CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

PFC Emission Reductions at ALBRAS, Alumínio Brasileiro S.A.

Version 02 – 10/09/2007

A.2. Description of the project activity:

The purpose of this project activity is to reduce PFC emissions, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), in an aluminium smelting facility, funded through the sale of carbon credits in the context of the Clean Development Mechanism (CDM) of the Kyoto Protocol. Such PFC emissions are produced intermittently during brief process upset periods known as anode effect.

Alumínio Brasileiro S.A. (Albras) leads this project activity that involves the improvement of the automatic control system in 960 pots of its aluminium smelting facility. The technology of these pots is Center Work Prebake with Point Feeder system (PFPB).

Albras is a binational joint venture company established by Companhia Vale do Rio Doce (51%) and Nippon Amazon Aluminium Co., Ltd. (49%) in 1978, based on the joint declaration between the Brazilian and Japanese governments for the construction of an aluminium manufacturing complex in Amazon region. Albras has an outstanding safety performance recognized by international organizations, strict environmental controls, excellent organizational environment and is driven by a motivated and nationally awarded team.

Companhia Vale do Rio Doce (CVRD), founded in 1942, is the largest global producer and exporter of iron ore and pellets and an important world producer of manganese and ferroalloys, copper concentrates, bauxite, potash, kaolin, alumina and aluminium, as well as a remarkable player in the area of logistics and energy. CVRD is present in 18 countries including South American countries, Africa, Asia, and Oceania, always acting in a responsible and harmonious manner with society and the environment.

Nippon Amazon Aluminium Co., Ltd. (NAAC) was constituted in 1977 as a consortium of 32 Japanese private enterprises such as large aluminium smelters, aluminium consumers, a private bank, trading companies, and the Japanese Government, who is the biggest shareholder, through the Overseas Economic Cooperation Fund (OECF), actually the Japan Bank for International Cooperation (JBIC). At present, the shareholders of NAAC are 16 leading private companies (55.08%) and the JBIC (44.92%).

The project activity involves the following two stages:

1) Installation of an Anode Effect Early Detection Algorithm.
2) Installation of a new Feeding Algorithm that will be integrated to the Anode Effect Early Detection Algorithm mentioned above.

Through the implementation of the proposed project activity, a reduction of the anode effect frequency is obtained, and thus, emissions of PFC are also reduced. The project has the capacity to reduce around 802,862 tonnes of CO_2 equivalent emissions over a 10-year time frame. The project also brings environmental and social benefits (better health and labour conditions for workers), thus contributing to sustainable development of the region.

A.3. Project participants:

Table 1: Project Participants

Name of Party involved (*). ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	ALBRAS - Alumínio Brasileiro S.A. (private)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party (ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil

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

Pará State

A.4.1.3. City/Town/Community etc:

Barcarena

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

Albras is a Brazil-based company that was installed in 1985 in Barcarena City, Pará State, Brazil. The project's geographical coordinates are West longitude 48°43'59.71" and South latitude 1°33'12.47". Figure 1 shows the project activity's location.

The geographic localization of the plant, basic condition for a competitive performance, is extremely favorable, by being placed in an easy-access place for sea and fluvial access, with a port that receives raw materials and where the product is shipped at less than one kilometer from the plant, with easy access to main consumers in Asia, Europe, and the USA. Thus, Albras possesses a competitive advantage for its product, mainly as for logistic conditions.

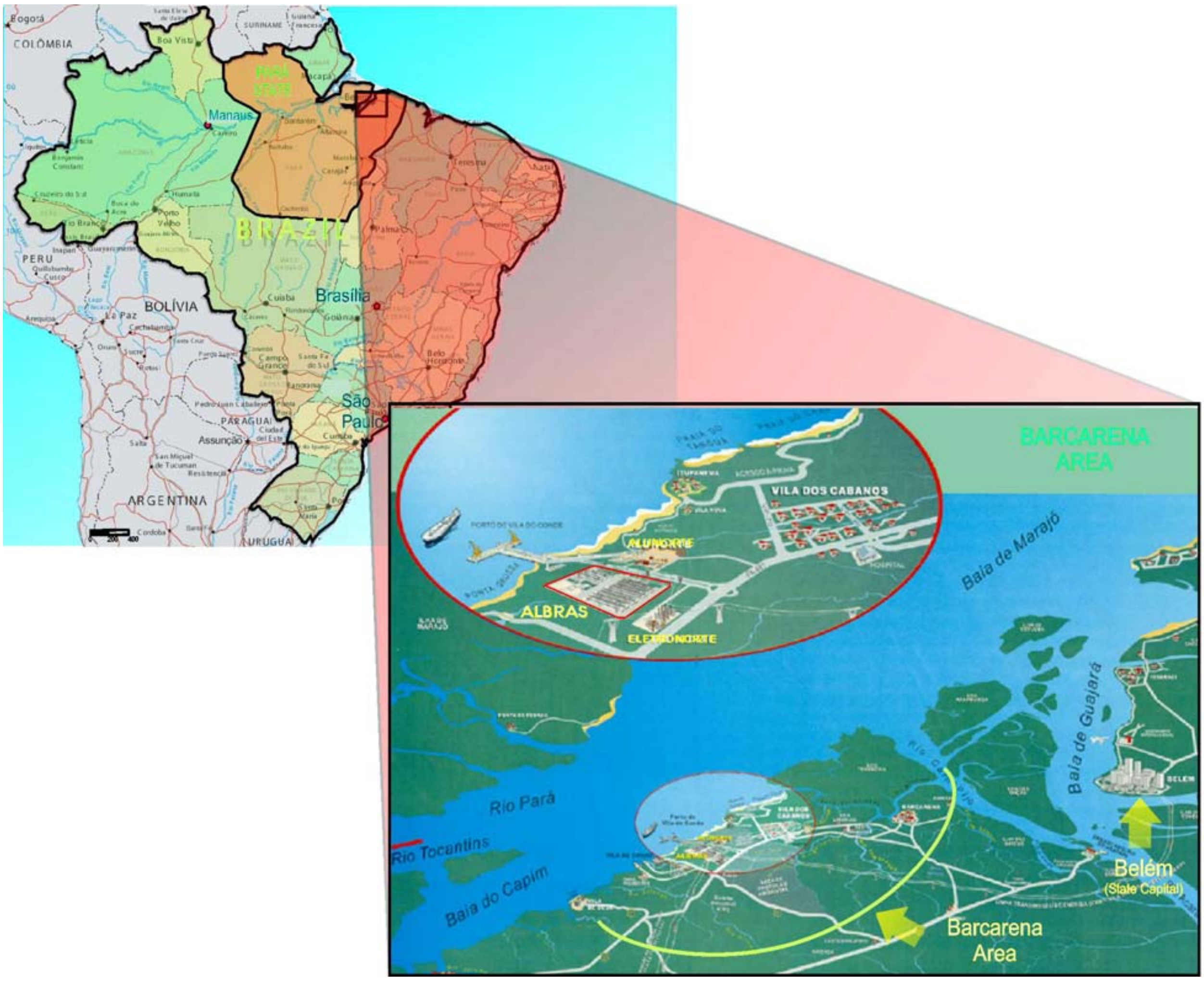

Figure 1: Albras' location

A.4.2. Category(ies) of project activity:

The appropriate category is (9) Metal production.

A.4.3. Technology to be employed by the project activity:

The objective of this project is to reduce PFC emissions from anode effect through the improvement of the automatic control system in 960 pots of the Albras smelter. The technology of these pots is Center Work Prebake with Point Feeder system (PFPB).

The project activity involves the following two stages:

1) Installation of an Anode Effect Early Detection Algorithm: it is based on the pot resistance behaviour. There is a specific pot resistance variation pattern, which is indicative that an anode effect is going to occur in the pot. The system detects the pattern and sends a message to the pot operator before the occurrence of the anode effect. The pot operator must attend the cell and eliminate any cause of anode effect before its occurrence.

   This is a new procedure that was developed by the technical team of Albras, and it was implemented in May 2005 in order to reduce the anode effect frequency, and thus, the PFC emissions.

2) Installation of a new Feeding Algorithm that will be integrated to the Anode Effect Early Detection Algorithm mentioned above: the Anode Effect Early Detection Algorithm will be complemented by the new Feeding Algorithm presently under development, which will allow an additional reduction of anode effect frequency, and thus, of PFC emissions. Through this new algorithm, the frequency of alumina feeding will be increased in order to over-feed the pot as soon as the anode effect pattern is detected. This will give to the pot operator time enough to detect and eliminate anode effect causes.

   The new Feeding Algorithm is expected to be implemented during 2007 but some pilot tests are presently running at 10 prototypes of retrofitted pots in Line 3.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The estimated emission reductions over a 10-year crediting period are shown in Table 2.

Table 2: Estimated emission reductions

Years	Annual estimation of emission reductions in tonnes of CO_2e
April 2008	60,215
2009	80,286
2010	80,286
2011	80,286
2012	80,286
2013	80,286
2014	80,286
2015	80,286
2016	80,286
2017	80,286
March 2018	20,072
Total estimated reductions (tonnes of CO_2e)	**802,862**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**80,286**

A.4.5. Public funding of the project activity:

Albras will not receive any national or international public funding whatsoever for the development of this project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The project activity uses an already existing baseline and monitoring methodology (AM0030/Version01), which has been approved and made publicly available by the CDM Executive Board. The methodology is named *“PFC emission reductions from anode effect mitigation at primary aluminium smelting facilities”*

According to the methodology, the project additionality justification, as well as the baseline scenario selection, is carried out using the latest version of the *“Tool for the demonstration and assessment of additionality”* (in this case, Version 03 is used).

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology is applicable to project activities:

1) Primarily aimed at the avoidance of PFC emissions in Primary Aluminium smelting facilities that use Center Work Prebake cell technology with Bar Brake (CWPB) or Point Feeder systems (PFPB);
2) At Aluminium smelting facilities that started operations before 31 December 2002;
3) Where at least three years of historical data are available regarding current efficiency, anode effect and Aluminium production of the industrial facility from 31 December 2002 onwards or, in case of project activities with a starting date before 31 December 2005, from 3 years prior to the implementation of the project activity onwards, until the starting date of the project activity.
4) At facilities where the existing number of potlines and pots within the system boundary is not increased during the crediting period. The methodology is only applicable up to the end of the lifetime of existing potlines if this is shorter than the crediting period.
5) Where it is demonstrated that, due to historical improvements carried out, the facility achieved an “operational stability associated to a PFC emissions level” that allows increasing the Aluminium production by simply increasing the electric current in the pots”. This can be demonstrated for example by providing results of pilot tests carried out by the company.

The proposed project activity meets all the conditions under which the methodology is applicable, as follows:

1) The objective of this project activity is to reduce PFC emissions from anode effect through the improvement of the automatic control system in 960 pots of the Albras smelter. The technology of these pots is Center Work Prebake with Point Feeder system (PFPB).

2) Albras started operations in 1985.
3) Albras has daily historical data related to current efficiency, aluminium production, and anode effect performance from the last three years, and more, prior to project implementation.
4) The existing number of potlines and pots within the project boundary will not be increased during the 10-year crediting period, and their remaining lifetime is 20 years.
5) It can be demonstrated that, due to historical improvements carried out by the company, the facility achieved an "operational stability associated to a PFC emissions level" that allows increasing the aluminium production by simply increasing the electric current in the pots (until an average value of 182.5 kA). More details are presented below in this PDD.

B.3. Description of the sources and gases included in the project boundary:

For this particular project activity, the project boundary includes the physical site of the 960 pots at the Albras smelter.

The emission sources included in the project boundary are listed in Table 3 below.

Table 3: Emission sources

<table>
<tr><th></th><th>Source</th><th>Gas</th><th>Included?</th><th>Justification / Explanation</th></tr>
<tr><td rowspan="12">Baseline</td><td rowspan="2">Anode effects in pots</td><td>CF_4</td><td>Yes</td><td rowspan="2">According to the methodology AM0030, only PFC emissions from anode effects are included in the project boundary.</td></tr>
<tr><td>C_2F_6</td><td>Yes</td></tr>
<tr><td>Carbon anode reaction</td><td>CO_2</td><td>No</td><td rowspan="6">These additional GHG emissions are not included in the methodology.</td></tr>
<tr><td>Use of Na_2CO_3</td><td>CO_2</td><td>No</td></tr>
<tr><td>Use of cover gas</td><td>SF_6</td><td>No</td></tr>
<tr><td rowspan="3">Internal transport</td><td>CO_2</td><td>No</td></tr>
<tr><td>CH_4</td><td>No</td></tr>
<tr><td>N_2O</td><td>No</td></tr>
<tr><td rowspan="3">Electricity consumption</td><td>CO_2</td><td>No</td><td rowspan="3">Electricity consumption is typically reduced to some extent, but it is not the trigger of this type of project activities. Thus, the emissions related to electricity consumption are excluded from further considerations, as a conservative assumption.</td></tr>
<tr><td>CH_4</td><td>No</td></tr>
<tr><td>N_2O</td><td>No</td></tr>
<tr><td rowspan="5">Project Activity</td><td rowspan="2">Anode effects in pots</td><td>CF_4</td><td>Yes</td><td rowspan="2">According to the methodology AM0030, only PFC emissions from anode effects are included in the project boundary.</td></tr>
<tr><td>C_2F_6</td><td>Yes</td></tr>
<tr><td>Carbon anode reaction</td><td>CO_2</td><td>No</td><td rowspan="3">These additional GHG emissions are not included in the methodology.</td></tr>
<tr><td>Use of Na_2CO_3</td><td>CO_2</td><td>No</td></tr>
<tr><td>Use of cover gas</td><td>SF_6</td><td>No</td></tr>
</table>

	Internal transport	CO_2	No	
		CH_4	No	
		N_2O	No	
	Electricity consumption	CO_2	No	Electricity consumption is typically reduced to some extent but it is not the trigger of this type of project activities. Thus, the emissions related to electricity consumption are excluded from further considerations, as a conservative assumption.
		CH_4	No	
		N_2O	No	

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline scenario is determined using the tool proposed in the methodology AM0030 that is supported on the *"Tool for the demonstration and assessment of additionallity"*.

Step 1: Identification of baseline scenario candidates

According to the methodology, the baseline scenario candidates can be the following:

1. The proposed project activity not undertaken as a CDM project activity.
2. All other plausible and credible anode effect mitigation alternatives to the project activity that deliver outputs with comparable quality, properties, and application areas:
   - Control measures (automatic and manual control system improvements);
   - Quality measures (changing the type of alumina).
3. No implementation of any anode effect mitigation measure.

There are not regulations on PFC emissions in Brazil, so, all the alternatives mentioned above are neither required nor forbidden by any law or regulation.

Alternative 2 may involve control and quality measures. In the case of Albras, different automatic control measures were already implemented in the past years in order to reduce the anode effect event and thus, to improve the stability of the cells, allowing to increase the current of the cells to the maximum value expected (more details are presented below in Section B.5). As a consequence, there is no need to implement new automatic control measures.

Moreover, manual control measures are not considered because these are disregarded by Albras since some operations are not safety for people involved in them. Almost 97% of anode effect suppression is done by automatic system.

Additionally, changing of alumina provider in order to improve alumina quality is not an alternative to the project participant. Albras buys alumina to a private qualified provider, Alunorte, which follows all quality control requested by Albras. The quality certificate that Albras awards to Alunorte may be shown to the DOE during the validation of the project.

Thus, Alternative 2 is not considered as a realistic and credible option for Albras, and only Alternatives 1 and 3 are analysed in order to determine the baseline scenario.

Step 2: Identification of the baseline scenario

Particularly, Alternative 1 is not a feasible alternative for Albras because it is not an economically attractive option to the project participant. Additionally, this alternative faces prohibitive barriers that prevent its implementation. These barriers, as well as the economic assessment, are described below in Section B.5.

Additionally, as it is shown also in Section B.5, Albras may continue making future improvements so as to increase aluminium production, with the levels of anode effect obtained prior to the implementation of the Anode Effect Early Detection Algorithm, and without having to implement any anode effect mitigation measure. Thus, Albras would not implement any anode effect mitigation measure without the incentive of the CDM related revenues. Without any motive to do otherwise, the baseline for Albras would be to continue using the current automatic control system without having to implement any anode effect mitigation measure. Thus, Alternative 3 results to be the baseline scenario.

The baseline regarded in this project considers the performance data from March 2004 to March 2005, prior to the installation of the Anode Effect Early Detection Algorithm with the intention to reduce the emissions of PFC. In this period:

- The cells were in stable operative conditions;
- The cells presented low values of Anode Effect Frequency;
- The cells could increase the current (and the aluminium production) without stability problems.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

During the year 2002, the World Bank contacted Albras in order to evaluate a possibility to carry out projects under the CDM, but the lack of clear rules and difficulties for baseline determination discouraged this initiative. However, Albras started to realize the importance of reducing PFC emissions.

During the year 2003, Albras started planning operative changes involving the improvement of the alumina feeding system and the feeder maintenance, the revision of filling hopers procedure, the inspection and elimination of plugged feeding holes, and the reduction of scheduled anode effect frequency, in order to improve the stability of the cells, allowing to increase progressively the current of the cells. By reducing scheduled anode effect frequency, Albras also reduced PFC emissions. In this context, Albras also trained its plant personnel in order to reduce the frequency of scheduled anode effects, facing a barrier associated with the belief that anode effects are necessary to obtain the best performance of the cells.

From the end of 2003 to October 2004, Albras implemented the current feeding algorithm, and the stability of the cells operating with this algorithm was achieved on March 2004. Albras could increase the current of the cells to the maximum value expected working with the anode effect conditions reached at this point.

By the end of 2004, the first CDM project was registered and a new methodology compatible with the proposed project activity was submitted for a similar project in Argentina. Thus, it showed that CDM was already on the road and renewed Albras motivation to develop a CDM project.

As a consequence, during the year 2005, Albras proposed to reduce non-scheduled anode effect frequency. In this case, Albras' motivation was the reduction of PFC emissions under the CDM rather than achieve performance improvements, since Albras could continue operating with the anode effect conditions reached in March 2004.

The first stage of project implementation started in May 2005, prior to the date of the project registration. However, the above-mentioned facts clearly demonstrate that the incentive of the CDM was seriously considered in the decision to proceed with the project activity.

As mentioned above, the project additionality justification is carried out using Version 03 of the *"Tool for the demonstration and assessment of additionality"*.

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

Sub-step 1a: Define alternatives to project activity

As described in Step 1 of Section B.4, the identified alternatives are the following:

1. The proposed project activity not undertaken as a CDM project activity.
2. All other plausible and credible anode effect mitigation alternatives to the project activity that deliver outputs with comparable quality, properties, and application areas:
    - Control measures (automatic and manual control system improvements)
    - Quality measures (changing the type of alumina)
3. No implementation of any anode effect mitigation measure.

As mentioned above, Alternative 2 is not considered as a realistic and credible option for Albras. Thus, Alternative 1 and 3 are compared in order to demonstrate the additionality of the project. At Sub-Step 2b these alternatives will be described detailed as Case 1, 2 and 3.

Sub-step 1b: Consistency with mandatory laws and regulations

There are no regulations on PFC emissions in Brazil. Consequently, all the alternatives are neither required nor forbidden by any law or regulation.

Step 2: Investment analysis

In this step, the economical comparison analysis between the Alternatives 1 and 3 is carried out.

Sub-step 2a: Determine appropriate analysis method

Since the project activity could expect a slight benefit from energy efficiency, an investment comparison analysis (Option II) is applied in order to justify the project additionality.

Sub-step 2b – Option II: Apply investment comparison analysis

In this comparison analysis, three cases are considered as shown in Table 4 below.

Table 4: Comparison cases for the cost analysis

Cases	Energy efficiency	Aluminium production	Algorithm Control was considered?	Expected results
Case 1	Up	No change	Yes	Energy efficiency only
Case 2	Up	Up	Yes	Energy efficiency + Production increase
Case 3	No change	Up	No	Production increase only

Cases 1 and 2 correspond to the proposed project activity under two business approaches: Case 1 related to save money from electricity savings, and Case 2 related to take advantage of the electricity savings in order to increase aluminium production. Finally, Case 3 corresponds to no implementation of any anode effect mitigation measure, and involves raising the electric current to increase the aluminium production in an amount comparable to that of Case 2.

Specifically, Case 1 is to first introduce the new algorithms whereas the production of aluminium stays the same and, as a result, an additional income from energy savings only could be expected. This is the typical case for an energy efficiency project.

On the other hand, Case 2 corresponds to introduce the new algorithms, and to increase the aluminium production through the energy savings and also try to sell that to the market.

Finally, Case 3 corresponds to simply increase the aluminium production by raising the current that circulates through the cell, providing additional income. The attractiveness for this case is that there is no need to change the current practice, which does not face any risk. The historical path (see Step 3) shows that this usually is the case in order to increase plant’s revenues.

Therefore, taking into account that no new investment is needed in Case 3, the comparison analysis uses Net Present Value (NPV) as financial indicator, since other financial indicators, such as project or equity internal rate of return (IRR), are not applicable.

Sub-step 2c: Calculation and comparison of financial indicators

This spreadsheet Albras_Economic Analysis_10Sep07.xls attached to this PDD shows the assumed values of investment, basic operating and maintenance costs, aluminium prices in the international market, and taxes. Hypothesis to the ratio in projecting future costs or prices are given by applying certain percentage taken from official sources.

Additionally, the comparison analysis for the impact of the CDM registration and the corresponding CER revenues are also considered.

When the number for the CER rate is zero (0), the NPV can be compared when there are not CDM revenues.

Table 5: Results obtained without considering CDM benefits

	Case 1	**Case 2**	**Case 3**
Investment amount (US$)	289,561	289,561	0
NPV before tax (US$)	2,583,598	6,632,934	7,100,971
NPV after tax (US$)	1,606,724	4,279,286	4,686,641

It could be seen from the results above that Case 2 is a more attractive course of action than Case 1, provided that the new algorithms are being introduced. But Case 3 has a more attractive result for two reasons:

- The NPV, both before and after tax, is higher compared to the former 2 cases, which itself gives a reasonable reason.
- Albras would not need to take any risks involved in going through the implementation of new untested algorithms (avoiding the risks associated as a result of investing in it).

The table below gives the results obtained by changing the CER rate number to ten (10), the current CER value in the market.

Table 6: Results obtained considering CDM benefits

	Case 1	**Case 2**	**Case 3**
Investment amount (US$)	439,561	439,561	0
NPV before tax (US$)	5,835,163	9,884,499	7,100,971
NPV after tax (US$)	3,684,757	6,357,319	4,686,641

The impact of CDM is evident as it could be seen above: Case 2 becomes more attractive, because it clearly provides the highest NPV, before and after taxes. Case 1 could be more attractive than Case 3 if CER price goes way up 14 dollars.

It is clear through the comparison between the two resulting tables that, without CDM benefits, Albras would not implement this kind of project activity.

Sub-step 2d: Sensitivity analysis

The sensitivity analysis considers as base case the one in which there are not CDM benefits.

Sensitivity analysis for aluminium price escalation

The sensitivity analysis shows that the NPV of Case 2 results lower than the one corresponding to Case 1 only if the aluminium price escalation is reduced from 9% (value considered in the analysis) to less than 2.98%, and the NPV of Case 3 results lower than the one corresponding to Case 1 only if the aluminium price escalation is reduced to less than 1.88%. These situations are highly improvable, due to the current aluminium price trend. Figure 2 shows the aluminium prices given by the London Metal Exchange (LME)[1], indicating that the annual average price rise ranges between about 5% and 32% since the year 2002. At Albras_Economic Analysis_10Sep07.xls attached to this PDD, it showed the results of this scenario.

On the other hand, for any number ranging between 5% and 32%, Case 3 is always the most attractive course of action.

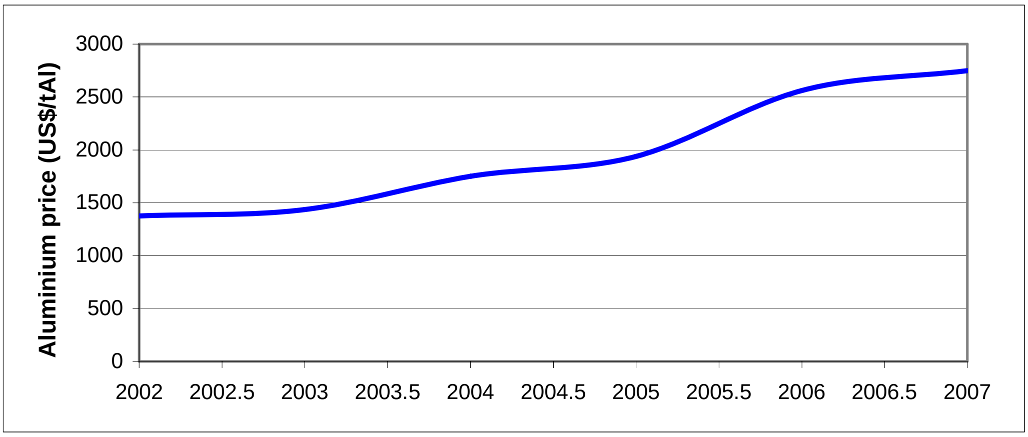

Figure 2: LME aluminium prices

Sensitivity analysis for electricity price escalation

The sensitivity analysis shows that the NPV of Case 2 results lower than the one corresponding to Case 1 only if the electricity price escalation is increased from 6% (value considered in the analysis) to more than 16.83%, and the NPV of Case 3 results lower than the one corresponding to Case 1 only if the electricity

[1] http://www.lme.co.uk/

price escalation is increased to more than 18.04%. These situations are highly improvable, since ANEEL[2] tax will not increase more than 15% per year during the next 10 years and, in the particular case of Albras, the rate will be kept in 6% per year due to Albras is considered a high-consumption user. At Albras_Economic Analysis_10Sep07.xls attached to this PDD, it showed the results of this scenario.

On the other hand, for any number ranging between 0% and 15%, Case 3 is always the most attractive course of action.

Sensitivity analysis for discount rate

The sensitivity analysis shows that, for any discount rate higher than 0%, the NPV of Case 3 results higher than the NPV of Case 2 and the NPV of Case 2 results higher than the NPV of Case 1. At Albras_Economic Analysis_10Sep07.xls attached to this PDD, it showed the results of this scenario. Thus, Case 3 is always the most attractive course of action.

All the sensitivity analysis presented above justifies the position that the project scenario is not the most economically attractive course of action and, therefore, the proposed project activity is additional.

Step 3: Barrier analysis

Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity

In order to prove that the project activity is additional, the following barriers were identified:

- Barriers due to business strategy: management business strategies are not focused on anode effect mitigation measures, so that the project activity is considered low priority by management;
- Barriers due to prevailing practice: the project activity is the “first of its kind”. No project activity of this type is currently operational in the host country.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

Barriers due to business strategy

Management business strategies of Albras are not focused on anode effect mitigation measures, so that the project activity is considered low priority by management.

As a result of project implementation, there would be a significant reduction of the anode effect frequency, as well as a small improvement in energy efficiency. This improvement reduces 0.17% the specific energy consumption for aluminium production (kWh/tAl). The management business strategies of Albras are not focused on the economical benefits from energy savings of the implementation of the

[2] Agencia Nacional de Energia Elétrica

new algorithms. The management business strategies of Albras are focused on the economical benefits from aluminium production.

As mentioned above, Albras may continue making future improvements so as to increase aluminium production, with the levels of anode effect obtained prior to the implementation of the Anode Effect Early Detection Algorithm, and without having to implement any anode effect mitigation measure. Albras could increase the current of the cells to the maximum value expected, working with the anode effect conditions reached on March 2004. Thus, Albras would be able to continue using the previous automatic control system without any modifications.

In order to demonstrate the validity of the statements mentioned above and to understand why the project activity receives low priority, it is necessary to begin by analysing the results of the modernization of its potlines, the associated investments throughout the process, and their relation with the current practice[3].

In the past, as many other smelters around the world, Albras has been increasing the line current. Albras smelter has four potlines with 240 PFPB pots in each, totalizing 960 pots. The side-by-side pots are derived from AP13 Pechiney technology and have undergone much development since operations began in 1985 with the start up of Potline 1, which was originally designed to operate at 135 kA with sidebrake feeding. In 1992, the Potline 1 retrofit from sidebreak to pointfeed was concluded, which made it possible to raise the current to 150 kA. The other three lines, started in 1986, 1990, and 1991, were designed to operate at 150 kA.

Due to limitations in the magnetic configuration of the busbars, the potlines have been operated for a long time with those same line currents. However, after the installation of an upstream side magnetic compensation on all the pots, voltage oscillation was reduced and the pots became more stable. It was possible in 2002, to gradually increase the current to 170 kA in Potline 1 and to 173 kA in Potlines 2, 3, and 4.

Additionally, Albras has done other different improvements in the potlines, amongst them the increasing of gas collection rate, the installation of slotted anodes, the increasing of the metal height, the reduction of the AlF_3 target, and the improvement of the anode cover.

The line current increases, linked to the other improvements, resulted in an aluminium production increase of 115,000 tones, from the original 320,000 tonnes per year in 1995 to 435,000 tonnes per year in 2003.

[3] It is important to note that, for the aluminium industry, the reduction of the occurrence of anode effects is desirable considering both environmental benefits and economic benefits. But, this statement depends on the original conditions of the anode effect/pot.day. If the original condition of a plant is such that the occurrence of anode effects is, e.g., as high as 2 AE/pot.day, it seems right to suggest an improvement program mainly focused on the reduction of anode effect. It is important to mention that, ten years ago, the anode effect was used as a method for controlling and correcting the process. The anode effects were programmed so as to recover the thermal balance of the cell as also to correct problems resulting from a deficient alumina feeding system to the pot. There was not much control over the added alumina mass. Moreover, the analysis of the historical evolution of the industry (e.g. as reported by IAI) shows that PFC reductions achieved to date were obtained as “by-product” (or as secondary targets) from programs centered on increasing aluminium production. Albras is one example of that situation. In order to attain a significant and consistent increase in aluminium production, the current in the cells must be increased. This action involves modifications in: alumina feeding systems, operating procedures, maintenance practices, and the operational control systems of the cells. All of these improvements result in a more stable operation of the cell, which results in a higher metal production, and, additionally, lower anode effects and, consequently, lower emissions of PFC.

During the year 2003, Albras started planning operative changes involving the improvement of the alumina feeding system and the feeder maintenance, the revision of filling hopers procedure, the inspection and elimination of plugged feeding holes, and the reduction of scheduled anode effect frequency, in order to improve the stability of the cells, allowing to increase progressively the current of the cells.

On July 2003, preliminary trials with 180 kA were performed in order to investigate possible operational problems. The results of the trials showed that is possible to operate with 180 kA except in Potline 1, because of its rectifier restrictions. This target of reaching 180 kA on these three lines was achieved on July 2004 with good operational results.

From the end of 2003 to October 2004, Albras also implemented a feeding algorithm. The stability of the cells operating with this algorithm was achieved on March 2004. Albras could increase the current of the cells to the maximum value expected (182.5 kA in average), working with the anode effect conditions reached at this point. This fact is confirmed by the results of the simulations in a mathematical model that were carried out by Albras. These results show that increasing the anode length to 1,480 mm, the current could be increased to 182.5 kA in average, without implementing any anode effect mitigation measure. This is in accordance with the methodology AM0030 that does not prevent the company for carrying out modifications that are different from anode effect mitigation measures. More details on the simulations will be provided to the DOE during the validation process.

The following table shows the maximum current to be achieved by each potline.

Table 7: Expected Amperages

Potline	**Expected cell current (kA)**
Potline 1	175
Potline 2	185
Potline 3	185
Potline 4	185
Average	**182.5**

From the foregoing information, it is evident that Albras has made modifications that have involved large investments resulting in associated benefits (such as energy savings, extension of the lifetime of the cells, and reduction of anode effects, among others).

The main objective of all these innovations and improvements was not focused on reducing PFC emissions but on reducing costs and maximizing aluminium production; reduction of PFC emissions was an additional benefit as a consequence of lowering the occurrence of anode effects. In particular, the objective was to improve efficiency and reduce the metal production costs in the aluminium industry. Towards meeting this objective, algorithms were optimised and actions were taken to improve the operating procedures and technology that additionally resulted in PFC emission reductions because of the reduction in the anode effect frequency.

Figure 3 below shows that Albras reached low anode effect frequency levels, which enabled it to attain high stability of the cells allowing an increase in the current, so that an increase in aluminium production could be achieved.

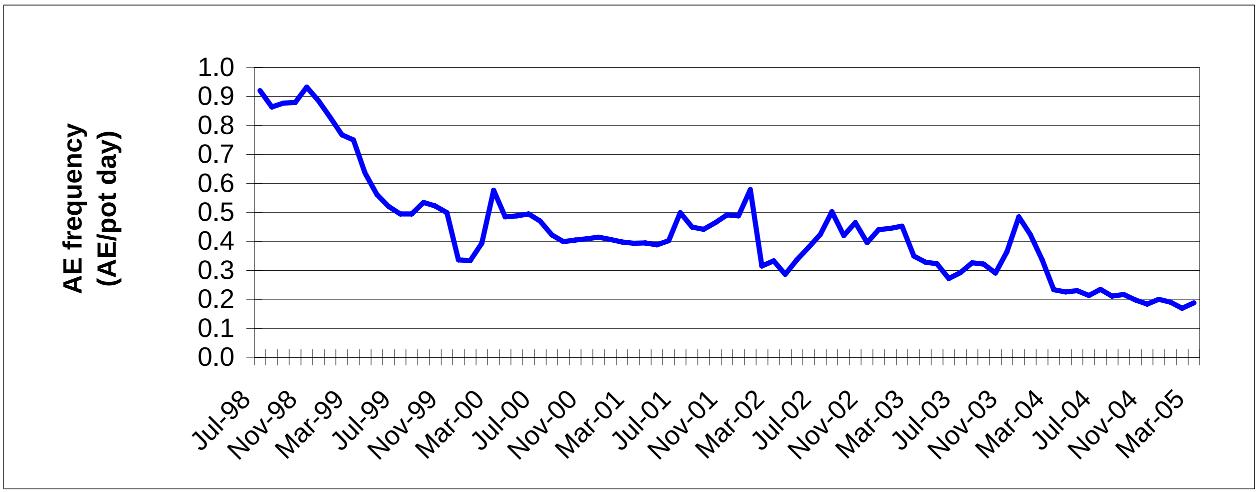

Figure 3: Anode Effect Frequency

Finally, it is concluded that Albras has invested large amounts in upgrading cells, and the investments made have been associated with huge financial benefits. Albras funded investments for the modernization of the plant and the management had no doubts at the time of approval of these investments about the resultant benefits. All these investments were focused on the final objective of the aluminium company of increasing aluminium production.

Additionally, Albras could continue making future improvements (by increasing the current) so as to increase aluminium production with the levels of anode effects obtained on March 2004 without having to implement anode effect mitigation measures. Albras had already achieved low anode effect frequency and there was no additional incentive to continue improving such anode effects further in order to achieve the projected aluminium production targets. This is due to the pots could keep stability conditions up to the average maximum current of 182.5 kA, which allows Albras increasing the production without having to mitigate anode effects.

The improvements shown above were primarily motivated by financial benefits. Even though by implementing the algorithms Albras would achieve an additional energy saving, this saving would result in a production increase rather than a cost reduction, since the cost savings are very insignificant (US$ 1.01/t Al) in comparison with the more relevant benefits resulting from an increase in production (US$ 4.87/t Al).

Albras has solid experience in increasing the current in order to increase the aluminium production. For Albras it is easier to increase the current compared with the implementation of new algorithms. Step 2 above has shown that Albras has a more attractive option to be implemented than the one represented by the proposed project activity without CDM revenues.

Figure 4 shows how Albras has been increasing the current of the potlines and, therefore, the aluminium production.

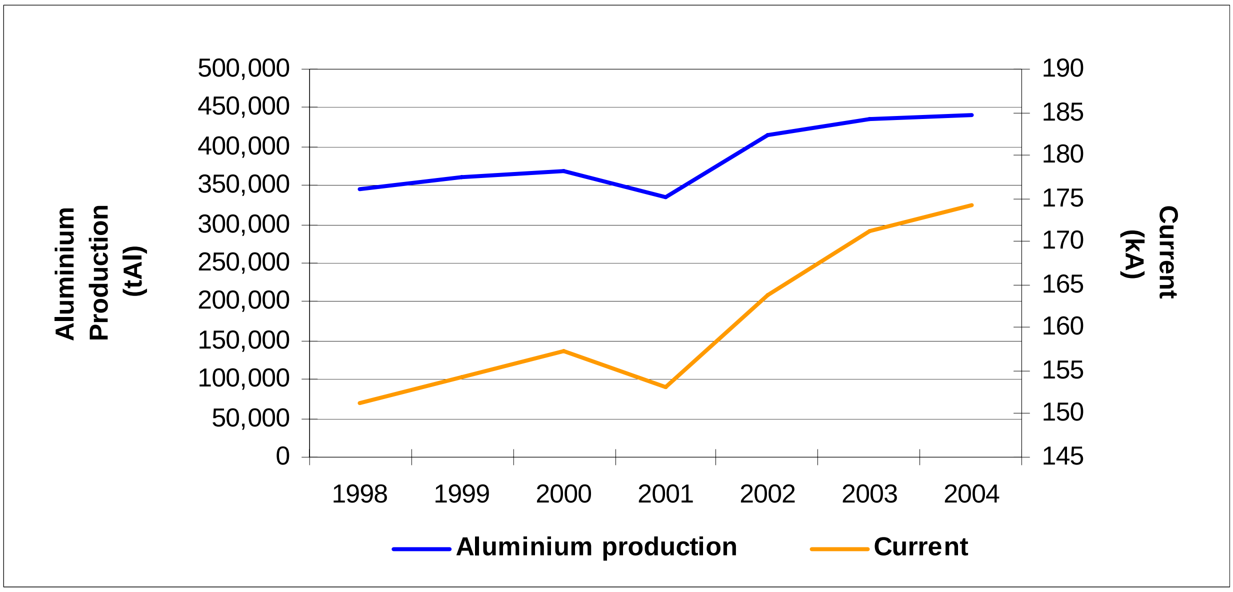

Figure 4: Current and Aluminium production

Albras' plan is to increase the current in potlines up to an average maximum of 182.5 kA, whereas the only objective is to raise aluminium production.

Finally, this increase in the current could be achieved regardless of the implementation of the new algorithms. The algorithms do not contribute to any increase in the operating current at all. In other words, the algorithms do not have any additional effect on production improvements.

Furthermore, from an environmental point of view, Albras is under no obligation to reduce GHG as a consequence of, for example, the legal framework.

It is important to note that under Albras' levels of anode effects obtained prior to project implementation, PFC emissions are already below the CO_2 emissions associated with the reducer agent oxidation. Therefore, the plant's new environmental performance improvements shall be focused on reducing CO_2 emissions rather than reducing PFC emissions. Figure 5 shows the historical evolution of the equivalent CO_2 emissions from anode consumption and from anode effects.

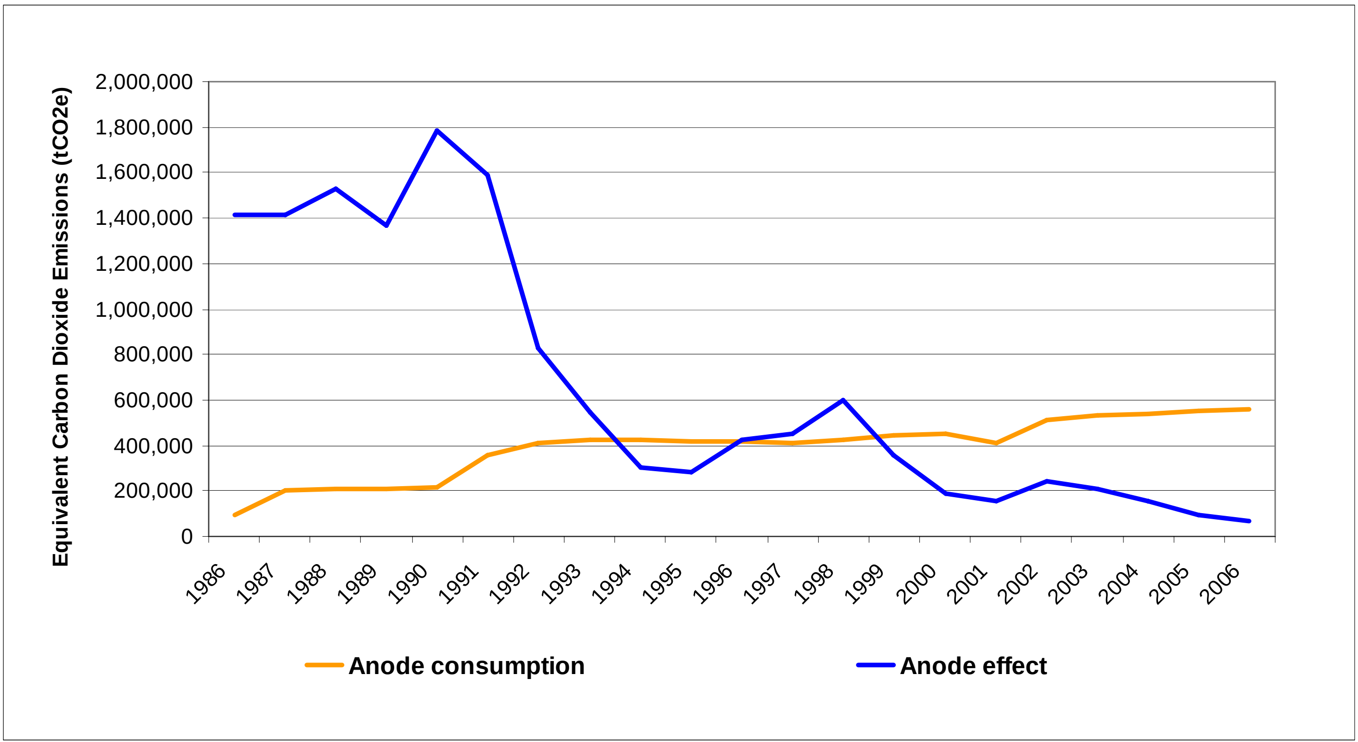

Figure 5: Historical evolution of the equivalent CO_2 emissions

On the other hand, there are no expectations that the aluminium industry implements technological changes such as switching over from the current anodes to ceramic material anodes aimed at reducing the anode effects further. No aluminium plant has made these technological changes and they are not expected to do so, at least for the next 10 years, since this would imply interrupting the plant operation for at least two years, resulting in a shutdown, and loss of production, loss of revenue, and loss of market share until the modified plant starts operating again.

In conclusion, although Albras has been reducing the occurrence of anode effects over a long term, it is evident from the foregoing that there is now no motivation —financial, legal, or environmental— to maintain this trend. Consequently, Albras could continue working with the anode effect conditions reached prior to project implementation during the proposed crediting period.

Barriers due to prevailing practice

Albras would be the first aluminium facility in applying this type of technology in Brazil. Thus, the project activity can be considered as the "first of its kind".

According to the explanation above, the implementation of the proposed project activity not undertaken as a CDM project activity (Alternative 1) faces prohibitive barriers that prevent its implementation.

Additionally, Albras would not implement any anode effect mitigation measure without the incentive of the CDM related revenues, since Albras could continue working with the anode effect conditions reached prior to project implementation. Thus, Alternative 3 (no implementation of any anode effect mitigation measure) is not prevented by these barriers and results to be the baseline scenario.

Step 4: Common practice analysis

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

The proposed project involves a technological innovation, which would be implemented for the first time in Brazil at the Albras industry. Thus there are no similar project activities in the country. The only project similar to the one proposed by Albras is the Aluar project, located in Argentina, which is being developed also under the CDM. Aluar's project is a new anode effect quenching procedure that involves the installation of a new algorithm based on the principle that each pot technology has a characteristic anode-catode distance in which a wave in the metal-bath interface is developed very quickly. Through this algorithm, the wave is used to produce local short-circuits to the anodes, allowing a fast removal of the isolating layer and replenishment of alumina in the interpolar volume.

Albras, on the other hand, proposes the installation of new algorithms that detect the anode effect before its occurrence, according to the cells behaviour, and feed more alumina to the cells in order to give to workers enough time to detect and eliminate anode effect causes.

The proposed project activity goes beyond the industry trends. Moreover, the project activity represents an industry-wide innovation.

Sub-step 4b: Discuss any similar options that are occurring

There are no similar options currently occurring in the country. The only project similar to the Albras project is the Aluar project, located in Argentina, which is being developed also under the CDM.

The implementation of these new algorithms would be founded through the sale of carbon credits in the context of the Clean Development Mechanism (CDM) of the Kyoto Protocol. The profits derived from the sale of carbon credits will allow Albras to pay for the installation of the new algorithms in the process control system and to cover development costs in order to optimise the management in the subsequent years.

Additionally, the project becomes an attractive opportunity only after carbon credits are taken into account. Otherwise, the most likely scenario is the no implementation of any anode effect mitigation measure (Alternative 3). The proposed project activity also faces prohibitive barriers, which can be overcome thanks not only to CER revenues but also to public recognition.

Taking into account the previous step-driven analyses, it is concluded that the proposed CDM project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

As mentioned above, the project activity uses an already existing baseline and monitoring methodology (AM0030/Version01), which has been approved and made publicly available by the CDM Executive Board. The methodology is named *"PFC emission reductions from anode effect mitigation at primary aluminium smelting facilities"*.

Albras' project is intended primarily to reduce PFC emissions from anode effect in the aluminium smelter by improving the automatic control system, which leads to a reduction of the anode effect frequency. According to the methodology AM0030, only PFC emissions from anode effects are included in the project boundary, in the baseline and project scenarios.

Baseline emissions

According to the Revised 2006 IPCC Guidelines, the most precise method for determining PFC emissions is either to monitor smelter emissions continuously (Tier 3a) or to develop a smelter-specific long-term relationship between measured emissions and operating parameters, and to apply this relationship using activity data (Tier 3b).

The Tier 3b method requires comprehensive measurements to develop the smelter-specific relationship and on-going collection of operating parameter data (e.g., frequency and duration of anode effects and the anode effect over-voltage) and production data.

On the other hand the Tier 2 approach uses default values for the technology-specific slope and over-voltage coefficients, whereas the Tier 1 approach provides default emission factors by technology type.

According to the methodology, only Tier 3b and Tier 2 methods can be considered in the calculation of baseline emissions. Tier 2 is applicable if it can be proven and documented that 95% of the anode effects are manually terminated prior to the implementation of the project activity (cell hood must be opened during termination of the anode effect), while in all other cases, Tier 3b is applicable.

In the case of Albras plant, 96% of the anode effects that take place prior to project implementation are automatically killed. As a result, Tier 3b method is used in order to determine baseline emissions.

In addition, according to the methodology, the following estimation relationships can be used:

- Slope method: it should be used with aggressive fast kill anode effect practices.
- Over-voltage method: it should be used with slow, repetitive anode effect kill practices.

In the case of Albras, the relationships established between the operating parameters and the PFC emissions are in accordance to the Slope method.

Baseline emissions *BE* (tCO_2e/year) are determined as follow:

$$if : \overline{BE} \leq BE_{IAI} \longrightarrow BE = \overline{BE} \times P_{Al} \quad (1a)$$

$$if : \overline{BE} > BE_{IAI} \longrightarrow BE = BE_{IAI} \times P_{Al} \quad (1b)$$

where

$\overline{BE}$	Baseline emissions per tone of aluminium produced (tCO_2e/tAl). It is determined *ex-ante* and considered fixed along the crediting period.
BE_{IAI}	Average value of "PFC emission per tone of Aluminium Produced" according to the most recent published IAI Survey for the PFBP technology (tCO_2e/tAl). The latest publication was in the year 2003, and the average value was rated as 0.65 tCO_2e/tAl. This value is considered fixed along the crediting period.
P_{Al}	Total aluminium production of the company (tAl/year)

Following project implementation, the Albras aluminium production will be monitored and the *ex-post* baseline emissions will be obtained from Equation (1).

Baseline emissions per tonne of aluminium produced ($\overline{BE}$) are determined as follow:

$$\overline{BE} = \left(\frac{EF_{CF_4} \times GWP_{CF_4} + EF_{C_2F_6} \times GWP_{C_2F_6}}{1000} \right) \quad (2)$$

where

EF_{CF_4}	Emission factor of CF_4 corresponding to the baseline scenario ($kgCF_4/tAl$)
$EF_{C_2F_6}$	Emission factor of C_2F_6 corresponding to the baseline scenario (kgC_2F_6/tAl)
GWP_{CF_4}	Global Warming Potential of CF_4 = 6,500
$GWP_{C_2F_6}$	Global Warming Potential of C_2F_6 = 9,200

As mentioned above, the relationships established between the operating parameters and the PFC emissions are in accordance to the Slope method. Thus, the CF_4 and C_2F_6 emission factors are determined as follows:

$$EF\,(kg\ CF_4\ or\ C_2F_6\ per\ \ tonne\ \ of\ \ Al) = Slope \times AE \min / cell\ day \quad (3)$$

where

Slope	Slope Coefficient corresponding to the baseline scenario [(kgPFC/tAl)/(AE min/cell day)]
AE min/cell day	Anode Effect corresponding to the baseline scenario (min/cell day)

The Anode Effect is obtained as shown below:

$$AE \min / cell\ day = AEF \times AED \qquad (4)$$

where:

AEF	Average Anode Effect Frequency (AE/cell day)
AED	Average Anode Effect Duration (min)

In order to determine baseline emissions, the average Anode Effect Frequency and Duration are determined using historical data of the Albras smelter. From the mean value and its standard deviation, a 95% confidence interval (applying a Student's t-distribution for *n* degrees of freedom) is set.

Regarding the Slope Coefficients for CF_4 and C_2F_6, they are determined prior to project implementation, by developing simultaneous measurements of emissions, aluminium production, and anode effect data over an appropriate period of time. According to the methodology, when properly established, the slope coefficient has an uncertainty of +/- 15%. Conservativeness is guaranteed by working with the lower limit for the baseline emissions.

Project emissions

Project emissions *PE* (tCO_2e/year) are determined as follows:

$$PE = \left(\frac{EF_{CF_4} \times GWP_{CF_4} + EF_{C_2F_6} \times GWP_{C_2F_6}}{1000} \right) \times P_{Al} \qquad (5)$$

where

EF_{CF_4}	Emission factor of CF_4 corresponding to the project scenario ($kgCF_4$/tAl)
$EF_{C_2F_6}$	Emission factor of C_2F_6 corresponding to the project scenario (kgC_2F_6/tAl)

GWP_{CF_4}	Global Warming Potential of CF_4 = 6,500
$GWP_{C_2F_6}$	Global Warming Potential of C_2F_6 = 9,200
P_{Al}	Total aluminium production of the company (tAl/year)

Following project implementation, the Albras aluminium production will be monitored and the *ex-post* project emissions will be obtained from Equation (5).

According to the methodology, project emissions should be obtained by the application of Tier 3b method only.

The CF_4 and C_2F_6 emission factors are determined as follow:

$$EF\,(kg\ CF_4\ or\ C_2F_6\ per\ \ tonne\ \ of\ \ Al) = Slope \times AE\,\mathrm{min}\,/\,cell\ day \qquad (6)$$

where

Slope	Slope Coefficient corresponding to the project scenario [(kgPFC/tAl)/(AE min/cell day)]
AE min/cell day	Anode Effect corresponding to the project scenario (min/cell day)

The Anode Effect is obtained as shown below:

$$AE\,\mathrm{min}\,/\,cell\ day = AEF \times AED \qquad (7)$$

where:

AEF	Anode Effect Frequency (AE/cell day)
AED	Anode Effect Duration (min)

Following project implementation, the Anode Effect Frequency and Duration, as well as the Slope coefficients, will be monitored, and the monitored values will be used in the *ex-post* determination of project emissions.

Regarding the Slope Coefficients for CF_4 and C_2F_6, they will be determined once after project implementation and every three years or less, according to the IAI/USEPA Protocol, by developing simultaneous measurements of emissions, aluminium production, and anode-effect data over an appropriate period of time. According to the methodology, when properly established, the slope coefficient has an uncertainty of +/- 15%. Conservativeness is guaranteed by working with the upper limit for the project emissions.

Emission reductions

According to the methodology, no leakage is expected to occur in this type of projects. Thus, the emission reductions, *ER* (tCO_2e/year), by the project activity are given by:

$$ER = BE - PE \tag{8}$$

where

BE Baseline Emission (tCO_2e/year)

PE Project Emission (tCO_2e/year)

B.6.2. Data and parameters that are available at validation:

This section includes a compilation of information on the data and parameters that are no monitored throughout the crediting period but that are determined only once and thus remain fixed throughout the crediting period and that are available when validation is undertaken.

Table 8: Description of data and parameters

Data / Parameter:	**Average Baseline Anode Effect Frequency**
Data unit:	AE/cell day
Description:	Number of anode effects per cell day at Albras smelter corresponding to the baseline scenario
Source of data used:	Historical data of Albras (measured)
Value applied:	0.208 AE/cell day
Justification of the choice of data or description of measurement methods and procedures actually applied:	According to the methodology, in order to determine the average anode effect frequency, it is necessary to have data from historical records. From the mean value and its standard deviation, a 95% confidence interval (applying t-distribution for *n* degrees of freedom) is set. In addition, the statistical error estimates are reported in this PDD.
Any comment:	It is used to determine the emission factors of CF_4 and C_2F_6 corresponding to the baseline scenario. It is determined prior to project implementation and considered fixed along the crediting period.
Data / Parameter:	**Average Baseline Anode Effect Duration**
Data unit:	Minutes
Description:	Duration of the anode effect in Albras smelter corresponding to the baseline scenario
Source of data used:	Historical data of Albras (measured)
Value applied:	4.641 min
Justification of the choice of data or description of	According to the methodology, in order to determine the average anode effect duration, it is necessary to have data from historical records. From the mean value and its

measurement methods and procedures actually applied:	standard deviation, a 95% confidence interval (applying t-distribution for n degrees of freedom) is set. In addition, the statistical error estimates are reported in this PDD.
Any comment:	It is used to determine the emission factors of CF_4 and C_2F_6 corresponding to the baseline scenario. It is determined prior to project implementation and considered fixed along the crediting period.
Data / Parameter:	**Baseline Slope coefficients**
Data unit:	(kgPFC /tAl)/(AE min/cell day)
Description:	Slope coefficients corresponding to the baseline scenario
Source of data used:	Measured
Value applied:	0.0340 (kgCF_4 /tAl)/(AE min/cell day) 0.00241 (kgC_2F_6 /tAl)/(AE min/cell day) These values correspond to the Slope coefficients determined less 15% in order to be conservative.
Justification of the choice of data or description of measurement methods and procedures actually applied:	According to the methodology, the Slope coefficients should be determined by simultaneous measurements of emissions and collection of anode effect data over an appropriate period of time. The measurements were made from 2 to 5 May, 2006 on a potline section containing 104 PFPB cells operating with the algorithm existing prior to project implementation. The measurement objective was to calculate the Intergovernmental Panel on Climate Change (IPCC) Tier 3 CF_4 slope factor and fraction of C_2F_6/CF_4 from the PFC measurements. CF_4 and C_2F_6 were measured in the exhaust ducts of aluminium electrolysis cells by Fourier Transform Infrared (FTIR) spectrometry using an extractive-type sampling system. Measured PFC emissions in the exhaust stack were adjusted for collection fraction of the cell fume collection system based on established measurement protocol principles. The total expected evolution rate of carbon containing gases was calculated from the net anode consumption and the measurement data for carbon dioxide and carbon monoxide were used as a quality control measure for the overall sampling and analysis system. The measurements were carried out according to the US EPA Protocol for Measurement of Tetrafluoromethane and Hexafluoroethane Emissions from Primary Aluminum Production, March 2003. According to the methodology, the Slope coefficients have an uncertainty of +/- 15%. Working with the lower limit for the baseline emissions guarantees conservatism.
Any comment:	These coefficients are used to determine the emission factors of CF_4 and C_2F_6 corresponding to the baseline scenario. They are determined prior to project implementation and considered fixed along the crediting period. The measurement report will be provided to the DOE during the validation process.
Data / Parameter:	**Average value of PFC emission per tonne of aluminium produced**
Data unit:	tCO_2e/tAl
Description:	Average value of PFC emission per tonne of aluminium produced according to the most recent published IAI Survey for PFPB technology.
Source of data used:	IAI Survey for the year 2003.
Value applied:	0.235 tCO_2e/tAl

Justification of the choice of data or description of measurement methods and procedures actually applied:	This is in accordance to the methodology AM0030. The baseline emissions per tonne of aluminium produced is lower than the IAI average value of "PFC emission per tonne of Aluminium Produced" (0.235 < 0.65 tCO2e/tAl). This poit will be more explained at B.6.3.
Any comment:	It is used to determine baseline emissions. It is determined prior to project implementation and considered fixed along the crediting period.

B.6.3 Ex-ante calculation of emission reductions:

Baseline Emission

As mentioned above, baseline emissions *BE* (tCO_2e/year) are determined through the following equations:

$$if : \overline{BE} \leq BE_{IAI} \longrightarrow BE = \overline{BE} \times P_{Al} \quad (1a)$$

$$if : \overline{BE} > BE_{IAI} \longrightarrow BE = BE_{IAI} \times P_{Al} \quad (1b)$$

$$\overline{\overline{BE}} = \left(\frac{EF_{CF_4} \times GWP_{CF_4} + EF_{C_2F_6} \times GWP_{C_2F_6}}{1000} \right) \quad (2)$$

$$EF\,(kg\ CF_4\ or\ C_2F_6\ per\ tonne\ of\ Al) = Slope \times AE\,\mathrm{min}/cell\ day \quad (3)$$

$$AE\,\mathrm{min}/cell\ day = AEF \times AED \quad (4)$$

By using historical data of the plant and the Slope coefficients measured, the CF_4 and C_2F_6 emission factors are determined and will remain constant throughout the crediting period.

In order to determine baseline emissions, the average Anode Effect Frequency and Duration are determined using historical data of the Albras smelter. Albras has daily historical data from the last three years, and more, prior to project implementation. As is shown below in Annex 3, the average Anode Effect Frequency and Duration are determined considering daily values of Anode Effect Frequency and Duration obtained from March 2004 (when the stability of the cells operating with the old feeding algorithm was achieved) to March 2005 (before project implementation). This period guarantees the conservatism in the calculation of baseline emissions.

According to the methodology, from the mean value and its standard deviation, a 95% confidence interval (applying a Student's t-distribution for *n* degrees of freedom) is set. Additionally, statistical error estimates are reported.

The values obtained are shown in the following table (for more details see Annex 3).

Table 9: Average Anode Effect Frequency and Duration

	AEF (AE/cell day)	**AED (min)**
Average	0.208	4.641
Confidence Interval (min)	0.204	4.581
Confidence Interval (max)	0.213	4.700
Error (standard deviation)	0.101	1.445

As it is shown, the average Anode Effect Frequency and Duration are determined with high accuracy.

Regarding the Slope Coefficients for CF_4 and C_2F_6, they were determined prior to project implementation, by developing simultaneous measurements of emissions, aluminium production, and anode effect data over an appropriate period of time. The measurements were made from 2 to 5 May, 2006 on a potline section containing 104 PFPB cells operating with the algorithm existing prior to project implementation. According to the methodology, when properly established, the slope coefficient has an uncertainty of +/- 15%. Conservativeness is guaranteed by working with the lower limit for the baseline emissions.

The values obtained during the measurements are shown in the following table (for more details see Annex 3).

Table 10: Baseline Slope Coefficients[4]

	CF_4	**C_2F_6**
Slope coefficient (kgPFC /tAl)/(AE min/cell day)	0.040	0.00284
Slope coefficient less 15% (kgPFC /tAl)/(AE min/cell day)	0.034	0.00241

Ex-ante baseline emissions are determined from the equations and data showed above and using the aluminium production value estimated by the plant for the crediting period (460,000 tAl/year). The resulting baseline emissions are showed in the table below.

Table 11: Baseline emissions

[4] **Source**: Calculation of IPCC Tier 3 PFC Calculation Coefficients from Measurement of PFC Emissions at Albras, page 17.

Year	Aluminium Production (tAl)	Average Anode Effect Frequency (AE/cell day)	Average Anode Effect Duration (min)	CF_4 Emission Factor ($kgCF_4/tAl$)	C_2F_6 Emission Factor (kgC_2F_6/tAl)	Baseline emissions per tonne of aluminium produced (tCO_2e/tAl)	Baseline emissions ($tCO_2e/year$)
April 2008	345,000	0.208	4.641	0.033	0.0023	0.235	81,174
2009	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2010	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2011	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2012	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2013	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2014	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2015	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2016	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
2017	460,000	0.208	4.641	0.033	0.0023	0.235	108,232
March 2018	115,000	0.208	4.641	0.033	0.0023	0.235	27,058

As shown above, the baseline emissions per tonne of aluminium produced is lower than the IAI average value of "PFC emission per tonne of Aluminium Produced" ($0.235 < 0.65\ tCO_2e/tAl$) and, for this reason, Equation (1a) is used in calculation of baseline emissions.

Project emissions

As mentioned above, project emissions *PE* ($tCO_2e/year$) are determined as follows:

$$PE = \left(\frac{EF_{CF_4} \times GWP_{CF_4} + EF_{C_2F_6} \times GWP_{C_2F_6}}{1000} \right) \times P_{Al} \qquad (5)$$

$$EF\,(kg\ CF_4\ or\ C_2F_6\ per\ \ tonne\ \ of\ \ Al) = Slope \times AE\,\mathrm{min}\,/\,cell\ day \qquad (6)$$

$$AE\,\mathrm{min}\,/\,cell\ \ day = AEF \times AED \qquad (7)$$

According to the methodology, in order to do the *ex-ante* calculation of project emissions, the plant should provide a justified estimation of the future values of the Anode Effect Frequency and Duration and the Slope coefficients.

According to the results obtained from the pilot test (10 prototypes of retrofitted cells are running in Line 3) Albras expects to reach an Anode Effect Frequency of 0.05 anode effects per cell per day and an Anode Effect Duration of 3 minutes after the complete implementation of the project activity.

Regarding the Slope Coefficients for CF_4 and C_2F_6, Albras carried out simultaneous measurements of emissions, aluminium production, and anode effect data over an appropriate period of time. The measurements were made from 2 to 5 May, 2006 on a potline section containing 104 PFPB cells operating with the new Anode Effect Early Detection Algorithm.

Even these Slope Coefficients only correspond to the first stage of the proposed project activity, these values are the best approximations available in order to carry out the *ex-ante* estimation of project missions.

According to the methodology, when properly established, the slope coefficient has an uncertainty of +/- 15%. Conservativeness is guaranteed by working with the upper limit for the project emissions.

The values obtained during the measurements are shown in the following table.

Table 12: Project Slope Coefficients[5]

	CF_4	C_2F_6
Slope coefficient (kgPFC /tAl)/(AE min/cell day)	0.048	0.00437
Slope coefficient plus 15% (kgPFC /tAl)/(AE min/cell day)	0.0552	0.00502

As it is shown above, the Slope Coefficients for CF_4 and C_2F_6 corresponding to the baseline and project scenarios are far different from the Default Coefficients for the Calculation of PFC Emissions from Aluminium Production (Tier 2 Methods) listed in page 8 of the methodology AM0030: 0.14 and 0.018 (kgPFC/tAl)/(AE min/cell day) for CF_4 and C_2F_6, respectively. Thus, these default values are not appropriate to be used in the *ex-ante* calculation of project emissions for this particular project activity.

On the other hand, the use of the Slope Coefficients measured prior to project implementation for both, baseline and project emission calculation, is also not an appropriate approach, since the Slope coefficients are expected to be slightly increased due to the project activity. This is because the average anode effect duration with the new algorithms is lower than the one corresponding to the old algorithm. The time rates of PFC emissions are highest at the start of anode effects and the rate of production of PFCs decreases as the anode effect continues until emissions are totally eliminated when the anode effect is terminated. Additionally, the fraction of C_2F_6/CF_4 ratio corresponding to the new algorithms is somewhat higher than that for the old algorithm, since highest C_2F_6 emissions tend to occur in the earlier stages of the anode effect and are less evident as the anode effect proceeds. With the longer durations of anode effects while operating with the old algorithm, additional CF_4 is produced without corresponding C_2F_6 emissions.

As a consequence of the explanation above, the Slope Coefficients determined for cells operating with the new Anode Effect Early Detection Algorithm result to be the best estimations available for the future

[5] **Source**: Calculation of IPCC Tier 3 PFC Calculation Coefficients from Measurement of PFC Emissions at Albras, page 17.

values that can be used to determine the *ex-ante* project emissions. Nevertheless, *ex-post* project emissions will be determined by using measured Slope Coefficients according to AM0030.

Ex-ante project emissions are determined from the equations and data showed above and using the aluminium production value estimated by the plant for the crediting period (460,000 tAl/year). The resulting project emissions are showed in the table below.

Table 12: Project emissions

Year	**Aluminium Production (tAl)**	**Average Anode Effect Frequency (AE/cell day)**	**Average Anode Effect Duration (min)**	**CF_4 Emission Factor ($kgCF_4/tAl$)**	**C_2F_6 Emission Factor (kgC_2F_6/tAl)**	**Project emissions ($tCO_2e/year$)**
April 2008	345,000	0.05	3.00	0.008	0.0008	20,959
2009	460,000	0.05	3.00	0.008	0.0008	27,946
2010	460,000	0.05	3.00	0.008	0.0008	27,946
2011	460,000	0.05	3.00	0.008	0.0008	27,946
2012	460,000	0.05	3.00	0.008	0.0008	27,946
2013	460,000	0.05	3.00	0.008	0.0008	27,946
2014	460,000	0.05	3.00	0.008	0.0008	27,946
2015	460,000	0.05	3.00	0.008	0.0008	27,946
2016	460,000	0.05	3.00	0.008	0.0008	27,946
2017	460,000	0.05	3.00	0.008	0.0008	27,946
March 2018	115,000	0.05	3.00	0.008	0.0008	6,986

Emission reductions

According to the methodology, no leakage is expected to occur in this type of projects. Thus, the emission reductions *ER* ($tCO_2e/year$) by the project activity is given by:

$$ER = BE - PE \qquad (8)$$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table 13: Emission reductions

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
April 2008	20,959	81,174	0	60,215
2009	27,946	108,232	0	80,286
2010	27,946	108,232	0	80,286
2011	27,946	108,232	0	80,286
2012	27,946	108,232	0	80,286
2013	27,946	108,232	0	80,286
2014	27,946	108,232	0	80,286
2015	27,946	108,232	0	80,286
2016	27,946	108,232	0	80,286
2017	27,946	108,232	0	80,286
March 2018	6,986	27,058	0	20,072
Total	**279,459**	**1,082,321**	**0**	**802,862**

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Table 13: Description of data and parameters

Data / Parameter:	**Project Anode Effect Frequency**
Data unit:	AE/cell day
Description:	Number of anode effects per cell day at Albras smelter corresponding to the project scenario
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0.05 AE/cell day

Description of measurement methods and procedures to be applied:	It is measured on-line. There are two programs that record the measurements done in the reduction lines: SISRED and SCORE. The first program, SISRED, is a daily update of the SCORE, which is a program that surveys on-line measurements.
QA/QC procedures to be applied:	Albras has a series of internal procedures that ensures that the data have low uncertainties during monitoring process and following IPCC guidelines measurements. The two programs have ISO 9000/2000 certification. In addition, all the measurement devices are calibrated according to the Albras internal calibration system that is included in the ISO 9000/2000 quality system.
Any comment:	It is used to determine the emission factors of CF_4 and C_2F_6 corresponding to the project scenario.
Data / Parameter:	**Project Anode Effect Duration**
Data unit:	Minutes
Description:	Duration of the anode effect in Albras smelter corresponding to the project scenario
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.6	3.0 min
Description of measurement methods and procedures to be applied:	It is measured on-line. There are two programs that record the measurements done in the reduction lines: SISRED and SCORE. The first program, SISRED, is a daily update of the SCORE, which is a program that surveys on-line measurements.
QA/QC procedures to be applied:	Albras has a series of internal procedures that ensures that the data have low uncertainties during monitoring process and following IPCC guidelines measurements. The two programs have ISO 9000/2000 certification. In addition, all the measurement devices are calibrated according to the Albras internal calibration system that is included in the ISO 9000/2000 quality system.
Any comment:	It is used to determine the emission factors of CF_4 and C_2F_6 corresponding to the project scenario.
Data / Parameter:	**Project Slope coefficients**
Data unit:	(kgPFC /tAl)/(AE-minute/cell day)
Description:	Slope coefficients corresponding to the project scenario
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0.0552 (kgCF_4 /tAl)/(AE min/cell day) 0.00502 (kgC_2F_6 /tAl)/(AE min/cell day) These values correspond to the Slope coefficients determined plus 15% in order to be conservative. Albras carried out simultaneous measurements of emissions, aluminium production, and anode effect data over an appropriate period of time. The measurements were made from 2 to 5 May, 2006 on a potline section containing 104 PFPB cells operating with the new Anode Effect Early Detection Algorithm. The measurement objective was to calculate

	the Intergovernmental Panel on Climate Change (IPCC) Tier 3 CF_4 slope factor and fraction of C_2F_6/CF_4 from the PFC measurements. CF_4 and C_2F_6 were measured in the exhaust ducts of aluminium electrolysis cells by Fourier Transform Infrared (FTIR) spectrometry using an extractive-type sampling system. Measured PFC emissions in the exhaust stack were adjusted for collection fraction of the cell fume collection system based on established measurement protocol principles. The total expected evolution rate of carbon containing gases was calculated from the net anode consumption and the measurement data for carbon dioxide and carbon monoxide were used as a quality control measure for the overall sampling and analysis system. The measurements were carried out according to the US EPA Protocol for Measurement of Tetrafluoromethane and Hexafluoroethane Emissions from Primary Aluminum Production, March 2003.
Description of measurement methods and procedures to be applied:	According to the methodology, the Slope coefficients should be determined by simultaneous measurements of emissions and collection of anode effect data over an appropriate period of time. This determination will be carried out once after project implementation and every three years or lees according to the instructions shown in page 34, section 10 of the Protocol for Measurement of Tetrafluomethane and Hexafluoroethane from Primary Aluminium Production, USEPA and IAI (2003). According to the methodology, the Slope coefficients will have an uncertainty of +/-15%. Working with the upper limit for the project emissions will guarantee conservatism.
QA/QC procedures to be applied:	Albras will follow the QA/QC procedures described in page 32, section 8 of the Protocol for Measurement of Tetrafluomethane and Hexafluoroethane from Primary Aluminium Production, USEPA and IAI (2003).
Any comment:	These coefficients are used to determine the emission factors of CF_4 and C_2F_6 corresponding to the project scenario.
Data / Parameter:	**Aluminium production**
Data unit:	tAl/year
Description:	Annual aluminium production of Albras smelter
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.6	460,000 tAl/year
Description of measurement methods and procedures to be applied:	It is measured on-line. There are two programs that record the measurements done in the reduction lines: SISRED and SCORE. The first program, SISRED, is a daily update of the SCORE, which is a program that surveys on-line measurements.
QA/QC procedures to be applied:	Albras has a series of internal procedures that ensures that the data have low uncertainties during monitoring process and following IPCC guidelines measurements. The two programs have ISO 9000/2000 certification. In addition, all the measurement devices are calibrated according to the Albras internal calibration system that is included in the ISO 9000/2000 quality system.
Any comment:	It will be used to determine baseline and project emissions.

Data will be archived until two years after finishing the crediting period.

B.7.2 Description of the monitoring plan:

The structure that the company will implement for the monitoring process is showed through the following table.

Table 14: Operational and management structure

Parameter monitored	Responsible	Frequency	Documentation
Anode Effect Frequency	Guilherme Epifano	Twice a second	Report from the automatic system (SISRED)
Anode Effect Duration	Guilherme Epifano	Twice a second	Report from the automatic system (SISRED)
Aluminium Production	Benigno Ramos Pinto Junior and Gilberto Correa	Every 32 hours (4 shifts)	Report from the automatic system
Slope Coefficient	Eduardo Macedo	Every three years or lees according to the Protocol for Measurement of Tetrafluomethane and Hexafluoroethane from Primary Aluminium Production, USEPA and IAI (2003).	Report from the external consultant that will carry out the measurements
Electric Current	Pedro Paulo Cecim Souza	Continuously	Substation Unit maintenance and control report

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion: December 2006.

Name of the responsible person/entity:

Eduardo Macedo, ALBRAS - Alumínio Brasileiro S.A.

Rodovia PA 483, KM 21, Distrito de Murucupi

ZIPCODE: 68447-000, Barcarena, Pará State - Brazil

Tel. +(55.91) 8867-0149

e-mail: edm25001@albras.net

Roberto Fujimoto, Marisa Zaragozi, and Fabián Gaioli, MGM International SRL
Av. Luis Carlos Berrini, 1297 - conj. 121
Zipcode: 04571-010, São Paulo, São Paulo State - Brazil
Tel. (55.11) 5102-3844
e-mail: rfujimoto@mgminter.com

R. Fujimoto, M. Zaragozi, and F. Gaioli are not project participants.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

The project activity started in May 2005 (01/05/2005).

C.1.2. Expected operational lifetime of the project activity:

20 years

C.2 Choice of the crediting period and related information:

Fixed crediting period

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

N/A

C.2.1.2. Length of the first crediting period:

N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/04/2008 or registered date

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The objective of this project is to reduce GHG emissions from anode effects through the improvement of the automatic control system, therefore this project does not degrade the environment; on the contrary, it will reduce the industrial impact on global warming.

Since the proposed project activity is not reached by the CONAMA Resolution Nº 001 of January 23rd 1986, which is based on Decree Nº 88,351 of June 1st 1983, it is not necessary to carry out an Environmental Impact Assessment under the pertinent authorities dealing with environmental matters in Brazil.

Albras has an implementation license registered at the State Secretary of Public Health, under process Nº 0115994, related to implementing the first stage of the aluminium production project in accordance with Decree Nº 88,351.

Albras also has the operation license since July 3rd 1985, which orders environmental requirements such as liquid effluents and particulates and fluoride emission control according to national and international technical norms (U.S. EPA), which are also updated annually. Last operation license update was in May 2006, under protocol Nº 0450/2006.

These licenses are only obtained following the evaluation and approbation of the Environmental Impact Assessment carried out by Albras prior to the installation of the plant.

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

No negative environmental impacts are expected from the project activity and an environmental impact study is not required by Brazilian authorities.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

Albras has submitted a set of documents to the Executive Secretariat of the Inter-ministerial Commission on Global Climate Change (Comissão Interministerial de Mudança Global do Clima – CIMGC), the Brazilian Designated National Authority, which has the following functions:

- To express a view on policies proposals that may have content related to the global climate change mitigation, adjusting it to the country and its impacts.
- To provide subsidies to government positions in negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) and other subsidiary entities in which Brazil takes Part.
- To keep an articulation with civil society entities in order to promote governmental and private entities actions, according to the commitments assumed before UNFCCC and other subsidiary entities in which Brazil takes Part.
- To define additional eligibility criteria to those considered by UNFCCC entities, according to Article 12 of Kyoto Protocol, in order to assure that the projects attend domestic strategies for sustainable development.
- To provide a view on projects that may result in emission reductions - considered potential CDM projects -, in accordance with the criteria mentioned above, and to emit a Letter of Approval for such projects when decided to do so.

The CIMGC designed the entities that, at least, must be invited to express their view on the proposed project activity. The entities designed by the CIMGC represent governmental, environmental, and social sectors, as follows:

- Municipal Prefecture
- Town/City Councillor's Chamber
- State Environmental Agency
- Municipal Environmental Agency
- Brazilian NGO and Social Organizations Forum for Environment and Development
- Community Associations
- Public Ministry (State Attorney for the Public Interest)

According to that, the following stakeholders were designed:

Table 15: Stakeholders designed

Entities	Name	Position
Municipal Prefecture	Laurival Magno Cunha	Mayor of Barcarena City Hall
Town/City Councillor's Chamber	Alírio César Magno	President of Barcarena Chamber
State Environmental Agency	Valmir Gabriel Ortega	Executive Secretary of the State Science, Technology, and Environmental Agency (SECTAM)
Municipal Environmental Agency	Silvana Maria Lobo Moraes	Executive Secretary of the Municipal Environmental Agency
Public Ministry (State Attorney for the Public Interest)	Walcyr César da Silva Ribeiro	Barcarena Attorney
Community Associations and Brazilian NGO and Social Organizations Forum for Environment and Development	Flávio Giovenale	Abaetetuba Archbishop
	José Maria	President of "Vila do conde" Community Center
	Áurea do Socorro	President of "Vila de São Francisco" Community Center
	Nelson Nascimento	President of "Laranjal" Community Center
	Raimundo Lucas da Silva Barros	President of "Itupanema" Community Center
	Rubens Barbosa Brandão	President of "Vila Nova" Community Center
	Adélia Barraqueth Costa	Representant of "Vila dos Cabanos" Residents Association

According to the CIMGC, the invitation letter must be addressed to each one of the stakeholders above listed. The letter should be sent by post office (no other type of communication with those actors is accepted), and the signed voucher of reception by the addressee must be attached to the copy sent to the Commission. The invitation letter should mention the project name, its localization, and its main objectives. The stakeholders should be provided of all necessary information in order to access technical, social, and environmental reports, as well as all relevant information necessary to express their views. All stakeholder comments received should be attached.

E.2. Summary of the comments received:

The following set of questions was sent to stakeholders:

1. Based on your knowledge on environment and climate change, the Kyoto Protocol and Clean Development Mechanism, please describe (briefly) your opinion about the Albras Project: GHG Emission Reduction.
2. Would you recommend other companies or organizations similar in scale to Albras to carry out similar projects on gas reductions?
3. Do you consider that the Albras Project GHG Emission Reduction will contribute for environmental, economic and social development (sustainable development) in the region of Barcarena City and the Pará State?
4. Any comment?

The table below shows the comments received up to now:

Table 16: Comments received

Question	1	2	3	4
Flávio Giovenale	Albras is one of the largest industries of Pará State. So, Albras' decision of increasing this effort begun years ago to reduce even more GHG is of ultimate importance. Advantages follow two directions: directly, it improves environmental conditions; indirectly, other companies will be influenced to follow the same path.	I think this effort by Albras should be imitated by similar scale companies and minor companies as well, since reduction of greenhouse effect will be achieved by summing everyone's efforts. It is clear that large-scale companies will contribute more, but it is important nobody be out of this.	The project aims to reduce 75,000 tons of CO_2 equivalent every year. Due to this, there will be a big beneficial impact in the region. If the "waterfall effect" reaches other companies in the region, then results will be even bigger. The social effect, I think, might be multiplied if the ecological mentality is implemented in everyday life of the whole population, thus avoiding wastefulness and increasing a rational use of natural assets.	I think it is appropriate to divulge this effort of Albras, which began years ago and has been further increased now. The company's reputation itself would be improved and similar initiatives by other companies and/or private entities would be encouraged.

Silvana Moraes	The initiative is very important and commendable. It demonstrates the company's concern and responsibility to the existence of different life forms.	It would be extremely important to take examples of this kind as an example.	Of course, the company already acts in this sector, as demonstrated through investments.	The company must keep investing in research, applying the CDM in order to reduce more emissions.
Alírio Ceza Magno	(…) We know and we are witness about these efforts that Albras has been developing, where it is reaching minimizing the effects incidents at environment, resulting from industrial actions at Barcarena City. All efforts with objective to avoid a impact at environment have to be persuaded and reached.	Lacks of detailed not make us to suggest, immediately, the implementation in others organizations as Albras. (…) It is important to become aware of, really, be reached these objectives.	I consider that all projects that objectives to reduce the greenhouse gases emissions is benefic. (…) However the concern from company about the influences at environment, is praiseworthy and point out civic duct regarding to social-environmental issues.	I would like to add a proposal to implement a campaign with objective to give knowledge to population (…) in order to collaborate to reduce and until extinguish the environmental injuries.

E.3. Report on how due account was taken of any comments received:

Tree comments have been received up to now and they were very positive for project implementation.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Table 17: Non-Annex I project participant

Organization:	ALBRAS – Alumínio Brasileiro S.A.
Street/P.O.Box:	Rodovia PA 483, KM 21, Distrito de Murucupi
Building:	Ed 711
City:	Barcarena
State/Region:	Pará
Postfix/ZIP:	68447-000
Country:	Brazil
Telephone:	+(55.91) 8867-0149
FAX:	
E-Mail:	edm25001@albras.net
URL:	http://www.albras.net/
Represented by:	Eduardo Macedo
Title:	Master Engineer
Salutation:	Master
Last Name:	Macedo
Middle Name:	
First Name:	Eduardo
Department:	Environmental Department
Mobile:	+(55.91) 8867-0149
Direct FAX:	
Direct tel:	
Personal E-Mail:	edm25001@albras.net

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No funds from public national or international sources were used in any aspect of the proposed project.

Annex 3

BASELINE INFORMATION

Averages of Anode Effect Frequency and Duration

The averages of Anode Effect Frequency and Duration are obtained considering the daily historical data of Albras aluminium smelter from March 2004 to March 2005, prior to installation of the Anode Effect Early Detection Algorithm. In this period:

- The cells were in stable operative conditions.
- The cells presented low values of Anode Effect Frequency.
- The cells could increase the current (and the aluminium production) without stability problems.

This period starts when the stability of the cells operating with the old feeding algorithm was achieved, and thus, it corresponds to the most stable operation of the cells and the lowest anode effect occurrence. Thus, the chosen period guarantees the conservatism in the calculation of baseline emissions.

The values of Anode Effect Frequency and Duration considered are presented in the sheet "Historical data" of the spreadsheet Albras_Emission Reductions_10Sep07.xls and they are summarized in the following table:

Table 18: Average Anode Effect Frequency and Duration

Date	Average Anode Effect Frequency (AE/cell day)				Average Anode Effect Duration (min)			
	Potline 1	Potline 2	Potline 3	Potline 4	Potline 1	Potline 2	Potline 3	Potline 4
Mar-04	0.270	0.308	0.157	0.205	4.947	7.309	4.837	4.449
Apr-04	0.266	0.298	0.191	0.149	4.728	6.554	5.237	3.917
May-04	0.258	0.258	0.197	0.200	4.593	6.087	4.843	4.037
Jun-04	0.270	0.245	0.175	0.167	5.315	6.488	5.099	3.991
Jul-04	0.312	0.248	0.218	0.208	5.377	6.377	5.095	4.037
Aug-04	0.267	0.215	0.170	0.194	4.955	5.644	5.344	3.739
Sep-04	0.284	0.199	0.156	0.228	4.839	5.000	4.773	4.266
Oct-04	0.267	0.187	0.152	0.191	4.598	5.640	4.615	4.433
Nov-04	0.297	0.175	0.100	0.165	4.616	4.614	3.411	3.566
Dec-04	0.314	0.182	0.126	0.169	4.776	4.378	4.204	3.609
Jan-05	0.322	0.191	0.111	0.142	4.533	4.612	3.574	3.628
Feb-05	0.206	0.233	0.096	0.138	4.458	4.668	3.674	3.811
Mar-05	0.308	0.199	0.117	0.125	3.632	3.437	3.048	3.782

Average	0.281	0.226	0.152	0.176	4.721	5.450	4.447	3.945
Total average	0.208				4.641			

The 95% confidence interval corresponding to these total averages are determined as follows:

$$\overline{X} \pm A \times \frac{S}{\sqrt{n}} \qquad (9)$$

where

$\overline{X}$	Average Anode Effect Frequency or Duration
S	Standard deviation
A	Point determining the distribution probability of 95%. It is obtained from the Student's t Distribution table as a function of the degrees of freedom (*n*) and the significance level.

Thus, as it is shown in the above-mentioned spreadsheet, the 95% confidence interval results to be:

Table 19: Confidence Interval

	Anode Effect Frequency	Anode Effect Duration
$\overline{X}$	**0.208 AE/cell day**	**4.641 min**
S	0.101 AE/cell day	1.445 min
n	1,584	1,584
α	0.05	0.05
A	1.645	1.645
Confidence interval	**0.204 AE/cell day**	**4.581 min**
	0.213 AE/cell day	**4.700 min**

As it is shown, the average Anode Effect Frequency and Duration are determined with high accuracy.

Baseline Slope coefficients

According to the methodology, the Slope coefficients should be determined by simultaneous measurements of emissions and collection of anode effect data over an appropriate period of time.

The measurements were made from 2 to 5 May, 2006 on a potline section containing 104 PFPB cells operating with the algorithm existing prior to project implementation. The measurement objective was to calculate the Intergovernmental Panel on Climate Change (IPCC) Tier 3 CF_4 slope factor and fraction of C_2F_6/CF_4 from the PFC measurements. CF_4 and C_2F_6 were measured in the exhaust ducts of aluminium electrolysis cells by Fourier Transform Infrared (FTIR) spectrometry using an extractive-type sampling system. Measured PFC emissions in the exhaust stack were adjusted for collection fraction of the cell fume collection system based on established measurement protocol principles. The total expected evolution rate of carbon containing gases was calculated from the net anode consumption and the measurement data for carbon dioxide and carbon monoxide were used as a quality control measure for the overall sampling and analysis system. The measurements were carried out according to the US EPA Protocol for Measurement of Tetrafluoromethane and Hexafluoroethane Emissions from Primary Aluminum Production, March 2003.

The following table summarizes the key parameters calculated from the measured data.

Table 20: Determination of the Baseline Slope Coefficients[6]

Quantity of CF_4 (kg)	10.17
Quantity of C_2F_6 (kg)	0.72
Aluminium Production (tonnes)	136.2
AE min/cell day	1.876
CF_4 Slope Coefficient (kgCF_4/tAl)/(AE min/cell day)	**0.040**
Fraction of C_2F_6/CF_4	**0.071**
C_2F_6 Slope Coefficient (kgC_2F_6/tAl)/(AE min/cell day)	**0.00284**

The complete measurement report will be shown to the DOE during the validation process.

[6] **Source**: Calculation of IPCC Tier 3 PFC Calculation Coefficients from Measurement of PFC Emissions at Albras, page 17.

Annex 4

MONITORING INFORMATION

The monitoring plan describes the procedures for data collection, and auditing required for the project, in order to determine and verify emissions reductions achieved by the project. This project will require only very straightforward collection of data, described below, most of which is already collected routinely by the staff of ALBRAS Plant, where the proposed CDM project is to be implemented:

- Slope Factor
- Anode Effect Frequency
- Anode Effect Duration
- Aluminium production

The monitoring plan fulfills the CDM Executive Board requirement that CDM projects have a clear, credible, and accurate set of monitoring and verification procedures. The purpose of these procedures is to direct and support continuous monitoring of project performance and periodic auditing, verification and certification activities to determine project outcomes, in particular in terms of greenhouse gas (GHG) emission reductions. The monitoring plan is a vital component of project design, and as such is subject to a formal third-party validation process —along with the project baseline and other project design features.

Managers of the project must maintain credible, transparent, and adequate data estimation, measurement, collection, and tracking systems to successfully develop and maintain the proper set of information to undergo an audit for a greenhouse gas (GHG) emission reduction investment. These records and monitoring systems are needed to subsequently allow an Operational Entity to verify project performance as part of the verification and certification process. In particular, this process reinforces the fact that GHG reductions are real and credible to the buyers of the Certified Emissions Reductions (CERs). This set of information will be needed to meet the evolving international reporting standards developed by the UNFCCC.

The document must be used by the project implementers and operators of the Technical Departments of the Albras smelter. Strict adherence to the guidelines set out in this monitoring plan is necessary for the project managers and operators to successfully measure and track project impacts for audit purposes.

The methodology describes the procedure and equations for calculating emission reduction from monitored data. For the specific project, the methodology is applied through a spreadsheet model Albras_MVP_21Jun07.xls. The staff responsible for project monitoring must complete the electronic worksheets on a monthly basis. The spreadsheet automatically provides annual totals in terms of GHG reductions achieved by the project.

The model contains a series of worksheets with different functions:

- Data entry sheet ("Monitored Data")
- Calculation sheets ("Baseline Emissions" and "Project Emissions")
- Result sheet ("Emission Reductions")

There are worksheets where the user is allowed to enter data. All other cells contain model fixed parameters or computed values that cannot be modified by the staff.

A color-coded key is used to facilitate data input. The key for the code is as follows***:***

- ***Input Fields:*** Pale yellow fields indicate cells where project operators are required to supply data input, as is needed to run the model;
- ***Result Fields:*** Green fields display result lines as calculated by the model.

Other sheets include fixed values, or values that are computed from data in the data entry sheets, and the last sheet shows the resulted annual emissions reductions.

All the monitored data will be archived for two years following the end of the crediting period.

- -