# Monitoring report of GHGs emission reduction

JI PROJECT:

**“IMPLEMENTATION OF MODERN TECHNOLOGIES OF SINTER PRODUCTION AND BLAST FURNACES CHARGING AT OJSC “MMK”**

**Monitoring period: 01.01.2009 – 31.12.2010**

Version 1.2. (final after verification)

Data of development of this version: 12 July 2011

**CONTENTS**

# A. General information on the project

## *A.1. Introduction*

The aim of the report is representation of monitoring results and results of calculation of Emission Reduction Units (ERUs) generated by JI project "Implementation of modern technologies of sinter production and blast furnaces charging at OJSC "MMK" for the period from January 01, 2009 to December 31, 2010.

Monitoring report is prepared in accordance with PDD version 1.4 from September 29, 2010 (positive determination opinion was received from Accredited Independent Entity Bureau Veritas, report № RUSSIA-det/0084/2010).

The project has no approval yet in the Russian Federation as a Host Party. This is in process of receipt awaiting the announcement for submission of the project application to the Operator of carbon units (Sberbank) in accordance with procedure stipulated in the Decree #843 of 28, October 2009.

The Declaration of Approval from State of the Netherlands, acting through the Ministry of Economic Affairs, Agriculture and Innovation and its implementing agency "NL Agency", being the Designated Focal Point for Joint Implementation (JI) in The Netherlands has been received for the project by 15$^{th}$ April 2011.

## *A.2. Brief description of the project*

The proposed Joint Implementation project considers complex resource-saving effect of construction of sinter cooling and stabilization units (SCaSU) at sintering plants #2 and #3 and sequential installation of bell-less top chargers (BLT) at blast furnaces #4, 6, 9, 10, 2. The project was implemented during 2006-2010 in accordance with the following schedule:

Table A.2.1. Project implementation schedule

| **Date** | **Activity** |
|---|---|
| November 2006 | Installation of BLT at BF #4 |
| December 2006 | Installation of SCaSU at SP #3 |
| March 2007 | Installation of BLT at BF #6 |
| July 2007 | Installation of SCaSU at SP #2 |
| December 2007 | Installation of BLT at BF #9 |
| August 2010 | Installation of BLT at BF #10 |
| March 2010 | Installation of BLT at BF #2 |

Due to installation of SCaSUs the efficiency and performance of the blast furnace process was improved because fine fraction of sinter cake is screened out at SCaSU and does not come to the blast furnace plant. Implementation of SCaSU reduces specific consumption of skip metallurgical coke in the blast furnace, besides less charging material is wasted as dust and slug. A bell-less top charger makes charging process more manageable, so that any desired profiles of furnace charge materials can be obtained. A blast furnace with BLT charger may use fine fractions of coke (coke nut) and iron ore, which is hardly possible with a bell charger.

In the absence of the proposed JI project MMK would have been used hot non-stabilized agglomerate on BF #4, 6, 9, 10, 2 equipped with the double bell chargers.

### *A.3. Emission reduction during monitoring period*

In the current report we take into account emission reduction generated during 2009 and 2010. Detailed calculations are given in the section D.

**Actual emission reduction units (ERUs) are:**

From January 1 to December 31, 2009: **217 636 tones** $CO_{2e}$

From January 1 to December 31, 2010: **140 448 tones** $CO_{2e}$

In accordance with PDD, version 1.4 from September 29, 2010 the expected volumes of Emission Reduction Units (ERUs) are**:**

From January 1 to December 31, 2009: 234 483 tones $CO_{2e}$

From January 1 to December 31, 2010: 333 580 tones $CO_{2e}$

The actual generation of ERUs in 2010 is less than calculated in the PDD because of increase of specific consumption of skip metallurgical coke and decrease of pig iron production in comparison with PDD assumptions.

### *A.4. Contact information of project participants.*

Contact person of project owner:

| | |
|---|---|
| Company: | OJSC "Magnitogorsk Iron and Steel Works" |
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| City: | Magnitogorsk |
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| Title: | Mr. |
| Family name: | Mitchin |
| Name: | Andrey Mikhailovich |
| Department: | Department for relations with state authorities and markets protection |

Contact person of consultant of project owner and developer of this monitoring report:

| | |
|---|---|
| Company: | CTF Consulting, LLC |
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| Department: | - |

# B. Monitoring system of GHGs emission reduction

## *B.1 Collection and archiving of information about environmental impact of the project*

In accordance with requirements of Articles 14, 22 the Federal Law on environmental protection # 7-FZ OJSC "MMK" has the approved Maximum Permissible Emissions (MPE) document. This document is approved by Chelyabinsk Regional Department of Technological and Environmental Surveillance of Rostechnadzor. This decision is valid for one year. Under this decision the harmful emission permit is issued. This permit quantified impacts to atmosphere by OJSC "MMK".

For confirmation of MPE the air emissions were estimated by OJSC "Magnitogorsk GIPROMEZ" in accordance with Russian "Guidelines for calculation of industrial emissions of air pollutants" (OND-86)[1] . These estimations were based on OJSC "MMK" Emission Inventory and Emission Sources Report done by Federal State Unitary Enterprise "All-Russian Institute for Carbon Chemistry" in Yekaterinburg (2008). This report was approved according to the established procedure.

Laboratory for Control of Air Quality of OJSC "MMK" performs environmental monitoring according to the monitoring schedule.

According to the provisions of Russian environmental law (Federal Law №7-FZ of 10.01.2002 "On Environmental Protection"), environmental experts and managers of polluting enterprises must have qualifications in environmental protection and environmental safety. Functions of the Department of environmental protection are ensuring compliance with environmental quality standards, obtaining government permits for emissions and discharges of hazardous substances, disposal of waste.

In accordance with referred above Federal Law OJSC "MMK" has the approved Maximum Permissible Discharge of Sewage document (MPDS) and Permissible Norm of Producing and Placement of Wastes document (PNPPW). In these documents procedure of collecting and archiving of information on the environmental impacts is defined.

There is a monitoring plan in MPDS document, which is defined the monitoring parameters, frequency of measurement for each parameter and responsible personnel. Monitoring plan is approved by OJSC "MMK". In PNPPW document list and quantity of produced wastes, frequency of producing, places of storage and responsible personnel are defined. This document is approved by OJSC "MMK".

Considering the above we can conclude that OJSC "MMK" conduct the periodic monitoring of the environment impacts. The enterprise also has an environmental management system certified by ISO 14001.

According to the information from Environmental department of OJSC "MMK" received during visits in August 2010 and January 2011:

The project was realized in 2006-2010 period and environmental protection equipment designed for it (new electrostatic scrubbers on sinter plant #2 and #3) operates normally.

Emissions of polluting substances are normalized in the permission to emission of the polluting substances, given out by Rostehnadzor in the Chelyabinsk area. Results of inventory of emissions are presented annually.

According to the permission, emissions of pollutant substances don't create maximum concentration limit excess, except for a number of substances (nitrogen (IV) a dioxide, sulfur a dioxide, hydrogen sulfide, carbon oxide, phenol) for which temporarily permission is established.

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[1] http://www.vsestroi.ru/snip_kat/ad977f56010639c6e1ba95802d182677.php

The polluted water is treated at local treatment facilities. The enterprise has several closed loop water turnover systems. The water which is subject to the discharge is released in the river Sukhaya (inflow of the river Ural).

Placing of a waste occurs in conformity to the project of specifications of formation of a waste and limits on their placing, confirmed by Rostehnadzor in the Chelyabinsk area.

### *B.2 Methodological approach (extracts from PDD, ver. 1.4 from September 29, 2010)*

Monitoring of project and baseline GHGs emissions in 2009-2010 was implemented in accordance with PDD ver. 1.4 from September 29, 2010 except of several adjustments and deviations described in section C.

JI specific approach is applied for the monitoring of GHGs emission which is based on the principles of the "Guidance on criteria for baseline setting and monitoring" (Version 02)

Project boundaries include (Diagram B.2.1 and B.2.2 below):

- By-product coke plant
- Blast-furnace plant: BF #4, 6, 9, 10, 2
- Sintering plants #2, 3
- Own power generation capacities of MMK: Combined heat power plant (CHPP), Central power plant (CPP), Steam-air blowing power plant (SABPP), turbine section in the steam plant, gas recovery section in the steam plant

Diagram B.2.1: Project boundaries. Project scenario.

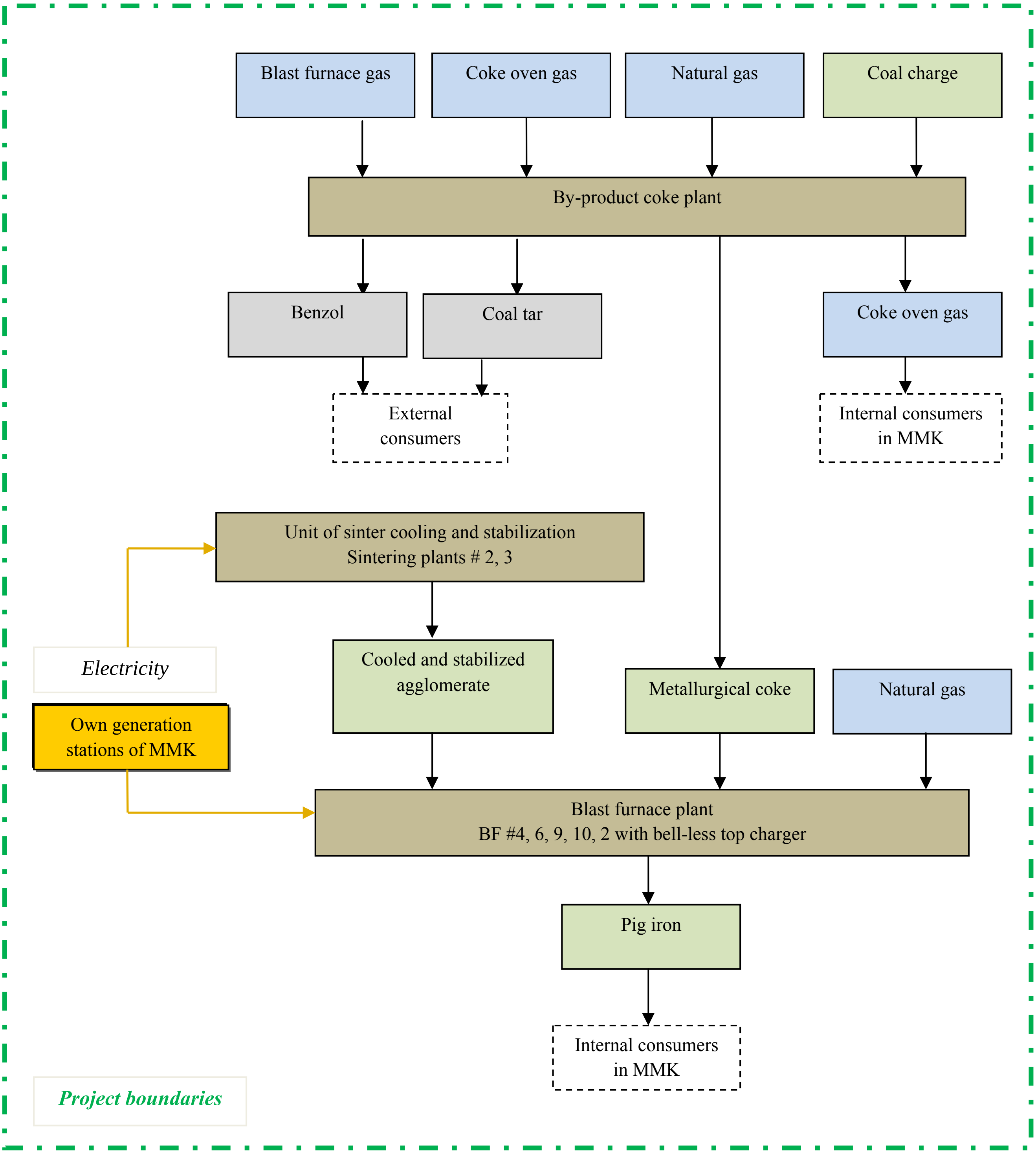
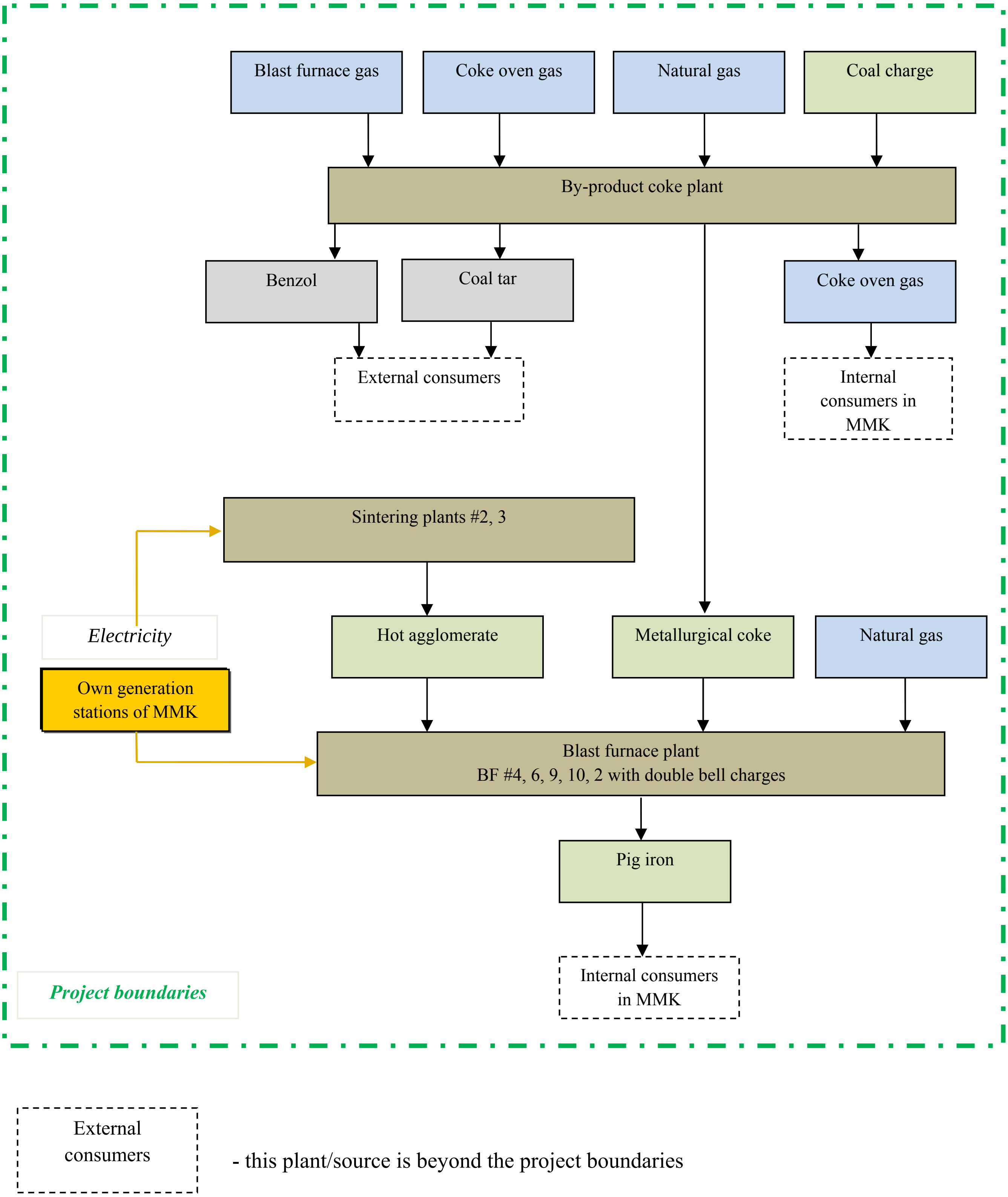


Diagram B.2.2: Project boundaries. Baseline scenario.



<u>To calculate the project $CO_2$ emissions the following approach is applied:</u>

1. Based on technical reports of Blast Furnace Plant the actual consumption of dry skip metallurgical coke and natural gas in BF #4, 6, 9, 10, 2 is determined. If production of pig iron in the project would exceed a maximum output of pig iron by BF #4, 6, 9, 10, 2 in the baseline scenario, the consumption of coke and natural gas will be mathematically reduced and not be considered for production of supplementary amount of pig iron in the project. Based on actual carbon content in metallurgical coke and natural gas the $CO_2$ emissions from consumption of dry skip metallurgical coke and natural gas at BF #4,6,9,10, 2 are calculated.
2. The emissions from production of coke consumed at BF #4, 6, 9, 10, 2 (dry skip metallurgical coke) are calculated on the basis of specific $CO_2$ emission factor per ton of metallurgical coke produced by BPCP. This emission factor is calculated by carbon balance for coke production at BPCP, as described in PDD "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works". This PDD had been determined by Accredited Independent Entity Bureau Veritas[2] (Annex 3 describes calculation methods).
3. The next step is calculation of $CO_2$ emissions from consumption of electricity by SCaSUs at sintering plant #2, 3 and $CO_2$ emissions from consumption of electricity for production of pure nitrogen required to cool down the BLT reduction gear at BF #4, 6, 9, 10, 2. The basis for that are actual consumption of electricity by SCaSU at the sintering plants #2 and #3 and the consumption of electricity for production of consumed pure nitrogen (no mathematic reduction depending on the iron production is done for conservativeness reason) and $CO_2$ emission factor for electricity produced at MMK, as described in PDD "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works". This PDD had been determined by Accredited Independent Entity Bureau Veritas (Annex 4 describes calculation methods).
4. Finally, total project $CO_2$ emissions are summed up.

Consumption of production inputs, raw materials, energy resources, and output of commercial products are routinely monitored at MMK by the system of corporate monitoring and reporting. These parameters are measured in accordance with applicable standards and rules of iron and steel industry of Russia, and international standards (MMK is certified under ISO 9001 standard). There are no any new parameters which would require to change the existing system of corporate accounting.

The majority of measured indicators required for $CO_2$ emission monitoring are regularly measured by direct analyses in Central Lab of MMK or calculated on the basis of chemical composition of carbon-containing substances (composition of natural gas is taken from its technical passport, issued by the supplier).

[2] http://ji.unfccc.int/JI_Projects/DB/3YOHME3FSIKG8602M8WN9D60QNIQT7/PublicPDD/YAGHLX0KYONQCEVWW7EHHU3EW75Z32/view.html

Tp calculate the baseline $CO_2$ emissions the following approach is applied:

1. Performance of the blast furnaces # 4, 6, 9, 10, 2 in the baseline is determined based on three-year period before project implementation and relevant historic parameters are fixed ex-ante. The annual technical reports of blast furnace plant of MMK for the period of 2004-2006 (i.e. before installation of the SCaSUs and bell-less top chargers) are used to determine a consumption of skip metallurgical coke (on dry mass) and natural gas as well as pig iron production by blast furnaces # 4, 6, 9, 10, 2. These data were used to calculate and fix ex-ante the average specific consumption of skip metallurgical coke and NG per ton of pig iron produced by each of these furnaces in the baseline.
2. Since actual production of pig iron in the project may be higher than in comparison period of 2004-2006 and no changes of the working volume of the blast furnaces were done, the historical maximal output of BF #4 and # 9 (date of 1988 year), BF #6 (date of 1990 year), BF # 10 (date of 1987) BF #2 (average value of historical data for the period of 2004-2006) equipped with double bell charges has been determined.
3. On the basis of actual pig iron production (which is limited for the baseline by maximal output of BF # 4, 6, 9, 10, 2) and average specific consumption of dry skip metallurgical coke and NG per ton of pig iron produced in the baseline the gross consumption of dry skip metallurgical coke and natural gas is calculated for each of the furnace. Based on these data and taking into account the actual carbon content in metallurgical coke and natural gas the total $CO_2$ emissions from consumption of dry skip metallurgical coke and natural gas at BF #4,6,9,10, 2 in the baseline are calculated.
4. Based on data of consumption of dry skip metallurgical coke by BF #4, 6, 9, 10, 2 in the baseline and specific $CO_2$ emission factor per ton of metallurgical coke produced in BPCP the emissions from consumed coke production are calculated. The $CO_2$ emission factor per ton of metallurgical coke is calculated as described in PDD "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works". This PDD had been determined by Accredited Independent Entity Bureau Veritas[3] (Annex 3 describes calculation methods).
5. Finally total baseline $CO_2$ emissions are calculated.

Table B.2.1. Parameters for calculation of the project and baseline emissions that are fixed ex-ante

| # | Data variable and unit | Notation | Value | Data source |
|---|---|---|---|---|
| 1. | Maximum production of pig iron by BF #4 in the baseline, th. t | $P_{max\ pig\ iron\ BF\ 4\ BL}$ | 1217,400 | Maximum output of BF #4 reached in 1988. Data from technical reports of blast furnace plant of Magnitogorsk metallurgical works here and in rows beneath. |
| 2. | Maximum production of pig iron by BF #6 in the baseline, th. t | $P_{max\ pig\ iron\ BF\ 6\ BL}$ | 1110,700 | Maximum output of BF #6 reached in 1990. |
| 3. | Maximum production of pig iron by BF #9 in the baseline, th. t | $P_{max\ pig\ iron\ BF\ 9\ BL}$ | 1768,0 | Maximum output of BF #9 reached in 1988. |
| 4. | Maximum production of pig iron by BF #2 in the baseline, th. t | $P_{max\ pig\ iron\ BF\ 2\ BL}$ | 1182,901 | Averaged value based on historical data for 2004-2006 |
| 5. | Maximum production of pig iron | $P_{max\ pig\ iron\ BF}$ | 1789,60 | Maximum output of BF #10 |

[3] http://ji.unfccc.int/JI_Projects/DB/3YOHME3FSIKG8602M8WN9D60QNIQT7/PublicPDD/YAGHLX0KYONQCEVWW7EHHU3EW75Z32/view.html

| | | | | |
|---|---|---|---|---|
| | by BF #10 in the baseline, th. t | 10 BL | | reached in 1987 |

Table B.2.3. Parameters for calculation of the baseline emissions only fixed ex-ante[4]

| № | Data variable and unit | Notation | Value | Data source |
|---|---|---|---|---|
| 1. | Consumption of dry skip metallurgical coke in BF #4 under the baseline, averaged over 2004-2006, t | $M_{skip\ metallurgical\_coke\_BF\ 4\ averaged\ BL}$ | 481 348 | Averaged value based on historical data for 2004-2006 |
| 2. | Production of pig iron in BF #4 in the baseline, t | $P_{pig\ iron\ BF\ 4\ averaged\ BL}$ | 1011,173 | |
| 3. | Consumption of NG in BF #4 in the baseline, th. m3/year | $FC_{NG\_BF\ 4\ averaged\ BL}$ | 103 017 | |
| 4. | Consumption of dry skip metallurgical coke in BF #6 in the baseline, t | $M_{skip\ metallurgical\_coke\_BF\ 6\ averaged\ BL}$ | 515 482 | |
| 5. | Production of pig iron in BF #6 in the baseline, t | $P_{pig\ iron\ BF\ 6\ averaged\ BL}$ | 1089,226 | |
| 6. | Consumption of NG in BF #6 in the baseline, th. m3/year | $FC_{NG\_BF\ 6\ averaged\ BL}$ | 116 505 | |
| 7. | Consumption of dry skip metallurgical coke in BF #9 under the baseline, t | $M_{skip\ metallurgical\_coke\_BF\ 9\ averaged\ BL}$ | 668 984 | The same as above |
| 8. | Production of pig iron in BF #9 in the baseline, t | $P_{pig\ iron\ BF\ 9\ averaged\ BL}$ | 1 492,464 | |
| 9. | Consumption of NG in BF #9 in the baseline, th. m3/year | $FC_{NG\_BF\ 9\ averaged\ BL}$ | 142 514 | |
| 10. | Consumption of dry skip metallurgical coke in BF #2 under the baseline, t | $M_{skip\ metallurgical\_coke\_BF\ 2\ averaged\ BL}$ | 552 198 | The same as above |
| 11. | Production of pig iron in BF #2 in the baseline, t | $P_{pig\ iron\ BF\ 2\ averaged\ BL}$ | 1 182,901 | |
| 12. | Consumption of NG in BF #2 in the baseline, th. m3/year | $FC_{NG\_BF\ 2\ averaged\ BL}$ | 123 167 | |
| 13. | Consumption of dry skip metallurgical coke in BF #10 under the baseline, t | $M_{skip\ metallurgical\_coke\_BF\ 10\ averaged\ BL}$ | 661 148 | |
| 14. | Production of pig iron in BF #10 in | $P_{pig\ iron\ BF\ 10\ averaged\ BL}$ | 1 525,061 | |

[4] Evidence for these parameters were provided in the PDD determination and are available on MMK on demand

| | | | | |
|---|---|---|---|---|
| | the baseline, t | | | |
| 15. | Consumption of NG in BF #10 in the baseline, th. m3/year | **FC** $_{NG\_BF\ 10\ averaged\ BL}$ | 131 324 | |
| 16. | Specific consumption of dry skip metallurgical coke in BF #4, kg/t | **SM** $_{skip\ metallurgical\_\ coke\ \_BF\ 4\ averaged\ BL}$ | 476,0 | The same as above |
| 17. | Specific consumption of NG in BF #4, m3/t | **SFC** $_{NG\_BF\ 4\ averaged\ BL}$ | 101,9 | |
| 18. | Specific consumption of dry skip metallurgical coke in BF #6, kg/t | **SM** $_{skip\ metallurgical\_\ coke\ \_BF\ 6\ averaged\ BL}$ | 473,3 | |
| 19. | Specific consumption of NG in BF #6, m3/t | **SFC** $_{NG\_BF\ 6\ averaged\ BL}$ | 107,0 | |
| 20. | Specific consumption of dry skip metallurgical coke in BF #9, kg/t | **SM** $_{skip\ metallurgical\_\ coke\ \_BF\ 9\ averaged\ BL}$ | 448,2 | |
| 21. | Specific consumption of NG in BF #9, m3/t | **SFC** $_{NG\_BF\ 9\ averaged\ BL}$ | 95,5 | |
| 22. | Specific consumption of dry skip metallurgical coke in BF #2, kg/t | **SM** $_{skip\ metallurgical\_\ coke\ \_BF\ 2\ averaged\ BL}$ | 466,8 | |
| 23. | Specific consumption of NG in BF #2, m3/t | **SFC** $_{NG\_BF\ 2\ averaged\ BL}$ | 104,1 | |
| 24. | Specific consumption of dry skip metallurgical coke in BF #10, kg/t | **SM** $_{skip\ metallurgical\_\ coke\ \_BF\ 10\ averaged\ BL}$ | 433,5 | |
| 25. | Specific consumption of NG in BF #10, m3/t | **SFC** $_{NG\_BF\ 10\ averaged\ BL}$ | 86,1 | |

### *B.3 Approach for organization and implementation of monitoring*

It should be noted that OJSC “MMK” had monitored all parameters used in the monitoring plan before development and determination the PDD but the specialized corporate procedure for the monitoring organization for the Joint Implementation project was adopted at MMK in February 2010 (PD MMK 3-SSGO-01-2010 “Regulation on monitoring of GHG emissions reduction, created as a result of the realization of the project: “Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works”), i.e. after approval of the project by an independent accredited entity.

Therefore the monitoring results for 2009 are based on reporting system existed prior to this point in time which is the same as nowadays with only exception of the involvement of Department for relations with state authorities and markets protection. Hereby all relevant monitoring information was collected and stored with accordance with MMK corporate rules and regulations but was not qualified as related to JI project boundaries. The mentioned internal Regulation MMK 3-SSGO-01-2010 has been designed to establish a clear and transparent set of authorities and responsibilities for identification of monitoring parameters, timely transfer of relevant reporting forms to MMK JI coordinator and to external consultant (CTF Consulting, LLC) and creation of provisions for secure long-term conservation of monitoring data in accordance with international requirements to JI.

The reporting forms of MMK departments used for monitoring of JI project “Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works” and considered project “Implementation of modern technologies of sinter production and blast furnaces charging at OJSC “MMK” are the same.

Monitoring of greenhouse gases emission reduction is carried out at OJSC “MMK” based on continuous monitoring of the monitoring parameters (Table B.3.1) specified in the PDD. Monitoring report is subject for verification. A reference about monitoring of each parameter is presented as informational matrix of the approved form. The data relating to the monitoring of the project is posted on a dedicated server of OJSC “MMK”.

Departments responsible for monitoring of each parameter in the JI project carry a responsibility for the treatment of primary reporting documents, processing, preparation, verification and transfer to the Department for relations with state authorities and markets protection (JI project implementation coordinator) of the reporting documents containing the information about monitored parameters. In each department of OJSC “MMK” involved in monitoring under the JI project the head of the department assigns a person responsible for provision of the reporting documents and tracking of the parameters change.

Picture B.3.1. Management structure of monitoring process

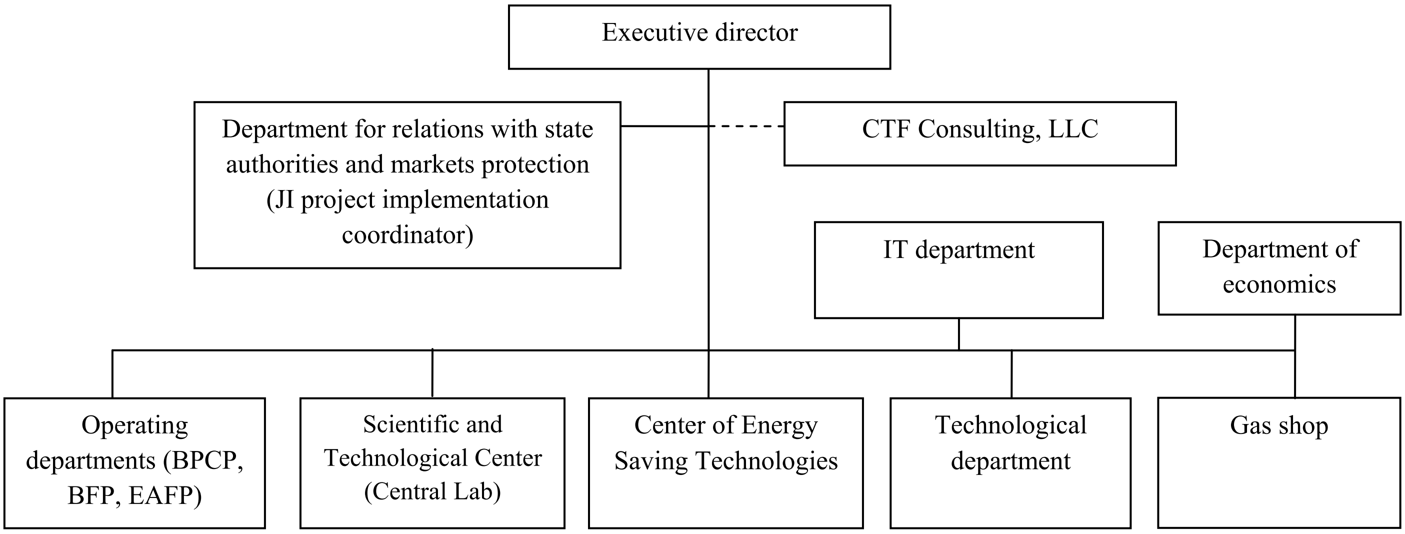



Table B.3.1. Responsibility of departments for monitoring parameters

| # | Department | Monitoring parameter |
|---|---|---|
| 1. | Blast-furnace plant | 1. Consumption of dry skip metallurgical coke in BF #4, 6, 9, 10, 2<br>2. Consumption of pure nitrogen in BF #4, 6, 9, 10, 2<br>3. Production of pig iron in BF # 4, 6, 9, 10, 2 |
| 2. | Central Laboratory of Control (as part of Scientific and Technological Center) | 4. Carbon content in dry metallurgical coke |
| 3. | Gas shop | 5. Carbon content in natural gas |
| 4. | Technological department | 6. Consumption of electricity by SCaSU at sintering plant #2<br>7. Consumption of electricity by SCaSU at sintering plant #3 |
| 5. | Center of Energy Saving Technologies | 8. Consumption of natural gas in BF#4, 6, 9, 10, 2 |

The periodicity of data transfer by structural departments of OJSC "MMK" is monthly within 5 working days after their preparation and approval of paper form. Submission of the reports to Department for relations with state authorities and markets protection is performed by responsible person in electronic form.

Responsible person from department prepares documents containing information about monitoring parameters in electronic format *.doc, *.xls, *.pdf, *.jpeg (depending the type of the document, see Table B.3.2). From e-mail address assigned for each department these files are sent to the e-mail address of Department of informational technologies that is registered as a resource for the monitoring of the project "Implementation of arc-furnace steelmaking at OJSC "MMK". Then received files are placed on the server of OJSC "MMK". Read access to this server is provided to users on the basis of an application for access to information resource. Editing rights of the electronic documents are restricted. Approved reported documents in paper form are stored in accordance with procedure existing in each department.

Storage of all records on monitoring for JI project (describing the period from January 1, 2008 to December 31, 2012) in electronic form is provided until January 1, 2015 by Department for relations with state authorities and markets protection.

Department for relations with state authorities and markets protection controls the completeness of the data and the term of data transfer. Every quarter all the relevant data are transferred to CTF Consulting, LLC. (consultant for the project) by e-mail. Similarly the information matrix of parameters, which were changed and other important information is sent to CTF Consulting, LLC in order that relevant definitions are made during a preparation of the monitoring report.

Within 10 working days after receipt of the complete set of reporting forms the specialists of CTF Consulting, LLC calculate $CO_2$ emission reduction achieved by JI project for each quarter. The results of calculation are reported to the Department for relations with state authorities and markets protection.

CTF Consulting, LLC develops for OJSC "MMK" the annual monitoring report on $CO_2$ emission reduction based on quarterly reporting upon receipt of the reporting for $4^{th}$ quarter. The monitoring report is sent then to Department for relations with state authorities and markets protection, which submits it for consideration of relevant departments. Department of Economics of MMK has to compare the figures contained in the monitoring report on consumption of raw materials and manufacture of products with Calculation of prime costs and confirm their compliance. Annual monitoring report is approved by Executive Director of MMK.

Table B 3.2. List of reporting documents prepared by departments of OJSC "MMK", which are used in project monitoring

| # | Department | The name of the reporting documents fixed in the Quality Management System (QMS) | Format of electronic from |
|---|---|---|---|
| 1. | Blast-furnace plant | Technical repot of blast-furnace plant | .XLS |
| 2. | Central Laboratory of Control in structure of Scientific and Technological Center | Carbon content in dry coal charge and metallurgical coke of BPCP of OJSCC "MMK". Monthly average data | .JPEG (scanned tables signed by the head of Central laboratory) |
| 3. | Department of plant engineering, gas shop | Natural gas quality passport (provided by supplier) | .PDF/.JPEG (scanned passport of NG) |
| 4. | Technological department | Report on electricity consumption by MMK departments | .XLS |

According to PDD version 1.4 dated September, 29 2010 two monitoring parameters (listed in the table below) are calculated by consultant as a part of monitoring of the JI project "Implementation of arc-furnaces steelmaking at Magnitogorsk iron and steel works"[5].

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5 http://ji.unfccc.int/JI_Projects/DB/3YOHME3FSIKG8602M8WN9D60QNIQT7/PublicPDD/YAGHLX0KYONQCEVWW7EHHU3EW75Z32/view.html

Table B 3.3. Monitoring parameters, calculated by consultant in 2009-2010

| # | Data variable and unit | Notation | Value | Data source, remarks |
|---|---|---|---|---|
| 1. | Specific $CO_2$ emissions per ton of produced metallurgical coke, t $CO_2$/t | $\mathbf{SPE}_{\mathbf{metallurgical\_coke}}$ | 2009 - 0,966 t $CO_2$/t<br>2010 - 0,955 t $CO_2$/t | Calculation model for monitoring report for the JI project “Implementation of arc-furnace technology at Magnitogorsk iron and steel works»[6], developed by CTF Consulting, LLC which is a subject of annual verification. |
| 2. | $CO_2$ emission factor for electricity produced by own generating capacities of MMK, t $CO_2$/MWh | $\mathbf{EF}_{\mathbf{own\ generation\_PJ}}$ | 2009 - 0,895 t $CO_2$/MWh<br>2010 - 0,920 t $CO_2$/MWh | |

[6] http://www.bureau-veritas.ru/wps/wcm/connect/1e7d908042fac653a3d0ef82b8d2d2f3/Monitoring+report+MMK+EAFP+2008+2009+ver+1.0_08.06.10.pdf?MOD=AJPERES&CACHEID=1e7d908042fac653a3d0ef82b8d2d2f3

## B.5 Technical means of measurements and its accuracy

| # | *Monitoring parameter* | *Measuring device* | *Inaccuracy of measurements* |
|---|---|---|---|
| 1. | Consumption of dry metallurgical coke in BF #4, 6, 9, 2, 10 | Weighting funnels with strain sensor VDD6-0.5. Besides humidity is measured to recalculate on dry mass | 1% |
| 2. | Production of pig iron in BFP №#4,6,9,2,10 | Railway scales | 0,3-1% depending on the scales type |
| 3. | Consumption of NG in BF #4,6,9,2,10 | Pressure differential flow meters Yokogava Eja110a measure flows of NG in BFP, CHPP, CPP, SABPP and the turbine section of the steam plant. Then the consumption of natural gas is calculated by SPG-762 calculator. | 1% |
| 4. | Consumption of pure nitrogen in BF #4,6,9,2,10 | Gas flow meter | 1% |
| 5. | Carbon content in dry metallurgical coke | Carbon analyzer LECO SC144DR | 0,25% |
| 6. | Carbon content in NG | Component composition of NG is specified in technical passport by the supplier. Carbon content is then estimated on the basis of that measured composition of gas | 0,5% |
| 7. | Consumption of ectricity by SCaSUs at sintering plants #2, 3 | Active and reactive electricity meters.<br>Meter type: active electricity meter C6805V, f.66B-01, active electricity meter SAZU-I670M; reactive electricity meter SR4U-I673M, f.66B-01 reactive electricity meter SAZU-I670D. | 0,5%; 2,0% (it depends on meter type) |

## C. Adjustments and deviations from the monitoring plan presented in PDD

Some adjustments and deviations were made in the monitoring plan presented in section D of PDD, version 1.4 from September 29, 2010 (this version of PDD has been determined by Bureau Veritas Certification Holding SAS № RUSSIA-det/0084/2010. Expert opinion of October 20, 2010). The changes have been made for monitoring plan adaptation and representation the actually existing situation. Another monitoring parameters and calculation formulae are in compliance with PDD.

| Mentioned in PDD | Implemented in practice | Explanation |
|---|---|---|
| Table D.1.1.1. **Parameter %C $_{metallurgical\ coke\_PJ}$ – Carbon content in the metallurgical coke**<br>Recording frequency – 2 times a day<br>Averaged over sample measurements. | BPCP lab of OJSC "MMK" did not perform systematic measurements of carbon content in coal charge in January 2009 due to replacement of the old measuring device on a new one (carbon analyzer LECO SC144DR), which entailed the development and approval of new measurements methodologies and staffed training.<br>Therefore in the calculations the value of the carbon content in dry coal charge for January 2009 was taken as for February 2009 (**83,39 % by mass.**). | A deviation in average values of carbon content in metallurgical coke (on dry weight) was less than 1% by mass in the period from February 2009 to December 2009, which suggests a stable composition of the coal charge loaded into the coke ovens. It is achieved by pre-mixing of different types of coking coal before it is fed to the ovens. This is a common practice of the enterprise.<br>In the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Chapter 4. Table 4.3.the standard value for carbon content in metallurgical coke is 83 % by mass, which is quite close to the taken value of 83,51% by mass and therefore taking into account the import of $CO_2$ emission factor for metallurgical coke production from calculation model for monitoring report for the JI project "Implementation of arc-furnace technology at Magnitogorsk iron and steel works» (where also for January 2009 the average value for February 2009 – December 2009 was taken) such action is reasonable as the difference in ERUs for 2009 while taking each of the mentioned values would be less than 100 tones $CO_{2eq}$, which is immaterial. |

| | | |
|---|---|---|
| ***Specific $CO_2$ emissions per ton of produced metallurgical coke***<br>**$SPE_{metallurgical\ coke} = PE_{metallurgical\ coke} / P_{metallurgical\ coke\_PJ}$ (D.1.1.2.-2)**<br>Where:<br>$SPE_{metallurgical\_coke}$ – Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP, t CO2/t<br>$PE_{metallurgical\_coke}$ – Project emissions from production of metallurgical coke in BPCP, th. t of CO2<br>$P_{metallurgical\ coke\_PJ}$ – Production of dry metallurgical coke, th. t | The monitoring plan means that OJSC "MMK" fully meets their requirements for metallurgical coke, which was the practice in recent years. However in 2nd and 3rd quarters of 2009 OJSC "MMK" purchased a part of required metallurgical coke from other coke producers by reason of shut down of several coke batteries at the end of 2008 (due to the global economic and financial crisis). Thereby the value of specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP was assumed to be the same for own produced and purchased coke since other producers of coke have not lesser carbon intensity during its production. | Mentioned deviation in the calculation model have been illustrated in section E.1 of PDD and approved by independent accredited entity during determination. |
| **$PE_{coke,\ NG\ for\ BF4\ reduced}$** – Project emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4, reduced, th. tones $CO_2$.<br>**$PE_{EC\ CSU\ AF\ 2.3}$** – $CO_2$ project emissions from electricity consumption by SCaSU, th. tones $CO_2$.<br>**$PE_{EC}$** – Total project $CO_2$ emissions from electricity consumption, th. tones $CO_2$<br>**$PE_{EC}$** – Total project $CO_2$ emissions from electricity consumption, th. tones $CO_2$<br>**$BE_{coke,\ NG\ for\ BF4}$** – Baseline emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4, th. tones $CO_2$<br>**BE** – Baseline CO2 emissions, th. tones $CO_2$ | The dimensionality of the value of $CO_2$ emissions has been changed from "thousand tones $CO_2$" to "tones $CO_2$" in the formulae **D.1.1.2.-1, D.1.1.2.-5, D.1.1.2.-9, D.1.1.2.-13, D.1.1.2.-17, D.1.1.2.-21, D.1.1.2.-25, D.1.1.2.-26, D.1.1.4.-1, D.1.1.4.-5, D.1.1.4.-9, D.1.1.4.-13, D.1.1.4.-17, D.1.1.4.-21** | It was done to provide consistency throughout of the Monitoring report. |

# D. Calculation of GHG emissions reduction

## D.1 PROJECT EMISSIONS

**Production of pig iron**

1) **Total reduced emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4**

$PE_{coke, NG\ for\ BF4\ reduced} = M_{skip\ metallurgical\ coke\_BF\ 4\ reduced\ PJ} * \%C_{metallurgical\ coke\_PJ} / 100 * 44/12 + M_{skip\ metallurgical\ coke\_BF\ 4\ reduced\ PJ} * SPE_{metallurgical\ coke} + FC_{NG\_BF\ 4\ reduced\ PJ} * C_{NG\_PJ} * 44/12$ **(PDD formula D.1.1.2.-1)**

$M_{skip\ metallurgical\ coke\_BF\ 4\ reduced\ PJ} = M_{skip\ metallurgical\ coke\_BF\ 4\ PJ} * K_1$ **(PDD formula D.1.1.2.-2)**

$K_1 = 1$ **если** $P_{pig\ iron\ BF\ 4\ PJ} <= P_{max\ pig\ iron\ BF\ 4\ BL}$ **(PDD formula D.1.1.2.-3)**
$K_1 = P_{max\ pig\ iron\ BF\ 4\ BL} / P_{pig\ iron\ BF\ 4\ PJ}$ **if** $P_{pig\ iron\ BF\ 4\ PJ} > P_{max\ pig\ iron\ BF\ 4\ BL}$

$FC_{NG\_BF\ 4\ reduced\ PJ} = FC_{NG\_BF\ 4\ PJ} * K_1$ **(PDD formula D.1.1.2.-4)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $PE_{coke, NG\ for\ BF4\ reduced}$ | Project emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4, reduced | tones $CO_2$ | $\%C_{metallurgical\ coke\_PJ}$ | Carbon content in metallurgical coke | % by weight | $FC_{NG\ \ BF\ 4\ reduced\ PJ}$ | Project consumption of NG in BF #4, reduced | th. m3 |
| $M_{skip\ metallurgical\ coke\_BF\ 4\ reduced\ PJ}$ | Project consumption of dry skip metallurgical coke in BF #4, reduced | tones | $SPE_{metallurgical\_coke}$ | Specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP | tons CO2/t | $C_{NG\_PJ}$ | Carbon content in NG | kgC/ m3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **M** $_{skip\ metallurgical\ coke\_BF\ 4\ PJ}$ | Project emissions from consumption of dry skip metallurgical coke in BF #4 | tones | **К** $_{1}$ | Project adjustment coefficient for BF #4 | - | **P** $_{max\ pig\ iron\ BF\ 4\ BL}$ | Maximum production of pig iron in BF #4 under the baseline scenario (1217.4 thousand tons in 1988) | tones |
| **P** $_{pig\ iron\ BF\ 4\ PJ}$ | Project production of pig iron in BF #4 | tones | **FC** $_{NG\_BF\ 4\ PJ}$ | Project consumption of NG in BF #4 | th. m3 | | | |

## *12 months of 2009*

Consumption of coke, NG and pig iron production in 2009 in BF #4, maximum production of pig iron by BF #4 and adjustment coefficient K1

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 42 104 | 40 298 | 45 059 | 45 431 | 42 637 | 46 840 | 44 729 | 47 618 | 47 244 | 44 760 | 45 424 | 44 573 | 536 718 |
| 2 | Consumption of NG actual | th. $m^3$ | 10 374 | 10 010 | 12 311 | 12 656 | 11 351 | 11 448 | 10 982 | 12 169 | 12 241 | 11 757 | 11 990 | 10 962 | 138 251 |
| 3 | Pig iron production | tones | 93 083 | 91 864 | 102 832 | 104 208 | 98 098 | 107 791 | 103 326 | 109 454 | 108 672 | 103 675 | 104 810 | 102 081 | **1 229 894** |
| 4 | Maximum production of pig iron in BF#4 (historical data of 1988) | tones | 1 217 400 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K1 | | 0,990 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 41 677 | 39 889 | 44 601 | 44 969 | 42 204 | 46 364 | 44 275 | 47 134 | 46 764 | 44 305 | 44 963 | 44 120 | 531 266 |
| 2 | Carbon content in dry skip coke | % | 83,39 | 83,39 | 84,02 | 83,39 | 83,41 | 83,31 | 83,43 | 83,64 | 83,40 | 83,84 | 83,63 | 83,10 | 83,50 |
| | | tones C | 34 754 | 33 263 | 37 474 | 37 500 | 35 202 | 38 626 | 36 938 | 39 423 | 39 001 | 37 146 | 37 602 | 36 664 | 443 595 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 10269 | 9 908 | 12 186 | 12 527 | 11 236 | 11 332 | 10 870 | 12 045 | 12 117 | 11 638 | 11 868 | 10 851 | 136 847 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,50 | 0,50 |
| | | tones C | 5085 | 4 906 | 6 033 | 6 201 | 5 562 | 5 612 | 5 381 | 5 962 | 5 995 | 5 760 | 5 874 | 5 372 | 67 743 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 40279 | 38 551 | 43 105 | 43 461 | 40 788 | 44 809 | 42 789 | 45 553 | 45 195 | 42 819 | 43 455 | 42 640 | 513 444 |
| 6 | CO2 emissions from coke consumption in BF #4 (reduced) | tones $CO_2$ | 127432 | 121965 | 137405 | 137500 | 129075 | 141629 | 135441 | 144551 | 143005 | 136200 | 137876 | 134435 | 1626514 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | CO2 emissions from NG consumption in BF #4 (reduced) | tones $CO_2$ | 18646 | 17987 | 22122 | 22738 | 20394 | 20576 | 19729 | 21861 | 21983 | 21118 | 21539 | 19696 | 248390 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4 (reduced)** | **tones $CO_2$** | **186 356** | **178 503** | **202 633** | **203 699** | **190 257** | **207 014** | **197 959** | **211 966** | **210 183** | **200 138** | **202 870** | **196 771** | **2 388 348** |

## *12 months of 2010*

Consumption of coke, NG and pig iron production in 2010 in BF #4, maximum production of pig iron by BF #4 and adjustment coefficient K1

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 27 799 | 42 548 | 48 107 | 45 851 | 40 846 | 42 262 | 43 576 | 41 811 | 44 465 | 46 331 | 47 147 | 46 648 | 517 391 |
| 2 | Consumption of NG actual | th. $m^3$ | 5 408 | 9 454 | 12 125 | 12 199 | 11 002 | 11 577 | 12 427 | 11 417 | 10 391 | 11 871 | 11 808 | 11 773 | 131 452 |
| 3 | Pig iron production | tones | 56 779 | 91 705 | 109 292 | 105 352 | 93 825 | 97 630 | 100 784 | 93 708 | 95 393 | 103 782 | 105 154 | 104 556 | **1 157 960** |
| 4 | Maximum production of pig iron in BF#4 (historical data of 1988) | tones | 1 217 400 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K1 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 27 799 | 42 549 | 48 107 | 45 851 | 40 846 | 42 262 | 43 576 | 41 811 | 44 465 | 46 331 | 47 147 | 46 648 | 517 392 |
| 2 | Carbon content in dry skip coke | % by mass | 83,05 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 82,96 | 82,94 | 82,80 | 82,90 | 82,90 | 83,00 | 83,01 |
| | | tones C | 23 087 | 35 145 | 40 025 | 38 286 | 34 025 | 35 077 | 36 150 | 34 677 | 36 817 | 38 408 | 39 085 | 38 718 | 429 498 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 5 408 | 9 454 | 12 125 | 12 199 | 11 002 | 11 577 | 12 427 | 11 417 | 10 391 | 11 871 | 11 808 | 11 773 | 131 452 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | tones C | 2 677 | 4 680 | 5 999 | 6 036 | 5 441 | 5 726 | 6 148 | 5 644 | 5 136 | 5 871 | 5 841 | 5 825 | 65 025 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 27 664 | 42 343 | 47 874 | 45 629 | 40 648 | 42 057 | 43 365 | 41 608 | 44 249 | 46 106 | 46 918 | 46 422 | 514 882 |
| 6 | CO2 emissions from coke consumption in BF #4 (reduced) | tones $CO_2$ | 84 653 | 128 867 | 146 758 | 140 380 | 124 757 | 128 617 | 132 549 | 127 148 | 134 996 | 140 831 | 143 311 | 141 965 | 1 574 833 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | CO2 emissions from NG consumption in BF #4 (reduced) | tones $CO_2$ | 9 817 | 17 160 | 21 996 | 22 133 | 19 952 | 20 995 | 22 541 | 20 694 | 18 832 | 21 528 | 21 419 | 21 360 | 238 425 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4 (reduced)** | **tones $CO_2$** | **122 133** | **188 370** | **216 628** | **208 142** | **185 357** | **191 669** | **198 455** | **189 450** | **198 077** | **208 465** | **211 648** | **209 747** | **2 328 140** |

**2) Total reduced emissions from consumption of dry skip metallurgical coke in BF #6, production of this metallurgical coke in BPCP, consumption of NG in BF #6**

$\mathbf{PE}_{\text{coke, NG for BF6 reduced}} = \mathbf{M}_{\text{skip metallurgical coke\_BF 6 reduced PJ}} * \%\mathbf{C}_{\text{metallurgical coke\_PJ}} /100 * 44/12 + \mathbf{M}_{\text{skip metallurgical coke\_BF 6 reduced PJ}} * \mathbf{SPE}_{\text{metallurgical coke}} + \mathbf{FC}_{\text{NG\_BF 6 reduced PJ}} * \mathbf{C}_{\text{NG\_PJ}} * 44/12$ **(PDD formula D.1.1.2.-5)**

$\mathbf{M}_{\text{skip metallurgical coke\_BF 6 reduced PJ}} = \mathbf{M}_{\text{skip metallurgical coke\_BF 6 PJ}} * \mathbf{K}_2$ **(PDD formula D.1.1.2.-6)**

$\mathbf{K}_2 = 1$ **если** $\mathbf{P}_{\text{pig iron BF 6 PJ}} <= \mathbf{P}_{\text{max pig iron BF 6 BL}}$ **(PDD formula D.1.1.2.-7)**
$\mathbf{K}_2 = \mathbf{P}_{\text{max pig iron BF 6 BL}} / \mathbf{P}_{\text{pig iron BF 6 PJ}}$ **if** $\mathbf{P}_{\text{pig iron BF 6 PJ}} > \mathbf{P}_{\text{max pig iron BF 6 BL}}$

$\mathbf{FC}_{\text{NG\_BF 6 reduced PJ}} = \mathbf{FC}_{\text{NG\_BF 6 PJ}} * \mathbf{K}_2$ **(PDD formula D.1.1.2.-8)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $\mathbf{PE}_{\text{coke, NG for BF6 reduced}}$ | Project emissions from consumption of dry skip metallurgical coke in BF #6, production of this metallurgical coke in BPCP, consumption of NG in BF #6, reduced | tones $CO_2$ | $\mathbf{FC}_{\text{NG BF 6 reduced PJ}}$ | Project consumption of NG in BF #6, reduced | th. m3 | $\mathbf{M}_{\text{skip metallurgical coke\_BF 6 reduced PJ}}$ | Project consumption of dry skip metallurgical coke in BF #6, reduced | tones |
| $\mathbf{M}_{\text{skip metallurgical coke \_BF 6 PJ}}$ | Project emissions from consumption of dry skip metallurgical coke in BF #6 | tones | $\mathbf{K}_2$ | Project adjustment coefficient for BF #6 | - | $\mathbf{P}_{\text{max pig iron BF 6 BL}}$ | Maximum production of pig iron in BF #6 under the baseline scenario (1110,7 thousand tons in 1990) | tones |
| $\mathbf{P}_{\text{pig iron BF 6 PJ}}$ | Project production of pig iron in BF #6 | tones | $\mathbf{FC}_{\text{NG\_BF 6 PJ}}$ | Project consumption of NG in BF #6 | th. m3 | | | |

# *12 months of 2009*

Consumption of coke, NG and pig iron production in 2009 in BF #6, maximum production of pig iron by BF #6 and adjustment coefficient K2

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 35 233 | 34 928 | 39 761 | 37 640 | 36 320 | 36 736 | 41 079 | 38 864 | 40 927 | 42 569 | 39 513 | 40 522 | 464 091 |
| 2 | Consumption of NG actual | th. $m^3$ | 7 698 | 9 947 | 11 649 | 10 094 | 9 250 | 10 435 | 11 339 | 10 952 | 9 902 | 10 653 | 10 171 | 10 076 | 122 163 |
| 3 | Pig iron production | tones | 76 728 | 79 563 | 91 157 | 85 735 | 82 139 | 84 025 | 94 248 | 89 220 | 93 699 | 97 821 | 90 702 | 92 460 | **1 057 495** |
| 4 | Maximum production of pig iron in BF#6 (historical data of 1990) | tones | 1 110 700 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K2 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 35 233 | 34 928 | 39 761 | 37 640 | 36 320 | 36 736 | 41 079 | 38 864 | 40 927 | 42 569 | 39 513 | 40 522 | 464 091 |
| 2 | Carbon content in dry skip coke | % | 83,39 | 83,39 | 84,02 | 83,39 | 83,41 | 83,31 | 83,43 | 83,64 | 83,40 | 83,84 | 83,63 | 83,10 | 83,50 |
| | | tones C | 29 380 | 29 126 | 33 407 | 31 388 | 30 295 | 30 605 | 34 272 | 32 506 | 34 133 | 35 690 | 33 045 | 33 673 | 387 520 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 7 698 | 9 947 | 11 649 | 10 094 | 9 250 | 10 435 | 11 339 | 10 952 | 9 902 | 10 653 | 10 171 | 10 076 | 122 163 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,50 | 0,50 |
| | | tones C | 3 812 | 4 925 | 5 768 | 4 997 | 4 579 | 5 167 | 5 612 | 5 421 | 4 899 | 5 272 | 5 034 | 4 988 | 60 474 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 34 051 | 33 756 | 38 427 | 36 377 | 35 102 | 35 504 | 39 701 | 37 560 | 39 554 | 41 141 | 38 187 | 39 162 | 448 522 |
| 6 | CO2 emissions from coke consumption in BF #6 (reduced) | tones $CO_2$ | 107 728 | 106 796 | 122 494 | 115 089 | 111 080 | 112 217 | 125 665 | 119 188 | 125 155 | 130 863 | 121 164 | 123 469 | 1 420 907 |
| 7 | CO2 emissions from NG consumption in BF #6 (reduced) | tones $CO_2$ | 13 977 | 18 057 | 21 148 | 18 321 | 16 789 | 18 947 | 20 578 | 19 876 | 17 964 | 19 331 | 18 459 | 18 289 | 221 737 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6 (reduced)** | **tones $CO_2$** | **155 756** | **158 608** | **182 068** | **169 787** | **162 971** | **166 668** | **185 944** | **176 625** | **182 673** | **191 335** | **177 810** | **180 920** | **2 091 167** |

# *12 месяцев 2010 г.*

Consumption of coke, NG and pig iron production in 2010 in BF #6, maximum production of pig iron by BF #6 and adjustment coefficient K2

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 39 337 | 38 458 | 41 755 | 38 576 | 31 476 | 0 | 0 | 8 877 | 44 523 | 45 449 | 45 591 | 42 812 | 376 854 |
| 2 | Consumption of NG actual | th. $m^3$ | 9 031 | 9 010 | 9 935 | 9 565 | 6 618 | 0 | 0 | 1 066 | 7 281 | 11 721 | 11 800 | 10 888 | 86 915 |
| 3 | Pig iron production | tones | 86 964 | 85 306 | 92 852 | 86 680 | 71 466 | 0 | 0 | 14 351 | 95 200 | 101 533 | 102 293 | 95 330 | **831 975** |
| 4 | Maximum production of pig iron in BF#6 (historical data of 1990) | tones | 1 110 700 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K2 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 39 337 | 38 458 | 41 755 | 38 576 | 31 476 | 0 | 0 | 8 877 | 44 523 | 45 449 | 45 591 | 42 812 | 376 854 |
| 2 | Carbon content in dry skip coke | % | 83,05 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 82,96 | 82,94 | 82,80 | 82,90 | 82,90 | 83,00 | 83,01 |
| | | tones C | 32 669 | 31 766 | 34 740 | 32 211 | 26 220 | 0 | 0 | 7 362 | 36 865 | 37 677 | 37 795 | 35 534 | 312 834 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 9 031 | 9 010 | 9 935 | 9 565 | 6 618 | 0 | 0 | 1 066 | 7 281 | 11 721 | 11 800 | 10 888 | 86 915 |
| 4 | Carbon content in NG | kg $C/m^3$ | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | tones C | 4 471 | 4 460 | 4 915 | 4 733 | 3 273 | 0 | 0 | 527 | 3 599 | 5 797 | 5 838 | 5 387 | 43 000 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 39 146 | 38 271 | 41 552 | 38 389 | 31 323 | 0 | 0 | 8 834 | 44 307 | 45 229 | 45 370 | 42 604 | 375 026 |
| 6 | CO2 emissions from coke consumption in BF #6 (reduced) | tones $CO_2$ | 119 788 | 116 476 | 127 381 | 118 107 | 96 138 | 0 | 0 | 26 995 | 135 172 | 138 150 | 138 581 | 130 291 | 1 147 079 |
| 7 | CO2 emissions from NG consumption in BF #6 (reduced) | tones $CO_2$ | 16 393 | 16 354 | 18 023 | 17 354 | 12 002 | 0 | 0 | 1 932 | 13 196 | 21 256 | 21 404 | 19 754 | 157 667 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6 (reduced)** | **tones $CO_2$** | **175 327** | **171 102** | **186 956** | **173 849** | **139 463** | **0** | **0** | **37 761** | **192 674** | **204 634** | **205 356** | **192 650** | **1 679 773** |

3) **Total reduced emissions from consumption of dry skip metallurgical coke in BF #9, production of this metallurgical coke in BPCP, consumption of NG in BF #9**

$$PE_{coke,\ NG\ for\ BF9\ reduced} = M_{skip\ metallurgical\_coke\_BF\ 9\ reduced\ PJ} * \%C_{metallurgical\ coke\_PJ} /100 * 44/12 + M_{skip\ metallurgical\ coke\_BF\ 9\ reduced\ PJ} * SPE_{metallurgical\ coke\_} + FC_{NG\_BF\ 9\ reduced\ PJ} * C_{NG\_PJ} * 44/12$$ **(PDD formula D.1.1.2.-9)**

$$M_{skip\ metallurgical\ coke\_BF\ 9\ reduced\ PJ} = M_{skip\ metallurgical\ coke\_BF\ 9\ PJ} * K_3$$ **(PDD formula D.1.1.2.-10)**

$$K_3 = 1 \text{ если } P_{pig\ iron\ BF\ 9\ PJ} <= P_{max\ pig\ iron\ BF\ 9\ BL}$$ **(PDD formula D.1.1.2.-11)**

$$K_3 = P_{max\ pig\ iron\ BF\ 9\ BL} / P_{pig\ iron\ BF\ 9\ PJ} \text{ if } P_{pig\ iron\ BF\ 9\ PJ} > P_{max\ pig\ iron\ BF\ 9\ BL}$$

$$FC_{NG\_BF\ 9\ reduced\ PJ} = FC_{NG\_BF\ 9\ PJ} * K_3$$ **(PDD formula D.1.1.2.-12)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $PE_{coke,\ NG\ for\ BF9\ reduced}$ | Project emissions from consumption of dry skip metallurgical coke in BF #9, production of this metallurgical coke in BPCP, consumption of NG in BF #9, reduced | tones $CO_2$ | $FC_{NG\_BF\ 9\ reduced\ PJ}$ | Project consumption of NG in BF #9, reduced | th. m3 | $M_{skip\ metallurgical\ coke\_BF\ 9\ reduced\ PJ}$ | Project consumption of dry skip metallurgical coke in BF #9, reduced | tones |
| $M_{skip\ metallurgical\ coke\ \_BF\ 9\ PJ}$ | Project emissions from consumption of dry skip metallurgical coke in BF #9 | tones | $K_3$ | Project adjustment coefficient for BF #9 | - | $P_{max\ pig\ iron\ BF\ 9\ BL}$ | Maximum production of pig iron in BF #9 under the baseline scenario (1768,0 thousand tons in 1988) | tones |
| $P_{pig\ iron\ BF\ 9\ PJ}$ | Project production of pig iron in BF #9 | tones | $FC_{NG\_BF\ 9\ PJ}$ | Project consumption of NG in BF #9 | th. m3 | | | |

# *12 months of 2009*

Consumption of coke, NG and pig iron production in 2009 in BF #9, maximum production of pig iron by BF #9 and adjustment coefficient K3

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 54 551 | 54 823 | 58 443 | 60 479 | 55 969 | 55 685 | 62 306 | 55 992 | 58 605 | 63 327 | 57 326 | 62 661 | 700 167 |
| 2 | Consumption of NG actual | th. $m^3$ | 12 629 | 14 735 | 17 262 | 15 915 | 13 844 | 12 946 | 14 364 | 12 714 | 13 481 | 15 350 | 14 972 | 16 266 | 174 476 |
| 3 | Pig iron production | tones | 120 434 | 124 905 | 134 199 | 140 050 | 129 207 | 128 451 | 143 893 | 129 202 | 136 064 | 147 375 | 133 094 | 144 764 | **1 611 639** |
| 4 | Maximum production of pig iron in BF#9 (historical data of 1988) | tones | 1 768 000 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K3 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 54 551 | 54 823 | 58 443 | 60 479 | 55 969 | 55 685 | 62 306 | 55 992 | 58 605 | 63 327 | 57 326 | 62 661 | 700 167 |
| 2 | Carbon content in dry skip coke | % | 83,39 | 83,39 | 84,02 | 83,39 | 83,41 | 83,31 | 83,43 | 83,64 | 83,40 | 83,84 | 83,63 | 83,10 | 83,50 |
| | | tones C | 45 490 | 45 717 | 49 104 | 50 433 | 46 684 | 46 391 | 51 982 | 46 832 | 48 877 | 53 093 | 47 942 | 52 071 | 584 615 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 12 629 | 14 735 | 17 262 | 15 915 | 13 844 | 12 946 | 14 364 | 12 714 | 13 481 | 15 350 | 14 972 | 16 266 | 174 476 |
| 4 | Carbon content in NG | kg $C/m^3$ | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,50 | 0,50 |
| | | tones C | 6 254 | 7 295 | 8 547 | 7 878 | 6 853 | 6 411 | 7 110 | 6 293 | 6 670 | 7 597 | 7 411 | 8 053 | 86 370 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 52 721 | 52 984 | 56 482 | 58 450 | 54 091 | 53 817 | 60 216 | 54 114 | 56 639 | 61 203 | 55 403 | 60 559 | 676 679 |
| 6 | CO2 emissions from coke consumption in BF #9 (reduced) | tones $CO_2$ | 166 797 | 167 629 | 180 046 | 184 923 | 171 174 | 170 101 | 190 600 | 171 716 | 179 214 | 194 676 | 175 786 | 190 928 | 2 143 590 |
| 7 | CO2 emissions from NG consumption in BF #9 (reduced) | tones $CO_2$ | 22 931 | 26 749 | 31 337 | 28 886 | 25 127 | 23 507 | 26 069 | 23 076 | 24 456 | 27 854 | 27 174 | 29 526 | 316 692 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9 (reduced)** | **tones $CO_2$** | **242 449** | **247 362** | **267 866** | **272 258** | **250 392** | **247 425** | **276 885** | **248 906** | **260 309** | **283 732** | **258 362** | **281 013** | **3 136 960** |

# *12 months of 2010*

Consumption of coke, NG and pig iron production in 2010 in BF #9, maximum production of pig iron by BF #9 and adjustment coefficient K3

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 57 756 | 58 857 | 60 561 | 60 591 | 60 150 | 52 659 | 57 751 | 60 658 | 55 825 | 62 264 | 62 392 | 58 066 | 707 530 |
| 2 | Consumption of NG actual | th. $m^3$ | 13 272 | 15 386 | 15 640 | 15 444 | 15 335 | 12 381 | 12 732 | 11 956 | 10 571 | 14 037 | 14 121 | 13 238 | 164 113 |
| 3 | Pig iron production | tones | 129 696 | 132 701 | 136 805 | 139 741 | 139 362 | 121 994 | 135 088 | 138 102 | 120 981 | 140 142 | 138 701 | 129 901 | **1 603 214** |
| 4 | Maximum production of pig iron in BF#9 (historical data of 1988) | tones | 1 768 000 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K3 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 57 756 | 58 857 | 60 561 | 60 591 | 60 150 | 52 659 | 57 751 | 60 658 | 55 825 | 62 264 | 62 392 | 58 066 | 707 530 |
| 2 | Carbon content in dry skip coke | % | 83,05 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 82,96 | 82,94 | 82,80 | 82,90 | 82,90 | 83,00 | 83,01 |
| | | tones C | 47 966 | 48 616 | 50 387 | 50 593 | 50 105 | 43 707 | 47 909 | 50 308 | 46 223 | 51 617 | 51 723 | 48 195 | 587 335 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 13 272 | 15 386 | 15 640 | 15 444 | 15 335 | 12 381 | 12 732 | 11 956 | 10 571 | 14 037 | 14 121 | 13 238 | 164 113 |
| 4 | Carbon content in NG | kg $C/m^3$ | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | tones C | 6 570 | 7 617 | 7 738 | 7 642 | 7 585 | 6 124 | 6 298 | 5 910 | 5 225 | 6 942 | 6 986 | 6 550 | 81 187 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 57 476 | 58 572 | 60 267 | 60 297 | 59 858 | 52 404 | 57 471 | 60 364 | 55 554 | 61 962 | 62 089 | 57 784 | 704 098 |
| 6 | CO2 emissions from coke consumption in BF #9 (reduced) | tones $CO_2$ | 175 877 | 178 258 | 184 751 | 185 509 | 183 718 | 160 259 | 175 667 | 184 462 | 169 485 | 189 262 | 189 651 | 176 714 | 2 153 613 |
| 7 | CO2 emissions from NG consumption in BF #9 (reduced) | tones $CO_2$ | 24 092 | 27 928 | 28 372 | 28 020 | 27 810 | 22 453 | 23 094 | 21 671 | 19 158 | 25 456 | 25 614 | 24 018 | 297 685 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9 (reduced)** | **tones $CO_2$** | **257 444** | **264 757** | **273 391** | **273 827** | **271 386** | **235 115** | **256 232** | **266 496** | **244 197** | **276 679** | **277 355** | **258 516** | **3 155 396** |

4) **Total reduced emissions from consumption of dry skip metallurgical coke in BF #2, production of this metallurgical coke in BPCP, consumption of NG in BF #2**

$PE_{coke,\ NG\ for\ BF2\ reduced} = M_{skip\ metallurgical\_coke\_BF\ 2\ reduced\ PJ} * \%C_{metallurgical\ coke\_PJ} /100 * 44/12 + M_{skip\ metallurgical\ coke\_BF\ 2\ reduced\ PJ} * SPE_{metallurgical\ coke\_} + FC_{NG\_BF\ 2\ reduced\ PJ} * C_{NG\_PJ} * 44/12$ **(PDD formula D.1.1.2.-13)**

$M_{skip\ metallurgical\ coke\_BF\ 2\ reduced\ PJ} = M_{skip\ metallurgical\ coke\_BF\ 2\ PJ} * К_4$ **(PDD formula D.1.1.2.-14)**

$К_4 = 1$ **если** $P_{pig\ iron\ BF\ 2\ PJ} <= P_{max\ pig\ iron\ BF\ 2\ BL}$ **(PDD formula D.1.1.2.-15)**
$К_4 = P_{max\ pig\ iron\ BF\ 2\ BL} / P_{pig\ iron\ BF\ 2\ PJ}$ **if** $P_{pig\ iron\ BF\ 2\ PJ} > P_{max\ pig\ iron\ BF\ 2\ BL}$
$FC_{NG\_BF\ 2\ reduced\ PJ} = FC_{NG\_BF\ 2\ PJ} * К_4$ **(PDD formula D.1.1.2.-16)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $PE_{coke,\ NG\ for\ BF2\ reduced}$ | Project emissions from consumption of dry skip metallurgical coke in BF #2, production of this metallurgical coke in BPCP, consumption of NG in BF #2, reduced | tones $CO_2$ | $FC_{NG\ BF\ 2\ reduced\ PJ}$ | Project consumption of NG in BF #2, reduced | th. m3 | $M_{skip\ metallurgical\ coke\_BF\ 2\ reduced\ PJ}$ | Project consumption of dry skip metallurgical coke in BF #2, reduced | tones |
| $M_{skip\ metallurgical\ coke\ \_BF\ 2\ PJ}$ | Project emissions from consumption of dry skip metallurgical coke in BF #2 | tones | $К_4$ | Project adjustment coefficient for BF #2 | - | $P_{max\ pig\ iron\ BF\ 2\ BL}$ | Maximum production of pig iron in BF #2 under the baseline scenario (1182,901 thousand tons averaged for period 2004-2006) | tones |
| $P_{pig\ iron\ BF\ 2\ PJ}$ | Project production of pig iron in BF #2 | tones | $FC_{NG\_BF\ 2\ PJ}$ | Project consumption of NG in BF #2 | th. m3 | | | |

# *12 months of 2010*

Consumption of coke, NG and pig iron production in 2010 in BF #2, maximum production of pig iron by BF #2 and adjustment coefficient K4

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 0 | 0 | 36 129 | 43 455 | 37 930 | 41 033 | 42 277 | 43 520 | 41 589 | 43 801 | 45 969 | 47 737 | 423 440 |
| 2 | Consumption of NG actual | th. $m^3$ | 0 | 0 | 7 079 | 11 971 | 9 368 | 10 624 | 11 617 | 11 363 | 9 734 | 11 616 | 12 546 | 12 509 | 108 427 |
| 3 | Pig iron production | tones | 0 | 0 | 75 297 | 99 893 | 87 156 | 95 968 | 99 458 | 99 748 | 90 328 | 98 870 | 102 478 | 107 382 | **956 578** |
| 4 | Maximum production of pig iron in BF#2 (averaged 2005-2009) | tones | 1 182 901 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K4 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #2 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 0 | 0 | 36 129 | 43 455 | 37 930 | 41 033 | 42 277 | 43 520 | 41 589 | 43 801 | 45 969 | 47 737 | 423 440 |
| 2 | Carbon content in dry skip coke | % | 83,05 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 82,96 | 82,94 | 82,80 | 82,90 | 82,90 | 83,00 | 83,01 |
| | | tones C | 0 | 0 | 30 059 | 36 285 | 31 596 | 34 057 | 35 072 | 36 094 | 34 436 | 36 311 | 38 108 | 39 622 | 351 506 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 0 | 0 | 7 079 | 11 971 | 9 368 | 10 624 | 11 617 | 11 363 | 9 734 | 11 616 | 12 546 | 12 509 | 108 427 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | tones C | 0 | 0 | 3 502 | 5 923 | 4 633 | 5 255 | 5 747 | 5 617 | 4 811 | 5 745 | 6 207 | 6 190 | 53 630 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 0 | 0 | 35 954 | 43 244 | 37 746 | 40 834 | 42 072 | 43 309 | 41 387 | 43 589 | 45 746 | 47 505 | 421 386 |
| 6 | CO2 emissions from coke consumption in BF #2 (reduced) | tones $CO_2$ | 0 | 0 | 110 218 | 133 045 | 115 851 | 124 877 | 128 598 | 132 345 | 126 264 | 133 140 | 139 730 | 145 280 | 1 289 348 |
| 7 | CO2 emissions from NG consumption in BF #2 (reduced) | tones $CO_2$ | 0 | 0 | 12 842 | 21 719 | 16 989 | 19 267 | 21 072 | 20 596 | 17 641 | 21 065 | 22 757 | 22 695 | 196 643 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #2 (reduced)** | **tones $CO_2$** | **0** | **0** | **159 013** | **198 008** | **170 586** | **184 978** | **191 742** | **196 250** | **185 293** | **197 794** | **208 234** | **215 480** | **1 907 377** |

**5) Total reduced emissions from consumption of dry skip metallurgical coke in BF #10, production of this metallurgical coke in BPCP, consumption of NG in BF #10**

$$PE_{coke,\ NG\ for\ BF10\ reduced} = M_{skip\ metallurgical\_coke\_BF\ 10\ reduced\ PJ} * \%C_{metallurgical\ coke\_PJ} /100 * 44/12 + M_{skip\ metallurgical\ coke\_BF\ 10\ reduced\ PJ} * SPE_{metallurgical\ coke\_} + FC_{NG\_BF\ 10\ reduced\ PJ} * C_{NG\_PJ} * 44/12$$ **(PDD formula D.1.1.2.-17)**

$$M_{skip\ metallurgical\ coke\_BF\ 10\ reduced\ PJ} = M_{skip\ metallurgical\ coke\_BF\ 10\ PJ} * K_5$$ **(PDD formula D.1.1.2.-18)**

$$K_5 = 1 \text{ если } P_{pig\ iron\ BF\ 10\ PJ} <= P_{max\ pig\ iron\ BF\ 10\ BL}$$ **(PDD formula D.1.1.2.-19)**

$$K_5 = P_{max\ pig\ iron\ BF\ 10\ BL} / P_{pig\ iron\ BF\ 10\ PJ} \text{ if } P_{pig\ iron\ BF\ 10\ PJ} > P_{max\ pig\ iron\ BF\ 10\ BL}$$

$$FC_{NG\_BF\ 10\ reduced\ PJ} = FC_{NG\_BF\ 10\ PJ} * K_5$$ **(PDD formula D.1.1.2.-20)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $PE_{coke,\ NG\ for\ BF10\ reduced}$ | Project emissions from consumption of dry skip metallurgical coke in BF #10, production of this metallurgical coke in BPCP, consumption of NG in BF #10, reduced | tones $CO_2$ | $FC_{NG\ BF\ 10\ reduced\ PJ}$ | Project consumption of NG in BF #10, reduced | th. m3 | $M_{skip\ metallurgical\ coke\_BF\ 10\ reduced\ PJ}$ | Project consumption of dry skip metallurgical coke in BF #10, reduced | tones |
| $M_{skip\ metallurgical\ coke\ \_BF\ 10\ PJ}$ | Project emissions from consumption of dry skip metallurgical coke in BF #10 | tones | $K_5$ | Project adjustment coefficient for BF #10 | - | $P_{max\ pig\ iron\ BF\ 10\ BL}$ | Maximum production of pig iron in BF #10 under the baseline scenario (1768,0 thousand tons in 1988) | tones |
| $P_{pig\ iron\ BF\ 10\ PJ}$ | Project production of pig iron in BF #10 | tones | $FC_{NG\_BF\ 10\ PJ}$ | Project consumption of NG in BF #10 | th. m3 | | | |

# *12 months of 2009*

Consumption of coke, NG and pig iron production in 2009 in BF #10, maximum production of pig iron by BF #10 and adjustment coefficient K5

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 46 161 | 53 096 | 54 019 | 60 357 | 58 674 | 56 399 | 59 354 | 62 780 | 61 558 | 61 427 | 57 326 | 61 019 | 692 170 |
| 2 | Consumption of NG actual | th. $m^3$ | 8 817 | 11 548 | 13 315 | 11 929 | 11 928 | 11 118 | 12 033 | 12 941 | 11 510 | 12 407 | 14 972 | 12 079 | 144 597 |
| 3 | Pig iron production | tones | 102 356 | 120 979 | 124 002 | 139 435 | 135 277 | 130 428 | 136 798 | 145 164 | 142 668 | 142 793 | 127 860 | 141 197 | **1 588 957** |
| 4 | Maximum production of pig iron in BF#10 (historical data of 1987) | tones | 1 789 600 | | | | | | | | | | | | |
| 5 | Adjustment coefficient K5 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #10 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 46 161 | 53 096 | 54 019 | 60 357 | 58 674 | 56 399 | 59 354 | 62 780 | 61 558 | 61 427 | 57 326 | 61 019 | 692 170 |
| 2 | Carbon content in dry skip coke | % | 83,39 | 83,39 | 84,02 | 83,39 | 83,41 | 83,31 | 83,43 | 83,64 | 83,40 | 83,84 | 83,63 | 83,10 | 83,50 |
| | | tones C | 38 494 | 44 277 | 45 386 | 50 332 | 48 940 | 46 986 | 49 519 | 52 509 | 51 339 | 51 500 | 47 942 | 50 707 | 577 931 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 8 817 | 11 548 | 13 315 | 11 929 | 11 928 | 11 118 | 12 033 | 12 941 | 11 510 | 12 407 | 14 972 | 12 079 | 144 597 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,50 | 0,50 |
| | | tones C | 4 366 | 5 717 | 6 592 | 5 905 | 5 904 | 5 506 | 5 956 | 6 406 | 5 695 | 6 140 | 7 411 | 5 980 | 71 579 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 44 613 | 51 315 | 52 207 | 58 332 | 56 706 | 54 507 | 57 363 | 60 674 | 59 493 | 59 366 | 55 403 | 58 972 | 668 950 |
| 6 | CO2 emissions from coke consumption in BF #10 (reduced) | tones $CO_2$ | 141 144 | 162 348 | 166 417 | 184 550 | 179 447 | 172 282 | 181 570 | 192 534 | 188 244 | 188 835 | 175 786 | 185 926 | 2 119 081 |
| 7 | CO2 emissions from NG consumption in BF #10 (reduced) | tones $CO_2$ | 16 010 | 20 963 | 24 172 | 21 652 | 21 649 | 20 187 | 21 839 | 23 488 | 20 882 | 22 514 | 27 174 | 21 925 | 262 456 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #10 (reduced)** | **tones $CO_2$** | **201 767** | **234 626** | **242 795** | **264 534** | **257 802** | **246 977** | **260 772** | **276 695** | **268 619** | **270 715** | **258 362** | **266 823** | **3 050 487** |

# *12 months of 2010*

Consumption of coke, NG and pig iron production in 2010 in BF #10, maximum production of pig iron by BF #10 and adjustment coefficient K5

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke actual | tones | 57 833 | 57 841 | 63 270 | 60 673 | 56 513 | 57 612 | 58 652 | 60 432 | 57 817 | 61 420 | 62 177 | 65 601 | 719 841 |
| 2 | Consumption of NG actual | th. $m^3$ | 11 554 | 12 816 | 13 403 | 12 509 | 10 941 | 11 249 | 11 111 | 11 406 | 10 444 | 11 466 | 11 500 | 12 317 | 140 716 |
| 3 | Pig iron production | tones | 130 138 | 130 426 | 143 650 | 139 668 | 130 913 | 134 129 | 137 806 | 138 006 | 125 510 | 137 432 | 139 578 | 147 470 | **1 634 726** |
| 4 | Maximum production of pig iron in BF#10 (historical data of 1987) | tones | 1 789 600 | | | | | | | | | | | | |
| 5 | Коэффициент приведения К5 | | 1,000 | | | | | | | | | | | | |

CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #10 (reduced)

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of dry skip metallurgical coke (reduced) | tones | 57 833 | 57 841 | 63 270 | 60 673 | 56 513 | 57 612 | 58 652 | 60 432 | 57 817 | 61 420 | 62 177 | 65 601 | 719 841 |
| 2 | Carbon content in dry skip coke | % | 83,05 | 82,60 | 83,20 | 83,50 | 83,30 | 83,00 | 82,96 | 82,94 | 82,80 | 82,90 | 82,90 | 83,00 | 83,01 |
| | | tones C | 48 030 | 47 777 | 52 641 | 50 662 | 47 075 | 47 818 | 48 657 | 50 120 | 47 872 | 50 917 | 51 545 | 54 449 | 597 555 |
| 3 | Consumption of NG (reduced) | th. $m^3$ | 11 554 | 12 816 | 13 403 | 12 509 | 10 941 | 11 249 | 11 111 | 11 406 | 10 444 | 11 466 | 11 500 | 12 317 | 140 716 |
| 4 | Carbon content in NG | kg C/$m^3$ | 0,50 | 0,50 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 | 0,49 |
| | | tones C | 5 720 | 6 344 | 6 631 | 6 190 | 5 411 | 5 564 | 5 497 | 5 638 | 5 162 | 5 671 | 5 689 | 6 095 | 69 611 |
| 5 | CO2 emissions from coke production in BPCP (reduced) | tones $CO_2$ | 57 552 | 57 560 | 62 963 | 60 379 | 56 239 | 57 333 | 58 368 | 60 139 | 57 537 | 61 122 | 61 875 | 65 283 | 716 349 |
| 6 | CO2 emissions from coke consumption in BF #10 (reduced) | tones $CO_2$ | 176 111 | 175 181 | 193 016 | 185 761 | 172 610 | 175 333 | 178 407 | 183 775 | 175 532 | 186 696 | 188 997 | 199 646 | 2 191 064 |
| 7 | CO2 emissions from NG consumption in BF #10 (reduced) | tones $CO_2$ | 20 973 | 23 263 | 24 314 | 22 695 | 19 841 | 20 400 | 20 154 | 20 674 | 18 928 | 20 793 | 20 860 | 22 347 | 255 242 |
| **8** | **CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #10 (reduced)** | **tones $CO_2$** | **254 637** | **256 004** | **280 293** | **268 834** | **248 690** | **253 065** | **256 929** | **264 587** | **251 997** | **268 612** | **271 733** | **287 275** | **3 162 656** |

**Project $CO_2$ emissions from electricity consumption**

**$CO_2$ emissions from electricity consumption by sinter cooling and stabilization units (SCaSU) at sintering plants #2 and #3**

$$PE_{EC\ CSU\ AF\ 2.3} = \sum EC_{CSU\ AF\ 2.3} * EF_{own\ generation\_PJ} \quad \text{(PDD formula D.1.1.2.-21)}$$

$$\sum EC_{CSU\ AF\ 2.3} = EC_{CSU\ AF\ 2} + EC_{CSU\ AF\ 3} \quad \text{(PDD formula D.1.1.2.-22)}$$

**$CO_2$ emissions from electricity consumption for production of pure nitrogen**

$$PE_{EC\_pure\ N2} = EC_{pure\ N2} * EF_{own\ generation\_PJ} \quad \text{(PDD formula D.1.1.2.-23)}$$

$$EC_{pure\ N2} = (V_{pure\ N2\_BF4} + V_{pure\ N2\_BF6} + V_{pure\ N2\_BF9} + V_{pure\ N2\_BF2} + V_{pure\ N2\_BF10}) * SEC_{pure\ N2} \quad \text{(PDD formula D.1.1.2.-24)}$$

$$PE_{EC} = PE_{EC\ CSU\ AF\ 2.3} + PE_{EC\_pure\ N2} \quad \text{(PDD formula D.1.1.2.-25)}$$

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| **$PE_{EC\ CSU\ AF\ 2.3}$** | CO2 project emissions from electricity consumption by SCaSU | tones $CO_2$ | **$\sum PE_{EC\ CSU\ AF\ 2.3}$** | Total electricity consumption by SCaSU at SP #2 and SP #3 | MWh | **$EF_{own\ generation\_PJ}$** | Average CO2 emission factor for electricity generation at MMK | $tCO_2$/MWh |
| **$EC_{CSU\ AF\ 2}$** | Electricity consumption by SCaSU at SP #2 | MWh | **$EC_{CSU\ AF\ 3}$** | Electricity consumption by SCaSU at SP #3 | MWh | **$PE_{EC\_pure\ N2}$** | CO2 emissions from electricity consumption for production of pure nitrogen | tones $CO_2$ |
| **$EC_{pure\ N2}$** | Electricity consumption for production of pure nitrogen | MWh | **$V_{pure\ N2\_BF4}$** | Consumption of pure nitrogen in BF #4 | th. m3 | **$V_{pure\ N2\_BF6}$** | Consumption of pure nitrogen in BF #6 | th. m3 |
| **$V_{pure\ N2\_BF9}$** | Consumption of pure nitrogen in BF #9 | th. m3 | **$V_{pure\ N2\_BF2}$** | Consumption of pure nitrogen in BF #2 | th. m3 | **$V_{pure\ N2\_BF10}$** | Consumption of pure nitrogen in BF #10 | th. m3 |
| **$SEC_{pure\ N2}$** | Specific electricity consumption for production of pure nitrogen | MWh/ th. m3 | **$PE_{EC}$** | Total project CO2 emissions from electricity consumption | tones $CO_2$ | | | |

# *12 months of 2009*

Electricity consumption by USCaS at Sintering Plants #2,3

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Electricity consumption by USCaS at SP #2,3 | MWh | 6 033 | 5 150 | 5 925 | 5 615 | 5 469 | 5 239 | 5 177 | 5 572 | 5 526 | 5 740 | 5 818 | 6 050 | **67 315** |

Electricity consumption for pure nitrogen production

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of pure nitrogen | th. $m^3$ | 5 537 | 5 007 | 5 481 | 5 387 | 5 469 | 5 400 | 5 486 | 5 524 | 5 440 | 5 726 | 4 791 | 5 176 | 64 425 |
| 2 | Specific electricity consumption for pure nitrogen production | MWh/ths. $m^3$ | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 |
| 3 | Electricity consumption for pure nitrogen production | MWh | 4 574 | 4 136 | 4 527 | 4 450 | 4 517 | 4 461 | 4 532 | 4 563 | 4 493 | 4 729 | 3 958 | 4 276 | **53 215** |

Emission factor for electricity produced at MMK

| # | Name | Unit | Value |
|---|---|---|---|
| **1** | **Average CO2 EF for electricity produced at MMK*** | **ton CO2/MWh** | **0,895** |

** The value from Monitoring report 2009 for project "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works"*

CO2 emissions from electricity consumption in the project

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Emissions from electricity consumption by USCaS in SP #2,3 | tones CO2 | 5 401 | 4 610 | 5 303 | 5 027 | 4 895 | 4 690 | 4 634 | 4 988 | 4 947 | 5 138 | 5 208 | 5 416 | 60 257 |
| 2 | Emissions from electricity consumption for pure nitrogen production | tones CO2 | 4 094 | 3 702 | 4 052 | 3 983 | 4 044 | 3 993 | 4 057 | 4 084 | 4 022 | 4 234 | 3 543 | 3 827 | 47 635 |
| **3** | **Total emissions from electricity consumption** | **tones CO2** | **9 495** | **8 312** | **9 356** | **9 010** | **8 939** | **8 683** | **8 691** | **9 073** | **8 969** | **9 371** | **8 751** | **9 243** | **107 892** |

## *12 months of 2010*

Electricity consumption by USCaS at Sintering Plants #2,3

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Electricity consumption by USCaS at SP #2,3 | MWh | 6 082 | 5 551 | 5 900 | 5 529 | 5 397 | 5 186 | 5 385 | 5 514 | 5 384 | 5 639 | 5 645 | 5 791 | **67 003** |

Electricity consumption for pure nitrogen production

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Consumption of pure nitrogen | th. $m^3$ | 3 905 | 3 591 | 4 266 | 4 874 | 5 135 | 3 935 | 4 032 | 4 012 | 4 262 | 4 501 | 4 119 | 3 699 | 50 331 |
| 2 | Specific electricity consumption for pure nitrogen production | MWh/ths. $m^3$ | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 | 0,826 |
| 3 | Electricity consumption for pure nitrogen production | MWh | 3 226 | 2 966 | 3 524 | 4 026 | 4 242 | 3 250 | 3 330 | 3 314 | 3 520 | 3 718 | 3 402 | 3 055 | **41 573** |

Emission factor for electricity produced at MMK

| # | Name | Unit | Value |
|---|---|---|---|
| **1** | **Average CO2 EF for electricity produced at MMK*** | **ton CO2/MWh** | **0,920** |

** The value from Monitoring report 2010 for project "Implementation of arc-furnace steelmaking at Magnitogorsk Iron and Steel Works"*

CO2 emissions from electricity consumption in the project

| # | Name | Unit | Jan. | Feb. | March | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total per year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Emissions from electricity consumption by USCaS in SP #2,3 | tones CO2 | 5 595 | 5 107 | 5 428 | 5 086 | 4 965 | 4 771 | 4 954 | 5 073 | 4 953 | 5 188 | 5 194 | 5 328 | 61 643 |
| 2 | Emissions from electricity consumption for pure nitrogen production | tones CO2 | 2 968 | 2 729 | 3 242 | 3 704 | 3 902 | 2 990 | 3 064 | 3 049 | 3 239 | 3 420 | 3 130 | 2 811 | 38 248 |
| **3** | **Total emissions from electricity consumption** | **tones CO2** | **8 563** | **7 835** | **8 670** | **8 790** | **8 867** | **7 762** | **8 018** | **8 122** | **8 192** | **8 609** | **8 324** | **8 138** | **99 891** |

**<u>Total project $CO_2$ emissions</u>**

$$PE = PE_{coke,\ NG\ for\ BF4\ reduced} + PE_{coke,\ NG\ for\ BF6\ reduced} + PE_{coke,\ NG\ for\ BF9\ reduced} + PE_{coke,\ NG\ for\ BF2\ reduced} + PE_{coke,\ NG\ for\ BF10\ reduced} + PE_{EC}$$

**(PDD formula D.1.1.2.-26)**

## *12 months of 2009*

| # | Parameter | **Project emissions, tones CO2/year** |
|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 307 596 |
| 2 | Dry skip metallurgical coke consumption | 7 310 092 |
| 3 | NG consumption | 1 049 274 |
| 4 | Electricity consumption | 107 892 |
| 5 | Total | **10 774 854** |

## *12 months of 2010*

| # | Parameter | **Project emissions, tones CO2/year** |
|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 731 742 |
| 2 | Dry skip metallurgical coke consumption | 8 355 938 |
| 3 | NG consumption | 1 145 662 |
| 4 | Electricity consumption | 99 891 |
| 5 | Total | **12 333 232** |

## D.2 BASELINE EMISSIONS

**Total $CO_2$ emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4, in the baseline**

$BE_{coke, NG\ for\ BF4} = SM_{skip\ metallurgical\_coke\_BF\ 4\ averaged\ BL} * P_{pig\ iron\ BF\ 4\ BL} * \%C_{metallurgical\ coke\_PJ} / 100 * 44/12 + SM_{skip\ metallurgical\_coke\_BF\ 4\ averaged\ BL} * P_{pig\ iron\ BF\ 4\ BL} * SPE_{metallurgical\ coke} + SFC_{NG\_BF\ 4\ averaged\ BL} * P_{pig\ iron\ BF\ 4\ BL} * C_{NG\_PJ} * 44/12$ **(PDD formula D.1.1.4.-1)**

$P_{pig\ iron\ BF\ 4\ BL} = P_{pig\ iron\ BF\ 4\ PJ}$ if $P_{pig\ iron\ BF\ 4\ PJ} <= P_{max\ pig\ iron\ BF\ 4\ BL}$ **(PDD formula D.1.1.4.-2)**
$P_{pig\ iron\ BF\ 4\ BL} = P_{max\ pig\ iron\ BF\ 4\ BL}$ if $P_{pig\ iron\ BF\ 4\ PJ} > P_{max\ pig\ iron\ BF\ 4\ BL}$

$SM_{skip\ metallurgical\_coke\_BF\ 4\ averaged\ BL} = M_{skip\_coke\_BF\ 4\ averaged\ BL} / P_{pig\ iron\ BF\ 4\ averaged\ BL}$ **(PDD formula D.1.1.4.-3)**

$SFC_{NG\_BF\ 4\ averaged\ BL} = FC_{NG\_BF\ 4\ averaged\ BL} / P_{pig\ iron\ BF\ 4\ averaged\ BL}$ **(PDD formula D.1.1.4.-4)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $BE_{coke, NG\ for\ BF4}$ | Baseline emissions from consumption of dry skip metallurgical coke in BF #4, production of this metallurgical coke in BPCP, consumption of NG in BF #4 | tones $CO_2$ | $SM_{skip\ metallurgical\_coke\_BF\ 4\ averaged\ BL}$ | Baseline specific consumption of dry skip metallurgical coke in BF #4, averaged for 2004-2006 | kg/t pig iron | $P_{pig\ iron\ BF\ 4\ BL}$ | Baseline production of pig iron in BF #4 | t |
| $SFC_{NG\_BF\ 4\ averaged\ BL}$ | Specific baseline consumption of NG in BF #4, averaged for 2004-2006 | m3/ t pig iron | $M_{skip\_coke\_BF\ 4\ averaged\ BL}$ | Baseline consumption of dry skip metallurgical coke in BF #4, averaged for 2004-2006 | t | $P_{pig\ iron\ BF\ 4\ averaged\ BL}$ | Baseline production of pig iron in BF #4, averaged for 2004-2006 | t |
| $\%C_{metallurgical\ coke\_PJ}$ | Carbon content in metallurgical coke | % by weight | $FC_{NG\_BF\ 4\ averaged\ BL}$ | Baseline consumption of NG in BF #4, averaged for 2004-2006 | m3 | $P_{max\ pig\ iron\ BF\ 4\ BL}$ | Maximum baseline production of pig iron in BF #4 (1217.4 thousand tons in 1988) | t |
| $C_{NG\_PJ}$ | Carbon content in NG | kg C/ m3 | $SPE_{metallurgical\_coke}$ | Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP | t CO2/t | | | |

## *12 months of 2009*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 579 482 |
| 2 | Carbon content in coke | % | 83,50 |
| | | tons C | 483 844 |
| 3 | Baseline consumption of NG | th. m3 | 124 053 |
| 4 | Carbon content in NG | kg C/m3 | 0,50 |
| | | tons C | 61 410 |
| 5 | Pig iron production (baseline) | tones | 1 217 400 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 560 043 |
| 7 | CO2 emissions from coke consumption in BF #4 | t CO2 | 1 774 093 |
| 8 | CO2 emissions from NG consumption in BF #4 | t CO2 | 225 170 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4** | t CO2 | **2 559 306** |

BF#4 baseline parameters

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Specific consumption of dry skip coke in BF #4 | kg/ ton of pig iron | 476,0 |
| 2 | Specific consumption of NG in BF #4 | m3/ton of pig iron | 101,9 |

## *12 months of 2010*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 551 189 |
| 2 | Carbon content in coke | % | 83,01 |
| | | tons C | 457 553 |
| 3 | Baseline consumption of NG | th. m3 | 117 996 |
| 4 | Carbon content in NG | kg C/m3 | 0,49 |
| | | tons C | 58 371 |
| 5 | Pig iron production (baseline) | tones | 1 157 960 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 548 515 |
| 7 | CO2 emissions from coke consumption in BF #4 | t CO2 | 1 677 696 |
| 8 | CO2 emissions from NG consumption in BF #4 | t CO2 | 214 027 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #4** | t CO2 | **2 440 238** |

**Total $CO_2$ emissions from consumption of dry skip metallurgical coke in BF #6, production of this metallurgical coke in BPCP, consumption of NG in BF #6, in the baseline**

$BE_{coke, NG for BF6} = SM_{skip metallurgical\_coke\_BF 6 averaged BL} * P_{pig iron BF 6 BL} * \%C_{metallurgical coke\_PJ} / 100 * 44/12 + SM_{skip metallurgical\_coke\_BF 6 averaged BL} * P_{pig iron BF 6 BL} * SPE_{metallurgical coke} + SFC_{NG\_BF 6 averaged BL} * P_{pig iron BF 6 BL} * C_{NG\_PJ} * 44/12$ **(PDD formula D.1.1.4.-5)**

$P_{pig iron BF 6 BL} = P_{pig iron BF 6 PJ}$ if $P_{pig iron BF 6 PJ} <= P_{max pig iron BF 6 BL}$ **(PDD formula D.1.1.4.-6)**
$P_{pig iron BF 6 BL} = P_{max pig iron BF 6 BL}$ if $P_{pig iron BF 6 PJ} > P_{max pig iron BF 6 BL}$

$SM_{skip metallurgical\_coke\_BF 6 averaged BL} = M_{skip\_coke\_BF 6 averaged BL} / P_{pig iron BF 6 averaged BL}$ **(PDD formula D.1.1.4.-7)**

$SFC_{NG\_BF 6 averaged BL} = FC_{NG\_BF 6 averaged BL} / P_{pig iron BF 6 averaged BL}$ **(PDD formula D.1.1.4.-8)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $BE_{coke, NG for BF6}$ | Baseline emissions from consumption of dry skip metallurgical coke in BF #6, production of this metallurgical coke in BPCP, consumption of NG in BF #6 | tones $CO_2$ | $SM_{skip metallurgical coke BF 6 averaged BL}$ | Baseline specific consumption of dry skip metallurgical coke in BF #6, averaged for 2004-2006 | kg/t pig iron | $P_{pig iron BF 6 BL}$ | Baseline production of pig iron in BF #6 | t |
| $SFC_{NG BF 6 averaged BL}$ | Specific baseline consumption of NG in BF #6, averaged for 2004-2006 | m3/ t pig iron | $M_{skip coke BF 6 averaged BL}$ | Baseline consumption of dry skip metallurgical coke in BF #6, averaged for 2004-2006 | t | $P_{pig iron BF 6 averaged BL}$ | Baseline production of pig iron in BF #6, averaged for 2004-2006 | t |
| $SPE_{metallurgical\_coke}$ | Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP | t CO2/t | $FC_{NG BF 6 averaged BL}$ | Baseline consumption of NG in BF #6, averaged for 2004-2006 | m3 | $P_{max pig iron BF 6 BL}$ | Maximum baseline production of pig iron in BF #6, (1110,7 thousand tons in 1990) | t |

## *12 months of 2009*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 500 512 |
| 2 | Carbon content in coke | % | 83,50 |
| | | tons C | 417 907 |
| 3 | Baseline consumption of NG | th. m3 | 113 152 |
| 4 | Carbon content in NG | kg C/m3 | 0,50 |
| | | tons C | 56 014 |
| 5 | Pig iron production (baseline) | tones | 1 057 495 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 483 722 |
| 7 | CO2 emissions from coke consumption in BF #6 | t CO2 | 1 532 326 |
| 8 | CO2 emissions from NG consumption in BF #6 | t CO2 | 205 383 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6** | t CO2 | **2 221 431** |

## *12 months of 2010*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 393 774 |
| 2 | Carbon content in coke | % | 83,01 |
| | | tons C | 326 880 |
| 3 | Baseline consumption of NG | th. m3 | 89 021 |
| 4 | Carbon content in NG | kg C/m3 | 0,49 |
| | | tons C | 44 037 |
| 5 | Pig iron production (baseline) | tones | 831 975 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 391 864 |
| 7 | CO2 emissions from coke consumption in BF #6 | t CO2 | 1 198 559 |
| 8 | CO2 emissions from NG consumption in BF #6 | t CO2 | 161 471 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #6** | t CO2 | **1 751 894** |

BF #6 baseline parameters

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Specific consumption of dry skip coke in BF #6 | kg/ ton of pig iron | 473,3 |
| 2 | Specific consumption of NG in BF #6 | m3/ton of pig iron | 107,0 |

**Total $CO_2$ emissions from consumption of dry skip metallurgical coke in BF #9, production of this metallurgical coke in BPCP, consumption of NG in BF #9, in the baseline**

$$BE_{coke,\ NG\ for\ BF\ 9} = SM_{skip\ metallurgical\ coke\_BF\ 9\ averaged\ BL} * P_{pig\ iron\ BF\ 9\ BL} * \%C_{metallurgical\ coke\_PJ} / 100 * 44/12 + SM_{skip\ metallurgical\_\ coke\_BF\ 9\ averaged\ BL} * P_{pig\ iron\ BF\ 9\ BL} * SPE_{metallurgical\ coke} + SFC_{NG\_BF\ 9\ averaged\ BL} * P_{pig\ iron\ BF\ 9\ BL} * C_{NG\_PJ} * 44/12$$

**(PDD formula D.1.1.4.-9)**

$P_{pig\ iron\ BF\ 9\ BL} = P_{pig\ iron\ BF\ 9\ PJ}$ if $P_{pig\ iron\ BF\ 9\ PJ} <= P_{max\ pig\ iron\ BF\ 9\ BL}$ **(PDD formula D.1.1.4.-10)**

$P_{pig\ iron\ BF\ 9\ BL} = P_{max\ pig\ iron\ BF\ 9\ BL}$ if $P_{pig\ iron\ BF\ 9\ PJ} > P_{max\ pig\ iron\ BF\ 9\ BL}$

$$SM_{skip\ metallurgical\_coke\_BF\ 9\ averaged\ BL} = M_{skip\_coke\_BF\ 9\ averaged\ BL} / P_{pig\ iron\ BF\ 9\ averaged\ BL}$$

**(PDD formula D.1.1.4.-11)**

$$SFC_{NG\_BF\ 9\ averaged\ BL} = FC_{NG\_BF\ 9\ averaged\ BL} / P_{pig\ iron\ BF\ 9\ averaged\ BL}$$

**(PDD formula D.1.1.4.-12)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $BE_{coke,\ NG\ for\ BF9}$ | Baseline emissions from consumption of dry skip metallurgical coke in BF #9, production of this metallurgical coke in BPCP, consumption of NG in BF #9 | tones $CO_2$ | $SM_{skip\ metallurgical\_coke\_BF\ 9\ averaged\ BL}$ | Baseline specific consumption of dry skip metallurgical coke in BF #9, averaged for 2004-2006 | kg/t pig iron | $P_{pig\ iron\ BF\ 9\ BL}$ | Baseline production of pig iron in BF #9 | t |
| $SFC_{NG\_BF\ 9\ averaged\ BL}$ | Specific baseline consumption of NG in BF #9, averaged for 2004-2006 | m3/ t pig iron | $M_{skip\_coke\_BF\ 9\ averaged\ BL}$ | Baseline consumption of dry skip metallurgical coke in BF #9, averaged for 2004-2006 | t | $P_{pig\ iron\ BF\ 9\ averaged\ BL}$ | Baseline production of pig iron in BF #9, averaged for 2004-2006 | t |
| $SPE_{metallurgical\_coke}$ | Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP | t CO2/t | $FC_{NG\_BF\ 9\ averaged\ BL}$ | Baseline consumption of NG in BF #9, averaged for 2004-2006 | m3 | $P_{max\ pig\ iron\ BF\ 9\ BL}$ | Maximum baseline production of pig iron in BF #9 (1768,0 thousand tons in 1988) | t |

### *12 months of 2009*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 722 336 |
| 2 | Carbon content in coke | % | 83,50 |
| | | tons C | 603 121 |
| 3 | Baseline consumption of NG | th. m3 | 153 911 |
| 4 | Carbon content in NG | kg C/m3 | 0,50 |
| | | tons C | 76 191 |
| 5 | Pig iron production (baseline) | tones | 1 611 639 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 698 105 |
| 7 | CO2 emissions from coke consumption in BF #9 | t CO2 | 2 211 443 |
| 8 | CO2 emissions from NG consumption in BF #9 | t CO2 | 279 366 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9** | t CO2 | **3 188 914** |

### *12 months 2010*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 718 561 |
| 2 | Carbon content in coke | % | 83,01 |
| | | tons C | 596 492 |
| 3 | Baseline consumption of NG | th. m3 | 153 107 |
| 4 | Carbon content in NG | kg C/m3 | 0,49 |
| | | tons C | 75 740 |
| 5 | Pig iron production (baseline) | tones | 1 603 214 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 715 075 |
| 7 | CO2 emissions from coke consumption in BF #9 | t CO2 | 2 187 137 |
| 8 | CO2 emissions from NG consumption in BF #9 | t CO2 | 277 712 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #9** | t CO2 | **3 179 925** |

BF #9 baseline parameters

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Specific consumption of dry skip coke in BF #9 | kg/ ton of pig iron | 448,2 |
| 2 | Specific consumption of NG in BF #9 | m3/ton of pig iron | 95,5 |

**Total $CO_2$ emissions from consumption of dry skip metallurgical coke in BF #2, production of this metallurgical coke in BPCP, consumption of NG in BF #2, in the baseline**

$$BE_{coke, NG\ for\ BF\ 2} = SM_{skip\ metallurgical\ coke\_BF\ 2\ averaged\ BL} * P_{pig\ iron\ BF\ 2\ BL} * \%C_{metallurgical\ coke\_PJ} / 100 * 44/12 + SM_{skip\ metallurgical\_\ coke\_BF\ 2\ averaged\ BL} * P_{pig\ iron\ BF\ 2\ BL} * SPE_{metallurgical\ coke} + SFC_{NG\_BF\ 2\ averaged\ BL} * P_{pig\ iron\ BF\ 2\ BL} * C_{NG\_PJ} * 44/12$$ **(PDD formula D.1.1.4.-13)**

$$P_{pig\ iron\ BF\ 2\ BL} = P_{pig\ iron\ BF\ 2\ PJ}\ \text{if}\ P_{pig\ iron\ BF\ 2\ PJ} <= P_{max\ pig\ iron\ BF\ 2\ BL}$$ **(PDD formula D.1.1.4.-14)**

$$P_{pig\ iron\ BF\ 2\ BL} = P_{max\ pig\ iron\ BF\ 2\ BL}\ \text{f}\ P_{pig\ iron\ BF\ 2\ PJ} > P_{max\ pig\ iron\ BF\ 2\ BL}$$

$$SM_{skip\ metallurgical\_coke\_BF\ 2\ averaged\ BL} = M_{skip\_coke\_BF\ 2\ averaged\ BL} / P_{pig\ iron\ BF\ 2\ averaged\ BL}$$ **(PDD formula D.1.1.4.-15)**

$$SFC_{NG\_BF\ 2\ averaged\ BL} = FC_{NG\_BF\ 2\ averaged\ BL} / P_{pig\ iron\ BF\ 2\ averaged\ BL}$$ **(PDD formula D.1.1.4.-16)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $BE_{coke,\ NG\ for\ BF2}$ | Baseline emissions from consumption of dry skip metallurgical coke in BF #2, production of this metallurgical coke in BPCP, consumption of NG in BF #2 | tones $CO_2$ | $SM_{skip\ metallurgical\_coke\_BF\ 2\ averaged\ BL}$ | Baseline specific consumption of dry skip metallurgical coke in BF #2, averaged for 2004-2006 | kg/t pig iron | $P_{pig\ iron\ BF\ 2\ BL}$ | Baseline production of pig iron in BF #2 | t |
| $SFC_{NG\_BF\ 2\ averaged\ BL}$ | Specific baseline consumption of NG in BF #2, averaged for 2004-2006 | m3/ t pig iron | $M_{skip\_coke\_BF\ 2\ averaged\ BL}$ | Baseline consumption of dry skip metallurgical coke in BF #2, averaged for 2004-2006 | t | $P_{pig\ iron\ BF\ 2\ averaged\ BL}$ | Baseline production of pig iron in BF #2, averaged for 2004-2006 | t |
| $SPE_{metallurgical\_coke}$ | Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP | t CO2/t | $FC_{NG\_BF\ 2\ averaged\ BL}$ | Baseline consumption of NG in BF #2, averaged for 2004-2006 | m3 | $P_{max\ pig\ iron\ BF\ 2\ BL}$ | Maximum baseline production of pig iron in BF #2 (1182,901 – averaged for 2004-2006) | t |

## *12 months of 2010*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 446 531 |
| 2 | Carbon content in coke | % | 83,01 |
| | | tons C | 370 674 |
| 3 | Baseline consumption of NG | th. m3 | 99 580 |
| 4 | Carbon content in NG | kg C/m3 | 0,49 |
| | | tons C | 49 261 |
| 5 | Pig iron production (baseline) | tones | 956 578 |
| 6 | CO2 emissions from coke production in BPCP | t CO2 | 444 365 |
| 7 | CO2 emissions from coke consumption in BF #2 | t CO2 | 1 359 139 |
| 8 | CO2 emissions from NG consumption in BF #2 | t CO2 | 180 622 |
| **9** | **Baseline CO2 emissions from the coke production in BPCP, consumption of coke and NG in BF #2** | t CO2 | **1 984 126** |

BF #2 baseline parameters

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Specific consumption of dry skip coke in BF #2 | kg/ ton of pig iron | 466,8 |
| 2 | Specific consumption of NG in BF #2 | m3/ton of pig iron | 104,1 |

**Total $CO_2$ emissions from consumption of dry skip metallurgical coke in BF #10, production of this metallurgical coke in BPCP, consumption of NG in BF #10, in the baseline**

$$BE_{coke,\ NG\ for\ BF\ 10} = SM_{skip\ metallurgical\ coke\_BF\ 10\ averaged\ BL} * P_{pig\ iron\ BF\ 10\ BL} * \%C_{metallurgical\ coke\_PJ} / 100 * 44/12 + SM_{skip\ metallurgical\_\ coke\_BF\ 10\ averaged\ BL} * P_{pig\ iron\ BF\ 10\ BL} * SPE_{metallurgical\ coke} + SFC_{NG\_BF\ 10\ averaged\ BL} * P_{pig\ iron\ BF\ 10\ BL} * C_{NG\_PJ} * 44/12$$ **(PDD formula D.1.1.4.-17)**

$$P_{pig\ iron\ BF\ 10\ BL} = P_{pig\ iron\ BF\ 10\ PJ} \text{ if } P_{pig\ iron\ BF\ 10\ PJ} <= P_{max\ pig\ iron\ BF\ 10\ BL}$$ **(PDD formula D.1.1.4.-18)**

$$P_{pig\ iron\ BF\ 10\ BL} = P_{max\ pig\ iron\ BF\ 10\ BL} \text{ if } P_{pig\ iron\ BF\ 10\ PJ} > P_{max\ pig\ iron\ BF\ 10\ BL}$$

$$SM_{skip\ metallurgical\_coke\_BF\ 10\ averaged\ BL} = M_{skip\ metallurgical\_coke\_BF\ 10\ averaged\ BL} / P_{pig\ iron\ BF\ 10\ averaged\ BL}$$ **(PDD formula D.1.1.4.-19)**

$$SFC_{NG\_BF\ 10\ averaged\ BL} = FC_{NG\_BF\ 10\ averaged\ BL} / P_{pig\ iron\ BF\ 10\ averaged\ BL}$$ **(PDD formula D.1.1.4.-20)**

| Notation | Data variable | Unit | Notation | Data variable | Unit | Notation | Data variable | Unit |
|---|---|---|---|---|---|---|---|---|
| $BE_{coke,\ NG\ for\ BF10}$ | Baseline emissions from consumption of dry skip metallurgical coke in BF #10, production of this metallurgical coke in BPCP, consumption of NG in BF #10 | tones $CO_2$ | $SM_{skip\ metallurgical\ coke\ BF\ 10\ averaged\ BL}$ | Baseline specific consumption of dry skip metallurgical coke in BF #10, averaged for 2004-2006 | kg/t pig iron | $P_{pig\ iron\ BF\ 10\ BL}$ | Baseline production of pig iron in BF #10 | t |
| $SFC_{NG\ BF\ 10\ averaged\ BL}$ | Specific baseline consumption of NG in BF #10, averaged for 2004-2006 | m3/ t pig iron | $M_{skip\ coke\ BF\ 10\ averaged\ BL}$ | Baseline consumption of dry skip metallurgical coke in BF #10, averaged for 2004-2006 | t | $P_{pig\ iron\ BF\ 10\ averaged\ BL}$ | Baseline production of pig iron in BF #10, averaged for 2004-2006 | t |
| $SPE_{metallurgical\_coke}$ | Specific CO2 emissions per ton of dry metallurgical coke produced in BPCP | t CO2/t | $FC_{NG\ BF\ 10\ averaged\ BL}$ | Baseline consumption of NG in BF #10, averaged for 2004-2006 | m3 | $P_{max\ pig\ iron\ BF\ 10\ BL}$ | Maximum baseline production of pig iron in BF #10, (1789.6 thousand tons in 1987) | |

## *12 months 2009*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 688 813 |
| 2 | Carbon content in coke | % | 83,50 |
| | | tons C | 575 130 |
| 3 | Baseline consumption of NG | th. m3 | 136 809 |
| 4 | Carbon content in NG | kg C/m3 | 0,50 |
| | | tons C | 67 725 |
| 5 | Pig iron production (baseline) | tones | 1 588 957 |
| 6 | $CO_2$ emissions from coke production in BPCP | t $CO_2$ | 665 706 |
| 7 | $CO_2$ emissions from coke consumption in BF #10 | t $CO_2$ | 2 108 810 |
| 8 | $CO_2$ emissions from NG consumption in BF #10 | t $CO_2$ | 248 323 |
| **9** | **Baseline $CO_2$ emissions from the coke production in BPCP, consumption of coke and NG in BF #10** | t $CO_2$ | **3 022 839** |

## *12 months 2010*

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Baseline consumption of dry skip metallurgical coke | tones | 708 654 |
| 2 | Carbon content in coke | % | 83,01 |
| | | tons C | 588 268 |
| 3 | Baseline consumption of NG | th. m3 | 140 750 |
| 4 | Carbon content in NG | kg C/m3 | 0,49 |
| | | tons C | 69 627 |
| 5 | Pig iron production (baseline) | tones | 1 634 726 |
| 6 | $CO_2$ emissions from coke production in BPCP | t $CO_2$ | 705 216 |
| 7 | $CO_2$ emissions from coke consumption in BF #10 | t $CO_2$ | 2 156 983 |
| 8 | $CO_2$ emissions from NG consumption in BF #10 | t $CO_2$ | 255 298 |
| **9** | **Baseline $CO_2$ emissions from the coke production in BPCP, consumption of coke and NG in BF #10** | t $CO_2$ | **3 117 498** |

BF #10 basleline parameters

| # | Name | Unit | Value |
|---|---|---|---|
| 1 | Specific consumption of dry skip coke in BF #10 | kg/ ton of pig iron | 433,5 |
| 2 | Specific consumption of NG in BF #10 | m3/ton of pig iron | 86,1 |

**Total baseline $CO_2$ emissions**

**$BE = BE_{coke,\ NG\ for\ BF4} + BE_{coke,\ NG\ for\ BF6} + BE_{coke,\ NG\ for\ BF9} + BE_{coke,\ NG\ for\ BF2} + BE_{coke,\ NG\ for\ BF10}$** **(PDD formula D.1.1.4.-21)**

## *12 months 2009*

| # | Parameter | **Baseline emissions, tones CO2/year** |
|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 407 577 |
| 2 | Dry skip metallurgical coke consumption | 7 626 672 |
| 3 | NG consumption | 958 242 |
| 4 | Total | **10 992 490** |

## *12 months 2010*

| # | Parameter | **Baseline emissions, tones CO2/year** |
|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 805 035 |
| 2 | Dry skip metallurgical coke consumption | 8 579 515 |
| 3 | NG consumption | 1 089 130 |
| 4 | Total | **12 473 680** |

## D.3 CALCULATION OF EMISSION REDUCTION UNITS

**The following formula shall be used to calculate emission reduction:**

**ER = BE - PE** **(PDD formula D.1.4.-1)**

### *12 months 2009*

| # | Parameter | Baseline emissions, tones CO2/year | Project emissions, tones CO2/year | ERUs, tones CO2/year |
|---|---|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 407 577 | 2 307 596 | 99 981 |
| 2 | Dry skip metallurgical coke consumption | 7 626 672 | 7 310 092 | 316 580 |
| 3 | NG consumption | 958 242 | 1 049 274 | -91 033 |
| 4 | Electricity consumption | - | 107 892 | -107 892 |
| 5 | Total | **10 992 490** | **10 774 854** | **217 636** |

### *12 months 2010*

| # | Parameter | Baseline emissions, tones CO2/year | Project emissions, tones CO2/year | ERUs, tones CO2/year |
|---|---|---|---|---|
| 1 | Metallurgical coke production in BPCP | 2 805 035 | 2 731 742 | 73 293 |
| 2 | Dry skip metallurgical coke consumption | 8 579 515 | 8 355 938 | 223 577 |
| 3 | NG consumption | 1 089 130 | 1 145 662 | -56 532 |
| 4 | Electricity consumption | - | 99 891 | -99 891 |
| 5 | Total | **12 473 680** | **12 333 232** | **140 448** |

# Appendix 1

**Colour legend for calculation tables**

| | |
|---|---|
| (yellow) | Carbon contaning flow |
| (peach) | Data input from MMK reports |
| (grey) | Carbon mass |
| 0,19 | Carbon content |
| (lilac) | Specific CO2 emissions |
| (blue) | CO2 emissions, associated with production of profiled steel billet |
| (light green) | value fixed ex-ante |
| (light blue) | value which requires a special note in the monitoring report |
| (beige) | Baseline data fixed-ex-ante |

# Appendix 2

## List of abbreviations

| | |
|---|---|
| AIE | Accredited Independent Entity |
| BC | Bell charger |
| BF | Blast furnace |
| BFG | Blast furnace gas |
| BFP | Blast furnace plant |
| BLT | Bell-less top |
| BPCP | By-product coke plant |
| CEST | Center for Energy Saving Technologies |
| CHPP | Combined heat power plant |
| CL | Central Lab |
| CMP | Conference of the Parties serving as the Meeting of the Parties |
| COG | Coke oven gas |
| CPP | Central power plant |
| DBC | Double bell charger |
| EF | Emission factor |
| EIA | Environmental impact assessment |
| ERU | Emission reduction unit |
| GDS | Gas-distributing station |
| GHG | Greenhouse gas |
| IPCC | Intergovernmental Panel on Climate Change |
| IT | Information technology |
| JI | Joint Implementation |
| KP | The Kyoto Protocol |
| LLC | Limited liability company |
| LoA | Letter of Approval |
| MED | Ministry of Economic Development |
| MMK | Magnitogorsk iron and steel works |
| MNR | Ministry of Natural Resources |
| MPDS | Maximum Permissible Discharge of Sewage document |
| MPE | Maximum Permissible Emissions |
| NG | Natural gas |
| OJSC | Open joint stock company |
| PDD | Project design documentation |
| PNPPW | Permissible Norm of Producing and Placement of Wastes document |
| QMS | Quality management system |
| SABPP | Steam-air blowing power plant |
| SCaSU | Sinter cooling and stabilization unit |
| SP | Sintering plant |
| TEE | Turbine expansion engine |

# Appendix 3

## CALCULATION OF SPECIFIC $CO_2$ EMISSIONS PER TON OF DRY METALLURGICAL COKE PRODUCED IN BPCP

Calculation of specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP by carbon balance method is in line with Tier 3 approach described in Section 4.2.2 of Chapter 4 of "2006 IPCC Guidelines for National Greenhouse Gas Inventories" (IPCC Guidelines 2006).

**Production of metallurgical coke**

$$PE_{metallurgical\_coke} = [(M_{coking\ coal\_PJ} * \%C_{coking\ coal\_PJ}) + (FC_{BFG\_CP\_PJ} * C_{BFG\_PJ}) + (FC_{COG\_CP\_PJ} * C_{COG\_PJ}) + (FC_{NG\_CP\_PJ} * C_{NG\_PJ}) - (P_{metallurgical\ coke\_PJ} * \%C_{metallurgical\ coke\_PJ}) - (P_{COG\_CP\_PJ} * C_{COG\_PJ}) - (P_{benzol\_PJ} * \%C_{benzol}) - (P_{coal\text{-}tar\_PJ} * \%C_{coal\text{-}tar})] * 44/12 \quad (3.\text{-}1)$$

Where:
$PE_{metallurgical\ coke}$ – Project emissions from production of metallurgical coke in BPCP, th. tons of $CO_2$
$M_{coking\ coal\_PJ}$ – Consumption of dry coal charge in BPCP, th. tons
$\%C_{coking\ coal\_PJ}$ – Carbon content in dry coal charge, % by mass
$FC_{BFG\_CP\_PJ}$ – Consumption of BFG in BPCP, million $m^3$
$C_{BFG\_PJ}$ – Carbon content in BFG, kg $C/m^3$
$FC_{COG\_CP\_PJ}$ – Consumption of COG in BPCP, million $m^3$
$C_{COG\_PJ}$ – Carbon content in COG, kg $C/m^3$
$FC_{NG\_CP\_PJ}$ – Consumption of NG in BPCP, million $m^3$
$C_{NG\_PJ}$ – Carbon content in NG, kg $C/m^3$
$P_{metallurgical\ coke\_PJ}$ – Production of dry metallurgical coke, th. tons
$\%C_{metallurgical\ coke\_PJ}$ – Carbon content in dry metallurgical coke, % by mass
$P_{COG\_CP\_PJ}$ – Output of COG in BPCP, million $m^3$
$P_{benzol\_PJ}$ - Production of crude benzol, th. tons
$\%C_{benzol}$ – Carbon content in dry benzol, % by mass
$P_{coal\text{-}tar\_PJ}$ – Output of dry coal tar, th. tons
$\%C_{coal\text{-}tar}$ – Carbon content in dry coal tar, % by mass

***Specific $CO_2$ emissions per ton of produced metallurgical coke***

$$SPE_{metallurgical\ coke} = PE_{metallurgical\ coke} / P_{metallurgical\ coke\_PJ} \quad (3.\text{-}2)$$

Where:
$SPE_{metallurgical\_coke}$ – Specific $CO_2$ emissions per ton of dry metallurgical coke produced in BPCP, $tCO_2/t$
$PE_{metallurgical\_coke}$ – Project emissions from production of metallurgical coke in BPCP, th. $tCO_2$
$P_{metallurgical\ coke\_PJ}$ – Production of dry metallurgical coke, th. tons

Most parameters are monitored, while some of then are fixed ex-ante:

Table 4.1. Fixed parameters

| № | Data variable and unit | Notation | Value |
|---|---|---|---|
| 1. | Carbon content in crude benzol, % by weight | $\%C_{benzol}$ | 90.0 |
| 2. | Carbon content in coal tar (dry), % by weight | $\%C_{coal\text{-}tar}$ | 86.0 |

Table 4.2. Monitored parameters

| № | Data variable and unit | Notation | Data source (MMK department) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. | Consumption of dry coal charge in BPCP, th. tons | $M_{coking\ coal\_CP\_PJ}$ | BPCP technical report (BPCP) |
| 2. | Carbon content of dry coal charge, % by weight | $\%C_{coking\ coal\_CP\_PJ}$ | Protocols of chemical analyzes in BPCP (CL) |
| 3. | Consumption of BFG in BPCP, million $m^3$ | $FC_{BFG\_CP\_PJ}$ | Report "Gas balance by MMK departments" (CEST) |
| 4. | Carbon content in BFG, $kgC/m^3$ | $C_{BFG\_PJ}$ | Calculated on the basis of chemical composition of BFG (CEST) |
| 5. | Consumption of COG in BPCP, million $m^3$ | $FC_{COG\_CP\_PJ}$ | Report "Gas balance by MMK departments" (CEST) |
| 6. | Carbon content in COG, $kgC/m^3$ | $C_{COG\_PJ}$ | Calculated on the basis of chemical composition of BFG (CEST) |
| 7. | Consumption of NG in BPCP, million $m^3$ | $FC_{NG\_CP\_PJ}$ | Report "Gas balance by MMK departments" (CEST) |
| 8. | Carbon content in NG, $kgC/m^3$ | $C_{NG\_PJ}$ | Calculated on the basis of chemical composition of NG (Department of Chief Energy Expert) |
| 9. | Production of dry metallurgical coke, thousand t | $P_{metallurgical\ coke\_PJ}$ | BPCP technical report (BPCP) |
| 10. | Carbon content in metallurgical coke, % by weight | $\%C_{metallurgical\ coke\_PJ}$ | Protocols of chemical analyzes in BPCP (CL) |
| 11. | Output of COG in BPCP, million $m^3$ | $P_{COG\_CP\_PJ}$ | Report "Gas balance by MMK departments" (CEST) |
| 12. | Production of crude benzol, th. t | $P_{benzol\_PJ}$ | BPCP technical report (BPCP) |
| 13. | Production of anhydrous coal tar (dry), th. t | $P_{coal\text{-}tar\_PJ}$ | BPCP technical report (BPCP) |

# Appendix 4

## CALCULATION OF $CO_2$ EMISSION FACTOR FOR ELECTRICITY PRODUCED AT MMK

Calculation of $CO_2$ emission factor for electricity produced at MMK is based on fuel consumption (blast-furnace gas, coke oven gas, natural gas and energy coal) at own generation stations of MMK (CHPP, CPP, SABPP, turbine section of the steam plant, and gas recovery section of the steam plant).

**$CO_2$ emission factor for electricity produced at MMK**

$$EF_{own\ generation\_PJ} = PE_{total\ electricity\ generation} / (EC_{gross\_PJ} - EC_{import\_PJ}) \quad (4.-1)$$

Where:
$EF_{own\ generation\_PJ}$ – $CO_2$ emission factor for electricity produced at MMK, t $CO_2$/MWh
$PE_{total\ electricity\ generation}$ – Total $CO_2$ emissions from electricity generation at MMK, th. tons of $CO_2$
$EC_{gross\_PJ}$ – Total electricity generation at MMK, GWh
$EC_{import\_PJ}$ – Electricity purchases from Unified Energy Systems of Urals grid, GWh

**$CO_2$ emissions from electricity generation at MMK**

$$PE_{total\ electricity\ generation} = PE_{combustion\ gases\_electricity} + PE_{combustion\ coal\_electricity} \quad (4.-2)$$

Where:
$PE_{total\ electricity\ generation}$ – $CO_2$ emissions from electricity generation at MMK, th. tons of $CO_2$/year
$PE_{combustion\ gases\_electricity}$ - $CO_2$ emissions from combustion of gases for electricity generation at MMK, th. t$CO_2$/year
$PE_{combustion\ coal\_electricity}$ - $CO_2$ emissions from combustion of power station coal for electricity generation at MMK, th. t$CO_2$/year

**$CO_2$ emissions from combustion of gases for electricity generation at MMK**

$$PE_{combustion\ gases\_electricity} = (FC_{BFG\_CPP\_PJ} * C_{BFG\_PJ} + FC_{NG\_CPP\_PJ} * C_{NG\_.PJ} + FC_{NG\_CHPP\_PJ} * C_{NG\_PJ} + FC_{BFG\_SABPP\_PJ} * C_{BFG\_PJ} + FC_{COG\_SABPP\_PJ} * C_{COG\_PJ} + FC_{NG\_SABPP\_PJ} * C_{NG\_PJ} + FC_{NG\_turbine\ section\ of\ SP\ \_PJ} * C_{NG\_PJ} + FC_{NG\_gas\ recovery\ unit\text{-}2\ of\ SP\ \_PJ} * C_{NG\_PJ})/100 * 44/12 \quad (4.-3)$$

Where:
$PE_{combustion\ gases\_electricity}$ - $CO_2$ emissions from combustion of gases for electricity generation at MMK, thousand tons of $CO_2$
$FC_{BFG\_CPP\_PJ}$ – Consumption of BFG in CPP, million $m^3$
$FC_{BFG\_SABPP\_PJ}$ – Consumption of BFG in SABPP, million $m^3$
$C_{BFG\_.PJ}$ – Carbon content in BFG, kg C/$m^3$
$FC_{COG\_SABPP\_PJ}$ – Consumption of COG in SABPP, million $m^3$
$C_{COG.PJ}$ – Carbon content in COG, kg C/$m^3$
$FC_{NG\_CPP\_PJ}$ – Consumption of NG in CPP, million $m^3$
$FC_{NG\_CHPP\_PJ}$ – Consumption of NG in CHPP, million $m^3$
$FC_{NG\_SABPP\_PJ}$ – Consumption of NG in SABPP, million $m^3$
$FC_{NG\_turbine\ section\ of\ SP\ \_PJ}$ – Consumption of NG in turbine section of Steam Plant, million $m^3$
$FC_{NG\_gas\ recovery\ unit\text{-}2\ of\ SP\ \_PJ}$ – Consumption of NG in gas recovery unit of Steam Plant, million $m^3$
$C_{NG\_.PJ}$ - Carbon content in NG, kg C/$m^3$

**$CO_2$ emissions from combustion of power station coal for electricity generation at MMK**

$$PE_{combustion\ coal\_electricity} = (FC_{energy\ coal\_CHPP\_PJ} * \%C_{energy\ coal})/100 * 44/12 \quad (4.-4)$$

Where:

$PE_{combustion\ coal\_electricity}$ - $CO_2$ emissions from combustion of power station coal, thousand tons of $CO_2$
$FC_{energy\ coal\_CHPP\_PJ}$ – Consumption of power station coal by CHPP, thousand tons
$\%C_{energy\ coal}$ – Carbon content in power station coal, % by mass

While most parameters are monitored, some of them are fixed ex-ante:

Table 4.1. Fixed parameters

| № | Data variable and unit | Notation | Value |
|---|---|---|---|
| 1. | Carbon content in energy coal, % by weight (IPCC Guidelines 2006) | $\%C_{energy\ coal}$ | 73 |

Table 4.2. Monitored parameters

| № | Data variable and unit | Notation | Data source (MMK department) |
|---|---|---|---|
| 1. | Consumption of BFG in CPP, million $m^3$ | $FC_{BFG\_CPP\_PJ}$ | Report on fuel consumption by MMK power generation capacities (Technological Department) |
| 2. | Consumption of NG in CPP, million $m^3$ | $FC_{NG\_CPP\_PJ}$ | The same as above |
| 3. | Consumption of NG in CHPP, million $m^3$ | $FC_{NG\_CHPP\_PJ}$ | The same as above |
| 4. | Consumption of BFG in SABPP, million $m^3$ | $FC_{BFG\_SABPP\_PJ}$ | The same as above |
| 5. | Consumption of COG in SABPP, million $m^3$ | $FC_{COG\_SABPP\_PJ}$ | The same as above |
| 6. | Consumption of NG in SABPP, million $m^3$ | $FC_{NG\_SABPP\_PJ}$ | The same as above |
| 7. | Consumption of NG in the turbine section of the Steam Plant, million $m^3$ | $FC_{NG\_turbine\ section\ of\ SP\_PJ}$ | The same as above |
| 8. | Consumption of NG in the gas recovery unit of the Steam Plant, million $m^3$ | $FC_{NG\_gas\ recovery\ unit\text{-}2\ of\ SP\ PJ}$ | The same as above |
| 9. | Consumption of power station coal in CHPP, th. t | $FC_{energy\ coal\_CHPP\_PJ}$ | The same as above |
| 10. | Total electricity consumption at MMK, GWh | $EC_{gross\_PJ}$ | Report on electricity consumption by MMK departments/Electricity consumption report (Technological Department) |
| 11. | Electricity imported by MMK from Urals power grid, GWh | $EC_{import\_PJ}$ | Report “Analysis of consumption of energy resources at MMK” (Technological Department) |