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:

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Reduction of PFC emissions at Irkutsk aluminium smelter

Sectoral scope: Metal production

Version: 04
Date: 12.04.2012

A.2. Description of the project:

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Irkutsk Aluminium Smelter (abbreviated name: OAO RUSAL-IrkAZ, formerly known as OAO IrkAZ-SUAL) is one of the largest and oldest aluminium smelters in Eastern Siberia and in the Russian Federation. It is located in the industrial area of the town of Shelekhov, Irkutsk region. The smelter belongs to UC RUSAL.

The smelter was founded in 1962. It belongs to UC RUSAL.

IrkAZ total production volume of aluminium was 351,513 tonnes in 2008.

IrkAZ production facilities include ten potrooms. Eight potrooms use the Soederberg technology with upper current distributor without aluminium point feeder (VSS) and No. 9 and 10 potrooms use a modern point feed pre-bake technology (PFPB). 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) in the old Soederberg cells with upper current leads (VSS) envisaged for implementation at the Irkutsk Aluminium Smelter in early 2002 and conversion to the modern and green PFPB technology (OA-300 cells) in 2005. 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 Shelekhov and the Irkutsk region.

Baseline scenario

Prior to implementation of the 2002 and 2005 project actions the smelter would have continued producing primary aluminium using the Soederberg technology with upper current distributor in alkaline baths with high cryolite ratio and would have retained the current overall production 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.

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. Adoption of acidic bath technology (change of the cryolite ratio) in potrooms 1-8 in 2002;
2. Adoption of point feed pre-bake technology with an extension to all of the 10 potrooms in 2005.

Adoption of technology

The particular feature of this CO 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 existed until 2001 technology of alkaline baths at 2.6-2.8 cryolite ratio.

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

The purpose of this adoption is to change the bath composition in potrooms 1-8 using the Soederberg technology which will provide the pot with maximum stability to aluminium feed fluctuations which is typical of Soederberg electrolytic cells without automatic feed. Acidic bath technology has been found optimal.

Baseline conditions (early 2002):

- Frequency of anode effect in different types of pots — 1.63-2.46 occurrences per day
- Aluminium fluoride specific rate — 34.1 kg/t
- Current effervescive — 88.8%
- Specific power rate — 15474 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. Reduction of cryolite ratio (adoption of acidic bath technology) demanded essential financial expenditures for laboratory re-equipment with spectral assay instrumentation; specialised vehicles for centralised aluminium fluoride distribution; development and introduction of special software for aluminium fluoride return.

Achieved performance in 2011:

- Frequency of anode effect in different types of pots – 0.53 pcs per day
- Aluminium fluoride specific rate – 32.1 kg/t
- Current effervescive – 88.8%
- Specific power rate – 15434 kW*h/t

Adoption of the feed pre-bake technology (PFPB)

The main reason why this ecologically softer smelting cell technology was adopted at that time was (and remains until now) the fact that increasing the share of 'green' aluminium production at IrkAZ was made a priority.

In the framework of adoption of the feed pre-bake technology a construction of 5^{th} potline of smelting cell for 300 kA with a dry off-gas treatment and total capacity of 166,500 tonnes of crude aluminium took place. At the same time the smelter capacities were expanded to potrooms 9 and 10 and C2 potline potrooms 3 and 4, where the old Soederberg VSS technology had been used, were closed down.

The fifth potline includes 200 newest smelting cells with amperage of 300 kA, developed by the SibVAMI scientists. Modern point feed pre-bake technology with its high technological and ecological standards is the basis of the fifth potline. These smelting cells enable operating acidic baths with minimum frequency of anode effect (0.01-0.1). Efficiency increases at such frequency, and ecological parameters of metal production improve. Besides the two smelting cells there is also an electrolytic power facility, anode rodding shop, aluminium storage and other facilities. The modern dry off-gas treatment which is in operation in IrkAZ 5^{th} potline new potrooms enables to capture 99.5% of fluorides and electrolytic dust.

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

'Before' and 'after' comparison of the electrolyte pot workshop (at the top there is the closed C2 potline using the standard Soederberg VSS technology, below there is the new 5th potline at 300 kA with PFPB, vertical load and dry off-gas treatment)

RUSAL-IrkAZ 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-IrkAZ 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.

The main factors, which made this project viable:

- 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 Shelekhov residents' health and quality of life.

Implementation of this project was associated with a number of serious economic obstacles. However, RUSAL-IrkAZ 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:

<u>Adoption of acidic bath technology</u>

On February 1st, 2002 an intention to adopt the acidic bath technology for reducing anode effect within the framework of Article 6 of the Kyoto Protocol was discussed at SUAL-IrkAZ technical council.

<u>Adoption of the prebaked anodes technology and construction of the 5th potline</u>

On January 15th, 2004 a feasibility study development and adoption of PFPB technology within the framework of Article 6 of the Kyoto Protocol and start of the 5th potline were discussed with OAO SUAL-IrkAZ and SibVAMI specialists.

Recommendations of SibVAMI for starting the 5th potline with reference to the developed feasibility study and regarding the ecological constituent and implementation of the project as a joint implementation project were given on June 20th,2005.

At OAO SUAL-IrkAZ technical council held on September 13th, 2005 SibVAMI recommendations for starting the 5th potline were examined.

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

Year	Description
2001/2002 (management decision)	<u>Action</u>: Intention to adopt the acidic bath technology for reducing anode effect within the framework of Article 6 of the Kyoto Protocol. <u>Evidence:</u>Decision of Technical Council. Minutes of discussion of Technical Council of 01.02.2002 <u>Justification of the evidence:</u>

	That was a management decision to start the project as a JI activity.
2003	Action: decision on PIN development and on the start of monitoring of national legislation on Kyoto Protocol ratification and JI-procedure establishment Evidence: SeeMinutes of discussionof 19.11.2003 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 onKP-related issues was established.From this point that was a real action to secure a JI status.
2004	Action: Monitoring of KP ratification status and PIN elaboration Evidence:PIN elaborated Justification of the evidence: Elaboration of PIN was a first step on a way to PDD development. Keeping adherence to commitment to develop the project under JI-mechanism after KP ratification and establishment of JI approval procedure the IRKAZ smelter were proceeding with the monitoring of status of laws on adoption of these documents. That is why this is a real action to provide a JI status for the project.
2005	Action: Monitoring of KP ratification status and PIN elaboration Evidence:Minutes of discussion of 22.03.2005 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 IRKAZ smelter were proceeding with the monitoring of status of laws on adoption of these documents.
2006	Action: Monitoring of KP ratification status and PIN elaboration. Observation of national legislative documents on realization of KP mechanism in Russia. Evidence:Minutes of discussion of 28.03.2006 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 IRKAZ smelter were proceeding with the monitoring of status of laws on adoption of these documents.

A year later IrkAZ 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 acceptedon 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 1-8 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.

But it would be necessary to increase the operating voltage on the electrolysis current from 150 kA to 184 kA with the expansion of productive capacity of the plant at 136 Soderberg cell with an upper current lead (VSS).

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:

- reduction of CO2 from 1.7 t to 1.6 t per tonne of anodes.
- significant reduction of soot and benzapyrene emissions.
- essential improvement of working conditions for the workers involved in smelting industry.
- reduction in PCF (CF4 и C2F6) emission for 1,204,506 tonnes of annual production of aluminium or 6,022,528 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 IrkAZ" Joint Stock Company	No
Party B – No	To be determined further	-

JSC "RUSAL IrkAZ" 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):

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Russian Federation

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

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The Project is being implemented at IrkAZ territory in the city of Shelekhov, Irkutsk oblast.

Figure 4.1.2 Irkutsk oblast on the map of the RF

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

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The city of Shelekhov is locatet in the south of Irkutsk oblast in the valley of the rivers of Irkut and Olkha, in 18 kilometers between the centers or in 7 kilometers (between the borders) from Irkutsk and in 75 kilometers from the lake of Baikal. The territory of the city is 3100 ha.

Figure 4.13 Shelekhov 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 10 shops of electrolysis production located in the industrial zone of Shelekhov, 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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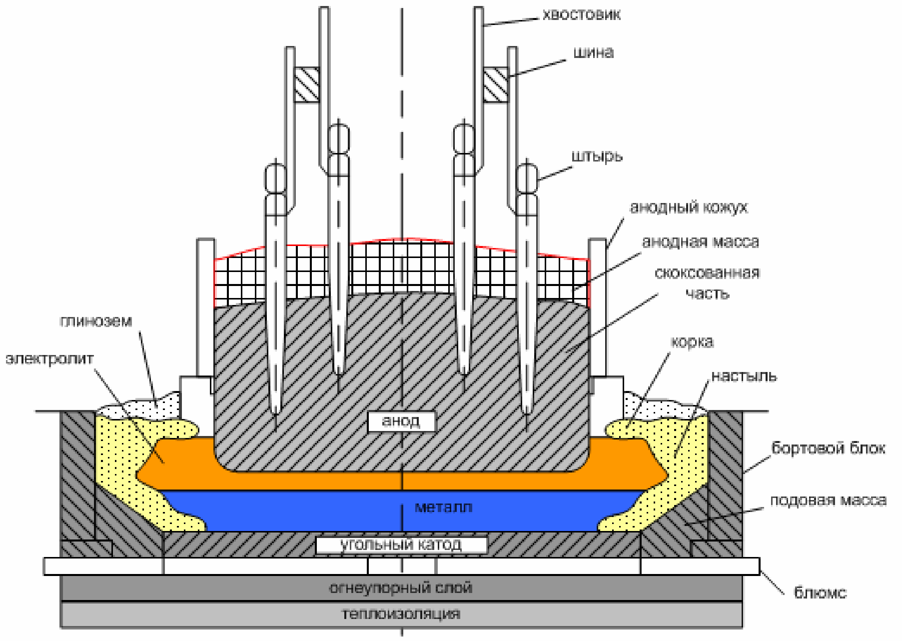
Process system description

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 IrkAZ, electrolyte cells with Soederberg anodes with upper conductor (VSS) are used. Aluminium is fed manually: with a manually controlled aluminium 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 aluminium (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 aluminium loading method with crust breaking is used. In this case, the electrolyte crust is broken along the pot longitudinal wall and the aluminium 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 aluminium 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 aluminium 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 aluminium;
- 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 aluminium, 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 aluminium, 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 aluminium 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 aluminium 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 (early 2002):
- Frequency of anode effect in different types of pots — 1.63-2.46 occurrences per day
- Aluminium fluoride specific rate — 34.1 kg/t
- Current effervescive — 88.8%
- Specific power rate — 15474 kW*h/t

Achieved performance in 2011 within the project:
- Frequency of anode effect in different types of pots – 0.53 pcs per day
- Aluminium fluoride specific rate – 32.1 kg/t
- Current effervescive – 88.8%
- Specific power rate – 15434 kW*h/t

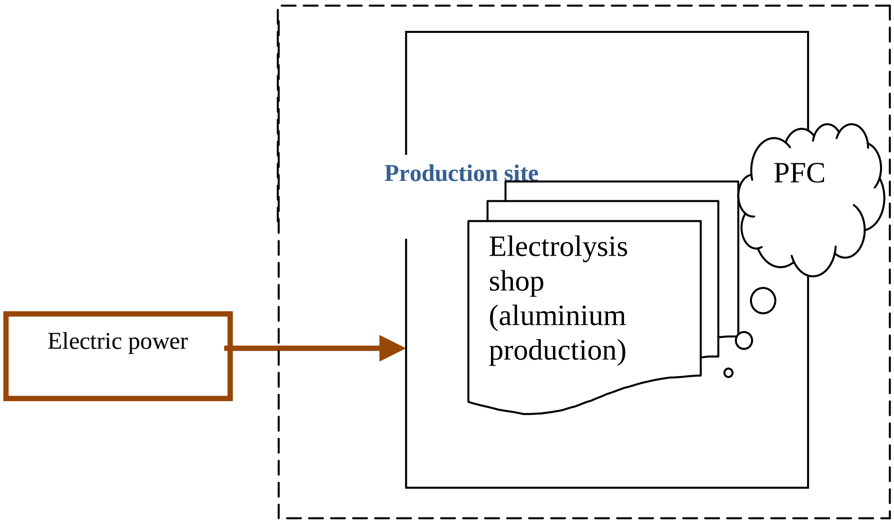
The data output of the project (closed shell red. Entry 5 Series-yellow)

IrKAz	**Номер серии электролиза**										
	I		II			III		IV		V	
	Номер корпуса										
	1	2	3	4		5	6	7	8	9	10
Type of electrolise	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	PFPB	PFPB
Technology of process	C8B	C8B	C3	C2	C3	C8BM	C8BM	C8BM	C8B	OA-300M2	OA-300M2
type	BF	BF	BF	BF	BF	BF	BF	BF	BF	BF	BF

IrKAz	**Number of electrolyze**							
	1		3		4		5	
	Number of pot room							
	1	2	5	6	7	8	9	10
Type of electrolyze	VSS	VSS	VSS	VSS	VSS	VSS	PFPB	PFPB
Technology of process	С8Б	С8Б	С8БМ	С8БМ	С8БМ	С8Б	OA-300M2	OA-300M2
type	SF	SF	SF	SF	SF	SF	PF	PF

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

Figure. A.4.2. Layout of the project activity



Project history:

Adoption to acidic electrolytes

On February 1st, 2002 an intention to adopt the acidic bath technology for reducing anode effect within the framework of Article 6 of the Kyoto Protocol was discussed at SUAL-IrkAZ technical council.

The adoption was carried over in accordance with the following schedule:

Implementation of centralised sampling schedule for testing cryolite ratio	*2002*
Introduction of fluorine dispensers in potrooms	*2002*
Setting the target CR value of 2.7 units	*2002*
Development of process instruction on calculation and correction of electrolyte composition in aluminium electrolyte pots	*2002*
Testing the reduction procedure with the target CR of 2.5 units within the unit	*2002*
Transition to testing cryolite ratio with the help of ARL-9800 spectrometer	*2003*
Reducing CR target down to 2.5 units	*2003*
Reducing CR target down to 2.4 units	*2004*
Introduction of 3-day sampling schedule (laboratory transition to daily working schedule)	*2004*
Research of the optimal CR reduction ratio	*2004*
Reducing the target CR level down to 2.35 units and selection of the optimal process parameters of electrolyte pots operation	*2005*
Reducing the target CR level down to 2.3 units and selection of the optimal process parameters of electrolyte pots operation	*2006*
Optimisation electrolyte pots operational regime using the acidic electrolytes process.	*2007-2011*

Transition to baked anodes and construction of the 5th series

On January 15th, 2004 a feasibility study development and adoption of PFPB technology within the framework of Article 6 of the Kyoto Protocol and start of the 5th potline were discussed with SUAL-IrkAZ and SibVAMI specialists.

January 15th, 2004 - January 16th, 2004 –Feasibility Study

Recommendations of SibVAMI for starting the 5th potline with reference to the developed feasibility study and with respect of the ecological constituent and implementation of the project as a joint implementation project were given on June 20th,2005.

At SUAL-IrkAZ technical council held on September 13th, 2005 SibVAMI recommendations for starting the 5th potline were examined.

September 13th, 2005 -2007 –CMP

2007-2008 –Precommissioning

January 01st,, 2009- Achievement of target operational conditions

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 Irkutsk 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	672 004
2009	1 017 504
2010	1 398 972
2011	1 467 024
2012	1 467 024
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	6 022 528
Annual average of emission reductions over the crediting period (tonnes of CO_2 equivalent)	1 204 506

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	1467024
2014	1467024
2015	1467024
2016	1467024
2017	1467024
Total estimated emission reductions over the crediting period (tonnes of CO_2 equivalent)	7335119
Annual average of emission reductions over the crediting period (tonnes of CO_2 equivalent)	1467024

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), RUSAL Irkutsk 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 cryolite reduction measures designed for reduction of frequency 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 IrkAZ 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.

For this scenario it is necessary to increase the operating voltage on the electrolysis current of 150 kA to 184 kA with the expansion of productive capacity of the plant at 136 Soderberg cell with an upper current lead (VSS). [1]

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Volume of Aluminium prodiction	280443	298200	309950	325100	325330	351 513	345 059	389 896	398 043	Option 2 - set for overhaul the electrolysers on the current strength of 170-184 kA
Potrom 1-8	280443	298200	309950	325100	325330	332200	332230	332230	332230	
Potrom 9 (on 184 кА Содерберг)	0	0	0	0	0	16390	32700	49164	65550	type operating in the housing 6 and the construction of five series of electrolysis (136 Soderberg pots on the strength of the current 184 kA).
Amperage, кА										
Potroom 1-8	153,13	160,9	167,7	174.3	177.1	180,5	180,5	180,5	180,5	
(entries all potroms on 184 кА Soderberg)						184,0	184,0	184.0	184,0	

Expansion of the plant according to the first technology, offers the following advantages and disadvantages:

-easy & finished making the expansion of Soderberg electrolysis

-much less capital investment and as a consequence of a faster time to payback

-greater volume of emissions of pollutants and PFCs

-the worst environmental performance over time

We should also note that increasing the current strength of 14% during the development of this scenario on the primary production, may lead to a corresponding increase in PFC emissions and pollutants.

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 aluminium, intermittent aluminium 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

[1] Official data of OAO Sual subsidiary IrkAZ dated 17.03.2003

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 CF4 = 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, aluminium dust), and the company, provided the project is implemented in full, meets the environmental standards. Therefore, the Irkaz 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 cryolite reduction measures designed for reduction of frequency of anode effects, without being registered as a JI-project activity

This scenario would require the following actions:

- change the electrolyte composition which will provide the pot with maximum stability to aluminium 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 aluminium;
- 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 aluminium, which may increase 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 project additional consumption by 40 kWh (or 40/14,880 * 100 = 0.26%) is challenged by serious technical difficulties:
-In most electrolytic pots series of IrkAZ 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.
Nevertheless the theoretical benefit from energy savings can be calculated by multiplying reduction in project additional consumption by 40 kWh per tonne Aluminium with aluminium production (e.g. in 2002 it was approx. 280 Ths t) tonne with the tariff as of 2002. The theoretical savings would be approx. 2 Mio Rub (40kWh/t*280 ths.t *0.2 rub/kWh = 2 Mio rub)
The investment costs for implementing the project activity are 26,9 Mio Rub. As evident from this analysis even the theoretically estimated savings are significantly lower than the investment costs.

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 reduce cryolite ratio (transition to ‘acidic’ electrolytes technology) required substantial financial investments:

- To refit the laboratory with spectral analysis instrumentation;
- To purchase specialised machinery for centralised distribution of aluminium fluoride;
- For development and implementation of specialised software to calculate the aluminium fluoride output dosage.

Implementation of 5^{th} series has required the construction of 2 new shops (9^{th} and 10^{th}) with dry gas scrubbers.

Possible expansion of the plant according to this scenario, will give the following advantages and disadvantages: -increasing the productivity of the plant by closing the two series of Soderbergh's new environmental and input 5 Series 200 pots at 300kA prebaked anodes on the block with dry gas cleaning.[2]

-lower emissions of pollutants and PFCs because of more modern technology and its environmental pillar

-are the best environmental performance in a long time with a consistent ability to improve them

-an opportunity to attract significant funding (50%) due to a corresponding reduction in PFC emissions and pollutants

-more complex and capital-intensive technology of the installation

-as a consequence, the production cost per tonne of aluminum raw later (in 1450 dollars / ton)

-much higher investment and, consequently, a longer way to return (13.4 billion rub)

However as evident from the table below till 2008 the plant was able to meet the increased demand of aluminium through the increase of the voltage at the existing facilities.

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
Volume of aluminium production	280443	298200	309950	325100	325330	351 513	345 059	389 896	398 043	A variant of the construction of five series (200 pots with prebaked anodes at a current 300 kA) and the closure of two of the series.
Potroom **1-8**	280443	298200	309950	325100	325330	297441	234881	232895	232116	
5 series	0	0	0	0	0	51149	130049	148499	165664	
amperage. кA										
Potrom1-8	153,13	160,9	167,7	174.3	177.1	161.6	168,47	168,94	169,21	
5 series						300	30O	300	300	

During implementation of measures aimed at reducing the frequency of anode effect, and transition to a 5^{th} series 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 company at its own expense in the amount of RUR 13,396 mln has implemented the project.

[2] Official data of OAO Sual subsidiary IrkAZ

In the baseline scenario it would be necessary to increase the operating voltage on the electrolysis current from 150 kA to 184 kA with the expansion of productive capacity of the plant at 136 Soderberg cell with an upper current lead (VSS). 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 13,396 mln, which is far higher than the option to use old pots of proven Soederberg technology and to install additional 136 Soderberg pots (6 Mln Rub).

Thus, the ability to implement this alternative scenario is unlikely.

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.

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

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;

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)[3];

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

[3] 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)

6500 – Global Warming Potential for CF_4[4]
9200 – Global Warming Potential for C_2F_6[5]

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 (please see the annex to PDD).
Applied values of the slope coefficient and weight fraction for appropriate technology are taken from 2006 IPCC, Chapter 4, p. 4.58, table 4.16.

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: 351 513; 2009: 345 059; 2010: 389 896; 2011: 398 043; 2012: 398 043
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)	С-2 3: 2008-2012 — 2,53 С-8Б: 2008-2012 — 1,93 С-8БМ: 2008-2012 — 1,75
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

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

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

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)	С-2,3: 2008-2012 — 2,46 С-8Б: 2008-2012 — 1,74 С-8БМ: 2008-2012 — 1,59
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
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 and parameters that are not monitored throughout the crediting period but determined only once (and thus remain fixed throughout the crediting period)

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	Determined once (referenced value)
Source of data (to be) used	2006 IPCC, Volume 3, Chapter 4.4., page 4.55, table 4.16
Value of data applied (for ex-ante calculations/determinations)	Technology / VSS / PFPB 2008-2012 / 0,092 / 0,143
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Reference data that used in the absence of direct measurements. One value for each technology
QC/QA procedures (to be) applied	Reference data
Any comment	-

Data/Parameter	$F_{C2F6/CF4}$
Data unit	C_2F_6/CF_4

Description	Weight fraction
Time of determination/monitoring	Determined once (reference data)
Source of data (to be) used	2006 IPCC, Volume 3, Chapter 4.4., page 4.54, table 4.16
Value of data applied (for ex-ante calculations/determinations)	Technology: 2008-2012; VSS: 0,053; PFPB: 0,121
Justification of the choice of data or description of measurement methods and procedures (to be) applied	Reference data that used in the absence of direct measurements. One value for each technology
QC/QA procedures (to be) applied	Reference data
Any comment	-

Technology	VSS	PFPB
2008-2012	0,053	0,121

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	-

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 cryolite reduction measures designed for reduction of frequency of anode effects as well as a shift to prebaked anode technology with construction of the 5th stage, 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
A simple cost-benefit analysis is applied, if the proposed JI project does not generate any financial or economic benefits, in addition to the sale of ERUs and related income. The proposed JI project does not generate additional revenue from sales of electricity and an additional aluminum or significant and measurable fuel economy,therefore the simple cost analysis is applied.

Sub-step 2.2b. Simple cost analysis
According to the initial conditions, the plant continued to be the production of primary aluminum in the chassis 1-8 Soderberg without any measures to reduce the AE and additional environmental measures. This is due to the current practice in the stable operation of the plant from year to year, with no breakdowns and shutdowns of production. Soderberg technology comprehensively studied, stable and common in the world, in addition, it employs the basic large-scale enterprises in Russia. At the same time, the company invested an investor of the project would be a much smaller amount of capital 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 through the reduction of cryolite ratio 26,9 million rubles.The proposed JI project does not generate a measurable and/or significant 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.
In the first alternative to this would be achieved at the expense of poorer environmental performance and lower capital investment, the second due to large capital investments, but with a much more environmentally friendly way of production. Payments for the emission of harmful substances are not implemented in any scenario.

Comparisons of alternatives 1 and 2

	Alternative 1	Alternative 2 (Project)
Investments, mln Rubles	Nil since no additional expenses are required	26,9 Mio Rub

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 40 kWh per tonne Aluminium with aluminium production (e.g. in 2002 it was approx. 280 Ths t) tonne with the tariff as of 2002. The theoretical savings would be approx. 2 Mio Rub (40kWh/t*280 ths.t *0.2 rub/kWh = 2 Mio rub)
The investment costs for implementing the project activity are 26,9 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 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 10 electrolysis potrooms. The Project does not considers reduction of CO2 emissions due to a shift to 5th series as it is a not a considerable part of the Project and also is not designed for reduction of anode mass.

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

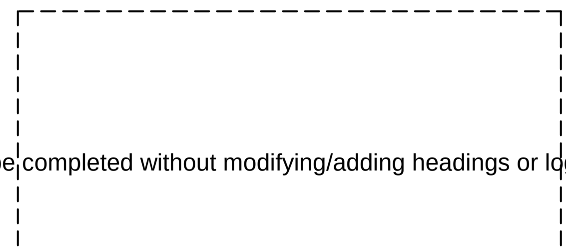
In accordance with “Guidance on criteria for baseline setting and monitoring” (Version 03) the leakage is determined as “the net change of anthropogenic emissions by sources and/or removals by sinks of GHGs which occurs outside the project boundary, and that can be measured and is directly attributable 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.

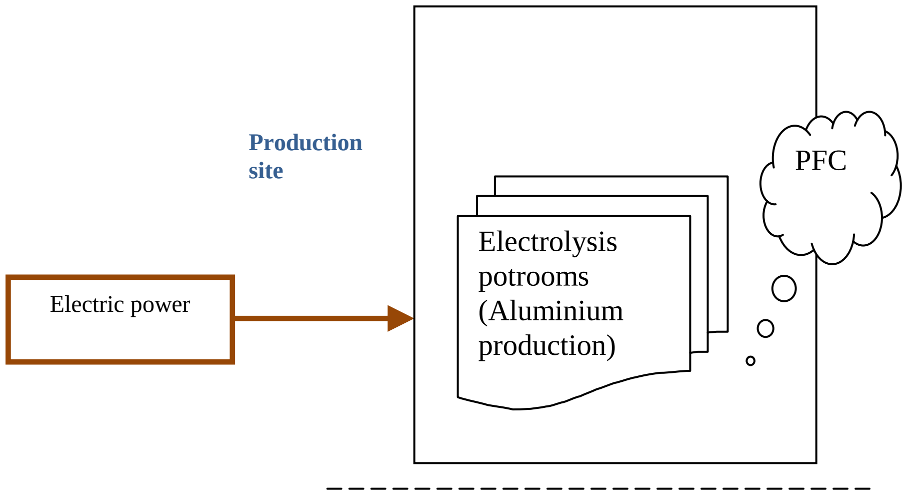
Main potential leakages attributable to the Project activity are GHG emissions due to electric power generation in the grid.

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:

>>
The Project's starting date is 11 February 2002. Implementation schedule for sampling at the cryolite ratio

C.2. Expected operational lifetime of the project:

>>
Operational lifetime of the Project is 20 years or 240 months: from 11/02/2002 till 11/02/2022.

C.3. Length of the crediting period:

>>
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:

>>

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 IrkAZ.

Resently IrkAZ 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.

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) [6];

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

6500 – Global Warming Potential for CF_4[7]
9200 – Global Warming Potential for C_2F_6[8]
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.

---

[6] 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)

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

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

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

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	*Reference data in 2006 IPCC*	*(kg of* CF_4 */tonne of aluminium)/(number of minutes of anode effect/pot day)*	*e*	*Constantly*	*100%*	*Paper and electronically*	-
D.1.1.1.5	C_2F_6/CF_4	*Reference data in 2006 IPCC*	-	*e*	*Constantly*	*100%*	*Paper and electronically*	-

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;

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

AED_p –is the average duration of anode effect under the project, 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) [9];

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

6500 – Global Warming Potential for CF_4 [10]
9200 – Global Warming Potential for C_2F_6 [11]

[9] 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)

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

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

D.1.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions of greenhouse gases by sources within the project boundary, and how such data will be collected and archived:								
ID number *(Please use numbers to ease cross-referencing to D.2.)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
D.1.1.3.1.	*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*
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*
D.1.1.3.4	S_{CF4} *Slope coefficient of* CF_4	*Reference data in 2006 IPCC*	*(kg of* CF_4 */tonne of aluminium)/(number of minutes of anode effect/pot day)*	*e*	*Constantly*	*100%*	*Paper and electronically*	-
D.1.1.3.5	C_2F_6/CF_4	*Reference data in 2006 IPCC*	-	*e*	*Constantly*	*100%*	*Paper and electronically*	-

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;

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

AED_p –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);

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

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.	from 0,5 to 5,0	0,043

			Determination of total sulfur. Method of Eshka»		

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 based on 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.*

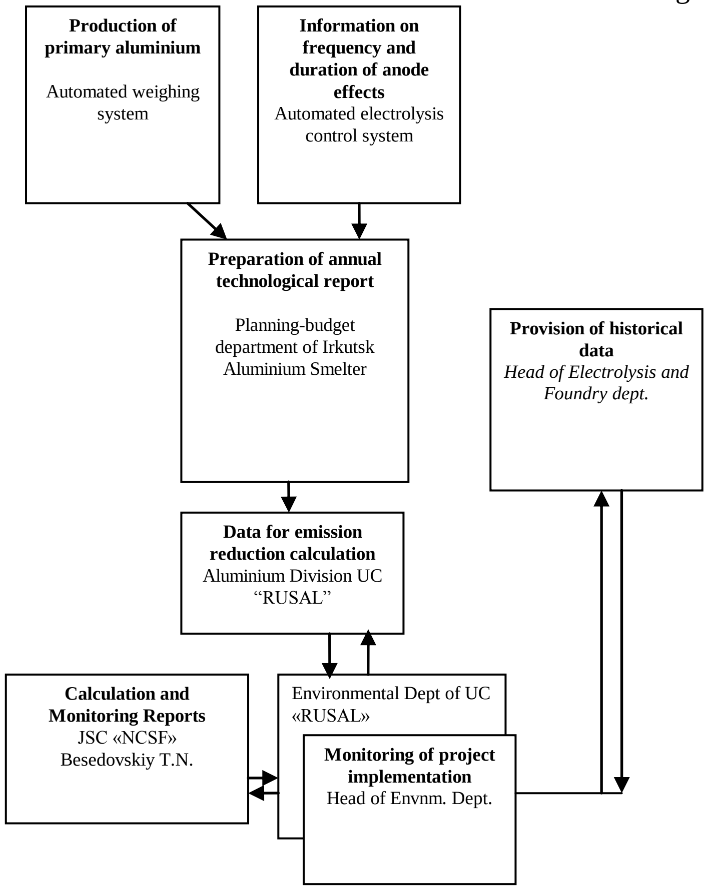
D.3. Please describe the operational and management structure that the project operator will apply in implementing the monitoring plan:

>>

Necessary to calculate the emission reductions of greenhouse gas emissions information is collected as is usually done at the Irkutsk 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 Irkutsk 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 Irkutsk Aluminium Smelter. The baseline was calculated as a result of expert judgment of specialists of Irkutsk aluminium smelter based on historical data.Below is a schematic diagram of the organization of monitoring reductions in greenhouse gases by JSC "RUSAL Irkutsk."
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		DAE	
					project	**Baseline**	**project**	**Baseline**
1	C8Б	VSS	2008	38 096,7	1,3	1,74	1,85	1,93
2	C8Б	VSS	2008	38 081,4	1,2	1,74	1,87	1,93
3	C3	VSS	2008	33 255,3	1,3	2,46	1,55	2,53
4	C2	VSS	2008	24 958,1	1,3	2,46	2,42	2,53
5	C8БM	VSS	2008	37 986,0	1,2	1,59	1,85	1,93
6	C8БM	VSS	2008	38 132,9	1,3	1,59	2,45	1,93
7	C8БM	VSS	2008	39 621,4	0,9	1,59	2,04	1,93
8	C8Б	VSS	2008	42 395,0	1,1	1,74	1,66	1,93
9	OA-300M2	PF	2008	38 488,6	0,1	2,46	2,04	2,53
10	OA-300M2	PF	2008	20 497,6	0,1	2,46	2,34	2,53
All			2008	351 512,9				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium	FAE		DAE	
					project	**Baseline**	**project**	**Baseline**
1	C8Б	VSS	2009	37 820,2	0,9	1,74	1,77	1,93
2	C8Б	VSS	2009	37 632,1	0,9	1,74	1,75	1,93
3	C8БM	VSS	2009	36 986,3	0,7	1,59	2,02	1,75
4	C8БM	VSS	2009	37 402,2	0,7	1,59	2,02	1,75
5	C8БM	VSS	2009	38 861,5	0,7	1,59	1,62	1,75
6	C8Б	VSS	2009	41 934,2	0,8	1,74	1,60	1,93
7	OA-300M2	PF	2009	60 512,6	0,0	2,46	1,06	2,53
8	OA-300M2	PF	2009	53 909,9	0,0	2,46	1,22	2,53
All			2009	345 059,0				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium	FAE		DAE	
					project	**Baseline**	**project**	**Baseline**
1	C8Б	VSS	2010	37 870,6	0,59	1,74	1,47	1,93
2	C8Б	VSS	2010	37 853,5	0,61	1,74	1,40	1,93
3	C8БM	VSS	2010	37 710,8	0,45	1,59	1,81	1,75
4	C8БM	VSS	2010	37 802,0	0,51	1,59	1,84	1,75
5	C8БM	VSS	2010	39 495,8	0,32	1,59	1,59	1,75
6	C8Б	VSS	2010	42 162,5	0,41	1,74	1,60	1,93
7	OA-300M2	PF	2010	79 441,1	0,05	2,46	1,20	2,53

8	OA-300M2	PF	2010	77 560,1	0,05	2,46	1,25	2,53
All			2010	389 896,3				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium	FAE		DAE	
					project	**Baseline**	**project**	**Baseline**
1	C8Б	VSS	2011	37 911,3	0,53	1,74	1,32	1,93
2	C8Б	VSS	2011	37 838,4	0,57	1,74	1,30	1,93
3	C8БM	VSS	2011	37 614,0	0,45	1,59	1,49	1,75
4	C8БM	VSS	2011	37 694,1	0,46	1,59	1,45	1,75
5	C8БM	VSS	2011	39 456,0	0,46	1,59	1,35	1,75
6	C8Б	VSS	2011	42 117,1	0,51	1,74	1,37	1,93
7	OA-300M2	PF	2011	82 726,3	0,07	2,46	1,15	2,53
8	OA-300M2	PF	2011	82 685,4	0,05	2,46	1,18	2,53
All			2011	398 042,6				

Potrom	Technology	Type of electrolyze	Year	Production of aluminium	FAE		DAE	
					project	**Baseline**	**project**	**Baseline**
1	C8Б	VSS	2012	37 911,3	0,53	1,74	1,32	1,93
2	C8Б	VSS	2012	37 838,4	0,57	1,74	1,30	1,93
3	C8БM	VSS	2012	37 614,0	0,45	1,59	1,49	1,75
4	C8БM	VSS	2012	37 694,1	0,46	1,59	1,45	1,75
5	C8БM	VSS	2012	39 456,0	0,46	1,59	1,35	1,75
6	C8Б	VSS	2012	42 117,1	0,51	1,74	1,37	1,93
7	OA-300M2	PF	2012	82 726,3	0,07	2,46	1,15	2,53
8	OA-300M2	PF	2012	82 685,4	0,05	2,46	1,18	2,53
All			2012	398 042,6				

E.1. Estimated project emissions:

>>

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

Year	GHG project emissions
2008	442306
2009	210839
2010	121325
2011	109631
2012	109631
Total (tCO_2e)	993733

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	1114311
2009	1228344
2010	1520297
2011	1576655
2012	1576655
Total (t CO_2e)	7016260

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	442306	-	1114311	672004
2009	210839	-	1228344	1017504
2010	121325	-	1520297	1398972
2011	109631	-	1576655	1467024
2012	109631	-	1576655	1467024
Total (tonnes of CO2 equivalent	993733	-	7016260	6022528

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 aluminium 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 6,022,528 tSO2ekv 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:	Open Joint Stock Company "Rusal Irkutsk"
Street/P.O.Box:	-
Building:	-
City:	Shelekhov
State/Region:	Russia
Postal code:	324211
Country:	Russia
Phone:	+7 (39550) 9-40-13
Fax:	-
E-mail:	-
URL:	officeIrkAZ@rusal.com
Represented by:	
Title:	General Director - Vladimir Berstenev
Salutation:	Mr.
Last name:	Berstenev
Middle name:	Vladimir
First name:	-
Department:	-
Phone (direct):	-
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 (PFC001 form)				
Value of data applied (for ex-ante calculations/determinations)	2008	2009	2010	2011	2012
	351 513	345 059	389 896	398 043	398 043
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	MP				
Data unit	tonnes				
Description	Electrolytic aluminium remained in the pots (Work-in-progress)				
Time of determination/monitoring	constantly				
Source of data (to be) used	Graduated stick (PFC 001 form)				
Value of data applied (for ex-ante calculations/determinations)	2008	2009	2010	2011	2012
	351 513	345 059	389 896	398 043	398 043
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)	<table><tr><td>C-2,3</td><td>2008-2012</td></tr><tr><td></td><td>2,53</td></tr><tr><td>C-8Б</td><td>2008-2012</td></tr><tr><td></td><td>1,93</td></tr><tr><td>C-8БМ</td><td>2008-2012</td></tr><tr><td></td><td>1,75</td></tr></table>
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
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)	<table><tr><td>C-2,3</td><td>2008-2012</td></tr><tr><td></td><td>2,46</td></tr><tr><td>C-8Б</td><td>2008-2012</td></tr><tr><td></td><td>1,74</td></tr><tr><td>C-8БМ</td><td>2008-2012</td></tr><tr><td></td><td>1,59</td></tr></table>
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
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 and parameters that are not monitored throughout the crediting period but determined only once (and thus remain fixed throughout the crediting period)

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	Determined once (referenced value)
Source of data (to be) used	2006 IPCC, Volume 3, Chapter 4.4., page 4.55, table 4.16
Value of data applied (for ex-ante calculations/determinations)	<table><tr><td>Technology</td><td>VSS</td><td>PFPB</td></tr></table>

<table>
<tr><td></td><td><table><tr><td>2008-2012</td><td>0,092</td><td>0,143</td></tr></table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures (to be) applied</td><td>Reference data that used in the absence of direct measurements. One value for each technology</td></tr>
<tr><td>QC/QA procedures (to be) applied</td><td>Reference data</td></tr>
<tr><td>Any comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$F_{C2F6/CF4}$</td></tr>
<tr><td>Data unit</td><td>C_2F_6/CF_4</td></tr>
<tr><td>Description</td><td>Weight fraction</td></tr>
<tr><td>Time of determination/monitoring</td><td>Determined once (reference data)</td></tr>
<tr><td>Source of data (to be) used</td><td>2006 IPCC, Volume 3, Chapter 4.4., page 4.54, table 4.16</td></tr>
<tr><td>Value of data applied (for ex-ante calculations/determinations)</td><td><table><tr><td>Technology</td><td>VSS</td><td>PFPB</td></tr><tr><td>2008-2012</td><td>0,053</td><td>0,121</td></tr></table></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures (to be) applied</td><td>Reference data that used in the absence of direct measurements. One value for each technology</td></tr>
<tr><td>QC/QA procedures (to be) applied</td><td>Reference data</td></tr>
<tr><td>Any comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>6500</td></tr>
<tr><td>Data unit</td><td>tCO_2/tCF_4</td></tr>
<tr><td>Description</td><td>Global Warming Potential for CF_4</td></tr>
<tr><td>Time of determination/monitoring</td><td>Determined once during PDD development</td></tr>
<tr><td>Source of data (to be) used</td><td>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</td></tr>
<tr><td>Value of data applied (for ex-ante calculations/determinations)</td><td>6500</td></tr>
</table>

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 IrkAZ")

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 Irkutsk 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.

For C2 and C3 pots for the period 2009-2011 for the duration of anode effect we used average value for the period from the beginning of the project.

It should be noted that the adopted mean value indicates the conservative actual level of DAE with alkaline baths. It is obvious that there is a trend of significant increase of DAE since 2001. There may be fluctuations in one direction or another, associated with many factors: the quality of aluminium, 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

С-2,3	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Duration of anode effect	2,48	2,57	2,53	2,53	2,53	2,53	2,53	2,53	2,53	2,53	2,53	2,53	2,53

С-8Б	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Duration of anode effect	1,88	1,97	1,93	1,93	1,93	1,93	1,93	1,93	1,93	1,93	1,93	1,93	1,925

С-8БМ	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Duration of anode effect	1,70	1,79	1,75	1,75	1,75	1,75	1,75	1,75	1,75	1,75	1,75	1,75	1,745

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 IrkAZ 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.

Values for the basic FAE for the smelter in general since 2000 are given below.

С-2,3	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Frequency of anode effect	2,42	2,50	2,46	2,46	2,46	2,46	2,46	2,46	2,46	2,46	2,46	2,46	2,46
С-8Б	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Frequency of anode effect	1,70	1,78	1,74	1,74	1,74	1,74	1,74	1,74	1,74	1,74	1,74	1,74	1,74
С-8БМ	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Frequency of anode effect	1,55	1,63	1,59	1,59	1,59	1,59	1,59	1,59	1,59	1,59	1,59	1,59	1,59

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.

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 **IrkAZ** 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

Condition as of the beginning of the project (early 2002):

Frequency of anode effect in different types of pots – 1.63-2.46 pcs / day
Aluminium fluoride specific rate – 34.1 kg /t
Current effervescive – 88.8%
Specific power rate – 15474 kW*h/t

Achieved performance is satisfactory in general, but high frequency of anode effect is completely not justified. In order to control the process, it is enough to perform anode effect once in 1 or 2 days.

The project aims to reduce the frequency of AE less than 1 times / day.
Achieved performance in 2011:
- Frequency of anode effect in different types of pots – 0.53 pcs per day
- Aluminium fluoride specific rate – 32.1 kg/t
- Current effervescive – 88.8%
- Specific power rate – 15434 kW*h/t

Thus, within the project implementation we did not get increase of the current effervescive, and the most important thing is that we did not get reduction of specific power rate (decrease down to 40 kW*h / t due to activities outside the project). That is, the ratio of energy consumed (the basic component of production costs) to the aluminium produced within the project, has not changed.

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 2.6-2.8 cryolite ratio.
Critical drop of aluminium 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 aluminium 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 aluminium;
- 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 aluminium, 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 aluminium, 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 aluminium 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 aluminium 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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