RECENT 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. A technical paper[1] was prepared and these additional examples were considered at the June 4, 2003 meeting. The two most promising alternatives from those additional examples were retained for further consideration. Those alternatives were: 1) highest energy price plus an adder to insure that the bad contributors are penalized, and 2) each party to use its own hourly market price. This document presents an evaluation of the latest proposal and the two retained proposals in detail and provides example applications of the pricing alternatives.

The three pricing alternatives evaluated are as follows.

1. Highest energy price plus an adder to insure that the bad contributors are penalized. (Steve Terelmes – Ameren Energy)
2. Each party using its own hourly market price. (Howard Illian – Energy Mark)
3. Highest energy price with a +/-0.015 Hz dead-band. (Al DiCaprio – PJM)

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

2. MARKET EFFECTS

A 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.

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[1] **Illian, H. F.**, Inadvertent Interchange Energy Pricing Alternatives, May 28, 2003, Presented at the NAESB Inadvertent Interchange Payback Task Force Meeting on June 4, 2003, NAESB Document weq_iiptf060403w3.pdf.

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.

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. 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. 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.

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 prices 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 a marginal price available represented by their hourly market price.
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.

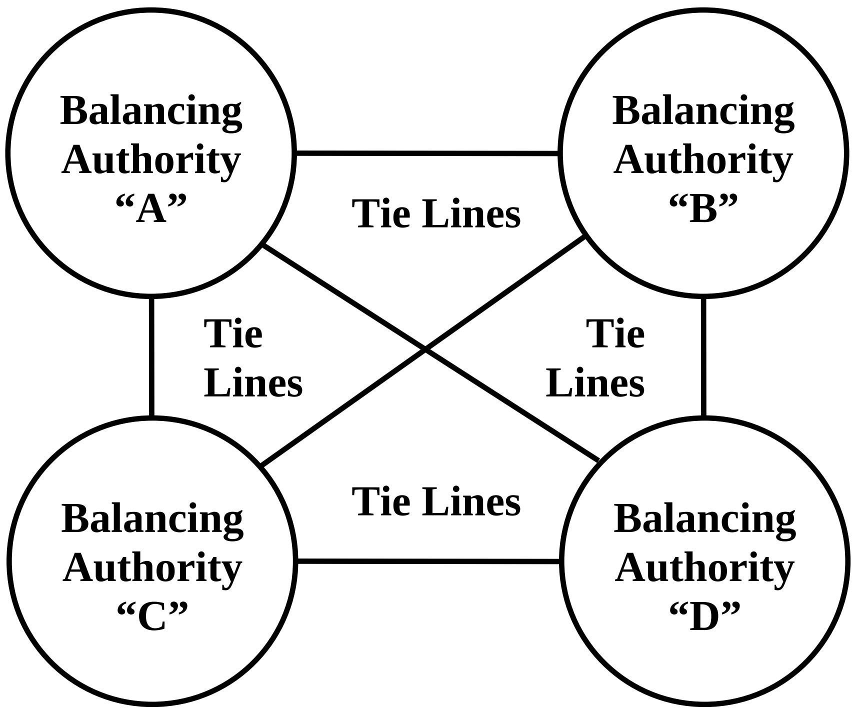

Figure 1. Example Interconnection

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 = $25; B = $50; C = $35; D = $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 also transmission constraints, and that in some cases, the price is negative. These example prices are: A = $-5; B = $5; C = $0; D = $5 per MWh. These prices are consistent with transmission and loss constraints of $10 / MWh from A to B, $5 / MWh from A to C, $10 / MWh from A to D, $5 / MWh from C to D, $5 / MWh from C to B, and no constraint from D to B.

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.

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.

Transmission Congestion and Losses for Example X-3:

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-4:

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.

Transmission Congestion and Losses for Example X-5:

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net reduction of $300.

Transmission Congestion and Losses for Example X-6:

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net increase of $300.

Transmission Congestion and Losses for Example X-7:

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net reduction of $300.

Transmission Congestion and Losses for Example X-8:

As long as the net flows shown in this example are maintained, the congestion cost associated with the case is a net increase of $300.

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. 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 1-1:

Interconnection	**Frequency Low**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**
Profit or (Loss) / MWh	**($25 / MWh)**	**$0 / MWh**	**$15 / MWh**	**$5 / MWh**
Profit or (Loss) Total	**($ 1,250)**	**$ 0**	**$ 600**	**$ 175**
Interconnection Position	**$ 2,500**	**$ 1,250**	**($ 2,000)**	**($ 1,750)**

Example 1-2:

Interconnection	**Frequency Low**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**
Profit or (Loss) / MWh	**$25 / MWh**	**$0 / MWh**	**($15 / MWh)**	**($5 / MWh)**
Profit or (Loss) Total	**$ 1,250**	**$ 0**	**($ 600)**	**($ 175)**
Interconnection Position	**($ 2,500)**	**($ 1,250)**	**$ 2,000**	**$ 1,750**

For both examples 1-1 and 1-2, 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.

Example 1-3:

Interconnection	Frequency High			
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)	$25 / MWh	$50 / MWh	$35 / MWh	$45 / MWh
Settlement Price (Negative)	$25 / MWh	$25 / MWh	$25 / MWh	$25 / MWh
Profit or (Loss) / MWh	$0 / MWh	$25 / MWh	($10 / MWh)	($20 / MWh)
Profit or (Loss) Total	$ 0	$ 625	($ 400)	($ 700)
Interconnection Position	$ 1,250	$ 625	($ 1,000)	($ 875)

Example 1-4:

Interconnection	Frequency High			
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)	$25 / MWh	$50 / MWh	$35 / MWh	$45 / MWh
Settlement Price (Negative)	$25 / MWh	$25 / MWh	$25 / MWh	$25 / MWh
Profit or (Loss) / MWh	$0 / MWh	($25 / MWh)	$10 / MWh	$20 / MWh
Profit or (Loss) Total	$ 0	($ 625)	$ 400	$ 700
Interconnection Position	($ 1,250)	($ 625)	$ 1,000	$ 875

For both examples 1-3 and 1-4, since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the lowest market sales price.

Example 1-5:

Interconnection	Frequency High			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	($5 / MWh)	($5 / MWh)	($5 / MWh)	($5 / MWh)
Profit or (Loss) / MWh	$0 / MWh	$5 / MWh	($5 / MWh)	($10 / MWh)
Profit or (Loss) Total	$ 0	$ 125	($ 200)	($ 350)
Interconnection Position	($ 250)	($ 125)	$ 200	$ 175

Example 1-6:

Interconnection	Frequency High			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	($5 / MWh)	($5 / MWh)	($5 / MWh)	($5 / MWh)
Profit or (Loss) / MWh	$0 / MWh	($10 / MWh)	$5 / MWh	$10 / MWh
Profit or (Loss) Total	$ 0	($ 250)	$ 200	$ 350
Interconnection Position	$250	$ 125	($ 200)	($ 175)

For both examples 1-5 and 1-6, 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.

Example 1-7:

Interconnection	**Frequency Low**			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**$5 / MWh**	**$5 / MWh**	**$5 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**($10 / MWh)**	**$0 / MWh**	**$5 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**($ 500)**	**$ 0**	**$ 200**	**$ 0**
Interconnection Position	**$ 250**	**$ 125**	**($ 200)**	**($ 175)**

Example 1-8:

Interconnection	**Frequency Low**			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**$5 / MWh**	**$5 / MWh**	**$5 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**$10 / MWh**	**$0 / MWh**	**($5 / MWh)**	**$0 / MWh**
Profit or (Loss) Total	**$ 500**	**$ 0**	**($ 200)**	**$ 0**
Interconnection Position	**($ 250)**	**($ 125)**	**$ 200**	**$ 175**

For both examples 1-7 and 1-8, since the frequency is low, the settlement price for the Inadvertent Interchange would be the price of the BA with the highest market purchase price.

In all of the examples 1-1 through 1-8 the Interconnection is financially neutral, but retains no funds for the settlement of transmission congestion and losses.

Conclusions:

This alternative appears to work well in many cases.

1. It removes the incentive to manipulate 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 differences than with value of energy.

2. The good contributors may not be rewarded.
3. The good contributors may not be equally rewarded.
4. The bad contributors may not be penalized.
5. The bad contributors may not be equally penalized.
6. The final compensation excludes the effects of managing transmission congestion and losses.

The only way to insure that good contributors always get rewarded and bad contributors always get penalized is to include the adder to penalize bad contributors and use those penalties to reward good contributors.

This alternative is unacceptable in this form because of the arbitrary magnitude of the penalties and rewards.

5. LOCATIONAL PRICE

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

Settlement Pricing Rules:

1. Each BA would use its own price for settling the Energy Component of Inadvertent Interchange.

For all examples 2-1 through 2-8, each BA would use their hourly sale market price to settle the Inadvertent Interchange.

Example 2-1:

Interconnection	Frequency Low			
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)	$25 / MWh	$50 / MWh	$35 / MWh	$45 / MWh
Settlement Price (Negative)	$25 / MWh	$50 / MWh	$35 / MWh	$45 / MWh
Profit or (Loss) / MWh	$0 / MWh	$0 / MWh	$0 / MWh	$0 / MWh
Profit or (Loss) Total	$ 0	$ 0	$ 0	$ 0
Interconnection Position	$ 1,250	$ 1,250	($ 1,400)	($ 1,575)

The Net Interconnection Position is minus $475 and equals the decrease in cost of transmission congestion and losses.

Example 2-2:

Interconnection	Frequency Low			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**($ 1,250)**	**($ 1,250)**	**$ 1,400**	**$ 1,575**

The Net Interconnection Position is plus $475 and equals the increase in cost of transmission congestion and losses.

Example 2-3:

Interconnection	Frequency High			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**$ 1,250**	**$ 1,250**	**($ 1,400)**	**($ 1,575)**

The Net Interconnection Position is minus $475 and equals the decrease in cost of transmission congestion and losses.

Example 2-4:

Interconnection	**Frequency High**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**($ 1,250)**	**($ 1,250)**	**$ 1,400**	**$ 1,575**

The Net Interconnection Position is plus $475 and equals the increase in cost of transmission congestion and losses.

Example 2-5:

Interconnection	**Frequency High**			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**($5 / MWh)**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**($ 250)**	**$ 125**	**$ 0**	**($ 175)**

The Net Interconnection Position is minus $300 and equals the decrease in cost of transmission congestion and losses.

Example 2-6:

Interconnection	Frequency High			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**($5 / MWh)**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**$ 250**	**($ 125)**	**$ 0**	**$ 175**

The Net Interconnection Position is plus $300 and equals the increase in cost of transmission congestion and losses.

Example 2-7:

Interconnection	Frequency Low			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**($5 / MWh)**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**($ 250)**	**$ 125**	**$ 0**	**($ 175)**

The Net Interconnection Position is minus $300 and equals the decrease in cost of transmission congestion and losses.

Example 2-8:

Interconnection	**Frequency Low**			
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 / MWh**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Settlement Price (Negative)	**($5 / MWh)**	**$5 / MWh**	**$0 / MWh**	**$5 / MWh**
Profit or (Loss) / MWh	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**	**$0 / MWh**
Profit or (Loss) Total	**$ 0**	**$ 0**	**$ 0**	**$ 0**
Interconnection Position	**$ 250**	**($ 125)**	**$ 0**	**$ 175**

The Net Interconnection Position is plus $300 and equals the increase in cost of transmission congestion and losses.

Conclusions:

This alternative appears to work well in many cases.

1. This method removes the incentive to manipulate the system.
2. It includes the effects of transmission congestion and losses in the final compensation.
3. There are no arbitrary rewards or penalties included in the compensation.

There are some weaknesses associated with the method.

1. The good contributors are not rewarded.
2. The bad contributors are not penalized.
3. The interconnection incurs some compensation risk due to locational price differences.

If this alternative is combined with a separate method for penalizing bad contributors and rewarding good contributors, weakness 1. and 2. above could be eliminated leaving the compensation risk due to locational price differences as the only weakness.

This alternative is unacceptable in this form. If the interconnection risk problem can be resolved and it could be coupled with an acceptable method to penalize bad contributors and reward good contributors this method could be workable.

6. HIGHEST PRICE WITH +/- 0.015 HZ DEAD-BAND

Al DiCaprio of PJM suggested setting the settlement price at the highest price of energy with a +/- 0.015 Hz dead-band. Although the description of the pricing proposal was deficient in detail, the spreadsheet example included sufficient information to develop the following settlement pricing rules.

Settlement Pricing Rules:

1. If the Frequency Error for the hour is negative, 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 positive, the interconnection frequency is above schedule (high), use the highest hourly price of all BAs with the sign reversed to price the settlement.
3. Only hours with Frequency Error above +0.015 Hz or below -0.015 Hz will be financially settled.

The examples show the settlement for those hours when the Frequency Error is outside the dead-band.

Example 3-1:

Interconnection	**Frequency Low**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**
Profit or (Loss) / MWh	**($25 / MWh)**	**$0 / MWh**	**$15 / MWh**	**$5 / MWh**
Profit or (Loss) Total	**($ 1,250)**	**$ 0**	**$ 600**	**$ 175**
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.

Example 3-2:

Interconnection	**Frequency Low**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**	**$50 / MWh**
Profit or (Loss) / MWh	**$25 / MWh**	**$0 / MWh**	**($15 / MWh)**	**($5 / MWh)**
Profit or (Loss) Total	**$ 1,250**	**$ 0**	**($ 600)**	**($ 175)**
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.

Example 3-3:

Interconnection	**Frequency High**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**($50 / MWh)**	**($50 / MWh)**	**($50 / MWh)**	**($50 / MWh)**
Profit or (Loss) / MWh	**$75 / MWh**	**$100 / MWh**	**($85 / MWh)**	**($95 / MWh)**
Profit or (Loss) Total	**$ 3,750**	**$ 2,500**	**($ 3,400)**	**($ 3,325)**
Interconnection Position	**($ 2,500)**	**($ 1,250)**	**$ 2,000**	**$ 1,750**

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the highest market sales price with the sign reversed.

Example 3-4:

Interconnection	**Frequency High**			
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)	**$25 / MWh**	**$50 / MWh**	**$35 / MWh**	**$45 / MWh**
Settlement Price (Negative)	**($50 / MWh)**	**($50 / MWh)**	**($50 / MWh)**	**($50 / MWh)**
Profit or (Loss) / MWh	**($75 / MWh)**	**($100 / MWh)**	**$85 / MWh**	**$95 / MWh**
Profit or (Loss) Total	**($ 3,750)**	**($ 2,500)**	**$ 3,400**	**$ 3,325**
Interconnection Position	**$ 2,500**	**$ 1,250**	**($ 2,000)**	**($ 1,750)**

Since the frequency is high, the settlement price for the Inadvertent Interchange would be the price of the BA with the highest market sales price with the sign reversed.

Example 3-5:

Interconnection	Frequency High			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	($5 / MWh)	($5 / MWh)	($5 / MWh)	($5 / MWh)
Profit or (Loss) / MWh	$0 / MWh	$10 / MWh	($5 / MWh)	($10 / MWh)
Profit or (Loss) Total	$ 0	$ 250	($ 200)	($ 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.

Example 3-6:

Interconnection	Frequency High			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	($5 / MWh)	($5 / MWh)	($5 / MWh)	($5 / MWh)
Profit or (Loss) / MWh	$0 / MWh	($10 / MWh)	$5 / MWh	$10 / MWh
Profit or (Loss) Total	$ 0	($ 250)	$ 200	$ 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.

Example 3-7:

Interconnection	Frequency Low			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	$5 / MWh	$5 / MWh	$5 / MWh	$5 / MWh
Profit or (Loss) / MWh	($10 / MWh)	$0 / MWh	$5 / MWh	$0 / MWh
Profit or (Loss) Total	($ 500)	$ 0	$ 200	$ 0
Interconnection Position	$ 250	$ 125	($ 200)	($ 175)

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.

Example 3-8:

Interconnection	Frequency Low			
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 / MWh	$5 / MWh	$0 / MWh	$5 / MWh
Settlement Price (Negative)	$5 / MWh	$5 / MWh	$5 / MWh	$5 / MWh
Profit or (Loss) / MWh	$10 / MWh	$0 / MWh	($5 / MWh)	$0 / MWh
Profit or (Loss) Total	$ 500	$ 0	($ 200)	$ 0
Interconnection Position	($ 250)	($ 125)	$ 200	$ 175

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.

In all of the above examples 3-1 through 3-8, the Interconnection is neutral, and retains no funds for the settlement of transmission congestion and losses.

Conclusions:

This alternative appears to work well in those cases where the frequency is high.

1. It removes the incentive to manipulate 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 differences 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 penalized.
5. The bad contributors may not be equally penalized.
6. The magnitude of the penalties and rewards is many times greater when there is high frequency than when there is low frequency.
7. The costs of managing transmission congestion and losses are not compensated.

The unequal magnitude of the penalties and rewards for high frequency versus low frequency creates an additional problem with this method. Because the penalties and rewards for high frequency are significantly greater than the penalties and rewards for low frequency, the settlement will create a natural bias to under-generate. That bias will increase as market prices increase. Since market prices are highest during the day, the method will create the greatest bias to under-generate during the day. This is contrary to good operating practice and good reliability.

The only way to insure that good contributors always get rewarded and bad contributors always get penalized is to include the adder to penalize bad contributors and use those penalties to reward good contributors.

This alternative is unacceptable in this form and should be ranked below most of the alternatives already investigated.

7. OBSERVATIONS AND RECOMMENDATIONS

Alternatives 1 is still the best alternative of those considered that do not include a provision for locational prices. Alternative 1 requires an additional penalty and reward adder to insure that the settlement signals the correct action.

Alternative 2 is still the best alternative of those considered that include provision for locational prices. Alternative 2 also requires an additional penalty and reward adder to insure that the settlement signals the correct action.

Alternative 3 does not simplify the either the Alternative 1 or the Alternative 2 proposals. Alternative 3 also requires an additional penalty and reward adder to insure that the settlement signals the correct action.

Selection of any of the three above alternatives still requires consideration of a separate penalty and reward adder to insure that the settlement signals the correct action. The Frequency Control Component could provide the necessary signal in the settlement process.

The IIPTF should continue to investigate the compensation provided by the NERC JIITF Frequency Control Component. This could be the supplemental compensation necessary to enable either Alternative 1 or 2 to provide the correct price signals for Inadvertent Interchange in all cases.

The investigation of Alternative 3 above has failed to provide an alternative better that those currently being considered or any methods that would improve on the alternatives already on the table. The NAESB IIPTF should continue on the previous path of investigation it was pursuing prior to the deviating to consider Alternative 3.