

# The Security and Stability Analysis Of 500kV West Channel To Shanxi Datong Power Grid

Xinyuan Liu<sup>1</sup>, Xiaojia Zhai<sup>2</sup>, Huiping Zheng<sup>1</sup> and Weiwen Duan<sup>1</sup>

<sup>1</sup>State Grid Shanxi Electric Power Research Institute, Qingnian Road NO.6, Taiyuan, Shanxi Province, China

<sup>2</sup>State Grid Shanxi Electric Power Company Taiyuan Power supply branch, Bingzhou Road NO.89, Shanxi Province, China

**Abstract**—This paper researches the limit of Shanxi Datong power grid static stability, transmission capacity, security and stability of power grid characteristics under the serious fault by simulation after the commissioning of 500kV west channel. Then compared with the pre production, the importance and necessity of west channel production are demonstrated.

**Keywords**—west channel; Datong power grid; security and stability; transmission capacity

## I. INTRODUCTION

Shanxi, as a major energy province, is to transport large quantities of electricity to the surrounding areas. Datong Power Grid in northern Shanxi is connected with the Shanxi power grid by Double circuit line of Shenyang and also is connected with the Beijing power grid through the Datong to three circuit line of Fangshan. the amount of security measures is too large after Shenyang double N-2 serious faults, which may cause the Datong Power Grid and grid splitting, affect the safe and stable operation of the whole North China Power Grid.

It is planning and production Yantong - Pinglu - Wuzhai 500kV West Channel, which ensures Datong Power Grid in complex situations can be maintained stable in 2017, and enhance the links between Datong grid and the main grid. After the Western channel operation, it is increased to six 500kV lines, respectively, three circuit line of Datong - Fangshan (hereinafter referred to as Da-Fang three ), double-circuit line of Shener -Yantong (line of Shen-Yan double) and the circuit line of Pinglu - Yantong (line of Ping-Yan ).The topology of Datong 500kV Power Grid is shown in figure I. There are greatly changed in the static, transient stability characteristics and transmission capacity of Datong grid after the Western channel operation. Therefore, there is very important practical significance to study deeply the Western channel on the security and stability of Shanxi Datong power grid.

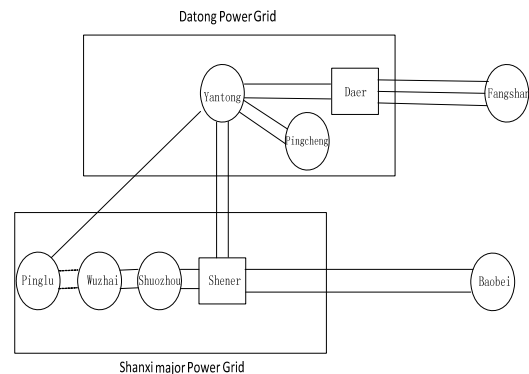


FIGURE I. THE TOPOLOGY OF DATONG 500KV POWER GRID

## II. CALCULATION PROGRAM AND CALCULATION CONDITION

### A. Calculation Program

It is used the PSD System Software Tools of China Electric Power Research Institute, the power flow of PSD-BPA and the transient stability program of PSD-BPA.

### B. Calculation Conditions

- The calculation network includes all 220kV and the network in Shanxi, taking into account the 2017 Shanxi power grid, transmission and substation planning and load conditions.
- The generator model put to use the model of Ed and Eq, and the excitation, PSS and the speed regulation system are considered.
- Load model, using 40% constant impedance and 60% motor model.

## III. THE STATIC STABILITY LIMIT OF DATONG POWER NETWORK AFTER THE OPERATION OF THE WEST CHANNEL

It is increased 500kV line of Ping Yan between the Datong power grid and the main grid connection line of Shanxi after the operation of West channel. With the practical engineering algorithm, respectively of Datong power network in normal way, line of Shen-Yan double out of service, line of Da-Fang three out of service, it is figured out the limit of static stability with simulation delivery section. The simulation curves are

shown in Figure II-IV and the calculated results are shown in Table I .

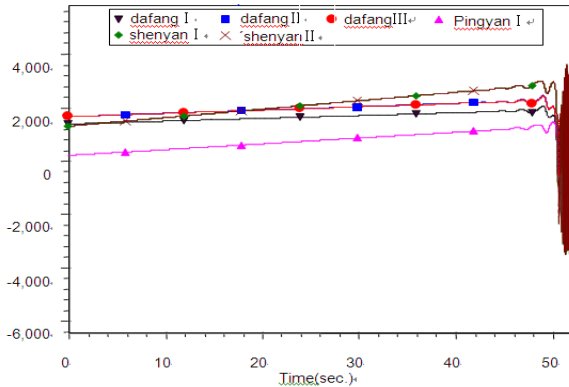


FIGURE II. THE STATIC STABILITY LIMIT OF EXTERNAL POWER SUPPLY SECTION OF DATONG POWER GRID IN NORMAL MODE

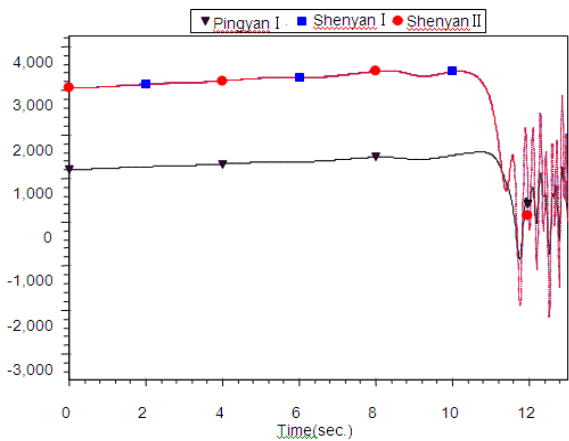


FIGURE III. THE STATIC STABILITY LIMIT OF DATONG POWER GRID TRANSMISSION SECTION AFTER THE THREE CIRCUIT LINE OF DA-FANG OUT OF SERVICE

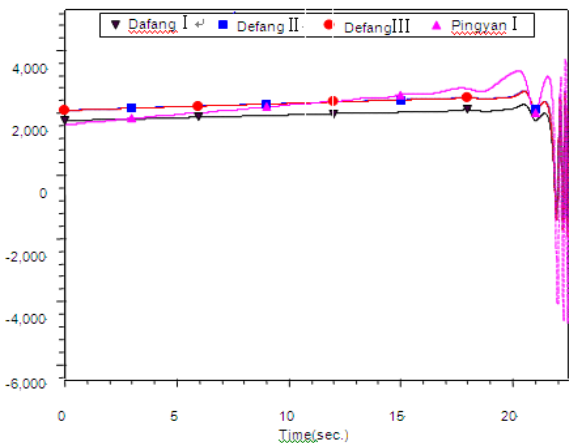


FIGURE IV. THE STATIC STABILITY LIMIT OF DATONG POWER GRID TRANSMISSION SECTION AFTER THE DOUBLE CIRCUIT LINE OF SHEN-YAN OUT OF SERVICE

TABLE I. THE COMPARISON TABLE OF THE STATIC STABILITY LIMIT OF DATONG POWER GRID TRANSMISSION SECTION UNDER WEST CHANNEL OPERATION BEFORE AND AFTER

Operation mode	Grid structure	Section composition	Static stability limit of external delivery section	double-circuit line of Shenyan	three circuit line of Dafang	line of Ping-Yan
Normal mode	before operation	Line of Dafang three and Shenyan double	12760	5527	7233	-
	after operation	line of Dafang three ,Shenyan double and Ping-Yan	14468	6014	6993	1461
the three circuit line of Dafang out of service	operation before	Line of Dafang and Shenyan double	10180	7467	2713	-
	operation after	Line of Dafang ,Shenyan double and Ping-Yan	11117	6594	2856	1667
the double circuit line of Shenyan out of service	operation before	line of Dafang three	6739	-	6739	-
	operation after	line of Dafang three and Ping-Yan	10983	-	7650	3333

From the Table I we can see that the static stability limit of Datong Power Grid transmission section is increased under the three situations after the western channel is put into operation. In normal mode, the static stability limit is 14468MW, which improved the 1708MW, the static stability limit obviously increases to 10983MW after Shen-yan double out of service and improve the 4244MW.

#### IV. THE TRANSMISSION CAPACITY ANALYSIS OF DATONG POWER GRID AFTER THE OPERATION OF THE WEST CHANNEL

Before West Channel production, Datong power grid transmission capacity limit for 6700MW, which is included 4200 MW of three circuit line of Datong - Fangshan and 2500MW of double-circuit line of Shener -Yantong.

After the operation of the west channel, the transmission capacity of Datong Power Grid has been improved. In 2017, the Datong power grid installed to 10500MW. Under the Datong power unit fully open, the transmission capacity of Datong power grid by six circuit is 8008MW, which is included 4902MW of three circuit line of Dafang, 311mw of the circuit line of Pingyan, and 2795MW of double-circuit line of Shenyan. The Shenyan double N-1, and the line of II 2098MW, which are fully open .Therefore, under the thermal stability limit of Shenyan double N-1 ( $4 * 300$  wire and flow limit 2100MW) ,the transmission capacity of Datong power grid is 8000MW, improved 1300MW. The power flow diagram of Datong Power Grid after the western channel is put into operation as shown in figure V.

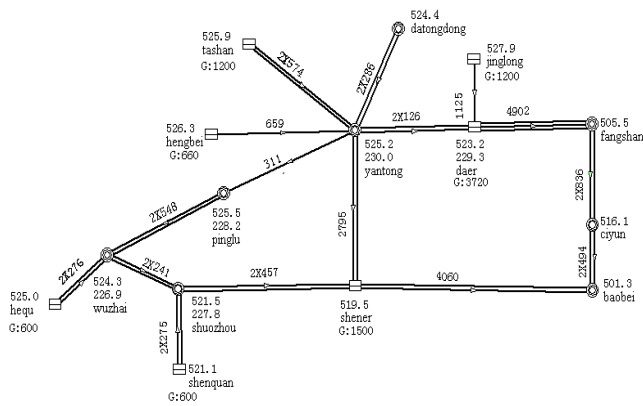


FIGURE V. THE POWER FLOW DIAGRAM OF DATONG POWER GRID AFTER THE OPERATION OF THE WESTERN CHANNEL

### V. SAFETY AND STABILITY ANALYSIS OF DATONG POWER GRID UNDER THE SERIOUS FAULTS AFTER THE OPERATION OF THE WEST CHANNEL

The West channel put into production and operation before and after, the stability calculation and analysis is used respectively on the fault of Dafang double line and Shenyang double line. The stable calculation results are shown in TABLE II and TABLE III.

TABLE II. SAFETY AND STABILITY ANALYSIS OF DATONG POWER GRID UNDER THE SERIOUS FAULTS BEFORE THE OPERATION OF THE WEST CHANNEL

NO.	the fault location	Fault side	stable state	security controls
1	Dafang double N-2	Datong side	stable	no
2	Dafang double N-2	Fangshan side	stable	no
3	Shenyang double N-2	Yantong side	astable	Removal of 1600MW unit, power grid system is stable
4	Shenyang double N-2	Shener side	astable	Removal of 5200MW unit, power grid system is stable

TABLE III. SAFETY AND STABILITY ANALYSIS OF DATONG POWER GRID UNDER THE SERIOUS FAULTS AFTER THE OPERATION OF THE WEST CHANNEL

NO .	the fault location	Fault side	stable state	security controls
1	Dafang double N-2	Datong side	stable	no
2	Dafang double N-2	Fangshan side	stable	no
3	Shenyang double N-2	Yantong side	astable	Removal of 200MW unit, power grid system is stable
4	Shenyang double N-2	Shener side	astable	Removal of 3240MW unit, power grid system is stable

Comparisons of Table II and Table III:

- After the first and end of the Dafang N-2 fault, the system can keep stable operation.
- After the first and end of the Shenyang N-2 fault, the system cannot keep stable operation. the system can maintain stable operation after taking control measures. The 3240MW unit can maintain the stable operation of the N-2 unit after the fault of the Shenyang N-2, when Removal of 5500MW unit, the power grid system is stable, and the stability of the system is greatly improved.

For the output system, the grid construction has a positive impact on the safe and stable operation of the power grid, but also improves the ability of the system. According to the classical areas of the law, the grid is enhanced, the static stability of the outer section is improved, and the increase of the reduction area of the rear system is increased. In normal operation mode, the power grid connection is more closely. After the occurrence of Shenyang N-2 fault, the stability of Datong power grid is effectively improved.

### VI. CONCLUSIONS

For the north of Shanxi power grid planning and construction of the Yantong - Pinglu - Wuzhai 500kV west channel in 2017, this research prospect the Datong power grid stability characteristics and the amount of removal under the serious fault after the operation of the west channel. The main conclusions are:

- After the operation of West channel, Datong power grid transmission capacity is 8000MW, which increased by 1300MW restricted by the thermal stability limit of Shenyang N-1 fault.
- After commissioning of the west channel, it is enhanced the connection of Datong Power Grid and Shanxi main grid effectively. The static stability limit of the northern Shanxi section is 10983MW, which improves 4244MW obviously.
- After commissioning of West channel, the deceleration area of Datong power grid unit increased after Shenyang double circuit N-2 fault, which is conducive to the recovery of the system to a stable state. Furthermore, the amounts of removal of safety control decreased from 3240MW to 5200MW.

Thus, 500kV west channel of Yantong – Pinglu - Wuzhai could effectively improve the security and stability of Datong power grid, which has important practical significance to ensure the safe and stable operation of the North China Power Grid.

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