NATIVE-MARKET-PRICING FOR INADVERTENT INTERCHANGE

Prepared for

The NAESB Inadvertent Interchange Payback Task Force

by

Howard F. Illian, President
Energy Mark, Inc.
334 Satinwood Ct. N.
Buffalo Grove, Illinois 60089
March 25, 2004

1. INTRODUCTION

The NAESB Inadvertent Interchange Payback Task Force has evaluated a number of alternatives for pricing the Energy Component of Inadvertent Interchange. This paper provides support for a pricing alternative and the rational for selecting that alternative. It enumerates insights derived from preparing examples of the many pricing alternatives.

The choice of the Native-Market-Pricing[1] alternative is based as much on the disadvantages of the other alternatives as it is on the advantages of the Native-Market-Pricing alternative. One lesson that has been learned from the weaknesses and failures of power markets is that first, the pricing method must do no harm to the market. This is much the same as the primary rule of medicine. Only by following a path that first does no harm to the market is success likely to be achieved.

2. SINGLE-PRICE VERSUS MULTIPLE-PRICE MARKETS

Although I have spent literally years studying power markets, most of my efforts have been directed toward the study of Ancillary or Reliability Services. As we began to investigate the Energy Component of Inadvertent Interchange I started with many of the same biases toward single-price markets as others in the group. However, during the investigation of these alternatives I realized that there was a fundamental question with respect to the type of market within which we are working.

Single-price Design:

When restructuring began the preferred method of selecting the market price for power markets was a Single-Price auction. From a theoretical point of view, this is still the preferred method for many market designs when there are no transmission constraints that cause the market to experience multiple prices. The performance of many of these markets was observed to be less than acceptable because the transmission constraints caused price differences between market regions. These price differences could be manipulated in the Single-Price market design to extract unreasonable profits by some market participants. These market limitations contributed to the market problems experienced in California, New England, Texas and elsewhere. All of these markets have since modified their designs to include some form of Multiple-Pricing (most use Locational Marginal Pricing, LMP) to reduce the detrimental effects that valid price differences can have on the market.

---

[1] Defining Native-Market-Pricing: There are many different market designs currently in use in North America. Most of these designs use locational prices because locational prices enable the market to function correctly when the markets are constrained. The FERC SMD is just one of these designs that recognize transmission constraints. Markets can be constrained for many reasons including transmission constraints, losses, transmission use charges, lack of contracts or lack of contracting authority. In a constrained market, the prices for energy will vary from location to location regardless of the market design. However, the market design can affect the relative price variation. Native-Market-Pricing is the recognition of the price(s) provided by the market design used in the native area. Native-Market-Pricing explicitly recognizes there are many market designs in use and that to prevent harm to the native market, the best price to use is the price provided by that market.

Native-Market-Price Alternative:

As we began developing the energy price component, a task that was not done as part of the JIITF, I began to realize that the alternatives we were considering were based on the assumptions of a Single-Priced market. Therefore, the best of the Single-Price alternatives, the highest price plus a bad contributor adder (Example 2), still contained all of the disadvantages associated with attempting to manage a Multiple-Priced market with a Single-Price alternative. This is why I suggested that an alternative that actually used the Native-Market-Prices to represent the Energy Component be investigated along with the other alternatives. The development of the alternative examples leads me to conclude that the best alternative for pricing the Energy Component of Inadvertent Interchange is a Native-Market-Pricing alternative.

3. REVIEW OF THE ALTERNATIVES CONSIDERED

Four pricing alternatives are currently being considered by the IIPTF. They are:

1. Highest energy price plus an adder to insure that the bad contributors are penalized. (Steve Terelmes – Ameren Energy)
2. Highest regional energy price plus a percentage of energy price adder with a Pay-In-Kind frequency dead-band. (Tony Reed – Southern Company)
3. Highest energy price with a +/-0.015 Hz no payback frequency dead-band. (Al DiCaprio – PJM)
4. Each party using its own hourly market price plus a frequency dependent adder. (Howard Illian – Energy Mark)

Examples of each method are presented and discussed in Appendix 1.

The results of these examples are shown in Table 1 – Summary of Alternatives on page 5. These results are presented relative to the three components of Inadvertent Interchange as stated in the JIITF White Paper and the initial charge of the NAESB IIPTF. These three components are indicated by the column headings of E, for Energy Component, T, for Transmission Component, and F, for Frequency Component. Each of the components is evaluated with respect to the direction of the incentive, the magnitude of the incentive and the additional effect of the suggested adder on these base incentives.

4. SINGLE-PRICE ENERGY COMPONENT ALTERNATIVES

There are a number of characteristics of the single energy price alternatives that we have considered that make them unacceptable as a valuation method for Energy Component of Inadvertent Interchange. Many of these disadvantages are discussed below.

Single-Price Selection:

The selection of a Single-Price to use in a Single-Price Energy Component alternative requires the selection of the highest price from all of the available prices when frequency is low and the lowest price from all of the available prices when frequency is high. The selection of any other single price creates the opportunity for control areas to manipulate Inadvertent Interchange to their advantage, if their price is higher than the selected price when frequency is low or their price is lower than the selected price when frequency is high. This opportunity to manipulate Inadvertent Interchange is unacceptable in a market because is encourages a control area to exchange services reserved to manage reliability for economic gain thus reducing the interconnections ability to respond to emergencies and reducing reliability.

Balanced Compensation:

All of the Single-Price alternatives result in a balance between total revenue collected for Inadvertent Interchange and the total revenue paid out for Inadvertent Interchange. This revenue derives directly from the fact that Inadvertent Interchange In and Inadvertent Interchange Out is always balanced for every hour. This balancing of revenue coupled with the selection of either the highest price or the lowest price insures that all participants with Inadvertent Interchange In will pay the same settlement price for energy and all participants with Inadvertent Interchange Out will receive the same settlement price for energy, although these prices could be negative in some cases. Therefore, the balanced compensation results in penalties in the form of price differences between the Native-Market-Price and the settlement price for those with bad Inadvertent Interchange that is more dependent on magnitude of transmission constraints than it is on the effect on reliability. This balanced compensation also results in rewards in the form of price differences between the Native-Price and the settlement price for those with good Inadvertent Interchange that is more dependent on magnitude of transmission constraints than it is on the effect on reliability. This characteristic of potential over-reward and over-penalization is unacceptable. The addition of a Bad Contributor Adder can only modify these unjustified levels of penalty and reward.

Un-penalized and Un-rewarded Participants:

In the Single-Price alternatives, the party whose price is used to set the Inadvertent Interchange price will not pay a penalty or receive a reward. In addition, others with the same price will also be in the same position of not being penalized for bad inadvertent or rewarded for good inadvertent. Therefore, to insure that these parties are properly penalized and rewarded for their behavior their price must be modified by an adder to incent the correct behavior. Even the Single-Price alternatives require a behavior adder.

Constraint Bypass:

If the market price differences result from valid system constraints, the compensation differences for Inadvertent Interchange will not maintain those price differences. This results in the provider of good Inadvertent Interchange receiving compensation that should go to the party managing the system constraint. Providing that compensation to the wrong party insures that the constraint is subject to bypass. Discouraging constraint bypass is one of the major reasons that markets are moving to Multiple-Pricing alternatives.

Conclusions:

1. Single-Price alternatives require prices from all participants to identify the highest or lowest price.
2. Single-Price alternatives result in penalties and rewards that are unrelated to the reliability problem.
3. Single-Price alternatives still require adders to insure that penalties and rewards are provided for all participants.
4. Single-Price alternatives do not respect system constraints that Native-Market-Prices represent.

5. NATIVE-MARKET-PRICE ENERGY COMPONENT ALTERNATIVES

As analysis of the pricing alternatives moved forward, I realized that the Single-Price alternative created perverse effects because of the base price differences between interconnection locations. Valid prices are required from each participant to insure that the highest or lowest price is selected. Even the choice of a Single-Price would not eliminate the need to have an adder to assure that all parties are penalized for bad Inadvertent Interchange and rewarded for good Inadvertent Interchange. Therefore, the Single-Price alternative is no simpler than a Native-Market-Price alternative. Since the Native-Market-Price alternative is no more complex than the Single-Price alternative, why not make the Energy Price Component neutral by selecting the Native-Market-Price and use just the adder to reward good behavior and penalized bad behavior.

Single-Price Disadvantages Corrected by Native-Market-Pricing:

The selection of a Native-Market-Price solution eliminates most of the disadvantages associated with the Single-Price alternatives.

1. Most opportunities to manipulate the market are eliminated because each participant sees its own price as the Energy Component Price. There is no need to select the highest or lowest price.
2. Since the prices are different, the compensation is not balanced. Therefore, there is no unjustified penalty or reward related to the price differences.
3. All participants remain unrewarded by the Energy Component Price. Therefore, the Frequency Component is the only penalty or reward for bad or good Inadvertent Interchange. This demands that the penalty reward adder, Frequency Control Component, be well supported technically. In the Single-Price alternatives the adder could be overlooked easily and based on judgment alone.
4. Since Native-Market-Prices are used there is no need to design an Energy Component pricing system. This method relies solely on the hourly market to set prices and leaves the native market in control of the Energy Component pricing rules. If the native energy market design is changed, then the change will automatically be reflected in the Inadvertent Interchange Energy Component Price. As a result, there will be no constraint bypass of valid system constraints reflected in the market prices.

Native-Market-Pricing Compensation Balance:

As with all Multiple-Pricing methods, there is no assurance that the revenues for the Inadvertent Interchange Energy Components Out will equal the revenues for Inadvertent Interchange Energy Components In. There are some factors that may allow us to estimate the long-term position that the Interconnection will be required to support.

1. If Inadvertent Interchange is driven by random error, even a Native-Market-Pricing method will tend to be revenue neutral over the long-term.
2. If as others have suggested, that higher prices tend to incent leaning on the interconnection for energy and lower prices tend to result in over-generation, it will only take a small bias in these directions coupled with the first factor to put the interconnection in a positive revenue position over the long-term.
3. This means that a method to distribute this excess revenue back to the market without creating market distortions will be required.

The above compensation balance indicates the risk associated with revenue adequacy is small.

Frequency Control Component:

The Frequency Control Component of Inadvertent Interchange would provide the penalty and reward adder. The penalties and rewards would be more than just an arbitrary adjustment. Because the Frequency Control Component is designed to provide appropriate compensation for the supply and use of Ancillary or Reliability Services provided to others to control the interconnection energy balance and interconnection frequency, it can be a cost justified tariff initially and potentially turned into a market based adjustment in the long-term as Reliability Markets develop.

6. RECOMMENDATIONS

The NAESB IIPTF should move forward with the development of a Native-Market-Price based Energy Component pricing model. Only this alternative supports all of the different market designs being implemented interconnection wide because only this model defers the full pricing mechanism to the hourly market. This method addresses both the energy and transmission congestion (constraint) components of the Inadvertent Interchange as suggested in the NERC JIITF document.

The IIPTF should investigate the compensation provided by the NERC JIITF Frequency Control Component. This could be the supplemental compensation necessary to enable native Energy Component pricing to provide the correct price signals for Inadvertent Interchange in all cases.

Summary of Alternatives Table 1

ALTERNATIVE	EXAMPLE	1			2			3			4			5			6			7			8		
	Prices	High			High			High			High			Low			Low			Low			Low		
	Frequency	Low			Low			High			High			Low			Low			High			High		
	Inadvertent	In / Out			Out / In			In / Out			Out / In			In / Out			Out / In			In / Out			Out / In		
	Component	E	T	F	E	T	F	E	T	F	E	T	F	E	T	F	E	T	F	E	T	F	E	T	F
1. High or Low	Incentive	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N	G/N	B	G/N
Price + Bad	Magnitude	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N	A/N	A	A/N
Contributor Adder	Adder	Adder Not Yet Defined																							
2a. Payback-In-	Incentive	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G	B/G	B	B/G
Kind Dead-band,	Magnitude	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Adder	Not Applicable																							
2b. High or Low	Incentive	G	B	G	G	B	G	G	B	G	G	B	G	G	B	G	G	B	G	G	B	G	G	B	G
Price + % Adder	Magnitude	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Adder	A	B	A	A	B	A	A	B	A	A	B	A	A	B	A	A	B	A	A	B	A	A	B	A
3a. No Payback	Incentive	B	B	B	B	B	B	G	B	G	G	B	G	B	B	B	B	B	B	G	B	G	G	B	G
Dead Band	Magnitude	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	Adder	Not Applicable																							
3b. + High Price	Incentive	G/N	B	G/N	G/N	B	G/N	G	B	G	G	B	G	G/N	B	G/N	G/N	B	G/N	G/B	B	G/B	G/B	B	G/B
with Frequency	Magnitude	A/N	A	A/N	A/N	A	A/N	A	A	A	A	A	A	A/N	A	A/N	A/N	A	A/N	A	A	A	A	A	A
Reversal	Adder	No Adder						A	A	A	A	A	A	No Adder						A	A	A	A	A	A
4. Native Market	Incentive	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Price + Frequency	Magnitude	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Control Component	Adder	E	N	E	E	N	E	E	N	E	E	N	E	E	N	E	E	N	E	E	N	E	E	N	E

Headings: E = Energy Component; T = Transmission Component; F = Frequency Component
A – The magnitude is arbitrary. The magnitude of the actual incentive is unrelated to the magnitude of the desired incentive.
B – Bad Incentive, discourages the correct response.
E – Equitable magnitude, magnitude of incentive is appropriate.
G – Good Incentive, encourages the correct response.
N – Neutral Incentive, neither encourages nor discourages the correct response.

1. 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.

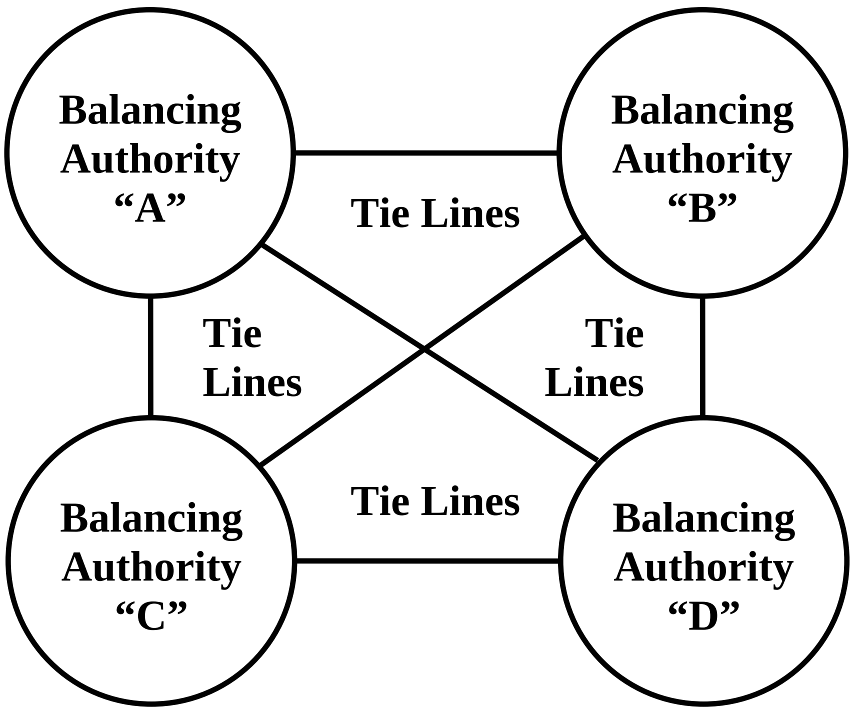

Figure 1. Example Interconnection

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, as long as the net flows shown in this example are maintained.

Transmission Congestion and Losses for Example X-1:

The congestion cost associated with the case is a net reduction of $475.

Transmission Congestion and Losses for Example X-2:

The congestion cost associated with the case is a net increase of $475.

Transmission Congestion and Losses for Example X-3:

The congestion cost associated with the case is a net reduction of $475.

Transmission Congestion and Losses for Example X-4:

The congestion cost associated with the case is a net increase of $475.

Transmission Congestion and Losses for Example X-5:

The congestion cost associated with the case is a net reduction of $300.

Transmission Congestion and Losses for Example X-6:

The congestion cost associated with the case is a net increase of $300.

Transmission Congestion and Losses for Example X-7:

The congestion cost associated with the case is a net reduction of $300.

Transmission Congestion and Losses for Example X-8:

The congestion cost associated with the case is a net increase of $300.

2. 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**

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

Example 1-5:

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 1-6:

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**

Example 1-7:

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 1-8:

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)**

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.

3. IN-KIND DEAD-BAND WITH HIGHEST PRICE PLUS % ADDER

Tony Reed of Southern Company suggested setting an In-Kind Dead-band with settlement outside the dead-band at the highest price of energy plus a percentage adder.

Settlement Pricing Rules:

1. Payback-In-Kind inside a frequency dead-band..
2. If the Frequency Error for the hour is negative, the interconnection frequency is below schedule (low), use the highest hourly price of all BAs plus 25% to price the settlement.
3. If the Frequency Error for the hour is positive, the interconnection frequency is above schedule (high), use the lowest hourly price of all BAs minus 25% to price the settlement.

The examples, 2a-1 through 2a-8, show the settlement for those hours when the Frequency Error is inside the dead-band.

The settlement price is determined at the time the payback is performed. The incentives are based on the price of energy at the time of payback. The interconnection position is always balanced. This is true for all examples.

Example 2a-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**	**$45 / MWh**
Settlement Price (Negative)	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Profit or (Loss) / MWh	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Profit or (Loss) Total	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Interconnection Position	**$ 0**	**$ 0**	**$ 0**	**$ 0**

Example 2a-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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-5:

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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-6:

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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-7:

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)	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) / MWh	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Profit or (Loss) Total	Set at Payback	Set at Payback	Set at Payback	Set at Payback
Interconnection Position	$ 0	$ 0	$ 0	$ 0

Example 2a-8:

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**	**$5 / MWh**
Settlement Price (Negative)	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Profit or (Loss) / MWh	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Profit or (Loss) Total	**Set at Payback**	**Set at Payback**	**Set at Payback**	**Set at Payback**
Interconnection Position	**$ 0**	**$ 0**	**$ 0**	**$ 0**

The examples, 2b-1 through 2b-8, show the settlement for those hours when the Frequency Error is outside the dead-band.

Example 2b-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)	**$62.5 / MWh**	**$62.5 / MWh**	**$62.5 / MWh**	**$62.5 / MWh**
Profit or (Loss) / MWh	**($37.5 / MWh)**	**($12.5 / MWh)**	**$27.5 / MWh**	**$17.5 / MWh**
Profit or (Loss) Total	**($ 1,875)**	**($ 312.5)**	**$ 1,100**	**$ 612.5**
Interconnection Position	**$ 3,125**	**$ 1,562.5**	**($ 2,500)**	**($ 2,187.5)**

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 plus 25%.

Example 2b-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)	$62.5 / MWh	$62.5 / MWh	$62.5 / MWh	$62.5 / MWh
Profit or (Loss) / MWh	$37.5 / MWh	$12.5 / MWh	($27.5 / MWh)	($17.5 / MWh)
Profit or (Loss) Total	$ 1,875	$ 312.5	($ 1,100)	($ 612.5)
Interconnection Position	($ 3,125)	($ 1,562.5)	$ 2,500	$ 2,187.5

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 plus 25%.

Example 2b-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)	$18.75 / MWh	$18.75 / MWh	$18.75 / MWh	$18.75 / MWh
Profit or (Loss) / MWh	$ 6.25 / MWh	$ 31.25 / MWh	($16.25 / MWh)	($26.25 / MWh)
Profit or (Loss) Total	$ 312.5	$ 781.25	($ 650)	($ 918.75)
Interconnection Position	$ 937.5	$ 468.75	($ 750)	($ 656.25)

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 less 25%.

Example 2b-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)	$18.75 / MWh	$18.75 / MWh	$18.75 / MWh	$18.75 / MWh
Profit or (Loss) / MWh	($6.25 / MWh)	($31.25 / MWh)	$16.25 / MWh	$26.25 / MWh
Profit or (Loss) Total	($ 312.5)	($ 781.25)	$ 650	$ 918.75
Interconnection Position	($ 937.5)	($ 468.75)	$ 750	$ 656.25

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 less 25%.

Example 2b-5:

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)	$6.25 / MWh	$6.25 / MWh	$6.25 / MWh	$6.25 / MWh
Profit or (Loss) / MWh	($11.25 / MWh)	($1.25 / MWh)	$6.25 / MWh	$1.25 / MWh
Profit or (Loss) Total	($ 562.5)	($ 31.25)	$ 250	$ 43.75
Interconnection Position	$ 312.5	$ 156.25	($ 250)	($ 218.75)

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 plus 25%.

Example 2b-6:

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)	**$6.25 / MWh**	**$6.25 / MWh**	**$6.25 / MWh**	**$6.25 / MWh**
Profit or (Loss) / MWh	**$11.25 / MWh**	**$1.25 / MWh**	**($6.25 / MWh)**	**($1.25 / MWh)**
Profit or (Loss) Total	**$ 562.5**	**$ 31.25**	**($ 250)**	**($ 43.75)**
Interconnection Position	**($ 312.5)**	**($ 156.25)**	**$ 250**	**$ 218.75**

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 plus 25%.

Example 2b-7:

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)	**($6.25 / MWh)**	**($6.25 / MWh)**	**($6.25 / MWh)**	**($6.25 / MWh)**
Profit or (Loss) / MWh	**$1.25 / MWh**	**$11.25 / MWh**	**($6.25 / MWh)**	**($11.25 / MWh)**
Profit or (Loss) Total	**$ 62.5**	**$ 281.25**	**($ 250)**	**($ 393.75)**
Interconnection Position	**($ 312.5)**	**($ 156.25)**	**$ 250**	**$ 218.75**

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 less 25%.

Example 2b-8:

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)	**($6.25 / MWh)**	**($6.25 / MWh)**	**($6.25 / MWh)**	**($6.25 / MWh)**
Profit or (Loss) / MWh	**($1.25 / MWh)**	**($11.25 / MWh)**	**$6.25 / MWh**	**$11.25 / MWh**
Profit or (Loss) Total	**($ 62.5)**	**($ 281.25)**	**$ 250**	**$ 393.75**
Interconnection Position	**$ 312.5**	**$ 156.25**	**($ 250)**	**($ 218.75)**

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 less 25%.

In all of the above examples 2b-1 through 2b-8, the Interconnection is neutral, and retains no funds for the settlement of transmission congestion and losses.

Conclusions:

This alternative fails to mitigate the disadvantages of the current payback-in-kind method inside the frequency dead-band.

This alternative appears to work well outside the dead-band.

1. It removes the incentive to manipulate the system.
2. It always 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 energy price differences than with value of energy or reliability.
2. The good contributors may not be equally rewarded.
3. The bad contributors may not be equally penalized.
4. 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 associated with both the energy and the adder.

This alternative is unacceptable in this form, but it does demonstrate the value that an adder can contribute to the solution of the problem.

4. NON-PAYBACK DEAD-BAND WITH HIGHEST PRICE PLUS FREQUENCY REVERSAL

Al DiCaprio of PJM suggested setting the settlement price at the highest price of energy with a +/- 0.015 Hz dead-band.

Settlement Pricing Rules:

1. Only hours with Frequency Error above +0.015 Hz or below -0.015 Hz will be financially settled. Hours within this frequency range will not be settled either financially or with payback-in-kind.
2. 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.
3. 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.

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

Example 3b-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 3b-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 3b-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 3b-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 3b-5:

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 purchase price.

Example 3b-6:

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 purchase price.

Example 3b-7:

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 highest market sales price with the sign reversed.

Example 3b-8:

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 highest market sales price with the sign reversed.

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.

5. NATIVE-MARKET-PRICE

Howard Illian of Energy Mark suggested setting the settlement price at the Native-Market-Price of each BA.

Settlement Pricing Rules:

1. Each BA would use its own Native-Market-Price for settling the Energy Component of Inadvertent Interchange.

For all examples 4-1 through 4-8, each BA would use their hourly market price to settle the Inadvertent Interchange.

Example 4-1:

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 4-2:

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 4-3:

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 4-4:

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 4-5:

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 4-6:

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.

Example 4-7:

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 4-8:

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.

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. However, if the interconnection risk problem can be resolved and coupled with an acceptable method to penalize bad contributors and reward good contributors such as the Frequency Control Contribution adder, this method would be superior to the others.

6. OBSERVATIONS AND RECOMMENDATIONS

Alternatives 1 and 2 are the best alternatives of those considered that do not include a provision for Native-Market-Prices. Alternative 1 requires an additional penalty and reward adder to insure that the settlement signals the correct action.

Alternative 2 is simply Alternative 1 with a dead-band and a specific energy price percentage adder. Alternative 2 is a good example of the positive effect that a penalty and reward adder can have on settlement, but the adder is arbitrary. The adder does not vary with frequency risk and, therefore, does not differentiate between levels of imbalance.

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

Alternative 4 is the best alternative of those considered because it does include provision for Native-Market-Prices. When coupled with an effective penalty and reward adder it would provide the best solution to the settlement problem.

Selection of any of the four 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 would 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 Alternative 1, 2 or 4 to provide the correct price signals for Inadvertent Interchange in all cases.