JOINT IMPLEMENTATION PROJECT DESIGN DOCUMENT FORM
Version 01 - in effect as of: 15 June 2006

CONTENTS

Annexes

SECTION A. General description of the project

A.1. Title of the project:

Title: **Reduction of PFC emissions from RUSAL Krasnoyarsk Aluminium Smelter**
Project type: **Reduction of GHG emissions from a source**
Industry sector: **Metal production**
Version 3.0
October 27, 2008

A.2. Description of the project:

RUSAL Krasnoyarsk Aluminium Smelter (KrAZ) is located in the city of Krasnoyarsk, Russian Federation. The smelter was put into operation in 1964. Currently, it is a part of United Company RUSAL (UC RUSAL). Today, KrAZ produces about 950 000 of aluminium annually and is the second largest smelter in the world. KrAZ production capacities include 24 potrooms grouped into 12 potlines with two potrooms in each. Twenty one of these potrooms use vertical stud Søderberg process, the remaining – prebake anode process (PB). The smelter does not have its own power generation capacities and receives electricity from the local power grids.

The purpose of this project is to reduce emissions of PFCs through the reduction of anode effect frequency (AEF), by implementing a number of organizational and technical measures included specifically for that purpose in the RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project being implemented from the beginning of 2006, which aims to:

1. *Reduce AEF (as a JI Project)*;
2. Improve current efficiency;
3. Reduce out-of-operation time due to pot relining;
4. Increase production through additional improvements (not those listed in 2 and 3);

This project became possible due to Automated Alumina Point Feeder System, which was implemented as a part of the Joint Smelter Modernization project designed to increase production, eliminate Anode Plant and Casting House bottlenecks and reduce smelter's environmental impact. The Modernization Project includes:

- Installation of 19 new dry scrubbers for removal of fluorides from the reduction plant gas emissions, which will reduce environmental impact.
- Extension of 15 (9 through 23) potrooms and installation of 4 additional pots in each potroom.
- Merger of the first and second, third and fourth potrooms into a single potline, extension of potrooms #1 and #4 by 40 meters and installation of additional 8 pots in each.
- Raising potline current to 174 kA.
- Installation of automated alumina point feeders on all VSS pots.
- Modernization and further development of automatic electrolysis process control systems.

The modernization project was launched in 2004. Its completion is planned for 2008. The planning and implementation of the proposed JI Project to reduce AEF, was started only after analyzing the results of a significant portion of KrAZ modernization measures.

As practical experience shows, the installation of point feeders on all VSS pots and modernization of automatic electrolysis process control systems alone does not ensure a significant AEF reduction without additional measures associated with the selection of feeding algorithms, processes and pot maintenance procedures. Therefore, the implementation of automated alumina feeder system and modernization of automatic electrolysis process control systems is not included in the scope of this project and is considered as a baseline scenario. The project also deals with the emissions from prebake pots, which were not part of the modernization project and were equipped with automatic alumina feeders long before this project was started: potroom 7 - in 1998, 8 – in 2000 and 26 – in 2001. The analysis of AEF data for these potrooms shows that anode effect frequency was reduced only marginally - due to process improvements aimed at better current efficiency and more stable pot operation. Before this project was started there were no specific efforts to reduce AEF in these potrooms, which proves the additionality of this Joint Implementation (JI) Project (Project).

The Project began in January 2006. Full benefits from its implementation are expected by the end of 2012, while the main improvements have already taken place in 2006-2007.

Despite the JI project is being implemented as a part of KrAZ Operational Efficiency Improvement project, it is, nonetheless, an additional effort and was only included in the smelter Efficiency Improvement project to reduce PFC emissions with the intent to finalize it later as a JI project implemented in accordance with Article 6 of Kyoto Protocol.

At present, most of KrAZ production capacity is based on VSS technology (1938 pots). In the modernization plan were envisaged 76 additional pots, which have already been installed. These additional pots are also within the scope of Project since they cannot be separated from other pots in the potroom and the planned AEF reduction measures will be equally applied to them. All newly installed pots will be exact copies of the existing pots and as such, without the measures proposed in the JI project, they won't provide any AEF reduction.

A.3. Project participants:

Table A.3.1.T: Project participants

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party wishes to be considered as project participant (Yes/No)
Russian Federation (Host party)	RUSAL Krasnoyarsk OJSC	No
Party B: EU countries	Legal Party B1 Carbon Trade & Finance SICAR S.A.	No

RUSAL Krasnoyarsk Aluminium Smelter is one of the Russian Federation's primary aluminium producers belonging to UC RUSAL. KrAZ is the project owner and its direct contractor while UC RUSAL provides capital, organizes preparation of JI project documentation, its registration and selling of Emission Reduction Units (ERU). UC RUSAL also controls implementation of the project.

Carbon Trade & Finance is a joint venture between Dresdner Bank (via its investment bank Dresdner Kleinwort) and Gazprombank to capture opportunities in the rapidly developing carbon emissions trading market. The joint venture, based in Luxembourg, invests in primary projects generating CO_2 certificates, with a focus on Russia and the Commonwealth of Independent States (CIS).

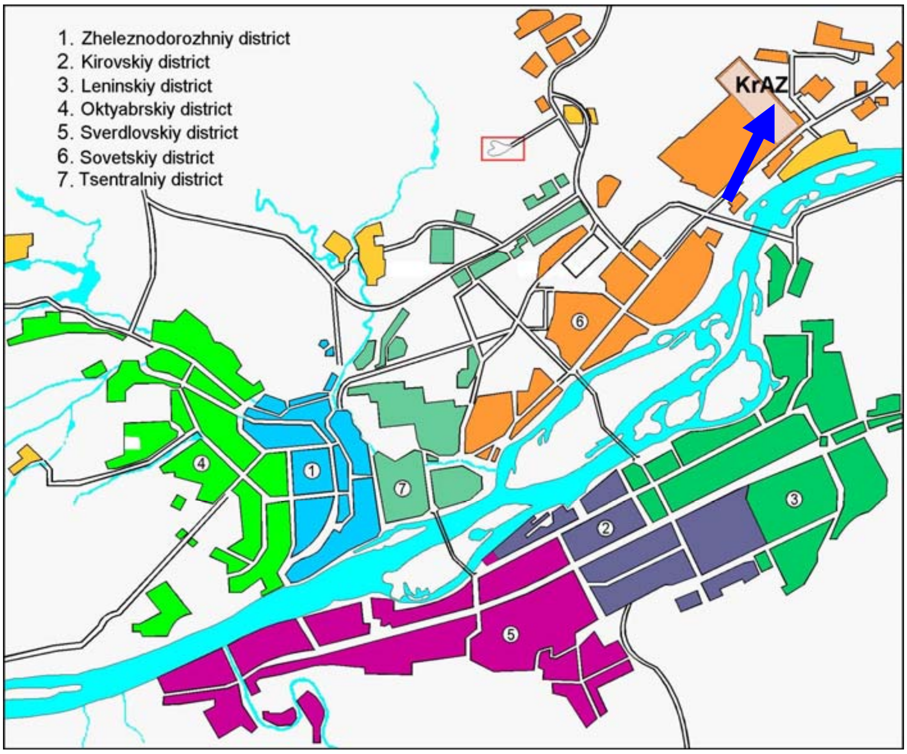
Carbon Trade & Finance provide clients with integrated carbon solutions – from risk management, project advisory and carbon finance to the actual purchase of carbon credits and we will develop secondary products for financial institutions, compliance buyers and governments.

A.4. Technical description of the project:

A.4.1. Location of the project:

The Project is implemented at the RUSAL Krasnoyarsk OJSC, city of Krasnoyarsk, Russian Federation.


ARCTIC OCEAN
Barents Sea
Bering Sea
SIBERIA
URAL MTS.
MOSCOW
Kaliningrad
Vyborg
Saint Petersburg
Petrozavodsk
Murmansk
Arkhangel'sk
Nizhniy Novgorod
Kazan'
Yekaterinburg
Chelyabinsk
Rostov
Novorossiysk
Volgograd
Sochi
Tuapse
Astrakhan'
Omsk
Novosibirsk
Krasnoyarsk
Irkutsk
Lake Baikal
Noril'sk
Yakutsk
Magadan
Anadyr'
Provideniya
Petropavlovsk-Kamchatskiy
Sea of Okhotsk
NORTH PACIFIC OCEAN
KURIL ISLANDS
Kholmsk
Nevel'sk
Khabarovsk
Nakhodka
Vostochnyy
Vladivostok
KAZAKHSTAN
CHINA
JAPAN
MONG.
N. KOR.
UKRAINE
POLAND
BELARUS
GER.
NOR.
SWE.
FIN.
IRAN
Black Sea
Caspian Sea
Aral Sea


1. Zheleznodorozhniy district
2. Kirovskiy district
3. Leninskiy district
4. Oktyabrskiy district
5. Sverdlovskiy district
6. Sovetskiy district
7. Tsentralniy district
KrAZ

Source: Googlearth ©

A.4.1.1. Host Party(ies):

Russian Federation

A.4.1.2. Region/State/Province etc.:

Krasnoyarsk territory

A.4.1.3. City/Town/Community etc.:

Krasnoyarsk city

A.4.1.4. Detail of physical location, including information allowing the unique identification of the project (maximum one page):

The Project is implemented on the territory of RUSAL Krasnoyarsk Aluminium Smelter. Total area of the smelter is 512.1 ha, including: main aluminium production complex, waste water treatment facilities, mud disposal areas, industrial waste storage area, pump water intake and auxiliary production facilities.

RUSAL Krasnoyarsk aluminum smelter is on the territory of Emelyanovsky district's industrial hub (Krasnoyarsk territory), in the north-eastern part of Krasnoyarsk city, 800 meters from the left bank of Yenisei river. Its geographical coordinates are 56º05'32" N and 93º00'43" E. 2,5 km to the south-west of the site is Zelenaya Roscha town, 4 km to the north-west is Solnechny urban district and 3,5 km to the south-east - Peschanka village.

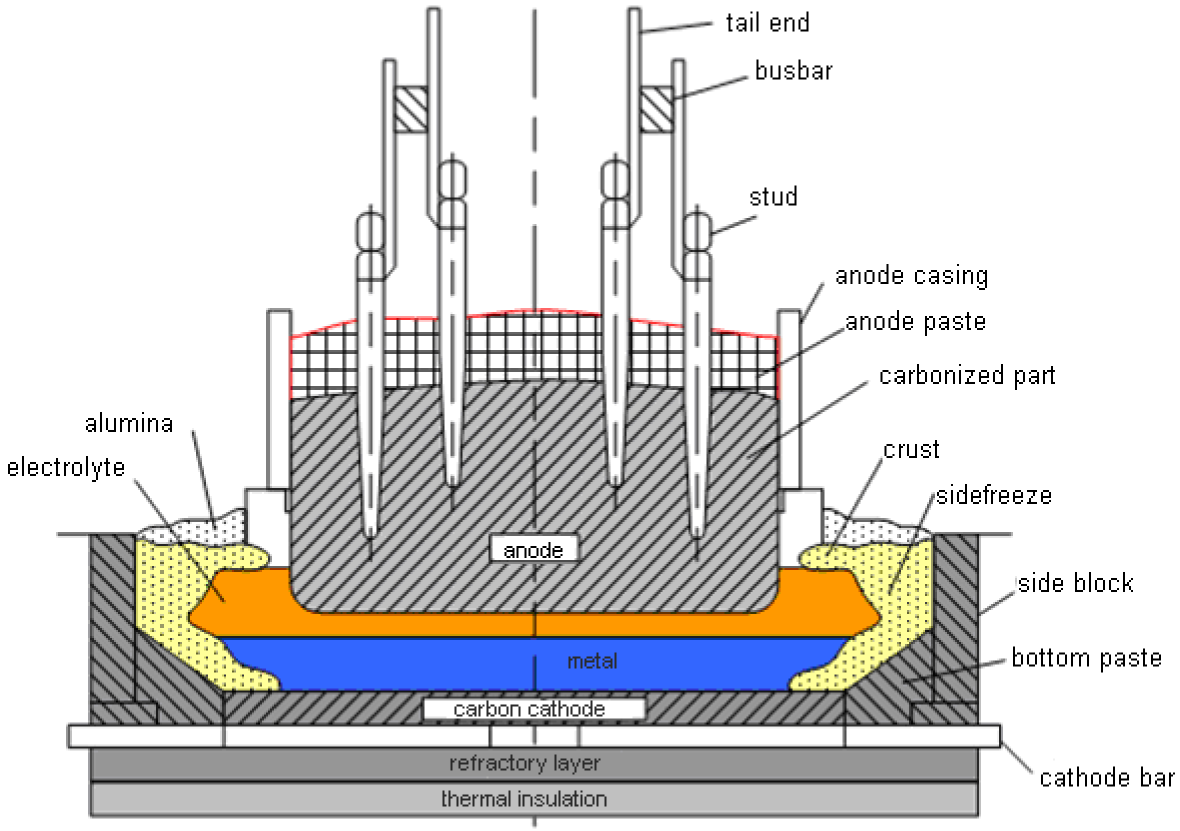
The site is in the continental climatic zone with long cold winters and short hot summers. Average temperature in January is -20°C, in July +18°C. Absolute minimum ever recorded in the neighborhood of Krasnoyarsk is -56°C, absolute maximum +36°C. Annual number of days with temperatures below 0°C is from 170 - 220.

A.4.2. Technology(ies) to be employed, or measures, operations or actions to be implemented by the project:

Aluminium production process is based on electrolytic reduction of aluminium oxide (Al_2O_3) dissolved in a electrolyte where cryolite is the main component. The process takes place at 950-970°C in a electrolytic cell. The electrolytic cell is a pot lined with carbon blockswhich serve as a cathode. Liquid aluminium settles on the bottom of the pot since it is denser (specific gravity 2.3 at 960° C) than the electrolyte (specific gravity 2.1). Periodically, this aluminium is siphoned off by vacuum into crucibles. Steel bars carry the electric current through the insulating bricks into the carbon cathode floor of the pot. Carbon anode blocks are suspended on steel rods, and dip into the electrolyte. This carbon is consumed during the electrolysis process. In the case of PB technology - prebake carbon anodes, burn gradually in the oxygen released by decomposing aluminium oxide, forming carbon monoxide (CO) and carbon dioxide (CO_2). The following two types of anodes are used in aluminium production:

a) Self-baking Søderberg anodes consisting of anode paste (calcined coke mixed with coal or petroleum pitch) encased in a steel shell. At high temperatures the paste is baked (sintered). There are two types of Søderberg anodes - with vertical studs (VSS) and horizontal studs (HSS). KrAZ uses Vertical Stud Søderberg pots (VSS).

b) The more modern prebake technology involves producing pre baked anodes in furnaces outside the electrolysis pot, which are often an integrated part of Primary Aluminium plants. (e.g. 1900×600×500 mm weighing about 1.1 t).



During pot operation, regularly appears a phenomenon called "anode effect". Anode effect (AE) (“flare”) is the result of anode polarization during electrolysis process. AE appears when concentration of alumina (Al_2O_3) in the bath falls below critical level (1.5 to 2%) (bath "starvation") and is characterized by the sharp increase in pot voltage because of reduced wetting of anode by the bath and increased electrical resistance on the anode-bath interface.

AE is accompanied by emissions of two gases perfluorocarbons (PFCs): tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6).

$4Na_3AlF_6 + 3C \rightarrow 4Al + 12NaF + 3CF_4$

$4Na_3AlF_6 + 4C \rightarrow 4Al + 12NaF + 2C_2F_6$

The majority of pots use a side feeding of alumina through a broken crust. The crust is broken on the long side of the pot and alumina is loaded using an alumina feeder machine. With this scheme the amount of alumina fed into the bath cannot be controlled precisely and this results in unbalanced chemical composition of the bath causing some of it to settle on the bottom that leads to process interruption. In addition, there is loss of alumina when small particles of it are released into the potroom atmosphere.

The main advantages of automatic feeding systems are:

- Timely feeding of alumina into the pot so that its stable operation is ensured and anode effects are prevented.
- Reduced dust in the air at the workplace.

Under the modernization project 4 automatic feeder hoppers are installed on each VSS pot: 2 on each side. Automatic alumina point feeder systems require compressed air and must be controlled either by existing pot controllers or new controllers, depending on their location. An automatic alumina feeder system performs two basic operations. First, the crust breaker makes a hole in the crust. The crust is a layer of solidified electrolyte which covers the molten bath. After that, the batch feeder loads the required quantity of alumina into the hole. This operation is periodically repeated and controlled by pot controllers. Alumina transfer trucks regularly fill up the hoppers.

As was mentioned above, alumina point feeders itself do not reduce AEF significantly. The reason for this is the process management and long-established work practices of the personnel. New approaches are therefore required. The AEF reduction efforts were integrated into the RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project launched in 2006.

Although, the main AEF improvements were gained in 2006-2007, the work to achieve further reductions of PFC emissions will continue until 2015. Thus, the proposed JI project goes beyond the RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project.

The major goals of the long-term RUSAL strategy to increase technical, economic and environmental performance of the smelter to the highest Russian and world standards are set in the Improvement project. To achieve these goals, RUSAL management hired YOMO consultants. The activities in the first stage of the project included technical and economic assessment of the smelter, evaluation of ecological aspects of the work, of smelter's organizational structure and its business-processes.

The project is managed by three different groups representing the major departments of the smelter:

- Reduction plant group;
- Electrolytic cell relining quality group;
- Electrolytic cell replacement group.

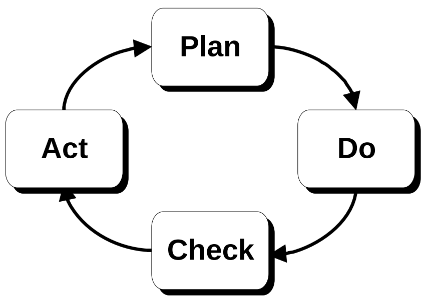
Project philosophy is summarized in the following cycle of re-engineering work:

- Observation;
- Analysis and planning;
- Modeling and experimentation using allocated pot groups;
- Implementation of the best practices and results;
- Replication of the achieved results enterprise-wide.

Potroom Nr. 13 was allocated for experimentation to try and achieve the set goals. This potroom was used by smelter's specialists together with the consultants to optimize the project solutions, which were then replicated in other potrooms. A dedicated unit was established (under RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project) and additional smelter's personnel were enlisted for the work. YOMO was hired specially for this work.

From the very beginning AEF reduction was planned as a separate project and required significant financial outlays (see Annex 4) and this confirms additionality of the project. The cost of this work amounts to 18% of the entire RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project budget.

The entire project activity is a continuous Demnig cycle improvement process.



- **Plan**: *establish performance objectives and standards*
- **Do**: *measure actual performance*
- **Check**: *compare actual performance with objectives & standards, determine the gap*
- **Act**: *take necessary actions to close the gap and make necessary improvements*

In accordance with the above cycle, changes are introduced in work practices, technologies and other processes on which AEF depends.

The following is a description of the practical implementation of this approach.

After creation of a dedicated project team, including RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project personnel and Yomo Services Ltd.'s consultants, a comprehensive analysis of the initial state of the smelter was performed taking into account its technical, economic, environmental and technology performance. After that, based on the aluminium production technology used by the smelter, the main goals of the project were determined, including reduction of PFC emissions through reduction of AEF. Then "a potline comprising potrooms 13 and 14" (SKE #13,14) business-unit was allocated as an experimental facility to optimize proposed operational changes.

Initially, to determine the kind of actions required (potential operational changes), all participants of the team perform independent assessment of smelter's technological parameters and the condition of its potrooms. After that, an alignment meeting is held where project managers, heads of business-units and senior consultants from YOMO discuss the remarks and violations, their probable causes and possible corrective measures. Participants of this meeting also determine main directions of activities for further, more detailed study and final solution of the identified problems as well as set up dedicated working groups to pursue each of these directions.

Each of the working groups then continues with a still more detailed and multifaceted analysis of a particular problem. To get a clear picture regarding the causes of a particular problem, the working groups hold routine meetings and invite experts and consultants in appropriate fields. In these meetings their participants identify main causes of problems, propose and agree the necessary corrective measures. During subsequent implementation of these measures on a pilot group of electrolytic cells, additional proposals may be put forward to further improve and adjust earlier adopted measures. As the work moves in a continuous and progressive manner towards the set objectives, the main performance indicators related to each specific issue are being controlled and analyzed.

The results of the work to solve a particular problem are then presented at the alignment meeting in the form of a progress report. During this meeting a decision is taken what to do next: to continue the work in this direction with additional measures outlined, or, if the problem was eliminated completely, to implement (replicate) the experience (solution) on the entire pilot facility, namely, SKE No. 13,14. If the measures were successfully implemented at the pilot facility and the achieved results remain stable for a certain period of time, the practice is approved and implemented on the entire smelter.

This methodology is labor intensive and draw smelter's management and technical specialists from their direct functions. Nonetheless, it guarantees reliable and high-quality solutions to problems. Also, the smelter has to pay significant sums to outside consultants for their services. That is why the AEF reduction project was planned and financially evaluated from the very beginning. RUSAL Krasnoyarsk Aluminium Smelter's management approved this JI project counting on the future financial rewards from selling Emission Reduction Units as is said further in this document.

KrAZ specialists, as they started to implement the proposed PFC emissions reduction measures, encountered a problem of higher then expected AEF despite installation of automated alumina point feeder systems in the potrooms. After a joint study of this problem, the project personnel and Yomo Services Ltd. consultants proposed to work in the following three main directions:

- organization of control and repair of mechanical defects in automated alumina feed systems;
- optimization of process parameters for automated alumina feed systems;
- selection of automated alumina feed system's work algorithm.

It should be underlined that these measures were initially planned in the JI project context. To reach the goals of the RUSAL Krasnoyarsk Aluminium Smelter's Operational Efficiency Improvement project, other measures were planned and implemented as well, in order to meet certain objectives of the Improvement project. In other words the above measures to reduce AEF are not the only ones implemented to achieve all the goals of the Operational Efficiency Improvement project.

Examples of implemented operational changes:

1. Organization of control and repair of mechanical defects in automated alumina feed systems

Among the supposed causes of high AEF is mechanical malfunction in automated alumina feeders. Automated alumina feed system's main function is timely loading of alumina into the pot to ensure its stable operation. With minor mechanical malfunction the system still continues to work with the consequence of more frequent anode effects. An Equipment Capability group was established to try and organize control and repair of mechanical defects in automated alumina feed systems. The group included representatives from the Alumina and Fluorides Transportation Area, the Fluorides Production Area, RUSAL Krasnoyarsk smelter's power shop, the Engineering Department of the Engineering and Technology Center and from Equipment Repair Directorate of the Krasnoyarsk branch of JSC «RUS-Engineering».

At the kick-off meeting of this group the problems to be tackled were listed: detection of defects in automated alumina feed systems, submission of repair requests, timely repair of these defects and the absence of approved maintenance repair system for the automated alumina feed systems.

After that the group compiled descriptions of problems underlying the supposed causes. Regarding the difficulty of detecting malfunction in alumina feeder systems was found to lie in the absence of the capability for quick and precise identification of fault sources: whether it is an electrical problem, mechanical malfunction, alumina-related issues or problems related to the supply and quality of compressed air. As part of the solution, compressed air supply control buttons were installed on the alumina feed systems at the pilot facility allowing instant detection of problems with air supply. Also, the alumina hopper mouthpieces were equipped with gate valves, which allowed positive identification of problems with the mechanical part of the system - the crust breaker. An analysis of alumina quality was performed to try and eliminate alumina-related issues (namely, alumina arching in the feed hoppers) and the most frequent arching locations were identified. As to the determination of the necessity of repairs on automated alumina feed systems, the submission of repair requests and the timely repair of detected problems, a malfunction checking procedure was established for alumina feeders and an automated system for submission of repair requests into the GST WS data base, which solved the problem of non-existent feed-back on performed repairs.

Further replication of this work group's successful practices was carried out in accordance with the Procedure for Introduction of Operational Changes into Production Process.

2. Optimization of process parameters for automated alumina feed systems

A technology group was created to optimize process parameters for automated alumina feed systems including representatives from RUSAL Krasnoyarsk smelter's Electrolyze Production Directorate and from the Technology Repair Directorate of the Krasnoyarsk branch of JSC «RUS-Engineering».

At the kick-off meeting of this work group the problems to be solved were listed, their detailed descriptions and probable causes: e.g. accumulation of thick sediments of alumina under the hoppers makes production more labor intensive, increases the time of pot unsealing, causes formation of side freeze under the hoppers, leading to problems with automated alumina feed system operation; absence of planning procedure for AE during routine operations on a pot; absence of intelligible guides as to how often and after what time AE should appear. The work performed by this group includes: optimization of pot cavity shape; additional measurements of the distance between pot hood and bath to exclude alumina feed system failures caused by bath sticking to the crust breaker; evaluation of the effect of alumina sedimentation on pot operation; determination of pot dynamics regarding sedimentation; identification of ways to deal with sedimentation problem by modifying process parameters; development of a supervisor guidance procedure to manage planned anode effects during routine operations on a pot.

Further replication of work group's successful practices was carried out in accordance with the Procedure for Introduction of Operational Changes into Production Process.

3. Selection of automated alumina feed system's work algorithm.

An algorithm group was created to select work algorithms for automated alumina feed systems, including representatives from the RUSAL Krasnoyarsk smelter's Reduction Plant Directorate and from the Technology Repair Directorate of the Krasnoyarsk branch of RUSAL Engineering.

At the kick-off meeting of this working group the problems to be solved, their detailed descriptions and causes were listed: e.g. automated alumina feed system's algorithm is not adapted to the line treatment so that operation of this system does not change with increased inflow of alumina during line treatment; automated alumina feed system's algorithm is not adapted to handle process upsets in a pot; there is no link between automated alumina feed system's algorithm and pot control.

The following measures were implemented by this group:

1. Control of the anode-to-cathode distance by moving anode mechanism up/down is only allowed during nominal pot operating mode. In the "Test" and "Underfeed" modes only UP movement is allowed, while in the "Starve" mode, the control is only allowed if the voltage is below the sensitivity threshold set by the process engineer.

2. For process upsets where bath temperature rises above normal, there are two operating modes with reduced alumina feeding – "Test" and "Underfeed". In addition, the pot is periodically switched into the "Starve" mode until initial signs of AE appear - to evaluate concentration of alumina in the bath. Other types of upsets, such as melt break-out or low bath level, envisage a range of measures to be implemented by the process engineer and shift supervisor (described in normative and technical documentation).

3. When for some reason or other the concentration of alumina in the bath changes (increases or decreases), the algorithm switches the pot into a particular alumina feeding mode. In addition, there is a

system for automatic adjustment of automated alumina feed system's set point, which changes depending on alumina concentration.

Further replication of this work group's successful practices was carried out in accordance with the Procedure for Introduction of Operational Changes into Production Process.

All above measures are listed here as an example. The complete list of all performed works is much longer. All these measures are not of primary importance for metal production and are, in effect, nothing more than a "fine tuning" of pot and automatic process control system's operating parameters, whose main goal is AEF reduction. It should be underlined that even without these measures automatic alumina point feeder system still performs its main function.

A.4.3. Brief explanation of how the anthropogenic emissions of greenhouse gases by sources are to be reduced by the proposed JI project, including why the emission reductions would not occur in the absence of the proposed project, taking into account national and/or sectoral policies and circumstances:

The project aims to reduce frequency of anode effects leading to PFCs emissions. This reduction may be achieved by technical means or by operational activities. The introduction of automated alumina feed system is one of the technical means and is considered as the baseline scenario, since this system together with the dry scrubber system was implemented to reduce untreated emissions of pollutants when dust-forming fine particle of alumina loaded with fluorides was returned back into the electrolysis process after purification. As was mentioned above and will be discussed in more detail further, alumina point feeder system by itself does not reduce AEF significantly. Other possible technical measures, such as devices for automatic AE quenching, have not been considered neither in the baseline nor in the project scenario. The AEF reduction within the scope of this project is expected to be achieved by the introduction of operational improvements. The main operational improvements will be made in the following AEF sensitive areas:

- alumina properties (e.g. moisture content);
- thermal balance;
- automatic process control system algorithms;
- electrolysis process technology, electrolysis process practices and procedures, personnel training, analysis of pot operating parameters.

The additionality is established using both economic analysis and barrier (obstacle) analysis, where established work practices and business management strategies are considered as the barriers. Under the current company management strategy, the methods of AEF reduction are not of primary importance, so that the management regards the measures proposed within this project as of secondary priority. One of the proofs of such attitude is high AEF in the PFPB potrooms where automated alumina feed system was implemented in 1999-2001 (Thus, in 1998 the AEF for potrooms using prebake technology was 1.16 a.e./pot*day, after installation of the automated alumina feed system in 2001 the average AEF was 1.12 a.e./pot*day, 0.91 in 2002 and 0.94 in 2003. In other words, there was no sharp decline in AEF, since the management was not particularly interested.) This project is the first of its kind, a breakthrough in the area of AEF reduction in the Russian aluminium industry. Without Kyoto Protocol's Joint Implementation mechanism UC RUSAL would not have had incentives to implement this project since it does not bring any significant benefits apart from reduction of PFC emissions. This project, therefore, is an additional one.

A.4.3.1. Estimated amount of emission reductions over the crediting period:

Emission reductions in periods: 2006-2007 and 2008-2012. The table lists difference between baseline and project emissions in tons of CO_2 equivalent.

Year	Emission reductions, tonnes CO_{2E}
2006	122,070
2007	180,407
Total:	**302,477**
2008	189,390
2009	207,445
2010	230,945
2011	266,945
2012	270,391
Total:	**1,165,116**

A.5. Project approval by the Parties involved:

Letters of Approval by the Parties will be received later.

SECTION B. Baseline

B.1. Description and justification of the baseline chosen:

The most suitable methodology out of those approved for the CDM projects is AM0030 ver. 02 "PFC emission reductions from anode effect mitigation at primary aluminium smelting facilities". (http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_KIYGY1SBL9N1M704JBKMHWS1SSADE9). This methodology, however, applys only to the PFPB technology. As this project includes not only PFPB, but also VSS technology, the methodology is thus not applicable . Besides this methodology is based on the first version of the emission calculation methodology of the International Aluminium Institute, included in 1996 IPCC Guidelines for National Greenhouse Gas Inventories. At present, the 3-rd version of the methodology "The Aluminium Sector Greenhouse Gas Protocol" (Addendum to the WRI/WBCSD Greenhouse Gas Protocol) 2006 has been approved, which is included in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The PDD developer for JI projects is not obliged to use the CDM methodologies and does not have to approve his own methodology. This is why during the baseline determination the developer proposes to use his own approach that is described in the 3-rd version of the methodology "The Aluminium Sector Greenhouse Gas Protocol", without special compliance with some approved CDM methodologies, but certainly with compliance with the requirements of *Decision 9/CMP.1*, *Appendix B*. Everything related to emission assessment, is sufficiently described and proved.

In connection with this, it is worthwhile developing the most probable baseline scenario on the basis of existing and estimated until the year 2012 data related to the project already implemented and the corresponding greenhouse gases emissions. That is, initially it is reasonable to create a project scenario taking all available data into account, and then using it as a basis, prove everything that is connected with the baseline scenario. This proposal is in conformity with the recommendations of *Decision 9/CMP.1*, *Appendix B, 2a*, where, in particular, it is said that the baseline is determined as "on a project-specific basis".

According to the IPCC methods, perfluorocarbon emissions in 2006 were influenced by four parameters which depended on the specific aluminium production: overall production of electrolytic aluminium, frequency and duration of anode effects and slope coefficient for CF_4 and C_2F_6 emissions.

For baseline calculation it is estimated that the overall production of electrolytic aluminium will be the same as for the project scenario. This conservative approach is accepted because the overall production neither decreases nor increases with reduction in frequency of anode effects and implementing of the project specific measures. Since the possible reduction in metal loss as a result of reduction in the frequency of anode effects is impossible to measure, and in any case it will be insignificant, it is assumed that the overall production of electrolytic aluminium will remain the same as for the project scenario. For the overall production of electrolytic aluminium in 2006 was taken a real figure, for the year 2007 – the planed production capacity was taking into account. The overall production for the years 2008-2012 are taken from the document "Targets for aluminium smelters until 2017 and prognosis of development of prime cost of aluminium". Because the plant fulfills its plans every year, one can surely say that these targets will be reached and even exceeded. This value will change every year depending on the plant performance results for the calendar year and will be used for the baseline and project line calculation.

Slope coefficient is a value depending on the technology and is constant for pots operating on the same technology. According to recommendations of the International Aluminium Institute (IAI) consultant Jerry Marks, who is the author of the perfluorocarbon emissions measurement method, these coefficients will be measured once in three years. Measurements will be taken more frequently than once in three years in the event of considerable changes in the technology. Because the project provides reduction in perfluorocarbon emissions by means of reducing the frequency of anode effects (AEF), which does not imply changes in technology, it is assumed to use the same slope coefficient for the baseline and project calculation. KrAZ specific emission coefficients were obtained as a result of direct measurements of perfluorocarbon emissions taken within the period from 06.09 to 21.09.2007 in three potrooms of the plant: No 10, 22, and 26. The measurements were taken by an IAI consultant Jerry Marks. The measurements were taken for three types of technology PFVSS - VSS with alumina point feeders (22^{nd} potroom), VSS without alumina point feeders (10^{th} potroom), and PFPB (26^{th} potroom). Because the working parameters of the pots by the above mentioned technologies are the same for other pots, and the types of pots are also the same or very similar, it was assumed that the given factors could be applied for all the other potrooms in the smelter (see the report on perfluorocarbon emissions measuring in KrAZ).

The number of potrooms for measuring was suggested by the IAI consultant Jerry Marks. The choice of the rooms was also coordinated with him. According to his expert opinion , this choice was representative enough to make it possible to use the obtained results for all the potrooms. This was reflected in the report on the performed measurements:

"Given the similarity of technology of the manual fed VSS cells, the point fed VSS cells across the Krasnoyarsk location, I recommend adopting the newly measured IPCC Tier 3 coefficients for CF_4 Slope and for weight ratio of C_2F_6/CF_4 for calculation of PFC emissions at the Krasnoyarsk site for potlines operating with similar technology to those measured and reported here."

The implementation of this project had begun earlier than the last alumina point feeders on the VSS pots were installed (the last alumina point feeders in potroom 10 are to be commissioned before the end of 2007). Thus to calculate emissions before the end of 2007, the three above mentioned slope coefficients were used. For the surveyed period 2008-2012, only two coefficients for the PFVSS and PFPB technologies were used. This is due to the fact that from 2008 all the potrooms operating with the VSS technology will be working with point feeders. Only in the event of considerable shut-offs of the alumina point feeders for longer than 3 days a year for each potroom operating on Søderberg technology, the actual slope coefficient for VSS without alumina point feeders will be considered; in the event of a similar situation in the PFPB potrooms the slope coefficients from Tier 2 of IPCC, for the SWPB technology will be considered (this is because during measurement program it was not possible to take measurements with the alumina point feeder system turned off). As the time of the possible emergency shut-off of the alumina point feeder system is insignificant, it is conventionally assumed to perform recalculation only in the event of the alumina point feeder shut-off for longer than three days a year.

During periodical perfluorocarbon emissions measurements the slope coefficient used for the baseline and project calculation will be changed only if the new measurements show there is a statistical difference between the measurements. The only factor which will not be changed is the slope coefficient for the VSS technology without alumina point feeders, because there will be no pots in the factory using this technology anymore.

The biggest challenge was connected with estimation of the AEF and duration of AE for the baseline. Because since 2006 the project has been carried out in all potrooms, it was not possible to say unambiguously what frequency and duration of AE would have been if the project did not exist. Therefore, for calculation of these baseline values, the approach of construction of linear trends is taken on the basis of historical data of the smelter for the last several years (not fewer than 4).

During estimation of annual average AEF for the baseline for the VSS technology, there is a problem of determination the influence of the alumina point feeder system on the AEF. Even though different publications say that the alumina point feeder system leads to considerable decrease in the frequency of anode effects, the KrAZ smelter's practice, the practice of introducing of alumina point feeders in Sayanogorsk Aluminium Smelter for the prebaked anode technology, pilot alumina point feeders in BrAZ and some smelters of the former SUAL Holding, have shown that this does not take place. For instance, two graphs are shown below with historical data of the frequency of anode effects in KrAZ potrooms and average frequency of AE for the potrooms with the VSS technology in 2004-2005, when almost half of the potrooms were equipped with the alumina point feeder system.

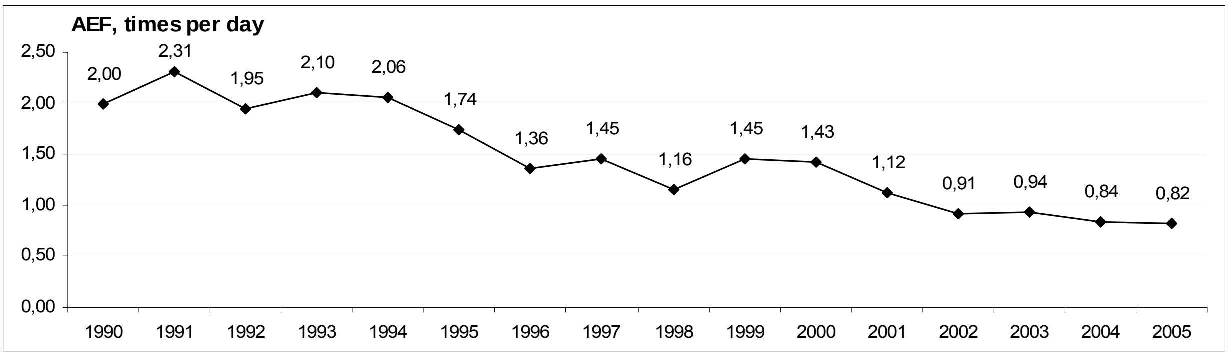


Fig. B.1.1.F Annual average frequency of anode effects for the prebaked anode technology (Potrooms 7, 8 and 26). Commissioning of alumina point feeders was taking place in 1999 to 2000. Potroom 26 was transferred to prebaked anodes with alumina point feeders in 2001.

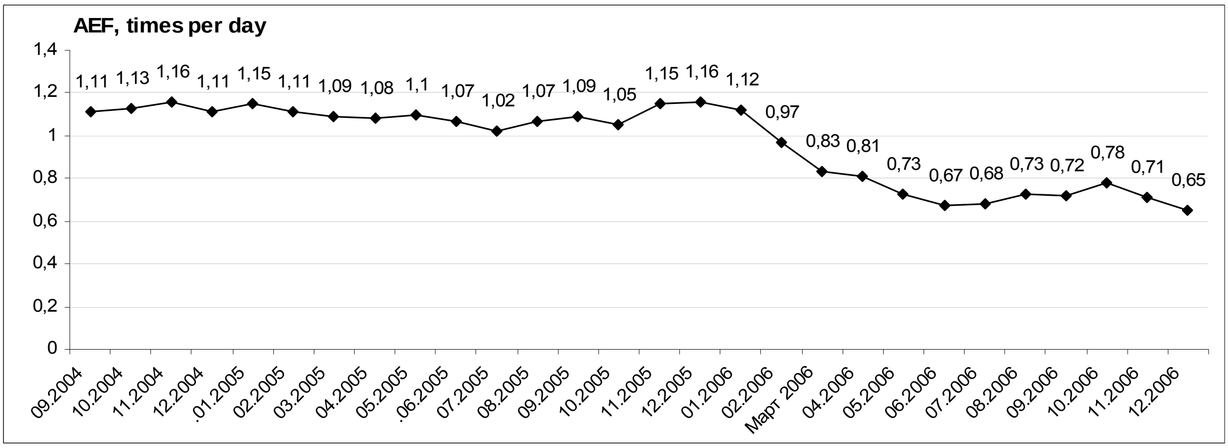


Fig. B.1.2.F Monthly average frequency of anode effects for the VSS technology.

As it is seen in Annex 2, during the initial period after commissioning of the alumina point feeder system a rather fast decline in the frequency of anode effects was observed because of reduction in the number of unscheduled anode effects caused by unsteady feeding of the pot with alumina, but later the situation stabilizes and the frequency reduction rates become the same as prior to the anode point feeder system installation. To a greater extent, this is explained by practical approaches to the reduction process running when the pot is deliberately put on "starvation" in order to cause an anode effect. This is used to determine how the pot operates and what problems exist. The existing process computer control does not allow getting information on which anode effects took place casually and which ones were caused intentionally. This is why to determine the degree of influence of the alumina point feeder system on the frequency of anode effects the data for those rooms VSS technology was analyzed where the alumina point feeders had been installed prior to the project commencement and where they had been in operation not less than four months before January 1, 2006 (the commencement of the project). These potrooms are 1 to 6, 13, 19 and 20. Out of them data for rooms 6 and 20 was analyzed separately, because the alumina point feeders in these rooms were installed in 2004 and they had been in operation for more than a year.

Annex 2 contains a detailed description of how baseline data was obtained.

Actual emission calculations of the project for 2006 to 2007 were made taking into account the time of commissioning of the alumina point feeder systems by potrooms. Using an automatic control system ARM SMIT , data of aluminium overall production, frequency and duration of anode effects were obtained before the alumina point feeders commissioning date from the first potgroup in each potroom where alumina point feeders were installed. Further on during the alumina point feeders commissioning period on the other potgroups of the potroom with ARM SMIT workstation, the data for aluminium overall production, AEF and duration of AE between the alumina point feeders commissioning dates were determined. At the same time the number of pots in the room was determined, where alumina point feeders had already been working and had not been working yet, and the overall production of metal is divided in proportion to their number. Frequency and duration of anode effects were also determined at the same time. After commissioning of the last alumina point feeder system in the potroom, aluminium overall production, frequency and duration of anode effects were determined from the date of commissioning of the last alumina point feeder system to the end of the year. Based on these data, emission calculation for the pots with and without alumina point feeders was made using the correspondent slope coefficients. If the alumina point feeder system commissioning period falls within two consecutive calendar years (e.g. end of 2006 and beginning of 2007), additional intervals were considered: one from the commissioning date of the first alumina point feeder system in the previous year (e.g. 2006) till December 31 and second from January 1 of next year (e.g. 2007) to the commissioning date of the last alumina point feeder system .

B.2. Description of how the anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the JI project:

Proof of additionality

Additionality of actions is proved by the next series of operations within the framework of "Tool for the demonstration and assessment of additionality (ver 3)" - http://cdm.unfccc.int/methodologies/Pamethodologies /AdditionalityTools/Additionality_tool.pdf).

Phase 0. Preliminary verification of the projects whose implementation started after January 1, 2000 and before December 31, 2005.

The main technical feasibility for this project implementation appeared with the beginning of the smelter modernization project and the beginning of the alumina point feeder system commissioning in 2004. However, the direct activities within the framework of this JI project for operation improvement aimed at reduction in the frequency of anode effects began in January 2006, and this is why this phase may be disregarded.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity: Selection of the baseline scenario is based on estimate of the alternative scenarios which could have been potentially implemented:

Scenario 1. Transfer of the reduction technology from self-baking anodes to prebaked anodes (the most worldwide widespread scenario).

Scenario 2. Implementation of the smelter modernization project and the efficiency upgrading project without actions aimed at reduction in the frequency of anode effects.

Scenario 3. Implementation of the smelter modernization project and the efficiency upgrading project with actions aimed at reduction in the frequency of anode effects without its further development as a JI project.

Scenario 1.

This scenario provides complete replacement of the VSS pots with pots using prebaked anodes.

Pots S-8BM, S8B and EY 165 will be equipped with prebaked anodes, operating with 180 kA current, with 92.0 % current efficiency.

The most preferable variant of replacement of VSS with prebaked anodes is the schedule replacement within the relining work scope. In this case: S-8BM pots relining work scope will be 390 to 400 pots per year (391 VSS pots per year according to 2007 business plan). In such a case, replacement with prebaked anode pots without installation of additional pots will be:

1878 / 400 = 4.7 years, where

- 1878 is the number of VSS pots (without additional pots), pieces;
- 400 is VSS pots relining work scope, pots/year.

Finally the total crude aluminium overall production (if replacement would have been started in January 2004) in 2010 would be 1,000,000 to 1,030,000 tonnes. These pots would have been working with the frequency of anode effects from 0.3 to 0.4 per day (taking into account use of floury alumina from domestic suppliers for production of aluminium), duration of AE killing would be 2.0 to 3.0 minutes as the smelter's average. Specific consumption for aluminium fluoride (without “dry” gas cleaning facilities) after transition to prebaked anodes would be 45 to 50 kg/tonne as the smelters average.

Transfer of VSS pots to the prebaked anode technology requires large investments:

- pots with prebaked anodes require change in cathode and anode blocks construction, pot busbar;
- tending of pots with prebaked anodes will require other machines and reconstruction of filling points;
- installation of other alumina point feeder and fluorides point feeder systems will be required for pots with prebaked anodes.

This scenario was considered in late 80s and in mid 90s; it was discarded as economically inadvisable. These concepts were taken into consideration in 2002 to 2003 during determination of the KrAZ modernization strategy, and this scenario was not considered as alternative and economically attractive.

Scenario 2.

This scenario provides implementation of the smelter modernization project with installation of alumina point feeder systems and implementation of the efficiency upgrading project of RUSAL Krasnoyarsk OJSC.

Installation of alumina point feeders was aimed at:

1. Maintenance of a lower range of alumina concentration in the bath;
2. Reducing pot operation instability;
3. Reducing heat losses;
4. Maintenance of stable pot voltage;
5. Reducing dust pollution (during manual breaking small alumina particles enter the potroom air with hot gases emission);
6. Increasing overall metal production by 1%.

The reduction of pollutant emissions like benz(a)pyrene, tarry matters, HF, dust is achieved due to combined installation of alumina point feeder and dry gas treatment system, which also considerably reduces roof emissions due to increasing in pot cover efficiency.

The efficiency upgrading project for RUSAL Krasnoyarsk OJSC has the following objectives:

1. to increase current output
2. to reduce relining outage
3. to reduce the number of pots with life less that 18 months
4. to obtain additional quantity of metal

Reduction in the frequency of AE is not expected, because the main advantage of this activity will be reduction in perfluorocarbon emissions, which are not regulated by the legislation of the RF. The additional advantages may include:

- saving electric energy,
- reduction in metal losses,
- reduction in emission of pollutants without treatment via potroom roof vents.

Because metal overall production and energy consumption are influenced by many factors, the effect, which is achieved due to reduction in AEF, is impossible to estimate and measure. This is one of the reasons why so far no attempts have been made to reduce the frequency of anode effects in Russian aluminium smelters and even in those production rooms where alumina point feeders were installed (in the rooms with prebaked anodes and alumina point feeders there were all prerequisites).

Increase in emissions due to depressurizing of pots during an anode effect and its killing will be minor, because the duration of anode effects and the percentage of depressurizing are small (at KrAZ for anode effect killing a wooden poles are used, while only a part of the pot side is opened). Therefore, reduction in emission of controlled pollutants will be insignificant, and it will be impossible to measure precisely (within tolerance limits) (see Section F.1.).

Because there are some barriers for implementing the AE reduction measures, apart from the reduction in perfluorocarbon emissions, these activities are excluded from this scenario. Thus this scenario is the most probable and therefore can be considered as the baseline one.

Scenario 3.

This scenario encompasses the same activities as the baseline scenario (Scenario 2), but within the framework of the efficiency upgrading project in addition measures aimed at reduction of the frequency of anode effects are performed in order to reduce perfluorocarbon emissions. As there are no advantages resulting from reduction in perfluorocarbon emissions, but there are different barriers, this scenario without selling emission reduction units (ERU) became unlikely, and it can not be considered as baseline one.

Scenario 2 is chosen as the baseline scenario, and the volume of perfluorocarbon emissions according to it is chosen as the baseline one.

Sub-step 1b. Consistency with mandatory laws and regulations: Implementation of all the 3 scenarios is in compliance with the requirements of the environmental legislation, because their implementation will not lead to excess of the maximal allowable impact on the environment, which could become a barrier preventing the implementation of a certain scenario. Implementation of the 1st scenario is the most preferable from the point of view of compliance with the requirements of the environmental legislation, but is not favorable from the financial point of view. Implementation of the 2nd scenario is based on the smelter modernization plan, approved by the governmental authorities. Implementation of this scenario is the first phase of the gradual reduction in emissions of pollutants into the atmosphere at KrAZ. Because reduction in the frequency of AE generally influences perfluorocarbon emissions, which are not regulated in the Russian Federation, and there is no other strict reinforcement which requires their reduction, implementation of activities to reduce the frequency of AE is not the baseline scenario according to this criterion. In this connection, Scenario 2 is considered as the baseline one.

Step 2. Investment analysis During this phase comparative economic analyses of the current practice and activities within the project frameworks is performed.

Sub-step 2a. Determine appropriate analysis method During this phase it is necessary to determine, which analysis method should be used: direct costs analysis, comparative investment analysis or benchmark analysis (Intermediate phase 2b, Options I, II and III). Option I corresponds to a simple cost analysis, where activities within the project frameworks do not give any financial and economic advantages, apart from profit, related to the JI project, whereas Option II represents comparative analysis of investments, and Option III – the benchmark analysis.

By implementing the activities aimed at reduction in frequency of anode effects, the management of the smelter did not set a target of getting additional profit from the economic effect resulting from reduction in AEF, among which one can mention reduction in electric energy use and metal losses and reduction in atmospheric emissions. The main reason for this is the impossibility to measure the effect, obtained as a result of those measures, what otherwise would have been a convincing argument for the management to carry on AEF reduction measures. An argument in support of this is the installation of point feeders on the prebaked anode technology : after commissioning of the alumina point feeder system in 2000 nobody has been dealing purposefully with the intention of reduction of AEF. The related information can be found in Section A.4.3. of this project. Regardless of the possibility to get profit from energy saving and reduction of metal loss, also having the technical possibility, i.e. the installed alumina point feeder system, the management have not taken any measures aimed at reduction in the frequency of anode effects.

Capital expenditures for the project implementation are shown in Annex 4.

Total JI project expenditures within the frameworks of the efficiency upgrading project of RUSAL Krasnoyarsk OJSC for the period between 2006-2007 were about USD 4,200,000 (at the rate of the Central Bank of Russia). The efficiency upgrading project of RUSAL Krasnoyarsk OJSC is planned to be completed in 2008, and the JI project to be completed in 2015. Nonetheless, the main JI project expenditures were made exactly in 2006 to 2007. As it is expected, in 2008 to 2012 the profit from the JI project sales can amount at assuming a price of € 6 per tonne of CO_{2eq}: 1,162,619 x 6 = € 6,975,714. In case of higher prices the profit will be rising. This condition was one of the determinative factors for making the decision to undertake this work.

Thus, from the financial point of view this project is considered additional.

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed JI project activity: The project is not a part of the baseline scenario; because certain barriers exist that prevent its implementation, which would be impossible or impractical to overcome under standard conditions:

- **Barriers in the form of business strategy**:
  The smelter and the company business activity management strategies do not pay much attention to the AEF reduction measures due to the impossibility to assess their economic benefit. As it is impossible to estimate electric energy saving and increase in metal output activities aimed at AEF reduction as envisaged within the framework of the JI project are not the subject of primary importance to the company management.

- **Barriers in the form of existing practice**
  Activities within the framework of this project are "the first of their kind". Neither in the receiving country nor in the whole region there are projects of this kind being implemented at present. From the point of view of the environmental legislation of the Russian Federation, the greenhouse gases included into the project are not subject to regulation, and no change in the legislation in relation to greenhouse gases emission control are expected. Because reduction in the frequency of anode effects does not lead to significant reduction in pollutants emitted to the atmosphere during anode effects via roof vents without treatment (solid and gaseous fluorides, alumina dust), and the plant complies fully with the environmental norms upon condition of the project implementation, the KrAZ management does not have any motivation to implement additional measures to reduce the frequency of anode effects.

It was worthwhile overcoming the indicated barriers only having a potential possibility to participate in the mechanisms of the Kyoto protocol.

The decision on the project implementation was made, to a greater extent, considering the potential possibility to partly cover the expenses of the project of KrAZ efficiency upgrading.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity): The smelter and the company business activity management strategies do not pay much attention to the AEF reduction measures, therefore, activities aiming at AEF reduction are not the subject of primary importance to the company management. If the management would have paid any attention to AEF reduction, this would had happened on a much earlier stage, for instance, after the installation of alumina point feeders in potrooms with prebaked anode technology. Besides, the installation of alumina point feeders in VSS pots would have not been a determining factor also. For example, the average frequency of anode effects for potroom 10 before installation of alumina point feeders was reduced from 1.33 in 2005 to 0.7 in the middle of 2007. The same reduction by 0.6 was observed in other potrooms where alumina point feeders were installed (such as potroom 14 in 2005 had AEF = 0.96, and in 2007 it was reduced to 0.6 only). It was necessary to provide the management with weighty arguments, so that it would make a decision to reduce AEF. Electric energy saving and reduction in metal loss were not such arguments, because: first, they could not be measured directly, as metal overall production and electric energy consumption related to it are influenced by so many factors that it is simply impossible to see the effect of reduction in the frequency of anode effects; second, because practically nobody in the world is improving the VSS technology, and it is the main technology used in KrAZ, there is no certainty, that the efforts to reduce AEF will not be in vain, and separately only implementing AEF reduction measures in potrooms 7, 8 and 26 with the prebaked anodes technology, was not of interest to anyone. Furthermore, the implementation of AEF reduction measures would require hiring consultants who could organize the process, which is connected with additional costs. On the other hand, there is no urgent need for reduction of greenhouse gases emissions, as no enforcements exist from the side of the government. After coming into force of the Kyoto protocol and after the Russian Federation has made some steps towards creating a mechanism of the JI project implementation, the management started to show interest in this issue, and a decision was made to include AEF reduction measures into the efficiency upgrading project for RUSAL Krasnoyarsk OJSC, where their share is about 18% of the total activity.

Alternative Scenario 1 is not faced anyone of identified barriers as business strategy for new built plants concern of implementation of Prebake technology. It is also a business as usual scenario for most countries in the world. The only barrier for that Scenario is too high capital costs that are irresistible barrier right now.

Alternative Scenario 3 is not realized without JI investments because of identified barriers.

Alternative Scenario 2 is not faced anyone of identified barriers as business strategy of company is for receiving of maximum production of aluminium and relative cost minimization on tone of Aluminium. Therefore the Scenario 2 actions are aimed at reduction technology stabilization and better controllability in conditions of high current strength of cells. Actions for rising of stability of aluminium reduction process and increasing of aluminium production are realized at all UC RUSAL plants and this project of increasing of efficiency considered as pilot project for replication of its experience.

Step 4. Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:

The project is characterized by the unique nature of the enterprise, thus one can say that such project is being implemented for the first time. First, this is the first smelter in the country operating on VSS technology, which has installed the alumina point feeder system on a technological scale; this is why standard readymade solutions for electrolytic reduction maintenance and reducing the frequency of anode effects simply do not exist. Everything had to be made from scratch. Potrooms with the prebaked anodes technology are absolutely outnumbered (3 out of 24), and pots installed in these potrooms are different from those installed in Sayanogorsk Aluminium Smelter (SAZ). Therefore, even having alumina point feeders installed in these potrooms and having possibilities of using this technology in SAZ and also in other plants in Russia and other countries, no efforts have been made to reduce the frequency of anode effects in these potrooms. One of the reasons for this was the development of own specific approach to maintain the electrolyisis process particularly at KrAZ. This means that no measures similar to the ones within the frameworks of this project exist anywhere else.

In the aluminium industry worldwide the measures to reduce perfluorocarbon emissions are undertaken by means of quenching of anode effects. However, the proposed project goes beyond the trends existing in the industry, as it was explained earlier in the description of Phase 3a. Here specific approaches for quenching anode effects are not implemented. Anode effects are quenched as before with wooden poles.

Sub-step 4b. Discuss any similar options that are occurring: No similar variants exist anywhere in the world.

Summary

Thus, sufficient evidence is provided to state that the project is not a part of the baseline scenario and it would not have been implemented as a common practice. Therefore, reductions achieved as a result of the project implementation are additional to what would have been in any other case.

B.3. Description of how the definition of the project boundary is applied to the project:

The project is limited to CF_4 and C_2F_6 emissions produced as a result of anode effects in VSS pots (1878 pots) with the prebaked anodes technology in potrooms 7, 8 and 26 (278 pots).

The project also covers pots newly installed within the frameworks of the smelter modernization project (total 76 pots are added to existing 1878 ones; in potrooms 9 to 23, installation of 4 additional pots was made in each room. In potroom 1 and 4, 8 additional pots in each are installed). Including new pots into the project boundary is explained by the fact that their installation is implied by the baseline scenario, and the implementation of individual measures aimed at reduction of AEF for the new VSS pots separately without considering the existing pots in the corresponding potrooms will be inappropriate and even impossible, because there are groups of pots serviced by a team of pot operators. And otherwise, excluding them from the activities aimed at reducing AEF is also inappropriate for the same reason.

Pots for aluminium refining (74 pots for production of high purity aluminium (HPA)) are not included into the project boundary, as another pot technology is used (the anode and cathode are reversed), and greenhouse gases are not emitted here, because the anode and the cathode are not consumed.

The project boundary does not include activity related to installation of the alumina point feeder system. Reduction in perfluorocarbon emissions is only achieved due to reduction in AEF resulting from operational improvements.

The project does not either contain reduction in indirect emissions due to electric energy saving resulting from reduction in the frequency of AE because of impossibility of measuring the electricity savings.

The project also excludes CO_2 emissions produced as a result of anode consumption, as the project activity is not aimed at reduction of anode paste/anode consumption.

B.4. Further baseline information, including the date of baseline setting and the name(s) of the person(s)/entity(ies) setting the baseline:

Date of baseline installation: August 15, 2007
The baseline was corrected on Ocotober 31, 2007 based on the results of processing perfluorocarbon emissions measurement taken by IAI consultant Jerry Marks.

The baseline was developed by the Kyoto protocol Project Director of the United Company RUSAL, Spirin Alexey Victorovich.

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SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

01 January 2006.

C.2. Expected operational lifetime of the project:

11 years.

C.3. Length of the crediting period:

5 years/ 60 months (Kyoto Protocol first commitment period – from 1st January 2008 to 31st December 2012).

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

Collection of all key parameters required for determining of both project and baseline perfluorocarbon emissions is performed according to the KrAZ existing practice of measurement and recording of technical and economical indicators, environmental impact assessment. Monitoring procedure requires the adding of only one parameter – slope coefficient, so that it can be used for calculating perfluorocarbon emissions according to Tier 3b of 2006 IPCC Guidelines. The slope coefficient, according to recommendations of IAI consultant Jerry Marks, must be verified no less than one time per 3 years. Measurements are to be performed according to the Protocol for measurements of tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) emissions from primary aluminium production[1]. As for the rest data, the project monitoring does not require changes to the existing system of recording and collection of information. All the necessary data is determined and recorded in any case (it would be recorded even in the case of absent of project activity). It is also important to mention the fact that from 2008 at the KrAZ environmental service personnel will be performing annual calculation of perfluorocarbon emissions based on the results of inventory. The inventory will be completed by the end of 2007. The Inventory and the project monitoring are closely interconnected.

The techniques and formulae for the project emissions components assessment are described in the latest version of The Aluminium Sector Greenhouse Gas Protocol, 2006' developed by the IAI. This Protocol is included into the IPCC guidelines for 2006 national GHG inventory, Section 4. The techniques and the formulae are presented below. According to this technique, for the proposed project the Tier 3 method for calculating emissions should be used. This method is based on calculations using the site specific anode effect process data, aluminium production data and coefficients based on direct local facility measurements of PFCs. The measurements on which the coefficients are based should be made according to the PFC Measurement Protocol describing good measurement practices: Protocol for measurements of tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) emissions from primary aluminium production (US EPA and IAI, May 2003). The first measurements were performed in September 2007 for Vertical stud Søderberg technology potrooms (VSS) without alumina point feeders, for VSS with alumina point feeders and for prebaked anodes (PB) with alumina point feeders. Such measurements will be performed periodically every three years, selectively for different potrooms, excluding potrooms without alumina point feeders, as from 2008 all pots will be equipped with alumina point feeders.

According to 2006 IPCC guidelines perfluorocarbon emissions may be calculated by either:

1. The "slope" method – Calculation of emission rate of for CF_4 and C_2F_6 per tonne aluminium using anode effects minutes per pot-day (slope coefficient).
2. The "overvoltage" method - Calculation of emission rate of CF_4 and C_2F_6 per tonne of aluminium using anode effect overvoltage.

The overvoltage method is used for Alcan Pechiney pots and can not be used for baseline and project baseline calculations, because measurements of anode effect overvoltage at KrAZ is different from that accepted for the Pechine technology. Therefore, the "Slope" method is used for perfluorocarbon emission calculations.

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[1] Protocol for Measurement of Tetrafluoromethane (CF_4) and Hexafluoroethane (C_2F_6) Emissions from Primary Aluminum Production, US EPA and IAI, May 2003.

Slope coefficient: the slope coefficient is the kg of CF_4 per metric tonne of aluminium produced, divided by anode effect minutes per pot-day[2]. Since perfluorocarbon emissions are measured per tonne of aluminium produced, the slope coefficient includes the effects of pot amperage and current efficiency – the two main factors determining the amount of aluminium produced in the pot.

Anode effect minutes per pot-day is the parameter which represents the emission rate of aluminium production process.

Perfluorocarbon emission calculations should be performed separately for each technology type, and can be made for groups of potrooms of one technology, potline or potroom, as well as for a part of a potroom if installed pots of one technology represent only a part of the all pots. One technology type refers to:

- VSS - Søderberg pots with vertical studs without alumina point feeders
- PFVSS – Søderberg pots with vertical studs with alumina point feeders
- PFPB – Pots with prebaked anodes with alumina point feeders

CF_4 and C_2F_6 emission rates should be calculated following the formulae below:

$$R_{CF_4} = AEM \times S_{CF_4}$$ Formula (1)

$$R_{C_2F_6} = R_{CF_4} \times F_{C_2F_6/CF_4}$$ Formula (2)

$$AEM = AEF \times AED$$ Formula (3)

where

R_{CF_4}	CF_4 emission rates, kg of CF_4 per tonne of aluminium
AEM	Minutes of anode effect per pot-day
AEF	Average frequency of anode effect
AED	Average duration of anode effect
S_{CH_4}	Slope coefficient for CF_4, kg of CF_4 per tonne of aluminium multiplied by the number of minutes of anode effect per pot-day
$F_{C_2F_6/CF_4}$	Weight fraction C_2F_6/CF_4

Total volume of perfluorocarbon emissions should be calculated using formulae 4 and 5. Emission rate of each gaseous perfluorocarbon per tonne of primary aluminium produced is multiplied by the quantity of aluminium produced employing this particular pot technology, which gives the total volume of perfluorocarbon emissions for this particular technology. Calculations can also be performed for groups of potrooms using one technology, potline or potroom,

[2] The term ‘pot-day’ refers to the number of pots operating multiplied by the number of days of operation

and also for a part of a potroom if installed pots of one technology represent only a part of all pots. Total volume of perfluorocarbon emissions is calculated by means of adding up emissions from all potrooms/potlines operating at the smelter.

$$E_{CF_4} = MP \times R_{CF_4} \quad \text{Formula (4)}$$

$$E_{C_2F_6} = MP \times R_{C_2F_6} \quad \text{Formula (5)}$$

where:

E_{CF_4}	Tetrafluoromethane emissions, kg of CF_4 per year
$E_{C_2F_6}$	Hexafluoroethane emissions, kg of C_2F_6 per year
R_{CF_4} and $R_{C_2F_6}$	CF_4 and C_2F_6 emission rates, kg per tonne of aluminium produced
MP	Metal overall production, tonnes of aluminium per year

Perfluorocarbon emissions in tonnes of CO_2 equivalent are calculated by means of product of emission volumes of each perfluorocarbon and corresponding global warming potential (GWP). GWP is the IPCC default value.

$$E_{CO_{2э}} = \left(\frac{E_{CF_4} \cdot GWP_{CF_4} + E_{C_2F_6} \cdot GWP_{C_2F6}}{1000} \right) \quad \text{Formula (6)}$$

where:

$E_{CO_{2э}}$	CO_2 equivalent emissions in tonnes per year
E_{CF_4}	Tetrafluoromethane emissions, kg of CF_4 per year
$E_{C_2F_6}$	Hexafluoroethane emissions, kg of C_2F_6 per year
GWP_{CF_4}	Global warming potential of CF_4 = 6 500
GWP_{C_2F6}	Global warming potential of C_2F_6 = 9 200

Inserting formulae 1, 2, 3, 4, 5 into formula 6:

$$E_{CO_{2\ni}} = MP \times AEF \times AED \times S_{CF_4} \times \left(\frac{6500 + F_{C_2F_6/CF_4} \times 9200}{1000} \right)$$ Formula (7)

where:

MP	Metal overall production, tonnes of aluminium per year
AEF	Average frequency of anode effect
AED	Average duration of anode effect
S_{CF_4}	Slope coefficient for CF_4, kg of CF_4 per tonne of aluminium multiplied by the number of minutes of anode effect per pot-day
$F_{C_2F_6/CF_4}$	Weight fraction of C_2F_6/CF_4
6,500	Global warming potential of CF_4
9,200	Global warming potential of C_2F_6

Before the final results of perfluorocarbon emission measurements at the smelter are obtained and perfluorocarbon emission rates are calculated, one should refer to default emission ratios set out in IPCC, 2006 Tier 2. In such case the emission calculations are then the preliminary estimations

Table D.1.0 Technology specific slope coefficients for the calculation of perfluorocarbon emissions (Tier 2) per tonne aluminium from anode effect process data

Technology	**Slope coefficient** [(a, b,c)] **[(perfluorocarbon in kg /tonne of Al) / (Anode effect Minutes / pot per day)]**		**Weight fraction C2F6 / CF4**	
	S_{CF4}	**Uncertainty (±%)**	$F_{C2F6/CF4}$	**Uncertainty (±%)**
Centre worked prebake (CWPB) pots	0.143	6	0.121	11
Vertical stud Søderberg pots(VSS)	0.092	17	0.053	15

a.Source: Measurements reported to IAI, US EPA sponsored measurements and multiple site measurements

b. Embedded in each Slope coefficient is an assumed emissions collection efficiency as follows:: centre worked prebake pots = 98%, vertical stud Søderberg pots = 85%. These collection efficiencies have been assumed based on measured PFC collection fractions, measured fluoride collection efficiencies and expert opinion

c. According to the results of perfluorocarbon emission measurements performed at KrAZ and calculations of slope coefficients (Tier 3), uncertainty for these coefficients is ±12%.

D.1.1. Option 1 – Monitoring of the emissions in the project scenario and the baseline scenario:

D.1.1.1. Data to be collected in order to monitor emissions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
D.1.1.1.1.	*Overall production of electrolytic aluminium (MP)*	*Smelter, Electrolysis department*	*Tonne*	*m*	*monthly*	*100%*	*On paper*	
D.1.1.1.2.	*Average frequency of*	*Smelter,*	*pieces/ pot-day*	*m*	*constantly*	*100%*	*On paper and*	

	anode effects, (AEFp)	*Electrolysis department*					*electronically (Process computer control workstation ARM SMITH, Elvis)*	
D.1.1. 1.3.	*Average duration of anode effects, (AEDp)*	*Smelter, Electrolysis department*	*minutes*	*m*	*constantly*	*100%*	*On paper and electronically (Process computer control workstation ARM SMITH, Elvis)*	
D.1.1. 1.4.	*Slope coefficient for CF_4 (S_{CF_4})*	*VAMI*	*(kg of perfluorocarbon/ tonne of aluminium)/ (number of minutes of anode effect/ pot per day)*	*m*	*Once in three years, or once changing pot type/ considerable change in technology*	*No less than 15 anode effects per each reduction technology type (VSS, PFPB)*	*Report on measurements*	*For more detailed information on frequency of measurements and taking new measurements, see the Protocol for Measurement of Tetrafluoromethane (CF_4) and Hexafluoroethane (C_2F_6) Emissions from Primary Aluminium Production, US EPA and IAI, May 2003.*
D.1.1. 1.5.	*Weight fraction of C_2F_6/CF_4*	*VAMI*	*Unit fraction*	*m*				

D.1.1.2. Description of formulae used to estimate project emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

Project perfluorocarbon emissions calculation is performed following the formula 8:

$$Ep_{CO_{2E}} = MP \times AEFp \times AEDp \times S_{CF_4} \times \left(\frac{6500 + F_{C_2F_6/CF_4} \times 9200}{1000} \right) \qquad \text{Formula (8)}$$

where:

MP	Metal overall production, tonnes of aluminium per year
AEFp	Estimate average frequency of anode effects for the chosen project scenario
AEDp	Estimate average duration of anode effects for the chosen project scenario
S_{CF_4}	Slope coefficient for CF_4, kg of CF_4 per tonne of aluminium multiplied by the number of minutes of anode effect / pot per day
$F_{C_2F_6/CF_4}$	Weight fraction of C_2F_6/CF_4
6,500	Global warming potential for CF_4
9,200	Global warming potential for C_2F_6

In order to estimate project perfluorocarbon emissions, the smelter has been provided with a sound estimate (forecast) of AEF and AED values expected in future. This forecast made by the smelter's process engineers and experts from Russian Engineering Company (part of UC RUSAL) (see Annex 6 and Table F.1.1.T). The future overall aluminium output is determined in UC RUSAL document "Target values of aluminium smelters until 2017 and forecast of aluminium prime cost trends." Aluminium output will be determined annually upon the fact. Estimate project emissions are calculated by using the values obtained during monitoring of the parameters presented in the Section D.1.1.1 and applying the Formula (8).

Since 2008, specific coefficients for VSS with alumina point feeders and PFPB technologies are to be used as the slope factors for CF_4 (S_{CF_4}) and weight fraction of C_2F_6/CF_4 ($F_{C_2F_6/CF_4}$). These specific coefficients should be obtained as a result of perfluorocarbon emission measurements.
In order to calculate actual emissions for 2006 to 2007, coefficients for VSS technology without alumina point feeders are also used, taking into account the dates of actual commissioning of alumina point feeders in particular potrooms.

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
D.1.1.3.1.	*Overall production of electrolytic aluminium (MP)*	*Smelter, Electrolysis department*	*Tonne*	*m*	*monthly*	*100%*	*On paper*	
D.1.1. 3.2.	*Average frequency of anode effects, (AEFb)*	*Smelter, Electrolysis department*	*pieces/ pot per day*	*m*	*constantly*	*100%*	*On paper and electronically (Process computer control workstation ARM SMITH, Elvis)*	
D.1.1. 3.3.	*Average duration of anode effects, (AEDb)*	*Smelter, Electrolysis department*	*minutes*	*m*	*constantly*	*100%*	*On paper and electronically (Process computer control workstation ARM SMITH, Elvis)*	
D.1.1. 3.4.	*Slope coefficientr for* CF_4 *(* S_{CF_4} *)*	*VAMI*	*(kg of perfluorocarbon/ tonne of aluminium)/ (number of minutes of anode effect/ pot per day)*	*m*	*Once in three years, or once changing pot type/ considerable change in*	*No less than 15 anode effects per each reduction technology type (VSS, PFPB)*	*Report on measurements*	*For more detailed information on frequency of measurements and taking new measurements, see the Protocol for Measurement of Tetrafluoromethane (*CF_4*) and Hexafluoroethane*

D.1.1.3.5.	*Weight fraction C_2F_6/CF_4*		*Unit fraction*		*technology*			*(C_2F_6) Emissions from Primary Aluminium Production, US EPA and IAI, May 2003.*

D.1.1.4. Description of formulae used to estimate baseline emissions (for each gas, source etc.; emissions in units of CO_2 equivalent):

Baseline perfluorocarbon emissions are calculated following the formula 9:

$$Eb_{CO_{2E}} = MP \times AEFb \times AEDb \times S_{CF_4} \times \left(\frac{6500 + F_{C_2F_6/CF_4} \times 9200}{1000} \right) \qquad \text{Formula (9)}$$

where:

MP	Metal overall production, tonnes of aluminium per year
AEFb	Estimate average frequency of anode effects for the chosen project scenario
AEDb	Estimate average duration of anode effects for the chosen project scenario
S_{CF_4}	Slope coefficient for CF_4, kg of CF_4 per tonne of aluminium times the number of minutes of anode effect / pot per day
$F_{C_2F_6/CF_4}$	Weight fraction of C_2F_6/CF_4
6500	Global warming potential for CF_4
9200	Global warming potential for C_2F_6

For estimation of perfluorocarbon emissions in the absence of the project activity (baseline scenario), the smelter has been provided with a sound estimate of AEF and AED values, that would have been in the case of absence of the project (see Annex 2). The future aluminium (output) is determined in UC RUSAL document "Target values of aluminium smelters until 2017 and forecast of aluminium prime cost trends". Aluminium output will be determined annually upon the fact. Estimate baseline emission are calculated by using the values obtained during monitoring of the parameters presented in the Section D.1.1.3 and applying Formula (9).

Since 2008 specific coefficients for VSS with alumina point feeders and PFPB technologies are to be used as the slope factors for CF_4 (S_{CF_4}) and weight fraction of C_2F_6/CF_4 ($F_{C_2F_6/CF_4}$). These specific coefficients should be obtained as a result of perfluorocarbon emission measurements.

In order to calculate actual emission for 2006 to 2007, coefficients for VSS technology without alumina point feeders are also used, taking into account the dates of actual commissioning of alumina point feeders in particular potrooms.

D. 1.2. Option 2 – Direct monitoring of emission reductions from the project (values should be consistent with those in section E):

D.1.2.1. Data to be collected in order to monitor emission reductions from the project, and how these data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Direct monitoring of emission reduction from the project is not foreseen.

D.1.2.2. Description of formulae used to calculate emission reductions from the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

To calculate emission reduction from the project, the project perfluorocarbon emissions are simply subtracted from baseline perfluorocarbon emissions following the Formula 10.

$$R_{CO_{2E}} = Eb_{CO_{2E}} - Ep_{CO_{2E}}$$ Formula (10)

where,

$R_{CO_{2Э}}$ – Emission reduction, tonnes of CO_{2E}

$Eb_{CO_{2Э}}$ – Baseline emissions, tonnes of CO_{2E}

$Ep_{CO_{2Э}}$ – Project emissions, tonnes of CO_{2E}

D.1.3. Treatment of leakage in the monitoring plan:

D.1.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

There are no leakages in this project because the activities within the project frameworks (operational improvements and reduction in the frequency of anode effects) do not lead to increase in greenhouse gases emissions or cause appearance of new sources of greenhouse gases emissions outside the project boundaries.

D.1.3.2. Description of formulae used to estimate leakage (for each gas, source etc.; emissions in units of CO_2 equivalent):

There are no leakages in this project.

D.1.4. Description of formulae used to estimate emission reductions for the project (for each gas, source etc.; emissions/emission reductions in units of CO_2 equivalent):

As there are no any leakages in this project, the formula from Section D.1.2.2. is used for calculation of emission reduction.

D.1.5. Where applicable, in accordance with procedures as required by the host Party, information on the collection and archiving of information on the environmental impacts of the project:

Calculation of atmospheric emissions of pollutants is carried out by specialists from the environmental department according to “Techniques for determining volumes of harmful substances (pollutants) released to the atmospheric air from electrolytic production of aluminium” approved by the order No 182, dated March 31, 2005, of the Federal Service for Ecological, Technological and Atomic Inspection.

The following data is used to calculate emissions of pollutants into the atmospheric air:

- data from technical reports: for each type of process (anodic, electrolytic);
- results of inspection of sanitary and ecological standards (gas treatment units operation, and pot sealing data);
- data on quality characteristics of raw materials used in production.

Collection of data from different departments for environmental impact estimation is performed according to the “Regulations for organization of environmental reporting of the enterprise”, put into effect by order No 809 dated December 19, 2006. These regulations determine requirements for the type of information, submitted by different departments, terms of information submission and people responsible for the submission of information.

Implementation of the issues of the Regulations for each particular type of information is controlled with Automatic Control System for Operating Documentation.

Measurements of technological parameters for technical reporting for every technological process are performed employing the measuring tools, verified (calibrated) according to the requirements of the “Regulations for calibration/checking of measuring tools”.

The personnel responsible for technological parameters measurements is trained according to the periodical procedure, set out by the enterprise standard STP 2.01-2004 “Professional training of workers”. This personnel is certified and allowed to work without assistance

The personnel responsible for calibration of measuring tools is periodically certified according to the requirements of standard STP 04.06-2000 “Measurement assurance. Measuring tools calibration specialists” certification procedure’.

The data on quality of raw materials used in production is submitted by the technical control department specialists based on the results of laboratory tests conducted in the central smelter laboratory accredited within the accreditation system of control laboratories of the Federal Agency for Technique Regulation and Metrology.

The list of approved techniques for determining raw materials quality characteristics

No	Name of material	Determined component	Regulatory document for analysis method	Measurement range, $\%_{mass.}$	Analysis accuracy, $\%_{abs}$
1	Fluoride aluminium (AlF_3)	F	GOST 19181-78 “Technical aluminium fluoride. Technical conditions” i.4.4	From 10 to 65 incl.	1.30
2	Fluoride aluminium (AlF_3)	SO_4	GOST 19181-78 “Technical aluminium fluoride. Technical conditions” i.4.11	From 0.1 to 0.7 incl.	0.09
3	Calcium fluoride (CaF_2)	CaF_2	GOST 7619.3-81 “Fluorspar. Calcium fluoride estimation method”	From 70 to 90 incl. Over 90	0.95 1.14
4	Calcium fluoride (CaF_2)	S	GOST 7619.7-81 “Fluorspar. Sulfur (total) estimation method”	From 0.1 to 0.3 incl.	0.038
5	Coke	S	GOST 8606-93 “Solid mineral fuel. Total sulfur content estimation. Eshk method”	from 0.5 to 5.0	0.043

The results of control of sanitary and ecological standards (data on gas treatment units operation and pot sealing data) is submitted by the specialists of the sanitary industrial laboratory. This laboratory complies with the requirements of the accreditation system for control laboratories (centres), as well as complies with the

GOST R ISO/MEK 17025 requirements. The sanitary industrial laboratory is accredited for technical competency and registered in the State register under No ROCC ru.0001.510517.

Every year the sanitary industrial laboratory is the object of supervisory examination provided by the accreditation body. Sanitary industrial laboratory should prove its competency in the declared field of activity during this examination.

All measuring tools are included in the “list of measuring tools subject to control”, and are inspected according to the approved schedule.

For the whole field of activity the measurement techniques, listed in the State register can be applied.

Measurement methods:

DOCUMENT INDEX	NAME OF DOCUMENT
MVI No PrV 2000/3	Method for measurement of mass concentration of solid fluorides in industrial emissions.
MVI No PrV 2000/4	Method for measurement of mass concentration of dust in industrial emissions from organized exhaust.
MVI No PrV 2000/5	Method of measurement of mass concentration of sulfur dioxide in emissions of organized exhaust of aluminium smelters production facilities.
MVI No PrV 2000/7	Method of measurement of mass concentration of HF in emissions from organized exhaust from aluminium smelters.
MR No SPEK P-01-2003	Guidelines for estimation of mass concentration of dust, tarry substances, benz(a)pyrene and solid fluorides from one gas sample from organized emissions.
GOST R 50820-95	Method for estimation of particulate level of gas-dust flows.

Both records containing data for calculating pollutant emissions to the atmosphere and final reports are stored according to the requirements of the Aluminium Division standard ST AD 09.4.2.4 “Record management”. These documents are stored in the environmental department during the period of 5 years.

Documentation management at the enterprise (recording, storing, issuing of control copies, revision and cancellation) is performed according to the requirements of the cross organizational instruction I 10.22-2006 “Documentation management”.

In order to verify compliance with the existing procedures in the smelter concerning registering, collecting and storage of information on environmental impacts; equipment calibration/check-up procedures, personnel training procedures periodical internal audits are provided. These audits are organized according to the requirements of the cross organizational instruction I 10.47-2007 and called "Internal audit of quality systems and ecology". The audits cover activities of all departments in the frameworks of environmental management.

D.2. Quality control (QC) and quality assurance (QA) procedures undertaken for data monitored:		
Data (Indicate table and ID number)	Uncertainty level of data (high/medium/low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
Overall production of electrolytic aluminium per year by potrooms, tonnes. D.1.1.1.1., D.1.1.3.1.	low	Overall production of electrolytic aluminium per year by potrooms is calculated by means of adding up the metal weight, which is determined by weighting of ladles with metal taken from potrooms, and determining the weight of liquid aluminium in potrooms as metal in progress. 1. Weighting of ladles is performed applying the scales "Scalex-1000" by the quality control department personnel according to the "Areal-type scales "Scalex-1000" User's Manual. The scales are included into the "List of measuring tools subject to control", and annually checked according to "Measuring tools check-up schedule" by the specialists of the Federal State Facility "Krasnoyarskiy TsSM" with issuing calibration certificates. Permissible maximum accuracy is ±20 kg within the range of 5,000 to 20,000 kg. (GOST 8.453-82 Scales for statistical weighting. Methods and means of verification.) Records of weighting of ladles with metal are kept on an electronic medium in "Weighting workstation" during the period of no less than 5 years. 2. Quantity of liquid aluminium in pots is determined quarterly with the "Techniques for determining liquid aluminium in pots" according to instruction I 10.03-02 "Techniques for inventory accounting of raw materials, materials, metal in progress in potrooms". The method of determining is as follows: Quantity of liquid metal in the potroom is determined by multiplying the average level (height) of metal in the potroom by average weight of one centimeter of metal and by the number of operating pots. The level of metal is measured with a gage according to I 8-21-2001 "Measurement procedures on vertical stud pots". Average weight of one centimeter of liquid metal is determined not less than once per year with the help of

		indicator metal by the following method. The method is based on determining the difference between the weight fraction of copper in aluminium which is measured at different but certain periods of time, change of level of metal in the pot and further calculation using a formula. Measurements are taken for 10% of pots. During analysis of metal, conditions provided in the normative documents for measuring tools are observed. Records of quantity of aluminium in the pots are documented by "Act for determining metal in progress in pots of RUSAL Krasnoyarsk OJSC" and stored for at least 5 years. Based on all above mentioned, one can assume that the degree of uncertainty of data is composed of the scales accuracy 0.1% (assuming that the ladle with metal weighs 10 tonnes) and no less than 10% of metal in progress, based on the fact that measurements are taken on 10% of pots taking into account the accuracy of the used measuring tools and indirect measurement. But because the quantity of metal in progress is less than 1% of the annual production of electrolytic aluminium, the total accuracy for this indicator will be no more than 0.1%.
Average frequency of anode effects by potrooms per year, times/pot-day, D.1.1.1.2., D.1.1.3.2. Average duration of anode effects, minutes D.1.1.1.3., D.1.1.3.3.	low	Average anode effect frequency by potrooms per year, times/pot per day and anode effect duration by potrooms per year, min/ pot per day is measured by the aluminum electrolysis process automatic control system (ACS) SAAT-1. The responsibilities and work sequence of ACS operator is outlined in "SAAT-1 Operator's Manual". The process computer control SAAT-1 has a hierarchical two-level structure. The upper level is based on SUN server station (host computer). To provide the maintenance and process personnel with information, the server station is connected via Ethernet 10Base-T to the control station operator workstation, to chief foremen workstations and to workstations of foremen of the anode facility. The data concentrator provides the data exchange between the host computer and the controllers of the control boxes of pots (lower level controllers). Both the data concentrator and the operator workstation are located in the control station of the potroom. Operation of the pot control system is based on the principle of generation (elaboration) of control actions on the actuating mechanisms of pots by means of mathematical processing of information on the reduction process (electrolysis process), logical processing of signals about control positioning and actuating mechanisms condition. One of the functions of the process control system is to control anode effects on the voltage measure channel on the ANODE AND CATHODE (Ua-k) section. During the 5 minute averaging interval, voltage gain is estimated, and in case this voltage gain value exceeds the threshold value, for instance, +8 mV, in 5 minute time a possible anode effect is announced. At that, automatic downward movement of anode is prohibited. When voltage gain is reduced to +6 mV, the sign of a possible anode effect is cancelled. The

		channel's basic accuracy is ±0.2 %. The measuring channel is calibrated regularly according to the "GUIDELINES FOR THE MEASURING SYSTEM PROCESS CONTROL SYSTEM FOR ELECTROLYTIC REDUCTION OF ALUMINIUM CALIBRATION PROCEDURE". Calibration is performed by specialists of a contracted organization according to the Regulations for "check-up/calibration of measuring tools." Records of the frequency and duration of anode effects are kept on electronic medium in ARM SMIT workstation for the period of not less than 5 years. Based on the data accumulated during the process automatic control system operation, the percentage of lost information on frequency and duration of AE due to process automatic control system failure is approximately equal to 2%, therefore the degree of uncertainty is low, and it is composed of the channel accuracy and availability of the process control system.
Slope factor for CF_4 (kg of perfluorocarbon / tonne of aluminium (number of minutes of AE / pot per day) D.1.1.1.4., D.1.1.3.4. Weight fraction C_2F_6/CF_4 (Unit fractions) D.1.1.1.5., D.1.1.3.5.	high	According to the data collected by mr. Jerry Marks (IAI consultant), presented in the report on perfluorocarbon emission measurements, the main sources of uncertainty during continuous measuring are: - spectrometer calibration uncertainty, - the effectiveness of the analytical method in calculating the CF_4 and C_2F_6 concentrations from the measured spectrum, - the measurement of the flow rate of exhaust gases in the collection ducts. Another source of uncertainty in the Krasnoyarsk VSS measurements is the estimation of exhaust gas collection fraction and the short term variability of the collection fraction during anode effects. The table below summarizes sources of uncertainty in the PFC measurement and estimates the magnitudes of each uncertainty source. Using IPCC Tier I guidelines (see *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,* Section 6.3.2*,* *http://www.ipcc-nggip.iges.or.jp/public/gp/pdf/6_Uncertainty.pdf)* for estimating uncertainty, the overall combined uncertainty from all sources is expected to give a result that is ± 12% of the actual value. The calculation methodology is based on the combined variances of all the major sources of uncertainty and is calculated as the square root of the sum of the squares of the individual uncertainties. **Summary table of sources and values of uncertainty** **Uncertainty Source** — **Estimated Uncertainty**

		Spectrometer calibration < ± 2% Calculations performed with spectrometer < ± 10% Exhaust Stack Flow Measurement < ± 5% Collection Fraction Uncertainty < ± 5% ***Overall combined Uncertainty < ± 12%*** Thus, Uncertainty of slope coefficients is ±12%.

Note: High/medium/low* uncertainty *is defined as follows: low <±5%, medium from ±5% to ± 10%, high >±10%, respectively

Within the frameworks of JI project for calculation of baseline project emissions, project participants accepted do not consider measurement inaccuracies:

- First, uncertainty of measurement of overall aluminium production, the frequency and duration of anode effects is insignificant, and during calculation of slope coefficients, a conservative method was already applied - namely median value determination. Should maximum uncertainty of ±12% for slope coefficients be considered and in case the lowest limit of uncertainty for slope coefficient for baseline emissions calculation, and the upper limit of the slope coefficient for the project emissions calculation are chosen, then about 24% of perfluorocarbon emissions are not taken into account, which varies greatly from reality.
- Second. Should the lowest limit of uncertainty for the slope coefficient for baseline emission calculation and the upper limit of slope coefficient for the project emission calculation be applied, then at the yearly or even at some later stage of the project the paradox might occur, when the project emissions are greater than the baseline emissions, despite the presence of all other obvious improvements (reduction in frequency and duration of anode effects), which is unacceptable. Should the lowest limit of uncertainty for slope coefficients for both baseline and project emissions calculation be applied, the project emissions are reduced, that does not reflect the real situation.

To avoid calculation collisions and inadequate reflection of the reality, project participants decided do not take into account the inaccuracies of the values used for baseline and project line calculations.

Relevant data necessary for calculation the PFC's emissions from the project will be kept not less than 2 years after the end of the credit period of Kyoto protocol (2012).

D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

Gathering of information necessary to perform calculations of greenhouse gases emission reduction from the project is carried out as it is usually done at the smelter, because monitoring does not require any other additional information to that already being collected and summarized, apart from periodical measurements of perfluorocarbon emissions, which will be carried out by the personnel of RUSAL VAMI.

Initial data to be provided by the environmental department and electrolytic production Directorate of RUSAL Krasnoyarsk OJSC.

Calculations of emission reductions at the end of each year of crediting period will be performed by Project Director "Kyoto protocol" UC RUSAL Spirin Alexey Victorovich, or by a specially appointed and instructed person of RUSAL Krasnoyarsk OJSC.

D.4. Name of person(s)/entity(ies) establishing the monitoring plan:

The monitoring plan was developed by "Kyoto protocol" Project Director UC RUSAL Spirin Alexey Victorovich. Contact information is provided in Annex A.

SECTION E. Estimation of greenhouse gas emission reductions

E.1. Estimated project emissions:

Estimated project emissions for the periods of 2006-2007 and 2008-2012 are presented in the table below.

Year	Project emissions, tonnes CO_{2E}
2006	522,668
2007	383,113
Total:	**905,781**
2008	345,007
2009	315,441
2010	279,507
2011	223,136
2012	207,387
Total:	**1,370,478**

For detailed calculations, please see Annex 6.

E.2. Estimated leakage:

There are no leakages in this project.

E.3. The sum of E.1. and E.2.:

The total project emissions for the period of 2006-2007 are **905,781 tCO_{2e}**
The total project emissions for the period of 2008-20012 are **1,370,478 tCO_{2e}**

E.4. Estimated baseline emissions:

Estimated baseline emissions for the periods of 2006-2007 and 2008-2012 are presented below.

Year	Baseline emissions, tonnes CO_{2E}
2006	644,738
2007	563,520
Total:	**1,208,258**
2008	534,397
2009	522,886
2010	510,452
2011	490,081
2012	477,778
Total:	**2,535,594**

E.5. Difference between E.4. and E.3. representing the emission reductions of the project:

This table below shows the difference between baseline and project emissions in tonnes of CO_2 equivalent.

Year	Emission reductions, tonnes CO_{2E}
2006	122,070
2007	180,407
Total:	**302,477**

2008	189,390
2009	207,445
2010	230,945
2011	266,945
2012	270,391
Total:	**1,165,116**

E.6. Table providing values obtained when applying formulae above:

The data used for baseline emission calculations is shown in Table A.2.11.T. of Annex 2.

The tables with data used for project emission calculations are shown in Annex 6.

SECTION F. Environnemental impacts

F.1. Documentation on the analysis of the environmental impacts of the project, including transboundary impacts, in accordance with procedures as determined by the host Party:

The changes implemented to the operational component of the production process do not fall within the "Provisions for the environmental impact assessment (EIA) from planned business and other activity in the Russian Federation" approved by order No 372, dated May 16, 2000, of the National Environment Protection Committee of the Russian Federation. Thus, within the frameworks of the project objectives internal environmental impact assessment was carried out. The main objective of the project is voluntary reduction of perfluorocarbon emissions from potrooms due to anode effect frequency reduction, which means that this project can not damage the environment, and on the contrary, it helps to reduce emissions of pollutants related to the process of electrolytic reduction.

To eliminate anode effects in current conditions of aluminium production technology, it is necessary to introduce a wooden pole to break the crust on the anode-bath border and add a portion of alumina to the bath melt. In connection with this, breaking of about one third of the bath crust is a necessary procedure. Thus, direct perfluorocarbon emission during the anode effect is accompanied by an additional release of pot gases, such as solid and gaseous fluorides, carbon oxide and carbon dioxide, sulfur dioxide, non-organic dust, etc. This means that reduction of anode effect frequency suggests the absence of a negative environmental impact.

Nonetheless, pollutant emissions reduction, as the main component of the project, is not the major factor for the implementing activities aimed at reduction in the frequency of anode effects. VAMI specialists made calculations of the AEF reduction impact on the atmospheric emissions of other harmful substances. According to these calculations, reduction in roof emissions is about one percent, which can be estimated within the accuracy limits of the pollutant emission calculation techniques.

Reduction in roof emissions of pollutants (%) for the project scenario

Calculation of gas recovery efficiency by the gas collector was performed on the basis of stop-watch reading data for condition of the pots in potroom No 13 (Report upon agreement No 059-06-PA "Development of techniques for reduction of emissions via potrooms roof vents and roof exhaust efficiency upgrading", RUSAL VAMI, 2006). Only frequency and duration of anode effects in VSS pots varied. Thus, the tables below describe the effect from AEF reduction only, without considering activities of the 2nd phase of modernization of RUSAL Krasnoyarsk OJSC.

Table F.1.1.T Efficiency of cover of VSS pots

Year	Action	AEF Søderberg, times/day (τ)	Duration of AE, minutes (t)	Duration of AE, minutes/day ($\tau \times t$)	Efficiency of cover, %	
					Anode gases	Fluorides
2006	Baseline	0.84	2.40	2.02	95.8824	90.2125
	Project	0.78	2.47	1.93	95.8836	90.2163
2007	Baseline	0.80	2.45	1.96	95.8831	90.2149
	Project	0.54	2.80	1.51	95.8887	90.2339
2008	Baseline	0.76	2.50	1.90	95.8839	90.2174
	Project	0.52	2.82	1.47	95.8893	90.2358
2009	Baseline	0.73	2.55	1.86	95.8844	90.2191
	Project	0.48	2.86	1.37	95.8905	90.2398
2010	Baseline	0.69	2.61	1.80	95.8851	90.2216
	Project	0.4	2.94	1.18	95.8929	90.2481
2011	Baseline	0.65	2.66	1.73	95.8860	90.2247
	Project	0.32	3.00	0.96	95.8956	90.2573
2012	Baseline	0.62	2.71	1.68	95.8866	90.2267
	Project	0.28	3.10	0.87	95.8968	90.2611

Substance	Dynamics of reduction in pollutants emissions from roof vents , %						
	2006	2007	2008	2009	2010	2011	2012
HF	0.0317	0.1586	0.1536	0.1731	0.2214	0.2725	0.2879
F solid	0.0340	0.1705	0.1650	0.1860	0.2379	0.2929	0.3094
SO_2	0.0233	0.1165	0.1128	0.1272	0.1626	0.2001	0.2114
CO	0.0248	0.1244	0.1204	0.1358	0.1736	0.2137	0.2258
Benz(a)pyrene	0.0045	0.0224	0.0217	0.0245	0.0313	0.0385	0.0407
Tarry substances	0.0045	0.0224	0.0217	0.0245	0.0313	0.0385	0.0407
Non-organic dust: up to 20% SiO_2	0.0511	0.2564	0.2483	0.2799	0.3580	0.4407	0.4656

The above mentioned data are estimate values, which will be clarified upon the actual data, but no significant deviations from the above mentioned values are expected.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to supporting documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

The project participants do not expect any negative environmental impact resulting from implementation of activities within the frameworks of this project, and the Russian governmental bodies do not require any surveys regarding environmental impact of the project.

SECTION G. Stakeholders' comments

G.1. Information on stakeholders' comments on the project, as appropriate:

No comments have been received so far.

Annex 1

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Annex 2

BASELINE INFORMATION

Table D.1.1.3. specifies 5 parameters required for baseline calculation.

Anode effect duration (AED)

Duration of AE cannot be a constant and it depends on how quickly AE is terminated. AE is terminated manually by means of wooden poles at all potrooms of Krasnoyarsk Aluminium Smelter. With the decrease of the anode effect frequency (AEF), its duration is increasing. It is accounted for by the fact that with the decrease of AEF, the crust becomes harder, and it takes more time to make a hole in it to terminate AE. Besides, in the total number of AE, the share of AE occurring during scheduled pot treatments is increasing. This operation can result in AE with duration up to 5 minutes. Hence, one may not consider this parameter to be a constant, and it is also necessary to define how it is going to augment.

A linear historical data trend has been used separately for PFPB and VSS technologies to assess average annual AED values. See the table and schedules with historical data and plotted linear trends provided below.

Table A.2.1.T. Historical data on AED by VSS and PFPB technologies

Year	VSS, AED, minutes	PFPB, AED, minutes
2000	1.81	1.85
2001	1.78	1.90
2002	1.82	1.90
2003	1.92	1.91
2004	1.98	1.96
2005	2.05	2.01

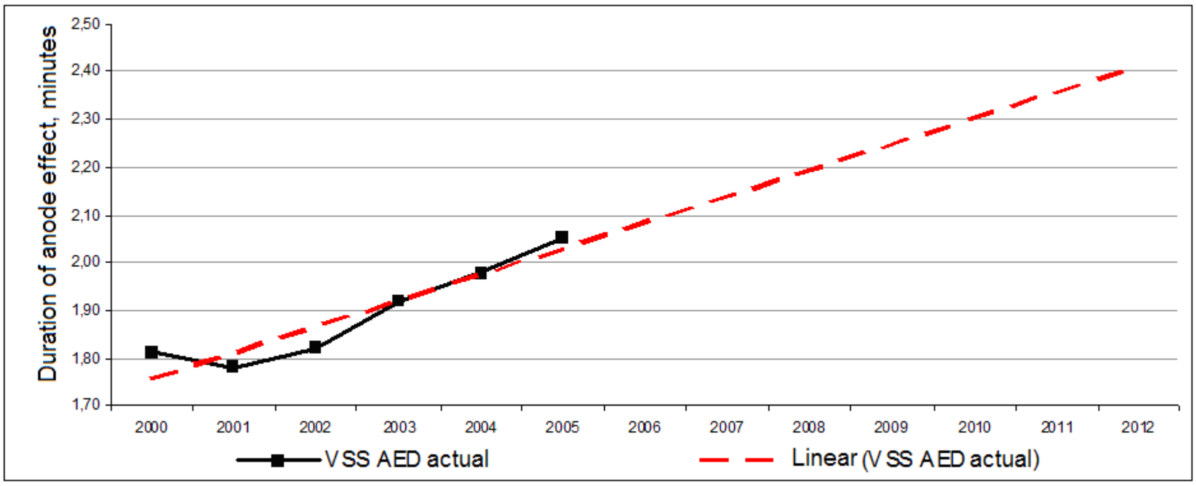


Fig. A.2.1.F. AED for VSS technology and linear trend till 2012.

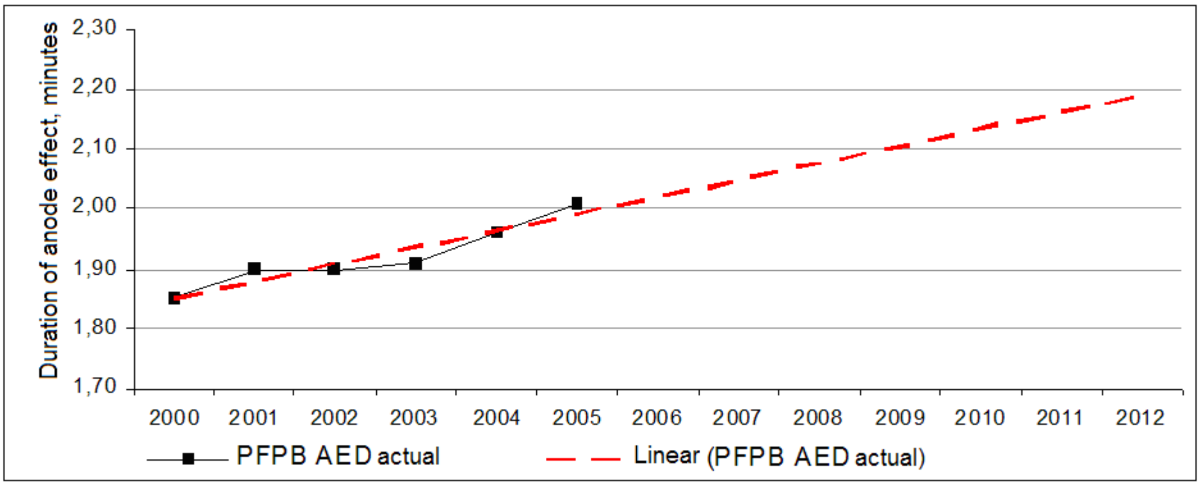


Fig. A.2.2.F. AED for PFPB technology and linear trend till 2012.

The trend has been plotted till year 2012 and, on its basis, indicators of average annual AED have been defined till year 2012. This is considered to be a conservative approach, since, in the absence of the Project, there is no alternative way to define most probable average annual AED. The figures and table with the extended trend and calculated values of AED during 2006 to 2012 are presented below.

Table A.2.2.T. The forecasted baseline AED for VSS and PFPB

Year	VSS, AED, minutes	PFPB, AED, minutes
2006	2.09	2.04
2007	2.14	2.06
2008	2.19	2.09
2009	2.24	2.11
2010	2.30	2.14
2011	2.35	2.17
2012	2.40	2.20

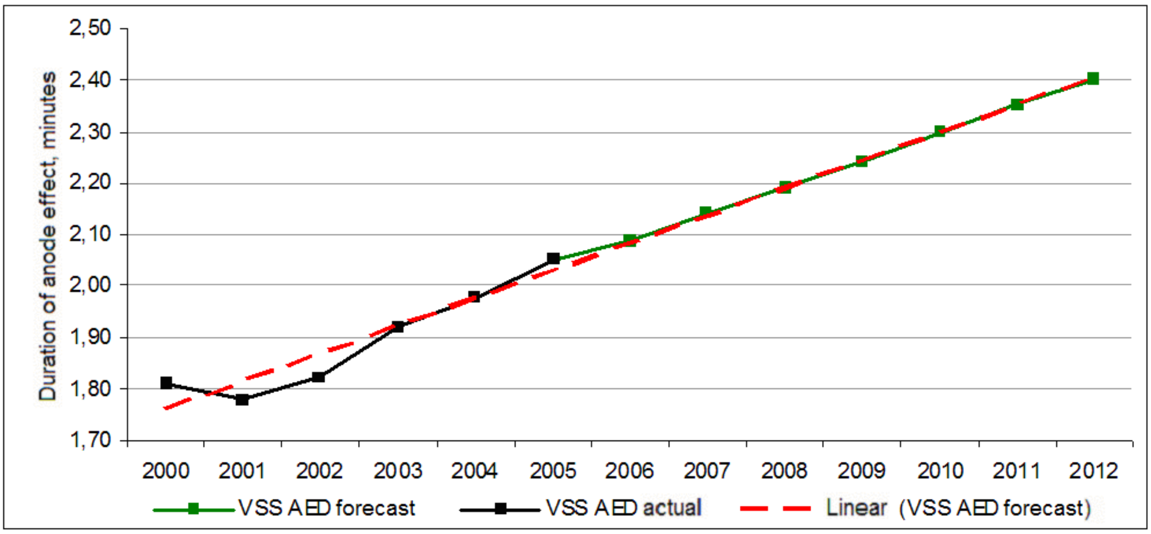


Fig. A.2.3.F. Actual AED and forecast of baseline AED till 2012 for VSS technology

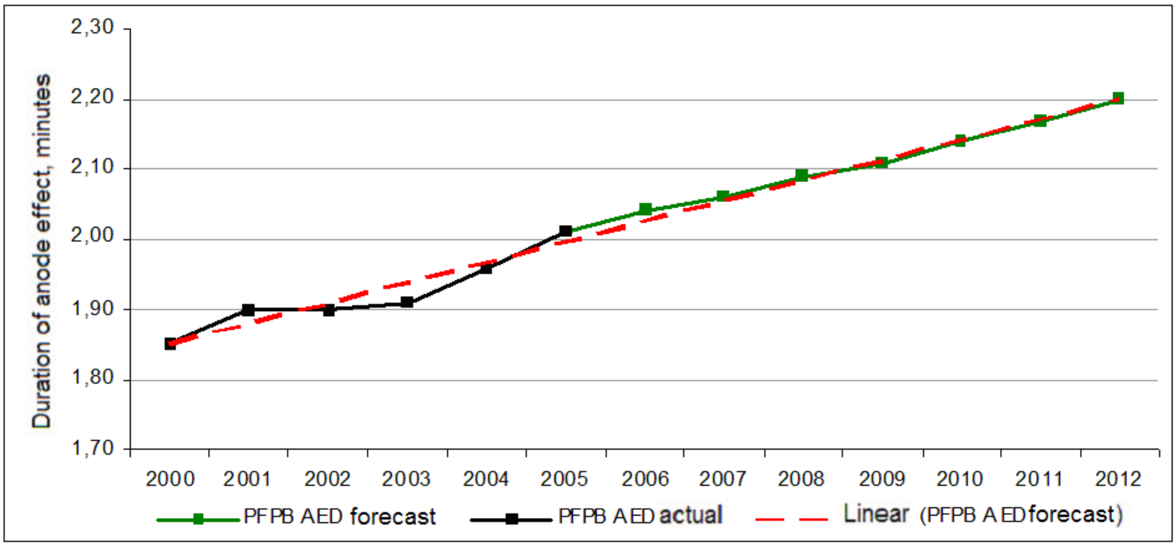


Fig. A.2.4.F. Actual AED and forecast of baseline AED till 2012 for PFPB technology

Anode effect frequency (AEF).

Both AE frequency and duration cannot be accepted to be constant, taken into account the decrease in frequency which is observed year after year as the result of implementation of various improvements in technology, which is "business as usual". Historical data reveal the change of AEF with the course of time. This historical data is used to define the trend and predict the baseline AEF.

Average annual AEF values for PFPB technology have been calculated in the similar way as anode effect duration values, using the linear trend, please see below.

Table A.2.3.T. Historical data and forecast of baseline AEF for PFPB technology.

Year	PFPB, AEF, pcs, pots/day
2002	0.91
2003	0.94
2004	0.84
2005	0.82
2006	0.78
2007	0.74
2008	0.71
2009	0.67
2010	0.64
2011	0.60
2012	0.56

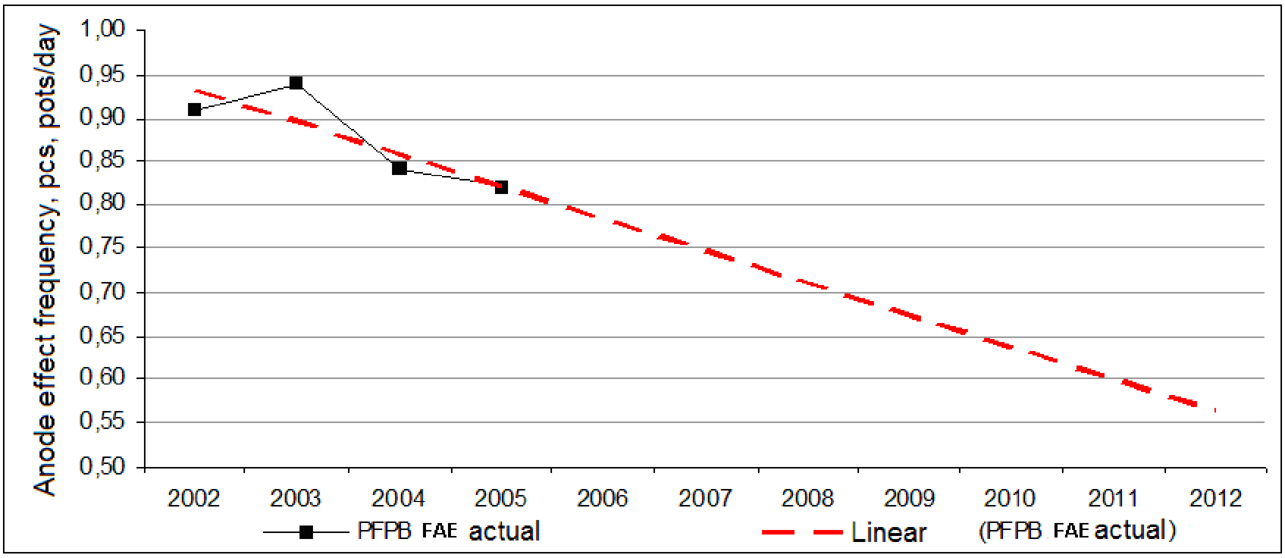


Fig.A.2.5.F. AEF for PFPB technology and linear trend till 2012.

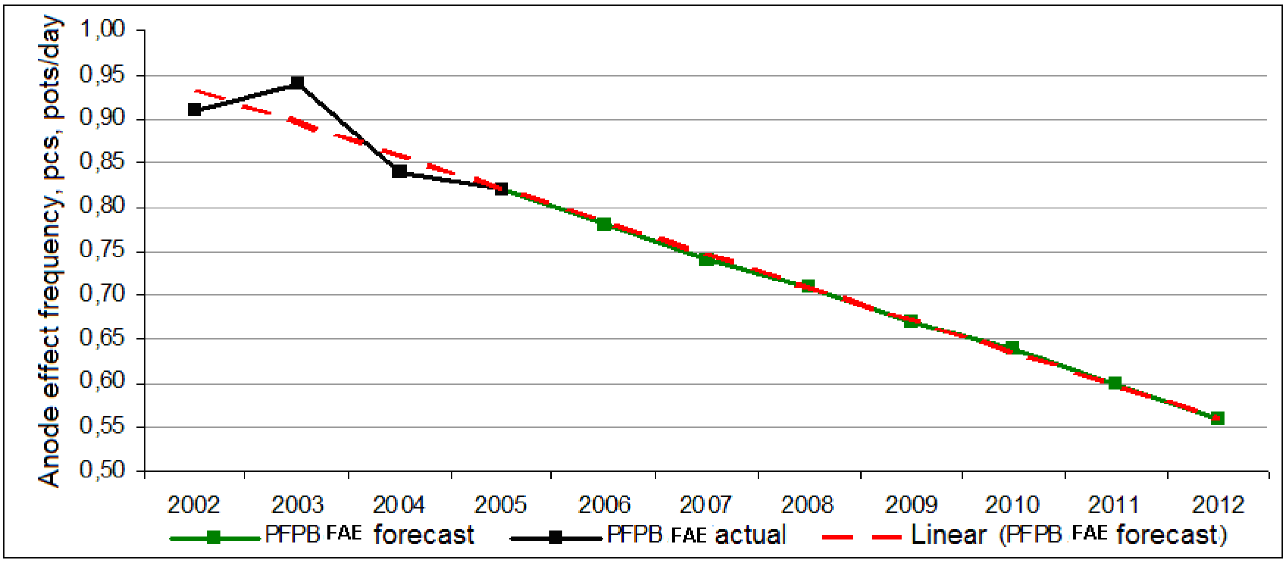


Fig. A.2.6.F. Actual AEF and forecast of baseline AEF till 2012 for PFPB technology

To forecast the average annual AEF for VSS technology it was also necessary to plot historical data trend and forecast till 2012. See please the table and figure below.

Table A.2.4.T. Historical data and forecast of baseline AEF for VSS.

Year	VSS, AEF, pcs, pots/day
2002	1.21
2003	1.16
2004	1.11
2005	1.10
2006	1.05
2007	1.01
2008	0.97
2009	0.94
2010	0.90
2011	0.86
2012	0.83

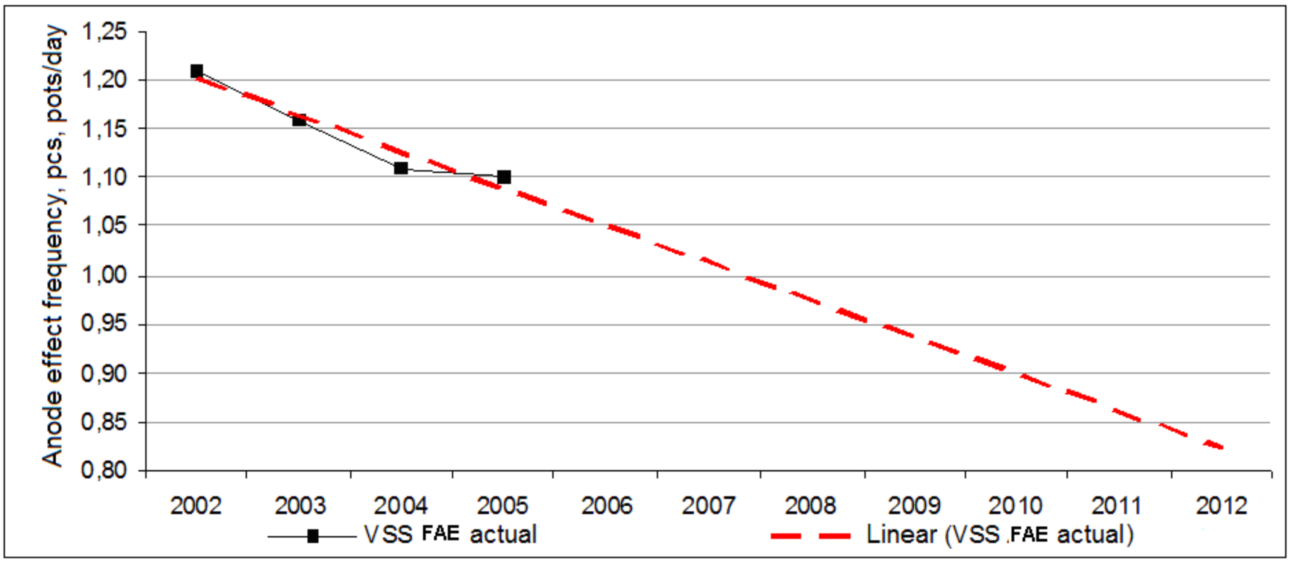


Fig. A.2.7.F. AEF for VSS technology and linear trend till 2012.

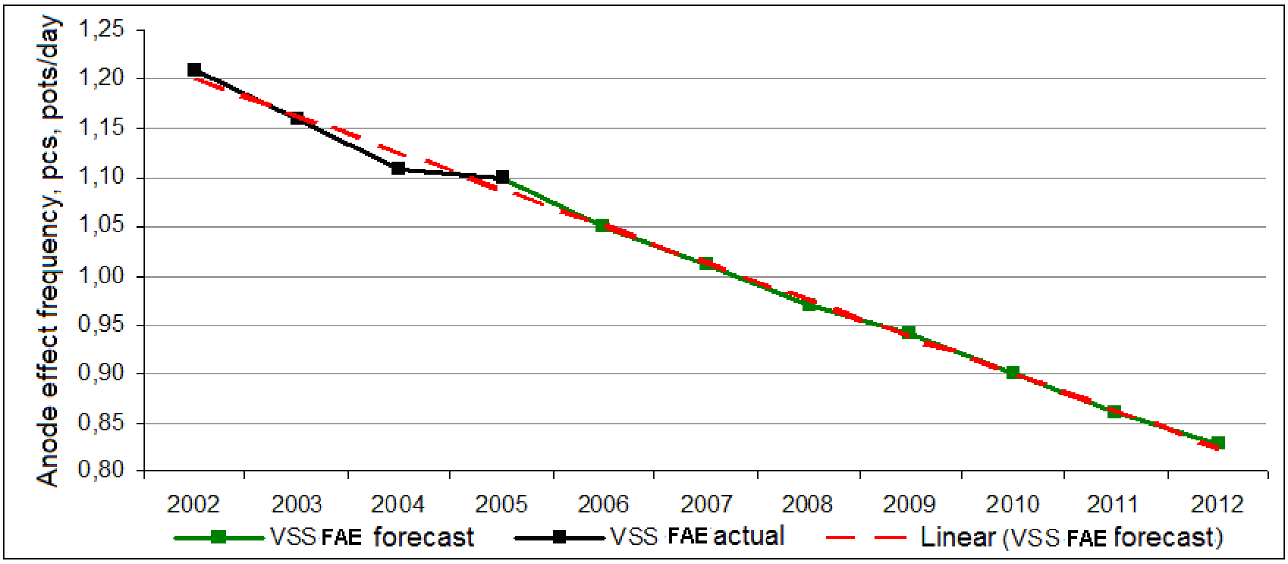


Fig. A.2.8.F. Actual AEF and forecast of baseline AEF till 2012 for VSS technology.

However, this forecasts can not be considered as absolutely correct, because VSS pots have already been equipped with alumina point feeders, which also provide the decrease in AEF. Therefore, it is necessary to separate this component (AEF reduction due to point feeders installation) and subtract it from the forecasted values.

Since the project was launched in 2006, the impact of alumina point feeders onto the decrease in AEF can be defined by AEF data analysis for 2004-2005, when some potrooms with VSS technology were equipped with alumina point feeders.

The following data is used for the analysis:

1. **Table A.2.5.T. Schedule of installation and commissioning of alumina point feeders in potrooms.**

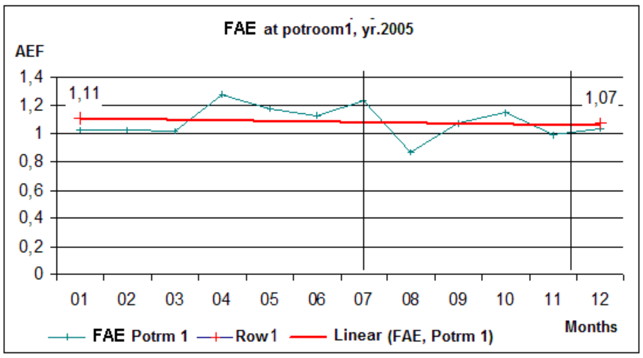
Potroom No.	Date of the alumina point feeders installation start	Date of the first point feeder commissioning	Date of the potroom complete commissioning (when potroom is fully operated in alumina point feeding mode)
1	14.05.2005	14.07.2005	24.11.2005
2	19.04.2005	19.06.2005	25.07.2005
3	01.02.2005	05.04.2005	05.05.2005
4	05.04.2005	03.06.2005	15.07.2005
5	07.02.2005	15.04.2005	21.05.2005
6	01.09.2004	16.10.2004	16.11.2004
13	01.04.2005	08.06.2005	05.08.2005
19	15.01.2005	04.03.2005	12.04.2005
20	10.09.2004	10.11.2004	06.01.2005
21	01.10.2005	11.12.2005	11.01.2006
22	01.10.2005	03.01.2006	26.01.2006
23	01.10.2005	16.12.2005	20.01.2006
14	20.05.2006	21.07.2006	18.11.2006
15	10.08.2006	19.10.2006	19.12.2006
17	20.09.2006	27.11.2006	29.01.2007
16	01.10.2006	27.12.2006	13.02.2007
11	15.01.2007	28.02.2007	28.03.2007
12	01.03.2007	27.04.2007	12.05.2007
9	05.07.2007	18.07.2007	24.08.2007
18	01.06.2007	04.06.2007	27.06.2007
10	No data	26.09.2007	Not accomplished

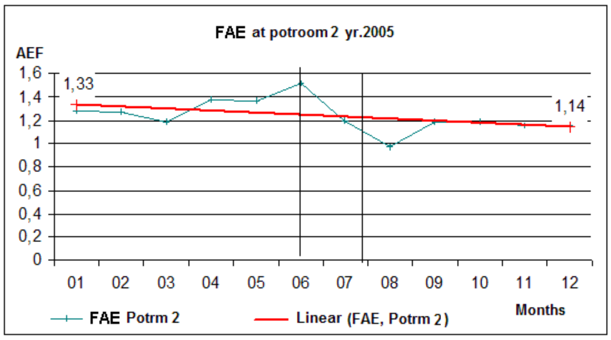
Potrooms marked grey in the table are acceptable for the analysis, since the alumina point feeders operating period in the potroom (not less than 4 months) provides sufficient data for the analysis of the impact of alumina point feeders on the AEF.

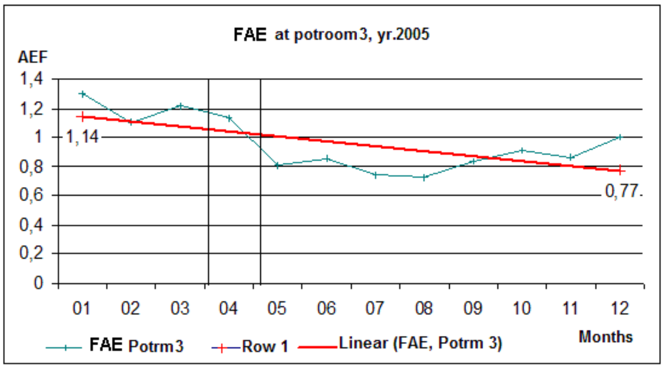
2. Table A.2.6.T. AEF in the selected potrooms by months for 2004-2005

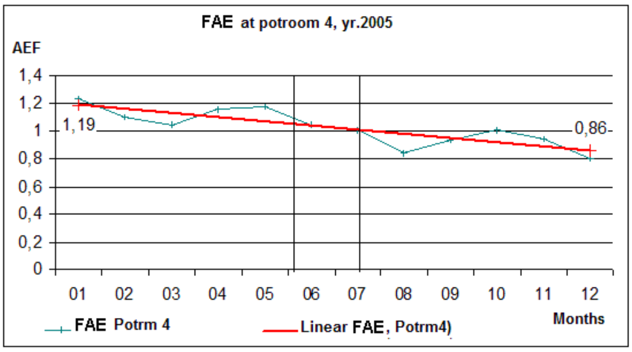
Year	Month	Commissioned in 2004		Commissioned in 2005						
		No. 6	No. 20	No. 1	No.2	No. 3	No. 4	No. 5	No. 13	No. 19
2005	01	1.00	0.92	1.03	1.28	1.30	1.23	1.32	1.27	1.30
	02	0.98	1.10	1.03	1.27	1.10	1.10	1.24	1.24	1.19
	03	0.84	1.02	1.02	1.18	1.21	1.05	1.24	1.07	1.30
	04	0.79	1.08	1.28	1.38	1.13	1.16	1.38	1.06	1.15
	05	0.90	1.01	1.18	1.37	0.81	1.18	1.18	1.13	1.13
	06	0.72	1.04	1.13	1.52	0.85	1.05	0.99	1.18	1.09
	07	0.70	1.03	1.23	1.19	0.74	1.01	1.00	0.97	0.98
	08	0.90	0.97	0.87	0.97	0.72	0.84	1.03	0.93	0.96
	09	1.06	1.07	1.07	1.18	0.83	0.93	1.43	0.90	1.04
	10	0.91	1.10	1.15	1.18	0.91	1.01	1.17	0.89	1.25
	11	0.90	1.23	0.99	1.15	0.86	0.94	1.12	1.00	1.41
	12	0.92	1.15	1.04	1.15	1.00	0.80	0.95	0.91	1.37
2004	01	1.11	1.42							
	02	1.05	1.32							
	03	1.18	1.20							
	04	1.08	1.26							
	05	0.99	1.35							
	06	0.97	1.31							
	07	1.31	1.30							
	08	1.20	1.57							
	09	1.19	1.25							
	10	1.17	1.27							
	11	0.99	1.36							
	12	1.00	1.30							

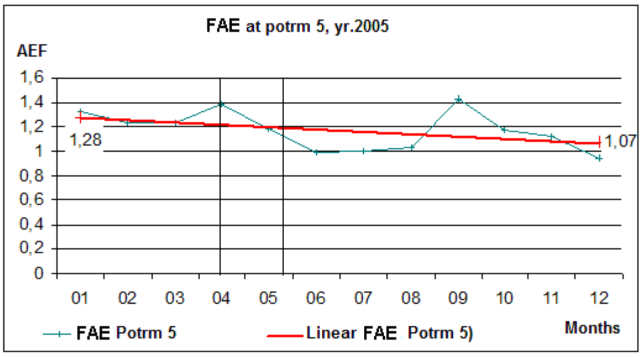
Fig. A.2.9.F. Change of anode effect frequency at the selected potrooms.

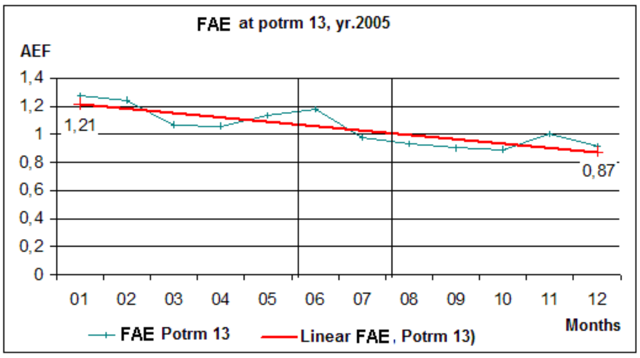


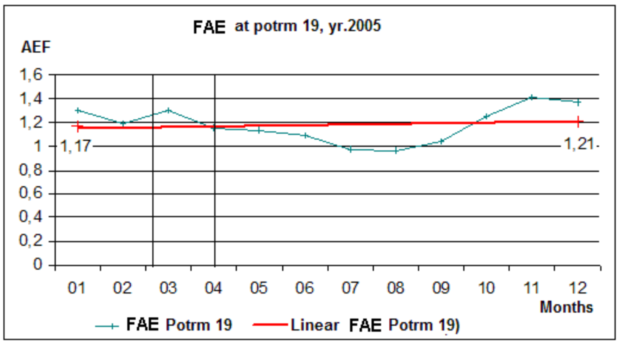


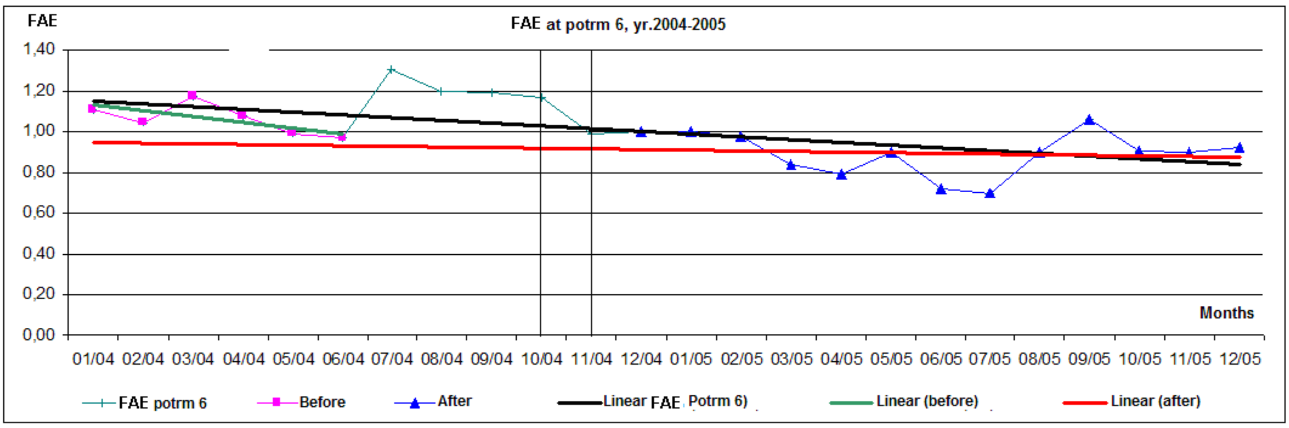

FAE at potroom3, yr.2005
AEF
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,14
0,77
01 02 03 04 05 06 07 08 09 10 11 12
Months
FAE Potrm3
Row 1
Linear (FAE, Potrm 3)

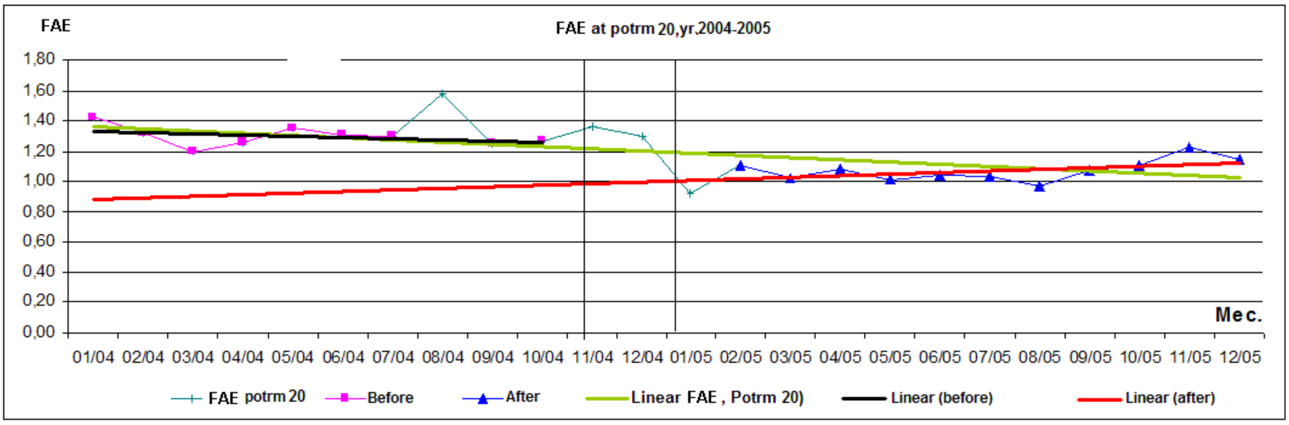

FAE at potroom 4, yr.2005
AEF
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,19
0,86
01 02 03 04 05 06 07 08 09 10 11 12
Months
FAE Potrm 4
Linear FAE, Potrm4)


FAE at potrm 5, yr.2005
AEF
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,28
1,07
01 02 03 04 05 06 07 08 09 10 11 12
Months
FAE Potrm 5
Linear FAE Potrm 5)


FAE at potrm 13, yr.2005
AEF
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,21
0,87
01 02 03 04 05 06 07 08 09 10 11 12
Months
FAE Potrm 13
Linear FAE, Potrm 13)


FAE at potrm 19, yr.2005
AEF
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,17
1,21
01 02 03 04 05 06 07 08 09 10 11 12
Months
FAE Potrm 19
Linear FAE Potrm 19)


FAE
FAE at potrm 6, yr.2004-2005
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
Months
01/04 02/04 03/04 04/04 05/04 06/04 07/04 08/04 09/04 10/04 11/04 12/04 01/05 02/05 03/05 04/05 05/05 06/05 07/05 08/05 09/05 10/05 11/05 12/05
FAE potrm 6
Before
After
Linear FAE Potrm 6)
Linear (before)
Linear (after)



Note: Vertical lines on diagrams indicate commissioning of alumina point feeders in the first potline and commissioning of alumina point feeder in the last potline in the potroom.

Due to insufficient data for precise analysis, for conservative assessment of the impact of alumina point feeders on AEF for potrooms 1-5, 13, 19, where introduction of alumina point feeders started in 2005, the linear trends have been plotted for AEF. The values of AEF as of beginning of the year and as of end of the year have been defined for these trends.

Table A.2.7.T. Difference in AEF as of beginning and end of 2005 for potrooms 1-5, 13, 19

	Commissioning in 2005							
	No. 1	No.2	No. 3	No. 4	No. 5	No. 13	No. 19	Average
AEF as of beginning of the year	1.11	1.33	1.14	1.19	1.28	1.21	1.17	1.20
AEF as of end of the year	1.07	1.14	0.77	0.86	1.07	0.87	1.21	1.00
Difference:	0.04	0.19	0.37	0.33	0.21	0.34	-0.04	**0.21**

Other technique has been used for potrooms 6 and 20. For these potrooms, the average AEF was defined by means of ARM SMIT computer-aided workstation. Average AEF was defined from beginning of 2004 till commissioning of the first potline, and after commissioning of all alumina point feeders of the potroom till end of 2005. Following the conservative approach, the abnormally high AEF values displayed after and prior to commissioning of alumina point feeders have been excluded during definition of the average AEF. Such abnormally high values are specified for July to September 2004 for potroom 6 and for August for potroom 20. As the result, for potroom 6 we have arrived at 1.1 "before"[3] and 0.885 "after"[4]. For potroom 20 – 1.282 "before" and 1.068 "after". Then the difference of average AEF values between "before" and "after" values was obtained. For potroom No.6 it is: 1.1 – 0.885 = 0.215; for potroom No.20: 1.282 – 1.068 = 0.214.

Following the conservative approach, the alumina point feeders installation influence on AEF is determined by biggest value among the three figures (differences of AEF values before and after point feeders installation for different potrooms): 0.21; 0.215; 0.214

Thus, the degree of impact of alumina point feeders onto AEF for VSS pots is assessed. It is accepted to be equal to 0.215.

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[3] Term „before“ refers to “Before the installation of alumina point feeders

[4] Term „After“ refers to „After the installation of alumina point feeders“

Based on the above, the value 0.215 should be subtracted from baseline AEF values for VSS pots. However, during 2004-2007, alumina point feeders were being installed at different potrooms at different time. Thus the question "how to recalculate AEF" appears. In order to provide the conservative approach, it is assumed that since 2006 all potrooms have been already equipped with alumina point feeders. Thus 0.215 value should be subtracted from the obtained trend of AEF for VSS (please see also Table A.2.4.T) beginning from year 2006. The table and figure below represent the AEF values, which are applied for baseline emissions calculation.

Table A.2.8.T. AEF historical data and baseline AEF forecast for VSS technology with consideration of the impact of alumina point feeders installation.

Year	VSS AEF, pcs, pots/day
2002	1.21
2003	1.16
2004	1.11
2005	1.10
2006	**0.84**
2007	**0.80**
2008	**0.76**
2009	**0.73**
2010	**0.69**
2011	**0.65**
2012	**0.62**

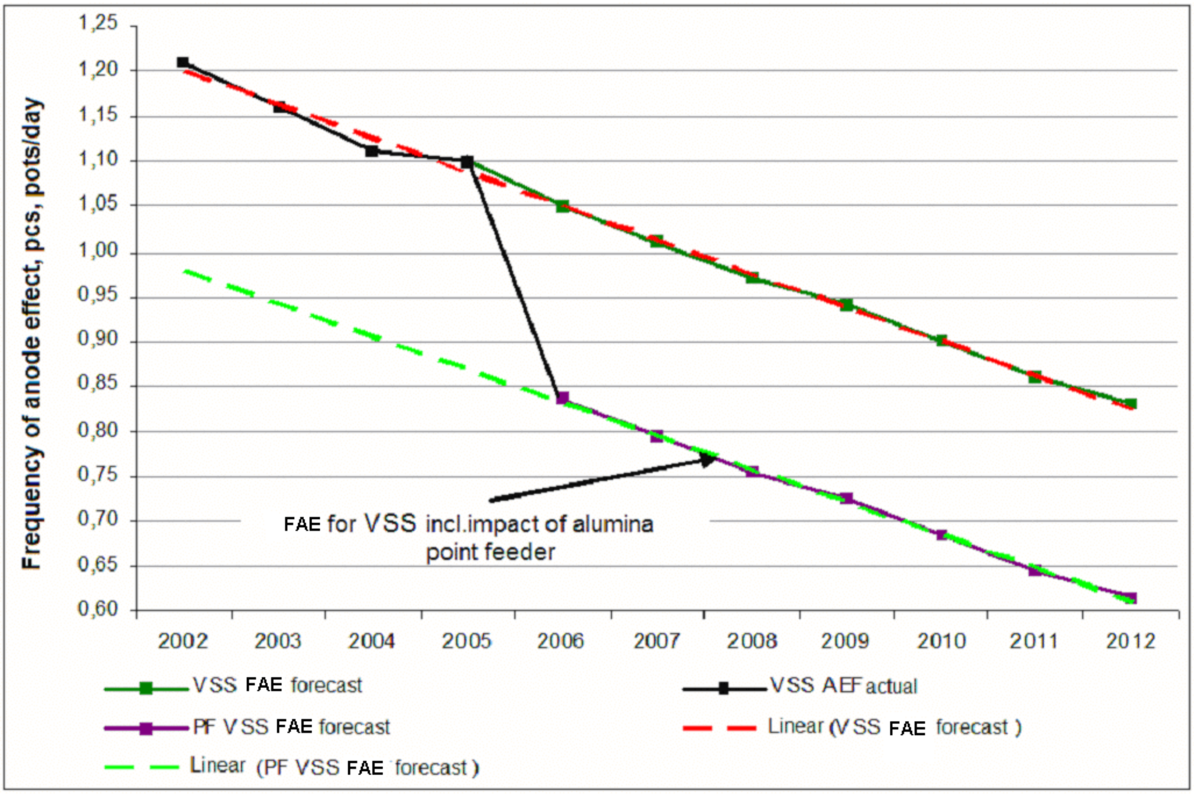

Fig. A.2.10.F. Anode effect frequency for VSS technology – actual and baseline forecast till 2012, with consideration of the impact of alumina point feeders.

As the result of the baseline AEF decrease by the value of the impact of alumina point feeders, the AED should grow adequately. The degree of impact of alumina point feeders' installation and corresponding AEF decrease onto the baseline AED is determined below.

0.83 value of AEF as of 2006 is equivalent to AEF of 2012 but obtained without consideration of the impact of alumina point feeders. Therefore, to be conservative, it is assumed that value of AED (with the impact of point feeders installation) in 2006 would be the same as the value of AED in 2012 without the impact of alumina point feeders = 2.40. The difference between this value (2.40) and the value of AED in 2006 obtained without the impact of alumina point feeders is the sought value. Thus $\Delta = 2.40 - 2.09 = 0.31$ min.

Adding 0.31 to average annual values of AED for VSS in table A.2.2.T the values of AED with the impact of point feeders can be obtained.

Table A.2.9.T. The forecasted baseline values of AED for VSS technology with consideration of the impact of alumina point feeders

Year	VSS, AED, minutes
2006	2.40
2007	2.45
2008	2.50
2009	2.55
2010	2.61
2011	2.66
2012	2.71

The values of baseline slope coefficients for CF_4 and C_2F_6 are the same as that of project scenario. Despite the fact that PFC emissions at Krasnoyarsk Aluminium Smelter were measured only in September, 2007, still, following the conservative approach, project participants decided to apply values of slope coefficients obtained during measurements. Such decision was adopted as:

- Values of slope coefficients obtained during measurements are below the average world values for the relevant technologies specified in 2006 IPCC guidelines, for Tier 2;
- The technology practically has not been changed since the beginning of 2006;
- Adopted decision correlates with the recommended frequency of slope coefficient measurements (1 per 3 year).

Due to the fact that slope coefficients of VSS pots with alumina point feeders significantly differ from those of VSS pots without alumina point feeders, and during 2006 to 2007 alumina point feeders have been introduced approximately at half of the smelter's potrooms, calculation of baseline emissions during 2006 to 2007 should be carried out in accordance with the procedure described below.

Volume of metal produced – is considered to be the same as that in the project scenario. The planned production volume is provided in the smelter's annual business plans and at UC RUSAL's internal document "Target indicators for smelters till 2017 and forecasted aluminium cost dynamics".

For both project and baseline emissions calculations the amount of electrolytic aluminium is used. The electrolytic aluminium is the aluminium actually produced during the year, including the work in progress (WIP) aluminium[5]. The annual volume of electrolytic aluminium breakdown by months cannot be obtained as amount of WIP aluminium is not defined every month. Thus the crude aluminium amount is used. (The planned production volumes for 2007-2012 are also defined in tons of crude aluminium). Crude aluminium is the aluminium actually tapped from pot (without consideration of WIP). Theoretically, these values should be equal, but since the amount of aluminium tapped of the pot is fluctuating, in practice they differ from each other. The longer is the period, the less is the difference between these values. The difference observed during several days usually constitutes less than 1% and,

[5] Work in progress aluminium (WIP) is the aluminium remaining in the pots

therefore, taking into consideration that WIP is defined once a quarter, it is assumed that these values are equal.

The long-term plan of aluminium production at Krasnoyarsk Aluminium Smelter is defined at UC RUSAL's internal document "Target indicators for smelters till 2017 and forecasted aluminium cost dynamics".

In this document annual crude aluminium production volumes without breakdown by technologies for all smelters are presented. The short-term plan of aluminium production for 2007 and 2008 with breakdown by technologies provides volume of crude aluminium both for potrooms employing VSS technology and potrooms employing PFPB technology. Considering the fact that no significant changes are scheduled for PFPB pots, nor any change in their number, and considering the fact that slope factors of PFPB technology are higher than those of VSS technology, it is conservatively assumed that production volume of metal produced by PFPB pots is not going to be changed starting with year 2008. in such case the volume of aluminium produced by VSS pots starting with year 2009 is obtained by subtracting volume of crude aluminium to be produced at PFPB pots in 2008 from the total amount of planned aluminium production for the respective year, as defined at UC RUSAL's document "Target indicators for smelters till 2017 and forecasted aluminium cost dynamics".

These figures will be corrected annually with consideration of actual metal output.

Since slope coefficients for VSS pots with alumina point feeders differ significantly from those of VSS pots without alumina point feeders, and with consideration of the fact that during 2006 to 2007 alumina point feeders have been implemented at approximately half of the smelter's potrooms, to calculate PFC emissions, it is necessary separately define the amount of metal produced at VSS pots with alumina point feeders and amount of metal produced at VSS pots without alumina point feeders.

To be conservative, it is assumed, that starting with the month when the first system of alumina point feeders was commissioned, all the aluminium at the potroom has been produced with application of alumina point feeders. E.g., for potroom No.15 in 2006 it is assumed that all aluminium in this potroom from January till September have been produced at pots without alumina point feeders and, from October till the end of the year 2006 (end of December), at pots with alumina point feeders, although the first group of alumina point feeders was commissioned on October 19th, and the last group – on December 19th.

Determination of electrolytic aluminium produced during 2006-2007 by VSS pots with and without point feeders

Step 1: The total amount of crude aluminium produced by the potrooms with VSS technology, but not yet equipped with alumina point feeders in the specified year during 2006-2007 can be calculated employing the process control system "ARM SMIT computer-aided workstation",

Step 2: Calculation of crude aluminium production by potrooms at which the alumina point feeders had been installed during the specified year: sum of the volumes of aluminium produced during the months lying prior the month of commissioning of the first group of point feeders,

Step 3 Sum up the values obtained at step 1 and step 2: in order to obtain the volume of electrolytic aluminum produced at VSS pots without alumina point feeders.

Step 4 The amount of electrolytic aluminum produced at VSS pots with alumina point feeders is determined by subtraction of the amount of aluminium produced at VSS pots without alumina point feeders (defined by step 3) from the total amount of electrolytic aluminium produced at VSS pots during the specified year

Example.

Step 1: In order to get the amount of metal produced in 2006 at VSS pots without alumina point feeders, the annual amounts of metal produced at potrooms No. 11, 12, 9, 18 and 10 should be summed up.

Step 2: Then the amount of aluminium produced at potroom No.14 from January till June, at potroom No.15 from January till September, at potroom No.17 from January till October, at potroom No.16 from January till November are summed up

Step 3 Value obtained at step 1 is added to the value obtained at step 2. (potrooms 22 and 23 are excluded from consideration, as it is assumed that the alumina point feeders at these potrooms have been in operation already since January).

Step 4: Finally to determine the amount of aluminium produced at VSS pots with alumina point feeders the value obtained at step 3 is subtracted from the total annual volume of electrolytic aluminium produced at VSS pots in 2006

For year 2007 the total sum of volumes of actual aluminium production at pots without alumina point feeders should be applied. Planned crude aluminium production volume at VSS pots with alumina point feeders is determined by the subtraction of above sum from the planned crude aluminium production volume for 2007.

Taking into account all above mentioned the following tables presented below were developed.

Table A.2.10.T. Amount of metal by potrooms with consideration of point feeders installation commissioning date.

Year 2006

Potroom No. 1,2,3,4,5,6,13,19,20,21,22,23	Year 2006 (with alumina point feeders)	
Crude aluminium, tonnes	**497,609.7**	
Potroom No.14	January-June 2006 (without alumina point feeders)	July-December 2006 (with alumina point feeders)
Crude aluminium, tonnes	**19,494**	**19,241**
Potroom No.15	January-September 2006 (without alumina point feeders)	October-December 2006 (with alumina point feeders)
Crude aluminium, tonnes	**28,881**	**9,807**
Potroom No.17	January-October 2006 (without alumina point feeders)	November-December 2006 (with alumina point feeders)
Crude aluminium, tonnes	**34,357**	**7,369**
Potroom No.16	January-November 2006 (without alumina point feeders)	December 2006 (with alumina point feeders)
Crude aluminium, tonnes	**34,924**	**3,413**
Potroom No. 11,12,9,10,18	2006 (without alumina point feeders)	
Crude aluminium, tonnes	**195,622**	
Total for potrooms, crude aluminium, tonnes	**without alumina point feeders**	**with alumina point feeders**
	313,278	**537,439.7**

Year 2007

Potroom No. 1,2,3,4,5,6,13,14,15,16,17, 19,20,21,22,23	2007 (with alumina point feeders)	
Crude aluminium, tonnes	**713,223**	
Potroom No.11	January 2007 (without alumina point feeders)	February-September 2007 (with alumina point feeders)
Crude aluminium, tonnes	**3,519**	**27,072**
Potroom No.12	January-March 2007 (without alumina point feeders)	April-September 2007 (with alumina point feeders)
Crude aluminium, tonnes	**10,072**	**20,632**
Potroom No.9	January-June 2007 (without alumina point feeders)	July-September 2007 (with alumina point feeders)
Crude aluminium, tonnes	**18,657**	**9,858**
Potroom No.18	January-May 2007 (without alumina point feeders)	June-September 2007 (with alumina point feeders)
Crude aluminium, tonnes	**17,509**	**14,587**
Potroom No.10	January-August 2007 (without alumina point feeders)	September 2007 (with alumina point feeders)
Crude aluminium, tonnes	**27,445**	**3,227**
Total for potrooms, crude aluminium, tonnes	**without alumina point feeders**	**with alumina point feeders**
	77,202	**788,599**

Applying the conservative approach and due to the fact that it is not possible to certainly define baseline indicators for particular potrooms, the average annual AEF and AED data for VSS and PFPB technologies should be used.

Thus the following table for calculation of baseline PFC emissions was developed.

Table A.2.11.T. Date for baseline PFC emission calculation

Type of pot	Crude aluminium production, tonnes (D.1.1.3.1.)	AEF, pcs, pots/day (D.1.1.3.2.)	AED, minutes (D.1.1.3.3.)	Slope coefficient for CF_4, (D.1.1.3.3.)	Weight fraction of C_2F_6/CF_4, (D.1.1.3.3.)
2006					
- VSS without alumina point feeders	313,278.00	0.84	2.40	0.053	0.054
- VSS with alumina point feeders	537,439.70	0.84	2.40	0.032	0.044
- PFPB	116,185.58	0.78	2.04	0.133	0.050
2007					
- VSS without alumina point feeders	77,202.00	0.80	2.45	0.053	0.054
- VSS with alumina point feeders	788,599.00	0.80	2.45	0.032	0.044
- PFPB	117,560.00	0.74	2.06	0.133	0.050
2008					
- VSS with alumina point feeders	882,990.00	0.76	2.50	0.032	0.044
- PFPB	119,180.00	0.71	2.09	0.133	0.050
2009					
- VSS with alumina point feeders	892,095.00	0.73	2.55	0.032	0.044
- PFPB	119,180.00	0.67	2.11	0.133	0.050
2010					
- VSS with alumina point feeders	903,091.00	0.69	2.61	0.032	0.044
- PFPB	119,180.00	0.64	2.14	0.133	0.050
2011					
- VSS with alumina point feeders	906,845.00	0.65	2.66	0.032	0.044
- PFPB	119,180.00	0.60	2.17	0.133	0.050
2012					
- VSS with alumina point feeders	920,846.00	0.62	2.71	0.032	0.044
- PFPB	119,180.00	0.56	2.20	0.133	0.050

Baseline PFC emissions in tonnes of CO_2eq are calculated following the formula 9 (please see Section D.1.1.4), and are presented in section E.4.

Annex 3

MONITORING PLAN

Monitoring plan describes data collection procedures, as well as the project analysis process required to define and confirm the fact of PFC emissions' reduction achieved within the project.

This project requires diligent data collection which procedure is described below.

Variables, frequency, accuracy and selection procedures for data to be monitored are defined in section D.

Annual volume of actually produced electrolytic aluminium shall be defined as for the whole smelter, as well as for each particular technology: for VSS and PFPB pots. In 2006-2007, the amount of crude aluminium produced by PFVSS and VSS technologies is to be calculated separately.

Baseline AEF and AED are not monitored due to the impossibility of doing so. The, average annual project AEF and AED values are to be defined separately for both VSS and PFPB pots. In 2006-2007, AEF and AED are to be defined taking into account the commissioning dates of alumina point feeders installation at potrooms

Slope coefficients are measured once every three years, or more frequently, in case of significant technological change.

A large share of above data has already been collected by the smelter employees in the course of their current activity.

PFC emissions' calculation procedure for this specific project is provided in the electronic spreadsheet format (Sheet 8), which is the standard tool for calculation of greenhouse gases' emissions from aluminium smelter, developed by IAI, in accordance with 2006 IPCC guidelines: http://www.ghgprotocol.org/.

Another format may be used for calculations as well. This format might be developed as a result of smelter greenhouse gas emissions inventory by the end of year 2007. The results will be checked applying IAI's standard tool.

Annex 4

INVESTMENT ANALYSIS

Enclosure (confidential)

Annex 4.xls

Annex 5

TERMS AND DEFINITIONS

- KrAZ – RUSAL Krasnoyarsk OJSC (Krasnoyarsk Aluminium Smelter)
- UC RUSAL – United Company Russian Aluminium
- VSS – Vertical Stud Søderberg
- PFVSS – Point Feeder Vertical Stud Søderberg
- PFPB – Point Feeder Prebaked
- Alumina point feeder(s) – automatic alumina supply system or automatic pot feeding system.
- PF – (Point Feeder) automatic alumina feeding system
- PB – (Prebaked) pots with prebaked anodes
- PFC – perfluorocarbons, defined by Kyoto protocol as greenhouse gases - CF_4 (tetrafluoromethane), C_2F_6 (hexafluoroethane)
- AE – anode effect
- AEF – anode effect frequency
- AED – anode effect duration
- Automatic process control system – system of automatic control of production process.
- JI – Joint Implementation – the mechanism defined by the article 6 of the Kyoto protocol.
- JIP – joint implementation projects.
- GHG – greenhouse gas
- IAI - International Aluminium Institute
- ERU – Emission Reduction Units

Annex 6

PROJECT EMISSIONS INFORMATION

Calculation of project and baseline emissions.

Annex 6.xls