

Proposed Modification in the Methodology for Calculating Escalation Indices for Use in Tariff Based Competitive Bidding

1. Introduction

Section 63 of the Act provides for competitive procurement of electricity by the DISCOMs through transparent process of bidding in accordance with the guidelines issued by the Central Government. Such guidelines - *Guidelines for Determination of Tariff by Bidding Process for Procurement of Power by Distribution Licensees* - have been framed and notified by the Ministry of Power. The Guidelines provide that Central Electricity Regulatory Commission (CERC) will notify and update, every six months, the escalation rates for various elements of the power procurement cost such as fuel costs, fuel transportation costs, fuel handling costs, power transmission costs, etc.

In recent times, CERC has received representations from several stakeholders, requesting CERC to ensure that the escalation and other rates being computed and notified by the CERC are as realistic as possible. In view of the representations, CERC, on 18th August 2010, held a consultative round table meeting of the experts in the field for critical appraisal/review of CERC's escalation rate computation methodology and to assess the scope for further refinement in the methodology as also to explore the need, if any, for further study in the matter.

2. Consultative Round Table Meeting and its Outcome

The consultative round table meeting came up with four distinct set of suggestions:

- i) suggestions regarding the basic method (3 year moving average over past 12 years data) used by CERC for determining the escalation rates for evaluation purpose,
- ii) suggestions regarding refinements to be made to the existing method of moving averages while determining the escalation rates for both, evaluation as well as payment purposes,
- iii) suggestions regarding basis to be used for computation of escalation rates for normative transmission charges, and
- iv) suggestions regarding the evaluation methodology at large.

From the point of view of escalation methodology, it is the first three sets of suggestions that were really relevant. The fourth set of suggestions, namely, the suggestions regarding the evaluation methodology, while being important, were not directly linked to the escalation methodology *per se*.

2.1. Suggestions regarding the basic method (3 year moving average over past 12 years data) used by CERC

As regards the basic method of moving averages used by CERC, the consultative round table meeting recommended that appropriate time series, explanatory variables or other models be used in place of moving average model. Accordingly, it was decided to review the computation methodology of escalation rate for various cost elements like fuel transportation costs, power transmission costs, etc. and come up with a refined methodology, if possible. Following up on this decision, one of the participants in the consultative round table meeting - the SQC & OR Unit of Indian Statistical Institute (ISI), Kolkata - undertook a study to examine the feasibility of improving the procedure of estimating different escalation rates. The ISI team looked at six different methods chosen from theoretical perspectives and compared these methods with each other as well as with the existing method followed by CERC.

In particular, the ISI study team examined following six approaches:

- a) Method of proportion (method A)
- b) Method of range and median (method B)
- c) Method of time series (method C)
- d) Method of overall arithmetic mean (method D)
- e) Method of overall geometric mean (method E)
- f) Method of minimum mean square error (method F)

Second Draft Report of the ISI study team is available on the Commission website (www.cercind.gov.in/escalation_rates_2010.htm)

2.2. Suggestions regarding refinements to be made to the existing method of moving averages

As regards refinements in existing methodology of using moving average model, the round table meeting suggested that, pending the development of the refined methodology, CERC should immediately consider introducing following changes in its existing method of computation of escalation rates:

- i) Since while determining the escalation rates of all the parameters CERC is essentially determining the growth over periods, it is the geometric mean that is more appropriate in CERC's rate determination methodology. Hence, for arriving at mean escalation rates from a dataset that contains yearly changes (in percentage terms) in the value of the parameter for which escalation rates are being determined; the correct method is to find out the geometric mean of the dataset and not the arithmetic mean (which is what is being done by CERC at present). Thus, if the parameter for which escalation rate is being determined is say domestic coal cost, and if we have a dataset that contains "n" values of yearly changes in the cost of coal in percentage terms as say $X_1, X_2, X_3, \dots, X_n$; then, as per the recommendations, the mean escalation rate should not be the arithmetic mean of X_1, X_2, \dots, X_n , but the geometric mean, i.e. the mean escalation

rate should not be, as is being calculated by CERC at present, $(X1 + X2 + X3 + \dots + Xn)/n$, but should be $(X1 * X2 * X3 * \dots * Xn)^{1/n}$.

- ii) For arriving at mean escalation rates of a parameter that requires combining two or more series in pre-determined proportion (hybrid index); the correct method is to combine each data point of the two or more series in the pre-determined proportion to arrive at a composite new single series and then to find the escalation rate based on this composite new single series. The consultative meeting mentioned that the method that is presently being used by CERC, where the mean escalations rates are first computed for the two series separately and the two mean escalations rates are then combined in the pre-determined proportion should not be used. Thus, if the parameter for which escalation rate is being determined is say cost of domestic gas which requires consumer price of off-shore and north-east to be combined in the ratio of 90:10 (90% off-shore and 10% north-east), and if we suppose that the yearly escalation rates for off-shore gas for the past “n” years are X1, X2...Xn; and for north-east gas are Y1, Y2, ...Yn; then as per present CERC methodology, the Combined mean rate is calculated by first finding the mean escalation rates for off-shore and north-east gas, separately, and then combining the two in the ratio of 90:10. Thus, as per present CERC methodology, the mean escalation rate for off-shore and north-east gas would be $[(x1+x2+\dots+Xn)/n]$ and $[(Y1+Y2+\dots+Yn)/n]$. If we call these say Moi and Mnei respectively, then the escalation rate for the domestic price of gas (combined rate) as per present methodology is $[(0.9*Moi)+(0.1*Mnei)]$. As against this, the expert group recommended methodology involves combining each data point of the two or more series in the pre-determined proportion to arrive at a new composite single series, i.e
- finding Z1, Z2, ...Zn, where each $Z_t = \{0.9P_{1t}+0.1P_{2t}\}$, P1t being price of off-shore in year ‘t’ and P2t being price of north-east in year ‘t’;
 - then finding the annual escalation factors e1, e2, e3, e4...eR, computed exactly as per the present methodology of CERC (three years moving average of the series Z1, Z2, Z3....and then yearly escalations of the moving average values);
 - and then finding the mean of e1, e2...eR as $(e1 * e2 * \dots * eR)^{1/R}$.

2.3. *Suggestions regarding basis to be used for computation of escalation rates for normative transmission charges*

As regards normative transmission charges, it was proposed that the escalation rate be computed by taking per MVA or per connected MW transmission charge, instead of per kWh transmission charge.

3. Proposed Changes in the Escalation Rate Determination Methodology

Based on the suggestions, the ISI report and further analysis and study by the Commission staff, the Commission is proposing following changes to the existing escalation rate determination methodology for both evaluation and payment purposes.

3.1. Escalation Rate Determination Methodology for Evaluation Purposes

To account for possible escalation in costs over the period over which the DISCOMs wish to procure power and to bring uniformity in the escalation and other rates, the Tariff based Competitive Guidelines [Clause 5.6 (vi)] of Ministry of Power require that CERC notify, every six months, escalation rates or rates for following parameters for evaluation purposes:

1. Escalation rate for domestic coal prices
2. Escalation rate for domestic gas prices
3. Escalation rates for different escalable sub-components of energy charge for plants based on imported coal.
 - a. Escalation rate for coal sub-component
 - b. Escalation rate for transportation sub-component
 - c. Escalation rate for inland handling sub-component
4. Escalation rate for inland transportation charges for coal over various distances
5. Escalation rate for inland transportation charges for gas
6. Escalation rates for different escalable sub-components of energy charge for plants based on imported gas
 - a. Escalation rate for gas sub-component
 - b. Escalation rate for transportation of gas sub-component
 - c. Escalation rate for inland handling sub-component
7. Rate of Inflation to be applied to indexed capacity charge component
8. Rate of Inflation to be applied to indexed energy charge component in cases of captive fuel source
9. Dollar-Rupee exchange variation rate
10. Escalation for normative transmission charges

The Commission is proposing a revised escalation rate determination methodology with respect to all of the above listed parameters. As regards the methodology for determination of the Rate of discount to be used for bid evaluation; the Commission proposes to continue to use the existing methodology.

3.1.1. Proposed Changes with respect to Hybrid Series

In line with the suggestions of the round table meeting, the Commission proposes that the escalation rate for parameters that require combining of two or more series in pre-determined proportion (hybrid index) will henceforth be determined by combining each data point of two or more series in the pre-determined proportion to arrive at a composite new single series and then to find the escalation rate based on this composite new single series.

Presently, combining of two or more series in pre-determined proportion is being done with respect to following parameters.

1. Escalation rate for domestic gas prices; wherein off-shore and north-east gas prices are being combined in the ratio of 90:10.
2. Escalation rates for inland handling sub-component of energy charge for plants based on imported coal; wherein Consumer Price Index (CPI) and Wholesale Price Index (WPI) series are combined in the ratio of 40:60
3. Escalation rates for inland handling sub-component of energy charge for plants based on imported gas; wherein CPI and WPI series are combined in the ratio of 40:60
4. Rate of Inflation to be applied to indexed capacity charge component; wherein CPI and WPI series are combined in the ratio of 40:60
5. Rate of Inflation to be applied to indexed energy charge component in cases of captive fuel source; wherein CPI, WPI, WPI for HSD oil, WPI for matches, explosives and other chemicals, WPI for tyres, WPI for heavy machinery and parts series are combined in the ratio of 20:10:25:10:10:25, respectively.

Rationale

The Commission finds more merit in going by the consultative round table suggestion of combining each data point of two or more series in the pre-determined proportion to arrive at a new composite single series and then to find the escalation rate based on of this composite single series. Considering the example of domestic gas price, it is evident that combining off-shore price data for a particular year with the corresponding north-east price for the same year in the pre-determined ratio of 90:10 would in fact provide the India-wide average price of the gas for that particular year. Doing this for all the data points would thus provide the India-wide average price series which should be the correct series to use for determination of future escalation rate for domestic gas prices. As against this, the present method of estimating hybrid escalation rate by combining the mean escalation rate (and not price of gas) for off-shore gas with mean escalation rate for north-east gas in the proportion of 90:10 is incorrect because combining the escalation rates in the ratio of 90:10 connotes that the

escalation rates of off-shore gas and north-east gas are having a ratio of 90:10, where as in reality, the ratio of 90:10 is for the prices (and not escalation rates) of off-shore and north-east gas. Intuitively also, the present method of calculating escalation requires change because it is the price of off-shore gas and north-east gas, when combined in the proportion of 90:10, that gives the India-wide average price of gas in India and since we are interested in determining the future escalation rate for domestic gas price, it is the average price of the domestic gas which should be used for determination of future escalation rates in gas prices.

Example

An example in Annex 1 shows the methodology of determining the escalation rate for domestic gas by combining each data point of domestic off-shore gas price and domestic north-east gas price in the ratio of 90:10, respectively to arrive at a composite new single series and then finding the escalation rate based on this composite new single series. It also shows comparison of the results thus obtained with the existing method that is being followed by CERC.

3.1.2. Proposed Changes with respect to basic method (3 year moving average over past 12 years data) being used by CERC

The Commission proposes to adopt the method of minimum mean square error or the Method “F” as suggested by the SQC and OR unit of ISI, Kolkata for determination of escalation rates for the parameters listed in xx above

The Commission proposes to use the basic model as described in the ISI Report (Method “F”):

Where, annual escalation rate “e” is given by the formula:

e: annual escalation rate in percent = $g \times 100$
g: escalation factor = $[exp\{\{(6 \times \sum_{t=2}^n (t-1) \times \ln R_t\} / \{(n-1) \times n \times (2n-1)\}\}] - 1$
 $R_t = (Y_t / Y_1)$
 $Y_t =$ “t” th observation
 $Y_1 =$ initial observation
n = number of observations

Rationale

The Commission evaluated the various escalation rate determination methodologies, including the six methods as suggested by the ISI, Kolkata and the method of geometric mean as suggested during the round table meeting. Thus, including the existing method based on arithmetic mean, the Commission, in total comparatively evaluated eight different rate determination methods. The basic matrix used by the Commission to compare various escalation rate determination methodologies was the average squared error value; with the criterion that, whichever method gives least

average squared error value is the preferred method. Using the data that was used to notify the escalation rates for the period 1/4/2010 to 30/09/2010, the Commission calculated the escalation rates as well as the average squared error values for all the parameters as listed in section 3.1 as per all the eight methods. The results have been shown in Table 1 & 2. The average squared error values (Table 2) with respect to all but four parameters are least for Method of minimum mean square error or the Method “F” as suggested by the SQC and OR unit of ISI, Kolkata. Even in cases where the average squared error value is not the least for Method of minimum mean square error, the difference between the least value and the value as obtained with method of minimum mean square error is negligible – 0.01 in case of energy charges for plants based on imported gas, 0.02 in case of inland coal transportation charges up to 1000 Km, 0.10 in case of domestic coal prices, and 20 in case of normative transmission charges.

The exercise carried out by CERC thus shows that, overall, the Method of minimum mean square error provides the least average squared error values.

Example

An example in Annex 2 shows the methodology of determining the escalation rate for domestic gas by using the Method of minimum mean square error.

3.1.3. Proposed Changes regarding basis to be used for computation of escalation rates for normative transmission charges

For the computation of escalation rates for normative transmission charges, the Commission proposes to change from the existing practice of using Rupees per unit kWh transmitted as the basic unit and go as per the consultative round table meeting suggestion of using Rupees per unit MW connected as the basic unit.

Rationale

The basic reason for the proposed change is lumpy the nature of the transmission investment and the fact that the investments are made in advance, where as the load build up follows the investment. Thus, it is well established that the transmission systems are built to cater to pre-fixed loads, which always leaves a possibility of a certain part of the line capacity remaining unutilized for some time as transmission systems need to be planned and executed in advance and the load growth follows. Thus when you use per kWh as a unit, the per kWh transmission charge may be on the higher side in the initial year of the operation of the transmission line, when the load is relatively low. In a rapidly growing system, the distortion due to this lumpy nature of the investment, where investments have to be made in advance and load growth follows, could get much more amplified as compared to a system that is growing at low and steady rates. Using per MW (because the transmission charges are being on

the basis of per MW connected), instead, would result in normalizing the lumpy nature of the transmission investments.

CERC staff carried out an exercise to estimate the escalation rate using per MW connected charge instead of per kWh charge. Tables 1 & 2 (Rows corresponding to S.No. 10) indicate the escalation rate and average squared error values, respectively, for different escalation rate determination methods. It is seen that the Method of minimum mean square error gives not the least average squared error but near about the least average squared error value.

Thus, as regards computation of escalation rates for normative transmission charges are concerned, the Commission proposes to: a) use per MW connected load as the basic unit, and b) use the method of minimum mean square error for arriving at the escalation rate for normative transmission charges.

3.2. Escalation Rate Determination Methodology for Payment Purposes

3.2.1. Proposed Changes with respect to Hybrid Series

CERC also notifies escalation rates for following parameters for payment purposes:

1. Escalation rate for domestic coal prices
2. Escalation rate for domestic gas prices
3. Escalation rates for different escalable sub-components of energy charge for plants based on imported coal.
 - a. Escalation rate for imported coal
 - b. Escalation rate for transportation of imported coal
 - c. Escalation rate for inland handling of imported coal
4. Escalation rate for inland transportation charges for coal for various distances
5. Escalation rate for inland transportation charges for gas
6. Escalation rates for different escalable sub-components of energy charge for plants based on imported gas
 - a. Escalation rate for imported gas
 - b. Escalation rate for transportation of imported gas
 - c. Escalation rate inland handling of imported gas
7. Rate of Inflation to be applied to indexed capacity charge component
8. Rate of Inflation to be applied to indexed energy charge component in cases of captive fuel source

Out of the above parameters, escalation rate determination methodology for following factors involves working with hybrid data series.

1. Escalation rates for imported coal
2. Escalation rate for inland handling of imported coal

3. Escalation rate inland handling of imported gas
4. Rate of Inflation to be applied to indexed capacity charge component
5. Rate of Inflation to be applied to indexed energy charge component in cases of captive fuel source

In the case parameters that require combining of two or more series in pre-determined proportion (hybrid index), appropriate justification has been provided in section xx for determining the escalation rates for such parameters by combining each data point of two or more series in the pre-determined proportion to arrive at a composite new single series and then to find the escalation rate based on this composite new single series. Since the rationale remains same even in the case of escalation rate determination for payment purposes, the Commission proposes to determine the escalation rate for parameters that require combining of two or more series in pre-determined proportion (hybrid index) by combining each data point of two or more series in the pre-determined proportion to arrive at a composite new single series and then to find the escalation rate based on this composite new single series. Considering, however, that the existing projects would have worked out their cash flows on the basis of escalation rates that CERC has been notifying from time to time in the past, the Commission proposes to make this new refined method applicable to new future projects only and not to the existing projects. In other words, from October 2010 onwards, CERC proposes to notify two sets of escalation rates for payment purposes for the above five parameters, one set of escalation rates for new future projects with the proposed modified methodology of escalation rate determination, and second set of escalation rates for existing projects, based on old method of determining escalation rates.

CERC staff has carried out an exercise, wherein the escalation rates for the above five parameters have been calculated using the refinements suggested in this section. The exercise was carried out on the data that was used to notify the escalation rates for the period 1/4/2010 to 30/09/2010. The results obtained have been shown in Table 3 below, which also shows comparison with the rates that have been notified by the CERC. It is seen that the results though not significantly different, are nevertheless different than the values notified.

TABLE 3: Annual Escalation Rates (Payments): As per existing Methodology and As per Proposed Changes in Existing Methodology			
S.No	Description	Escalation rate: Existing method (march 2010 Notification) (%)	Escalation Rate: With Proposed Refinements * (%)
1	Imported Coal	38.10	38.13
2	Inland handling of imported coal	14.08	13.14
3	Inland handling of imported gas	14.08	13.14
4	Indexed Capacity Cost component	14.08	13.14
5	Indexed Energy charge component in cases of captive mines	8.66	8.97

**= Escalation rate determined by combining each data point of two or more series in the pre-determined proportion to arrive at a composite new single series and then to find the escalation rate based on this composite new single series*

Example

An example in Annex 3 shows the methodology of determining the escalation rate for inland handling of domestic coal by combining each data point of WPI and CPI series in the ratio of 60:40, respectively to arrive at a composite new single series and then finding the escalation rate based on this composite new single series.

TABLE 1: ESCALATION RATES WITH VARIOUS ESCALATION METHODS WHEN CALCULATED WITH INPUT DATA AS USED FOR 01/04/2010 TO 30/09/2010 NOTIFICATION OF CERC

S.No	Description	Escalation rate: Existng method (march 2010 Notification) (%)	Escalation Rate: Expert Group Suggestions* (%)	Escalation Rate: ISI Method A	Escalation Rate: ISI Method B	Escalation Rate: ISI Method C	Escalation Rate: ISI Method D	Escalation Rate: ISI Method E	Escalation Rate: ISI Method F
1	Domestic Coal	6.01	5.98	5.40	4.95	5.91	6.14	6.15	6.09
2	Domestic Gas	1.31	1.30	1.06	1.12	1.39	0.86	0.80	0.96
3.1	Imported Coal: Coal sub-component	16.40	15.64	10.32	23.99	21.08	11.41	9.75	11.12
3.2	Imported Coal: transportation sub-component	16.23	15.93	16.39	22.48	22.25	20.11	20.98	19.83
3.3	Imported Coal: inland handling sub-component	5.11	5.11	5.12	5.21	5.25	4.82	4.78	4.87
4.1	Inland Coal Transportation Charges: up to 100 Km	2.37	2.37	2.48	2.41	2.42	2.63	2.64	2.59
4.2	Inland Coal Transportation Charges: up to 500 Km	2.13	2.13	2.28	2.28	2.18	2.28	2.29	2.25
4.3	Inland Coal Transportation Charges: up to 1000 Km	1.98	1.98	2.14	2.16	2.03	2.03	2.03	2.03
4.4	Inland Coal Transportation Charges: up to 2000 Km	2.52	2.52	2.56	2.57	2.58	2.50	2.49	2.51
4.5	Inland Coal Transportation Charges: > 2000 Km	2.60	2.60	2.63	2.62	2.66	2.60	2.60	2.61
5	Inland Transportation for Gas	2.66	2.52	5.76	2.59	2.51	3.29	3.24	3.08

S.No	Description	Escalation rate: Existing method (march 2010 Notification) (%)	Escalation Rate: Expert Group Suggestions* (%)	Escalation Rate: ISI Method A	Escalation Rate: ISI Method B	Escalation Rate: ISI Method C	Escalation Rate: ISI Method D	Escalation Rate: ISI Method E	Escalation Rate: ISI Method F
6.2	Energy charge for plants based on imported gas: transportation of gas sub-component	16.23	15.93	16.39	22.48	22.25	20.11	20.98	19.83
6.3	Energy charge for plants based on imported gas: inland handling sub-component	5.11	5.11	5.12	5.21	5.25	4.82	4.78	4.87
7	Indexed capacity charge component	5.11	5.11	5.12	5.21	5.25	4.82	4.78	4.87
8	Indexed energy charge component in cases of captive fuel sources	6.01	6.96	6.50	6.28	7.27	7.13	7.13	7.12
9	Dollar-Rupee Exchange Rate	0.36	0.32	1.45	1.48	0.25	1.54	1.54	1.16
10	Normative Transmission Charge: MW connected as the basic unit	4.72	4.56	6.19	5.90	4.03	6.47	6.65	5.91

* = Use of geometric mean and combination of series

TABLE 2: AVERAGE SQUARED ERROR VALUES FOR VARIOUS ESCALATION METHODS

S.No	Description	Average Squared error Values							
		Existing Method	Geometric Mean Method	ISI Method A	ISI Method B	ISI Method C	ISI Method D	ISI Method E	ISI Method F
1	Domestic Coal	10.39	10.39	13.70	18.60	10.47	10.62	14.40	10.49
2	Domestic Gas	113.49	112.31	93.44	96.16	123.80	95.33	98.85	92.11
3.1	Imported Coal: Coal sub-component	26.21	23.30	20.06	79.72	54.35	18.59	27.41	18.92
3.2	Imported Coal: transportation sub-component	75.67	79.31	73.72	91.37	67.38	54.93	64.41	53.17
3.3	Imported Coal: inland handling sub-component	3.75	3.70	3.79	4.55	4.92	3.17	3.32	3.00
4.1	Inland Coal Transportation Charges: up to 100 Km	2.38	2.39	1.91	2.18	2.13	1.86	1.88	1.79
4.2	Inland Coal Transportation Charges: up to 500 Km	6.27	6.30	5.15	5.12	5.50	5.12	5.17	5.07
4.3	Inland Coal Transportation Charges: up to 1000 Km	11.93	11.97	13.01	13.56	11.61	20.08	11.61	11.61
4.4	Inland Coal Transportation Charges: up to 2000 Km	14.55	14.55	15.28	15.38	15.88	14.71	14.79	14.57
4.5	Inland Coal Transportation Charges: > 2000 Km	17.20	17.23	17.20	17.10	17.99	17.19	17.24	17.11
5	Inland Transportation for Gas	110.66	113.41	147.10	111.92	113.64	108.13	108.91	107.66
6.1	Energy charge for plants based on imported gas: gas sub-	1.18	1.18	1.37	3.64	1.53	1.18	1.19	1.19

	component								
		Average Squared error Values							
S.No	Description	Existing Method	Geometric Mean Method	ISI Method A	ISI Method B	ISI Method C	ISI Method D	ISI Method E	ISI Method F
6.2	Energy charge for plants based on imported gas: transportation of gas sub-component	75.67	79.31	73.72	91.37	67.38	54.93	64.41	53.17
6.3	Energy charge for plants based on imported gas: inland handling sub-component	3.75	3.70	3.79	4.55	4.92	3.17	3.32	3.00
7	Indexed capacity charge component	3.75	3.70	3.79	4.55	4.92	3.17	3.32	3.00
8	Indexed energy charge component in cases of captive fuel sources	16.67	6.79	11.28	13.86	8.22	7.67	7.67	5.67
9	Dollar-Rupee Exchange Rate	3.85	3.92	3.12	3.14	4.06	3.21	3.21	2.99
10	Normative Transmission Charge: MW connected as the basic unit	111290	116170	96760	93970	134470	102280	107420	93990

ANNEX 1

Hybrid Index (Combining two or more series)

Escalation Rate Determination for Domestic Gas: <u>PRESENT METHOD OF CERC</u>							
Consumer Price-Off-shore (Landfall point and On-shore) (Rs./'ooo' cubic metre)				Consumer Price (North-Eastern States) (Rs./'ooo' cubic metre)			
Year	Consumer Price-Off-shore (Landfall point and On-shore) (Rs./'ooo' cubic metre)	3 Year moving average	Annual Escalation Rate (%)	Year	Consumer Price (North-Eastern States) (Rs./'ooo' cubic metre)	3 Year moving average	Annual Escalation Rate (%)
1998	2850			1998	1700		
1999	2850			1999	1700		
2000	2850	2850.00		2000	1700	1700.00	
2001	2850	2850.00	0.00	2001	1700	1700.00	0.00
2002	2850	2850.00	0.00	2002	1700	1700.00	0.00
2003	2850	2850.00	0.00	2003	1700	1700.00	0.00
2004	2850	2850.00	0.00	2004	1700	1700.00	0.00
2005	3025	2908.33	2.05	2005	1810	1736.67	2.16
2006	3200	3025.00	4.01	2006	1920	1810.00	4.22
2007	3200	3141.67	3.86	2007	1920	1883.33	4.05
2008	3200	3200.00	1.86	2008	1920	1920.00	1.95
2009	3200	3200.00	0.00	2009	1920	1920.00	0.00
Mean Escalation Rate			1.31	Mean Escalation Rate			1.38
				Weight	Mean Escalation Rate	Contribution to Index	
Mean escalation for consumer price (Off-shore)				0.90	1.31	1.18	
Mean escalation for consumer price (North-East)				0.10	1.38	0.14	
Annual Escalation Rate for Domestic Gas (%)						1.31	
<i>MEAN Escalation Rates are first calculated for Off-shore and North-East Series and the</i>							
<i>Escalation rates are then combined in the 90:10 proportion</i>							

ANNEX 1 CONTINUED

Escalation Rate for Domestic Gas: AS PER PROPOSED METHOD OF COMBINING EACH DATA POINT OF THE TWO SERIES IN PRE-DETERMINED PROPORTION OF 90:10 TO ARRIVE AT NEW SINGLE SERIES OF AVERAGE PRICES													
Consumer Price-Off-shore (Landfall point and On-shore) (Rs./'ooo' cubic metre)				Consumer Price (North-Eastern States) (Rs./'ooo' cubic metre)				Proportion of off-shore gas Component in Total Gas Price	Proportion of North-East gas Component in Total Gas Price	Average Gas Price (Rs/'000 cubic meter)	3 Year Moving Average of Average Gas Price Series	Annual Escalation Rate (%)	Decimal Values
Year	Consumer Price-Off-shore (Landfall point and On-shore) (Rs./'ooo' cubic metre)	3 Year moving average	Annual Escalation Rate (%)	Year	Consumer Price (North-Eastern States) (Rs./'ooo' cubic metre)	3 Year moving average	Annual Escalation Rate (%)						
1998	2850			1998	1700			90%	10%	2735			
1999	2850			1999	1700			90%	10%	2735			
2000	2850	2850.00		2000	1700	1700.00		90%	10%	2735	2735		
2001	2850	2850.00	0.00	2001	1700	1700.00	0.00	90%	10%	2735	2735	0	1
2002	2850	2850.00	0.00	2002	1700	1700.00	0.00	90%	10%	2735	2735	0	1
2003	2850	2850.00	0.00	2003	1700	1700.00	0.00	90%	10%	2735	2735	0	1
2004	2850	2850.00	0.00	2004	1700	1700.00	0.00	90%	10%	2735	2735	0	1
2005	3025	2908.33	2.05	2005	1810	1736.67	2.16	90%	10%	2903.5	2791.167	2.053626	1.020536
2006	3200	3025.00	4.01	2006	1920	1810.00	4.22	90%	10%	3072	2903.5	4.024601	1.040246
2007	3200	3141.67	3.86	2007	1920	1883.33	4.05	90%	10%	3072	3015.833	3.868894	1.038689
2008	3200	3200.00	1.86	2008	1920	1920.00	1.95	90%	10%	3072	3072	1.862393	1.018624
2009	3200	3200.00	0.00	2009	1920	1920.00	0.00	90%	10%	3072	3072	0	1
GEOMETRIC MEAN (a)												1.013	
ANNUAL ESCALATION RATE FOR DOMESTIC GAS ((a-1)*100) (%)												1.30	

ANNEX 2

Escalation Rate for Domestic Gas For Evaluation Based On Method of Minimum Mean Square Error						
Value of "T"	Year	Average Price of Domestic Gas Rs/'000 cub. M From Hybrid Series in ANNEX 2	$R_t = Y_t/Y_1$ from "T" =2	LN(Rt)	"T" minus 1	LN (Rt) x (T-1)
1.00	1998.00	2735.00				
2.00	1999.00	2735.00	1.00	0.00	1.00	0.00
3.00	2000.00	2735.00	1.00	0.00	2.00	0.00
4.00	2001.00	2735.00	1.00	0.00	3.00	0.00
5.00	2002.00	2735.00	1.00	0.00	4.00	0.00
6.00	2003.00	2735.00	1.00	0.00	5.00	0.00
7.00	2004.00	2735.00	1.00	0.00	6.00	0.00
8.00	2005.00	2903.50	1.06	0.06	7.00	0.42
9.00	2006.00	3072.00	1.12	0.12	8.00	0.93
10.00	2007.00	3072.00	1.12	0.12	9.00	1.05
11.00	2008.00	3072.00	1.12	0.12	10.00	1.16
12.00	2009.00	3072.00	1.12	0.12	11.00	1.28
SUM						4.83
A = 6* Sum						29.00
B = (n-1) x n x (2n-1)						3036.00
C = A/B						0.01
g = Exponential (C) -1						0.01
e = escalation rate (%) = g x 100						0.96

ANNEX 3

ESCALATION RATE FOR INLAND HANDLING OF IMPORTED COAL (FOR PAYMENT): EXISTING METHOD			
Period		WPI	CPI
Jan-09		228.9	148.0
Feb-09		227.6	148.0
Mar-09		228.2	148.0
Apr-09		231.5	150.0
May-09		234.3	151.0
Jun-09		235.0	153.0
Jul-09		238.7	160.0
Aug-09		240.8	162.0
Sep-09		242.6	163.0
Oct-09		242.5	165.0
Nov-09		245.4	168.0
Dec-09		246.5	169.0
Average Index (Jan 09-Jun 09)		230.92	149.67
Average Index (July 09-Dec 09)		242.75	164.50
Half-Yearly Inflation		5.12%	9.91%
Annual Inflation		10.25%	19.82%
		WPI Component	CPI Component
Weights	1	0.6	0.4
Half-Yearly Inflation	7.04%	3.07%	3.96%
Annual Inflation Rate	14.08%	6.15%	7.93%

ANNEX 3 CONTINUED

ESCALATION RATE FOR INLAND HANDLING OF IMPORTED COAL (FOR PAYMENT): COMPOSITE INDEX METHOD					
Period	WPI	WPI Weight	CPI	CPI Weight	Composite Index= (WPIx0.6)+(CPI x 0.4)
Jan-09	228.9	0.6	148.0	0.4	196.54
Feb-09	227.6	0.6	148.0	0.4	195.76
Mar-09	228.2	0.6	148.0	0.4	196.12
Apr-09	231.5	0.6	150.0	0.4	198.90
May-09	234.3	0.6	151.0	0.4	200.98
Jun-09	235.0	0.6	153.0	0.4	202.20
Jul-09	238.7	0.6	160.0	0.4	207.22
Aug-09	240.8	0.6	162.0	0.4	209.28
Sep-09	242.6	0.6	163.0	0.4	210.76
Oct-09	242.5	0.6	165.0	0.4	211.50
Nov-09	245.4	0.6	168.0	0.4	214.44
Dec-09	246.5	0.6	169.0	0.4	215.50
Average Index (Jan 09-Jun 09)					198.42
Average Index (July 09-Dec 09)					211.45
Half-Yearly Inflation (%)					6.57
Annual Inflation (%)					13.14