Chapter 8

Determination of Available Transfer Capability

Determination of Available Transfer Capability is the final process of real-time ATC calculation. In this step, ATC value in each ATC interface is calculated by subtracting total transfer capability (TTC) at that path by the summation of its Existing Transmission Commitment (ETC) and Transmission Reliability Margin (TRM). Since concepts, definitions and calculation methodology of ETC and TRM have been explained in the previous chapters, this chapter will not cover these information but move forward to evaluate the real-time available transfer capability from the information both the real-time input and pre-calculated results as obtained in chapter 5-8.

Firstly, at a specific ATC interface, TRM value is determined to provide the necessary amount of transmission capability reserved for security reason. This dissertation will rely on the rating-reduction method to calculate TRM since it is the most reliable method for large-scale power system. It is evidently seen that TRM is necessary to ATC calculation since the power system conditions are not precisely predictable.

After TRM is calculated, real-time ATC value is obtained by simply subtracting TRM and ETC. Generally, amount of ETC in a power system is associated with availability of transmission services in each system. Recallable and non-recallable are two examples of transmission service existing in the United States that will affect real-time ATC calculation. If these transmission services are available in any power system, ATC calculation must be classified to be recallable ATC and non-recallable ATC in correspond with transmission services. However, since recallable and non-recallable services are not available in Thailand power system at least until the third stage of Electricity Supply Industry (ESI) master plan, transmission service concept will be withheld and loading conditions from EMS system, will be used as ETC in this dissertation.

When real-time ATC have been calculated, these values are required be accessible by market participant from appropriate medias. Transmission providers or ISO has full responsibility in calculating, coordinating and posting these values to the public. As seen in the United States (ATC obligation is varied by nature of each power system. However, electronics media such as online computer network or Internet is likely to be the most appropriate media for real-time ATC since they are easy to accessed, modified and need minimal refreshing time for updating real-time data)

For example, as have been implemented in the United States since January 1997, OASIS (Open Access Same Time Information System) is an interactive web-base database innovation developed by the United States electric power industry for sharing information among members throughout the United States. Transmission providers, transmission customers and other registered participants can access variety of database through their OASIS nodes. It is seen that not only the ATC values are

available in OASIS but also information of transmission capacity reservation; ancillary services and transmission prices are also available from this interactive computerized media. General structure of OASIS is shown in figure 8-1 [77-78].

This dissertation has followed the framework that has been defined by NERC for real-time ATC algorithm. Therefore, calculation is focused on non-simultaneous ATC. Nevertheless, methodologies used in non-simultaneous transfers in this dissertation can be conveniently applied to multiple transfer transaction though there are no numerical relationship between transmission capability of simultaneous and non-simultaneous transfers. Generally, the technical challenges of multiple transactions ATC is the degree of complexicity that may be increased drastically due to the possible combination of events and management of transactions while trying to maintain the security limits. These may lead to further development in market rules and regulations. Therefore, ATC calculation is limited to point-to-point transactions that covers all ATC interfaces at the present time. Selected multiple transactions can be added when the system security is in question under these combinations of transaction.

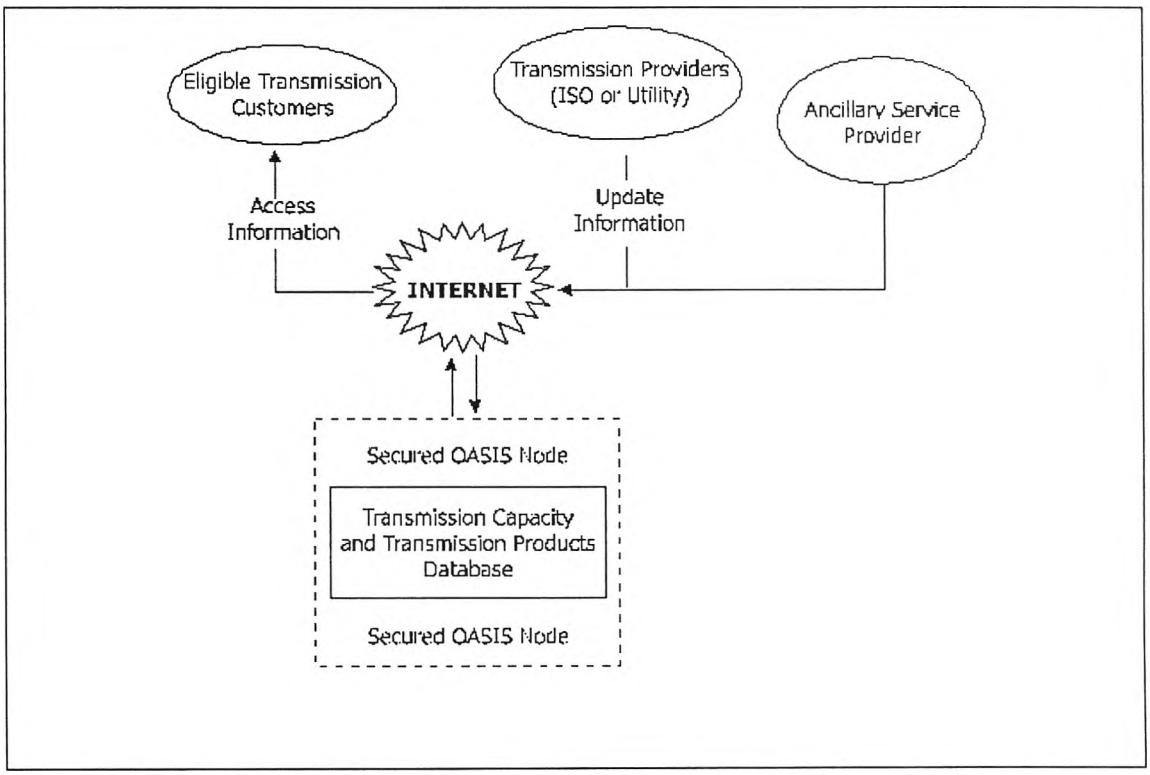

Figure 8-1 Structure of Open Access Same Time Information System (OASIS)

Generally, an ATC interface has more than one ATC value depend of time frame of consideration. Next seven days, next day, hourly or real-time basis are examples of ATC values at a specific time frame. This dissertation will concentrate in ATC calculation in Thailand power system that requires ATC values to be updated at

least every thirty minutes. Therefore, real-time ATC calculation will be able to provide operational ATC values of interfaces within the time limit.

After real-time ATC have been posted, they become reference for market participants to set up their future plan of transactions. Normally, authorization request for amount of transaction exceeding the ATC value of that interface will be rejected by ISO since it may create undesired circumstances in the systems. However, these transactions may be allowed if ISO considers these requests as feasible transactions under appropriate technique. In order to justify these requests from sellers, ISO must perform redispatching calculation in the systems that usually result in additional expense to the requesters.

8.1 Transmission Reliability Margin (TRM)

Since Transmission Reliability Margin provides a reasonable level of assurance that the interconnected transmission networks can be securely operated, TRM is a necessary term in transmission margin in ATC calculation due to uncertainties in power system.

As discussed in chapter 3, two methods are recommended by NERC to determine appropriate amount of their reserved transmission capability. This dissertation adopts the rating reduction method due to uncertainties of power system is unpredictable in both location and time of events.

TRM applied by rating reduction according to NERC framework is accomplished by two-step method base on TTC calculation as follows:

1) The TTC and ATC are determined using the full ratings of facilities in the systems (assume TRM is zero). Therefore, ATC is determined from simple formula as the following

$$ATC_{FULL} = TTC_{FULL} - ETC \tag{1}$$

Where

ATC_{FULL} = ATC values of the system using full facility ratings

TTC_{FULL} = TTC values of the system using full facility ratings

ETC = Total connected load

2) Determine ATC using reduced facility rating (2%-5% or more depend on the time).

$$ATC_{REDUCED} = TTC_{REDUCED} - ETC \tag{2}$$

Where

$ATC_{REDUCED}$ = ATC values of the system using reduced facility ratings

$TTC_{REDUCED}$ = TTC values of the system using reduced facility ratings

ETC = Total connected load

Then TRM can be determined as the algebraic different between the full ATC values given in equation 1) and reduced ATC values given in equation 2).

According to TRM applied by rating reduction method as explained above, one of the most important issues is what are the appropriate criteria to select the rate of reductions? What is the remarkable factors affecting amount of TRM and how to combine this factor in the calculation?

It is cleared that too small rating reduction may fail to ensure system security while too much rating reduction will directly affect on market opportunity of participants in the deregulated market. To cope with this question, this dissertation limits rating reduction to 2%-5% of normal rating depend on load level of the base case since real-time ATC would contain smaller uncertainties due to the frequency of data updating. During light load, 2% of rating reduction is applied to facility ratings since transmission and generation facilities usually have plenty of available transmission capability to dispatch additional electricity. On the contrary, during peak load conditions, 5% of rating reduction is selected as the appropriate amount of spared capability to cope with this stress operating conditions. According to TRM calculation procedures explained above, the flowchart of TRM calculation is shown in figure 8-2.

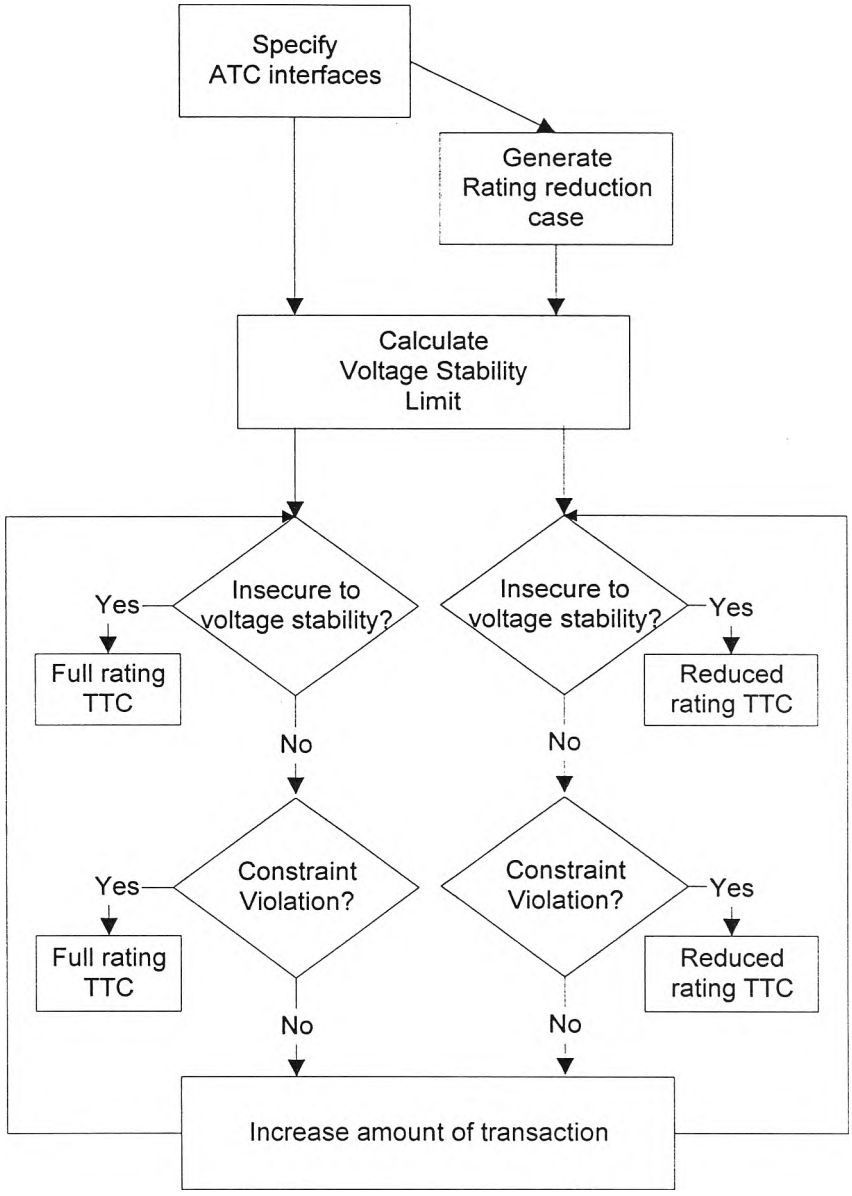

Figure 8-2. Calculation of Transmission Reliability Margin by Rating Reduction method

8.2 Simulation Results

In this section, several typical cases are simulated as examples of TRM calculation. Since Thailand power system during peak load is the selected base case for these calculation, 5% rating reduction from transmission lines thermal limit and generator limit is applied to major facilities as explained earlier. As shown in figure 8-2, the calculation of TRM is very similar to the TTC calculation.

Case 1: TRM of ATC interface between seller and buyer bus

Seller: Bus 1805- South Bangkok (area 1)
Buyer: Bus 3721 – Song Khla (area 3)

a) Available Transfer Capability and Total Transfer Capability of full rating systems

Under the scenario when transaction between seller (bus 1805 – South Bangkok) and buyer buse (bus 3721 – Song Khla) are executed, full-rating Total Transfer Capability of this interface is determined from thermal limit violation in area 7 as summarized below

TTC:

Amount of maximum power transferred: 2754.62 MW and 1568.81 MVar

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 7802 and 7204, this line is carrying 95.13% of thermal rating
- Transmission line connected between bus 7813 and 7812, this line is carrying 95.13% of thermal rating

ETC:

Existing Transmission Commitment (ETC) can be determined from either base conditions of seller or buyer side of the transaction. However, determination of ETC from the buyer side is slightly more complicate than the seller side since buyer bus may be either generation bus or load bus. The problem is relatively straightforward when buyer is a load bus since increasing load level at buyer bus can satisfy the simulation requirements of the transaction. In contrast, the problem is more complicate when buyer bus is attached with generator since the simulation should be performed by initially decrease generation level at buyer bus. It is going to reach the turning point from decreasing generation level to increasing load level at buyer bus if the systems can carry large amount of transaction. From this reason, this dissertation prefers the determination of ETC from the seller side so as to simplify the problem

and save computation resources. Generally, information of ETC is available through real-time system or transaction reservation from market participants. The decision to select source of information is depend on the availability of information in the system. Both of this information compatible with real-time ATC calculation algorithm proposed in this dissertation.

Therefore, amount of electricity generated at the seller bus during peak load conditions (2021 MW 1151 MVar) is accounted as ETC for full-rating TTC of ATC interface between buses 1805 and 3721

ATC:

According to information provided earlier, the algebraic different 733.62 MW 417.81 MVar between full-rating TTC and ETC is ATC value of ATC interface between buses 1805 and 3721

b) Available Transfer Capability and Total Transfer Capability of reduction rating systems

When rating reduction 5% is applied to the systems, similar procedures as full-rating calculation are performed to calculate the reduced-rating ATC.

TTC:

Amount of maximum power transferred: 2704.10 MW and 1540.04 MVar

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 7802 and 7204, this line is carrying 90.09% of thermal rating
- Transmission line connected between bus 7813 and 7812, this line is carrying 90.09% of thermal rating

ETC:

For the case of reduced-rating calculation of the transaction between seller and buyer buses, generation of 2021 MW 1151 MVar is accounted as ETC for full-rating TTC of ATC interface between bus 1805 and 3721. It is seen that this is the same amount of power generated at the seller bus as the full-rating case.

ATC:

According to information provided earlier, the algebraic different 683.10 MW 389.04 MVar between reduced-rating TTC and ETC is ATC value of ATC interface between bus 1805 and 3721

TRM:

As the conclusion for this case, algebraic different between full-rating ATC and reduced-rating ATC of 50.52 MW and 28.77 Mvar is the Transmission Reliability Margin of this case.

Case 2: TRM of ATC interface between generation sub-portfolio and buyer bus

Seller: Sub-portfolio2 of PowerGen2 (generation portfolio) compose of the following generation facilities

- Mae Moh (bus 4716, 4808 and 8881 in area 4 and 8)
- Lan Krabue (bus 4730 – area 4)

Buyer: Bus 4722 – Chiang Mai (area 4)

In this case, similar calculation as case 1 will be performed to calculate TRM and ATC of this interface:

a) Available Transfer Capability and Total Transfer Capability of full rating systems

The results of full-rating calculation of TTC and ATC between generation sub-portfolio2 of PowerGen2 seller and buyer bus are shown in table 8-1 below

Table 8-1. Total Transfer Capability of full-rating transaction between buyer bus and sub-portfolio

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Sub-portfolio2 PowerGen2 (Seller)					
Unit 1: Mae Moh (4716)	25.00	31.00	226.55	134.00	
Unit 2: Mae Moh (4808)	297.00	129.00	525.76	241.80	
Unit 3: Mae Moh (8881)	1301.00	542.00	1630.16	696.10	
Unit 4: Lan Krabue (4730)	126.00	39.00	337.66	142.80	
Entire area	**1749.00**	**741.0**	**2720.13**	**1214.7**	
Net generation increasing			**971.13**	**473.7**	
Bus 4722 (Buyer)	61.00	20.00	1030.25	509.64	
Net generation decreasing			**969.25**	**459.64**	

TTC:

According to the results given in table 8-1, amount of maximum power transferred (Net generation): 2720.13 MW and 1214.7 Mvar at sub-portfolio 2 represents the full-rating TTC of this case.

Stopping criteria: Thermal limit violations
Locations:

- Transmission line connected between bus 8882 and 4808, this line is carrying 92.16% of thermal rating

ETC:

In this scenario, ETC of ATC interface is represented by the base case conditions of seller which is generation sub-portfolio. As shown in table 8-1 above, sub-portfolio2 of PowerGen2 generated 1749.00 MW and 741.00 Mvar in peak load base case.

ATC:

When TTC and ETC have been provided, the algebraic different 971.13 MW 473.70 MVar between full-rating TTC and ETC is the ATC value of ATC interface between sub-portfolio2 and bus 4722

b) Available Transfer Capability and Total Transfer Capability of reduced rating systems

When rating 5% reduction is applied to major facilities in the system, necessary terms in ATC calculation are calculated as follows:

TTC:

Base on results given in table 8-2, TTC of the reduced-rating calculation of ATC interface between sub-portfolio seller and buyer bus is represented by amount of maximum power transferred (Net generation of 2705.88 MW and 1194.96 MVar) in sub-portfolio2 PowerGen2:

Table 8-2. Total Transfer Capability of reduced-rating transaction between buyer bus and sub-portfolio

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Sub-portfolio2 PowerGen2 (Seller)					
Unit 1: Mae Moh (4716)	25.00	31.00	199.57	121.35	
Unit 2: Mae Moh (4808)	297.00	129.00	523.81	234.05	
Unit 3: Mae Moh (8881)	1301.00	542.00	1666.81	708.98	
Unit 4: Lan Krabue (4730)	126.00	39.00	315.69	130.56	
Entire area	**1749.00**	**741.00**	**2705.88**	**1194.96**	
Net generation increasing			**956.88**	**453.96**	
Bus 4722 (Buyer)	61.00	20.00	1015.73	499.50	
Net generation decreasing			**954.73**	**479.50**	

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 7802 and 7204, this line is carrying 89.71% of thermal rating
- Transmission line connected between bus 7813 and 7812, this line is carrying 89.67% of thermal rating

ETC:

Under the case of reduced-rating scenario in this case, ETC is determined from the base case net-generation level at the seller (sub-portfolio). According to table 8-2, the amount of 1749.00 MW and 741.00 Mvar represents ETC values of this case.

ATC:

Similar to the previous study case, algebraic different 956.88 MW 453.96 MVar between reduced-rating TTC and ETC is the ATC value of ATC interface in this case

TRM:

When the computation results of both full-rating and reduced-rating are obtained, TRM is equal to the different between full-rating ATC and reduced-rating ATC which is equal to 14.25 MW and 19.74 Mvar.

Case 3: TTC of ATC interface between seller bus and generation sub-portfolios

Seller: Bus 2804 – Nam Phong (area 2)
Buyer: Sub-portfolio 1 of PowerGen1 containing buses
- North Bangkok (bus 1801 – area 1)
- Wang Noi (bus 5806 – area 5)

a) Available Transfer Capability and Total Transfer Capability of full rating systems

Information of power generated at base case and maximum power transfer of ATC case between seller bus and buyer generation sub-portfolio is shown in table 8-3. It is seen this scenario is simulated by increasing amount of power generation at the seller bus and decrease generation level inside buyer generation sub-portfolio simultaneously.

Table 8-3. Total Transfer Capability of full-rating transaction between buyer bus and sub-portfolio

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Bus 2804 (Seller)	225.00	186.00	1039.50	859.32	
Net generation increasing			**814.50**	**673.32**	
Sub-portfolio 1 PowerGen1 (Buyer)					
Unit 1: North Bangkok (1801)	120.00	24.57	0	0	
Unit 2: Wang Noi (5806)	1200.00	240.00	516.00	103.20	
Entire area	**1320.00**	**264.57**	**516.00**	**103.20**	
Net generation decreasing			**804.00**	**161.37**	

TTC:

As seen from the simulation results, TTC of this case is 1039.50 MW and 859.32 Mvar at the seller bus.

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 2804 and 2803 circuit #1, this line carrying 95.05% of thermal rating
- Transmission line connected between bus 2804 and 2803 circuit #1, this line carrying 95.05% of thermal rating

ETC:

Existing Transmission Commitment in this case is 225.00 MW and 186.00 Mvar.

ATC:

The algebraic different 814.50 MW 673.22 MVar between full-rating TTC and ETC is the full-rating ATC value of ATC interface between bus 2804 and generation sub-portfolio1 of PowerGen1

b) Available Transfer Capability and Total Transfer Capability of reduced rating systems

Results of the 5% rating reduction study of case 3, which employs similar procedures as full-rating calculation, are given in table 8-4 below

Table 8-4. Total Transfer Capability of reduced-rating transaction between buyer bus and sub-portfolio

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Bus 2804 (Seller)	225.00	186.00	987.75	816.51	
Net generation increasing			**762.75**	**630.51**	
Sub-portfolio1 PowerGen1 (Buyer)					
Unit 1: North Bangkok (1801)	120.00	24.57	0	0	
Unit 2: Wang Noi (5806)	1200.00	240.00	563.35	106.03	
PowerGen1 entire area	**1320.00**	**264.57**	**563.35**	**106.03**	
Net generation decreasing			**756.65**	**158.54**	

TTC:

Slightly different from the full-rating case, TTC of the reduced rating calculation is equal to 987.75 MW and 816.54 Mvar.

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 2804 and 2803 circuit#1, this line carrying 90.21% of thermal rating
- Transmission line connected between bus 2804 and 2803 circuit#2, this line carrying 90.21% of thermal rating

ETC:

It is seen that since both full-rating and reduced rating calculation employ the same base case conditions to perform the study. Therefore, base case generation at seller bus is accounted as ETC for both full-rating and reduced rating TTC of ATC interface between seller bus 2804 and buyer generation sub-portfolio1 of PowerGen1.

ATC:

In order to obtain ATC value of this ATC interface, algebraic different 762.75 MW 630.51 Mvar between TTC and ETC of reduced-rating calculation is accounted as reduced-rating ATC value of ATC interface between bus 2804 and portfolio PowerGen1

TRM:

As a conclusion for this case, algebraic different 6.1 MW and 471.97 Mvar between full-rating ATC and reduced-rating ATC is the Transmission Reliability Margin of this case.

Case 4: TTC of ATC interface between sub-portfolios

Seller: Sub-portfolio2 of PowerGen2 that compose of the following generation facilities

- Mae Moh (bus 4716, 4808 and 8881 in area 4 and 8)
- Lan Krabue (bus 4730 – area 4)

Buyer: Sub-portfolio 1 of PowerGen1 which will be restated again

- North Bangkok (bus 1801 - area 1)
- Wang Noi (bus 5806 – area 5)

a) Available Transfer Capability and Total Transfer Capability of full rating systems

Under the scenario when transaction between seller and buyer sub-portfolios is assumed ongoing in this case, information regarding full-rating ATC and TTC calculation is given in table 8-5 as shown below.

Table 8-5. Total Transfer Capability result of typical transaction between generation sub-portfolios

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Sub-portfolio2 PowerGen2 (seller)					
Unit 1: Mae Moh (4716)	25.00	31.00	403.18	219.12	
Unit 2: Mae Moh (4808)	297.00	129.00	618.60	297.54	
Unit 3: Mae Moh (8881)	1301.00	542.00	1413.70	627.94	
Unit 4: Lan Krabue (4730)	126.00	39.00	483.17	225.54	
Entire area	**1749.00**	**741.00**	**2918.73**	**1370.15**	
Net generation increasing			**1169.73**	**629**	
Sub-portfolio1 PowerGen1 (Buyer)					
Unit 1: North Bangkok (1801)	120.00	24.57	0	0	
Unit 6: Wang Noi (5806)	1200.00	240.00	159.21	15.67	
Entire area	**1320.00**	**264.57**	**159.21**	**15.67**	
Net generation decreasing			**1160.79**	**248.90**	

TTC:

TTC of full-rating transaction between generation sub-portfolios2 of PowerGen2 and sub-portfolio1 of PowerGen1 is represented by the amount of maximum power transferred: 2918.73 MW and 1370.15 Mvar base on generation at the seller portfolio.

Stopping criteria: Thermal limit violations
Locations:

- Transmission line connected between bus 8882 and 4808, this line carrying 95.18% of thermal rating
- Transmission line connected between bus 8882 and 8881, this line carrying 95.17% of thermal rating

ETC:

As explained above about the concept of ETC, net of electricity generated at the seller generation sub-portfolio during peak load conditions (1749.00 MW, 741.00 MVar) is accounted as ETC for full-rating TTC of ATC interface between sub-portfolios

ATC:

According to information provided earlier, the algebraic different 1169.73 MW 629 MVar between full-rating TTC and ETC is ATC value of ATC interface in this case

b) Available Transfer Capability and Total Transfer Capability of reduced rating systems

When rating reduction 5% is applied to facilities in the systems, similar procedures as full-rating calculation are performed to calculate the reduced-rating ATC as results given in table 8-6

Table 8-6. Total Transfer Capability of reduced-rating transaction between generation sub-portfolios

Generation	At Base Conditions		At TTC		Remark
	MW	MVAR	MW	MVAR	
Sub-portfolio2 PowerGen2 (seller)					
Unit 2: Mae Moh (4716)	25.00	31.00	392.17	211.58	
Unit 3: Mae Moh (4808)	297.00	129.00	609.77	289.98	
Unit 4: Mae Moh (8881)	1301.00	542.00	1412.98	620.38	
Unit 5: Lan Krabue (4730)	126.00	39.00	472.98	217.98	
Entire area	**1749.00**	**741.00**	**2887.9**	**1339.92**	
Net generation increasing			**1138.10**	**598.92**	
Sub-portfolio1 PowerGen1 (Buyer)					
Unit 1: North Bangkok (1801)	120.00	24.57	0	0	
Unit 6: Wang Noi (5806)	1200.00	240.00	205.65	40.8	
Entire area	**1320.00**	**264.57**	**205.65**	**40.8**	
Net generation decreasing			**1114.38**	**223.77**	

TTC:

In the reduced-rating calculation of transaction between sub-portfolios, amount of maximum power transferred: 2887.9 MW and 1339.92 MVar is determined as TTC.

Stopping criteria: Thermal limit violations
Locations:
- Transmission line connected between bus 8882 and 4808, this line carrying 90.02% of thermal rating

ETC:

As previously explained in case 3, net power generated at seller sub-portfolio of 1749.00 MW and 741.00 Mvar is selected as the ETC of both full-rating and reduced-rating calculation of this case.

ATC:

According to information provided earlier, the algebraic different 1138.10 MW 598.92 MVar between reduced-rating TTC and ETC is ATC value of ATC interface between sub-portfolios2 of PowerGen2 and sub-portfolio1 of PowerGen1

TRM:

As the conclusion for this case, algebraic different between full-rating ATC and reduced-rating ATC is the Transmission Reliability Margin. As a conclusion, quantities in ATC calculation procedure of each case is summarized in table 8-7

Table 8-7 Summary of ATC calculation results in typical transactions in chapter 8

ATC Interface	Full-rating TTC		Reduced-rating TTC		ETC		TRM		ATC	
	P(MW)	Q(Mvar)	P(MW)	Q(Mvar)	P(MW)	Q(Mvar)	P(MW)	Q(Mvar)	P(MW)	Q(Mvar)
Case 1 Transaction between seller and buyer bus	2829.40	1611.40	2704.10	1540.04	2021.00	1151.00	125.30	71.36	683.10	389.04
Case 2 Transaction between seller portfolio and buyer bus	2720.13	1214.70	2705.88	1194.96	1749.00	741.00	14.25	19.74	956.88	453.96
Case 3 Transaction between seller bus and buyer portfolio	1039.50	859.32	987.75	816.51	225.00	186.00	6.10	471.97	762.75	630.51
Case 4 Transaction between seller and buyer portfolios	2918.73	1370.15	2887.90	1339.92	1749.00	741.00	31.63	30.08	1138.10	741.00

8.3 Simultaneous ATC calculation

Basically, simultaneous ATC calculation of power system employs the same procedures as non-simultaneous ATC as given in this dissertation. Level of complexity due to tremendous combination of possible cases and transactions management are likely to be the technical challenge for this platform of transaction. However, this difficulty can be eliminated when real-time ATC calculation is applied to the system. Since real-time calculation acquires real-time information from EMS system containing up-to-date status of the system such as transmission reservation requests, real-time load, generation dispatch, availability of facilities etc., the calculation does not require numerous of speculated cases as mentioned in off-line study. The consistent market rules to manage transmission right or management such as contingency management and transmission loading relieve (TLR) program are likely to be concerned since they will result in the decision to "granted" or "denied" requests from participants. It is foreseeable that ISO will encounter a big challenge that what is the transparency procedures to "denied" portion of transmission reservation request of they exceed the security limits. This dissertation will propose several guidelines to manage simultaneous ATC in this situation as follows:

a) Reduce equally: Every transmission reservation requests share the same percentage of reduction in order to satisfy security criteria. This approach is simple and straightforward but does not identify that which request creates the congestion.

b) Reduce by the sensitivity to the limiting facilities: Sensitivity analysis between each transmission reservation request and limiting facilities is required in this method. The purpose of this method is to identify the participation factor of each request to the congestion and result in the amount of transaction will be allowed by the ISO. However, nonlinearity and dynamics of power system may affect the accuracy of results that complicate the decision.

c) Employ market rules for transaction: Several market rules may be issued for this situation to help the decision. Example of these rules such as first-in-first-serve basis (transmission reservation requests will be granted by the order they are received), considering amount of transaction if the requests are submitted at the same time (higher amount of transaction dominated small amount of transaction since it lessen the complexity of calculation) are two examples of these rules.

8.4 Conclusions and Discussions

This chapter concludes the concepts and calculation procedures for real-time ATC calculation in deregulated power system. When ATC interface is determined, ATC value at this location is obtained by preparing necessary terms in ATC calculation that are TTC, TRM and ETC respectively. It is seen that the methodology for ATC calculation in this dissertation is based on point-to-point, non-simultaneous, ATC as defined in NERC ATC framework.

However, it is seen that the simulation of simultaneous transactions has marginally covered in this chapter by the study of transaction between generation portfolios and transaction between portfolio and bus. During these scenarios, portfolio that composes of several generation facilities perform itself as many internal transaction to perform a transaction which is similar to simultaneous transaction in power system.

According to simulation results, it is seen that power system contains higher ATC value when seller is a generation portfolio compare to the case when seller is only a generation bus. This is because in the case of seller generation portfolio, generation facilities are distributed in the systems that result in distributed amount of power flow in the system. More transmission lines and bus are available for supplying electricity to customer, which is different from the case of seller, that less transmission lines and bus handle the same situation.

After real-time ATC has been given in specific ATC interface, it becomes a reference for further transactions in power system since it represents the maximum additional power to be securely dispatched throughout the network. Generally, ISO has full responsibility to regularly perform real-time ATC when systems conditions change and then post to public access. Any amount of transaction exceed ATC is considered as unsecured transaction in the systems and usually unauthorized by ISO.