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:

>>
Reduction of PFC emissions at RUSAL Bratsk aluminium smelter

Sectoral scope: Metal production
Version: 02
Date: 15.04.2012

A.2. Description of the project:

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Bratsk Aluminium Smelter (abbreviated name: RUSAL-BrAZ, BrAZ) is largest and oldest aluminium smelters in Siberia and in the Russian Federation. It is located in the industrial area of the town of Bratsk, Irkutsk region. The smelter belongs to UC RUSAL.

The smelter was founded in 1966. It belongs to UC RUSAL.

BrAZ total production volume of aluminium was 1007638,5 tonnes in 2008.

BrAZ production facilities include 25 potrooms. All potrooms use the Soederberg technology with upper current distributor (VSS). The smelter owns no energy generation capacities so all the power needs are satisfied by the local power generating systems.

Project goals:

This project goal is to reduce perfluorocarbon (PCF) emissions by reducing the frequency of anode effect and duration with a package of technical measures (reduction of the cryolite ratio) and operational measures in the old Soederberg cells with upper current leads (VSS) envisaged for implementation at the Bratsk Aluminium Smelter in 2000. The project is not aimed at the additional output of aluminium. Production volumes will remain equal to the pre-project outputs.

Implementation of this project is based on the principles of stable development, the principles of minimum harmful environmental impact. Reduction of anode effect for production of the same volumes of aluminium results in the reduction of perfluorocarbon (CF4 and C2F6) and soot emissions minimising the greenhouse effect and improving the ecology of the town of Bratsk and the Irkutsk region.

Pre-project situation

Prior to implementation of the 2000 project actions the smelter produced primary aluminium using the Soederberg technology with upper current distributor in alkaline baths with high cryolite ratio without reducing the frequency of anode effect and additional ecological measures. Anode effect used to be high in all the potrooms as this is a common practice for alkaline electrolytic cells.

Anode effect has always been regarded as an indicator of normal operation of electrolytic cells at the Russian smelters as the temperature of cell, the cell smelting shape, metal product and current effervescive indicate normal operation. If an anode effect failed to originate within a certain time it was induced artificially. In fact, reduction of frequency of anode effect does not significantly affect power consumption, aluminium quantity or quality rising as well as labour input. Consequently reduction of anode effect is not a very profitable measure and this issue had never been among the priorities for the smelter managers. Even more, the current Russian laws do not restrict large-scale greenhouse gas emissions allowing massive emissions of perfluorocarbon. And naturally the smelter management's attitude towards anode effect and the associated greenhouse gas emissions is not governed by the state.
The main problems in BrAZ in 2001 were:
- Lack of modern control systems of technological state of objects: an electrolyzer, building, plant;
- Non-optimal organizational structure of technological personnel in the management of EP;
- The use of a large variety of types of process equipment and structural cells;
- The lack of a systematic approach to assessing the performance of the main technological equipment, implementation of best practices and optimal technological parameters of the cell.

It was technically not possible to use a unified approach to the management of electrolysers: the same type of electrolysers operated with different process parameters, the service used different methods of work, lacking the necessary information about the operational status of electrolyzers. An analysis of existing information was extremely difficult because of the lack of systems for collecting, processing and delivery of information.

Baseline conditions (2000-2002):
- Frequency of anode effect in different types of pots — 1.52 occurrences per day
- Aluminium fluoride specific rate — 34.9 kg/t
- Current effervescive — 87.42%
- Specific power rate — 15820 kW*h/t

Project

This project goal is to reduce perfluorocarbon (PCF) emissions by reducing the frequency of anode effect due to the implementation of the following:

1. The rehabilitation program of electrolysis production technologies in buildings 1-25 through a series of organizational and technical measures, as well as reducing the cryolite ratio .

A characteristic feature of this project at the time of the plant that decision (to this day) is that the goal is to reduce the frequency of AE less than 1 AE. per day (at least 0.2%), which is unique in the world for the VSS technology without the APG on alkaline electrolytes. The decision was made based on a clear understanding of the causes of anode effects, as well as the main factors that contributed to the AE.

The most important factor influencing the occurrence of AE, is the concentration of dissolved alumina in the electrolyte and reduce the incidence of AE is only possible without allowing reduction of alumina concentration below 1.5-2.0%. Therefore, the frequency of AE can be taken as a constant for each type of technology. Since the process of electrolytic aluminum production is continuous, and the process of electrolysis power logic, it is necessary to prevent the reduction of alumina in the electrolyte concentration below 1.5-2.0% by changing the approach to electrolysis, namely stabilizing the technological state of the pots.

From 2001 at BrAZ activities under the Kyoto Protocol are carried out to implement programs of recovery technology action, which included the following technical parts:

1. Organization three-level process control of electrolysis;
2. Optimization of work in progress in the electrolysis of the metal;
3. Stabilization of the electrolyte composition and its modifications, namely the reduction of CR and an increase in the concentration of calcium fluoride.

The decision to adopt new measures was accepted with clear understanding of the ‘green’ component of aluminium production and existing ecological situation in the town of Bratsk. Ecological and economic recommendations of SibVAMI Institute specialists were also fully accepted.

RUSAL-BrAZ has always been devoted to the principles of stable development and responsibility for the environmental, industrial and social components of its activities.

Therefore the following purposes were set while developing this joint implementation project:

- reduction of man-induced impact to the vulnerable environment of the Baikal region;
- qualitative and ecologically pure production of aluminium;
- decrease in greenhouse gas emissions to the atmosphere by reducing PCF at aluminium production and CO2 at production of anode paste.
- improvement of working conditions at the electrolytic production.

By implementing this project RUSAL-BrAZ will not only solve the local ecological pressing issues of the smelter and town area but will improve the ecological situation of the whole Baikal region.

Further project aspects:

- minimising the expenditures for re-equipment of acidic baths and fundraising from feed prebaked technology for a further reinvestment to similar activities focused on improving the ecological situation and complying with the highest international standards in the framework of the Kyoto Protocol. Discussing the project at meetings and consultations the Company contemplated a chance of selling Emission Reduction Units and eventually came to a conclusion that such project is possible for delivery in the framework of Article 6 of the Kyoto Protocol.

-following the principles of sustainable development and best practices. This will significantly reduce emissions of pollutants in the area and benefit the Bratsk residents' health and quality of life.

Implementation of this project was associated with a number of serious economic obstacles. However, RUSAL-BrAZ hopes that profit from selling Emission Reduction Units generated by the project will substantiate the project and clear the obstacles if the project is approved as a joint implementation project.

The Kyoto constituent of the project:

Adoption of acidic bath technology and reform of electrolysis technology

10/12/2000 - discussion on the technical council of OAO "RUSAL BrAZ 'intentions to move to the program of recovery technology (reform of electrolysis technology), as well as the technology of electrolysis in acidic electrolytes to reduce the AE under Article 6 of the Kyoto Protocol.

In below table the information on measures that were provided at BrAZ to secure JI status of the project is presented.

Year	Description
2000 (management decision)	Action: Intention to adopt the acidic bath technology for reducing anode effect within the framework of Article 6 of the Kyoto Protocol. Evidence:Decision of Technical Council. Minutes of discussion of Technical Council of 10.12.2000 Justification of the evidence: That was a management decision to start the project as a JI activity.
2003	Action:Decision on the start of monitoring of national legislation on Kyoto Protocol ratification and JI-procedure establishment and PIN elaboration. Evidence: Minutes of discussion of 16.06.2003 and PIN Justification of the evidence: Elaboration of PIN was a first step on a way to PDD development. PDD was supposed to be elaborated after KP ratification and establishment of JI-procedure. To know that these conditions are in place the monitoring regarding the legislation on KP-related issues was established. From this point that was a real action to secure a JI status
2005	Action: Monitoring of KP ratification status and PIN elaboration Evidence: Minutes of discussion of 26.09.2005 Justification of the evidence: Keeping adherence to commitment to develop the project under JI-mechanism after KP ratification and establishment of JI approval procedure the BRAZ smelter were proceeding with the monitoring of

	status of laws on adoption of these documents.
2006	Action: Monitoring of KP ratification status Evidence:Minutes of discussion of 18.06.2006 Justification of the evidence: Keeping adherence to commitment to develop the project under JI-mechanism after KP ratification and establishment of JI approval procedure the BRAZ smelter were proceeding with the monitoring of status of laws on adoption of these documents.

A year later BrAZ merged with RUSAL Company and further the management of the JI project has been carried out on RUSAL level. The below table contains information on measures to secure JI status on RUSAL level.

2006	UC RUSAL Action: Setting the goals. Goal 2 is to secure interests of Company in sphere of GHG regulation and emission reduction circulation. Evidence: Environmental strategy accepted on 25/09/06.Presentation in PPT-format. Justification of the evidence: Due to a merger of assets and the establishment of a united company RUSAL the management of JI projects moved to a RUSAL central head office in Moscow. Initially, to start the management of a corporate JI project portfolio RUSAL accepted Environmental strategy, which, among others, set a goal on GHG regulation and emission reduction circulation. From that point this was a real action that initiated the development of JI projects of above smelters on a RUSAL level.
2007	UC RUSAL Action: Setting the goals on reduction of CO2 emissions at Company's smelters/getting additional income from ERU sales and on realization of 6 Company's projects as JI Evidence: Passport of corporate project "Kyoto Protocol" accepted. Presentations of passport of project "Kyoto protocol" and Kyoto project realization. Justification of the evidence: By establishing a corporate project "Kyoto protocol" UC RUSAL set timeframes and estimated budgets for realization of the projects as JI. That was a further RUSAL real action to secure JI status of the smelter's project.
2008	UC RUSAL Action 1: Evaluation of all potential JI projects realized in Company's smelters in 2000-2007. Evidence 1: Discussion of all potential JI projects in RUSAL carbon portfolio. Minutes of discussion on evaluation, checking and preparation of JI projects of 28/06/2008. Justification of the evidence 1: By this action RUSAL proceeded with actualizing the goals set in Environmental strategy and the project "Kyoto Protocol". Concrete assignment to evaluate potential JI projects realized in the smelters in 2000-2007 was provided. Action 2: Start of cooperation with a consulting company on JI project preparation for IrkAZ, SAZ, NkAZ projects. Evidence 2: Discussion of the cooperation with a consulting company (NOPPPU). Minutes of discussion # 1 of 24/09/2008. Justification of the evidence 2: This document can be considered as a real action because a certain consulting company was named and intentions stipulated for providing assessment of carbon potential of JI projects for attracting carbon investments. Action 3: Monitoring of PFC emissions in 2008 at IrkAZ, BrAZ, SAZ, NkAZ . Evidence3: see file XLS-file 2008-2011 "Meeting emission obligation" Justification of the evidence:

	This is a direct real action to provide JI status of the smelters' projects as the monitoring for the project emissions was established and provided.
2009	UC RUSAL Action 1: Postponing ofconsultancy services due toRUSAL difficult economic situation in the markets. Evidence 1: Discussion of the issue with participation of RUSAL and NOPPPU representatives. Minutes of discussion of 19/03/2009. Justification of the evidence 1: Despite postponing the development of JI projects was not terminated. Parties stuck with an intention to go back to the projects after improving financial health of RUSAL. Consistency of real actions provided on previous steps was not broken. Action 2: Monitoring of PFC emissions in 2009 at IrkAZ, BrAZ, SAZ, NkAZ . Evidence2: see file XLS-file 2008-2011 "Meeting emission obligation" Justification of the evidence: This is a direct real action to provide JI status of the smelters' projects as the monitoring for the project emissions was provided.
2010	UC RUSAL Action 1: Denial of approach proposed by former PDD developer (Poyry Energy) for KrAZ and BrAZ projects and intentions to enter into co-operation with NOPPPU on PDD development. Evidence 1:Discussion of approach proposed by NOPPPU. Minutes of discussion of 02.04.2010 Justification of the evidence 1: That is the evidence that RUSAL and NOPPPY (a third party consultant) were working closely on one of smelters' projects and were to sign a cooperation agreement for PDD development on IrkAZ, SAZ and NkAZ projects. Action 2: Monitoring of PFC emissions in 2010 at IrkAZ, BrAZ, SAZ, NkAZ. Evidence2: see file XLS-file 2008-2011 "Meeting emission obligation" Justification of the evidence 2: This is a direct real action to provide JI status of the smelters' projects as the monitoring for the project emissions was provided.
2011	UC RUSAL Action 1: Development ofpreliminary versions of PDD Evidence 1: Preliminary PDDs Justification of the evidence 1: That is a self-explanatory action. Action 2: Monitoring of PFC emissions in 2011 at IrkAZ, BrAZ, SAZ, NkAZ . Evidence 2: see file XLS-file 2008-2011 "Meeting emission obligation" Justification of the evidence 2: This is a direct real action to provide JI status of the smelters' projects as the monitoring for the project emissions was provided.
2012	UC RUSAL Action: Approval ofpreliminary versions of PDD with RUSAL Evidence: Submission of PDDs for determination.Letter of consultant to Tuev-Nord representative # ЮН-58/12 of 29/03/12. Justification of the evidence: That is a self-explanatory action.

Baseline scenario

According to the basic scenario the smelter would continue production of primary aluminium in potrooms 1-25 using the Soederberg technology with VSS (with high cryolite ratio) at the same volumes of production without taking measures for reduction of anode effect or improvement of ecology. This was dictated by the smelter's current practice of stable operation every year without breakages and stoppages. The Soederberg technology has been comprehensively studied; it is stable and widespread in the world practice, it is the major technology used at the Russian smelters. No other action, except for similar operation and technical efforts specifically aimed at reduction of anode effect, can influence the anode effect as anode effect is an indicator of smelting pot normal operation.

The following facts favoured the development of the basic scenario:

- Lack of drive stimuli for implementation of the project: anode effect has always been regarded as an appropriate operation of the pot. Moreover, reduction of frequency of anode effect does not significantly affect the key features of production, which are power consumption, volume and quality of aluminium and labour input. Therefore, reduction of anode effect does not benefit sufficiently and the smelter managers have never prioritised this issue. And even more, the current Russian laws on pollutant emissions and greenhouse gas emissions allow large-scale emissions of perfluorocarbon and naturally the smelter management's attitude towards anode effect and the associated greenhouse gas emissions is not governed by state.
- Lack of investment prospects for such projects: without the joint implementation tool offered by the Kyoto protocol the Company would not have commenced delivering this project as it brings no sufficient benefits except reduction in perfluorocarbon emission.

Gas emission reduction

The following will take place as a result of this project implementation:

- essential improvement of working conditions for the workers involved in smelting industry.

- reduction in PCF (CF_4 и C_2F_6) emission for 826024 tonnes of annual production of aluminium or 4130119 for the period of 2008-2012.

A.3. Project participants:

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Party involved	**Legal entity project participants (as applicable)**	**Please indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Party A - Russian Federation (Host party)	"RUSAL BrAZ" Joint Stock Company	No
Party B – No	To be determined further	-

JSC "RUSAL BrAZ" is one of producers of primary aluminium in the Russian Federation. It belongs to the United Company RUSAL and includes one of the world biggest smelter of primary aluminium.

A.4. Technical description of the project:

A.4.1. Location of the project:

A.4.1.1. Host Party(ies):

>>
Russian Federation

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

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The Project is being implemented at BrAZ territory in the city of Bratsk, Irkutsk oblast.

Figure 4.1.2 Irkutsk oblast on the map of the Russia

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

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Figure 4.1.3 Bratsk city on the map of Irkutsk oblast

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

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The Project is being implemented at the territory of the aluminium smelter in 25 potrooms of electrolysis production located in the industrial zone of Bratsk, Irkutsk oblast.

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

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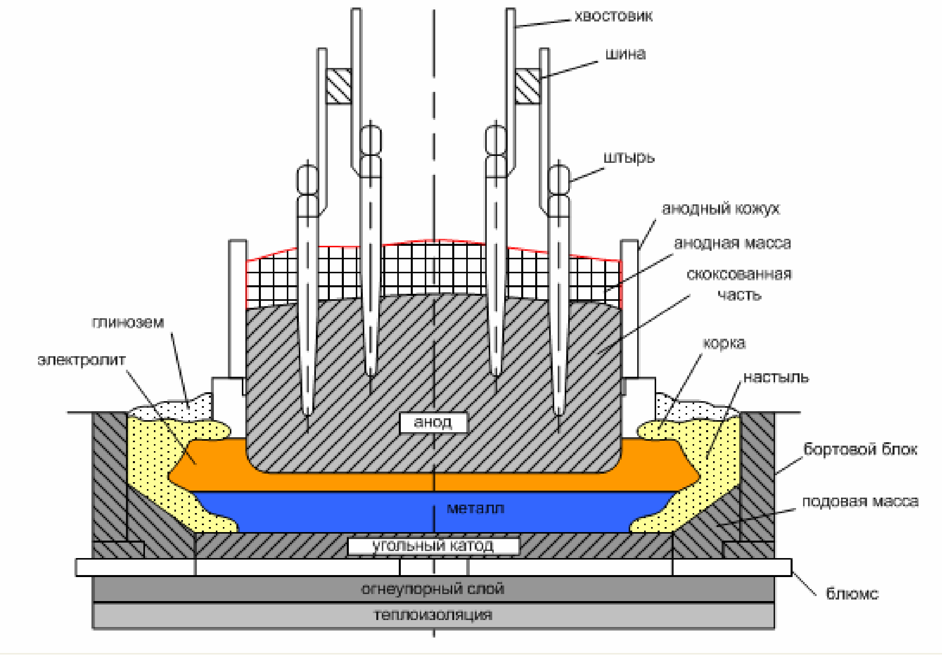
Process system description

Electrolytic aluminium production is based on electrolytic reduction of aluminium oxide (Al_2O_3) solved in cryolite melt in electrolyte pot at a temperature of 950-970°C. The electrolyte pot is a pot lined with carbon blocks serving as the cathode (the bottom). Molten aluminium is located on the bottom, because it is denser (its specific gravity is 2.7 g/cm^3 at 960 ^{0}C) than electrolyte (its specific gravity being 2.1 g/cm^3). Aluminium is pumped away with vacuum to vacuum ladles. Steel beams conduct electric current through fireproof siding brick away from the carbon cathode in the electrolyte pot footing. Anode is plunged in electrolyte from above, moving along steel guides. The anode carbon is consumed in the course of reduction. When prebaked anodes process is applied, carbon anodes are used, which burn in the atmosphere of oxygen produced from aluminium oxide producing carbon oxide (CO) and carbon dioxide (CO_2).



Two types of anodes are used in aluminium production:

a) Self-baking Soederberg anodes consisting of anode paste (calcinated coke mixed with coal tar or petroleum pitch) in steel casing. Exposed to high temperature, the anode paste is baked (sintered). There are two types of Soederberg electrolyte cells: - with horizontal conductor and with vertical conductor. At BrAZ, electrolyte cells with Soederberg anodes with upper conductor (VSS) are used. Alumina is fed manually: with a manually controlled alumina feeder (standard VSS procedure with SF).

b) More advanced baked anode procedure uses preliminary baked anodes from large carbon blocks (e.g. 1900×600×500 mm with a weight about 1.1 t) baked in special baking furnaces which are part of the refinery capacities.

Electrolyte pot operation procedure is regularly accompanied by the phenomenon called ‘anode effect’. Anode effect (‘flash’) is the result of anode polarisation at reduction. It takes place when alumina (Al_2O_3) concentration in electrolyte falls below the critical value (1.5 – 2%) (the so called ‘pot deficiency’) and is characterised by a dramatic growth of voltage due to worsened anode wetting with electrolyte, and due to increase of electrolytic resistance at the anode-electrolyte interface.

Two gaseous perfluorocarbons (PFC) are produced at anode effect – tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) – gases covered by this project.

$4Na3AlF_6 + 3C \rightarrow 4Al + 12NaF + 3CF_4$

$4Na3AlF_6 + 4C \rightarrow 4Al + 12NaF + 2C_2F_6$

For feeding most of electrolyte pots, the side alumina loading method with crust breaking is used. In this case, the electrolyte crust is broken along the pot longitudinal wall and the alumina is manually loaded into the pot. This procedure is the standard and basic electrolytic pot feeding method. It is established that the basic cause of anode effect is fall of alumina concentration below the critical level between feeding cycles.

The purpose of the project is to change the electrolyte composition which will provide the pot with maximum stability to alumina feed fluctuations which is typical for electrolytic pots without APF. Acidic bath technology has been found optimal.
In order to reduce cryolite ratio it is necessary to increase the amount of AlF3 additive in the electrolyte.

Increase of this additive will have the following effect:
- Decrease of the maximum solubility of alumina;
- Decrease of the initial temperature of crystallisation process (liquidus temperature);
- Decrease of the electrical conductivity;
- Decrease of the density of molten electrolyte;
- Increase of the partial pressure of vapour;
- Decrease of viscosity of the electrolyte.

The combined effect of additives in the conventional sense leads to increase in current effervescive due to decrease of the metal solubility and decrease of the process temperature and decrease of the solubility of alumina, which may increase the frequency of anode effect.

However, the decrease of cryolite ratio (increase of AlF_3 additives) leads to the following changes: significant decrease of the viscosity and density of the electrolyte, and it increases the velocity of electrolyte circulation and the solution rate of alumina, while the physical volume of the electrolyte in the electrolytic pot is increased due to faster removal of the gas phase formed during electrolysis.
Decrease of the maximum solubility of alumina within the range of cryolite ratio 2.3-2.2 is not so sufficient to affect the potential of unexpected anode effect, a much more significant factor is the increase in the rate of electrolyte mixing that prevents the alumina depletion of local areas of anode, which may cause the anode effect. Thus, in case of decrease of cryolite ratio (revamp to the technology

of 'acidic' electrolytes) there is a significant reduction in the frequency of anode effect to 1 instance per day.

Baseline conditions (2000-2002):

- Frequency of anode effect in different types of pots — 1.52 occurrences per day
- Aluminium fluoride specific rate — 34.9 kg/t
- Current effervescive — 87.42%
- Specific power rate — 15820 kW*h/t

As a whole the production performance was satisfactory for the further operation, however, high frequency of anode effect was absolutely unacceptable. The project was aimed at reducing anode effect frequencies to less than 1 per day.

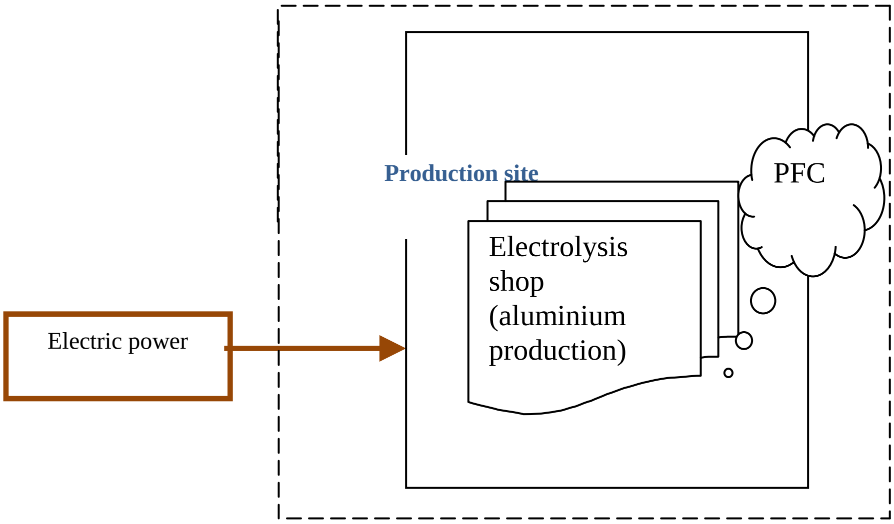
The data output of the project

BRAZ	Number of electrolyze series												
	1		2		3		4		5		6		7
	Potrom												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Category of electrolyze	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS
Technology	S8B	S8B	ShpVV	S8B	S8B	S8B	S8B	S8B	ShpVV	S8B	S8B	S8B	S8B
Feeding	SF	SF	SF	SF	SF	SF	SF	SF	SF	SF	SF	SF	SF

BRAZ	Number of electrolyze series (continued)											
		8		9		10		11		12		13
	Potrom											
	14	15	16	17	18	19	20	21	22	23	24	25
Category of electrolyze	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS
Technology	S8B	S8B	S8B	ShpVV	ShpVV	S8B	ShpVV	ShpBM	ShpBM	ShpVV	ShpVV	A-105; VT-120
Feeding	SF	SF	SF	SF	SF	SF	PF	SF	SF	SF	SF	PF

VSS –Soederberg electrolyte pots with the upper current conductor. PFPB – prebake pots with central feeding and with an alumina point feeding system. S – Soederberg process. SF – manual side feeding. PF-automatically feeding.

Figure. A.4.2. Layout of the project activity



Project history:

Transition to the improvement of technology of electrolysis (reform of electrolysis technology) and acidic electrolytes

10/12/2000 - discussion on the technical council of OAO "RUSAL BrAZ 'intentions to move to the program of recovery technology of electrolysis and electrolysis technology in acidic electrolytes to reduce the AE under Article 6 of the Kyoto Protocol.

The transition was carried out in accordance with the following plan

Measure	Date
Organization of three-level electrolysis process control	*2000-2002*
Changing the staffing process staff	*2000-2001*
Development of Regulations of the senior experts in order to control EP system of all pots	*2000-2001*
Technological change in the composition measurements	*2001*
Development of technical standards for technology management	*2000-2004*
The establishment of common targets and corridors of varying process parameters for the same type of pots	*2001*
Creating a single computer network of the plant, the development and introduction of automated workplaces (AWP) for professionals at every level of government	*2000-2001*
Development of advanced process control algorithms in the control system	*2001-2005*
The introduction of the planning system and the achievement of the technology of electrolysis	*2001*
2. Optimization of metal work in progress in electrolyzers	*2001-2003*
The introduction of methods for measuring the level of the metal using the bubble level	*2001*
Measuring the actual depth of the mine of electrolyzers working	*2001*
Setting the target level of metal pots, depending on the service life and design features	*2001*
Development of schedule to bring the volume of metal in each electrolytic cell to the optimal value	*2001-2003*
3. The stabilization of the electrolyte composition	*2001-2006*
Acquisition of the spectrometer ARL-9800 (2 pcs)	*2001*
Perform analysis of cryolite ratio using a spectrometer ARL-9800	*2002*
The introduction of the problem workstation "Correction of the electrolyte," the selection of coefficient	*2000-2001*
Reducing the target level of CR up to 2.45 units. and selection of the optimum technological parameters of the electrolysers.	*2002*
Reducing the target level of CR up to 2.4 units. and selection of the optimum technological parameters of the electrolytic cells.	*2004*
Finding the best rates for CR reduction.	*2006*
Determining an optimal time and frequency of treatment and the number of cell loaded alumina in order to minimize variations in the composition of the electrolyte	*2001*
Organization of the accounting system of uploaded GB aluminum fluoride to the electrolytic cell (equipped with machinery for loading fluorides counters that take into account the number of uploaded GB of raw materials, the development of the dose control system)	*2000-2001*

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:

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The project is aimed at minimising AEF which is the main cause of PFC emission. They can only be minimised by technical means provided in the project or by performing operational actions.

The specialists of the aluminium of UC RUSAL have always believed that aluminium production process can be made more effective at gradual reduction of AEF. Such a vision was out of tune with the common opinion that the process applied at electrolyte pot is imbalanced if no anode effect occurs. At Russia industrial facilities anode effect has always been considered as evidence of normal operation of electrolyte pot. Moreover, reduction of AEF has no significant impact on electric power consumption, aluminium production or its quality, or at workers' labour consumption. Consequently, decrease in anode effect brings no significant profit, therefore the refinery managers have never treated such a decrease as a priority. Moreover, the existing Russian laws allow for very significant perfluorcarbon emissions and has no influence on the refinery managers' attitude to anode effect and associated emission of greenhouse gases.

Without this project activity it would be impossible to achieve the decrease, since normal operation practice would provide for no actions aimed at anode effect decrease, and consequently a high level of anode effect would exist, characteristic of this type of reduction, which would lead to higher greenhouse gas emissions and environment deterioration.

All the above facts as well as the reasons provided in Section B mean that RUSAL Bratsk would not have started greenhouse gas emissions but for the support of Kyoto Protocol, and does so only within the framework of the joint implementation project.

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

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	Years
Length of the crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2equivalent
2008	665232
2009	897522
2010	806231
2011	880567
2012	880567
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4130119

Annual average of emission reductions over the crediting period (tonnes of CO_2 equivalent)	826024

In case of extending the crediting period beyond 2012 the monitoring plan and calculation of emission reductions will remain unchanged, which will be determined according to formulas in D sections.

	Years
Length of the second crediting period	5
Year	Estimate of annual emission reductions in tonnes of CO_2equivalent
2013	880567
2014	880567
2015	880567
2016	880567
2017	880567
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	4402835
Annual average of emission reductions over the crediting period (tonnes of CO_2 equivalent)	880567

A.5. Project approval by the Parties involved:

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On September 15, 2011 the Chairman of the Russian Federation Government signed Resolution 780 “On measures for realization of Article 6 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change”. This document depicts a JI-project approval procedure in the Russian Federation.

According to item 4 of the Provision the approval of projects will be carried out by the Ministry of Economic Development of the Russian Federation based on consideration of submitted project proposals. Competitive selection of demands is carried out by the operator of carbon units (Sberbank of RF) according to the item 10 of the Government Decree of the Russian Federation № 780.
According to item 7 of the Provision the application structure includes «the positive expert opinion on the project design documentation prepared according to the international requirements by the accredited independent entity chosen by the applicant».

Thus, according to the legislation of the Russian Federation in the field of JI projects realization, the Project approval is possible after reception of the positive determination opinion from AIE.

SECTION B. Baseline

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

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The chosen baseline will be described and justified on the basis of the "Guidelines for users of the joint implementation project design document form" (Version 04) and in accordance with the "Guidance on criteria for baseline setting and monitoring" (Version 03) and Appendix B to Decision 9/CMP.1 using the following step-wise approach:

Step. 1. Indication and description of the approach chosen regarding the baseline setting.

Step. 2. Application of the approach chosen.

The following is a detailed presentation of approach including two steps:

Step. 1. Indication and Description of the Approach Chosen Regarding the Baseline Setting

The baseline is determined through considerations of various alternative scenarios with regard to the proposed project activity. As criteria for choosing the baseline scenario the key factors will be determined. All alternatives will be considered in terms of influence on them of these factors. The alternative scenario, which is the least negatively influenced by the key factors, will be chosen as the baseline.

Therefore, the following stages of determining the baseline scenarios are envisaged:

a) *Description of alternative scenarios.*
b) *Description of the key factors.*
c) *Analysis of influence of key factors on alternatives.*
d) *Choosing the most plausible alternative scenario.*

Step. 2. Application of the Scenario Chosen

As options for production of electrolytic aluminium at project facilities (shops-potrooms), RUSAL Bratsk discusses the following scenarios:

Scenario 1. Continuation of smelter activity according to a standard Russian practice of Soderberg technology (VSS) application without measures specifically designed for reduction of frequency of anode effects.

Scenario 2. Implementation of the project with reform of electrolysis technology and cryolite reduction measures designed for reduction of of anode effects, without being registered as a JI-project activity

Other scenarios are not considered because they are not believable and not used in the Russian Federation. All smelters in Russia were built based on VSS technology. Exceptions are modern smelters Sayanogorsk aluminium smelter and Khakas aluminium smelter using prebaked PFPB anodes.

Compliance of selected alternatives with the current laws and regulations

In terms of regulations BrAZ is not required to reduce PFC emissions as they occur in anode effect, and anode effect is the normal operation of electrolytic pot.

Implementation of any of two scenarios complies with requirements of environmental legislation, as any of it will not exceed the maximum impact on environment capable of becoming a barrier to implementation of a certain scenario.

Conclusion: Thus, none of the stated options is in contradiction with the currently effective laws and may be considered for further analysis.

Stage 2. Key factors review

This stage involves identifying the factors that could interfere with alternative scenarios identified in the previous stage and analysis of influence of these factors on the implementation of alternatives. In result of factors review the conclusion on feasibility of each scenario is made.

The result of the two above stages is to determine the most likely options not hindered by factors considered.

Identification of factors that could interfere with alternative scenarios

For purposes of this analysis of key factors an influence of *technological factors* on above options is considered. These factors include:

Technical feasibility. As part of this factor, is considered the feasibility of option realisation from a technical and economic point of view taking into account remoteness of the project site, value of capital investments, availability and development of infrastructure. Should this factor not be overcome by one of the above options, it is not considered for further analysis.

Analysis of impact of key factors on these options

The influence of the factor of technical feasibility

Scenario 1. Continuation of smelter activity according to a standard Russian practice of Soderberg technology (VSS) application without measures specifically designed for reduction of frequency of anode effects.

Reducing the frequency of anode effect is not expected, as any high frequency at alkaline electrolytes in Soederberg technology is standard, and reflects the normal state of the pot, moreover, with this CR, sometimes anode effect is forced for prevention and treatment of the anode. At the smelter the production of electrolytic aluminium would continue using old buildings and Soederberg technology with upper current lead.

Use of existing technology of 'alkaline' electrolytes does not require cost increase.

Reduction of anode effect by itself is not anticipated; there may be minor fluctuations towards both, increase or decrease, due to different reasons: unstable structure of alumina, intermittent alumina loading (manual mode), poor sintering of anode, etc.

This, to some insignificant extent will result in

- Energy savings,
- Reduction of burnt out metal,
- Reduction of pollutant emissions through exhaust of reduction shop without processing thereof.

However, the total metal production and power consumption depend on many factors, so the results achievable as a result of unscheduled (by itself) reduction in frequency of anode effect are not measurable and assessable. This is one of reasons that at aluminium smelters in Russia there have been no attempts to reduce the frequency of anode effect. Exception of activities on reduction of anode effect frequency of this scenario is explained by existence of barriers to implementation of such measures (financial, institutional, and engineering-industrial).

The Russian laws on environmental protection do not regulate greenhouse gases considered in the project, despite the fact that the estimated safe level of exposure (ESLE) is established by GN 2.1.6.2309-07. According to 2.1.6.2309-07, ESLE of CF_4 = 10 mg/m3, C_2F_6 = 20mg/m3. Calculation of diffusion for the same smelter (Krasnoyarsk aluminium smelter) with a similar level of PFC emissions shows that the maximum single concentration of pollutants at the border of buffer zone is much lower than maximum permissible concentrations of these particles (in our case, this level is equal to ESLE).

Thus, according to the requirements of OND-86, such substances are not subject to restrictions. Therefore, they are not included in the maximum allowable concentration standards, and their emissions are not regulated.

Changes in the legislation relating to greenhouse gas emissions are not expected.

Slight reduction of frequency of anode effect during fluctuations in technological regime does not lead to a substantial reduction in emissions of pollutants when it enters the atmosphere through lamp exhaust of reduction shop without treatment (solid and gaseous fluorides, alumina dust), and the company, provided the project is implemented in full, meets the environmental standards. Therefore, the BrAZ management has no any reasons to implement additional measures to reduce the frequency of anode effect.

Thus, this option is quite feasible from a technical and economic point of view.

Scenario 2. Implementation of the project with reform of electrolysis technology and cryolite reduction measures designed for reduction of of anode effects, without being registered as a JI-project activity

During implementation of measures aimed at reducing the frequency of anode effect the management of the smelter did not set the goal of added value from the economic benefit associated with reduction in frequency of anode effect, including reducing power consumption and burnt out metal. The main reason for it is an impossibility to measure the effect resulting from these measures, which in other circumstances would become for management a strong case in favour of continuing work to reduce the frequency of anode effect.

The economic benefit of reducing the frequency of anode effect as a result of accompanying decrease in power consumption and burnt out metal cannot be measured with precision allowing the management to properly assess the decision to reduce the frequency of anode effect for the purpose to reduce power consumption and increase the production of aluminium.

The exact value of energy savings by reducing the frequency of anode effect can be calculated only theoretically, but its quantification is relatively simple.

Let us assume that the operating voltage of the electrolytic pot is 4.5 V and the current power in process is equal to 100 kA at the current effervescive of 88-90%.

Faraday's law is expressed as follows:

$m = k * I * \tau * CE$, kg

where:

k – is electrochemical equivalent of aluminium equal to 0.336 g/Ah (amount of aluminium produced at the cell cathode for an hour after passage of one Ampere electric current).

I – is a current power, kA.

τ – is the time during which the electric current passes through the pot, s.

CE – current effervescive.

Amount of aluminium produced by one electrolytic pot is defined by the Faraday's law. Within 24 hours an electrolytic pot produces:

$m = 0.336 * 100 * 24 * 90\ \% = 725.8$, kg

Power consumption is:

$W = U * I * 24 = 10{,}800$ kWh

Power consumption for production of one tonne of aluminium will be equal to 10,800/0.7258 = 14,880 kWh.

Let us assume, that at the electrolytic pot with the above operating parameters once a day anode effect with voltage of 40 V for 2 min is observed.

Additional daily power consumption due to the anode effect is:

$W = U * I *$ t*24 kWh

That corresponds to (40 -4.5)*100*(2 /(60*24))*24 = 118.3 kWh or 118.3/0.7258 = 163 kWh.

In the case of reducing the frequency of anode effect from 1 to 0.8 per day, additional power consumption will decrease by the same 20% and will be equal to 163 * 0.8 = 130 kWh.

In actual practice, reduction in additional consumption by 33 kWh (or 33/14,880 * 100 = 0.22%) is challenged by serious technical difficulties:

-In most electrolytic pots series of BrAZ the tolerance for measuring the current is 1-1.5% far exceeding the amount requiring a reduction of additional consumption. In such circumstances, the measurement of very small values is statistically meaningless.

Such theoretical change is not suitable for financial calculations as unsupported by measurements or actual significant changes in power consumption.

The same situation is with a change in pots performance due to reduction of anode effect frequency.

In the process of electrolysis, there are two types of product: electrolytic aluminium (i.e. aluminium produced by pot due to application of direct current) and crude aluminium extracted from the pot by vacuum bucket and passed to the casthouse.

In first approximation, the volumes of these two products can be considered approximately equal, although in practice, it is not so.

If the amount of crude aluminium can be determined by scales with accuracy of +/- 20 kg, amount of aluminium that always remains in pot is very difficult to determine with reasonable accuracy.

The design of electrolytic pots is such that on sides thereof there is a protective layer consisting of frozen electrolyte. This protective layer protects the pot walls against aggressive fluids.

The thickness of layer and its volume (as well as the amount of aluminium constantly remaining in the pot) cannot be determined with an accuracy of ± 7% using common methodology without use of radioactive isotopes or other costly methods.

At present there is no single hypothesis about the nature of the anode effect. Many researchers assume that the anode effect stops the emission of aluminium ions at the cathode. While others believe that the anode effect is the gas phase emission formed under anode with insufficient volume of electrolyte at the

bottom of the pot. In western literature, there are no consistent data that would support the assumption that the anode effect is systematically changing the current effervescive.
If we assume that under anode effect the current effervescive drops by 5%, then it should lead to an overall reduction in current effervescive equal to 5*2/(24*60) = 0.7%. In case of reduction the frequency of anode effect by 0.2 per day, in theory the drop in current effervescive should reduce by 0.14%.
To confirm such a connection a long experiment with completely stable baseline parameters is required. I.e., current, amount of raw material, temperature, etc. should remain strictly at the same level throughout the experiment. Thereafter it will be necessary to confirm that under these stable conditions, the amount of produced aluminium has changed, for example, by 0.14%. Until now, similar experiments were not conducted because of the impossibility to arrange thereof in an industrial environment.
All this means that it is not possible to determine the exact economic benefit of reduction of the loss of aluminium and power consumption. Nobody has ever measured these parameters and is not going to measure thereof in the future. Therefore, the only economic benefit considered by the company management in decision-making, is the possible benefit from sale of reduced emission units.
To support such a theory it is sufficient to recall that all Russian smelters have been built in sixties and use the same process. During all past decades, there was no effective plan to reduce the frequency of anode effect simply because it would not give a return on investment. Also this theory is supported by lack of any restrictions on PFC emissions in Russian regulatory documents.

Thus, we can say that in scope of the project there is a significant decrease in AE due to special measures aimed precisely at this, and, therefore, a significant reduction in PFC and carbon dioxide emissions.
However, in this scenario, we are talking about private funding in the event of environmental significance.
Implementation of project to reform of electrolysis technology and reduce cryolite ratio (transition to ‘acidic’ electrolytes technology) required substantial financial investments for:

- development of unified control system for monitoring electrolyte composition with the use of up-to-date equipment (spectrometer ARL);
- Equipping of technician workstations with software to provide accurate calculation of aluminum fluoride and calcium fluoride additives needed individually for each pot depending on the electrolyte composition and process conditions;
- Implementation of accounting system to account for upload quantity of aluminum fluoride into the pot (equipping of fluoride loaders with quantity meters, development of dose control systems);

- Calculation of the optimal time and pot service frequency as well as loaded alumina quantity for the purpose of minimization of composition variables;
- Change of technological personnel staffing list – introduction of Head technician, technician group, change of number of anode servicemen;
- Creation of tech management, that lead work on system development;
- Development of work regulations for senior electrolysis production specialists to control all pots;
- Changes in composition process measurements - new daily measurements of electrolyte and metal levels are introduced as well as new forms of pot work space;
- Development of technical standards for specific technology processes management, as well as creation of technical documents for technology control as a whole;
- Setting new target parameters and technology variables for similar pots;
- Creation of unified network, development and implementation of automated workplaces to provide more efficient control over technological data;
- Development of modern algorithms for technological process control.

The company at its own expense in the amount of RUR 23 mln. rub has implemented the project.
Given the situation with respect to the current understanding of anode effect, and taking into account the substantial private investments, it can be argued that without additional investments in this option, it is unlikely to have been implemented, as the costs have amounted to nearly RUR 23 mln. rub which is far higher than the option to use old pots of proven Soederberg technology. Thus, the ability to implement this alternative scenario is unlikely, but nevertheless, it will be considered in investment analysis.

Stage 3. Choosing the most plausible alternative scenario

Table B 1.1. Factor analysis

#	Factor	Scenario 1	Scenario 2
1.	Sectoral reform policies and legislation	Favors to implementation	Favors to implementation
2.	Economic situation in aluminium production sector	Makes this scenario the most plausible candidate for baseline	Unfavorably effects on its realization
3.	Availability of capital	Provides implementation of the scenario as no investments are needed.	Represents a considerable investment barrier for this scenario

Based on the conducted analysis it is quite obvious that the key factors favor the implementation of Scenario 1 and affect negatively Scenario 2. Therefore, Scenario 1 is the **baseline scenario**.

Theoretical description of the baseline scenario

Baseline GHG emissions take place due to the occurrence of anode effects during the production of primary aluminium.

$$BE = MP * AEF_b * AED_b * S_{CF4} * (6500 + F_{C2F6}/_{CF4} * 9200)/1000 \quad (1)$$

Where:
MP – is the production of electrolysis aluminium, t/year; equals to a quantity of aluminium poured out the pots plus aluminium remained in pots as work-in-progress.

AEF_b – is the average frequency of anode effects under the baseline, times per pot-days; in period 2000-2001 prior project implementation. Numeric value present in E section

AED_b –is the average duration of anode effect under the baseline, minutes, in period 2000-2001 prior project implementation. Numeric value present in E section

S_{CF4} – is the slope coefficient for CF_4, (kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot per day) [1];

$F_{C2F6 / CF4}$ – is the weight fraction of C_2F_6/CF_4

6500 – Global Warming Potential for CF_4 [2]
9200 – Global Warming Potential for C_2F_6 [3]

For calculation of the baseline PFC emissions the smelter provided a plausible estimate of the average frequency and average duration of anode effects which could happen in the absence of the project activity made by RUSAL BrAZ (please see the annex to PDD).
Applied values of the slope coefficient and weight fraction for appropriate technology are taken from technical report by RUSAL VAMI from 2009

The key information and data used to establish the baseline presented in the tables below:

Data/Parameter	MP
Data unit	tonnes
Description	Electrolytic aluminium poured out the pots
Time of determination/monitoring	constantly
Source of data (to be) used	Weight scale KGW-20
Value of data applied (for ex-ante calculations/determinations)	2008: 1007639 2009: 991578 2010: 977861 2011: 990192 2012: 990192

[1] Definition “pot-day” means the quantity of pots under operation multiplied by the quantity of working days (2006 IPCC, Volume 3, Chapter 4.4, page 4.55)

[2] http://unfccc.int/ghg_data/items/3825.php

[3] http://unfccc.int/ghg_data/items/3825.php

Justification of the choice of data or description of measurement methods and procedures (to be) applied	Data in 2008-2011 are actual and obtained on certified equipment. Data for 2012 are assumed on 2011 year level, considering global boost in aluminium supply.
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.
Any comment	-

Data/Parameter	AEDb
Data unit	Minutes
Description	Average duration of anode effect
Time of determination/monitoring	Constantly
Source of data (to be) used	Automatic process control system (APCS)
Value of data applied (for ex-ante calculations/determinations)	2,1 2,2 2,2 2,2 2,1 2,1 2,1 2,2 2,0 1,8 1,9 1,9 1,9 2,1 2,0 2,1 2,3 1,7 2,1 2,6 2,0 1,9 2,0 2,0 3,0 all 25 2,1
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Line trend based on Historical data from the database control system in period 2000-2001 prior project implementation. Numeric value present in E section
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.
Any comment	-

Data/Parameter	AEFb

Data unit	Anode effects per pot day
Description	Average frequency of anode effects
Time of determination/monitoring	Constantly
Source of data (to be) used	Automatic process control system (APCS)
Value of data applied (for ex-ante calculations/determinations)	1,48 1,37 1,25 1,57 1,59 1,58 1,62 1,42 1,46 1,24 1,42 1,27 1,26 1,44 1,33 1,37 1,43 1,37 1,55 1,21 1,41 1,33 1,45 1,5 2,2 All 25- 1,4
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Line trend based on Historical data from the database control system in period 2000-2001 prior project implementation. Numeric value present in E section
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.
Any comment	-

Data/Parameter	S_{CF4}
Data unit	(kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot day)
Description	Slope coefficient of CF_4
Time of determination/monitoring	Measured once in 3 years along with instrumental measurements by VAMI
Source of data (to be) used	2009 Measurement report
Value of data applied (for ex-ante	Pot room: ост — 0,084

calculations/determinations)	20 0,055 25 0,083
Justification of the choice of data or description of measurement methods and procedures (to be) applied	One value per unit
QC/QA procedures (to be) applied	Actual measurement data by certified equipment
Any comment	-

Data/Parameter	$F_{C2F6/CF4}$
Data unit	C_2F_6/CF_4
Description	Weight fraction
Time of determination/monitoring	Weighting ratio
Source of data (to be) used	Measured once in 3 years along with instrumental measurements by VAMI
Value of data applied (for ex-ante calculations/determinations)	2009 Measurement report
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Pot room: ост 0,051; 20 0,070; 25 0,073
QC/QA procedures (to be) applied	One value per unit
Any comment	-

Data and parameters that are not monitored throughout the crediting period but determined only once (and thus remain fixed throughout the crediting period)

Data/Parameter	**6500**
Data unit	tCO_2/tCF_4
Description	Global Warming Potential for CF_4
Time of determination/monitoring	Determined once during PDD development
Source of data (to be) used	Decision 2/CP.3 **http://unfccc.int/resource/docs/cop3/07a01.pdf#page=31** Climate Change 1995, Climate Change Science: Conclusion for politicians and technical conclusion of Report of Expert Group I, p.22 http://unfccc.int/ghg_data/items/3825.php
Value of data applied (for ex-ante calculations/determinations)	6500
Justification of the choice of data or description of	Global Warming Potential is needed for calculation of CO_2 equivalent emissions

measurement methods and procedures (to be) applied	
QC/QA procedures (to be) applied	Reference data
Any comment	-

Data/Parameter	**9200**
Data unit	tCO_2/tC_2F_6
Description	Global Warming Potential for C_2F_6
Time of determination/monitoring	Determined once during PDD development
Source of data (to be) used	Decision 2/CP.3 **http://unfccc.int/resource/docs/cop3/07a01.pdf#page=31** Climate Change 1995, Climate Change Science: Conclusion for politicians and technical conclusion of Report of Expert Group I, p.22 http://unfccc.int/ghg_data/items/3825.php
Value of data applied (for ex-ante calculations/determinations)	9200
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Global Warming Potential is needed for calculation of CO_2 equivalent emissions
QC/QA procedures (to be) applied	Reference data
Any comment	-

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:

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Additionality was demonstrated according to the paragraph 2 (a) of the Annex I to the "Guidance on criteria for baseline setting and monitoring" version 03 by "Provision of traceable and transparent information showing that the baseline was identified on the basis of conservative assumptions, that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of anthropogenic emissions by sources or enhancements of net anthropogenic removals by sinks of GHGs".
The analysis provided in subsection B.1. clearly demonstrates that the proposed project is not a baseline.

This section demonstrates that the project provides reductions in emissions by sources that are additional to any that would otherwise occur, using the following step-wise approach:

Step 1. Indication and description of the approach applied.

A JI-specific approach is chosen for justification of additionality. For this purpose provision a) is chosen defined in paragraph 2 of the annex I to the Guidance on criteria for baseline setting and monitoring version 02. 1, i.e: (a) Provision of traceable and transparent information showing that the baseline was identified on the basis of conservative assumptions, that the project scenario is not part of the identified baseline scenario and that the project will lead to reductions of anthropogenic emissions by sources or enhancements of net anthropogenic removals by sinks of GHGs.

Step 2. Application of the approach chosen.

The step includes consideration of three sub-steps:
Sub-step 2.1. Identification of alternative scenarios.

Sub-step 2.2. Investment analysis.

Sub-step 2.3. Common practice analysis.

For further analysis the alternatives identified in B1 Section are applied:

Sub-step 2.1. Identification of alternative scenarios.

Scenario 1. Continuation of smelter activity according to a standard Russian practice of Soderberg technology (VSS) application without measures specifically designed for reduction of frequency of anode effects.

Scenario 2. Implementation of the project with reform of electrolysis technology and cryolite reduction measures designed for reduction of of anode effects, without being registered as a JI-project activity

Sub-step 2.2. Investment analysis

It is determined on this sub-step:

- whether the Project is a most financially or economically attractive alternative;
- whether the Project is economically or financially viable without cash generated from ERU sales.

Sub-step 2.2a. Determination of appropriate analysis method
On this sub-step it is determined whether to apply simple cost analysis, investment comparison analysis or benchmark analysis. If the JI project activity generates no financial or economic benefits other than JI related income, then the simple cost analysis is applied.

The proposed JI project activity does not generate income from sales of electricity or additional quantity of aluminium or economy of fuel, therefore the simple cost analysis is applied.

Sub-step 2.2b. Simple cost analysis
Under the baseline the production of electrolysis aluminium would be continued in potrooms 1-25 as per VSS Soderberg technology with top-worked pots on alkaline electrolytes and maintaining the current production level without measures on reductions of AEF and additional environmental activities. This situation can be justified with historical practice of a year-by-year stable performance of the smelter without production breakdowns. VSS Soderberg technology is thoroughly known, stable and widespread in a global practice. Apart from that Russian major smelters use this technology. Besides, the Company would not make investments. Any planned or emergency repair takes place in both scenarios. Such a repair would be made at the expense of annual production plan funds and therefore it is not taken into account.

The project scenario including the measures is directed at the AE reductions at the expense of Company's funds and costs 23 million rubles. The proposed JI project does not generate an income from the economy of electricity and of fuel or from the sale of additional aluminium. Therefore the investing Company cannot get another income from project realization except from that of generated by ERU sales.

Comparisons of alternatives 1 and 2

	Alternative 1	Alternative 2 (Project)
Investments, mln Rubles	Nil since no additional expenses are required	23

The main parameters influencing the evaluation of electrolyze productions (and as a consequence of the current economy and aluminum) is:
-Cell operating voltage of 4.5 V
-Current amperage in the process is 100-150 kA (reference value for Soderbergh)
-Tolerance (error rate) measurements of the current amperage
-Tolerance of the measurement of weight of aluminum in the weights

All of the above options will be calculated on the basis of really logic and electrochemical laws, the amount of energy savings and the aluminium production in the AE reductions.
So, the explanation in Section B, indicate that reduction of electricity consumption this is a statistically small quantities are to be measured, because are located in the partings of errors involved in the monitoring.
To confirm that the auditors were presented passports instruments (scales and measuring channels of electrolyze process in Irkaz).
Passport error by scale = 20 kg weights.
The electrolyze channel error 1-1.5%
The remaining quantities, they are an advisory and standard options reflective of a process (electrolyze voltage and current). It can be found in the directory http://www.alfametal.ru/?id=hommadeall

As already noted the theoretical benefit from energy savings can be calculated by multiplying reduction in project additional consumption by 33 kWh per tonne Aluminium with aluminium production (e.g. in 2000 it was approx. 900 Ths t) tonne with the tariff as of 2000-2001. The theoretical savings would be approx. 6 Mio Rub (33kWh/t*900 ths.t *0.2 rub/kWh = 6 Mio rub)
The investment costs for implementing the project activity are 23 Mio Rub. As evident from this analysis even the theoretically estimated savings are significantly lower than the investment costs.

Therefore, considering the above it is quite obvious that Alternative 2 requires considerable costs for its implementation whereas no expenses are needed for implementation of Alternative 1.

Sub-step 2.3. Common practice analysis
Aluminium business management strategy pay little attention to AEF reduction measures due to an impossibility of estimating economic advantages associated with them. As it is impossible to assess economy of electric power and increasing aluminium output due to AEF reduction, such measures are out of priority for the managers of the smelters. Therefore, such measures are not widespread. There is a AEF reduction project at another smelter, KrAZ, but it is realized under Article 6 of Kyoto Protocol, therefore it cannot be considered as a common practice. As RUSAL today is an only company in Russia, which produces aluminium, it testifies to the fact that the proposed Project activity is a common practice.

Resume: Analysis conducted above clearly demonstrates that the Project activity is not an economically attractive alternative and is not a common practice. Therefore it is additional.

Step 3. Provision of additionality proofs.
Information provided as evidence of complementarity, the following documents:
-protocols for making decisions under Article 6 of the Kyoto Protocol
-financial documents for the project Capex

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

>>

The project boundary embraces GHG emission sources attributed to the project activity. It is only those sources are taken into account emissions from which are above (1%) in the overall quantity of GHG emissions. In the following table the emission sources and GHG types are considered as to including them in the baseline or project boundary.

Emission considered includes CF4 and C2F6 occurred due to the anode effect at all 25 electrolysis potrooms.

PFC reduction is achieved by reduction of anode effect duration and frequency reduction.

The Project doesn't include reduction of side emissions due to reduction of energy consumption, reduction of anode frequency
The project does not consider the reduction in indirect emissions achieved by energy savings, due to reduction of anode frequency, since it is not possible to measure the energy savings.

Table B 3.1. GHG emission sources

Scenario	GHG source	GHG type	Include/do not include	Comments
Baseline	PFC emissions during anode effect	CF_4 and C_2F_6	Include	Main emission source
		N_2O	Do not include	N_2O emissions does not occur
		CO_2 CH_4	Do not include	CO_2 и CH_4 are not considered to be conservative as emissions of these gases under the baseline are greater than that under the Project
Project activity	PFC emissions during anode effect	CF_4 and C_2F_6	Include	Main emission source
		N_2O	Do not include	N_2O emissions does not occur
		CO_2 CH_4	Do not include	Emissions of these gases are reduced during the Project. But Project participants decided not to consider them to simplify the monitoring.

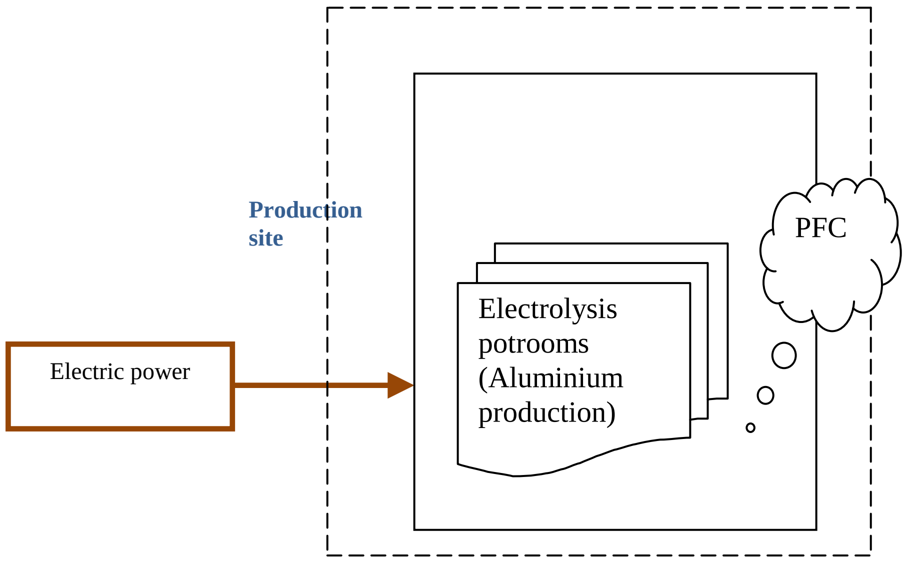
Leakage assessment
In accordance with "Guidance on criteria for baseline setting and monitoring" (Version 03) the leakage is determined as "the net change of anthropogenic emissions by sources and/or removals by sinks of GHGs which occurs outside the project boundary, and that can be measured and is directly attributable to the JI project." In case the potential leakage is determined the project participants must undertake an assessment of the potential leakage of the proposed JI project and explain which sources of leakage are to be calculated, and which can be neglected.

Main potential leakages attributable to the Project activity are GHG emissions due to electric power generation in the grid.

Due to the Project activity the electric power consumption will be reduced. So will be the fuel consumption (and hence GHG emissions) at the grid power plants. However, for conservativeness sake these emissions will not be taken into account.

Project boundary includes all electrolysis potrooms at which aluminium is produced.

Fig B.3.1. Project boundary



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 setting: 25.03.2012.

The baseline has been designed by:
National Carbon Sequestration Foundation – (NCSF, Moscow);

Contact person:
Timofey Besedovskiy,
Lead expert of Project Development Department;
Tel +7 499 788 78 35 ext. 108
Fax +7 499 788 78 35 ext. 107
E-mail: BesedovskiyTN@ncsf.ru

National Carbon Sequestration Foundation is not a participant of the Project.

SECTION C. Duration of the project / crediting period

C.1. Starting date of the project:

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The Project's starting date is 14/01/2001. On this date to move to the program of recovery technology (reform of electrolysis technology)

C.2. Expected operational lifetime of the project:

>>

Operational lifetime of the Project is 20 years or 240 months: from 14/01/2001 till 14/01/2021.

C.3. Length of the crediting period:

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Crediting period is determined within the first budget period of Kyoto Protocol from 01.01.2008 till 31 December 2012 and making 5 years or 60 months.

If the Russian Federation joins further extension of the budget period beyond 2012 the crediting period will be automatically prolonged.

The credit period of the project will not exceed the life of the project.

SECTION D. Monitoring plan

D.1. Description of monitoring plan chosen:

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The monitoring plan is described throughout a section D in accordance with paragraph 30 of the Guidance on criteria for baseline setting and monitoring. Project developer applies its own methodology for monitoring plan (JI specific approach) in accordance with paragraph 9 (a) of the Guidance on criteria for baseline setting and monitoring (Version 03), and other applicable JI guidelines. The JI-approach includes consideration of the following steps:

Step 1. Indication and description of the approach chosen regarding monitoring.

Step 2. Application of the approach chosen.

Below the approach is presented in more detail.

Step 1. Indication and description of the approach chosen regarding monitoring.

The electrolysis potshops 1-10 will participate in the monitoring at the smelter.

Description of monitoring points

M1i	M2i	M3i
Production of electrolysis aluminium, t	Average frequency of anode effect, anode effects per pot day	Average duration of anode effect, min

Key emission parameters

The emission parameters needed for determining of PFC emissions (including baseline and project emissions) are defined in accordance with the existing practice of measuring such emissions and fixing technical-economic indicators BrAZ.

Resently BrAZ smelter underwent through the process of modernization of the monitoring system, all data on aluminium production, AEF and AED are under control, stored in the electronic database and are updated on-line. The terminals are installed in the control rooms at each electrolysis potroom where reliable data are gathered.

Control for the Project implementation does not require changing in the existing system of data collection and registration system.

Technologies and formulas for defining emissions are described in the last version of 2006 Aluminium Sector Greenhouse Gas Protocol developed by International Aluminium Institute. The provisions of the Protocol are included in 2006 IPCC, Chapter 4.4 "Primary Aluminium Production".

According to the technology the Tier 2 method should applied for the emission calculation of the proposed project activity. Under the Tier 2, the actual data on anode effect, on aluminium production and standardized production factors are used in calculation.
Though RUSAL VAMI has conducted instrumental mearsurements (2009), which allowed to more accurately calculate emissions (tier 3 by IC) as compared to tier 2 results.

According to 2006 IPCC the PFC emissions will be determined according to the formula:

$$ER_{CO2} = MP * AEF * AED * S_{CF4} * (6500 + F_{C2F6}/_{CF4} * 9200)/1000$$

MP – is the production of electrolysis aluminium, t/year; equals to a quantity of aluminium poured out the pots plus aluminium remained in pots as work-in-progress.

AEF_b – is the average frequency of anode effects under the baseline, times per pot-days;

AED_b –is the average duration of anode effect under the baseline, minutes

S_{CF4} – is the slope coefficient for CF_4, (kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot per day) [4]; IPCC 2006 or real measured

$F_{C2F6\ /\ CF4}$ – is the weight fraction of C_2F_6/CF_4 ,IPCC 2006 or real measured

6500 – Global Warming Potential for CF_4[5]
9200 – Global Warming Potential for C_2F_6[6]

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[4] Definition "pot-day" means the quantity of pots under operation multiplied by the quantity of working days (2006 IPCC, Volume 3, Chapter 4.4, p. 4.55)

[5] http://unfccc.int/ghg_data/items/3825.php

[6] http://unfccc.int/ghg_data/items/3825.php

For defining the slope coefficient for CF_4 and the weight fraction $F_{C2F6/CF4}$ there is no need in measurements as the reference data from 2006 IPCC are used.

Technology	**Slope coefficient [(kg CF4/tonne Al) / (minutes of AE / Pot-day]**		**Weight fraction C_2/F_6**	
	S_{CF4}	Uncertainty (±%)	$F_{C2F6/CF4}$	Uncertainty (±%)
VSS	0,092	17	0,053	15
CWPB & PFPB	0,143	6	0,121	11

Slope coefficients for CF4 and weight ratio C2F6/CF4 in case of direct measurements.
The slope coefficients were obtained during instrumental measurements of PFCs performed by specialists of the department of ecology "RUSAL VAMI" at gas ducts of pot room #18 (VSS without point feeders), pot room 20 (VSS with point feeders) and port room 25 (VSS with point feeders).

All PFC measurement logs are stored on paper not less than 10 years in the HSE Department of UC RUSAL.

According to data reflected in PFC measurement report, the main source of uncertainty during direct continues measurements are:

-uncertainty of spectrometer calibration;
-accuracy of the analytical method for calculating the concentration of CF4 and C2F6 in measured spectrum;
- Accuracy of flow measurement in the gas ducts.

Specific coefficients were received as a result of “RUSAl VAMI” PFC emission measurements in 2009 at Bratsk Aluminum Smelter.

Results of “RUSAl VAMI” PFC emission measurements in 2009 at Bratsk Aluminum Smelter:

Parameter	Measurement unit	Sampling area		
		Pot room № 18	Pot room № 20	Pot room № 25
Slope coefficient	(kg CF4/t Al)/(min. AE/pot day)	**0,084**	**0,055**	**0,083**
Weight ration	(C_2F_6/CF_4)	**0,051**	**0,07**	**0,073**

For emission reduction calculations, RUSAL VAMI coefficients obtained in 2009 are used, but, since there was no change in technology since 2008, the use of same coefficients is justified, since those coefficients are more precise and correspond to tier 3 IPCC approach.

Step 2. Application of the approach chosen.

See below

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.	*MP Electrolytic aluminium production*	*Each potroom*	*tonnes*	*m*	*monthly*	*100%*	*Paper and electronically*	*Data stored in automated process control system (APCS)*
D.1.1.1.2.	*AED Average duration of anode effect*	*Each potroom*	*minutes*	*m*	*constantly*	*100%*	*Paper and electronically*	*Data stored in APCS*
D.1.1.1.3.	*AEF Average frequency of anode effects*	*Each potroom*	*Anode effects per pot day*	*m*	*constantly*	*100%*	*Paper and electronically*	*Data stored in APCS*
D.1.1.1.4	S_{CF4} *Slope coefficient of* CF_4	*VAMI*	*(PFC kg /t AL/AE min /day)*	*m*	*Once in three years, or when the pot type is changed, or after any*	*Not less than 15 AE per technology type (VSS, PFVSS)*	*Measurement report*	*Measurements were performed in 2009. After comparison standard tier 2*

					significant change in technology			*coefficients will be replace. To see a more thorough information on measurement period and measurement technics, please, see CF4 and C2F6 measurement for primary aluminum production report IAI, April 2008*
D.1.1.1.5	*C_2F_6/CF_4*	*ВАМИ*	*(PFC kg /t AL/AE min /day))*	*m*	*Once in three years, or when the pot type is changed, or after any significant change in technology*	*Not less than 15 AE per technology type (VSS, PFVSS)*	*Measurement report*	*Measurements were performed in 2009. After comparison standard tier 2 coefficients will be replace. To see a more thorough information on measurement period and measurement technics, please, see CF4 and C2F6 measurement for primary*

								aluminum production report IAI, April 2008

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

>>

GHG project emissions will take place due to the occurrence of anode effect during production of the primary aluminium:

1. $$PE_{pCO2_e} = MP * AEF_p * AED_p * S_{CF4} * (6500 + F_{C2F6}/_{CF4} * 9200)/1000$$

MP – is the production of electrolysis aluminium, t/year; (PFC001 form)

AEF_p – is the average frequency of anode effects under the project, aluminium effects per pot-days; (PFC001 form)

AED_p –is the average duration of anode effect under the project, minutes (PFC001 form)

S_{CF4} – is the slope coefficient for CF_4, (kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot per day) [7]; VAMI technical report

$F_{C2F6\,/\,CF4}$ – is the weight fraction of C_2F_6/CF_4 ,VAMI technical report

6500 – Global Warming Potential for CF_4[8]
9200 – Global Warming Potential for C_2F_6[9]

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:

---

[7] Definition "pot-day" means the quantity of pots under operation multiplied by the quantity of working days (2006 IPCC, Volume 3, Chapter 4.4, page 4.55)

[8] http://unfccc.int/ghg_data/items/3825.php

[9] http://unfccc.int/ghg_data/items/3825.php

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.	*MP Electrolytic aluminium production*	*Each potroom*	*tonnes*	*m*	*monthly*	*100%*	*Paper and electronically*	*Data stored in automated process control system (APCS)*
D.1.1.3.2.	*AED Average duration of anode effect*	*Each potroom*	*minutes*	*m*	*constantly*	*100%*	*Paper and electronically*	*Data stored in APCS in period 2000-2001 prior project implementation. Numeric value present in E section*
D.1.1.3.3.	*AEF Average frequency of anode effects*	*Each potroom*	*Anode effects per pot day*	*m*	*constantly*	*100%*	*Paper and electronically*	*Data stored in APCS in period 2000-2001 prior project implementation. Numeric value present in E section*
D.1.1.3.4	S_{CF4} *Slope coefficient of* CF_4	*Slope coefficient* S_{CF4} CF_4	*VAMI*	*(PFC kg /t AL/AE min /day))*	*m*	*Once in three years, or when the pot type is changed, or after any significant change in technology*	*Not less than 15 AE per technology type (VSS, PFVSS)*	-

D.1.1.3.5	*C_2F_6/CF_4*	*Slope coefficient S_{CF4} CF_4*	*VAMI*	*(PFC kg /t AL/AE min /day))*	*m*	*Once in three years, or when the pot type is changed, or after any significant change in technology*	*Not less than 15 AE per technology type (VSS, PFVSS)*	-

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

>>
GHG baseline emissions will take place due to the occurrence of anode effect during production of the primary aluminium:

2. $$BE_{bCO2_e} = MP * AEF_b * AED_b * S_{CF4} * (6500 + F_{C2F6/CF4} * 9200)/1000$$

MP – is the production of electrolysis aluminium, t/year; (PFC001 form)

AEF_p – is the average frequency of anode effects under the baseline, aluminium effects per pot-days; (PFC001 form)

AED_p –is the average duration of anode effect under the baseline, minutes , (PFC001 form)

S_{CF4} – is the slope coefficient for CF_4, (kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot per day); VAMI technical report

$F_{C2F6\,/\,CF4}$ – is the weight fraction of C_2F_6/CF_4 ,VAMI technical report

6500 – Global Warming Potential for CF_4
9200 – Global Warming Potential for C_2F_6

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

This option is not applicable.

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

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):

>>

This option is not applicable.

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

No leakage emissions identified due to implementation of this Project.

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

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

>>

Not applicable.

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):

>>

3. $$ER_{CO_{2e}} = BEb_{CO_{2e}} - PEp_{CO_{2e}}$$

$ER_{CO_{2e}}$ – reduction of PFC emissions due to the project implementation, tCO_2e/year;
$BEb_{CO_{2e}}$ – PFC baseline emissions, tCO_2e/year;
$PEp_{CO_{2e}}$ – PFC project emissions, tCO_2e/year.

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:

>>

In accordance with the legislation in the field of environmental protection, the company must control emissions, wastewater discharges, organize and ensure the management of waste production and consumption, established to provide accountability in public authorities (Federal Service for Ecological, Technological and Atomic Supervision).

During anode effect direct emissions of perfluorocarbons, solid and gaseous fluorides, carbon monoxide and carbon dioxide, sulfur dioxide, inorganic dust, etc are produced.

The main data sources to monitor polluting emissions into the atmosphere are:
- Technological reports by type of production (anode, electrolysis);
- Health and environmental monitoring data (gas cleaning and sealing pots);
- Primary data on the materials used.

Monitoring of emissions is based on a special control schemes, including standards, metering, operators, control periods, measuring methods and parameters. The calculation of emissions of harmful substances carried out by specialists of environmental department in accordance with the methodology for analyzing the composition and volume of emissions in the production of electrolytic aluminum, approved by the Federal Service for Ecological, Technological and Atomic Supervision in accordance with the Decree № 182 of March 31, 2005.

Data on qualitative characteristics of the raw materials used in the production are provided by technical control experts over the results of laboratory tests conducted in the central laboratory accredited in the system of analytical laboratories of the Federal Agency for Technical Regulation and Metrology.

A list of certified methods to determine the quality characteristics of raw materials.

#	Raw material	Component to determine	Normative document on analytical method	Range measurements, %масс.	Error of analysis, %абс
1	Aluminum fluoride (AlF_3)	F	GOST 19181-78 «Aluminium fluoride technical. Technical conditions», item.4.4	from 10 to 65 incl.	1,30
2	Aluminum fluoride (AlF_3)	SO_4	GOST 19181-78 «Aluminium fluoride technical. Technical conditions», item.4.1	from 0,1 to 0,7 inclusive	0,09
3	Calcium fluoride (CaF_2)	CaF_2	GOST 7619.3-81 «Fluor spar. Method of determination of calcium fluoride»	from 70 to 90 incl. s 90	0,95 1,14
4	Calcium fluoride (CaF_2)	S	GOST 7619.3-81 «Fluor spar. Method of determination of total sulfur»	from 0,1 to 0,3 incl.	0,038
5	Coke	S	GOST 8606-93 «Solid mineral fuel. Determination of total sulfur. Method of Eshka»	from 0,5 to 5,0	0,043

Sanitary and environmental parameters (data on gas cleaning and sealing of the electrolytic bath) is performed by specialists of sanitary and industrial laboratory (SIL). SIL is certified for the appropriate technology and is registered in the State Register. CIL is checked annually by Certification Service for technological competence.

Internal inspection is conducted on a regular basis in each department of environmental control in order to verify the accounting procedures, receiving and storing data, and calibration procedures, testing equipment and procedures for staff training in accordance with the Regulations "Internal Audit". Calibration of measuring instruments for monitoring environmental parameters used is carried out in accordance with the Regulation "Monitoring and control units of account".

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.

D.1.1.1.1., D.1.1.3.1.	*Low*	*The volume of production of electrolytic aluminum by potrooms for the year is determined by summing the mass of the metal, determined by weighing buckets with metal from the electrolysis, and determine the mass of aluminum in liquid form, located in electrolyzers as a work in progress.* *1. Weighing of bucket with aluminum is produced on scales «KGW-20" by DF staff (Directorate foundry) in accordance with instructions for use "Scales Crane type KGW». Scales are included in the "List of measuring equipment," and every year according to the "Schedule of verification and calibration of measuring instruments' are calibrated by specialists of contractor in accordance with GOST 8.453-82," Scales for statistical weighting. Methods and means of verification. "* *The maximum permissible error: ± 20 kg with a range of weighing 5000-20000kg.* *Entries for the weighing buckets with metal stored in electronic form in the "ARM weighting" of at least 5 years.* *2. Amount of aluminum in liquid form in electrolyzers is determined by "Method for determination of liquid aluminum in electrolysis cells," according to the instructions of TRP 00.01.02-04 "Electrolysis production. Determination of liquid goods in process of the electrolysis of aluminum is carried out by the indicator method "once a quarter.* *The method of definition is as follows: Number of molten metal in the body of a pot is determined by multiplying the average level of the metal in a pot by the average mass per centimeter of the metal and the number of existing electrolyzers.* *The level of metal line is measured in accordance with the KPVO 440.01.01.15.02-2008 "Measurement of the metal and an electrolyte."* *The average weight of one centimeter of the liquid metal set at least once a year with the metal-indicator method by GOST 3221-85.The method is based on determining the difference between the mass fraction of copper in aluminum for a certain period of time, measuring the metal level in the cell and the subsequent calculation of the formula. The measurements produce at 10% of electrolyzers. In the analysis of the metal the conditions are followed set by the normative documents of the means of measurement.* *Based on the foregoing, it can be assumed that the uncertainty of data consists of 0.1% error of the weights (based on the mass of the bucket with a weight of metal 10t) and not more than 10% of the accounting work in progress based on the fact that the measurement is made on 10% of pots with a view errors of the means of measurement and implementation of indirect measurements, but due to the fact that the volume of work in progress is less than 1% of the annual volume of electrolytic aluminum, the overall accuracy of this index will not exceed 0.1%.*

D.1.1.1.2., D.1.1.3.2., D.1.1.1.3., D.1.1.3.3		*AEF of the corps of electrolysis for the year, AEF /pot -day and the duration of the AE potrooms per year, min./pot day is carried out by an automated process control system of electrolysis aluminum).* *One of the functions of process control is the control of AE on the voltage measurement channel in the area anode-cathode (Ua-k) for a five-minute averaging interval. In excess of the increase a certain threshold, such as 8 mV for 5 minutes is declared the prediction of AE. It is prohibited to automatically move down the anode. By reducing the voltage gain up to 6 mV, a sign of the forecast AE removed. The basic error of the channel ± 0,2%. The measuring channel is regularly calibrated according to procedure "METODICAL GUIDANCE SYSTEM FOR MEASURING ALUMINUM ELECTROLYSIS PROCESS. CONTROL METHODS OF CALIBRATION." Specialists of contractor carry out calibration in accordance with the Rules of calibration of measuring instruments."* *Entries for the AEF and AED stored in electronic form at least 5 years.* *Based on the data accumulated during the operation control system, the percentage of lost information on the number and duration of anode effects due to the failure of the control system is approximately 2%, so the uncertainty is low and the sum of the percent error of the channel and control system performance of APCS.*

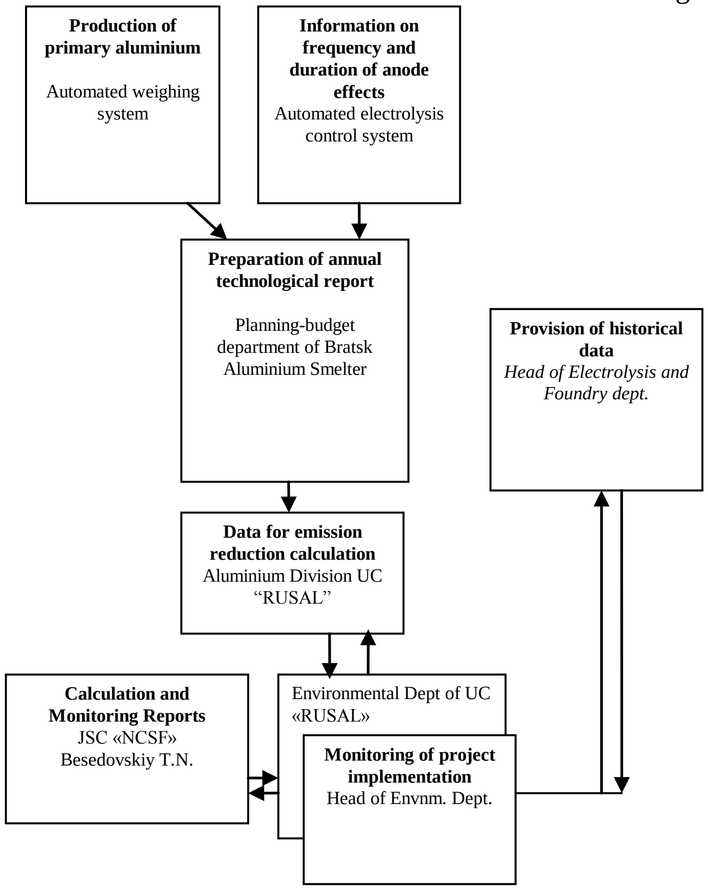
D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

>>

Necessary to calculate the emission reductions of greenhouse gas emissions information is collected as is usually done at the Bratsk aluminum smelter, so monitoring does not require any other additional information as compared with the already collected.
Measuring the output of electrolytic aluminum, frequency and duration of anode effects is carried out electronically without human intervention. Thus, the Bratsk aluminum smelter is the high-tech enterprise, with a fully automated accounting system operating parameters. The human factor is minimized.

The calculation of emission reductions at the end of each year of the crediting period is performed based on data that are provided by Aluminium Division of UC "RUSAL" for annual environmental reporting regulations (PFC Form 001) in the International Aluminium Institute (IAI). Calculation of GHG emission reductions is based on the annual technical reports of the Bratsk Aluminium Smelter. The baseline was calculated as a result of expert judgment of specialists of Bratsk aluminium smelter based on historical data. Below is a schematic diagram of the organization of monitoring reductions in greenhouse gases by JSC "RUSAL Bratsk."
If the monitored data are not available because of a failure of the instruments, it closes a gap similar to the average data for the same period at this site.
The data on the emission reductions achieved, and the original data will be available for project participants 2 years after the last transfer of ERUs.

Figure D.1.1 scheme of monitoring at the smelter.



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

>>

The monitoring plan has been established by:
National Carbon Sequestration Foundation – (NCSF, Moscow);

Contact person:
Timofey Besedovskiy,
Lead expert of Project Development Department;
Tel +7 499 788 78 35 ext. 108
Fax +7 499 788 78 35 ext. 107
E-mail: BesedovskiyTN@ncsf.ru

National Carbon Sequestration Foundation is not a participant of the Project.

SECTION E. Estimation of greenhouse gas emission reductions

In assessing the greenhouse gas emissions resulting from implementation of project activities and baseline the emissions are determined by the formulas given in Section D.

Production data to calculate of emission reductions

Potrom	Technology	Type of electrolyze	Year	Production of aluminium		FAE	
				project	**baseline**	**project**	**baseline**
1	VSS	2008	39 745,8	1,16	1,44	2,10	2,10
2	VSS	2008	39 768,9	1,08	1,44	1,75	2,10
3	VSS	2008	39 924,7	1,17	1,44	1,78	2,10
4	VSS	2008	39 857,0	1,13	1,44	1,94	2,10
5	VSS	2008	39 656,5	1,31	1,44	1,97	2,10
6	VSS	2008	39 709,7	1,12	1,44	1,87	2,10
7	VSS	2008	39 589,4	1,11	1,44	1,97	2,10
8	VSS	2008	39 306,7	1,31	1,44	2,01	2,10
9	VSS	2008	38 965,8	1,12	1,44	1,54	2,10
10	VSS	2008	39 217,1	0,98	1,44	1,66	2,10
11	VSS	2008	39 418,6	0,71	1,44	1,62	2,10
12	VSS	2008	39 210,9	0,54	1,44	1,62	2,10
13	VSS	2008	40 051,0	1,04	1,44	1,89	2,10
14	VSS	2008	40 120,4	1,27	1,44	1,99	2,10
15	VSS	2008	39 836,8	0,96	1,44	1,75	2,10
16	VSS	2008	39 861,4	1,12	1,44	1,84	2,10
17	VSS	2008	41 757,7	0,93	1,44	1,94	2,10
18	VSS	2008	41 714,9	1,23	1,44	1,91	2,10
19	VSS	2008	41 622,3	0,85	1,44	1,87	2,10
20	PFVSS	2008	41 505,4	0,93	1,21	1,93	2,64
21	VSS	2008	41 444,6	0,91	1,44	1,92	2,10
22	VSS	2008	41 537,6	0,88	1,44	1,87	2,10
23	VSS	2008	41 485,1	0,87	1,44	1,9	2,10
24	VSS	2008	41 488,4	0,97	1,44	2,10	2,10
25	PFVSS	2008	40 841,8	2,38	2,22	1,93	3,05
All		2008	1 007 638,5				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium		FAE	
				project	**baseline**	**project**	**baseline**
1	VSS	2009	39 165,3	0,87	1,44	1,73	2,10
2	VSS	2009	39 339,0	0,95	1,44	1,82	2,10
3	VSS	2009	39 551,6	0,82	1,44	1,80	2,10
4	VSS	2009	39 345,7	0,85	1,44	1,90	2,10
5	VSS	2009	39 436,8	0,84	1,44	1,87	2,10
6	VSS	2009	39 110,5	0,76	1,44	1,87	2,10
7	VSS	2009	38 487,9	0,83	1,44	1,86	2,10

8	VSS	2009	38 732,7	0,85	1,44	1,93	2,10
9	VSS	2009	38 543,4	1,10	1,44	1,64	2,10
10	VSS	2009	38 615,7	0,86	1,44	1,80	2,10
11	VSS	2009	38 912,0	0,92	1,44	1,73	2,10
12	VSS	2009	38 091,0	0,61	1,44	1,75	2,10
13	VSS	2009	39 619,6	0,78	1,44	1,80	2,10
14	VSS	2009	39 217,1	1,13	1,44	1,91	2,10
15	VSS	2009	39 047,1	0,80	1,44	1,84	2,10
16	VSS	2009	38 566,1	1,02	1,44	1,84	2,10
17	VSS	2009	41 135,2	0,76	1,44	1,97	2,10
18	VSS	2009	41 351,9	0,83	1,44	1,82	2,10
19	VSS	2009	40 318,5	0,70	1,44	1,91	2,10
20	PFVSS	2009	41 209,1	0,80	1,21	1,88	2,64
21	VSS	2009	41 181,4	0,74	1,44	1,90	2,10
22	VSS	2009	40 855,5	0,57	1,44	1,81	2,10
23	VSS	2009	40 953,1	0,67	1,44	1,97	2,10
24	VSS	2009	40 503,5	0,59	1,44	1,95	2,10
25	PFVSS	2009	40 288,2	2,17	2,22	1,94	3,05
All		2009	991 577,9				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium		FAE	
				project	**baseline**	**project**	**baseline**
1	VSS	2010	38 745,1	0,8	1,44	1,88	2,10
2	VSS	2010	38 627,0	0,8	1,44	1,98	2,10
3	VSS	2010	39 254,4	1,0	1,44	1,90	2,10
4	VSS	2010	39 038,9	0,9	1,44	2,01	2,10
5	VSS	2010	39 390,7	0,7	1,44	1,88	2,10
6	VSS	2010	39 097,0	0,6	1,44	1,91	2,10
7	VSS	2010	38 512,7	0,8	1,44	1,90	2,10
8	VSS	2010	38 082,6	0,9	1,44	1,96	2,10
9	VSS	2010	38 223,7	1,1	1,44	1,78	2,10
10	VSS	2010	38 481,5	0,9	1,44	1,88	2,10
11	VSS	2010	37 832,7	0,9	1,44	1,88	2,10
12	VSS	2010	37 671,1	0,8	1,44	1,86	2,10
13	VSS	2010	39 386,0	0,8	1,44	1,96	2,10
14	VSS	2010	38 644,6	1,1	1,44	1,98	2,10
15	VSS	2010	37 945,8	1,0	1,44	1,97	2,10
16	VSS	2010	37 652,7	1,2	1,44	2,02	2,10
17	VSS	2010	40 142,5	0,8	1,44	2,04	2,10
18	VSS	2010	40 474,7	1,0	1,44	1,89	2,10
19	VSS	2010	39 125,0	0,8	1,44	2,04	2,10
20	PFVSS	2010	40 440,7	1,3	1,21	1,99	2,64
21	VSS	2010	40 393,1	0,6	1,44	1,91	2,10
22	VSS	2010	40 300,6	0,5	1,44	1,84	2,10
23	VSS	2010	39 985,9	0,8	1,44	1,99	2,10
24	VSS	2010	40 061,1	0,6	1,44	1,97	2,10
25	PFVSS	2010	40 350,5	2,1	2,22	1,98	3,05

All		2010	977 860,7				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium		FAE	
				project	**baseline**	**project**	**baseline**
1	VSS	2011	39 175,8	0,78	1,44	1,87	2,10
2	VSS	2011	39 238,3	0,82	1,44	1,86	2,10
3	VSS	2011	39 662,6	1,13	1,44	1,76	2,10
4	VSS	2011	39 551,9	1,14	1,44	1,88	2,10
5	VSS	2011	39 462,6	0,79	1,44	1,81	2,10
6	VSS	2011	39 592,7	0,77	1,44	1,8	2,10
7	VSS	2011	38 750,0	0,84	1,44	1,86	2,10
8	VSS	2011	38 417,6	0,81	1,44	1,84	2,10
9	VSS	2011	38 876,7	1,16	1,44	1,75	2,10
10	VSS	2011	39 024,7	0,96	1,44	1,8	2,10
11	VSS	2011	38 863,4	0,86	1,44	1,83	2,10
12	VSS	2011	38 677,0	0,81	1,44	1,82	2,10
13	VSS	2011	39 540,6	0,77	1,44	1,9	2,10
14	VSS	2011	39 060,5	0,92	1,44	1,92	2,10
15	VSS	2011	39 025,9	0,72	1,44	1,81	2,10
16	VSS	2011	39 025,9	1,23	1,44	1,87	2,10
17	VSS	2011	40 557,7	0,86	1,44	1,82	2,10
18	VSS	2011	40 405,7	0,97	1,44	1,74	2,10
19	VSS	2011	40 313,7	1,00	1,44	1,84	2,10
20	PFVSS	2011	40 157,4	1,17	1,21	1,89	2,64
21	VSS	2011	40 707,6	0,64	1,44	1,8	2,10
22	VSS	2011	40 876,8	0,47	1,44	1,8	2,10
23	VSS	2011	40 467,3	0,69	1,44	1,83	2,10
24	VSS	2011	40 254,1	0,54	1,44	1,86	2,10
25	PFVSS	2011	40 505,0	1,71	2,22	1,86	3,05
All		2011	990 191,5				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium		FAE	
				project	**baseline**	**project**	**baseline**
1	VSS	2012	39 175,8	0,78	1,44	1,87	2,10
2	VSS	2012	39 238,3	0,82	1,44	1,86	2,10
3	VSS	2012	39 662,6	1,13	1,44	1,76	2,10
4	VSS	2012	39 551,9	1,14	1,44	1,88	2,10
5	VSS	2012	39 462,6	0,79	1,44	1,81	2,10
6	VSS	2012	39 592,7	0,77	1,44	1,8	2,10
7	VSS	2012	38 750,0	0,84	1,44	1,86	2,10
8	VSS	2012	38 417,6	0,81	1,44	1,84	2,10
9	VSS	2012	38 876,7	1,16	1,44	1,75	2,10
10	VSS	2012	39 024,7	0,96	1,44	1,8	2,10

11	VSS	2012	38 863,4	0,86	1,44	1,83	2,10
12	VSS	2012	38 677,0	0,81	1,44	1,82	2,10
13	VSS	2012	39 540,6	0,77	1,44	1,9	2,10
14	VSS	2012	39 060,5	0,92	1,44	1,92	2,10
15	VSS	2012	39 025,9	0,72	1,44	1,81	2,10
16	VSS	2012	39 025,9	1,23	1,44	1,87	2,10
17	VSS	2012	40 557,7	0,86	1,44	1,82	2,10
18	VSS	2012	40 405,7	0,97	1,44	1,74	2,10
19	VSS	2012	40 313,7	1,00	1,44	1,84	2,10
20	PFVSS	2012	40 157,4	1,17	1,21	1,89	2,64
21	VSS	2012	40 707,6	0,64	1,44	1,8	2,10
22	VSS	2012	40 876,8	0,47	1,44	1,8	2,10
23	VSS	2012	40 467,3	0,69	1,44	1,83	2,10
24	VSS	2012	40 254,1	0,54	1,44	1,86	2,10
25	PFVSS	2012	40 505,0	1,71	2,22	1,86	3,05
All		2012	990 191,5				

E.1. Estimated project emissions:

>>

Table E.1.1. GHG project emissions in 2008-2012

Year	GHG project emissions
2008	1189504
2009	927683,7
2010	995227,7
2011	943215,8
2012	943215,8
Total (tCO_2e)	4998847

E.2. Estimated leakage:

>>

To be conservative leakage emissions are not taken into account.

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

>>

Not applicable. Please see the table E.1.1.

E.4. Estimated baseline emissions:

>>

Table E.1.1. GHG baseline emissions in 2008-2012

Year	GHG baseline emissions (tCO_2e)
2008	1854736
2009	1825205,5
2010	1801458,7
2011	1823782,9
2012	1823782,9
Total ($t\ CO_2e$)	9128966,1

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

>>

Emission reductions are calculated according to the formula D.3 in the section D.1.3. folmulae 3

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

>>

Years	Estimated project emissions (tonnes of CO2 equivalent)	Estimated leakage (tonnes of CO2 equivalent)	Estimated baseline emissions (tonnes of CO2 equivalent)	Estimated emission reductions (tonnes of CO2 equivalent)
2008	1189504	-	1854736	665232
2009	927684	-	1825205	897522
2010	995228	-	1801459	806231
2011	943216	-	1823783	880567
2012	943216	-	1823783	880567
Total (tonnes of CO2 equivalent	4998847	-	9128966	4130119

SECTION F. Environmental 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:

>>

Changes to the functional component of the production process does not fall under the "Regulations for the assessment of environmental impacts (planned commercial and other activities in the Russian Federation", approved by order of the State Commission for the Protection of the Environment of the Russian Federation № 372 of May 16, 2000. So within the framework of the objectives of the project was carried out internal assessment of the impact on the environment. main goal of the project is voluntary reduction of PFC emissions from the electrolysis potrooms by reducing the anode effect frequency, which means that the project cannot harm the environment and, on the contrary, it helps to reduce emissions pollutants associated with the process of electrolysis.

To eliminate the anode effects in the current technology of aluminum, one must enter a wooden pillar in order to destroy the scum on the walls of the anodic bath and add a fraction of alumina in the bath to melt. In this connection, the destruction of approximately one-third scale bath is extremely necessary procedure. Thus, the direct emissions of perfluorocarbon in the anode effect accompanied by the release of additional electrolysis gases, such as solid and gaseous fluorides, carbon monoxide and carbon dioxide, sulfur dioxide, inorganic dust, etc. This means that the reduction of anode effect frequency assumes no negative impact on the environment.

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 activity does not adversely impact on the environment, as aimed at reducing emissions of PFCs. This leads to significant reductions in CO2 emissions in an amount of 4130119 tCO2e in the period 2008 - 2012.

SECTION G. Stakeholders' comments

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

>>

Consultations with stakeholders on the project activity have not been carried out because this is not a requirement of the Russian legislation.The project activity improves the ecological environment, since it reduces the implementation of pollution by harmful substances.

Annex 1

CONTACT INFORMATION ON PROJECT PARTICIPANTS

Organisation:	RUSAL Bratsk OJSC
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Represented by:	
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First name:	Sergey
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Fax (direct):	
Mobile:	
Personal e-mail:	-

Annex 2

BASELINE INFORMATION

Data/Parameter	MP
Data unit	tonnes
Description	Electrolytic aluminium poured out the pots
Time of determination/monitoring	constantly
Source of data (to be) used	Weight scale KGW-20
Value of data applied (for ex-ante calculations/determinations)	2008: 1007639 2009: 991578 2010: 977861 2011: 990192 2012: 990192
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Data in 2008-2011 are actual and obtained on certified equipment. Data for 2012 are assumed on 2011 year level, considering global boost in aluminium supply.
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.
Any comment	-

Data/Parameter	AEDb
Data unit	Minutes
Description	Average duration of anode effect
Time of determination/monitoring	Constantly
Source of data (to be) used	Automatic process control system (APCS)
Value of data applied (for ex-ante calculations/determinations)	2,1 2,2 2,2 2,2 2,1 2,1 2,1 2,2 2,0 1,8 1,9 1,9 1,9 2,1 2,0 2,1 2,3 1,7

	2,1 2,6 2,0 1,9 2,0 2,0 3,0 all 25 2,1	
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Line trend based on Historical data from the database control system in period 2000-2001 prior project implementation. Numeric value present in E section	
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.	
Any comment	-	

Data/Parameter	AEFb
Data unit	Anode effects per pot day
Description	Average frequency of anode effects
Time of determination/monitoring	Constantly
Source of data (to be) used	Automatic process control system (APCS)
Value of data applied (for ex-ante calculations/determinations)	1,48 1,37 1,25 1,57 1,59 1,58 1,62 1,42 1,46 1,24 1,42 1,27 1,26 1,44 1,33 1,37 1,43 1,37 1,55 1,21 1,41 1,33 1,45 1,5 2,2 All 25-

	1,4
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Line trend based on Historical data from the database control system in period 2000-2001 prior project implementation. Numeric value present in E section
QC/QA procedures (to be) applied	All devices used in monitoring are regularly checked in accordance with Russian legislation by competent entities.
Any comment	-

Data/Parameter	S_{CF4}
Data unit	(kg of CF_4 /tonne of aluminium)/(number of minutes of anode effect/pot day)
Description	Slope coefficient of CF_4
Time of determination/monitoring	Defined once in 3 years within the measurement program by VAMI
Source of data (to be) used	2009 Measurement report
Value of data applied (for ex-ante calculations/determinations)	Pot room all: 0,084 20: 0,055 25: 0,083
Justification of the choice of data or description of measurement methods and procedures (to be) applied	One value per technology
QC/QA procedures (to be) applied	Measured value by devices with appropriate certificates.
Any comment	-

Data/Parameter	$F_{C2F6/CF4}$
Data unit	C_2F_6/CF_4
Description	Weight fraction
Time of determination/monitoring	Weight ratio
Source of data (to be) used	Defined once in 3 years within the measurement program by VAMI
Value of data applied (for ex-ante calculations/determinations)	2009 Measurement report
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Pot room all: 0,051 20: 0,070 25: 0,073
QC/QA procedures (to be) applied	One value per technology
Any comment	-

Data and parameters that are not monitored throughout the crediting period but determined only once (and thus remain fixed throughout the crediting period)

Data/Parameter	**6500**
Data unit	tCO_2/tCF_4
Description	Global Warming Potential for CF_4
Time of determination/monitoring	Determined once during PDD development
Source of data (to be) used	Decision 2/CP.3 **http://unfccc.int/resource/docs/cop3/07a01.pdf#page=31** Climate Change 1995, Climate Change Science: Conclusion for politicians and technical conclusion of Report of Expert Group I, p.22 http://unfccc.int/ghg_data/items/3825.php
Value of data applied (for ex-ante calculations/determinations)	6500
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Global Warming Potential is needed for calculation of CO_2 equivalent emissions
QC/QA procedures (to be) applied	Reference data
Any comment	-

Data/Parameter	**9200**
Data unit	tCO_2/tC_2F_6
Description	Global Warming Potential for C_2F_6
Time of determination/monitoring	Determined once during PDD development
Source of data (to be) used	Decision 2/CP.3 **http://unfccc.int/resource/docs/cop3/07a01.pdf#page=31** Climate Change 1995, Climate Change Science: Conclusion for politicians and technical conclusion of Report of Expert Group I, p.22 http://unfccc.int/ghg_data/items/3825.php
Value of data applied (for ex-ante calculations/determinations)	9200
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Global Warming Potential is needed for calculation of CO_2 equivalent emissions
QC/QA procedures (to be) applied	Reference data
Any comment	-

BASELINE INFORMATION (data of the aluminum produced by JSC "RUSAL BrAZ")

Duration of anode effect (DAE)

Duration of anode effect depends on how quickly anode effect stops. Anode effect is stopped manually with the help of wooden poles in all potrooms at Bratsk Aluminium Smelter.

In compliance with the initial conditions it was not supposed to change the anode effect termination, so as the initial data we adopted by average realised value before the project with alkaline electrolytes was implemented in 2002.

It should be noted that the adopted mean value indicates the conservative actual level of DAE with alkaline baths.. There may be fluctuations in one direction or another, associated with many factors: the quality of alumina, the quality of fluoride additives, the quality of maintenance, and etc. However, such fluctuations could occur under any scenario, so taking the average value as the base, provided the technology remains the same, indicates realistic practices.

Data on the duration of the AE on the plant for alkaline EL

Data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
DAE	2.17	2.02	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1

Frequency of anode effect (FAE)

The frequency of anode effect can be taken as a constant for each type of technology. The project on revamp of pot technology from ‘alkaline’ to ‘acidic’ bath technology was implemented in 2002, in BrAZ based on the Kyoto Protocol. This allowed essential reduction in the frequency of anode effect. In order to estimate the baseline of the project we adopted the average frequency of anode effect achieved before switching to the technology of ‘acidic’ baths in 2002. It should be noted that for the estimation of the base frequency we assumed the conservative scenario where as the basis we took average values for 2000-2002 in spite of the emerging trend for increase.

Main issues at BrAZ up to 2001 were such as:

- lack of modern control systems over technological state the plant;
- Organizational structure of personnel and electrolysis was far from being optimal;
- The use of a large variety of types of process equipment and pots;
- The lack of a systematic approach to performance assessment of the main process equipment, lack of implementation of best practices and optimal cell technological parameters;

Existing situation did not allow to implement a unified electrolyser management approach: the same type of electrolysers were operated with different process parameters, service varied from electrolyser to electrolyser, there was a lack of, necessary information about the operational status of electrolyzers. As a result the analysis of real-time data was hampered due to lack of data processing system.

As result, the plant operated below its capacity – with increased Anode duration and frequency.

Within Kyoto Protocol a number of activities were conducted to implement technology reviving actions, which included the following:

- 3-level control and management of electrolysis process;
- Optimization of metal-in-progress;
- Stabilization of electrolyte composition and it's modification, i.e. reduction of crlyolyte ration and increase of concentration of calcium fluoride.

Brief description of technology revival program.

3-level control and management of electrolysis process.

The objective for organization of monitoring and process control is to prevent technology malfunctioning, maintain a high level of quality production and its improvement through implementation of a cycle control procedures ISMEC (identification, standardization, measurement, evaluation and correction). Achieving a set objective allows one to quickly identify electrolyzers operating in non-optimal mode, with an increased frequency of anode effects, and develop and implement measures aimed at reduce the frequency of anode effects.

To implement the program, the following had to be done:

- Change in staffing – introduction of a new position of a head technician, technical group and increase the number of anode specialists;
- Creation of process control system;
- Changes in the structure of process measurements – introduction of daily measurements of the level of the metal and the electrolyte, the electrolyte temperature and work space around pots;
- Introduction of unified key target points and allowed deviation;
- Development of technical standards for managing individual fragments of technology, then creation of documentation for the management of technology as a whole;
- Development of modern algorithms of process management within process control systems (PCS);
- Introductions of system for planning and target setting for electrolysis process.

Optimization of metal-in-progress

The purpose of metal-in-progress optimization in a cell is to stabilize thermal balance, creation of similar work conditions for same type of cells. Reaching of such objectives allows to decrease the number of overcooling and overheating incidents and to achieve a more stable concentration of alumia in electrolyte. As a result, the AE frequency rate is lowered.

Such an optimization requires the following:

- Introduction of modern methods of measuring the level of the metal using the bubble level;
- Measuring the actual depth of the shaft in working cells
- Establishing of a target level of metal in a cell, depending on the service life and design features
- Development of optimal metal in progress quantity in a cell

Stabilization of electrolyte composition

The purpose of stabilization of electrolyte composition is to achieve a balanced temperature of electrolysis, create similar conditions for alumia dissolution in the electrolyte for different type of cells. That allows for a smaller variation of alumina content in the electrolyte of different type of cells and apply the methods of management and maintenance techniques to achieve the minimum frequency of anode effects.

- The following activities were undertaken to implement the action: Organization of a unified monitoring system for electrolyte composition with the use of modern equipment (spectrometer ARL);
- Equipping master workstations with necessary software to estimate required adjustments of fluoride supplements and calcium fluoride individually for each cell depending on the electrolyte composition and process conditions;
- Organization of the accounting system for aluminum fluoride used in electrolytic cell (equipping fluoride loaders with quantity meters, development of dose control system);
- Setting optimal duration and frequency of cell treatment as well as quantity of loaded alumina in order to minimize variations in the composition of the electrolyte.

The Average frequency of anode effects achieved prior to the introduction of technology reviving program in 2002 was adopted for calculation of a baseline. It is necessary \ to be emphasized that average anode effects frequency (AEF) prior to 2002 revival program and a conservative scenario with the averages of 2000-2001were used for baseline. Some deviations are possible due to: alumia quality, fluoride supplements quality, service quality, etc. Though such deviations would take place in any scenario, therefore taking the average data as a baseline with the fact that technology hasn't been changed, reflect the plausibility of such a practice.

Below are the values for base FAE for the entire plant since 2000

Data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
FAE	1.41	1.48	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4

The values of the angular coefficients of the base line for CF_4 and C_2F_6

The values of the angular coefficients of the base line for CF_4 and C_2F_6 have not changed over the years since the moment when we started using the technique of Class 2 for estimations. They are listed in the recommendations of Intergovernmental Panel on Climate Change (IPCC) 2006.

Though in 2008 Rusal VAMI has conducted direct measurements, which allowed to obtain more precise emission data (IPCC tier 3 – direct measurements) compared to that of tier 2.

Nevertheless, that is a more precise approach for PFC emission reduction, when it comes down to actual emissions.

Aluminium production output

It is assumed that the output of metal produced is equal to that claimed for the project. The planned production output is specified in the annual business plans of the smelter and in the corporate document 'RUSAL **BrAZ** Targets Based on Approved Targets in Aluminium Division'.

Amount of electrolytic aluminium is used for calculations of project emissions and baseline emissions. Electrolytic aluminium is aluminium, which is actually produced during the year, including aluminium of non-complete production. The annual decrease of electrolytic aluminium output cannot be calculated for each month since the amount of aluminium of non-complete production is not estimated on a monthly basis. Thus, the amount of unprocessed aluminium is used. (Scheduled production output for 2008 – 2012 is also estimated in tonnes of unprocessed aluminium). Unprocessed aluminium is aluminium, which is actually yielded from the electrolytic pot (not including non-complete production).

Theoretically, these values should be equal, but due to the fact that aluminium yielded from the electrolytic pot is fluid, in actual practice they differ from each other. The longer the period is, the smaller the difference between values becomes. Difference observed for several days is usually less than 1%, thus taking into consideration the fact that non-complete production is estimated on a quarterly basis, it is assumed that these values are equal.

Project Rationale

Baseline conditions (2000-2002):

- Frequency of anode effect in different types of pots — 1.52 occurrences per day
- Aluminium fluoride specific rate — 34.9 kg/t
- Current effervescive — 87.42%
-

As a whole the production performance was satisfactory for the further operation, however, high frequency of anode effect was absolutely unacceptable. The project was aimed at reducing anode effect frequencies to less than 1 per day.

Achieved performance in 2011:

- Frequency of anode effect in different types of pots – 0.92 occurrences per day
- Aluminium fluoride specific rate – 39,9 kg/t
- Current effervescive – 87.81%

These activities of the program improvement technologies have greatly reduced the frequency and duration of anode effects.

Actual dynamics of the achieved frequency and duration of anode effects from 2000 to 2011.

Data	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
FAE	1.41	1.48	1.34	1.28	1.25	1.34	1.25	1.20	1.08	0.91	0.95	0.92
DAE	2.09	2.00	1.92	1.84	1.88	1.86	1.94	1.85	1.77	1.85	1.86	1.83

The particular feature of this joint implementation project at the time of this decision was taken at the smelter (and to the present day) is that the objective is to reduce the frequency of anode effect less than 1 per day which is unique for the use of VSS technology without APF in the world practice.This decision was accepted on the basis of clear understanding of reasons and major factors favouring the occurrence of this effect. At the same time, this project critically reconsiders existing until 2001 technology of ‘alkaline’ baths at 2.4-2.6 cryolite ratio.

Critical drop of alumina concentration between feed cycles has been established as the main reason for anode effect.

The purpose of the project is to change the bath composition which will provide the pot with maximum stability to alumina feed fluctuations which is typical for pots without APF. Acidic bath technology has been found optimal.

Effect of the cryolite ratio reduction on the technology of electrolysis.

The influence of additives and temperature on the properties of molten salts

Variable	Additive, %	Solubility Al_2O_3, %	t liquidus, ^0C	Metal solubility, %	Electrical conductivity, 1/(Ohm·cm)	Density, g/cm^3	Vapour pressure, Pa	Viscosity, mPa·s
Na_3AlF_6	100	12.4	1011	0.131	2.874	2.103	534	2.323
CaF_2	4 7	-1.5 -2.5	-12 -20	-0.013 -0.022	-0.057 -0.099	0.018 0.033	-2 -3	0.130 0.228
AlF_3	4 12	-0.4 -1.4	-1 -24	-0.033 -0.078	-0.171 -0.439	-0.025 -0.060	137 596	-0.091 -0.399
LiF	1 3	-0.5 -1.3	-9 -27	-0.018 -0.021	0.047 0.142	-0.005 -0.014	-11 -33	-0.123 -0.399
MgF_2	3 5	-0.5 -1.4	-5 -15	-0.004 -0.012	-0.047 -0.139	0.005 1.013	-10 -11	0.041 0.123
Al_2O_3	3 5		-16 -28	-0.003 -0.005	-0.145 -0.282	-0.022 -0.040	-90 -130	0.029 0.118
T, ^0C	-25 -50	-1.5 -2.8		-0.040 -0.082	-0.090 -0.182	0.023 0.047	-165 -282	0.195 0.398

It is required to increase AlF_3 additive in the bath to reduce the cryolite ratio. Increase of this additive will have the following effect:

- Decrease of the maximum solubility of alumina;
- Decrease the initial temperature of crystallisation process (liquidus temperature);
- Decrease of the electrical conductivity;
- Decrease in the density of molten electrolyte;
- Increase of the partial pressure of vapour;
- Decrease of viscosity of the electrolyte.

The combined effect of additives in the conventional sense leads to increase of current effervescive due to decrease of the metal solubility and decrease of the process temperature and decrease of the solubility of alumina, which may increase the frequency of anode effect.

However, the decrease of cryolite ratio (increase of AlF_3 additives) leads to the following changes: significant decrease of the viscosity and density of the electrolyte, and it increases the velocity of electrolyte circulation and the solution rate of alumina, while the physical volume of the electrolyte in the pot is increased due to faster removal of the gas phase formed during electrolysis.

Decrease of the maximum solubility of alumina within the range of cryolite ratio 2.3-2.2 is not so sufficient to affect the potential of unexpected anode effect, much more significant factor is the increase in the rate of electrolyte mixing that prevents the alumina depletion of local areas of anode, which may cause the anode effect. Thus, in case of decrease of cryolite ratio (revamp to the technology of 'acidic' baths) there is a significant reduction in the frequency of anode effect.

Annex 3

MONITORING PLAN

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