



## **INADVERTENT INTERCHANGE ENERGY PRICING ALTERNATIVES**

Prepared for

**The NAESB Inadvertent Interchange Payback Task Force**

by

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### **1. INTRODUCTION**

The NAESB Inadvertent Interchange Payback Task Force evaluated a preliminary analysis for the pricing Inadvertent Interchange Energy during the May 8 2003 meeting. As an aid in evaluating the additional pricing methods suggested, the Task Force requested the preparation of examples of the additional methods as applied to different conditions. This document presents that proposal in detail and provides example applications of the pricing methods.

Four pricing methods were suggested. They are as follows.

1. Weighted average energy price of the Good Inadvertent Interchange contributors plus an adder to eliminate any gaming by the bad contributors. (Victor Bissonnette – Hydro-Quebec Transenergie)
2. Highest energy price plus an adder to insure that the bad contributors are penalized. (Steve Terelmes – Ameren Energy)
3. Next highest energy price plus an adder to insure that the bad contributors are penalized. (Lou Oberski – Dominion Energy)
4. Each party using its own hourly market price. (Howard Illian – Energy Mark)

Examples of each method are presented and discussed in the following sections.

### **2. MARKET EFFECTS**

The previous paper prepared for this group stated that the power markets that underlie the Inadvertent Interchange would affect the prices available for settlement. Instead of setting arbitrary prices for the Balancing Authorities (BAs), prices are set based on some reasonable assumptions associated with the existence of a robust hourly power market. The following repeats some of the market effects listed in the previous paper.

#### **Market Effects:**

Start with a very simple market, and assume the following:

1. There is an interconnection-wide market in electric energy.
2. The market is efficient.
3. There are no restricted transactions.
4. There are no frequency errors.
5. There are no transmission losses.
6. There is no transmission congestion.
7. There is no charge for using transmission.

Using the above assumptions, some conclusions can be drawn.

The market price should be the same interconnection wide. If any price differential existed, the market would schedule a transaction from the lower price to the higher price. This transaction would reduce the total cost of energy on the interconnection. This interconnection wide price is similar to System Lambda for a single BA.

The examples from the previous paper assumed that prices were different between BAs. These price differences must be explained for the examples to represent the total problem.

### **Buy and Sell Prices:**

Each BA will normally have both a Buy Offer Price and a Sell Offer Price for each hour representing the prices at which it is willing to execute transactions in the hourly market. The difference between these quotes represents the minimum incremental cost of executing the transaction plus the minimum profit that the BA is willing to accept on the transaction. For example, a BA might have a Buy Quote of \$20 / MWh and a Sell Quote of \$22 / MWh. If there are no incremental costs associated with the transaction, the spread indicates the BA's minimum profit required to entice the BA to enter into a transaction. In most cases, these prices will be very close to each other. This will be true even for transactions over long distances.

### **Transmission Use Charges:**

Some of the markets have transmission use charges that are in the range of a few dollars per MWh to pay for the Investment and O&M for the transmission. In many markets these are paid by the power purchaser. Including these charges will increase the price spread between the Buy and Sell Quotes by an amount equal to the Transmission Use Charge. Adding a \$3 / MWh Transmission Use Charge to the above example increases the price spread from the \$2 / MWh to \$5 / MWh. When there are many BAs between the Buyer and the Seller, these charges can add up quickly. This is what FERC refers to when it talks about pan-caking. These charges also reduce the number of transactions that would appear to be profitable. Since there is also no incremental cost associated with an incremental transaction (capital costs are sunk and O&M are not influenced by transacted amount), these charges also make the market less efficient. For the examples shown here, it will be assumed that the Transmission Use Charge is not transaction specific, but instead collected from the end energy user, independent of whether they used wheeled power.

### **Transmission Congestion and Losses:**

The solutions that account for transmission congestion and losses in a market have adequately demonstrated that there are real incremental operating costs associated with both congestion and losses. In addition, these methods have demonstrated that a marginal pricing solution to both the congestion and losses problem are similar in nature and result in marginal prices that vary across the interconnection. In a market these marginal price differences would be expected to appear also in the Buy and Sell Quotes. For example, transmission congestion between two BAs would cause the normal price difference to increase to an amount that includes the cost of managing the congestion. However, this price difference will not appear as an additional spread between the Buy and Sell Quotes for a BA, it will appear as a stable difference in the Buy and Sell Quotes between BAs.

### **Frequency Errors:**

The issue of managing frequency errors has not been addressed in any market design. NERC rules insure that there are no frequency errors inherent in the planning of operations. The requirement that all BAs have balanced schedules is part of this initial planning without frequency error. Therefore, there is no allowance for frequency error and Inadvertent Interchange in the market prices that are represented by the Buy and Sell Quotes from the hourly market.

**Example Interconnection:**

The above effects are used in the creation of the Example Interconnection and the Buy and Sell Quotes that each BA uses within the examples presented. These differences represented in the prices for the examples are important to the understanding of the fair settlement of Inadvertent Interchange.

**3. COMMON ASSUMPTIONS USED**

Each of the four pricing methods investigated are based on a common set of assumptions. The assumption(s) are.

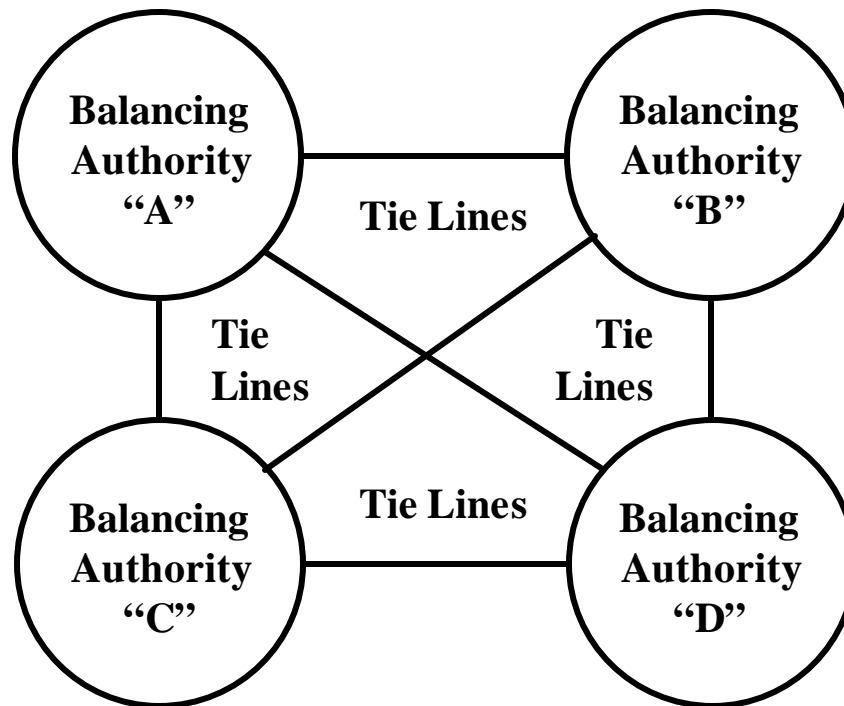
**Assumptions :**

1. Each Balancing Authority has marginal prices available represented by their Buy and Sell Quotes in the hourly market.
2. These marginal prices are consistent with prices that would be observed in an active hourly interchange market.

Using only this assumption, the example methods of settling Inadvertent Interchange on an hourly basis were developed.

**Example Interconnection:**

For all examples, a four Balancing Authority interconnection is used. The BAs are labeled A, B, C and D.



**Figure 1. Example Interconnection**

**Example Prices**

Two sets of BA prices were developed for the example. One set represents the prices that might exist during a peak period. The other set represents the prices that might exist during a minimum load period.

### **Peak Period Prices:**

It is assumed that the marginal prices during the peak period are high and that there is a transmission constraint between A and B, with losses included in the pricing. The prices are: A = \$20-25; B = \$45-50; C = \$30-35; D = \$40-45 per MWh. These prices are consistent with transmission and loss constraints of \$25 / MWh from A to B, \$10 / MWh from A to C, \$20 / MWh from A to D, \$10 / MWh from C to D, \$5 / MWh from D to B, and \$15 / MWh from C to B.

### **Minimum Load Prices:**

It is assumed that the marginal prices during the minimum load period are low, that there are no transmission constraints and that in some cases, the price is negative. These example prices are: A = \$-5-0; B = \$0-5; C = \$0-5; D = \$0-5 per MWh.

### **Transmission Congestion and Losses:**

The same sets of flows and prices are used in the four examples developed. This makes it possible to calculate the costs associated with the transmission congestion and losses in the first two examples. This effect is not included in the prices for the third and fourth examples.

#### **Transmission Congestion and Losses for Example X-1:**

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net reduction of \$475.

#### **Transmission Congestion and Losses for Example X-2:**

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net increase of \$475.

### **Price Discussion:**

If the Inadvertent Interchange settlement method is based on market prices set before the amount of inadvertent is determined, the opportunity for gaming the system for financial advantage is reduced. This result derives from the fact that gaming the price requires the BA to offer that price in the hourly market and risk that it will be accepted for transaction, assuring a loss to the BA as compared to only a potential gain from inadvertent. The market price exposure assures honest prices in a robust market.

## **4. AVERAGE PRICE PLUS BAD CONTRIBUTOR ADDER**

Victor Bissonnette of Hydro Quebec Transenergie suggested setting the settlement price at the average price of the good contributors plus an adder to eliminate gaming by the bad contributors.

### **Settlement Pricing Rules:**

1. If the Frequency Error for the hour is negative, the interconnection frequency is below schedule (low), the hourly sales prices of all BAs with Inadvertent Interchange **Out** should be used to price the settlement.
2. If the Frequency Error for the hour is positive, the interconnection frequency is above schedule (high), the hourly purchase prices of all BAs with Inadvertent Interchange **In** should be used to price the settlement.
3. The average price for settlement is adjusted by an adder to insure that gaming opportunities are eliminated for the bad contributors.

**Example 1-1:**

Interconnection	Frequency Low			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	( In )	( In )	Out	Out
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$50 / MWh	\$50 / MWh	\$45.33 / MWh	\$55.33 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$30 / MWh )	( \$5 / MWh )	\$10.33 / MWh	\$10.33 / MWh
Profit or ( <b>Loss</b> ) Total	( \$ 1,500 )	( \$ 125 )	\$ 600	\$ 125
Interconnection Position	\$ 2,500	\$ 1,250	( \$ 1,813.33 )	( \$ 1,936.67 )

Since the frequency is low, the base settlement price for the Inadvertent Interchange would be the average sales price of the BA with the Inadvertent Interchange Out (  $((40 \times 35 + 35 \times 45) / 75) = 39.67$  ). The adder would raise the price to an amount necessary to eliminate gaming by bad contributors (  $50 - 39.67 = 10.33$  ). The final price would be the highest price of the contributors of bad Inadvertent Interchange (  $39.67 + 10.33 = 50$  ). The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses. In the case above, the extra revenue from the adder was distributed to the good contributors. It could also be retained by the Interconnection.

**Example 1-2:**

Interconnection	Frequency Low			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	Out	Out	( In )	( In )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$36.67 / MWh	\$61.67 / MWh	\$45 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	\$11.67 / MWh	\$11.67 / MWh	( \$15 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	\$ 583.33	\$ 291.67	( \$ 600 )	( \$ 175 )
Interconnection Position	( \$ 1,833.33 )	( \$ 1,541.67 )	\$ 1,800	\$ 1,575

Since the frequency is low, the base settlement price for the Inadvertent Interchange would be the average sales price of the BA with the Inadvertent Interchange Out (  $((50 \times 25 + 25 \times 50) / 75) = 33.33$  ). The adder would raise the price to an amount necessary to eliminate gaming by bad contributors (  $45 - 33.33 = 11.67$  ). The final price would be the highest price of the contributors of bad Inadvertent Interchange (  $33.33 + 11.67 = 45$  ). The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 1-3:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction (Bad)	In	In	( Out )	( Out )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price (Negative)	( \$5 / MWh )	\$0 / MWh	( \$3.33 / MWh )	( \$3.33 / MWh )
Profit or (Loss) / MWh	\$0 / MWh	\$0 / MWh	( \$8.33 / MWh )	( \$8.33 / MWh )
Profit or (Loss) Total	\$0 / MWh	\$0 / MWh	( \$ 333.33 )	( \$ 291.67 )
Interconnection Position	\$ 250	\$ 0	\$ 133.33	\$ 116.67

Since the frequency is high, the base settlement price for the Inadvertent Interchange would be the average purchase price of the BA with the Inadvertent Interchange In (  $((50 \times -5 + 25 \times 0) / 75) = -3.33$  ). The negative adder would lower the price to an amount necessary to eliminate gaming by bad contributors (  $0 - (-3.33) = 3.33$  ). The final price would be the highest price of the contributors of bad Inadvertent Interchange (  $-3.33 + 3.33 = 0$  ). The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 1-4:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction (Bad)	( Out )	( Out )	In	In
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price (Negative)	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or (Loss) / MWh	( \$5 / MWh )	( \$10 / MWh )	\$5 / MWh	\$5 / MWh
Profit or (Loss) Total	( \$ 250 )	( \$ 250 )	\$ 200	\$ 175
Interconnection Position	\$250	\$ 125	( \$ 200 )	( \$ 175 )

Since the frequency is high, the base settlement price for the Inadvertent Interchange would be the average purchase price of the BA with the Inadvertent Interchange In (  $((40 \times 0 + 35 \times 0) / 75) = 0$  ). The adder would lower the price an amount necessary to eliminate gaming by bad contributors (  $-5 - 0 = -5$  ). The final price would be the highest price from contributors of bad Inadvertent Interchange (  $0 - 5 = -5$  ). The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Conclusions:**

This method appears to work well in many cases.

1. This method removes the incentive to game the system.
2. It usually rewards the good contributors and penalizes the bad contributors.
3. It distributes the reward from the penalty evenly among the good contributors.

Some significant weaknesses are associated with this method.

1. The bad contributors may not be penalized. (see example 1-3)
2. The bad contributors may not be equally penalized. (see example 1-1)
3. Good contributors may not be rewarded.
4. The penalties and rewards are associated more with price spread than with value of energy.
5. The costs of managing transmission congestion and losses are not compensated.

This method is unacceptable in this form.

**5. HIGHEST PRICE PLUS BAD CONTRIBUTOR ADDER**

Steve Terelmes of Ameren Energy suggested setting the settlement price at the highest price of energy plus an adder to penalize the bad contributors.

**Settlement Pricing Rules:**

1. If the Frequency Error for the hour is positive, the interconnection frequency is below schedule (low), use the highest hourly price of all BAs to price the settlement.
2. If the Frequency Error for the hour is negative, the interconnection frequency is above schedule (high), use the lowest hourly price of all BAs to price the settlement.
3. The price may be adjusted by an additional penalty on the bad contributor. (Note: an adder is not included in these cases)

**Example 2-1:**

Interconnection	Frequency Low			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction (Bad)	( In )	( In )	Out	Out
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price (Selected)	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price (Negative)	\$50 / MWh	\$50 / MWh	\$50 / MWh	\$50 / MWh
Profit or (Loss) / MWh	( \$30 / MWh )	( \$5 / MWh )	\$15 / MWh	\$5 / MWh
Profit or (Loss) Total	( \$ 1,500 )	( \$ 125 )	\$ 600	\$ 125
Interconnection Position	\$ 2,500	\$ 1,250	( \$ 2,000 )	( \$ 1,750 )

Since the frequency is low, the settlement price for the Inadvertent Interchange would be the price of the BA with the highest market sales price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 2-2:**

Interconnection	Frequency Low			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	Out	Out	( In )	( In )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$50 / MWh	\$50 / MWh	\$50 / MWh	\$50 / MWh
Profit or ( <b>Loss</b> ) / MWh	\$25 / MWh	\$0 / MWh	( \$20 / MWh )	( \$10 / MWh )
Profit or ( <b>Loss</b> ) Total	\$ 1,250	\$ 0	( \$ 800 )	( \$ 350 )
Interconnection Position	( \$ 2,500 )	( \$ 1,250 )	\$ 2,000	\$ 1,750

Since the frequency is low, the settlement price for the Inadvertent Interchange would be the price of the BA with the highest market sales price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 2-3:**

Interconnection	Frequency High			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	In	In	( Out )	( Out )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) / MWh	\$0 / MWh	\$5 / MWh	( \$10 / MWh )	( \$10 / MWh )
Profit or ( <b>Loss</b> ) Total	\$ 0	\$ 125	( \$ 400 )	( \$ 350 )
Interconnection Position	( \$ 250 )	( \$ 125 )	\$ 200	\$ 175

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the lowest market purchase price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 2-4:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority				
Inadvertent Direction ( <b>Bad</b> )	( Out )	( Out )	In	In
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$10 / MWh )	\$5 / MWh	\$5 / MWh
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 250 )	\$ 200	\$ 175
Interconnection Position	\$250	\$ 125	( \$ 200 )	( \$ 175 )

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the lowest market purchase price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Conclusions:**

This method appears to work well in many cases.

1. This method removes the incentive to game the system.
2. It usually rewards the good contributors and penalizes the bad contributors.

Some significant weaknesses are associated with this method.

1. The penalties and rewards are associated more with price spread than with value of energy.
2. Good contributors may not be rewarded.
3. The good contributors may not be equally rewarded.
4. The bad contributors may not be equally penalized.
5. The costs of managing transmission congestion and losses are not compensated.

This method is unacceptable in this form.

**6. NEXT HIGHEST PRICE PLUS BAD CONTRIBUTOR ADDER**

Lou Oberski of Dominion Energy suggested setting the settlement price at the second highest price of energy plus an adder to eliminate gaming and penalize the bad contributors. This is consistent with the design of some auctions that use the second highest price rather than the highest price to reduce the effect of shortages on the prices.

**Settlement Pricing Rules:**

1. If the Frequency Error for the hour is positive, the interconnection frequency is below schedule (low), use the second highest hourly price of all BAs to price the settlement.
2. If the Frequency Error for the hour is negative, the interconnection frequency is above schedule (high), use the second lowest hourly price of all BAs to price the settlement.
3. The price may be adjusted by an additional penalty on the bad contributor. (Note: an adder is not included in these cases)

**Example 3-1:**

Interconnection	Frequency Low			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	( In )	( In )	Out	Out
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$45 / MWh	\$45 / MWh	\$45 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$25 / MWh )	\$0 / MWh	\$10 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) Total	( \$ 1,250 )	\$ 0	\$ 400	\$ 0
Interconnection Position	\$ 2,250	\$ 1,125	( \$ 1,800 )	( \$ 1,575 )

Since the frequency is low, the settlement price for the Inadvertent Interchange would be the price of the BA with the second highest market sales price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 3-2:**

Interconnection	Frequency Low			
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	Out	Out	( In )	( In )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$45 / MWh	\$45 / MWh	\$45 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	\$20 / MWh	( \$5 / MWh )	( \$15 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	\$ 1,000	( \$ 125 )	( \$ 600 )	( \$ 175 )
Interconnection Position	\$ 2,250	\$ 1,125	( \$ 1,800 )	( \$ 1,575 )

Since the frequency is low, the settlement price for the Inadvertent Interchange would be the price of the BA with the second highest market sales price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 3-3:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	In	In	( Out )	( Out )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	\$0 / MWh	\$0 / MWh	\$0 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	\$0 / MWh	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	\$ 0	( \$ 200 )	( \$ 175 )
Interconnection Position	\$ 0	\$ 0	\$ 0	\$ 0

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the second lowest market purchase price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Example 3-4:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	( Out )	( Out )	In	In
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	\$0 / MWh	\$0 / MWh	\$0 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) / MWh	\$0 / MWh	( \$5 / MWh )	\$0 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) Total	\$ 0	( \$ 125 )	\$ 0	\$ 0
Interconnection Position	\$ 0	\$ 0	\$ 0	\$ 0

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the second lowest market purchase price. The Interconnection is neutral, but retains no funds for the settlement of transmission congestion and losses.

**Conclusions:**

This method does not seem to work as well as the second, but the example may not highlight some of the advantages that it offers.

## 7. LOCAL PRICE

Howard Illian of Energy Mark suggested setting the settlement price at the local price of each BA.

### Settlement Pricing Rules:

1. Each BA would use its own price for settling the Energy Component of Inadvertent Interchange.
2. If the Interconnection Frequency is Low, the sale price would be used.
3. If the Interconnection Frequency is High, the purchase price would be used.

### Example 4-1:

Interconnection	Frequency Low			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	( In )	( In )	Out	Out
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$25 / MWh	\$50 / MWh	\$35 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$5 / MWh )	\$0 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 125 )	\$ 0	\$ 0
Interconnection Position	\$ 1,250	\$ 1,250	( \$ 1,400 )	( \$ 1,575 )

Since the frequency is low, each BA would use their hourly sale market price to settle. The Net Interconnection Position is minus \$475 and equals the reduction in the cost of transmission congestion and losses. Only the bad contributors would be subject to a loss limited to their price spread.

### Example 4-2:

Interconnection	Frequency Low			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	Out	Out	( In )	( In )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$25 / MWh	\$50 / MWh	\$35 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	\$0 / MWh	\$0 / MWh	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	\$ 0	\$ 0	( \$ 200 )	( \$ 175 )
Interconnection Position	( \$ 1,250 )	( \$ 1,250 )	\$ 1,400	\$ 1,575

Since the frequency is low, each BA would use their hourly sale market price to settle the Inadvertent Interchange. The Net Interconnection Position is plus \$475 and equals the increase in cost of transmission congestion and losses. Only the bad contributors would be subject to a loss limited to their price spread.

**Example 4-3:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction (Bad)	In	In	( Out )	( Out )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price (Selected)	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price (Negative)	( \$5 / MWh )	\$0 / MWh	\$0 / MWh	\$0 / MWh
Profit or (Loss) / MWh	\$0 / MWh	\$0 / MWh	( \$5 / MWh )	( \$5 / MWh )
Profit or (Loss) Total	\$ 0	\$ 0	( \$ 200 )	( \$ 175 )
Interconnection Position	( \$ 250 )	\$0 / MWh	\$0 / MWh	\$0 / MWh

Since the frequency is high, each BA would use their hourly purchase market price to settle the Inadvertent Interchange. The Net Interconnection Position is minus \$250. This net position is a result of the price spread. Only the bad contributors would be subject to a loss limited to their price spread.

**Example 4-4:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction (Bad)	( Out )	( Out )	In	In
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price (Selected)	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price (Negative)	( \$5 / MWh )	\$0 / MWh	\$0 / MWh	\$0 / MWh
Profit or (Loss) / MWh	( \$5 / MWh )	( \$5 / MWh )	\$0 / MWh	\$0 / MWh
Profit or (Loss) Total	( \$ 250 )	( \$ 125 )	\$ 0	\$ 0
Interconnection Position	\$250	\$ 0	\$ 0	\$ 0

Since the frequency is high, each BA would use their hourly purchase market price to settle the Inadvertent Interchange. The Net Interconnection Position is plus \$250. This net position is a result of the price spread. Only the bad contributors would be subject to a loss limited to their price spread.

**Conclusions:**

This method appears to work well in many cases.

1. This method removes the incentive to game the system.
2. Bad contributors are equally penalized.
3. It provides an opportunity to compensate for transmission congestion and losses.

Some difficulties are associated with the method.

1. Good contributors are not rewarded.
2. The Interconnection incurs some compensation risk due to price spread.

This method could be supplemented with appropriate compensation for frequency services provided.

**8. ALTERNATIVE LOCAL PRICE ( ADDED EXAMPLE )**

An alternative local pricing method could be used in place of the method above. This method would eliminate the ability to game the system by increasing the price spread and would encourage the minimization of the price spread. It only requires a small change in the rules.

**Settlement Pricing Rules:**

1. Each BA would use its own price for settling the Energy Component of Inadvertent Interchange.
2. If the Inadvertent Interchange is In, the sale price would be used.
3. If the Inadvertent Interchange is Out, the purchase price would be used.

**Example 5-1:**

Interconnection	Frequency Low			
	A	B	C	D
Balancing Authority				
Inadvertent Direction ( <b>Bad</b> )	( In )	( In )	Out	Out
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$25 / MWh	\$50 / MWh	\$30 / MWh	\$40 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 125 )	( \$ 200 )	( \$ 175 )
Interconnection Position	\$ 1,250	\$ 1,250	( \$ 1,200 )	( \$ 1,400 )

Each BA would use their hourly market price based on the direction of the Inadvertent Interchange to settle the Inadvertent Interchange. The Net Interconnection Position is minus \$100 and is less than the reduction in the cost of transmission congestion and losses of \$475. All contributors would be subject to a loss limited to their price spread.

**Example 5-2:**

Interconnection	Frequency Low			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	Out	Out	( In )	( In )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	\$20-25 / MWh	\$45-50 / MWh	\$30-35 / MWh	\$40-45 / MWh
Settlement Price ( <b>Negative</b> )	\$20 / MWh	\$45 / MWh	\$35 / MWh	\$45 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 125 )	( \$ 200 )	( \$ 175 )
Interconnection Position	( \$ 1,000 )	( \$ 1,125 )	\$ 1,400	\$ 1,575

Each BA would use their hourly market price based on the direction of the Inadvertent Interchange to settle the Inadvertent Interchange. The Net Interconnection Position is plus \$850 and is greater than the increase in the cost of transmission congestion and losses of \$475. All contributors would be subject to a loss limited to their price spread.

**Example 5-3:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	In	In	( Out )	( Out )
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	\$0 / MWh	\$5 / MWh	\$0 / MWh	\$0 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 125 )	( \$ 200 )	( \$ 175 )
Interconnection Position	\$0 / MWh	\$125 / MWh	\$0 / MWh	\$0 / MWh

Each BA would use their hourly market price based on the direction of the Inadvertent Interchange to settle the Inadvertent Interchange. The Net Interconnection Position is plus \$125. This net position is a result of the price spread. All contributors would be subject to a loss limited to their price spread.

**Example 5-4:**

Interconnection	Frequency High			
	A	B	C	D
Balancing Authority	A	B	C	D
Inadvertent Direction ( <b>Bad</b> )	( Out )	( Out )	In	In
Inadvertent Amount - MW	50 MW	25 MW	40 MW	35 MW
Energy Price ( <b>Selected</b> )	-\$5-0 / MWh	\$0-5 / MWh	\$0-5 / MWh	\$0-5 / MWh
Settlement Price ( <b>Negative</b> )	( \$5 / MWh )	\$0 / MWh	\$5 / MWh	\$5 / MWh
Profit or ( <b>Loss</b> ) / MWh	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )	( \$5 / MWh )
Profit or ( <b>Loss</b> ) Total	( \$ 250 )	( \$ 125 )	( \$ 200 )	( \$ 175 )
Interconnection Position	\$250	\$ 0	\$ 200	\$ 175

Each BA would use their hourly market price based on the direction of the Inadvertent Interchange to settle the Inadvertent Interchange. The Net Interconnection Position is plus \$625. This net position is a result of the price spreads. All contributors would be subject to a loss limited to their price spread.

**Conclusions:**

This method appears to work well.

1. This method removes the incentive to game the system.
2. Bad contributors are equally penalized.
3. It provides an opportunity to compensate for transmission congestion and losses.
4. This method encourages the minimization of price spread and improves market efficiency.

Some difficulties are associated with the method.

1. Good contributors are penalized for their price spread.

This method could be supplemented with appropriate compensation for frequency services provided.

**9. OTHER CONSIDERATIONS**

The issue of how to handle the costs associated with transmission congestion and losses still needs to be addressed.

Further investigation could be performed on the effect of price spreads.

**10. OBSERVATIONS AND RECOMMENDATIONS**

Methods 4 and 5 assure that the costs of congestion and losses at marginal prices are included in the compensation for inadvertent. These methods address both the energy and transmission congestion components of the Inadvertent Interchange as suggested in the NERC JIITF document.

The IIPTF should investigate the settlement of transmission congestion and losses included in the market energy prices. Specifically, how does the compensation get to the correct party?

Methods 4 and 5 do not address the compensation for frequency control.

The IIPTF should investigate the compensation provided by the NERC JIITF Frequency Control Component. This could be the supplemental compensation necessary to enable either Method 4 or 5 to provide the correct price signals for Inadvertent Interchange in all cases.