

Settlement Price Regulation of HUDEX Hungarian Derivative Energy Exchange Ltd.

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Table of contents

I. General rules	3
I.1. General principles.....	3
I.1.1. Scope of the Settlement Price Regulation.....	3
I.1.2. Persons bound by the Settlement Price Regulation and effective date.....	3
I.1.3. Definition.....	3
I.1.4. Official language	3
I.2. Basic Settlement Price calculation principles	3
I.3. Legal issues.....	4
I.3.1. Protection of the Settlement Price.....	4
I.3.2. Publication	4
I.3.3. Utilization of Settlement Price	4
II. Settlement Prices on Power Segment.....	5
II.1. Settlement Price calculation principles.....	5
II.1.1. Theory and method.....	5
II.1.2. Minimum number of Settlement Prices.....	5
II.2. Calculation process	6
II.2.1. Settlement window.....	6
II.2.2. Steps of the calculation	6
II.3. Parameters for Primary SP inputs.....	7
II.3.1. Bid-ask parameters.....	7
II.3.2. Quality parameters.....	7
II.3.3. Technical Prices	8
II.3.4. Incoming Product Handling	9
II.4. Parameters for Secondary SP inputs.....	9
II.5. Price determination.....	9
II.5.1. Preliminary SP1	9
II.5.2. Preliminary SP2	10
II.5.3. Arbitrage-Free SP.....	10

II.5.4. Final SP	10
II. 6. Settlement price calculation during the delivery period	11
III. Settlement Prices on Natural Gas Segment	12
III.1. Settlement Price calculation principles	12
III.1.1. Theory and method	12
III.1.2. Minimum number of Settlement Prices	12
III.2. Calculation process	13
III.2.1. Settlement window	13
III.2.2. Steps of the calculation	13
III.3. Parameters for Primary SP inputs	14
III.3.1. Bid-ask parameters	14
III.3.2. Quality parameters	14
III.3.3. Technical Prices and Incoming Product Handling	15
III.3.4. Incoming Product Handling	<u>161615</u>
III.4. Parameters for Secondary SP inputs	<u>171716</u>
III.5. Price determination	<u>171716</u>
III.5.1. Preliminary SP1	<u>171716</u>
III.5.2. Preliminary SP2	<u>171716</u>
III.5.3. Arbitrage-Free SP	<u>181817</u>
III.5.4. Final SP	<u>181817</u>

I. General rules

I.1. General principles

I.1.1. Scope of the Settlement Price Regulation

The Settlement Price Regulation is set of rules applicable to calculation process and methodology for the Settlement Price of HUDEX Hungarian Derivative Energy Exchange Private Company Limited by Shares (in the following: HUDEX) including parameters and prescriptions.

HUDEX shall publish the Settlement Price Regulation on its website.

I.1.2. Persons bound by the Settlement Price Regulation and effective date

The present Settlement Price Regulation is binding on HUDEX and on persons bound by the HUDEX Rules and Regulations.

The present Settlement Price Regulation will become effective at the earliest on the 5th Trading Day following their publication on the HUDEX website, or on any other later date specified by the decision of the CEO of HUDEX.

I.1.3. Definition

The definitions used in the Settlement Price Regulation shall have the meaning as defined in the HUDEX Market Rules.

I.1.4. Official language

The present Settlement Price Regulation is issued in Hungarian and English. The official language of HUDEX is Hungarian.

I.2. Basic Settlement Price calculation principles

Settlement Prices are calculated by HUDEX on each trading day on the HUDEX Power Segment and HUDEX Natural Gas Segment.

The Settlement Price serves as input for the daily margining process at the Clearing House.

I.3. Legal issues

I.3.1. Protection of the Settlement Price

The Settlement Price manual is protected by copyright.

I.3.2. Publication

Settlement Price related information (Settlement Price values, composition of Settlement Price, calculation parameters, decisions, releases, etc.) are published via the website of the HUDEX (www.hudex.hu).

I.3.3. Utilization of Settlement Price

Utilization of Settlement Price – in accordance with the relevant legislation – is primarily subject to the laws on copyright protection. Usage of the Settlement Price by service providers within the framework of products is subject to the conclusion of a license agreement.

II. Settlement Prices on Power Segment

II.1. Settlement Price calculation principles

II.1.1. Theory and method

The basic inputs of the Settlement Price calculation are the HUDEX Power Segment market data for the relevant trading day (trading and bidding activity) and the activity of economically equivalent products on OTC broker platforms and other exchanges. In the absence of the trades and bid-ask pairs the Settlement Price of the previous trading day is also used.

Essentially, for the determination of daily Settlement Prices HUDEX uses the market data of the HUDEX Power Segment within the relevant settlement window, specified in section 2.1 of this document. The inputs are weighted by quality attributes: time, volume and spread.

A trade's price spread is zero, thus its weight is the highest weight (value 1), otherwise a bid-ask pair's spread weight can range from 0 to 1 exponentially.

Using the weights of the three quality attributes HUDEX defines the overall quality for every input, which is a harmonic mean. The aggregated value of these overall qualities is the Quality Sum for every Contract, which indicates how sufficient the primary inputs are. In case there is not enough information available from the primary inputs in order to calculate the Settlement Price, HUDEX uses secondary inputs. Secondary inputs are OTC broker(s) indicative closing prices, price indications of HUDEX members and other publicly available indications.

In case there is no primary input (bid-ask pairs, trades) available, the price determination is based on a technical price. This takes into account the Settlement Price of the previous day for the corresponding Contract.

The Settlement Prices of the Contracts are arbitrage-free and are placed between the last observed bid and ask prices on HUDEX Power segment at the end of the settlement window.

II.1.2. Minimum number of Settlement Prices

HUDEX determines Settlement Prices for the following tradable Contracts at least:

- Day: front 1
- Weekend: 0
- Week: front 4
- Month: front 3
- Quarter: front 4
- Year: front 3

II.2. Calculation process

II.2.1. Settlement window

Settlement window is a time frame when trades and bid-ask pairs are considered.

The settlement window is between 8.00 a.m. and 5.00 p.m.

II.2.2. Steps of the calculation

The detailed steps of the calculations are the following.

No.	Calculation phase	Comment
1	Primary SP inputs	1.1, in absence 1.2, in absence 1.3
1.1	SP Estimate	Primary inputs: -I.: HUDEX trades and bid-ask pairs -II.: Trades and bid-ask pairs of economically equivalent products from other trading platforms -> SP Estimate and Quality Sum
1.2	HUDEX Technical Price	If no SP Estimate available -> Primary SP = Last SP + price shifting, if the Contract is in arbitrage with a Contract, which price has moved since the last calculation
1.3	Incoming Product Handling	In the absence of Last SP (e.g. first trading day), based on the Primary SP of other connected Contracts
2	Secondary SP inputs	Weighted average of 2.1 and 2.2
2.1	OTC broker closing prices and indications	OTC broker indicative closing prices and other publicly available indications
2.2	Indications	HUDEX member indications
3	Preliminary SP1	1 - if Quality Sum > SQS (Sufficient Quality Sum) weighted average of 1 & 2 - if Quality Sum < SQS
4	Preliminary SP2	Settling between the last BA at HUDEX
5	Arbitrage-Free SP	Arbitrage-free results
6	Final SP	Final SP, validated by the market operators

II.3. Parameters for Primary SP inputs

For the most accurate Settlement Price results, HUDEX uses different parameters in different phases of the calculation.

II.3.1. Bid-ask parameters

The corresponding bid and ask pairs for a Contract is classified as a potential trade in order to weight them along the same three quality attributes. While trades have exact volumes and prices, bid-ask pairs have two different volumes and prices. HUDEX takes the minimum of the two volumes and uses the average of the two prices.

The pairing rules and parameters for this process are the following. The lookback rule is not applied in case of HUDEX orders.

Parameter	Value	Explanation
Minimum duration of offers	0:03:00	The minimum duration [h:mm:ss], when HUDEX considers a Bid or an Ask to be a real offer. This parameter crosses out those actions, when someone make an offer for a moment, then immediately takes it off.
Lookback	1:00:00	The maximum time difference [h:mm:ss] between the paired Bid and Ask timestamps.
Minimum duration of paired offers	0:00:01	The minimum duration [h:mm:ss] for a bid-ask pair.

II.3.2. Quality parameters

HUDEX weights the inputs along the three attributes: time, volume and spread. Time and spread attributes have exponential distribution, while volume has linear.

Parameter	Explanation
Spread divisor	Exponential distribution, which value indicates the spread [EUR/MWh], where the spread quality drops to half. If the input is a trade the spread is considered as zero.
Time divisor	Exponential distribution, which value indicates the time [hour], when counting from the closing time of the settlement window the time quality drops to half.
Volume divisor	Linear distribution, which value indicates the volume [MWh/h], where the volume quality reach 1.
Spread zero threshold	In case the spread is greater than the value set for threshold [EUR/MWh], the spread quality is zero.
Time zero threshold	In case the time counting from the closing time of the settlement window is earlier than the value set for threshold [hour], the time quality is zero.

The calculation parameters for the different delivery periods are the following.

Parameter	Day	Weekend	Week	Month	Quarter	Year
Spread divisor	1,002.00	0,752.00	0.75	0.705	0.50	0.50
Time divisor	0.7	0.7	0.7	0.7	0.7	0.7
Volume divisor	105	105	105	75	5	5
Spread zero threshold	3,514.00	2,514.00	2,010.75	1,010.50	1,010.50	1,010.50
Time zero threshold	940	940	940	940	940	940

HUDEX calculates the overall quality as the harmonic mean of each primary inputs and the weighted average price as an estimated price (SP Estimate) for each individual Contract. Each SP estimate has a Quality Sum, which is an aggregated value of the overall qualities. HUDEX inputs have the priority, thus if the Quality Sum of the HUDEX inputs is sufficient, only those are considered in the calculation.

Parameter	Value	Explanation
Sufficient quality sum	1	This value shows the quality of the sufficient level of the primary inputs. The threshold for Quality Sum, under which the trading activity of economically equivalent products of other trading platforms are considered as input also. This threshold is considered then again in a second step, when the quality sums together do not exceed the sufficient level. In that case secondary inputs are considered.

II.3.3. Technical Prices

In case there are no primary inputs available (Quality Sum equals zero), HUDEX defines a Technical Price for that Contract. The Technical Price is based on the previous Settlement Price of that Contract.

If the Contract has a tradable superior Contract (it means they are in arbitrage) the Technical Price considers the price movement of the superior Contract. In this case the Technical Price is equal to the last Settlement Price shifted with the Preliminary Settlement Price change of the superior Contract.

If the Contract has not any superior Contract, the Technical Price is equal to the last Settlement Price.

In case there is SP Estimate available the Technical Price is not taken into consideration.

Parameter	Value	Explanation
Price shift factor	100%	This value shows the ratio of the price shifting in case of technical price determination.

II.3.4. Incoming Product Handling

For Contracts of incoming products, without any primary inputs and without a last Settlement Price, HUDEX determines an Incoming Product Price based on the Preliminary SP1 of the connecting Contracts according to the predefined rules below:

- Incoming weekly Contracts: calculated by the Preliminary SP1 of the other tradeable weekly Contracts' average.
- Incoming monthly Contracts: calculated by the Preliminary SP1 of the connecting quarterly and monthly Contracts' average, weighted with the size of the Contracts.
- Incoming quarterly Contracts: calculated by the Preliminary SP1 of the connecting yearly and quarterly Contracts' average, weighted with the size of the Contracts.
- Incoming yearly Contracts: determined by the nearest tradable yearly Contract's Preliminary SP1.

II.4. Parameters for Secondary SP inputs

If the Quality Sum of a Contract is not enough to reach the value of the sufficient quality sum then HUDEX utilizes the Secondary SP inputs. Secondary SP inputs are the HUDEX Member indications and OTC broker data and indications.

In order to prevent any market participant from unduly influencing the final Settlement Price and the usage of irrelevant market indications, HUDEX apply filters on the secondary inputs. These filters check, whether the secondary inputs are significantly different from the primary inputs or from the other secondary inputs. The arithmetic average of the filtered inputs is the Indices SP.

Parameter	Value	Explanation
OTC broker closing prices vs. member indications weight	2	The weight shows the ratio of the average of OTC broker data and indications against the average of member indications.

II.5. Price determination

II.5.1. Preliminary SP1

Preliminary SP1 is the Primary SP, when the Quality Sum exceeds the sufficient quality sum. If Quality Sum does not exceed the sufficient level, but SP Estimate exist, then Preliminary SP1 is the weighted average of SP Estimate and Secondary SP. In this case the weight of SP Estimate is the Quality Sum, while the weight of Secondary SP is the difference of Quality Sum and sufficient quality sum.

If Quality Sum is zero and SP Estimate doesn't exist, Preliminary SP1 is the weighted average of Primary SP and Secondary SP, where the weight is set by a parameter.

Parameter	Value	Explanation
Primary SP vs. Secondary SP weight	0.5075	The weight shows the ratio of Primary SP against Secondary SP during the calculation of weighted average price only in the case of when SP Estimate doesn't exist and Quality Sum is zero.

II.5.2. Preliminary SP2

HUDEX checks whether the Preliminary SP1 is greater than the last bid order's price or smaller than the last ask order's price. The observed timeframe is 15 minutes before the end settlement window, thus between 4:45 p.m. and 5:00 p.m. If the Preliminary SP1 is not lower than the best bid and not higher than the best ask the Preliminary SP1 is equal to preliminary SP2. If the Preliminary SP1 is out of the range the Preliminary SP2 is calculated as 0.01 EUR higher than the last best bid or 0.01 EUR lower than the last best ask.

II.5.3. Arbitrage-Free SP

The Settlement Price must be arbitrage-free. In order to define arbitrage-free Settlement Prices it may be needed to shift the Preliminary SP2. This shift is limited by two parameters. No-arbitrage is ensured in case of a difference of EUR 0.00 between the Contracts with an overlapping due date after standard rounding.

Parameter	Value	Explanation
Max price change (without SP Estimate)	3%	The maximum price deviation from the Preliminary SP2 in order to have arbitrage-free Settlement Prices when there isn't SP Estimate.
Max price change with SP Estimate	0.05%	The maximum price deviation from the Preliminary SP2 in order to have arbitrage-free Settlement Prices when there is SP Estimate.

II.5.4. Final SP

The market operators validate the results of the calculation. In case of any technical malfunction occurs HUDEX is entitled to modify the Settlement Price in accordance to appropriate rules for price calculation defined in HUDEX Market Rules.

II. 6. Settlement price calculation during the delivery period

HUDEX is required to calculate Settlement Prices for the week and month Contracts under delivery. During the delivery period these Contracts are not tradable, the price is calculated based on the Settlement Price on the last trading day and the average of the available HUPX day-ahead hourly prices.

$$SP = \frac{\textit{number of passed hours}}{\textit{number of total hours}} * \textit{average HUPX DAM price of passed hours} \\ + \left(1 - \frac{\textit{number of passed hours}}{\textit{number of total hours}}\right) * \textit{SP of last trading day}$$

III. Settlement Prices on Natural Gas Segment

III.1. Settlement Price calculation principles

III.1.1. Theory and method

The basic inputs of the Settlement Price calculation are the HUDEX Natural Gas Segment market data for the relevant trading day (trading and bidding activity) and the activity of economically analogical products on other exchanges. In the absence of the trades and bid-ask pairs Settlement Price of the previous trading day is also used.

Essentially, for the determination of daily Settlement Prices HUDEX uses the market data of the HUDEX Natural Gas Segment within the relevant settlement window, specified in section 2.1 of this document. The inputs are weighted by quality attributes: time, volume and spread.

A trade's price spread is zero, thus its weight is the highest weight (value 1), otherwise a bid-ask pair's spread weight can range from 0 to 1 exponentially.

Using the weights of the three quality attributes HUDEX defines the overall quality for every input, which is a geometric harmonic mean. The aggregated value of these overall qualities is the Quality Sum for every Contract, which indicates how sufficient the primary inputs are. In case there is not enough information available from the primary inputs in order to calculate the Settlement Price, HUDEX uses secondary inputs. Secondary inputs are price indications of HUDEX members.

In case there is no primary input (bid-ask pairs, trades) available, the price determination is based on a technical price. This takes into account the Settlement Price of the previous day for the corresponding Contract.

The Settlement Prices of the Contracts are arbitrage-free and are placed between the last observed bid and ask prices on HUDEX Natural Gas segment at the end of the settlement window.

III.1.2. Minimum number of Settlement Prices

HUDEX determines Settlement Prices for the following tradable Contracts at least:

- Month: _____ front 3
- Quarter: _____ front 4
- Seasonal: _____ front 3
- Yearly: _____ front 2
- Balance of Month (BoM): front 1, if the Contract is tradable

III.2. Calculation process

III.2.1. Settlement window

Settlement window is a time frame when trades and bid-ask pairs are considered.

The settlement window is between 8.00 a.m. and 6.00 p.m.

III.2.2. Steps of the calculation

The detailed steps of the calculations are the following.

No.	Calculation phase	Comment
1	Primary SP inputs	1.1, in absence 1.2, in absence 1.3
1.1	SP Estimate	Primary inputs: -I.: HUDEX trades and bid-ask pairs -II.: Relative price change of trades and bid-ask pairs of economically analogical products on other exchanges, BA: -> SP Estimate and Quality Sum
1.2	HUDEX Technical Price	If no SP Estimate available -> Primary SP = <u>I</u> Last SP + price shifting, if the Contract is in arbitrage with a <u>superior</u> Contract, which price has moved since the last calculation. <u>If no such a superior Contract is available, the Technical price is the last SP.</u> <u>In case of BoM:</u> <u>Primary SP = last SP + reference Contract SP change weighted</u>
1.3	Incoming Product Handling	In the absence of <u>I</u> Last SP (e.g. first trading day), based on the Primary SP of other connected Contracts
2	Secondary SP inputs	Average of 2.1
2.1	Indications	HUDEX member indications
3	Preliminary SP1	1 - if Quality Sum > SQS (Sufficient Quality Sum) weighted average of 1 & 2 - if Quality Sum < SQS
4	Preliminary SP2	Settling between the last BA at HUDEX
5	Arbitrage-Free SP	Arbitrage-free results <u>In case of BoM, there is no possibility of arbitrage.</u>
6	Final SP	Final SP, validated by the market operators

III.3. Parameters for Primary SP inputs

For the most accurate Settlement Price results, HUDEX uses different parameters in different phases of the calculation.

III.3.1. Bid-ask parameters

The corresponding bid and ask pairs for a Contract is classified as a potential trade in order to weight them along the same three quality attributes. While trades have exact volumes and prices, bid-ask pairs have two different volumes and prices. HUDEX takes the minimum of the two volumes and uses the average of the two prices.

The pairing rules and parameters for this process are the following. The lookback rule is not applied in case of HUDEX orders.

Parameter	Value	Explanation
Minimum duration of offers	0:03:00	The minimum duration [h:mm:ss], when HUDEX considers a Bid or an Ask to be a real offer. This parameter crosses out those actions, when someone make an offer for a moment, then immediately takes it off.
Lookback	1:00:00	The maximum time difference [h:mm:ss] between the paired Bid and Ask timestamps.
Minimum duration of paired offers	0:00:01	The minimum duration [h:mm:ss] for a bid-ask pair.

III.3.2. Quality parameters

HUDEX weights the inputs along the three attributes: time, volume and spread. Time and spread attributes have exponential distribution, while volume has linear.

Parameter	Value	Explanation
Spread divisor	0.1	Exponential distribution, which value indicates the spread [EUR/MWh], where the spread quality drops to half. If the input is a trade the spread is considered as zero.
Time divisor	5	Exponential distribution, which value indicates the time [hour], when counting from the closing time of the settlement window the time quality drops to half.
Volume divisor	10	Linear distribution, which value indicates the volume [MWh/h], where the volume quality reach 1. Volume quality cannot be greater than 1.
Spread zero threshold	1.2	In case the spread is greater than the value set for threshold [EUR/MWh], the spread quality is zero.
Time zero threshold	10	In case the time counting from the closing time of the settlement window is earlier than the value set for threshold [hour], the time quality is zero.

HUDEX calculates the overall quality as the harmonic mean of each primary inputs and the weighted average price as an estimated price (SP Estimate) for each individual Contract. Each SP estimate has a Quality Sum, which is an aggregated value of the overall qualities. HUDEX inputs have the priority, thus if the Quality Sum of the HUDEX inputs is sufficient, only those are considered in the calculation.

Parameter	Value	Explanation
Sufficient quality sum	1	This value shows the quality of the sufficient level of the primary inputs. The threshold for Quality Sum, under which the relative price change of economically analogical products of other exchanges is considered as input also. This threshold is considered then again in a second step, when the quality sums together do not exceed the sufficient level. In that case secondary inputs are considered.

III.3.3. Technical Prices and Incoming Product Handling

In case there are no primary inputs available (Quality Sum equals zero), HUDEX defines a Technical Price for that Contract. The Technical Price is based on the previous Settlement Price of that Contract.

If the Contract has a tradable superior Contract (it means they are in arbitrage) the Technical Price considers the price movement of the superior Contract. In this case the Technical Price is equal to the last Settlement Price shifted with the Preliminary SP1 change of the superior Contract.

If the Contract has not any superior Contract, the Technical Price is equal to the last Settlement Price.

In case there is SP Estimate available the Technical Price is not taken into consideration.

Parameter	Value	Explanation
Price shift factor	100%	This value shows the ratio of the price shifting in case of technical price determination.

In case of Balance of Month product in absence of primary inputs, HUDEX calculates Technical Price as the following. The Technical Price is the price change in percentage of the last SP of a Balance of Month – or in absence for the given month the monthly – Contract, where the price change in percentage is determined by the weighted average price change of the Reference Contracts.

The Reference Contracts are the CEEGEX Day-Ahead Contract and the HUDEX front month Contract. For the weighted average the weight of CEEGEX Day-Ahead Contract is the first delivery day of the Balance of Month Contract divided by the number of the days in the month. For the weighted average the weight of HUDEX front month Contract is the difference of the number of the days in the month and the first delivery day of the Balance of Month Contract, which difference is divided by the number of the days in the month.

III.3.4. Incoming Product Handling

For Contracts of incoming products, without any primary inputs and without a last Settlement Price, HUDEX determines an Incoming Product Price based on the Preliminary SP1 of the connecting Contracts according to the predefined rules below:

- Incoming monthly Contracts: calculated by the Preliminary SP1 of the connecting quarterly and monthly Contracts' average, weighted with the size of the Contracts.
- Incoming quarterly Contracts: calculated by the Preliminary SP1 of the connecting yearly and quarterly Contracts' average, weighted with the size of the Contracts.~~calculated by the Preliminary SP1 of the other quarterly Contracts' average.~~
- Incoming seasonal Contracts: the Preliminary SP1 of the previous seasonal Contract in terms of delivery, which is for the same season.
- Incoming yearly Contracts: the Preliminary SP1 of the previous yearly Contract in terms of delivery.

Incoming Product Handling is not applicable for Balance of Month Contracts, because Balance of Month Contracts always have Technical Price.

III.4. Parameters for Secondary SP inputs

If the Quality Sum of a Contract is not enough to reach the value of the sufficient quality sum then HUDEX utilizes the Secondary SP inputs. Secondary SP inputs are the HUDEX Member indications.

In order to prevent any market participant from unduly influencing the final Settlement Price and the usage of irrelevant market indications, HUDEX apply filters on the secondary inputs. These filters check, whether the secondary inputs are significantly different from the primary inputs or from the other secondary inputs. The arithmetic average of the filtered inputs is the Indices SP.

III.5. Price determination

III.5.1. Preliminary SP1

Preliminary SP1 is the Primary SP, when the Quality Sum exceeds the sufficient quality sum. If Quality Sum does not exceed the sufficient level, but SP Estimate exist, then Preliminary SP1 is the weighted average of SP Estimate and Secondary SP. In this case the weight of SP Estimate is the Quality Sum, while the weight of Secondary SP is the difference of Quality Sum and sufficient quality sum.

If Quality Sum is zero and SP Estimate doesn't exist, Preliminary SP1 is the weighted average of Primary SP and Secondary SP, where the weight is set by a parameter.

Parameter	Value	Explanation
Primary SP vs. Secondary SP weight	0.75	The weight shows the ratio of Primary SP against Secondary SP during the calculation of weighted average price only in the case of when SP Estimate doesn't exist and Quality Sum is zero.

III.5.2. Preliminary SP2

HUDEX checks whether the Preliminary SP1 is greater than the last bid order's price or smaller than the last ask order's price. The observed timeframe is 60 minutes before the end settlement window, thus between 5:00 p.m. and 6:00 p.m. If the Preliminary SP1 is not lower than the best bid and not higher than the best ask the Preliminary SP1 is equal to preliminary SP2. If the Preliminary SP1 is out of the range the Preliminary SP2 is calculated as 0.01 EUR higher than the last best bid or 0.01 EUR lower than the last best ask.

III.5.3. Arbitrage-Free SP

The Settlement Price must be arbitrage-free. In order to define arbitrage-free Settlement Prices it may be needed to shift the Preliminary SP2. This shift is limited by two parameters. No-arbitrage is ensured in case of a difference of EUR 0.00 between the Contracts with an overlapping due date after standard rounding.

Parameter	Value	Explanation
Max price change (without SP Estimate)	3%	The maximum price deviation from the Preliminary SP2 in order to have arbitrage-free Settlement Prices when there isn't SP Estimate.
Max price change with SP Estimate	30.05 %	The maximum price deviation from the Preliminary SP2 in order to have arbitrage-free Settlement Prices when there is SP Estimate.

III.5.4. Final SP

The market operators validate the results of the calculation. In case of any technical malfunction occurs HUDEX is entitled to modify the Settlement Price in accordance to appropriate rules for price calculation defined in HUDEX Market Rules.