Energy and Power Engineering, 2013, 5, 1421-1424
doi:10.4236/epe.2013.54B269 Published Online July 2013 (http://www.scirp.org/journal/epe)

Date Conversion in BPA and PSS/E Based on China Southern Power Grid

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Received March, 2013

ABSTRACT

This paper undertakes transference of BPA date of the China Southern Power Grid into PSS/E data, covering a comparison between DC data and calculated results of power flow which excluded DC data, testing the accuracy of transference of power flow data, and demonstrating the transference program in data conversion is applicative. The results show that the two results fundamentally resemble each other, which indicates the transferred data is correct.

Keywords: Flow Calculation; BPA; PSS/E; Date Conversion

1. Introduction

PSS/E software with its powerful function of the simulation calculation has been more and more popular among domestic research institutions. In the past, to complete the BPA and PSS/E data transformation, manually change conversion method is usually used or write the corresponding data conversion program for a particular grid data [1,2]. This paper takes the southern power grid in 2015 high flow operation mode as an example, carrying on the conversion between BPA and PSS/E with the data conversion software, and compares the results of pure AC and hybrid AC/DC system.

2. The Data Description of the Southern Power Grid

Southern power grid is a typical large capacity, long distance, multi-area and interconnected power grid, composed of the five provinces of Guangdong, Guangxi, Hainan, Guizhou, Yunnan, power grid and the company directly under it, and connect the power grid of Hong Kong and Macao by the Guangdong power grid [3-5]. The BPA data of Southern power grid 2015 High flow operation mode include 1158 generators, 6405 AC nodes, 7636 branches and SanGuang, TianGuang, GuiGuang double circuits, YunGuang, Nuozhadu DC, Xiluodu DC, Jinzhong, Lanshang nine HVDC transmission system [6].

In the BPA data of Southern power grid 2015 High flow operation mode, the generators adopt sub-transient model, considering the role of excitation system, the prime motor, governor and power system stabilizer(PSS), the load adopt static ZIP mode[7-9]. The data contain EA, EK, EC, FK/FZ, FJ/FZ, FQ/F+, and FV/F+ seven excitation system models, GS+TA, GS+TB, GG, GH four prime motor and governor models, and SS, SG, SP, SI/SI+ four PSS models, DC circuit adopt steady-state model.

For such a giant and complex network, the cost of manpower and material resources in the writing of BPA data is enormous. This paper converts it to PSS/E data with the help of BPA TO PSS/E data conversion software, greatly reducing the difficulty of manually filling original data and its stability data, saving a lot of manpower and resources, and reduces the risk of input errors.

3. The Flow Calculation Comparison of Pure AC Network

Correct flow data conversion is the premise and basis for transient stability analysis, this paper makes flow calculation of Southern power grid DC circuit using BPA and PSS/E separately to compare the correctness of the flow data conversion in the case of pure AC network. Due to space limitations, these paper only randomly select ten nodes as shown in **Table 1(a)**, the largest node voltage amplitude difference is 0.0006, and the maximum phase difference is 0.06°. The result shows that the converted PSS/E flow data is very accurate and reliable.

As shown in **Table 1(b)**, the flow calculation results of BPA and PSS/E are consistent, which proves the BPA TO PSS/E data conversion software can convert the flow data of pure AC system.

4. The Comparison of Flow Calculation in Hybrid AC/DC System

In the case of correct conversion in the pure AC system, then convert the flow data of BPA to PSS/E, with the DC circuit of the hybrid AC/DC system retained, **Table 2(a)** shows randomly selected voltage node contrast. The largest node voltage amplitude difference is 0.0283, there are 305 nodes which the maximum voltage amplitude error are greater than 0.0005, the difference of these nodes is also about 0.3°, the largest difference of voltage phase angle is 0.4°.

Table 1. The power flow comparison of ac system.

(a) The comparison of node voltage and phase angle

Node Name	Voltage class(kV)	BPA		PSS/E		Difference	
		Amplitude/(p.u.)	Phase angle/(°)	Amplitude/(p.u.)	Phase angle/(°)	Amplitude/(p.u.)	Phase angle/(°)
YN01HLZ1	525	1.01	10.5	1.0094	10.46	0.0006	0.04
HUIZHLZ1	525	1.004	-21.7	1.0034	-21.64	0.0006	0.06
JINGANQG	525	1.031	17.9	1.0315	17.89	0.0005	0.01
MAOM0H	525	1.005	-15.8	1.0055	-15.77	0.0005	0.03
CAOP.U.G	525	1.009	13.2	1.0085	13.21	0.0005	0.01
MEIZH0H	525	1.011	-23.6	1.0105	-23.58	0.0005	0.02
DIANXIG	525	1.02	18.5	1.0195	18.54	0.0005	0.04
HUIZXN0P	525	1.001	-26.3	1.0005	-26.26	0.0005	0.04
QUJINGBG	525	1.028	10.8	1.0275	10.76	0.0005	0.04
BAOFENGG	525	1.011	14.4	1.0114	14.41	0.0004	0.01

(b) The comparison of the results in the whole network

Project	BPA	PSS/E	error
Balancing machine active power contribution (MW)	491.63	491.6	-0.006%
Balancing machine reactive power contribution (Mvar)	290.65	290.7	0.017%
active power contribution of the whole network(MW)	187222.9	187222.9	0
Active load of the whole network (MW)	184171.5	184171.5	0
Active lossof the whole network (MW)	3051.479	3051.5	0.0007%

Table 2. The power flow comparison of hybrid ac/dc system.

(a) The comparison of node voltage and phase angle

Node Name	Voltage class(kV)	BPA		PSS/E		difference	
		Amplitude /(p.u.)	Phase angle(°)	Amplitude (p.u.)	Phase angle/(°)	Amplitude/(p.u.)	Phase angle(°)
GD01-HLZ	525	1.01	-27.1	0.9727	-26.7	0.0283	0.4
GD01-HLZ	500	0.973	-27	1.0008	-26.83	0.0278	0.17
HUIZHOU7	525	1.006	-21.9	1.0074	-21.6	0.0014	0.3
HUIZ-HLZ	525	1.006	-21.9	1.0073	-21.6	0.0013	0.3
HUIZHLZ1	525	1.006	-21.9	1.0073	-21.6	0.0013	0.3
BOLUO0H	525	1.002	-26.2	1.0029	-25.91	0.0009	0.29
HUICH50H	525	0.998	-27.5	0.9988	-27.2	0.0008	0.3
MAOM0H	525	1.005	-15.8	1.0055	-15.57	0.0005	0.23
CAOP.U.G	525	1.009	13.1	1.0085	13.4	0.0005	0.3
MEIZH0H	525	1.011	-23.6	1.0105	-23.34	0.0005	0.26

(b) The comparison of the results in the whole network

Project	BPA	PSS/E	error
Balancing machine active power contribution (MW)	496.15	478.6	3.5%
Balancing machine reactive power contribution (Mvar)	291.07	289.5	0.54%
active power contribution of the whole network (MW)	193234.5	193195.9	0.02%
Active load of the whole network (MW)	188396.1	188397.6	-0.0008%
Active lossof the whole network (MW)	4838.479	4787.2	1.06%

The error of node voltage amplitude and phase angle in pure AC and hybrid AC/DC system calculated by BPA and PSS/E is shown in **Table 3**. From the statistical results can be seen that the node voltage amplitude and phase angle difference calculated by hybrid AC/DC system is significantly larger than the pure AC system.

The comparison of active power and reactive power in DC system is shown in **Table 4**. From **Table 4(a)** can see the active power loss in PSS/E is less than that in BPA, This is because PSS/E ignores the power loss of the inverter, just considering the active loss of the converter transformer and DC circuit, and BPA calculates the active loss of the DC inverter.

The reactive loss of the rectifier station is shown in **Table 4(b)**, it tells the results calculated by BPA and PSS/E is a little different, but the difference of reactive

Table 3. Difference distribution of node voltage amplitude and phase angle.

(a)The error distribution of the voltage amplitude

The Error Of Voltage Amplitude ΔU(p.u.)	Pure AC system		Hybrid AC/DC system	
	Number of nodes	Proportion	Number of nodes	Proportion
ΔU<=0.0001	4424	69.5%	4706	73.5%
0.0001<ΔU<=0.0005	1852	29.1%	1394	21.8%
ΔU>0.0005	89	1.4%	305	4.8%

(b)The error distribution of phase angle

The Error Of Phase Angle Δδ(°)	Pure AC system		Hybrid AC/DC system	
	Number of nodes	Proportion	Number of nodes	Proportion
Δδ<=0.05°	6320	99.3%	128	2.0%
0.05°<Δδ<=0.1°	45	0.7%	0	0
0.1°<Δδ<=0.3°	0	0	4839	75.6%
0.3°<Δδ<=0.5°	0	0	1438	22.4%

Table 4. The loss comparison of active and reactive power.

(a) The comparison of active power loss (unit: MW)

DC System	Commutation bus of the rectifier	Commutation bus of inverter station	BPA	PSS/E	Error
SanGuang	JINZ-HLZ	HUIZ-HLZ	180.6	176.92	3.68
TianGuang	TSQD-M1	BEIJIAO	116.4	111.62	4.78
GuiGuang1	ANSH-HLZ	ZQ-HLZ	166.0	164.02	1.98
GuiGuang2	XREN-HLZ	GD-HLZ	206.8	203.28	3.52
YunGuang	YN01-HLZ	GD01-HLZ	220.6	215.46	5.14

(b) The comparison of reactive power loss (unit: Mvar)

DC System	Reactive power loss of rectifier station			Reactive power loss of the inverter station		
	BPA	PSS/E	Error	BPA	PSS/E	Error
SanGuang	1568.2	1592.4	-24.2	1613.2	1577.4	35.8
TianGuang	920.8	904.4	16.4	927.2	893.8	33.4
GuiGuang1	1568.4	1559.4	9	1618.6	1587.2	31.4
GuiGuang2	1568.4	1565.8	2.6	1603.4	1568.2	35.2
YunGuang	2780.8	2817.8	-37	2914.4	2743	171.4

loss of inverter station is large, it has some reasons as followed: 1) in the calculation process of PSS/E, the inverter station is given the γ angle control, but BPA adopts the given voltage control; 2) BPA equivalently calculates each level of the bridge converter transformer. It is because there is difference between BPA and PSS/E in calculation method and DC system model, which leads to the calculation difference about reactive loss in inverter station between both of the software.

5. Conclusions

This paper introduces data conversion software for BPA TO PSS/E, and makes conversion of BPA date of the China Southern Power Grid into PSS/E data, through the test of the data between pure AC system and hybrid AC/DC system, presenting the BPA TO PSS/E software is feasible. The most important is that it reduces the difficulty of manually filling original data and its stability data, saving a lot of manpower and resources, and reduces the risk of input errors.

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