Development of ATC Evaluation Method with Dynamic Stability Constraints
− Development of Efficient Contingency Screening Method −

Background

Fast and accurate evaluation of ATC (additional power which can be transferred over transmission network between a source and a sink) is essential to efficient use of networks in the deregulated environment. An ATC assessment involves a large number of contingency analyses based on supply/demand scenarios with various transaction volumes. Therefore, evaluation of ATC with dynamic stability constraints, which is important to Japanese interconnected network, requires much computation time, and development of efficient evaluation method is needed.

A promising method of efficient ATC assessment is an application of contingency screening method, where only contingencies chosen by screening method are closely examined by time domain simulation. However, conventional contingency screening methods focus mainly on first-swing instability and fail to identify severe contingencies with multi-swing instability.

Objectives

Development of efficient contingency screening method, which can accurately identify severe faults with both first-swing instability and multi-swing instability and contribute to the efficiency of ATC evaluation

Principal Results

1. A novel contingency screening method is developed, which utilizes both energy function method and eigenvalue analysis. The main features of the proposed method are as follows (Figure 1):
   1) It can accurately find out severe contingencies with both first-swing instability and multi-swing instability
   2) Supply/demand scenarios where time domain simulation is required are identified based on information obtained by energy function method.
2. A number of numerical examples show that the proposed method has very good performance from the viewpoint of accuracy of screening (Table 1). Examples also show that the computation time of ATC assessment is reduced to 1/2 ~ 1/4 by application of the proposed method (Table 2).

Future Developments

Further development is needed to make the proposed method more applicable to multi-swing instability cases, where nonlinearity has much effect on the stability.

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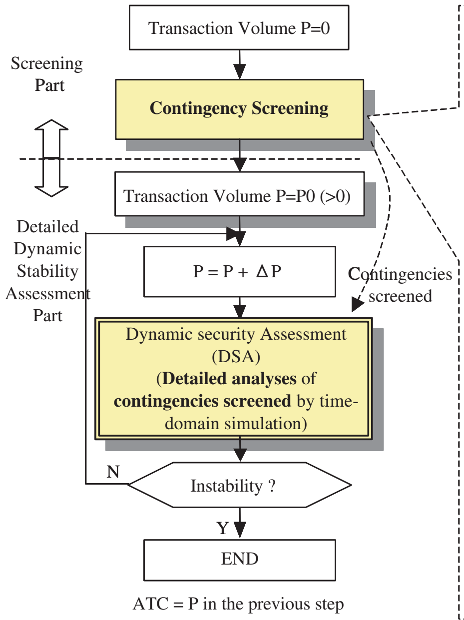
Reference

"An efficient contingency screening scheme for ATC assessment with transient stability constraints", CRIEPI Report, T03016, March 2004 (in Japanese)



● Screening Indices

Index	Cases to be screened	Method of screening
SEF	Mainly, cases with first-swing instability	･Based on energy function method ･Apply longer fault clearing time (e.g. 0.2[sec]) than usual to emphasis the severity of contingency ・Identify contingencies as "severe", where system is unstable just after fault is cleared ・Supply/demand scenarios, where detailed analysis is required, are identified based on the change in number of "severe" faults as transaction volume increases
SEV	Mainly, cases with multi-swing instability	･Based on eigenvalue analysis ･Utilize the sensitivities of the following quantities with respect to transaction volume 1) Damping of swing modes 2) Participation factors of the generator, which is "source" of transaction, with respect to swing modes ・Identify a given number of contingencies as "severe", which have largest sensitivities

Fig.1 The proposed ATC assessment procedure and contingency screening method

Table 1 Accuracy of the proposed contingency screening method

Model Power System	Base case Scenario	Number of transaction cases (*1) (number of cases with multi-swing instability)	Number of cases, where the proposed method identifies the severest faults	
			○	×
EAST30	Peak	84 (60)	84	0
	Night	84 (36)	84	0
WEST30	Peak	92 (82)	92	0
	Night	98 (94)	96	2
Total		358	356	2

*1...Number of cases among 100 cases (all combinations of 10 sources and 10 sinks), where dynamic stability constraints has limiting effect on transmission capability

Table 2 ATC evaluation results of 10 transaction cases in Table 1

Model power system & Base case scenario	Transaction pattern	ATC [MW] (*1)	Type of instability	Conventional method (*2)		Proposed method			
				Number of contingencies in DSA	**Computation Time [Sec]**	Number of contingencies screened	**Computation Time [Sec]**	**Ratio to conventional method**	Index identifing the severest fault (*3)
EAST30, Peak	E1	340	First-swing	136	**390.2**	15	**222.4**	**0.57**	SEF, SEV
	E2	6680	Multi-swing	136	**2284.5**	13	**502.6**	**0.22**	SEV
	E3	2030	Multi-swing	136	**880.4**	12	**211.3**	**0.24**	SEF
	E4	2600	First-swing	136	**944.7**	11	**274.0**	**0.29**	SEF, SEV
	E5	5250	Multi-swing	136	**1584.0**	14	**396.0**	**0.25**	SEF, SEV
WEST30, Peak	W1	170	Multi-swing	80	**327.6**	12	**144.1**	**0.44**	SEF
	W2	980	First-swing	80	**264.6**	10	**132.3**	**0.50**	SEF, SEV
	W3	3500	Multi-swing	80	**731.4**	16	**175.5**	**0.24**	SEF, SEV
	W4	2910	Multi-swing	80	**528.6**	12	**163.9**	**0.31**	SEV
	W5	3950	Multi-swing	80	**688.8**	12	**179.1**	**0.26**	SEF

*1…In all cases, ATC obtained by the proposed method is identical to ATC by conventional method.
*2…Conventional method doesn't utilize contingency screening and all contingencies are considered in DSA.
*3...SEF is based on energy function method, SEV is based on eigenvalue analysis.