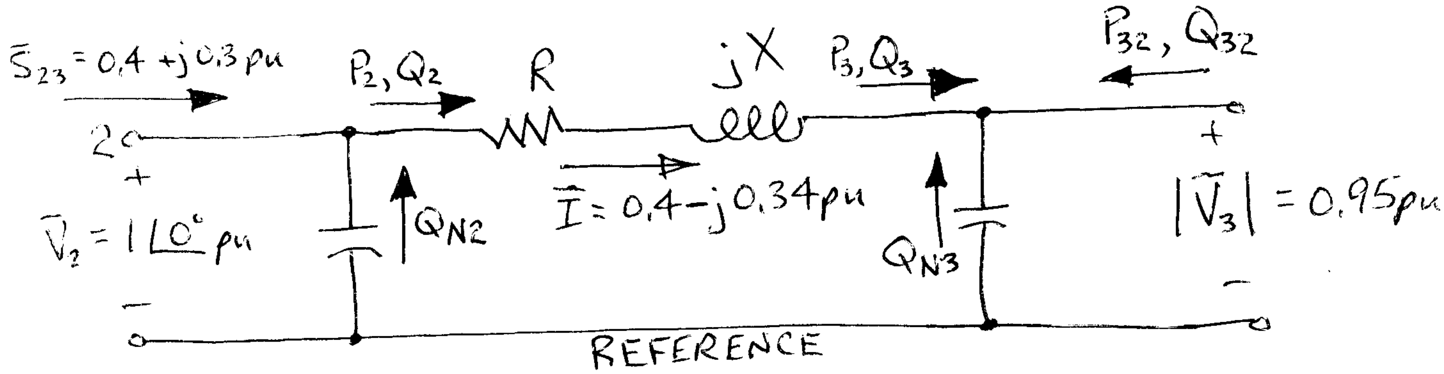
TLIN2 Exercises

Name & ID Number

1) [20pts] A medium-length transmission line connects Bus 2 to Bus 3 in a power system. The system base used for calculations is 100 MVA. It is modelled as a π-section. R = 0.08 p.u. and X = 0.105 p.u. The total shunt susceptance is given as 8.0 MVAR at rated voltage. V_2 is known to be $1.0\underline{/0^\circ}$ p.u. The magnitude of V_3 is known to be 0.95 p.u. It is known that the complex power leaving Bus 2 (toward Bus 3) is 0.4 + j0.3 p.u. The current flowing through the series impedance of the equivalent circuit is 0.4 - j0.34 p.u. **When calculating P & Q, give the correct signs based on the reference directions shown on the figure below.**



a) Calculate the correct value of susceptance to use for each capacitance in the π equivalent. Calculate the actual value of Q_{N2} and Q_{N3} in per unit.

b) Find P_2 and Q_2 in per unit.

c) Find P_3 and Q_3 in per unit.

d) Find P_{32} and Q_{32} in per unit.

e) What is the efficiency of this section of transmission line?

Name & ID Number

1) [20pts] A 250 mile 230-kV 60-Hz transmission line has a per phase impedance of $z = 0.2 + j0.6\ \Omega/\text{mi}$ and a per phase admittance of $y = j7.3\ \mu℧/\text{mi}$.

   a) Calculate the characteristic impedance $\mathbf{Z_C}$.
   b) Calculate the propagation constant γ.
   c) Calculate the **exact** ABCD parameters for the per phase π-equivalent of this line.

2) [20 pts] A 3ϕ 230-kV transmission line serves a load of 300 MVA, PF = 0.8 lagging. A per phase equivalent (assume it is phase A) is used for this calculation. It has the following ABCD parameters:

$$A = D = 0.82\angle 1.5^\circ$$
$$B = 150.0\angle 85.0^\circ\ \Omega$$
$$C = 0.0020\angle 90.0^\circ\ \mho$$

a) Assume that $\mathbf{V}_R$ has a reference angle of 0°. Calculate $\mathbf{I}_R$.
b) Calculate $\mathbf{V}_S$ and $\mathbf{I}_S$ for the given load.
c) Assuming $\mathbf{V}_S$ to remain constant when the load is removed, calculate $\mathbf{V}_R$ and $\mathbf{I}_S$ for no load.
d) Calculate the voltage regulation. If it is not acceptable, recommend corrective action.

4) [20 pts] Answer **any four of the** of the following short concept/essay questions. Be sure to clearly indicate which one you do not want graded, or the first four will be graded.

a) [5 pts] What type of compensation might result in subsynchronous resonance? Explain what subsynchronous resonance is.

b) [5 pts] What is SIL? Explain the advantages of SIL. In practice, is it possible to achieve SIL?

c) [5 pts] What are sparse matrix methods, and what are the advantages of using them for calculations involving a large power network?

d) [5 pts] If you were given a 2-port network and were told to go into a laboratory and determine what the B parameter was, what test would you perform and how would you calculate the B parameter?

e) [5 pts] Explain what the propagation constant γ is and what its real and imaginary components signify.

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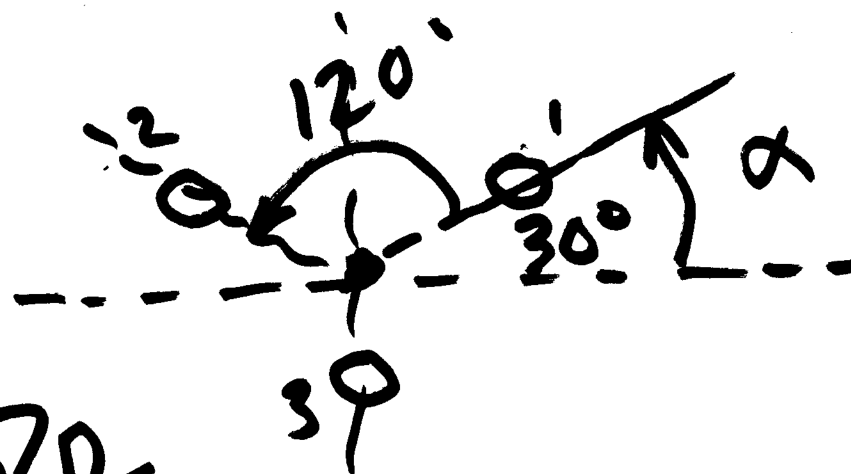
5) [20 pts] Refer to Problem 6 of homework TLIN. Input the line parameters into ATP Line Constants. Create the Pi line model, request output of all 12 matrices. Print out the .lis file that lists the matrices.

a) Using the verify feature, confirm that the per phase positive sequence impedance is reasonably close to what you calculated in the earlier homework problem. Also compare it to the value printed in .lis output. Comment on the zero sequence impedance, is it larger or smaller than pos sequence impedance? Why?

b) What is the characteristic impedance of the line? What is the propagation coefficient. Quantify their values, predict how the unloaded line will perform if a traveling wave goes from sending end to receiving end.

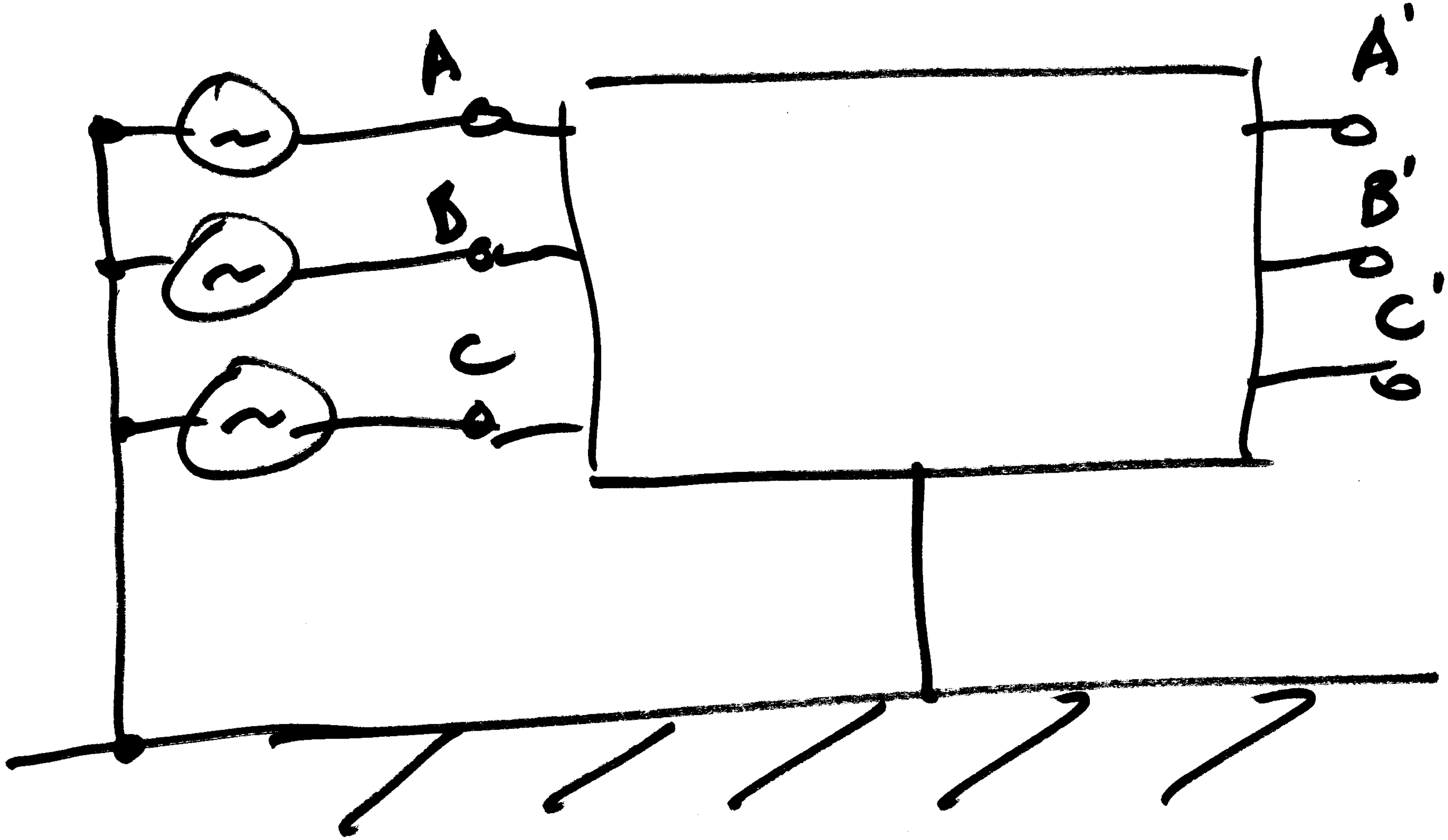


$R_{DC\,(20°C)} = .0637\Omega$

$R_{AC\,(75°C)} = 0.0779\Omega/1000'$

$r = 0.321''$ $\quad r_{inner} = 0.1181''$

$R_{DC} = (.0637)(5.28) =$



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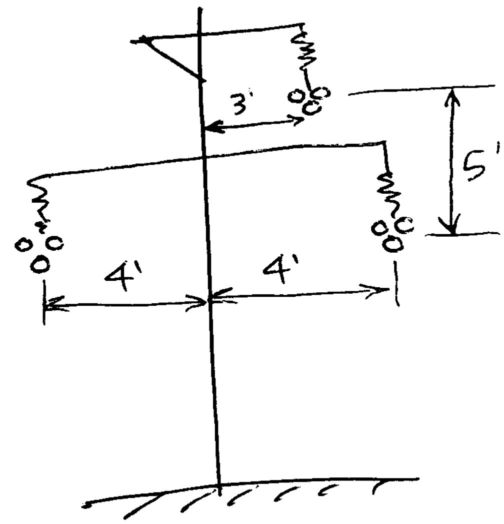
6) [20 pts] A standard single-tower design is used for a 69-kV single circuit transmission line, as shown. Each phase consists of 3 conductors of ~~6/1~~ ACSR Partridge, with a 4" bundle spacing. Neglecting the line's proximity to earth, assuming continuous transposition, and assuming that no current returns through the earth,

a) Calculate the 60-Hz resistance at 50°C in Ω/km per phase (assume that $R_{AC} = R_{DC}$ at 25°C).
b) Calculate the GMR and GMD used to calculate inductance for this conductor arrangement.
c) Calculate the GMR and GMD used to calculate capacitance for this conductor arrangement.
d) Calculate inductive reactance in Ω/km and capacitive susceptance in ℧/km per phase.



7) [5 pts] Short Essay: In terms of increasing or decreasing inductance, what effect do each of the following have?

- Decreasing height above ground.
- Using a smaller conductor.
- Decreasing the bundle spacing.
- Increasing the phase spacing.

Rdc (r')

CONDUCTOR	SIZE (KCM)	AL/STL	AREA (SI)	DIAM (IN)	WEIGHT (LB/FT)	RATED STREN (LBS)	L OHMS /MI	C MOHM /MI	R-25C OHMS /MI	R-50C OHMS /MI	CHART #	GMR (FT)	% WT ALUM
TURKEY	26.2	6/ 1	.0240	.198	.036	1190	.636	.1423	3.4590	3.9400	1-1023	.0053	67.90
SWAN	41.7	6/ 1	.0383	.250	.057	1860	.604	.1353	2.1780	2.5180	1-1023	.0069	67.90
SWANATE	41.7	7/ 1	.0411	.257	.067	2360	.608	.1346	2.1540	2.5230	1-670	.0067	58.10
SPARROW	66.4	6/ 1	.0608	.316	.091	2850	.578	.1284	1.3720	1.6280	1-1023	.0085	67.90
SPARATE	66.4	7/ 1	.0653	.325	.107	3640	.579	.1276	1.3570	1.6350	1-1023	.0085	58.10
GROUSE	80.0	8/ 1	.0847	.370	.149	5200	.570	.1240	1.1200	1.4040	1-430	.0091	50.40
ROBIN	83.8	6/ 1	.0767	.355	.115	3550	.564	.1250	1.0890	1.3050	1-938	.0096	67.90
PETREL	101.8	12/ 7	.1266	.461	.254	10400	.540	.1172	.8510	1.0840	1-546	.0117	37.80
RAVEN	105.7	6/ 1	.0967	.398	.145	4380	.550	.1216	.8640	1.0520	1-938	.0108	67.90
MINORCA	110.8	12/ 7	.1378	.481	.277	11300	.535	.1160	.8010	1.0240	1-546	.0122	37.80
QUAIL	133.2	6/ 1	.1219	.447	.183	5310	.536	.1186	.6860	.8530	1-938	.0121	67.90
LEGHORN	134.6	12/ 7	.1674	.530	.336	13600	.525	.1131	.6460	.8450	1-546	.0132	37.80
GUINEA	159.0	12/ 7	.1977	.576	.397	16000	.516	.1106	.5470	.7310	1-546	.0142	37.80
PIGEON	167.7	6/ 1	.1538	.502	.231	6620	.520	.1147	.5450	.6900	1-938	.0137	67.90
DOTTEREL	176.9	12/ 7	.2200	.607	.441	17300	.509	.1091	.4930	.6670	1-546	.0151	37.80
DORKING	190.8	12/ 7	.2373	.631	.476	18700	.504	.1079	.4570	.6250	1-546	.0157	37.80
BRAHMA	203.2	16/19	.3020	.714	.667	20700	.489	.1043	.4120	.5530	1-546	.0178	28.30
COCHIN	211.3	12/ 7	.2628	.663	.528	28400	.498	.1065	.4130	.5750	1-546	.0165	37.80
PENGUIN	211.6	6/ 1	.1939	.563	.291	8350	.508	.1113	.4340	.5690	1-938	.0152	67.90
WAXWING	266.8	18/ 1	.2211	.609	.289	6880	.476	.1090	.3488	.3831	1-844	.0198	86.45
PARTRIDGE	266.8	26/ 7	.2436	.642	.367	11300	.465	.1074	.3452	.3792	1-782	.0217	68.60
OSTRICH	300.0	26/ 7	.2740	.680	.413	12700	.458	.1057	.3070	.3372	1-782	.0229	68.60
MERLIN	336.4	18/ 1	.2789	.684	.365	8680	.462	.1055	.2767	.3037	1-844	.0222	86.45
LINNET	336.4	26/ 7	.3072	.721	.463	14100	.451	.1040	.2737	.3006	1-782	.0243	68.60
ORIOLE	336.4	30/ 7	.3259	.741	.527	17300	.445	.1032	.2719	.2987	1-773	.0255	60.35
CHICKADEE	397.5	18/ 1	.3295	.743	.432	9940	.452	.1031	.2342	.2572	1-844	.0241	86.45
BRANT	397.5	24/ 7	.3527	.772	.512	14700	.444	.1018	.2367	.2600	1-889	.0259	73.25
IBIS	397.5	26/ 7	.3630	.783	.547	16300	.441	.1015	.2323	.2551	1-782	.0264	68.60
LARK	397.5	30/ 7	.3850	.806	.623	20300	.435	.1007	.2306	.2533	1-773	.0277	60.35
PELICAN	477.0	18/ 1	.3954	.814	.518	11800	.441	.1004	.1957	.2148	1-844	.0264	86.45
FLICKER	477.0	24/ 7	.4232	.846	.615	17200	.432	.0992	.1943	.2134	1-889	.0284	73.25
HAWK	477.0	26/ 7	.4356	.858	.657	19500	.430	.0988	.1931	.2120	1-782	.0289	68.60
HEN	477.0	30/ 7	.4620	.883	.747	23800	.424	.0980	.1919	.2107	1-773	.0304	60.35
OSPREY	556.5	18/ 1	.4614	.879	.604	13700	.432	.0981	.1679	.1843	1-844	.0284	86.45
PARAKEET	556.5	24/ 7	.4938	.914	.717	19800	.423	.0969	.1669	.1832	1-889	.0306	73.25
DOVE	556.5	26/ 7	.5083	.927	.766	22600	.420	.0965	.1663	.1826	1-782	.0314	68.60
EAGLE	556.5	30/ 7	.5391	.953	.872	27800	.415	.0957	.1651	.1812	1-773	.0327	60.35
PEACOCK	605.0	24/ 7	.5368	.953	.780	21600	.418	.0957	.1536	.1685	1-889	.0319	73.25
SQUAB	605.0	26/ 7	.5526	.966	.833	24300	.415	.0953	.1529	.1679	1-782	.0327	68.60
TEAL	605.0	30/19	.5835	.994	.940	30000	.410	.0944	.1517	.1665	1-757	.0341	60.90
KINGBIRD	636.0	18/ 1	.5272	.940	.691	15700	.424	.0960	.1484	.1627	1-844	.1915	86.45
ROOK	636.0	24/ 7	.5643	.977	.819	22000	.415	.0950	.1461	.1603	1-889	.0327	73.25
GROSBEAK	636.0	26/ 7	.5809	.990	.875	25200	.412	.0946	.1454	.1596	1-782	.0335	68.60
EGRET	636.0	30/19	.6134	1.019	.988	31500	.406	.0937	.1447	.1589	1-757	.0352	60.90
FLAMINGO	666.6	24/ 7	.5914	1.000	.859	23700	.412	.0943	.1397	.1533	1-889	.0335	73.25
CROW	715.5	54/ 7	.6340	1.036	.921	26300	.407	.0932	.1304	.1430	1-838	.0349	73.25
STARLING	715.5	26/ 7	.6535	1.051	.985	28400	.405	.0948	.1294	.1420	1-537	.0355	68.60
REDWING	715.5	30/19	.6901	1.081	1.111	34600	.399	.0920	.1287	.1412	1-757	.0373	60.90
CUCKOO	795.0	24/ 7	.7035	1.092	1.024	27900	.402	.0915	.1193	.1308	1-889	.0366	73.20
DRAKE	795.0	26/ 7	.7261	1.108	1.094	31500	.399	.0912	.1172	.1284	1-537	.0373	68.60
MALLARD	795.0	30/19	.7668	1.140	1.235	38400	.393	.0904	.1159	.1272	1-757	.0392	60.90
COOT	795.0	36/ 1	.6416	1.040	.805	16500	.411	.0930	.1197	.1311	1-898	.0337	92.70
TERN	795.0	45/ 7	.6676	1.063	.896	22100	.406	.0925	.1188	.1302	1-955	.0352	83.70
CONDOR	795.0	54/ 7	.7053	1.093	1.024	28200	.400	.0916	.1174	.1286	1-838	.0370	73.25
CRANE	874.5	54/ 7	.7766	1.146	1.126	31400	.395	.0902	.1073	.1176	1-838	.0386	73.25
RUDDY	900.0	45/ 7	.7555	1.131	1.015	25400	.399	.0905	.1062	.1163	1-955	.0374	83.70
CANARY	900.0	54/ 7	.7985	1.162	1.159	31900	.393	.0898	.1041	.1140	1-838	.0392	73.25
RAIL	954.0	45/ 7	.8011	1.165	1.075	25900	.395	.0897	.0997	.1092	1-955	.0386	83.70
CARDINAL	954.0	54/ 7	.8464	1.196	1.229	33800	.390	.0890	.0988	.1082	1-838	.0402	73.25
ORTOLAN	1033.5	45/ 7	.8678	1.213	1.165	27700	.390	.0885	.0924	.1011	1-957	.0402	83.70
CURLEW	1033.5	54/ 7	.9169	1.246	1.331	36600	.385	.0877	.0914	.1000	1-838	.0402	73.25
BLUEJAY	1113.0	45/ 7	.9346	1.259	1.255	29800	.386	.0874	.0861	.0941	1-957	.0415	83.70
FINCH	1113.0	54/19	.9849	1.293	1.431	39100	.380	.0866	.0856	.0937	1-1009	.0436	73.70
BUNTING	1192.5	45/ 7	1.0010	1.302	1.344	32000	.382	.0864	.0809	.0884	1-957	.0429	83.70
GRACKLE	1192.5	54/19	1.0550	1.338	1.533	41900	.376	.0856	.0798	.0873	1-1009	.0451	73.70
BITTERN	1272.0	45/ 7	1.0680	1.345	1.434	34100	.378	.0855	.0762	.0832	1-957	.0444	83.70
PHEASANT	1272.0	54/19	1.1260	1.382	1.635	43600	.372	.0847	.0751	.0821	1-1009	.0466	73.70
DIPPER	1351.5	45/ 7	1.1350	1.386	1.522	36200	.374	.0846	.0721	.0786	1-957	.0459	83.70
MARTIN	1351.5	54/19	1.1960	1.424	1.737	46300	.368	.0838	.0710	.0775	1-1009	.0482	73.70
BOBOLINK	1431.0	45/ 7	1.2020	1.427	1.613	38300	.371	.0837	.0684	.0746	1-957	.0470	83.70
PLOVER	1431.0	54/19	1.2660	1.465	1.840	49100	.365	.0829	.0673	.0735	1-1009	.0494	73.70
NUTHATCH	1510.5	45/ 7	1.2680	1.466	1.702	40100	.367	.0829	.0649	.0707	1-957	.0486	83.70
PARROT	1510.5	54/19	1.3370	1.506	1.942	51700	.362	.0821	.0643	.0701	1-1009	.0506	73.70
LAPWING	1590.0	45/ 7	1.3350	1.502	1.792	42200	.364	.0822	.0623	.0678	1-957	.0498	83.70
FALCON	1590.0	54/19	1.4070	1.545	2.044	54500	.358	.0814	.0612	.0667	1-1009	.0523	73.70
CHUKAR	1780.0	84/19	1.5120	1.602	2.074	51000	.355	.0803	.0560	.0609	1-1020	.0536	81.30
BLUEBIRD	2156.0	84/19	1.8310	1.762	2.511	60300	.344	.0776	.0476	.0515	1-1020	.0586	81.20
KIWI	2167.0	72/ 7	1.7760	1.737	2.303	49800	.348	.0782	.0482	.0521	1-1053	.0568	89.20
THRASHER	2312.0	76/19	1.9140	1.802	2.526	57300	.342	.0767	.0446	.0482	1-1202	.0595	86.70
JOREE	2515.0	76/19	2.0830	1.880	2.749	61700	.337	.0755	.0418	.0450	1-1202	.0621	86.70