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2023 Interconnected Power System Fault Levels Report at Bulk Supply Points

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1.0 INTRODUCTION

Fault analysis of a power system is necessary to provide information for the selection of switchgear, setting of relays, and stability of system operation. The power system is not static but is continuously changing during operation (switching on or off generators and transmission lines) and during planning (addition of generators and transmission lines).

Short-circuit levels represent the prospective three-phase to ground maximum short-circuit currents that are expected to flow in response to a short-circuit fault at a given point in the power system.

According to the Electricity Regulation (Grid Code) of 2013, Chapter 4 Section 17, "COMMUNICATION OF SYSTEM CONDITIONS, OPERATIONAL INFORMATION AND IPS PERFORMANCE,"

"The System Operator (SO) shall annually publish expected fault levels, including rupturing of relevant TS (Transmission System) equipment for each point of supply."

This report provides the maximum three-phase short-circuit levels, measured in kiloamperes (kA), for the Interconnected Power System (IPS) focusing on the bulk supply points. The fault levels are determined using simulation software.

2.0 REFERENCE

I. The Electricity Regulations of 2013 (Grid Code)

II. IEC 60909 – Short Circuit Currents in three phase AC systems

3.0 MODELLING SOFTWARE

I. Power System Simulator for Engineers (PSSE)

II. Power Factory – DIgSILENT 2023

4.0 FAULT LEVEL CALCULATION ASSUMPTIONS

The calculated fault levels depend on the assumptions made and the method used to calculate them. Fault level calculations are based on assumptions about the generation and dispatch of grid assets and are generally used to ensure the coordination of protection relays between different levels of the power system. Protection coordination is essential for the reliability, security, and safety of the power system. If protection coordination is not well managed, it can have serious consequences, including outages, damage to equipment, and injury or death.

For this report, the following assumptions were made:

a. Generator positive sequence reactance were set to sub-transient.

b. Transformer tap ratios were set to 1.0 p.u and phase shift angles were set to zero.

c. The SNEL bus bar at Karavia was modelled as an external Grid (See Figure A-1)

d. The SAPP network was modelled as an external grid on the 330kV Kariba South (See Figure A-2)

e. The NamPower external grid set to short circuit current 1k" max 1.716kA and X/R ratio max of 6.527

f. For the management of generation, the following shall apply:

   i. MCL, VFPS, ITPC and the small hydro power stations shall be dispatched as base generation.

   ii. Minimum generation refers to five (5) machines synchronized at Kafue Gorge Upper Power station (KGU) and only three (3) machines synchronized at Kariba North Bank Power and two (2) machines at Kafue Gorge Lower power station (KGL).

   iii. Maximum generation refers to the full complement of the units at Kafue Gorge, Kafue Gorge Lower and Kariba complex power station.

   iv. It is assumed that inverter-based generation does not contribute to fault levels and is therefore not included in fault level calculations. This means that downstream distributed generation and the distribution network are also not included.

5.0 2023 IPS BASE CASE MODEL

The 2023 IPS Base case model has been developed by updating the 2022 base case model. This included the addition of new commissioned grid assets and those expected to be commissioned in 2023 while noting the decommissioned assets, in the IPS bas case model, the following circuits have been commissioned:

The notable of the additions includes the following:

- Commissioning of the Pensulo substation 120MVA 330/66kV T1B.
- Commissioning of the 330kV Kafue Gorge Lower-LSMFEZ line.
- Commissioning of the 330kV Kafue Gorge Lower- Lusaka West line. (Expected Q2 2023)
- Commissioning of the 330kV Kafue West - Lusaka West line 2. (Expected Q2 2023)
- Commissioning of the 150MW generator five (05) at Kafue Gorge.
- The 88kV Chongwe substation has been upgraded to 132kV.

The following notable projects following have not been included:

- 330kV Kabwe Stepdown - Pensulo line two (2) project.

6.0 METHODOLOGY

The following were taken into consideration:

a. The calculation of fault levels shall be in accordance with IEC 60909 and in compliance with the requirements of the Grid Code.

b. The following types of faults shall be calculated at all bus bars, namely, 330kV, 220kV, 132kV, 88kV and 66kV and also at 33kV and 11kV transmission — distribution interface bus bars, at bulk supply points on the IPS:

    i. Three Phase

    ii. Single Phase to Earth

c. The following shall be the outputs from the simulations:

    i. Short circuit currents, calculated for the above fault types, which provide the most onerous fault making duty and fault breaking duty for the switchgear.

d. The X/R ratio of the circuit being studied.

7.0 FAULT LEVEL RESULTS

7.1 Three (3) Phase Fault Level Results

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5116	Kariba North	330	30.152	17219	-87.3	19.564	26.095	14,908	-87.2	19.246
5119	Mpika Step Down	330	1.245	711	-82.9	8.178	1.234	705	-82.9	8.188
5126	Mukuni	330	3.159	1804	-84.8	10.795	3.142	1,794	-84.8	10.844
5202	Muzuma	330	5.425	3097	-85.8	12.711	5.345	3,051	-85.9	12.842
5206	MCL	330	5.190	2964	-86.2	13.462	5.126	2,928	-86.2	13.601
5239	LSMFEZ	330	16.894	9625	-85.9	13.367	14.336	8,173	-85.9	13.178
5240	Kabwe Step Down	330	9.814	5608	-84.6	10.504	8.997	5,140	-84.7	10.636
5241	Kitwe	330	5.081	2904	-84.1	9.612	4.864	2,779	-84.2	9.705
5243	Leopards Hill	330	18.409	10488	-86.0	13.461	15.561	8,871	-86	13.343
5244	Luano	330	4.966	2837	-84.1	9.542	4.756	2,718	-84.1	9.633
5246	Pensulo	330	1.936	1106	-83.1	8.361	1.909	1,091	-83.1	8.383
5247	Kafue Gorge	330	19.406	11063	-86.7	15.911	15.625	8912	-86.5	15.021
5247	Kafue Gorge	330	19.406	11063	-86.7	15.911	15.625	8912	-86.5	15.021
5248	Kafue West	330	16.297	9302	-85.8	12.947	14.075	8024	-85.8	12.921
52481	Lusaka West	330	13.066	7467	-85.3	12.002	11.497	6,564	-85.4	12.007
5249	Kafue Town	330	15.311	8739	-85.7	12.600	13.339	7,616	-85.7	12.630
5259	Chambishi East	330	4.874	2785	-84.1	9.575	4.673	2,670	-84.1	9.664
5269	Kansanshi	330	1.909	1091	-83.8	9.134	1.878	1,073	-83.8	9.173

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5270	Lumwana	330	1.559	891	-83.7	9.089	1.538	879	-83.8	9.122
5284	Kalumbila	330	2.200	1258	-83.2	8.363	2.155	1,232	-83.2	8.422
5293	Nambala	330	5.730	3274	-84.1	9.629	5.436	3,106	-84.2	9.750
5294	Msoro	330	1.231	704	-83.2	8.457	1.22	697.4	-83.2	8.469
5296	Chipata West	330	1.071	612	-83.2	8.511	4.673	2669.8	-84.1	9.664
5297	Kasama	330	0.915	523	-82.6	7.945	0.909	519.7	-82.6	7.950
5999	Kafue Gorge Lower	330	18.426	10506	-86.7	15.900	14.395	8,209	-86.3	14.526
5999	Kafue Gorge Lower	330	18.426	10506	-86.7	15.900	14.395	8,209	-86.3	14.526
5125	Mukuni	220	4.389	1671	-85.0	11.496	4.371	1,664	-85	11.527
5204	Itezi Tezhi	220	2.714	1035	-85.1	11.880	2.700	1,029	-85.1	11.940
5230	Nambala	220	4.443	1691	-86.8	17.634	4.347	1,655	-86.7	17.349
5242	Kitwe	220	6.931	2640	-84.4	10.252	9.568	3,646	-81.3	7.305
5245	Luano	220	6.718	2559	-84.4	10.144	6.462	2,462	-84.4	10.209
5252	Kansuswa	220	5.691	2168	-83.5	8.688	5.508	2,099	-83.5	8.769
5253	Maposa	220	5.792	2206	-83.6	8.938	5.608	2,136	-83.7	9.019
5254	Michelo	220	5.418	2065	-82.5	7.632	5.251	2,001	-82.6	7.722
5255	VFPS	220	4.281	1630	-84.9	11.164	4.266	1,625	-84.9	11.194
5256	Sesheke	220	2.741	1044	-81.3	6.545	2.740	1,044	-81.3	6.548
5257	Cosak	220	6.103	2326	-83.2	8.315	5.892	2,245	-83.2	8.408
5313	Chawama	132	4.985	1140	-75.5	4.568	4.886	1,117	-75.7	4.623
5313	Chawama	132	4.985	1140	-75.5	4.568	4.886	1,117	-75.7	4.623
5314	Chilanga	132	3.665	838	-72.2	3.485	3.612	825.8	-72.4	3.522
5314	Chilanga	132	3.665	838	-72.2	3.485	3.612	825.8	-72.4	3.522

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5319	Avondale	132	9.278	2121	-72.6	3.207	8.95	2,046	-73.1	3.301
5319	Avondale	132	9.278	2121	-72.6	3.207	8.95	2,046	-73.1	3.301
5322	Mpanshya	132	1.221	279	-67.5	2.421	1.215	277.8	-67.6	2.431
5323	Chitope	132	0.838	192	-67.1	2.374	0.835	191	-67.2	2.381
5423	Chipata West	132	2.096	479	-84.7	10.903	2.083	476.1	-84.7	10.897
5427	Industrial	132	9.669	2211	-78.5	5.605	9.298	2,126	-78.7	5.718
5427	Industrial	132	9.669	2211	-78.5	5.605	9.298	2,126	-78.7	5.718
5428	Coventry	132	7.307	1671	-75.0	4.078	7.095	1,622	-75.3	4.158
54281	Lusaka West	132	12.960	2963	-84.2	13.269	12.297	2,812	-84.3	13.188
5429	Roma	132	10.653	2436	-75.1	3.823	10.215	2,336	-75.5	3.940
5429	Roma	132	10.653	2436	-75.1	3.823	10.215	2,336	-75.5	3.940
5431	Leopards Hill	132	19.337	4421	-85.8	15.640	17.943	4,102	-85.8	15.421
5470	Water Works	132	7.872	1800	-74.3	3.736	7.632	1,745	-74.7	3.820
5470	Water Works	132	7.872	1800	-74.3	3.736	7.632	1,745	-74.7	3.820
5640	Lumwana T4	132	2.150	492	-86.5	16.537	2.134	487.9	-86.5	16.493
5641	Lumwana T5	132	2.150	492	-86.5	16.537	2.134	487.9	-86.5	16.493
5642	Mwinilunga	132	0.594	136	-71.5	2.986	0.593	135.6	-71.5	2.991
5643	Mufumbwe	132	0.745	170	-72.9	3.252	0.593	135.6	-71.5	2.991
5644	Kabompo	132	0.503	115	-70.6	2.844	0.503	114.9	-70.7	2.848
5645	Mumbezhi	132	0.426	97	-69.9	2.732	0.425	97.2	-69.9	2.735
5646	Lukulu	132	0.354	81	-69.2	2.634	0.353	80.7	-69.2	2.637
5647	Zambezi	132	0.366	84	-69.3	2.651	0.366	83.6	-69.4	2.654
5648	Chavuma	132	0.318	73	-68.9	2.589	0.318	72.7	-68.9	2.591

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5320	KKIA	132	6.406	1465	-74.1	3.527	6.247	1428.3	-74.4	3.595
5879	Chongwe	132	6.693	1530	-74.0	3.492	6.52	1490.7	-74.3	3.563
5116-1X	Siavonga	132	6.430	1470	-89.7	173.117	6.346	1450.9	-89.6	155.025
5239	LSMFEZ	132	7.672	1754	-82.3	10.855	7.436	1700.1	-82.4	10.879
5424	Mpongwe	88	0.685	105	-69.4	2.660	0.684	104.3	-69.4	2.663
5425	Kapiri Mposhi	88	1.007	153	-71.4	2.970	1.004	153.1	-71.4	2.976
5425	Kapiri Mposhi	88	1.007	153	-71.4	2.970	1.004	153.1	-71.4	2.976
5426	Kabwe Step Down (M)	88	4.673	712	-87.4	25.449	4.636	706.2	-87.4	24.938
5427	Sanje	88	0.636	97	-58.8	1.651	0.635	96.8	-58.8	1.654
5430	Leopards Hill	88	10.721	1634	-88.0	27.903	10.425	1,589	-87.9	27.011
5430	Leopards Hill	88	10.721	1634	-88.0	27.903	10.425	1,589	-87.9	27.011
5432	Chirundu	88	1.136	173	-60.9	1.797	1.133	172.7	-61	1.803
5433	Kafue Town	88	11.263	1717	-89.2	68.855	10.951	1,669	-89.1	61.373
5435	Nampudwe	88	2.032	310	-62.6	1.928	2.022	308.2	-62.7	1.937
5436	Mazabuka	88	2.051	313	-69.4	2.660	2.041	311.1	-69.5	2.672
5437	Maamba	88	1.821	278	-70.2	2.775	1.819	277.3	-70.2	2.779
5445	Muzuma	88	7.816	1191	-87.4	20.838	7.771	1,185	-87.4	20.896
5544	FigTree	88	1.939	296	-69.2	2.627	1.93	294.1	-69.3	2.639
5545	Mapepe	88	3.185	486	-71.8	3.034	3.159	481.5	-71.9	3.054
5649	Kabwe Step Down (R)	88	3.804	580	-89.4	101.735	3.769	574.4	-89.4	95.278
5129	Mpika Step Down	66	3.391	388	-86.1	15.029	3.375	385.8	-86.1	14.987
5209	Kaoma	66	0.156	18	-58.7	1.646	0.156	17.9	-58.7	1.646
5211	Luapa	66	0.164	19	-58.8	1.654	0.164	18.7	-58.8	1.654

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5212	Kasane	66	0.648	74	-74.7	3.651	0.648	74.1	-74.7	3.651
5261	Chambishi East	66	6.311	721	-87.4	22.119	8.941	1,022	-79.9	5.772
5263	Bwana Mkubwa	66	2.136	244	-75.6	3.907	2.13	243.5	-75.7	3.915
5264	Bancroft Central	66	10.919	1248	-82.6	8.011	10.713	1,225	-82.6	8.063
5295	Msoro	66	3.679	421	-85.6	13.265	3.662	418.6	-85.6	13.232
5298	Kasama	66	2.578	295	-85.3	13.065	2.57	293.8	-85.3	13.038
5316	Mwambashi	66	3.472	397	-77.2	4.394	3.451	394.5	-77.2	4.412
5317	Ndeke	66	2.435	278	-73.6	3.387	2.425	277.2	-73.6	3.398
5318	New Scaw	66	1.836	210	-71.5	2.984	1.83	209.2	-71.5	2.992
5320	Lusiwasi Upper	66	1.618	185	-75.8	4.801	1.616	185	-75.8	4.807
5363	Kabundi	66	8.913	1019	-81.1	6.695	8.775	1,003	-81.2	6.742
5364	Stadium	66	9.756	1115	-81.5	6.985	9.591	1,096	-81.6	7.036
5365	Avenue	66	9.545	1091	-81.2	6.689	9.388	1,073	-81.2	6.740
5366	Bancroft	66	10.549	1206	-81.7	7.102	10.357	1,184	-81.7	7.156
5367	Bancroft North	66	10.648	1217	-82.2	7.620	10.452	1,195	-82.2	7.673
5370	Chisenga	66	8.537	976	-78.9	5.233	8.411	962	-79	5.278
5399	Mporokoso	66	0.253	29	-68.4	2.608	0.253	29	-68.4	2.608
5399-1X	Mwange	66	0.275	31	-68.7	2.653	0.275	31.4	-68.7	2.653
5400	Kawambwa	66	0.406	46	-70.4	2.953	0.406	46.4	-70.4	2.954
5401	Chambasitu	66	0.579	66	-72.6	3.445	0.579	66	-72.6	3.446
5402	Musonda Falls	66	0.58	66	-74	3.878	0.58	66.1	-74	3.879
5403	Luwingu	66	0.694	79	-70.8	2.942	0.694	79.2	-70.8	2.944
5404	Lubushi T	66	0.933	107	-71.9	3.078	0.932	106.6	-71.9	3.080

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5404	Lubansanshi T	66	0.801	92	-71.1	2.965	0.8	91.5	-71.2	2.967
5406	Mbala	66	1.074	122.8	-76.1	4.032	1.074	122.8	-76.1	4.034
5406	Mbala (Sumbawanga)	66	0.461	52.7	-69.8	2.731	0.461	52.7	-69.8	2.731
5407	Kasaba Bay (Nkamba Bay)	66	0.448	51.2	-66	2.337	0.448	51.2	-66	2.337
5408	Nakonde	66	0.245	28	-66.6	2.315	0.245	28	-66.6	2.315
5409	Isoka	66	0.336	38.4	-67.2	2.378	0.336	38.4	-67.2	2.379
5410	Chinsali	66	0.466	53.3	-68	2.473	0.466	53.3	-68	2.474
5411	Mpika Old	66	3.309	378.2	-85.6	13.192	3.294	376.5	-85.6	13.168
5412	Chilonga T	66	0.511	58.4	-66.6	2.314	0.51	58.3	-66.6	2.316
5413	Lualuo	66	2.642	302	-84.4	10.987	2.634	301.1	-84.4	10.969
5414	Pensulo	66	6.748	770.9	-85	11.641	6.684	763.6	-85	11.616
5415	Serenje	66	1.7	194.3	-70.1	2.763	1.696	193.9	-70.1	2.768
5416	Mukando T	66	6.33	723.1	-83.7	9.226	6.273	716.6	-83.7	9.229
5417	Kanona	66	2.85	325.8	-73.4	3.369	2.839	324.5	-73.4	3.378
5418	Lusiwasi Tee	66	0.922	105.4	-67.8	2.454	0.921	105.2	-67.8	2.457
5419	Lusiwasi	66	1.674	192	-77.4	4.980	1.673	191.8	-77.4	4.988
5421	Msoro	66	3.679	420.5	-85.6	13.265	3.662	418.6	-85.6	13.232
5422	Azele	66	1.118	127.8	-64.9	2.139	1.117	127.6	-64.9	2.141
5438	Kalabo	66	0.201	22.9	-59.5	1.699	0.201	22.9	-59.5	1.699
5439	Mongu	66	0.239	27.3	-60.1	1.741	0.239	27.3	-60.1	1.741
5440	Senanga	66	0.338	38.6	-61.8	1.865	0.338	38.6	-61.8	1.865
5442	Sesheke	66	1.804	206.2	-88.3	33.506	1.804	206.2	-88.3	33.510
5443	Kazungula	66	0.703	80.4	-75.5	3.874	0.703	80.4	-75.5	3.875

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5449	Mfuwe	66	0.978	111.8	-63.8	2.037	0.977	111.7	-63.8	2.040
5468	Turf	66	8.182	935	-79.4	5.371	8.068	922	-79.5	5.415
5469	Mansa	66	0.441	50.3	-71.8	3.298	0.441	50.3	-71.8	3.298
5471	Converter	66	2.754	314.3	-77.1	4.754	2.748	313.6	-77.1	4.753
5542	Depot	66	5.42	618.6	-77.6	4.688	5.389	615.2	-77.7	4.714
5543	Mufulira West	66	8.635	987	-82.1	7.163	8.507	972	-82.1	7.207
5563	Lunzua	66	1.142	131.2	-81.7	7.656	1.142	131.1	-81.7	7.659
5590	Mupepetwe	66	1.765	201.7	-70.2	2.791	1.76	201.2	-70.3	2.797
5674	Kawambwa Tea	66	0.369	42.1	-69.9	2.862	0.368	42.1	-69.9	2.863
5674	Mununga T	66	1.087	124.3	-68.3	2.514	1.085	124.1	-68.3	2.518
5874	Luangwa	66	6.138	701.7	-75.3	3.817	6.074	694.4	-75.4	3.846
5998	Serenje	66	0.601	69	-67.4	2.412	0.601	69	-67.5	2.413
5283	Maposa	66	10.892	1244.2	-86.2	15.020	10.719	1224.4	-86.2	14.914
5262	Mushili	66	1.821	208.2	-75.3	3.802	1.817	207.7	-75.3	3.809
5262X1	Ndola Refinery	66	6.058	691.8	-78.8	5.259	6.02	687.4	-78.9	5.292
5262-S1X	SMKIA	66	4.265	487.6	-78.2	4.784	4.238	484.5	-78.2	4.801
201	Mbereshi	66	0.36	41.2	-69.8	2.843	0.36	41.2	-69.8	2.843
5271	Lumwana	33	9.961	569.4	-86	14.272	9.874	564.4	-86	14.251
5285	Kalumbila	33	15.811	904	-84.5	10.460	15.578	890	-84.6	10.487
5314-33	Chilanga M_1	33	10.271	587.1	-77	4.743	10.164	581	-77.1	4.773
5314-33	Chilanga M_2	33	10.271	587.1	-77	4.743	10.164	581	-77.1	4.773
5316T1	Mwambashi A	33	2.798	160	-84.9	11.136	2.792	159.6	-84.9	11.139
5316T2	Mwambashi B	33	2.798	160	-84.9	11.136	2.792	159.6	-84.9	11.139

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5319	Avondale M_1	33	11.702	668.9	-83.2	8.341	11.565	661	-83.2	8.374
5319	Avondale M_2	33	11.702	668.9	-83.2	8.341	11.565	661	-83.2	8.374
5322T1	Mpanshya BB1	33	2.956	169	-76.6	4.206	2.947	168.5	-76.6	4.215
5322T2	Mpanshya BB2	33	2.956	169	-76.6	4.206	2.947	168.5	-76.6	4.215
5323T1	Chitope BB1	33	2.322	132.7	-74.4	3.580	2.317	132.4	-74.4	3.586
5323T2	Chitope BB2	33	2.322	132.7	-74.4	3.580	2.317	132.4	-74.4	3.586
5324	Luangwa	33	0.594	34	-57.7	1.583	0.594	34	-57.7	1.584
5427-33	Industrial M_1	33	17.986	1,028	-83.6	9.709	17.656	1009.2	-83.6	9.740
5427-33	Industrial M_2	33	17.986	1,028	-83.6	9.709	17.656	1009.2	-83.6	9.740
54282	Lusaka West BB1	33	25.325	1,448	-86.9	24.155	24.617	1,407	-86.9	23.485
54282	Lusaka West BB2	33	25.325	1,448	-86.9	24.155	24.617	1,407	-86.9	23.485
5429	Roma BB1	33	14.199	811.6	-85.1	11.747	13.996	800	-85.1	11.754
5429	Roma BB2	33	14.199	811.6	-85.1	11.747	13.996	800	-85.1	11.754
5436LV	Mazabuka	33	3.512	200.7	-76.9	4.312	3.5	200.1	-77	4.321
5470	Water Works M_1	33	13.559	775	-82.7	8.069	13.358	763.5	-82.7	8.111
5470	Water Works M_2	33	13.559	775	-82.7	8.069	13.358	763.5	-82.7	8.111
5569	Kansanshi	33	15	857	-84.9	11.116	14.803	846	-84.9	11.130
5313 M2	Chawama M1	11	22.395	426.7	-83.5	9.627	22.223	423.4	-83.5	9.640
5313 M3	Chawama M2	11	22.395	426.7	-83.5	9.627	22.223	423.4	-83.5	9.640
5313 M1	Chawama M3	11	13.739	261.8	-85.3	13.049	13.674	260.5	-85.3	13.043
5314-M1	Chilanga M1	11	19.348	368.6	-80.5	6.420	19.22	366.2	-80.6	6.440
5314-M1	Chilanga M2	11	19.348	368.6	-80.5	6.420	19.22	366.2	-80.6	6.440
5314-M1	Chilanga M3	11	19.348	368.6	-80.5	6.420	19.22	366.2	-80.6	6.440

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5317T1	Ndeke A	11	7.202	137.2	-82	7.092	7.187	136.9	-82	7.099
5317T2	Ndeke B	11	7.202	137.2	-82	7.092	7.187	136.9	-82	7.099
5318T1	New Scaw A	11	7.212	137.4	-78	4.702	7.197	137.1	-78	4.708
5318T2	New Scaw B	11	7.212	137.4	-78	4.702	7.197	137.1	-78	4.708
5319	Avondale M1	11	26.858	511.7	-83.5	8.721	26.617	507.1	-83.5	8.746
5319	Avondale M2	11	26.858	511.7	-83.5	8.721	26.617	507.1	-83.5	8.746
5319	Avondale M3	11	26.858	511.7	-83.5	8.721	26.617	507.1	-83.5	8.746
5324T1	Luangwa BB1	11	1.530	29.1	-62.7	1.940	1.529	29.1	-62.7	1.941
5324T2	Luangwa BB2	11	1.530	29.1	-62.7	1.940	1.529	29.1	-62.7	1.941
5427-11	Industrial M1	11	26.373	502.5	-85	12.149	26.134	497.9	-85	12.146
5427-11	Industrial M2	11	26.373	502.5	-85	12.149	26.134	497.9	-85	12.146
5427-11	Industrial M3	11	26.373	502.5	-85	12.149	26.134	497.9	-85	12.146
5429	Roma	11	27.367	521.4	-86.5	16.650	27.114	516.6	-86.5	16.596
5429	Roma	11	27.367	521.4	-86.5	16.650	27.114	516.6	-86.5	16.596
5429	Roma	11	27.367	521.4	-86.5	16.650	27.114	516.6	-86.5	16.596
5438A	Kalabo	11	0.759	14.5	-71.4	2.964	0.759	14.5	-71.4	2.964
5439A	Mongu	11	1.314	25	-62.8	1.950	1.314	25	-62.8	1.950
5443A	Kazungula*(Southern)	11	2.099	40	-82.9	7.980	2.099	40	-82.9	7.980
5470	Water Works M1	11	26.368	502.4	-85.7	13.613	26.134	497.9	-85.7	13.601
5470	Water Works M2	11	26.368	502.4	-85.7	13.613	26.134	497.9	-85.7	13.601
5470	Water Works M3	11	26.368	502.4	-85.7	13.613	26.134	497.9	-85.7	13.601
5428-11	Coventry	11	15.533	295.9	-87.1	21.066	15.442	294.2	-87.1	20.969
5410-SX	Chinsali	11	2.067	39.4	-73.9	3.467	2.066	39.4	-73.9	3.469

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	X/R	Ik"	Sk"	Ik", Angle	X/R
		kV	kA	MVA	deg		kA	MVA	deg	kA
5409-SX	Isoka	11	1.679	32	-71.2	2.932	1.678	32	-71.2	2.933
5262-SS1X	SMKIA	11	5.567	106.1	-84.2	9.914	5.56	105.9	-84.2	9.915
5262-SS1X	SMKIA	11	5.567	106.1	-84.2	9.914	5.56	105.9	-84.2	9.915
5262-SS1X	KKIA BB1	11	25.124	478.7	-83.1	8.237	24.913	474.6	-83.1	8.261
5320-11X	KKIA BB2	11	25.124	478.7	-83.1	8.237	24.913	474.6	-83.1	8.261
5320-11X	VFPS	11	33.977	651.6	-87.5	23.209	33.956	651.2	-87.5	23.202

7.2 Single Phase Fault Level Results

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5116	Kariba North	330	31.147	5934	-86.8	31.147	28.203	5,373	-86.8	28.203
5119	Mpika Step Down	330	1.147	219	-81.7	1.147	1.14	217.2	-81.7	1.14
5126	Mukuni	330	1.785	340	-78.9	1.785	1.781	339	-78.9	1.781
5202	Muzuma	330	4.447	847	-83.5	4.447	4.409	840	-83.6	4.409
5206	MCL	330	5.088	969	-86.7	5.088	5.043	961	-86.7	5.043
5239	LSMFEZ	330	15.406	2935	-82.4	15.406	13.822	2,634	-82.8	13.822
5240	Kabwe Step Down	330	8.941	1703	-82.6	8.941	8.446	1,609	-82.7	8.446
5241	Kitwe	330	4.246	809	-81.3	4.246	4.137	788	-81.4	4.137
5243	Leopards Hill	330	17.508	3336	-83.0	17.508	15.597	2,972	-83.3	15.597
5244	Luano	330	4.362	831	-81.8	4.362	4.246	809	-81.9	4.246
5246	Pensulo	330	2.043	389	-83.0	2.043	2.021	385	-83.1	2.021
5247	Kafue Gorge	330	20.478	3902	-86.3	20.478	17.343	3304	-86.1	17.3
5247	Kafue Gorge	330	20.478	3902	-86.3	20.478	17.343	3304	-86.1	17.3
5248	Kafue West	330	15.112	2879	-83.0	15.112	13.684	2607	-83.3	13.7
52481	Lusaka West	330	12.434	2369	-83.7	12.434	11.381	2,168	-83.8	11.381
5249	Kafue Town	330	13.800	2629	-82.6	13.800	12.616	2,404	-82.9	12.616
5259	Chambishi East	330	4.195	799	-81.6	4.195	4.088	779	-81.7	4.088
5269	Kansanshi	330	2.105	401	-83.6	2.105	2.078	396	-83.6	2.078
5270	Lumwana	330	1.806	344	-84.2	1.806	1.786	340	-84.2	1.786
5284	Kalumbila	330	1.516	289	-79.0	1.516	2.078	396	-83.6	2.078
5293	Nambala	330	3.101	591	-75.4	3.101	3.039	578.9	-75.6	3.039

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5294	Msoro	330	1.350	257	-82.9	1.350	1.341	255.4	-83	1.341
5296	Chipata West	330	1.258	240	-84.0	1.258	1.25	238.1	-84	1.25
5297	Kasama	330	0.800	152	-81.7	0.800	0.797	151.8	-81.7	0.797
5999	Kafue Gorge Lower B1	330	19.089	3637	-86.0	19.089	15.834	3,017	-85.8	15.834
5999	Kafue Gorge Lower B2	330	19.089	3637	-86.0	19.089	15.834	3,017	-85.8	15.834
5125	Mukuni	220	2.464	313	-79.9	2.464	1.781	339	-78.9	1.781
5204	Itezi Tezhi	220	2.875	365	-86.1	2.875	2.862	364	-86.1	2.862
5230	Nambala	220	3.186	405	-80.6	3.186	3.150	400	-80.7	3.15
5242	Kitwe	220	6.324	803	-82.6	6.324	6.165	783	-82.6	6.165
5245	Luano	220	6.554	832	-82.8	6.554	6.380	810	-82.9	6.38
5252	Kansuswa	220	4.658	592	-80.1	4.658	4.570	581	-80.2	4.57
5253	Maposa	220	4.617	587	-80.3	4.617	4.534	576	-80.4	4.534
5254	Michelo	220	4.479	569	-79.4	4.479	4.397	559	-79.5	4.397
5255	VFPS	220	2.273	289	-79.4	2.273	2.270	288	-79.4	2.27
5256	Sesheke	220	1.088	138	-79.6	1.088	1.088	138	-79.6	1.088
5257	Cosak	220	5.398	686	-80.6	5.398	5.280	671	-80.7	5.28
5313	Chawama	132	5.489	418	-75.3	5.489	5.404	412	-75.4	5.404
5313	Chawama	132	5.489	418	-75.3	5.489	5.404	412	-75.4	5.404
5314	Chilanga	132	4.786	365	-74.2	4.786	4.721	359.8	-74.3	4.721
5314	Chilanga	132	4.786	365	-74.2	4.786	4.721	359.8	-74.3	4.721
5319	Avondale	132	10.361	790	-74.8	10.361	10.068	767	-75.2	10.068
5319	Avondale	132	10.361	790	-74.8	10.361	10.068	767	-75.2	10.068
5322	Mpanshya	132	1.676	128	-69.2	1.676	1.668	127.1	-69.3	1.668

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5323	Chitope	132	1.178	90	-68.5	1.178	1.174	89.5	-68.5	1.174
5423	Chipata West	132	2.907	222	-85.1	2.907	2.889	220.2	-85.1	2.889
5427	Industrial	132	12.632	963	-78.6	12.632	12.183	929	-78.9	12.183
5427	Industrial	132	12.632	963	-78.6	12.632	12.183	929	-78.9	12.183
5428	Coventry	132	8.752	667	-76.3	8.752	8.535	650	-76.5	8.535
54281	Lusaka West	132	17.504	1334	-84.2	17.504	16.648	1,269	-84.3	16.648
5429	Roma	132	11.152	850	-77.2	11.152	10.807	824	-77.5	10.807
5429	Roma	132	11.152	850	-77.2	11.152	10.807	824	-77.5	10.807
5431	Leopards Hill	132	19.799	1509	-84.7	19.799	18.747	1,429	-84.7	18.747
5470	Water Works	132	9.284	708	-76.6	9.284	9.046	689	-76.9	9.046
5470	Water Works	132	9.284	708	-76.6	9.284	9.046	689	-76.9	9.046
5640	Lumwana T4	132	2.817	215	-86.8	2.817	2.797	213.2	-86.8	2.797
5641	Lumwana T5	132	2.814	215	-86.8	2.814	2.794	213	-86.8	2.794
5642	Mwinilunga	132	0.392	30	-72.6	0.392	0.392	29.9	-72.6	0.392
5643	Mufumbwe	132	0.471	36	-71.4	0.471	0.471	35.9	-71.4	0.471
5644	Kabompo	132	0.281	21	-69.4	0.281	0.281	21.4	-69.4	0.281
5645	Mumbezhi	132	0.229	17	-68.8	0.229	0.229	17.4	-68.8	0.229
5646	Lukulu	132	0.191	15	-69.0	0.191	2.797	213.2	-86.8	2.797
5647	Zambezi	132	0.195	15	-68.7	0.195	0.195	14.8	-68.7	0.195
5648	Chavuma	132	0.170	13	-68.9	0.170	0.17	13	-68.9	0.17
5320	KKIA	132	6.059	462	-76.2	6.059	5.957	454	-76.4	5.957
5879	Chongwe	132	7.437	567	-76.9	7.437	7.284	555.1	-77.1	7.284
5116-1X	Siavonga	132	6.748	514	-89.6	6.748	6.687	509.6	-89.6	6.687

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5239	LSMFEZ	132	10.705	816	-82.2	10.705	10.381	791.1	-82.3	10.381
5424	Mpongwe	88	0.609	31	-72	0.609	0.608	30.9	-72	0.608
5425	Kapiri Mposhi	88	1.311	67	-73.7	1.311	1.308	66.5	-73.7	1.308
5425	Kapiri Mposhi	88	1.311	67	-73.7	1.311	1.308	66.5	-73.7	1.308
5426	Kabwe Step Down (M)	88	4.968	252	-88.1	4.968	4.937	250.9	-88.1	4.937
5427	Sanje	88	0.907	46	-60.4	0.907	0.905	46	-60.5	0.905
5430	Leopards Hill	88	19.158	973	-86.9	19.158	18.497	940	-86.9	18.497
5430	Leopards Hill	88	19.158	973	-86.9	19.158	18.497	940	-86.9	18.497
5432	Chirundu	88	0.709	36	-63.2	0.709	0.708	36	-63.2	0.708
5433	Kafue Town	88	14.718	748	-88.8	14.718	1.949	99	-77.5	1.949
5435	Nampudwe	88	2.516	128	-66.5	2.516	2.506	127.3	-66.6	2.506
5436	Mazabuka	88	2.119	108	-74.4	2.119	2.112	107.3	-74.4	2.112
5437	Maamba	88	1.126	57	-72	1.126	1.125	57.2	-72	1.125
5445	Muzuma	88	11.612	590	-86	11.612	11.541	586	-86	11.541
5544	FigTree	88	2.024	103	-73.8	2.024	2.017	102.5	-73.8	2.017
5545	Mapepe	88	2.285	116	-73.5	2.285	2.276	115.6	-73.6	2.276
5649	Kabwe Step Down (R)	88	4.297	218	-89.3	4.297	4.265	216.7	-89.3	4.265
5129	Mpika Step Down	66	3.341	127	-85.5	3.341	3.33	126.9	-85.5	3.33
5209	Kaoma	66	0.267	10	36.7	0.267	0.267	10.2	36.7	0.267
5211	Luapa	66	0.258	10	44.1	0.258	0.258	9.8	44.1	0.258
5212	Kasane	66	0.482	18	-74.6	0.482	0.482	18.4	-74.6	0.482
5261	Chambishi East	66	8.426	321	-87	8.426	8.338	318	-87	8.338
5263	Bwana Mkubwa	66	2.603	99	-76.2	2.603	2.596	98.9	-76.2	2.596

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5264	Bancroft Central	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5295	Msoro	66	3.817	145	-86.1	3.817	3.803	144.9	-86.1	3.803
5298	Kasama	66	2.400	92	-84.9	2.400	2.395	91.3	-84.9	2.395
5316	Mwambashi	66	2.713	103	-75.8	2.713	2.704	103	-75.8	2.704
5317	Ndeke	66	1.662	63	-73.8	1.662	1.659	63.2	-73.8	1.659
5318	New Scaw	66	1.170	45	-72.8	1.170	1.168	44.5	-72.8	1.168
5320	Lusiwasi Upper	66	2.000	76	-77	2.000	1.999	76.2	-77	1.999
5363	Kabundi	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5364	Stadium	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5365	Avenue	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5366	Bancroft	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5367	Bancroft North	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5370	Chisenga	66	0.063	2	89.9	0.063	0.063	2	89.9	0.063
5399	Mporokoso	66	0.1	4	-70.5	0.100	0.1	3.8	-70.5	0.1
5399-1X	Mwange	66	0.106	4	-70.6	0.106	0.106	4	-70.6	0.106
5400	Kawambwa	66	0.144	6	-71.3	0.144	0.144	5.5	-71.3	0.144
5401	Chambasitu	66	0.179	7	-71.5	0.179	0.179	6.8	-71.5	0.179
5402	Musonda Falls	66	0.163	6	-71.8	0.163	0.163	6.2	-71.8	0.163
5403	Luwingu	66	0.289	11	-71.6	0.289	0.289	11	-71.6	0.289
5404	Lubushi T	66	0.468	18	-72.7	0.468	0.468	17.8	-72.7	0.468
5404	Lubansanshi T	66	0.369	14	-72.1	0.369	0.369	14.1	-72.1	0.369
5406	Mbala	66	0.31	11.8	-72.2	0.310	0.31	11.8	-72.2	0.31
5406	Mbala (Sumbawanga)	66	0.176	6.7	-71.1	0.176	0.176	6.7	-71.1	0.176

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5407	Kasaba Bay (Nkamba Bay)	66	0.158	6	-69.1	0.158	0.158	6	-69.1	0.158
5408	Nakonde	66	0.123	4.7	-69.7	0.123	0.123	4.7	-69.7	0.123
5409	Isoka	66	0.169	6.4	-69.7	0.169	0.169	6.4	-69.8	0.169
5410	Chinsali	66	0.241	9.2	-70.2	0.241	0.241	9.2	-70.2	0.241
5411	Mpika Old	66	3.188	121.5	-84.8	3.188	3.178	121.1	-84.8	3.178
5412	Chilonga T	66	0.277	10.6	-70.6	0.277	0.277	10.6	-70.6	0.277
5413	Lualuo	66	2.377	90.6	-84	2.377	2.372	90.4	-84	2.372
5414	Pensulo	66	8.957	341.3	-85.1	8.957	8.876	338.2	-85.1	8.876
5415	Serenje	66	1.049	40	-72.1	1.049	1.048	39.9	-72.1	1.048
5416	Mukando T	66	7.658	291.8	-82.9	7.658	7.598	289.5	-82.9	7.598
5417	Kanona	66	2.003	76.3	-73.7	2.003	1.999	76.2	-73.8	1.999
5418	Lusiwasi Tee	66	0.53	20.2	-71.3	0.530	0.53	20.2	-71.4	0.53
5419	Lusiwasi	66	0.812	31	-75.5	0.812	0.812	30.9	-75.5	0.812
5421	Msoro	66	3.817	145.4	-86.1	3.817	3.803	144.9	-86.1	3.803
5422	Azele	66	0.722	27.5	-69.1	0.722	0.721	27.5	-69.1	0.721
5438	Kalabo	66	0.226	8.6	61.1	0.226	0.226	8.6	61.1	0.226
5439	Mongu	66	0.189	7.2	72.7	0.189	0.189	7.2	72.7	0.189
5440	Senanga	66	0.174	6.6	78.5	0.174	0.174	6.6	78.5	0.174
5442	Sesheke	66	0.184	7	80.7	0.184	0.184	7	80.7	0.184
5443	Kazungula	66	0.543	20.7	-75.1	0.543	0.543	20.7	-75.1	0.543
5449	Mfuwe	66	0.619	23.6	-68.5	0.619	0.619	23.6	-68.5	0.619
5468	Turf	66	6.076	232	-78.4	6.076	6.032	230	-78.5	6.032
5469	Mansa	66	0.139	5.3	-71.5	0.139	0.139	5.3	-71.5	0.139

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5471	Converter	66	2.143	81.6	-77.5	2.143	2.14	81.5	-77.5	2.14
5542	Depot	66	4.117	156.9	-78.7	4.117	4.104	156.4	-78.7	4.104
5543	Mufulira West	66	0.008	0	90	0.008	0.008	0	90	0.008
5563	Lunzua	66	0.27	10.3	-72.4	0.270	0.27	10.3	-72.4	0.27
5590	Mupepetwe	66	1.101	41.9	-72.3	1.101	1.099	41.9	-72.3	1.099
5674	Kawambwa Tea	66	0.134	5.1	-71.1	0.134	0.134	5.1	-71.1	0.134
5674	Mununga T	66	0.625	23.8	-71.3	0.625	0.625	23.8	-71.3	0.625
5874	Luangwa	66	4.079	155.4	-75.4	4.079	1.619	61.7	-81.3	1.619
5998	Serenje	66	0.601	69	-67.4		0.601	69	-67.5	
5383	Maposa	66	4.484	170.9	-78.4	4.484	4.463	170.1	-78.4	4.463
5262	Mushili	66	2.247	85.6	-75.9	2.247	2.241	85.4	-75.9	2.241
5262X1	Ndola Refinery	66	4.871	185.6	-80.7	4.871	4.853	184.9	-80.7	4.853
5262-S1X	SMKIA	66	1.959	74.7	-75.4	1.959	1.955	74.5	-75.5	1.955
201	Mbereshi	66	0.136	5.2	-71.6	0.136	0.136	5.2	-71.6	0.136
5271	Lumwana	33	2.154	41	-9.2	2.154	2.154	41	-9.3	2.154
5285	Kalumbila	33	1.077	21	3	1.077	1.077	21	3	1.077
5314-33	Chilanga M_1	33	1.042	19.9	-4.3	1.042	1.042	19.9	-4.3	1.042
5314-33	Chilanga M_2	33	1.042	19.9	-4.3	1.042	1.042	19.9	-4.3	1.042
5316T1	Mwambashi A	33	3.482	66.3	-85.8	3.482	3.475	66.2	-85.8	3.475
5316T2	Mwambashi B	33	3.482	66.3	-85.8	3.482	3.475	66.2	-85.8	3.475
5319	Avondale M_1	33	0.528	10.1	-2.2	0.528	0.528	10.1	-2.2	0.528
5319	Avondale M_2	33	0.528	10.1	-2.2	0.528	0.528	10.1	-2.2	0.528
5322T1	Mpanshya BB1	33	0.701	13.4	-8.9	0.701	0.701	13.4	-8.9	0.701

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5322T2	Mpanshya BB2	33	0.701	13.4	-8.9	0.701	0.701	13.4	-8.9	0.701
5323T1	Chitope BB1	33	0.685	13.1	-10.6	0.685	0.685	13.1	-10.6	0.685
5323T2	Chitope BB2	33	0.685	13.1	-10.6	0.685	0.685	13.1	-10.6	0.685
5324	Luangwa	33	0.286	5.5	-47.3	0.286	0.286	5.5	-47.3	0.286
5427-33	Industrial M_1	33	1.055	20	-2.7	1.055	1.055	20.1	-2.7	1.055
5427-33	Industrial M_2	33	1.055	20	-2.7	1.055	1.055	20.1	-2.7	1.055
54282	Lusaka West BB1	33	2.188	42	-3.9	2.188	2.188	42	-4	2.188
54282	Lusaka West BB2	33	2.188	42	-3.9	2.188	2.188	42	-4	2.188
5429	Roma BB1	33	16.982	323.6	-86	16.982	16.776	319.6	-85.9	16.776
5429	Roma BB2	33	16.982	323.6	-86	16.982	16.776	319.6	-85.9	16.776
5436LV	Mazabuka	33	3.927	74.8	-79.6	3.927	3.917	74.6	-79.7	3.917
5470	Water Works M_1	33	1.074	20.5	-3.6	1.074	1.073	20.5	-3.6	1.073
5470	Water Works M_2	33	1.074	20.5	-3.6	1.074	1.073	20.5	-3.6	1.073
5569	Kansanshi	33	8.617	164	13	8.617	8.623	164	12.7	8.623
5313 M2	Chawama M1	11	1.07	6.8	-2	1.070	1.07	6.8	-2	1.07
5313 M3	Chawama M2	11	1.07	6.8	-2	1.070	1.07	6.8	-2	1.07
5313 M1	Chawama M3	11	0.536	3.4	-1.7	0.536	0.536	3.4	-1.7	0.536
5314-M1	Chilanga M1	11	1.084	6.9	-2.3	1.084	1.084	6.9	-2.3	1.084
5314-M1	Chilanga M2	11	1.084	6.9	-2.3	1.084	1.084	6.9	-2.3	1.084
5314-M1	Chilanga M3	11	1.084	6.9	-2.3	1.084	1.084	6.9	-2.3	1.084
5317T1	Ndeke A	11	9.191	58.4	-83.2	9.191	9.174	58.3	-83.2	9.174
5317T2	Ndeke B	11	9.191	58.4	-83.2	9.191	9.174	58.3	-83.2	9.174
5318T1	New Scaw A	11	9.724	61.8	-79.2	9.724	9.704	61.6	-79.2	9.704

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5318T2	New Scaw B	11	9.724	61.8	-79.2	9.724	9.704	61.6	-79.2	9.704
5319	Avondale M1	11	1.088	6.9	-1.7	1.088	1.088	6.9	-1.7	1.088
5319	Avondale M2	11	1.088	6.9	-1.7	1.088	1.088	6.9	-1.7	1.088
5319	Avondale M3	11	1.088	6.9	-1.7	1.088	1.088	6.9	-1.7	1.088
5324T1	Luangwa BB1	11	2.137	13.6	-64.7	2.137	2.136	13.6	-64.7	2.136
5324T2	Luangwa BB2	11	2.137	13.6	-64.7	2.137	2.136	13.6	-64.7	2.136
5427-11	Industrial M1	11	1.088	6.9	-1.8	1.088	1.088	6.9	-1.8	1.088
5427-11	Industrial M2	11	1.088	6.9	-1.8	1.088	1.088	6.9	-1.8	1.088
5427-11	Industrial M3	11	1.088	6.9	-1.8	1.088	1.088	6.9	-1.8	1.088
5429	Roma	11	1.115	7.1	-1.7	1.115	1.115	7.1	-1.8	1.115
5429	Roma	11	1.115	7.1	-1.7	1.115	1.115	7.1	-1.8	1.115
5429	Roma	11	1.115	7.1	-1.7	1.115	1.115	7.1	-1.8	1.115
5438A	Kalabo	11	0.953	6.1	-74.5	0.953	0.953	6.1	-74.5	0.953
5439A	Mongu	11	1.89	12	-64	1.890	1.89	12	-64	1.89
5443A	Kazungula*(Southern)	11	2.408	15.3	-84.6	2.408	2.408	15.3	-84.6	2.408
5470	Water Works M1	11	1.119	7.1	-1.8	1.119	1.119	7.1	-1.8	1.119
5470	Water Works M2	11	1.119	7.1	-1.8	1.119	1.119	7.1	-1.8	1.119
5470	Water Works M3	11	1.119	7.1	-1.8	1.119	1.119	7.1	-1.8	1.119
5428-11	Coventry	11	1.096	7	-3	1.096	1.096	7	-3	1.096
5262-SS1X	SMKIA	11	1.068	6.8	-10.3	1.068	1.068	6.8	-10.3	1.068
5262-SS1X	SMKIA	11	1.068	6.8	-10.3	1.068	1.068	6.8	-10.3	1.068
5320-11X	KKIA BB1	11	1.096	7	-1.8	1.096	1.096	7	-1.8	1.096
5320-11X	KKIA BB2	11	1.096	7	-1.8	1.096	1.096	7	-1.8	1.096

Bus Number	Bus Name	Nominal Voltage	Maximum Generation				Minimum Generation			
			Ik"	Sk"	Ik", Angle	3*I0	Ik"	Sk"	Ik", Angle	3*I0
		kV	kA	MVA	deg	kA	kA	MVA	deg	kA
5447	VFPS	11	46.752	296.9	-88.3	46.752	46.717	296.7	-88.3	46.717

8.0 CONCLUSION

The fault levels are based on assumption made on the system model and are subject to refinements once system upgrades are completed and the operational scenarios are implemented.

A. APPENDIX

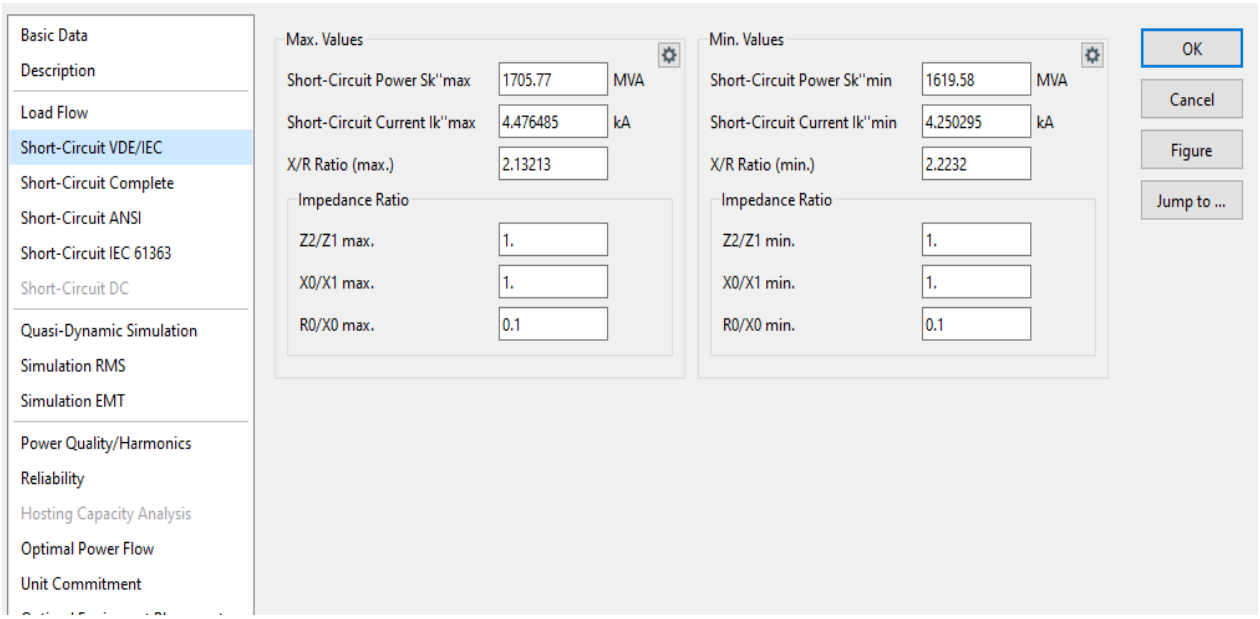

Figure A-1: SNEL External Grid Short Circuit parameters

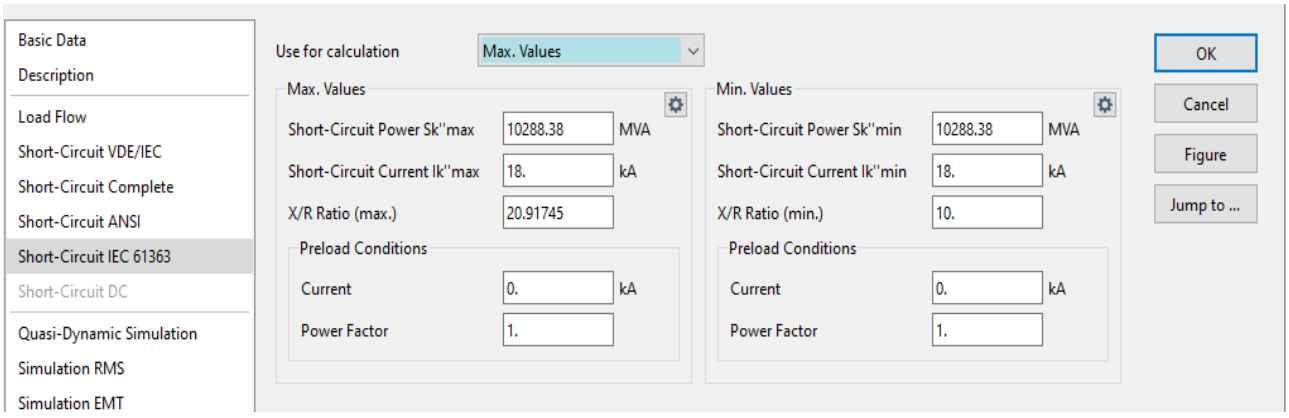

Figure A-2: ZESA External Grid Short Circuit parameters