North American Energy Standards Board
Inadvertent Interchange Payback Task Force

An Overview of Approaches

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IIPTF has identified three grand systems to achieve payback.

- Payback-in-kind, the system currently being used under the auspices of NERC.
- A system with two separate, distinct, and unrelated payments
  - A payment for an energy component of inadvertent interchange
  - A payment for a reliability component of inadvertent interchange.

  This is the concept being advocated by Robert Blohm and Howard Illian, with most of their rhetoric being associated with the latter.
- WOLF, a system with a single payment for inadvertent interchange on a geographically differentiated basis, which adjusts the price to reflect
  - The changing value of energy
  - The changing value of reliability measurements
  - Location

  This is the pricing plan that I have advocated.

I believe that payback-in-kind should be allowed when two utilities have agreed to that system. This would change payback-in-kind from being the default mode.

Absent a bilateral agreement specifying a payback-in-kind, there should be a default system to cash out inadvertent interchange, such as the Blohm/Illian approach or my WOLF approach. The rest of this summary will analyze the Blohm/Illian approach and compare that approach to WOLF. The comparison will show how my WOLF approach will improve the way the industry pays for inadvertent interchange while the Blohm/Illian approach provides confusion.

CONVENTIONAL MARKET MECHANISM FOR ENERGY

The Blohm/Illian energy payment is a conventional market mechanism. This is but one part of the two separate, distinct, and unrelated payments associated with the Blohm/Illian system. The other part is not a conventional market mechanism. I call the Blohm/Illian energy payment a conventional market mechanism because the Blohm/Illian energy payment is like buying groceries. The Blohm/Illian energy payment involves a quantity multiplied by a price. The quantity is inadvertent interchange as defined by NERC.

Here my WOLF pricing approach has some similarity with the Blohm/Illian approach. I also advocate a conventional market mechanism with a price multiplied by a quantity. I differ from Blohm/Illian in that my quantity would be independent of NERC's definition.

I would price the unscheduled flow between adjacent utilities. The quantity to be priced is the difference between what is scheduled on a line by the two utilities versus what is measured on the line by the two utilities. Inadvertent interchange, as now defined by NERC, is the sum of these quantities, summed across all of the interconnection points of a utility.

The quantity that I propose pricing could be called bilateral inadvertent interchange because it is between two utilities. The current NERC definition for inadvertent interchange could be considered to be multilateral inadvertent interchange because it is a sum of the unscheduled flows a utility has with all of its neighbors, not just the unscheduled bilateral flow between two utilities.

There are several advantages associated with pricing bilateral inadvertent interchange instead of multilateral inadvertent interchange (i.e., instead of using the current NERC definition).

- Two parties have incentives to get the numbers right – There has been considerable discussion during IIPTF meetings about the tardiness with which NERC checks out the inadvertent interchange account. Each utility gives NERC one inadvertent interchange figure for on-peak and one for off-peak. These separate numbers should add up to zero on a net basis across an interconnection. The discussion at the IIPTF indicates that these numbers haven't added up to zero on a reported basis since December 2002. Payments based on bilateral inadvertent interchange would force utilities to have verification procedures in place with each of their neighbors, eliminating the reliance on NERC.
- Utilities could get compensation for transmission – The NERC JIITF said that inadvertent interchange has a transmission location value. Tracking inadvertent interchange bilaterally allows a utility to pay one price for inadvertent interchange coming into its system on one side and to be paid a different price for inadvertent interchange going out on the other side. Thus utilities would get paid for loop flow and especially for parallel path flow.
- The settlement system would not require creating a bank – Payments would be from a first utility to a second utility for the unscheduled electricity that went from the second utility to the first utility.

These are compelling reasons to price inadvertent interchange bilaterally. Except for WOLF, the various proposals for pricing the energy component of inadvertent interchange can not address these compelling issues associated with bilateralism.

I note that WOLF does not require bilateral inadvertent interchange to be the market quantity. WOLF can also be used to price multilateral inadvertent interchange, the quantity defined by NERC. However, using WOLF to price multilateral inadvertent interchange loses the above benefits to the system of using bilateral inadvertent interchange as the market quantity.

The Blohm/Illian energy price concept relies on the existence of well defined market price for energy. The Illian memo of January 12 presents three energy pricing alternatives, nominally linked to three individuals who have mentioned these energy pricing alternatives. Though Illian supports each party using its own market price and is dismissive of comments presented by Al DiCaprio, Illian seems to accept that there might be other acceptable ways to price energy imbalances. I note that the Illian approach leaves the interconnection open to compensation risk.

WOLF works on the assumption that there is not a well defined market price for energy for the interconnection. WOLF continually adjusts the base price to reflect the cumulative imbalance in the market for energy, as measured by ACE including the integrations of ACE over time. To the extent that there is a defined market price for energy for the interconnection or a relevant portion of the interconnection, WOLF can use that defined market price as the base price. When WOLF is applied to bilateral inadvertent interchange, the interconnection is not subject to the compensation risk associated with the Illian approach to pricing energy imbalances.

NON-CONVENTIONAL MARKET FOR RELIABILITY

The second portion of the Blohm/Illian approach involves a separate payment for the utility's pattern of inadvertent interchange over a period of time. Illian points out in his recent paper that there is no allowance for frequency error or inadvertent interchange in the bid and offer quotes used in most markets. Accordingly, there needs to be some explicit allowance to reflect frequency error and inadvertent interchange in setting the price for inadvertent interchange.

WOLF provides an explicit allowance for reliability by explicitly adjusting the base price mentioned above. The WOLF adjustment that I have described is multiplicative, in that the base price is multiplied by a factor that could range from nearly zero to a large number. The resulting settlement price would thus range from a price of nearly zero to a large price. The large price would provide large incentives for utilities to help the network keep the lights on during shortages, much greater incentives than those proposed by the Blohm/Illian approach.

The Blohm/Illian approach to providing compensation for reliability is unnecessarily complicated. Indeed, the Blohm/Illian approach is so complicated that its own advocates have provided inconsistent analyses of the approach. The inconsistencies have been between the two advocates and within the presentations of each advocate.

To demonstrate the inconsistencies, I have extracted a portion of the tables used by Illian during his December 10 presentation and present those extracts below in Table 1. The files posted by NAESB were pdf. I obtained an xls file from Steve Terelmes when I sent a request to him and to Illian for such files.

The Blohm and Illian have been inconsistent with each other in regard to the basic value of reliability.

- Illian has estimated a basic value of reliability as $0.10/MW Hz.
- Blohm has usually described this value as $0.10/MWH Hz.

Note that Illian uses a power measurement and Blohm uses an energy measurement. The inconsistency in the dimensions of the value flunks basic principles taught in high school science.

Blohm has made at least three different and inconsistent claims as to what should be measured or calculated in setting the price of reliability. Illian provided a pricing example based on a fourth set of measurements.

- Blohm described a double average of frequency and inadvertent interchange to calculate a slope. (Page 12 of his December 10 presentation which was repeated from an earlier presentation.)
- During at least two presentations, Blohm said that the appropriate slope should be determined using a linear regression.
- Finally, Blohm said the linear regression must be forced through the origin. (See pages 15 ff of his December 10 presentation.)
- In contrast, the calculations in the Illian December 10 presentation are independent of regression analysis.

Clearly there is confusion on the Blohm/Illian team to pricing any reliability associated with inadvertent interchange. Blohm and Illian have presented no justification for this confusion. My WOLF approach avoids this confusion by having a conventional market mechanism for reliability, i.e., a super market approach of a price for a quantity.

The Blohm/Illian approach as implemented in the spreadsheet included with their December 2003 presentation uses a quasi-linear approach to pricing reliability imbalances. I call the presented approach quasi-linear because the price for each time period is nominally linear with respect to frequency error. This linearity can be seen by comparing the frequency error in Column B at with the value of reliability in Column D. Each number in Column D is $1,096.4 times the value in Column B.[1]

The price appears not to be completely linear in that the price is based on the absolute value of the frequency error and thus is non-linear at zero. This can also be seen in Table 1. Hour 7 has a negative frequency error in column B yet a positive value in column D. In addition to this absolute value twist, the price is also non-linear in that the

[1] For Hour 1, 0.010726 in column A times $1,096.4 is equal to $11.76 in column C. For Hour 2, 0.008122 in column A times $1,096.4 is equal to $8.90 in column C.

price is applied over an extended time period. The statistics for that time period are used to adjust the price.[2]

The lack of linearity in a model need not be a deficiency. I note that the reliability portion of the WOLF pricing model is exponential. When the reliability measure doubles the effect on prices is squared. The WOLF model has that exponential relation explicit, not buried in a statistical abstraction.

Illian's charge to Control Area #1 is presented in columns 1A to 1E. Though there are a number of intermediate steps, the charge in 1E is equal to the cost from column D times the MW error in column 1A, except for hour 7, when the negative frequency error causes the charge to be negative. Thus, though column D seems to indicate that the cost of frequency control is always positive, the application in column 1E shows that the effective price is negative when the frequency error is negative.

The frequency data in the Illian presentation has an average error of 0.003018 Hertz, extracted below in Table 1 from the Illian presentation of December 10. For the 264 hours, such an error would accumulate 0.7967 minutes or 47.8 seconds.[3] WSCC has a mechanism to get utilities to adjust their generation to eliminate these time errors. The size of the time error shows the importance of recognizing time error in any mechanism that compensates for inadvertent interchange. My WOLF approach to pricing inadvertent interchange includes a mechanism to adjust the price to eliminate time error.

The Blohm presentations indicate that the frequency payment should be based on the slope of the regression line of inadvertent interchange. The Illian spreadsheet effectively charges for the entire inadvertent amount shown in column 1A. Blohm and Illian provide no explanation for the difference between Blohm's theory and Illian's application of the theory.

Though we are attempting to provide a price for inadvertent interchange, the amount shown in column 1A does not appear to be inadvertent interchange. Of the 264 values in the original Illian spreadsheet, only one value was positive. Normally about half of the inadvertent interchange values for a long time period are positive and about half are negative, not 0.4% in one direction and 99.6% in the other direction.

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[2] The cited multiplier $1096.4 can be calculated as ($ 0.10) x 264 hours / 0.024086

[3]
264 hours x .003018 Hertz
=264 hours x .003018 ~~Hertz~~ [1 cycle/second / 1 ~~Hertz~~]
=264x.003014 hours-cycles/second
=264x.003014 h~~ours-cycles~~/**second** [~~**60**~~ minutes / ~~hour~~] [1 **~~second~~** / ~~**60**~~ ~~cycles~~]
=264x.003014 minutes
=0.7967minutes or 47.8 seconds

Table 1 shows that Control Area 1 had total inadvertent interchange for this period of -33,273 MWH, that is that Control Area 1 took this much energy off the grid without paying for it. This shows an inadvertent interchange burden on the network that is significantly at variance with my experience. Of the 16 control areas in the Illian example, 8 control areas had inadvertent interchange with an absolute magnitude of 33,273 MWH or greater, with Control Area 13 having total inadvertent interchange of 221,838 MWH. Thus though Illian presents the values in Column 1A as inadvertent interchange, Illian provides no explanation for why the pattern of the data is inconsistent with the normal pattern of inadvertent interchange.

Data from Howard Illian Presentation of December 10, 2003
Table 1

	Western Interconnection Data			**Control Area #1**				
A	B	C	D	1A	1B	1C	1D	1E
	Frequency Error	Frequency Error Squared	Marginal Cost of Control	Inadvertent	Absolute Inadvertent	Inadvertent x Freq Error	N x (I x ΔF) S(ΔF ^ 2)	FCC$ @ $ .1 / 10 β
	ΔF	ΔF ^ 2	$ / 10β-Hr	I	ABS(I)	I x ΔF	FCC = -10 β	1D x $ / 10 β
Hour	Hz	Hz ^ 2	$0.10	MWh	MWh	MWh - Hz	MWh / Hz	$
1	0.010726	0.000115	$11.76	-61	61	-0.654	-7,171.63	-$717.16
2	0.008122	0.000066	$8.90	-48	48	-0.390	-4,273.20	-$427.32
3	0.006821	0.000047	$7.48	-46	46	-0.314	-3,439.09	-$343.91
4	0.004623	0.000021	$5.07	-44	44	-0.203	-2,229.73	-$222.97
5	0.016746	0.000280	$18.35	-97	97	-1.624	-17,804.03	-$1,780.40
6	0.001628	0.000003	$1.78	-156	156	-0.254	-2,784.20	-$278.42
7	-0.000082	0.000000	$0.09	-64	64	0.005	57.29	$5.73
8	0.002930	0.000009	$3.21	-109	109	-0.319	-3,500.48	-$350.05
262	0.010987	0.000121	$12.04	-121	121	-1.329	-14,570.84	-$1,457.08
263	-0.000162	0.000000	$0.18	-167	167	0.027	295.92	$29.59
264	0.004475	0.000020	$4.90	-89	89	-0.398	-4,365.32	-$436.53
	0.003018	264	$8.32	-33,273	33,277		-951,522.45	
	Σ(ΔF^2)	0.024086			Σ (I x ΔF)	-86.415	CA Total $	-$95,152.24
		0.000091					Cost / MWh	$2.86
		0.009552					Cost / MWh	$2.86

An important issue is the effect of severe frequency errors. In my presentations of WOLF, I have prices escalate by a factor of 10 for every 0.02 Hertz decline in the frequency. Thus, if the base price is $30.00/MWH, the WOLF price for 59.98 Hertz is $300.00/MWH and the WOLF price for 59.96 Hertz is $3,000.00/MWH. I show this in Table 2. Of course, when the base price is different, the WOLF price will be different.

Though I usually do no separate out the base price from the WOLF price to show the effect of reliability, subtracting the base price from the WOLF price produces the column in Table 2 of reliability charges for WOLF.

The frequency adjustment for varying prices can be determined for the Blohm/Illian method by inserting different frequency variations into Column B of the Illian spread sheet. At 59.999 Hertz or 60.001 Hertz, the frequency adjustment is $1.10/MWH. At 59.980 Hertz or 60.020 Hertz, the adjustment is $21.66/MWH. At 59.960 Hertz or 60.040 Hertz, the adjustment is $41.30/MWH. In fairness, I note that these adjustments are based on the statistics peculiar to the Illian presentation of December 10. Other statistics will produce different results. The Blohm/Illian adjustment provides little incentive for control areas to adjust their error when frequency is low, such as when frequency is at the selected values of 59.980 Hertz or 59.960 Hertz. The total prices under the Blohm/Illian procedure[4] certainly provide much less of an incentive than does the incentive provided by the WOLF prices[5].

Comparison of Prices At Various Prices
Table 2

	WOLF Pricing			Blohm/Illian Method		
Frequency	WOLF Price	Base Price	Reliability Charge	Energy Charge	Reliability Charge	Total Price
60.040	$0.30	$30.00	$-29.70	$30.00	$-41.30	$-11.30
60.020	$3.00	$30.00	$-27.00	$30.00	$-21.66	$8.34
60.001	$26.74	$30.00	$-3.26	$30.00	$-1.10	$28.90
60.000	$30.00	$30.00	$0.00	$30.00	$0.00	$30.00
59.999	$33.66	$30.00	$3.66	$30.00	$1.10	$31.10
59.980	$300.00	$30.00	$270.00	$30.00	$21.66	$51.66
59.960	$3,000.00	$30.00	$2,970.00	$30.00	$41.30	$71.30

CONCLUSIONS

The Blohm/Illian approach to handling inadvertent interchange has two separate pricing plans: first, an energy price using a conventional market mechanism; and, second, a reliability price that has been inconsistently explained. Blohm presents inconsistent explanations as to how the charge for reliability should be determined. Illian presents data that are inconsistent with any of the disparate theories presented by Blohm. Further, Illian claims the numbers used in the presentation are inadvertent interchange, but the numbers used in the presentation have a pattern that is inconsistent with most patterns for

[4] The Blohm/Illian approach provides incentives of $51.66/MWH for 59.98 Hertz and $71.30/MWH for 59.96 Hertz.
[5] WOLF provides incentives of $300.00/MWH for 59.98 Hertz and $3,000.00 for 59.96 Hertz.

inadvertent interchange. Finally, the Blohm/Illian approach provides relative little incentive for control areas to assist with reliability issues.

In contrast, the WOLF pricing mechanism provides an internally consistent approach to pricing inadvertent interchange, not just for the energy portion when there is no well developed market price but also for the reliability portion. WOLF provides compensation to utilities for the use of their wires and eliminates compensation risk for the interconnection. The reliability portion of WOLF provides greater incentives for utilities to help balance the system when frequency is lower than about 60.03 Hertz.