.558	0.008	99.147	21.660	1.420	RPM K	5.000	POWER	116.000	RUN TIME 60

lift cl	profile drag	induced drag	total drag	total force	glide speed	reynolds number(k	sink speed	forward speed	L/D ratio	dive angle	prop eff.	gross climb	net climb	speed J/Jo	climb altitude	CLIMB ANGLE
1.000	0.019	0.038	0.065	1.002	21.64	99.29	1.41	21.59	15.30	3.74	51.9%	18.49	17.08	0.445	1025	38.35
0.900	0.017	0.031	0.056	0.902	22.81	104.67	1.42	22.77	15.99	3.58	53.9%	19.19	17.77	0.469	1066	37.97
0.800	0.015	0.024	0.247	0.801	24.20	111.03	1.43	24.15	16.91	3.38	56.1%	19.98	18.55	0.498	1113	37.52
0.700	0.014	0.019	0.040	0.701	25.87	118.70	1.49	25.82	17.34	3.30	58.6%	20.87	19.38	0.532	1163	36.89
0.600	0.012	0.014	0.034	0.601	27.94	128.22	1.59	27.90	17.56	3.26	61.4%	21.88	20.30	0.575	1218	36.04
0.500	0.012	0.010	0.029	0.501	30.61	140.45	1.78	30.55	17.18	3.33	64.7%	23.05	21.27	0.630	1275	34.85
0.400	0.011	0.006	0.025	0.401	34.22	157.01	2.13	34.15	16.04	3.57	68.4%	24.37	22.24	0.704	1335	33.08
0.350	0.011	0.005	0.023	0.351	36.57	167.82	2.43	36.49	15.05	3.80	70.4%	25.08	22.65	0.752	1359	31.83
0.300	0.010	0.003	0.022	0.301	39.49	181.23	2.88	39.39	13.70	4.18	72.4%	25.78	22.90	0.812	1374	30.18
0.250	0.010	0.002	0.021	0.251	43.25	198.45	3.57	43.10	12.06	4.74	74.1%	26.39	22.82	0.890	1369	27.90
0.200	0.010	0.002	0.020	0.201	48.32	221.73	4.69	48.09	10.26	5.57	75.0%	26.72	22.03	0.994	1322	24.61
0.150	0.012	0.001	0.021	0.152	55.65	255.36	7.83	55.09	7.03	8.09	73.4%	26.16	18.32	1.145	1099	18.40
0.120	0.015	0.001	0.024	0.122	61.94	284.24	11.91	60.79	5.10	11.09	69.4%	24.71	12.80	1.274	768	11.89
0.085	0.016	.000	0.024	0.088	72.83	334.19	20.16	69.98	3.47	16.08	56.4%	20.09	-0.08	1.498	-5	-0.06
.000	0.017	.000	0.025	0.025	135.74	622.86	135.73	0.53	.00	89.78	-165.9%	-59.08	-194.82	2.792	-11689	-89.85
CL	CD P	CD I	CD	FORCE	SPEED	RN (K)	SINK	FWD SPD	L/D	THETA	PROP EFF	CLIMB	NET CLIM	J/Jo	ALT	ANGLE

ALTITUDE CORRECTION		BEST CLIMB	1374 FEET	BEST L/D.....	17.56	MAX DISTANCE IN	2.0 MIN
ACTUAL ALTITUDE SEA LEVEL		LOWEST SINK RATE	1.41 FEET/SEC	MAX DISTANCE....	24127	REQUIRED SINK	11.450
DENSITY ALTITUDE	0	GLIDE TIME	16.22 MINUTES			FORWARD SPEED	60.000
DENSITY RATIO	1.000	TOTAL TIME	16.22 MINUTES	MAX LEVEL SPEED	69.98	DISTANCE feet	7200