INTERNATIONAL COMMITTEE FOR STUDY OF BAUXITE, ALUMINA AND ALUMINIUM

ICSOBA

NEWSLETTER

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CONTENTS

In case you consider publishing in this forum, please contact the editor before writing your article.

Deadlines for a June issue is 10th of June and for a December issue 10th of December.

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FOREWORD

Dear ICSOBA Members!

We continually hear about our increasingly global society. We harness the incredible connective power of the Internet to stay in constant touch with friends, family and colleagues on the other side of the world. Our businesses look past national borders and see vast opportunities for growth and success. Nations are cooperating on issues such as global climate change, science and commerce like never before.

At ICSOBA, we are honoured to play a role in the new opportunities of our global community. It is something we do not experience every day. We typically meet once a year to maintain the critical face-to-face relationships with colleagues, key clients and partners worldwide. That bond cannot be replaced with phone calls, video conferences and emails. Some of us travel halfway across the world to reunite with colleagues to learn and share. Our global reach is not limited to this one-time event. Increasingly, ICSOBA members are joining forces across national borders to build alliances that further open the world in the aluminium business. These alliances have been a source of growth for our international interactions creating a vast worldwide network. We persist in finding ways to better serve our members. We have made significant strides this year in assuring successful continuity of our ICSOBA organisation:

- ICSOBA's seat has been moved from India to Montreal, Canada. ICSOBA has been legally incorporated with the Canadian federal government and with the Quebec provincial government
- Executive services have been assured contractually
- ICSOBA's new bank account was opened in the province of Quebec. The money remaining in India at the end of 2011 was successfully transferred to Canada
- A new ICSOBA website was built and awaits your inspection (please forward comments)
- ICSOBA proceedings, the Travaux volumes, from past conferences and symposia were electronically scanned and will be available for members as searchable pdf files shortly
- Important progress was made with the organisation of the 2012 ICSOBA symposium in Belém. The speaker program is shaping up and logistics in Belém have been asserted.

ICSOBA has gone through some turbulence caused by the change of seat from India to Canada. As you already know, following the 2011 resignations by Ashok Nandi and T.R. Ramachandran, President Roelof Den Hond also stepped down early this year. Roelof directed ICSOBA in the period of 2008 to early 2012 and still serves as organizer of the Belém symposium speaker program.

The upcoming symposium in Belém will present a superb opportunity to validate, refresh and complement both Presidency and the Council. ICSOBA members will have to democratically approve ICSOBA's leadership and future.

Just prior to the actual symposium there will be two internal ICSOBA meetings in Belem:

Presidency meeting, mainly to determine strategy and policies for 2013 and beyond, to propose new candidates for vacancies, and to adopt a draft of the Bylaws, as well as the Council meeting, to discuss the proposals of the Presidency and to prepare elections for Council and Presidency members by

the General Assembly meeting of all members present in Belém.

The General Assembly meeting at the end of the symposium is for all members to participate. The agenda of the meeting includes election of Presidency and Council members, adoption of Bylaws, confirmation of the move to Canada, adoption of policy on future events and budget.

For ICSOBA to thrive in the years to come, it is essential that members step forward to contribute to leading our association. As every solid organization, ICSOBA too needs a document that sets out its principles and aspirations, vision and mission, goals and objectives, values and value proposition. For ICSOBA, that document is our strategic plan and vision for the future. Over the course of the rest of this year ICSOBA members of all stripes are invited to contribute to the process of updating and rewriting our key document, the **ICSOBA Strategic Plan for 2013 & beyond**. For many of us, the idea of creating a strategic plan may not induce enthusiasm. But this document will be the simplest and the most accessible statement of what ICSOBA is all about. This is why I am a member and hopefully its content will resonate with you as well.

As we decidedly need **new and active members** I strongly invite you to propose candidates not only for Presidency and Council. We also need people who will contribute to the Newsletter, or be responsible for 3 speaker programs in 2013, etc. **Please stand up and contribute your ideas on the Strategic Plan, on Draft Bylaws and on new active members,** which we will process and communicate to you during the Belém symposium.

It is an exciting time to be a global organisation and to move our annual event to a different place each year. Like no other organisation in the aluminium field we can benefit from local resources, their experiences and talents. We can hear the voices of those who very often would not have a chance to travel to places we come from. Such events create large opportunity for all of us and we should absolutely take advantage of it. As every year, again this time we expect great interest from all of you in getting to Belem for the 19th ICSOBA Symposium. The Belem Symposium will mark the 49th year of ICSOBA's continuing existence on the international forum. Please help us mark ICSOBA's contribution to the society with pride and joy. We count on your participation in great numbers!

I thank you for your attention in reading this document.

Dr Frank Feret

President, ICSOBA

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NEWS AND EVENTS

ICSOBA-2012, the 19th International Symposium in Belém, Brazil

Preparations for the ICSOBA-2012 symposium end of October in Brazil are progressing very well. In May logistics have been arranged and contacts have been established in Belém. In June the speaker program has by and large been put in place. The Preliminary Program brochure, which has recently been distributed, shows a well filled and interesting program of over 110 presentations on bauxite, alumina and aluminium. The Organizing Committee received 150 abstracts - many more than expected - and hence had to place a number of submitted abstracts in the back-up list.

Roelof Den Hond and Marja Brouwer discussing participation of the Federal University of Pará state with Professor Marcondes Lima da Costa.

Early bird registration with reduced fee induced many people to already register. In case you want to participate in one of the field trips, please note that the number of people that can participate is limited to 40 for the Albras smelter, 60 for the Alunorte refinery and 50 for the Paragominas mine and wash plant.

View of Belém from the Hilton Hotel with the theatre and patk in Belém's old city centre built during the rubber boom of the 19th century.

It looks like Belém is going to have a bauxite and alumina boom in the 21th century.

ICSOBA-2013

In 2013 ICSOBA will celebrate its 50th Anniversary and it is ICSOBA's intention to celebrate this milestone during the 20th International Symposium. Preparations are already underway to hold this ICSOBA-2013 event jointly with the International Congress and Exhibition of Non-Ferrous Metals Siberia in September 2013 in Krasnoyarsk, Russia. Krasnoyarsk is located in the proximity of Siberia's huge aluminium smelting and hydroelectric power generating facilities, providing for interesting field trips adjacent to the actual event.

The joint event would enhance the international character of the annual International Congress and Exhibition of Non-Ferrous Metals Siberia and provide the members and regular delegates of ICSOBA with a chance to learn more about the Russian aluminium industry. Once agreement on the joint organization has been reached, more information on ICSOBA-2013 will be made available during the symposium in Brazil and on ICSOBA's web site www.icsoba.info.

TECHNICAL PAPERS

Application of 6 Sigma methodology in reducing maintenance costs in CAT 988H wheel loader fleet

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Abstract

In 2010 the economic performance indicators (CFROGI and EBITDA) at Mineração Paragominas S.A (MPSA) were analyzed in order to determine which costs impacted most on the financial performance of the operation.

It became clear at that time that the huge spending on maintenance materials resulted in budget overruns in 2010, in particular maintenance of the fleet of CAT 988H wheel loaders. It was decided to carry out a cost-cutting strategy into the CAT 988H wheel loaders fleet and the 6 Sigma Methodology was chosen to conduct this study. After 12 months of the cost cutting project, it was possible to achieve a reduction of 60 % in maintenance costs, while at the same time Physical Availability (DF) of the fleet increased, losses by mechanical and electrical problems decreased and the quality of ownership information in Service Orders (O.S.) improved.

Keywords: 6 Sigma; Cost Reduction; Physical Availability; Maintenance equipment

1. Introduction

The Paragominas bauxite zone occupies an area of about 50,000 km^2 in the Eastern Amazon region, stretching from the eastern part of the State of Pará to the western part of the State of Maranhão,. This is the most extensive and dense grouping of bauxite deposits of Brazil, approximately 300 km from North to South and up to 200 km in East-West direction. This zone comprises the districts of Miltônia, Gurupi, Tiracambu, Camoai in the South, and the districts of Futuro and Jabuti to the North. Since March 2011, the MPSA is controlled by Norsk Hydro do Brasil.

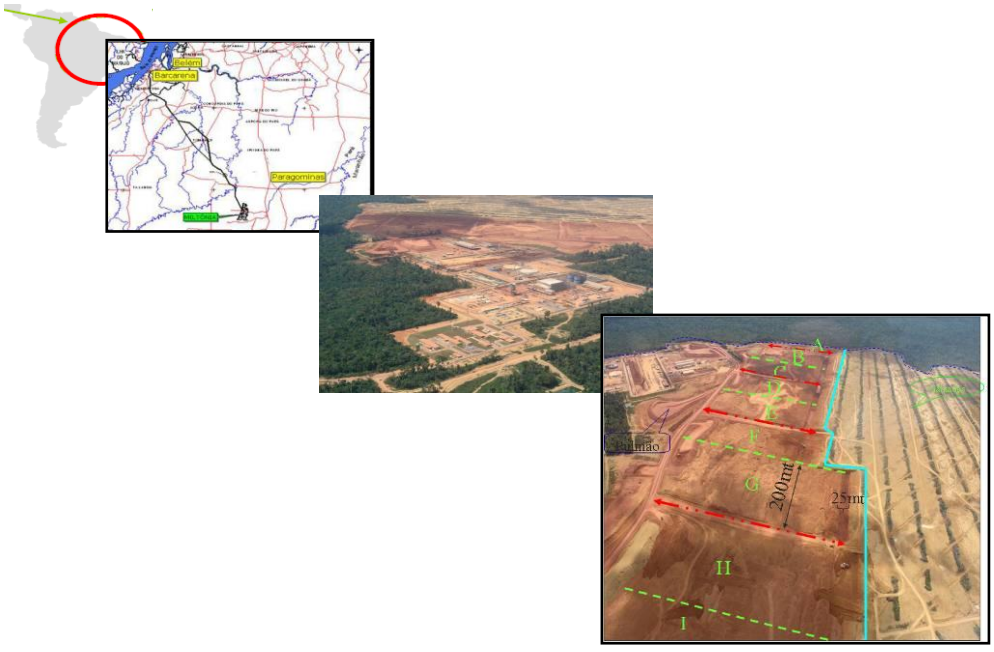


Fig 1 – Mineração Paragominas S.A overview

In MPSA, ore mining is carried out by the open pit method, in accordance with the strip mining method, determined by the long-term planning team in the design phase of the project, mainly based on the morphology of the mineral body. The mined ore loading is accomplished by hydraulic excavators.

Fig 2 –Loading of ore by a hydraulic excavator

CAT 988H wheel loaders were used essentially as support equipment for mining infrastructure activities – moving stacks of ore and topsoil supplies, formation of protection plots, etc.

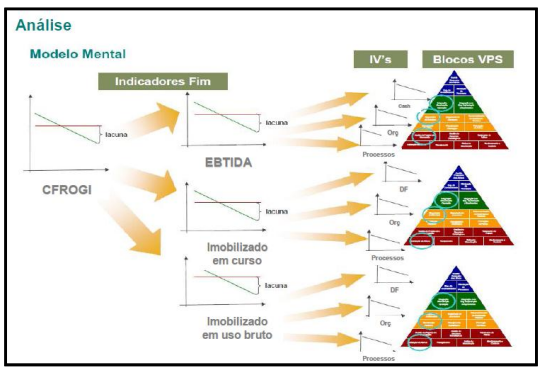
Changes in the mining operational scenario, caused by the world economic crisis of 2009 with market downturn and related lower production levels, and also a series of corrective maintenance occurrences caused a decline in the DF (Physical Availability) of mining hydraulic excavators and hence the CAT 988H fleet started to be used as production equipment.

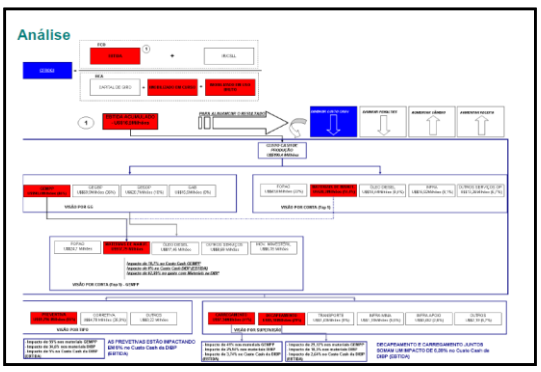
Fig 3 – Detail of the loading of ore by CAT 988H wheel loader

In a 2010 study the economic performance indicators, especially the CFROGI (Cash-flow Return on Gross Investment – Fig 4, below) and the EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization – Fig 5, below) of MPSA were analyzed and the costs that most impacted on the financial performance of the operation were assessed. It became clear at that time that one of the biggest problems faced by the General Management of mining (GEMPP) was the huge spending on maintenance materials resulting in budget overruns in 2010, in particular the high maintenance costs of the fleet of loaders CAT 988H.

It was decided to carry out a cost-cutting strategy into the CAT 988H wheel loaders fleet and 6 Sigma methodology was chosen to conduct this project between Jan and Dec 2011.

The 6 Sigma methodology works with a mind map for CFROGI and EBITDA analyses as illustrated in the graphs Fig 4 and Fig 5, below.





2. Case Study

2.1. Applied Methodology

Both the PDCA cycle (Plan – Do – Check – Act) and the DMAIC (Define – Measure – Analyze – Improve – Control) cycle comprise11 stages, as shown in Fig 6 below, which we followed.

Identify priorities
Establish general goal
Split the problem in smaller parts
Determine opportunities in the variety
Establish specific goals
Identify potential causes
Quantify and rank the causes
Test the measured and elaborate the action plan
Execute
Verify
Actions to be taken

Fig 6 – PDCA cycle applied to the 6 Sigma Methodology

2.1.1. Plan Stage - Identifying Priorities and Establishment of Goals

For identification of priorities notices in the 988H wheel loaders fleet database to the information systems ware analyzed. Information systems used at MPSA include SMARTMINE (Mine Operation Control System), MAXIMO (Maintenance Control System), ORACLE ERP System. In addition information from the Query (analytical report of costs) generated by the finance management of the operation, were used.

The overall goal was to obtain adherence to the 2011 budget. So, the goal would be to reduce costs of maintenance materials of wheel loaders up to December 2011.

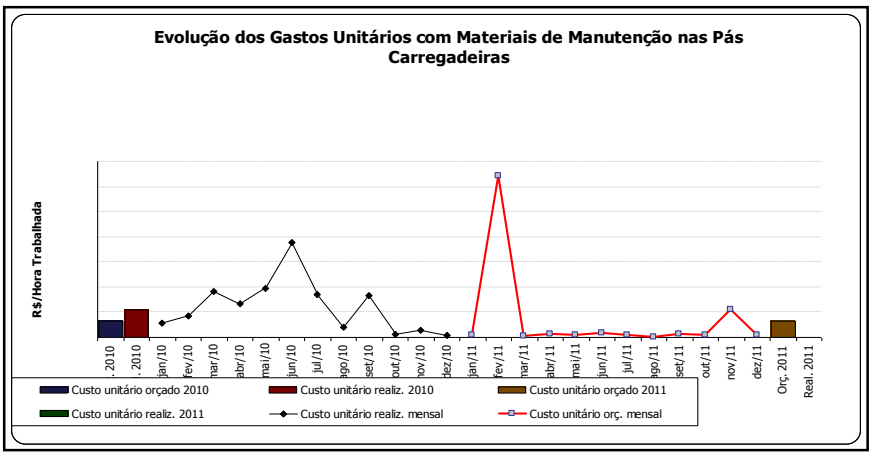


Fig 7 – Chart of costs with Maintenance Materials over time

Using Pareto methodology, we were able to separate corrective from preventive maintenance costs, and identify in each the types of maintenance and the major cost impacts. Fig. 8 below presents the data per class and the Pareto chart.

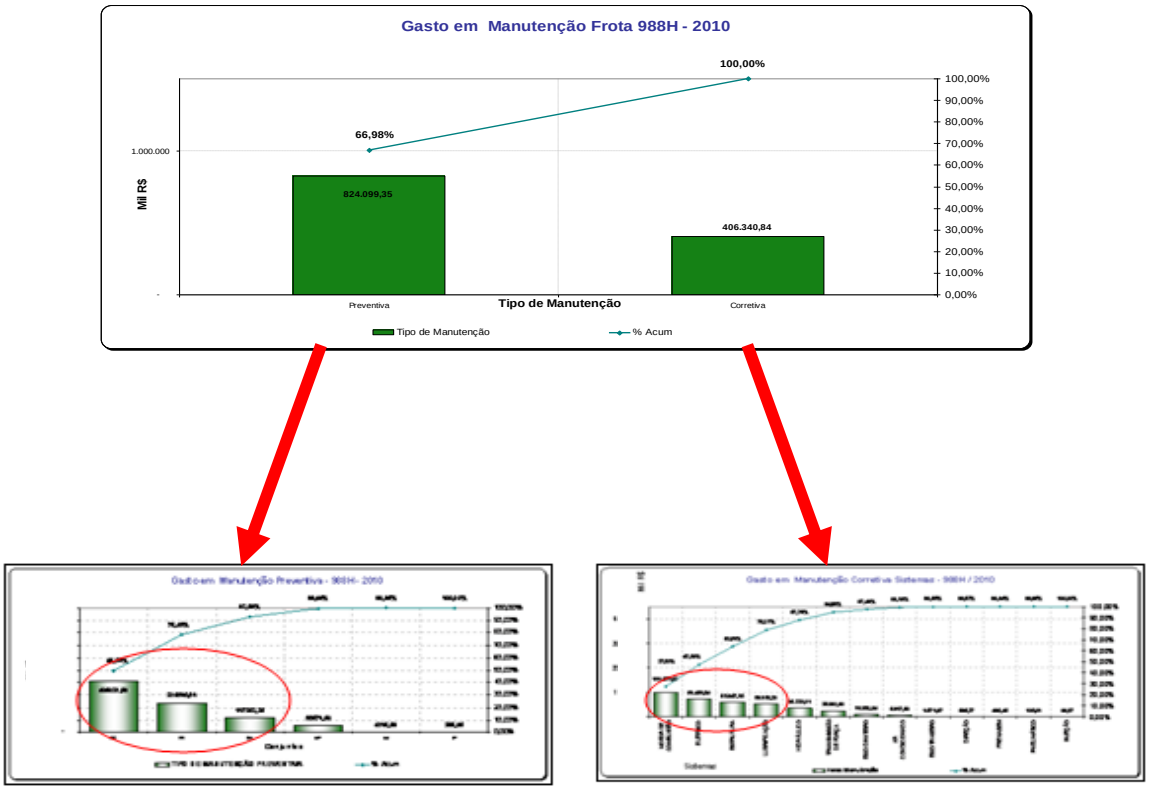
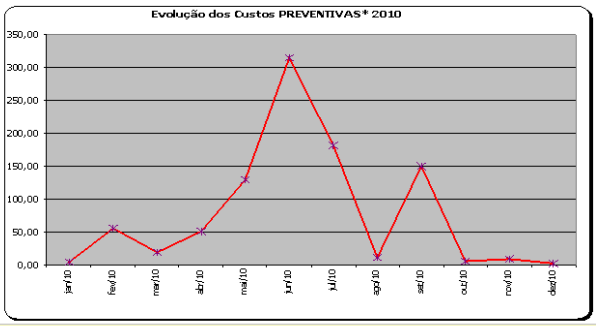


Fig 8 – Pareto chart – spending per type - 988H wheel loader fleet / 2010



Análises descritivas - Preventiva * (RR/S.A/PC)

Variável	Número de dados	Média	Desvio Padrão	Mínimo	1o. Quartil	Mediana	3o. Quartil	Máximo
Valores	12	77,94	97,53	2,65	8,20	35,45	135,04	314,23

Para o foco custo unitário com PREVENTIVA* observou-se uma média igual a R$77,94/HT e desvio-padrão igual a R$97,53/HT. Ainda, os valores mínimo e máximo foram respectivamente, R$2,65/HT a R$314,23/HT. Uma mediana igual a R$35,45/HT foi observada. Pelo menos 75% das observações possuem custos unitários igual ou menor que R$135,04/HT.

In this phase, each item causing outbreaks of impact received statistical processing. Excel spreadsheet was for analysis. As an example, in Fig 9, we have the chart with the Preventive focus analysis.

Fig 9 – Descriptive analysis of Preventive focus

The criteria Criticality, Facility and Authority were selected to determine priorities and reduction percentages for each of the identified critical issues were proposed.

Problemas críticos	Criticidade	Facilidade	Autoridade	Prioridade	Priorização	Atual	% Redução	Redução	Redução Total	Meta Específica
Preventiva * (PC / RR / S.A)	62,1	80	50	192,10	1	64,20	50%	32,10		32,10
Corretiva - Motor de Combustão	8,1	60	50	118,10	2	8,39	33%	2,77		5,62
Corretiva - Estrutura	5,4	60	50	115,40	3	5,53	33%	1,82	40,52	3,71
Corretiva - Lubrificação	4,8	60	50	114,80	4	4,96	33%	1,64		3,32
Corretiva - Elétrico	6,4	50	50	106,40	5	6,65	33%	2,19		4,46
Atual:	110,69									

Esse % deve ser superior ao do estabelecido para a meta geral. → 36,61%

Fig 10 – Specific Goals prioritization matrix

For further problem analysis, an Ishikawa diagram was used in a brainstorming session together with maintenance teams (Fig 11).

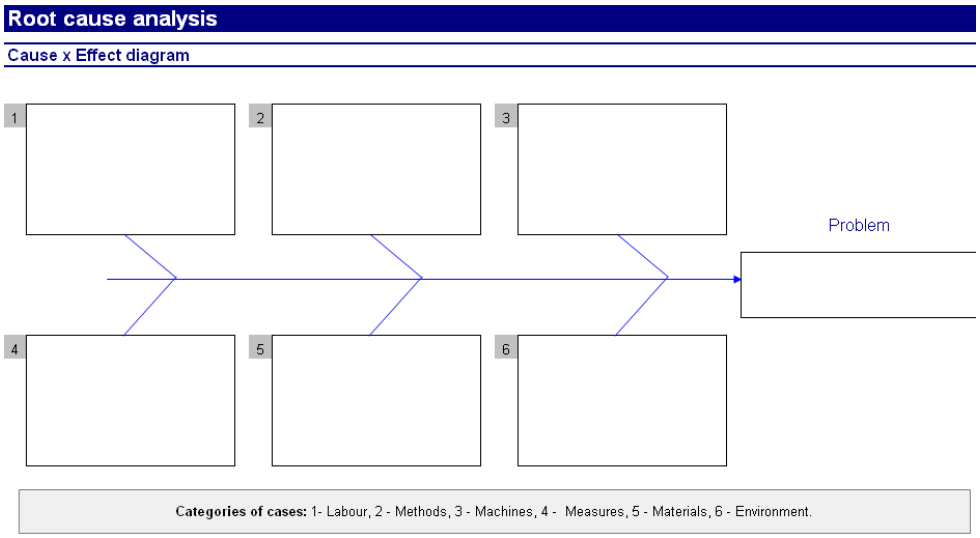


Fig 11 – Ishikawa diagram

Problem	Cause	Mitigating Measure	Technical Feasibility	Political Viability	Environmental Viability	Economic viability	Safety Feasibility	Viabilidade de continuidade	Sum	Priority
High cost of corrective maintenance	ACOMPANHAMENTO DA VIDA ÚTIL DOS COMPONENTES	REALIZAR TAGUEAMENTO FISICO DOS PRINCIPAIS COMPONENTES	5	5	5	5	5	5	30	1
	ACOMPANHAMENTO DA VIDA ÚTIL DOS COMPONENTES	INSERIR CODIGOS DOS COMPONENTES TAGUEADOS NO SISTEMA MAXIMO	5	5	5	5	5	5	30	
	ORÇAMENTAÇÃO DOS ITENS DE REPOSIÇÃO DA FROTA CAT 988H	IDENTIFICAR E ORÇAR PRINCIPAIS COMPONENTES A SEREM REPOSTOS POR FIM DE VIDA UTIL	5	5	5	5	5	5	30	
	ORÇAMENTAÇÃO DOS ITENS DE REPOSIÇÃO DA FROTA CAT 988H	REALIZAR ORÇAMENTAÇÃO DOS PLANOS DE 6000 HORAS	5	5	5	5	5	5	30	
		REALIZAR ORÇAMENTAÇÃO DOS PLANOS DE 12000 HORAS	5	5	5	5	5	5	30	
	VIDA ÚTIL DOS COMPONENTES ELÉTRICOS	APLICAR BUCHA CONFECCIONADA EM POLIURETANO	5	3	5	3	5	5	26	
		APERFEIÇOAR SISTEMA DE LUBRIFICAÇÃO CENTRALIZADA	5	3	5	3	5	5	26	
High cost of preventive maintenance	APROPRIAÇÃO DE INFORMAÇÕES DE MANUTENÇÃO NAS O.S	REALIZAR APROPRIAÇÃO ADEQUADA DAS INFORMAÇÕES DE MANUTENÇÃO NAS O.S	3	3	5	5	5	3	24	2
	CONTROLE ORÇAMENTÁRIO	RESTRINGIR PERMISSAO DE COMPRAS POR PESSOAS DA SUPERVISÃO	3	3	5	5	5	3	24	
		RESTRINGIR PERMISSAO DE COMPRAS NO CENTRO DE CUSTOS DA SUPERVISAO POR PESSOAS EXTERNAS À SUPERVISÃO	3	3	5	3	5	3	22	

Once the identified potential causes were compared - current versus ideal situation, meeting operational requirements yes or no, and the evidence of their status - an array of cost causing factors was created, establishing criteria for prioritization.

Fig 12 – Cost Causing Factors prioritization array

We defined an action plan (see below) for each Cause, which was very explicit regarding the actions (What), responsibilities (*Who* and *Where)* and deadlines (*When)* It is important to emphasis the need of full cooperation and the commitment of supervisors and their staff.

Action Plan

Cause	What	Who	When	Where	How
Elevado custo unitário de manutenção CORRETIVA	FUGA DE COMPRESSAO PELA JUNTA DE VEDAÇÃO DO CARTER DO MOTOR	SUP. ELIAS LOPES	31/08/2011	OFICINA CENTRALIZADA	SUBSTITUINDO AS JUNTAS DE VEDAÇÃO DO CARTER DO MOTOR
Elevado custo unitário de manutenção PREVENTIVA	ACOMPANHAMENTO DA VIDA ÚTIL DOS COMPONENTES	SUP. ELIAS LOPES	31/12/2011	OFICINA CENTRALIZADA	REALIZANDO MARCAÇÃO FISICA DOS COMPONENTES COM O USO DE FERRAMENTA ADEQUADA
Elevado custo unitário de manutenção CORRETIVA	IDENTIFICAÇÃO DE TODAS AS CORDOALHAS DOS EQUIPAMENTOS A SEREM SUBSTITUIDAS	TEC. FRANK CALIL	05/10/2011	OFICINA CENTRALIZADA	REALIZANDO INSPEÇÃO PARA IDENTIFICAÇÃO DAS CORDOALHAS DANIFICADAS
Elevado custo unitário de manutenção CORRETIVA	SUBSTITUIÇÃO DE TODAS AS CORDOALHAS IDENTIFICADAS QUE NECESSITAM SUBSTITUIÇÃO	TEC. FERREIRA SILVA	31/10/2011	OFICINA CENTRALIZADA	REALIZANDO SUBSTITUIÇÃO DAS CORDOALHAS DANIFICADAS
Elevado custo unitário de manutenção PREVENTIVA	VIDA UTIL DOS COMPONENTES PRINCIPAIS (TREM DE FORÇA / SISTEMA HIDRAULICO / BOMBAS HIDRAULICAS)	SUP. ALFEU SILVA	15/03/2012	OFICINA CENTRALIZADA	CUMPRINDO DEFINIÇÕES DO MAPA DE 52 SEMANAS DE SUBCONJUNTOS
Elevado custo unitário de manutenção PREVENTIVA	CONTROLE ORÇAMENTÁRIO	SUP. ELIAS LOPES	19/08/2011	SISTEMA MAXIMO	DEFININDO CRITERIOS E LIMITANDO QUANTIDADE DE PESSOAS AUTORIZADAS A REALIZAREM APROPRIAÇÕES NO CC DA SUPERVISAO

Fig 13 – Action Plan to be implemented

2.1.2. Do Stage – Implementation of Actions

This phase is eminently practical, fitting the diligence of actions and correcting any deviations.

The main actions taken were:

- perform physical identification of major components;
- identify and replace all equipment electric cabling that needed replacement;
- perform appropriate ownership of maintenance information on Service Orders;
- restrict purchase permission on the cost center of supervision;
- replace all sealing gaskets of engine crank axe of the fleet equipment.

These actions had a direct impact on the outcome of the work.

Some actions were cancelled due to external factors or supervision beyond their authority.

The plan of action was adjusted bi-weekly and its development was inserted at the lighthouse. The results were discussed with the Executive team.

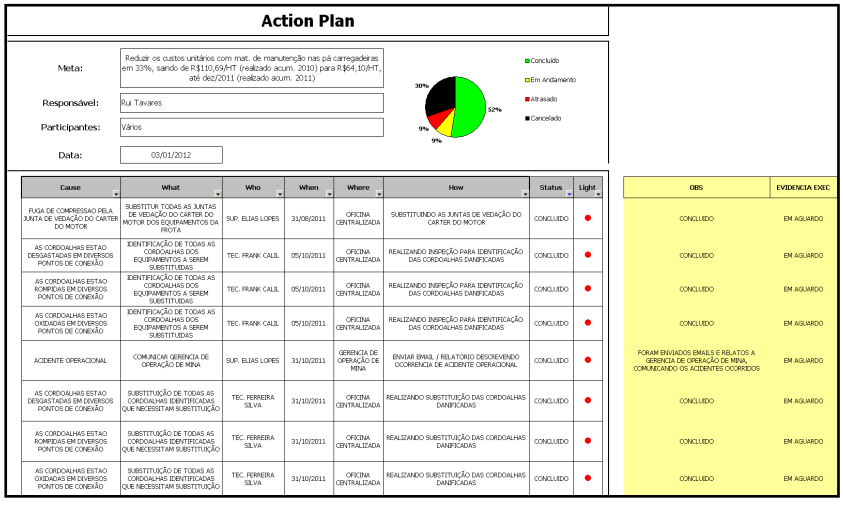


Fig 14 – Follow-up of the Action Plan

2.1.3. Check Stage – Verification of Results

The follow-up of the project was made, every month, using check charts of maintenance costs. Each goal had a specific check chart. Fig 15 below shows the overall goal check chart.

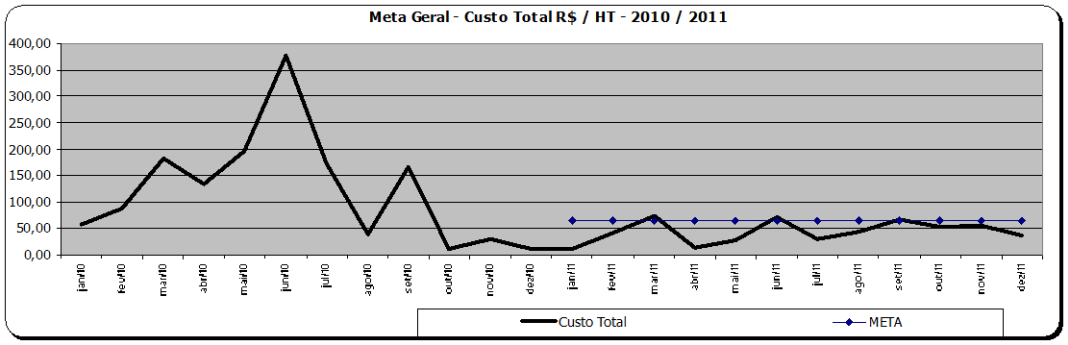


Fig 15 – Overall goal check chart

2.1.4. Act Stage – Actions to be taken

At this stage new, additional actions were defined, such as standardization of procedures and interface with other areas such as engineering, planning, maintenance and management components.

Best practices were documented and processed into procedures, for training of the teams and for implementation in maintenance management of mine equipment.

2.2. Results Obtained

2.2.1. Cost reduction of maintenance materials - R$ / hour worked

The financial result achieved was pretty significant – 60 % reduction compared with the previous year's run (from R$110.69 to R$43.84 per hour worked).

It should be noted that the result come for a great deal from eliminating faults in processes rather than from technical maintenance interventions.

This shows exactly the scope and possibilities of the 6 Sigma methodology. It made it possible to identify, treat and fix numerous weaknesses in the maintenance management process that were previously visible.

Year	Parameter	Budgeted	Run
2009	R$		391.000,00
	Worked Hour (WH)		11.366,00
	R$ / WH	#DIV/0!	34,40
2010	R$	680.373,65	1.206.000,00
	Worked Hour (WH)	16.480,80	10.895,00
	R$ / WH	41,28	110,69
2011	R$	808.000,00	618.745,37
	Worked Hour (WH)	12.605,00	14.114,00
	R$ / WH	64,10	43,84

Fig 16 – Statement of results (budgeted and realised)

2.2.2 . Improvement in Ownership of Service Orders (O. S.)

An indirect result of this work was thereby improving the quality of ownership of service orders.

Inappropriate use of components was eliminated under the Conditional Preventive code and with full ownership established components were used only for the intended equipment. In addition data on the cost of misuse were

no longer mixed up with external misuse. Nowadays the information extracted from equipment databases has become much more reliable.

2.2.3. Improvement in Physical Availability (DF) of Wheel Loaders Fleet

Although several actions taken by the maintenance personnel were effective (preventive maintenance routine itself, for example), the cost cutting project has contributed to the increased physical availability (DF) of the fleet of loaders. The graph of Fig. 17 illustrated the effect on the fleet DF.

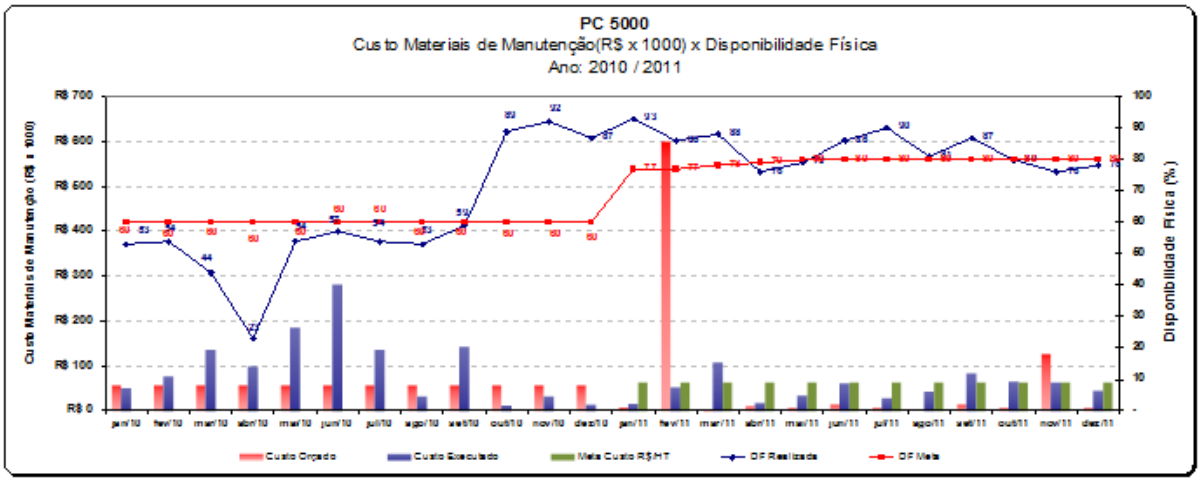


Fig 17 – Chart of Maintenance Materials Cost x Physical Availability

2.2.4. Improvement in Financial Management Supervision

From the observations made to the supervisor of the area where the project was done, one can also look at cost of ownership from the point of view better monitoring of available resources. For example, in the period from January to June 11, several areas had incorrect allocations on the cost center (CC) of the Mine Infrastructure Supervision mainly due to existing flaws in the entries of components and equipment. In this way, the supervisor had no effective control over his budget. The report was only available at the end of the month, making it impossible to repair incorrect values. This raised the question of the need to provide timely data to other supervisors, which would allow effective budget control.

3. Final Considerations

This work enabled huge gains, not just quantitatively in terms of cost savings achieved, but especially qualitatively. The lessons learned have been disseminated in all areas of maintenance of our operation.

The 6 Sigma Methodology has proven to be extremely suitable for the identification, analysis and solution of complex problems, where the causes are difficult to identify. It can be adapted to virtually any operation and enables a person or group to do upfront study as well as operational teams to analyze root causes of problems.

4. References

1. Campos, V.F, **Gerenciamento da Rotina do Trabalho do Dia-a-Dia**, 8ª edição, INDG, Nova Lima, 2004

2. **Six Sigma Green Belt Program,** version 8, INDG, 2010

The red mud pond dam failure at Ajka (Hungary) and subsequent developments

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Abstract

In November 2010 a keynote lecture was presented by the author on the failure of the dam of the red mud reservoir No. 10 of the Ajka Alumina Refinery in the course of the XVIIIth Symposium of ICSOBA in Zhengzhou, China. Based on this lecture a paper was published.

Since that time further relevant information have been made public by scientific studies, on the legal circumstances, the industrial, governmental and other actions, or their lack, which probably played role in the changes which eventually led to the dam failure. The scientific study results, the industrial and governmental actions, the activities of civil organizations, the report of a parliamentary committee, a study report of the "green party" of Hungary and a leading civil engineer' expert opinion will be summarized in this paper.

The paper challenges the method of the classification of the solid materials whether they are considered to be hazardous or not, a new approach has been proposed.

Though a better understanding on the probable reasons of the tragic failure of the dam has been achieved than was available a year ago, further relevant information may come up in the future.

Keywords: **bauxite residue, red mud, storage, embankment, failure**

Introduction

The NW corner of the embankment of the reservoir No. 10 of the red mud storage area of the Ajka Alumina Refinery of MAL Zrt (Hungarian Aluminium Production and Trade Company Limited by Shares) failured on October 4, 2010, shortly after noon. The facts, explanations and some lessons which could have been collected by the end of November 2010 were presented as a keynote lecture of the XVIIIth Symposium of ICSOBA in Zhengzhou, China and as a paper in the ICSOBA Newsletter [1]. The objective of the present paper to present a summary overview on investigations which have been revealed over the last year.

Ten residents lost their life due to the sudden release of the large amount of slurry containing bauxite residue. 286 people were given medical care, out of them 120 were hospitalized or treated for a longer period of time. The slurry inundated 1017ha agricultural land and 367 properties (houses and other buildings). Most of the houses and other properties were demolished, the rest was renovated. A number of new houses were built in Kolontár and Devecser, the two most effected places.

Significant efforts have been made to get answers to the basic question: "What happened and why?" Much more are known about the tragic event, though no consent has been arrived at a comprehensive explanation so far with proper and supportive public evidences.

Composition of the bauxite residue

Chemical composition

The chemical composition of the red mud as it was revealed by MAL shortly after the dam failure [2]:

Fe_2O_3 40-45%
Al_2O_3 10-15%
SiO_2 10-15%
CaO 6-10%
TiO_2 4-5%
Na_2O (bound) 5-6%

Mineralogical composition

An XRD pattern and the quantitative mineralogical composition of a characteristic bauxite residue of the Ajka refinery as determined by István Sajó [3] are shown on Figure 1 and in Table 1

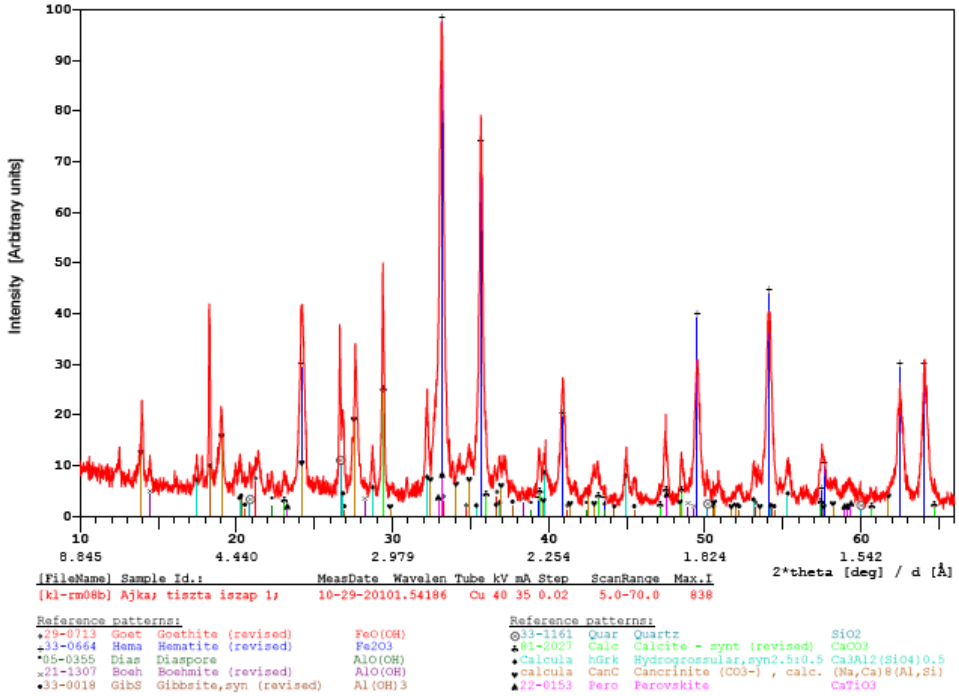

Fig. 1. XRD Pattern of a characteristic bauxite residue of the Ajka alumina refinery

Table 1. Quantitative mineralogical composition of a bauxite residue of the Ajka alumina refinery

[KL-RM08B] Ajka; tiszta iszap 1;

	SUM	Goet	Hema	Dias	Boeh	GibS	Quar	Calc	hGrk	CanC	Pero
Phase%	**98.00**	**5.00**	**40.00**	**2.00**	**3.00**	**6.00**	**3.00**	**8.00**	**8.00**	**20.00**	**3.00**
Fe_2O_3%	44.49	4.49	40.00								
TiO_2%	1.76										1.76
CaO%	10.26							4.48	3.45	1.09	1.24
SiO_2%	10.65						3.00		0.62	7.04	
Al_2O_3%	16.23			1.70	2.55	3.92			2.09	5.97	
Na_2O%	3.63									3.63	
CO_2%	4.38							3.52		0.86	
H_2O%	6.59	0.51		0.30	0.45	2.08			1.85	1.41	
LOI %	10.97	0.51	0.00	0.30	0.45	2.08	0.00	3.52	1.85	2.27	0.00

where: Goet – goethite, Hema – hematite, Dias – diaspore, Boeh – boehmite, GibS – gibbsite, Quar – quartz, Calc – calcite, hGrk – hidrogrossular, CanC – cancrinite, Pero – perovskite.

The supernatant liquor

The composition of the supernatant liquor has not been made public as yet. The data of the liquid phase accompanying the bauxite residue in my earlier paper (4.6 g/l Na_2O_{total}, 3.7 g/l Na_2O_{caust}, 1 g/l Al_2O_3, pH 13) are estimated values on earlier experiences. This solution is equivalent with a NaOH solution of about 0.4w%. It should be noted that over time significant part of the caustic content of the liquid phase transforms to sodium carbonate due to the CO_2 content of the air.

The Pannon University monitored the quality of the released liquid phase beginning of the day of the dam failure. The highest measured pH value was 12.87 in a sample taken on that day [4].

Health effects

Studies on the toxicity of bauxite residue (red mud)

The potential health effects of the fugitive red mud dust is summarized in the paper of A. Gelencsér et al. of Pannon University [5].

Extensive investigations have been carried out in Hungary to confirm or reject if there is any toxic effect of the bauxite residue. During these investigations the following aspects were tested, as it was summarized by Prof. Dr Schaff [6]:

- Cd, Ni, As, Co, V, Cr concentration of urine in 10 adults and 10 children
- extensive screening tests of several adults and children who lived in the affected area (1220 tests until March 1, 2011),
- chromosoma aberration tests on people who were exposed to red mud (52 people) and same number of people who were not,
- effect of red mud dust on the immune system, the lung and the digestive system,
- carcinogenic and toxic effects of red mud dust on stripe danio (Danio rerio) fishes as model species.

During these studies, for practical reasons "red mud" as discharged having a moisture content of about 50w% was used for the tests as starting material. In this case the caustic soda content of the adhesive moisture of the wet material may have affected the results.

It has been confirmed that the caustic content of the released liquor causes health hazards of various kind. The fine particulate material of the bauxite residue **as any other dust of similar size** may also cause health hazard. **Any health risk which is associated with the bauxite residue (understood as washed dry material) has not been identified.**

Chemical burns due to the caustic content of the liquor released

The huge amount of supernatant liquor that was abruptly discharged, like a tsunami (in the Kolontár village the caustic liquor waves were as high as 2m) caused the majority of the fatalities. The OH^- ion exposure caused the chemical burns of the injured people.

The caustic soda concentration of the discharged supernatant liquor being equivalent of a NaOH solution of 0.4w% or less, which **itself** is not considered to be high. Nevertheless, some injured people spent 2-3 hours in this liquid for various reasons. The OH^- ion exposure is understood as the OH^- ion concentration multiplied with the time of exposure. The unfortunate severe injuries of some people is well explained by the high OH^- ion exposure of those affected.

Composition and mechanical integrity of the dam

Fügedi and his co-workers of the Geological Institute of Hungary investigated the material of the dam at the crack [7].

Chemical composition of dam material samples

Table 2. Chemical composition of the dam material and sand

Samples	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	$-H_2O$	$+H_2O$	CO_2	SO_3
Western wall (Ny-5)	9.48	0.27	7.93	2.06	0.26	26.1	1.70	1.65	<0,2	18.9	22.4	3.05	6.13
Western wall (Ny-7)	9.81	0.22	6.59	2.29	0.14	35.5	1.89	1.01	<0,2	15.4	13.8	5.82	7.38
Western wall (Ny-11)	8.78	0.22	4.36	1.83	0.13	39.4	2.12	0.31	0.40	16.4	14.4	6.88	4.54
Sand (HU07)	76.9	0.59	8.01	1.41	1.54	1.06	0.61	0.81	1.16	1.38	6.31	<0,02	<0,15
Sand (HU11)	69.5	0.66	11.2	2.47	1.50	1.16	1.16	1.70	1.31	2.53	6.18	0.26	0.20

Remarks:

$-H_2O$: adhesive moisture content up to 105°C

$+H_2O$: chemically combined water between 105 and 1050°C

Mineralogical composition of dam material samples

Table 3: Mineralogical composition of the dam material and sand

Samples	Quartz	Calcite	Ettringite	Magnetite	$(Na,K)_2CO_3$	clay	felspar
Western wall (Ny-5)	0	0.2	95.5	1.1	3.2	0	0
Western wall (Ny-7)	0	20.0	77.4	0.7	1.8	0	0
Western wall (Ny-11)	0	42.0	56.4	0.7	0.9	0	0
Sand (HU07)	56	1	0	1	0	25	8
Sand (HU11)							

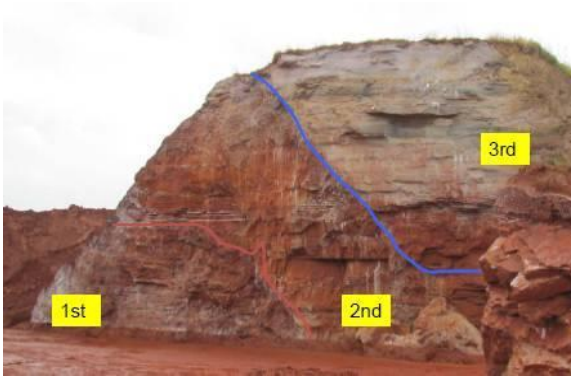

Fig. 4 Stages of building of the dam [8]

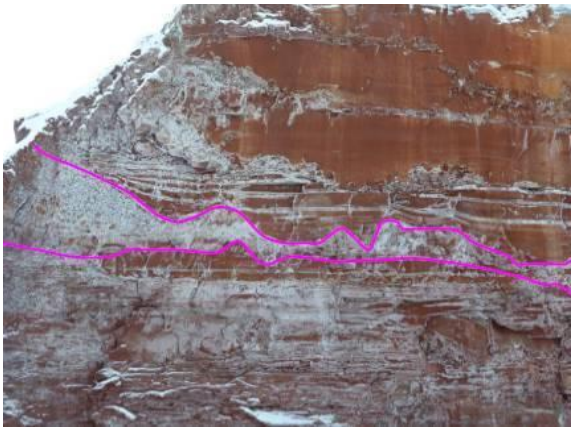

Fig. 5 Caustic corrosion sack in the dam [9]. The caustic containing supernatant liquor seem to have penetrated into and through the sand layer.

Fig. 6 Western wall having removed the fresh surface of the break. Open fissures with dislocations of a size of dm[10]

It can be concluded that the material of the dam is highly variable, with sacks of sand and clay. The clay can react with the caustic content of the liquid phase being stored in the red mud pond, however this reaction is slow [11]. Debris from an earlier construction stage can also be detected. All of these negatively affect the integrity of the dam material.

Metal content of the bauxite residue and its mobility

Bartha and his co-authors [12], Geological Institute of Hungary, studied the minor metals content of the red mud released and their mobility in different reagents.

Table 4. Minor metal content in red mud released

Samples		As	Cd	Cr	Ni	Pb	Zn	Cu	Mo	Co	Hg	pH
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	-
		aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	aqua regia	
Red mud1 Kolontár	1	88.0	0.83	450	210	116	114	54.4	17.2	50.5	1.84	12.4
Red mud2 Kolontár	2	70.7	0.585	332	127	87.6	88.1	38.3	8.44	37.1	0.737	12.6
Red mud3 Kolontár	3	78.5	0.87	487	210	117	118	52	8.24	53.3	1.62	12.2
Red mud4-Kol	4	100	0.81	570	268	147	128	61.6	14.5	63.7	2.73	12.1
Red mud5-Kol	5	114	0.94	611	276	154	129	63.5	5.17	68.1	2.96	12.2
Red mud6-Kol	6	90.8	0.92	488	227	130	115	49.3	5.21	53.8	3.59	12.1
Red mud7-Kol	7	104	0.96	514	220	128	121	51.3	8.97	59.8	1.69	12.3
Red mud8-Dev	8	101	1.02	492	220	129	125	45.6	4.97	57.8	1.73	12
Red mud9-Dev	9	85.6	0.803	363	162	93	104	39.9	10.9	44.9	1.06	12.1
Red mud10-Dev	10	97.5	0.96	485	211	119	126	46.9	6.56	56.2	1.57	12.1
	Average	93.1	0.87	479	213	122	117	50.3	9.02	54.5	1.95	12.2
	SD	12.9	0.1	83.7	43.8	20.8	12.7	8.2	4.1	9.0	0.9	0.18
Maximum contaminant levels for sewage sludge for agricultural use		75	10	1000	200	750	2500	1000	20	50	10	
Contaminant limits for soils		15	1	75	40	100	200	75	7	30	0.5	

Remarks:
Maximum allowed minor metal content levels for sewage sludge for agricultural use [13]

Contaminant limits (B) for soils [14]

The bauxite residue which was incidentally discharged is certainly not a soil for general purpose, therefore nothing to do with their tolerated very low contaminant levels. In the lack of specific rules for the bauxite residue, as a rule of thumb, the classification of sewage sludge for agricultural use can rather be used to assess the hazard, since the sewage sludge layer used as fertilizer is worked into the bulk of soil by plowing and other agricultural means.

Table 5. Mobility of heavy metals by different solvents

	Aqua regia	Deionised Water pH =10	Ammonium acetate pH=8	AcH pH=8	AcH pH=5	AcH pH=3	Total decomposition
	Average	Average	Average	Average	Average	Average	
	Rel. %	Rel. %	Rel. %	Rel. %	Rel. %	Rel. %	Rel. %
As	86,9	2,48	0,053	0,144	0,245	10,6	100
Cd	99,1	0,627	0,687	0,586	7,76	55,5	100
Co	90,1	0,036	0,018	0,028	0,366	8,21	100
Cr	96,0	0,024	0,005	0,012	0,065	8,23	100
Cu	99,8	1,78	0,518	0,313	0,564	42,9	100
Mo	87,8	53,7	31,6	39,8	1,64	<0,5	100
Ni	97,9	0,026	0,008	0,012	0,403	7,36	100
Pb	98,8	0,025	<0,03	<0,03	0,072	0,66	100
Zn	98,7	0,008	0,059	0,068	0,475	17,5	100

Remarks:
AcH- acetic acid. Different pH values were obtained at different acetic acid dosages mainly due to the caustic content of the adherent liquor.

It should be pointed out that in the important range from practical point of view, let' say pH 5-9 only Mo showed significant mobility. Though As, Ni and Co content exceeded the limits for sewage sludge to some extent (Table 4), however, their mobility was found to be negligible.

Investigations on contaminated soils

Investigations were carried out with soils which were covered by discharged red mud by Anton et al [15], Institute of Soil Sciences of Hungarian Academy of Sciences (HAS). The As, Cr, Cr_{VI}, Pb, Se and Ni contents were measured on samples taken from different depths of the contaminated gardens and fields. The mobility of these metals was studied using distilled water, ammonium acetate and Lakanen Erviö solution. Less than 1% of the total metal content could have been mobilized by these agents, which is in good agreement with the results of Bartha et al. The conclusions of these investigations were as follows:

- toxic metals penetrated into the soils not deeper than 10 cm, their environmental risk is minimal
- the effect of NaOH can be detected in the upper 30 cm of the soils
- the primary environmental risk is caused by the sodium hydroxide content of the adherent liquor.

Proposed remediation (full revitalization):

- removal of red mud having a height of more than 5 cm
- disking/plowing, using supplementary material (humus containing soil conditioners, manures, bacteria manures)
- plantation as early as possible.

"I would be ready to consume such a bread or alike which is made out of wheat grown on a land which had been inundated by red mud and was rehabilitated according to the suggestions of Institute of Soil Sciences" claimed Prof. Dr Tamás Németh soil scientist, General Secretary of HAS [16].

Risk assessment, classification of materials

The attention should be called that the tolerated minor metal levels **relate to the total metal contents** (except Cr_{VI}), however the studied metal constituents are in such forms in the bauxite residue which are virtually not mobile within the important pH range from the practical point of view. (The Mo is the single exception, though its level is negligable.) It is believed that **the classification of materials whether they are hazardous or not based on their total metal contents can be misleading and the regulations should be revised/modified. The classification should be based on the amount and the mobility of the toxic constituents in the relevant pH range from practical point of view.**

Comprehensive studies

Study Report of LMP

A comprehensive Report [17] was initiated and organized by the parliamentary party LMP (Politics Can Be Different). The party LMP commits itself as the "green party" of Hungary.

The Report revealed that the relevant European Union legislation had not been fully applied in Hungary and there were „holes" in the procedures of issuing permits, checking and supervising of the dam integrity. Beside the parts dealing with the legislation aspects the Executive Summary is probably the best part of the Report. Author of this paper provided inputs to the technical part of the Report.

When Author objected the statement of the Executive Summary "The relatively high concentration of metals (arsenic, mercury, etc.) in the pollutant mix has also presented further health and environmental problems." at one of the editors, he confirmed "this statement was probably exaggerated"[18].

Report of the Parliamentary Committee

The Parliament of Hungary established a committee to reveal the responsibility for the environmental catastrophe and prevention of similar ones in the future. After 10 months of investigation the Report [19] concluded:

- there were deficiencies during the design the storage facility, such as site selection and soil mechanics below the foundation of the dam, the collection of the supernatant liquor was

placed at the perimeter instead of a central position of the pond, the tensions arising in the dam having a height of 20-25m and their consequences were not considered,

- there were deficiencies during the permitting process. The red mud waste was improperly classified as non-hazardous waste, the local notary issued the permit for construction and the relevant mining authority had not been consulted beforehand, the Directorate for Disaster Management did not classify the facility under the effect of the Directive 96/82/EU (SEVESO II), therefore it did not control the operation, the environmental permit did not clarify if the facility was a waste disposal facility or a process facility, the cooperation among the various authorities was not seamless,
- the principal cause of the disaster was the large amount of caustic liquor stored having high pH, the height of the supernatant liquor might have been 1m as average and 1.5m as maximum as per the permit, the fact was 4.45m as average, in the middle of the pond 8m, this caused high load to the dams, the monitoring and checking of the operation of the reservoir was not satisfactory, there were no instruments installed to monitor the micro-motions of the dam, the yearly environmental checkings by the authorities were formal, they did not go into the details of the facility and its operation,
- the responsibility is very complex, though the disaster can not be considered as a consequence of the nature, it is rather the consequence of the industrial activity,
- responsibility for the deficiencies of the designers and constructors during the design and construction and can also be claimed,
- the Environmental Authority made substantial mistakes in the course of the classification of the waste and the checking of the construction of the dam and its operation,
- MAL has serious responsibility for the deficiencies during the operation,
- there have been deficiencies in the legislation which constitute the rules of the permitting, design and operation
- the statements above may not replace the legal procedures.

The MAL stressed some 300,000m^3 process media, containing bauxite residue which is a non-hazardous material was released due to the breach of the dam. A soil failure which was caused by the excessive amount of rain in 2010 and the reaction of montmorillonite of the clayey soil below the dam with the caustic content of the process liquor being stored caused the breach of the dam.

A measurement of later date by the Environmental Authority concluded that the red mud sludge released might have been 1,644,000 m^3, and one third of which was bauxite residue.

There are discrepancies in the pH of the released liquor. Zoltán Illés Environmental Secretary claimed the pH of the red mud slurry was 12.5-13 [20]. The Environmental Authority claimed the pH in the failure reservoir was likely 13.7. The highest field test results of Pannon University was pH 12.87. This latter value meets with the earlier process data of the Ajka Alumina Refinery.

Civil engineer's expert opinion

Dr István Kertai is a hydraulician (civil engineer), having enormous expertise in the design of dams and assessment of their operation, including their failure in extreme circumstances. As per the unanimous recommendation of the professionals and the responsible people, on 3rd November 2010 he was assigned with the steering of the Complex Assessment and Design Program [21].

Based on hundreds of meters of drilling program, geotechnical and building material expert assessments by various institutions, companies, professionals of Geological Institute of Hungary, Eötvös Loránd Geophysical Institute of Hungary and the Technical University of Budapest, Dr Kertai prepared a Summary Memorandum [22], which have been made public in parts. The following of this paragraph is based on the Summary Memorandum of Dr Kertai.

The soil failure of the fat clay soil being found at the surface of the original soil just below the basement of the dam almost exclusively at the affected section is claimed to be the primary reason of the dam failure. The fat clay became saturated with water, was submitted to the chemical effect of the caustic content of the liquor accompanying the

bauxite residue over years and lost most of its strength. The lower section of the dam which was built out of fly ash weakened due to the permanent load of water. Due to these effects the soil below the failured corner of the dam lost much of its strength, to the own weight of the quasi rigid dam and also to the load of the stored red mud slurry of low solids content, the affected corner mosaically fissured and bursted. The plastic behavior of the soil below the dam changed and it sank a few decimeters over the rigid break of the affected corner.

The hydraulic modeling suggest that about 1.2 million m^3 thin red mud slurry may have discharged when the dam ruptured.

The serious mistakes of the site selection, design, construction and the supervision by the authorities resulted in the failure of the dam as they follow:

- The foundation of the dam was inappropriate. The soil below the dam was highly heterogeneous and a rigid dam was constructed.
- The design calculations did not take into account the loosing of the strength of the clay due to the caustic content of the liquid phase nor the loosing of strength of the lower third of the dam being constructed out of fly ash due to the permanent load of water.
- The cross section of the dam was not satisfactory, bank slopes were steep, the tension of the dam toe was high.
- The design did not cover the effects of the uneven saggings.
- The material of the dam is largely heterogeneous both in horizontal and vertical directions and this facilitated the formation of fractures.
- The dam was not properly sealed, an inner water sealing wall was not applied
- The filling of the red mud slurry was not consistent, the red mud was randomly distributed at certain places. The safety of a dam having a height of 25m should not have been based on such a process technology.
- The dam integrity checkings were substantially defective.

Recent changes, rehabilitation

Filter presses were implemented in the Ajka refinery early 2011. The moisture content of the bauxite residue filter cake thereby is believed to be 30-35%. Some gypsum is added to the washed press-filtered bauxite residue to adjust its pH between 10 and 11. New phenomena is the dusting of the dry mud stacking during windy weather, this has not been kept under control as yet [24].

Some pictures are below to demonstrate the changes and remediation successfully achieved in the course of the year has passed subsequent to the accident.

Fig. 9 Arial photo of the Resevoir No. 10 after the dam failure in October 2010 [25]

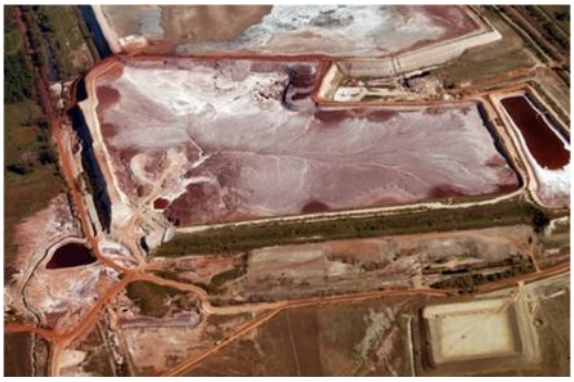

Fig. 10 One year later. Dry mud stacking of press filtered bauxite residue.

Fig. 13 New houses in the most affected **village, Kolontár [26]**

Concluding remarks

a) Factors which may have played role in the dam failure, among others:

- No sealing at the bottom of the reservoir or an inner sealing wall below the dam was applied.
- The material of the dam is highly variable, with sacks of sand and clay. This negatively affected the integrity of the dam material. The dam was a rigid construction. The strength of the clayey soil below the dam decreased over the years at the critical corner.
- „Holes" were in the design procedures, in the procedures of issuing permits and in the checking and supervising of the dam integrity during the construction and afterward.
- The water sealing wall around the storage area was successful in preventing the caustic contamination of the surrounding subsoil water, meanwhile it retarded the rainfall and caustic containing seepage liquor and weekened the clayey subsoil.

b) Events and other conclusions

- No toxic effect of the bauxite residue *itself* on human being has been identified though extensive investigations have been carried out. No question about the toxicity of the caustic content of the adherent and seepage liquor.
- The classification of materials whether they are hazardous or not based on their total metal contents and the regulations should be revised and modification is proposed where the mobilised metal content in the relevant pH range will be considered instead.
- Dry mud stacking has been introduced (pH of bauxite residue disposed of: 10-11).
- The contaminated land has been rehabilitated.
- The people who lost their homes got new homes, their houses have been renovated or they were relocated to other places.
- The cost of dislocation of people and land rehabilitation has reached million USD of 135.
- MAL has been fined by the Environmental Authorities to more than million USD 600. MAL appealed, the court suspended the execution of the fine.
- 30 affected individuals sued MAL and the Environmental Authorities.
- 15 present and former employees of MAL have been put to trial being accused of professional misconduct of causing deaths , impair of the environment and other issues.
- The design, permitting, construction and supervisory faults were made before the mother company of MAL acquired the Ajka Alumina Refinery in 1997, or were beyond the control of MAL.
- The investigations of the chemical reaction of the clay minerals and sodium hydroxide have started after the construction of the failured dam [27].

Acknowledgements:

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Development of Brazil's Aluminium Industry

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Introduction

Brazil, one of the countries displaying a newly advanced economic development, is an important contributor to the global aluminium industry. Presently the country accounts for 14% of the world's bauxite, 10% of the world's alumina and 4% of world's aluminium production. What were the drivers for the Brazilian aluminium industry development and what is the outlook?

History

Although the first kilos of Brazilian aluminium were produced in 1928, production of alumina and aluminium on an industrial scale only developed during the Second World War. Pioneering companies were Elquisa, with its production facilities in Ouro Preto, acquired by Alcan in 1950 and recently by Novelis, and CBA, Companhia Brasileira de Alumínio producing alumina and aluminium in Alumínio in São Paulo state since 1955. These plants and also the Alcoa operation in Poços de Caldas starting production in 1971, produce for the Brazilian market based small bauxite deposits in Minas Gerais state. They also have self-generation for most of their electric power requirements.

Despites negative exploration results in the coastal Amazon basin obtained by Kaiser in the fifties of last century, Alcan's geologist Dr. Staargaard set out to search for bauxite in the dense Amazon forest in 1963, using aerial photographs to identify bauxite capped plateaus in the vicinity of rivers - for ore transport. This resulted in the discovery of the large Trombetas bauxite deposit, which was developed by MRN, Mineração do Rio Norte. Other discoveries of major bauxite resources in the Amazon region followed in the seventies, including deposits west of Trombetas found the Ludwig group - later acquired by Alcoa and Billiton and subsequently merged with MRN, and the Jurutí deposit to the south found by Reynolds, now part of Alcoa. Towards the eastern edge of the Amazon basin the Paragominas deposits were found by Rio Tinto Zinc and later bought by CVRD. The Ludwig group and CVRD explored the area north of the Amazon River finding deposits in the Jarí basin.

The huge amount of bauxite in the Amazon region ranked Brazil third in global bauxite resources, after Guinea and Australia, and would allow Brazil to mine bauxite for export. Alcan, that feared the loss of bauxite supply to its Canadian alumina refinery in Arvida after the independence of Guyana, established the company MRN in 1970. The government took a 41% share in MRN through state-owned Companhia Vale do Rio Doce (CVRD) and became a main driver for the construction of the Trombetas bauxite mine. Smaller share percentages were acquired by CBA and foreign aluminium companies.

As MRN was being developed, the government wanted to develop hydro-electric facilities in the Tocantins River, but the scale of the project required large, new power consumers. With the incentive of low power prices major aluminium producers were encouraged to build the Alumar integrated alumina and aluminium operation and the Albras smelter, which were put in operation in 1984 and 1985 respectively. The Alunorte refinery followed 10 years later, after the market had recovered from the large global alumina capacity increase of the 1980-ies.

Current production locations

The geographical locations and the capacities of bauxite, alumina and aluminium operations in Brazil are show in the map on the cover page of this Newsletter and in the table below.

			Capacity in kt/year		
Location	**Start-up**	**Company**	**Bauxite**	**Alumina**	**Aluminium**
Ouro Preto	1945	Novelis	-	-	52
Alumínio	1955	Votorantim - CBA	Integrated	920	472
Poços de Caldas	1971	Alcoa	Integrated	390	97
Trombetas	1979	MRN	18,000	-	-
Sao Luís	1984	Alumar	-	3,600	454
Barcarena	1985	Albras	-	-	460
Barcarena	1995	Alunorte	-	6,300	-
Paragominas	2007	Hydro	9,900	-	-
Juruti	2009	Alcoa	3,800	-	-
(Santa Cruz)	1982	Valesul	-	-	(95)
(Aratu)	1971	Novelis	-	-	(59)

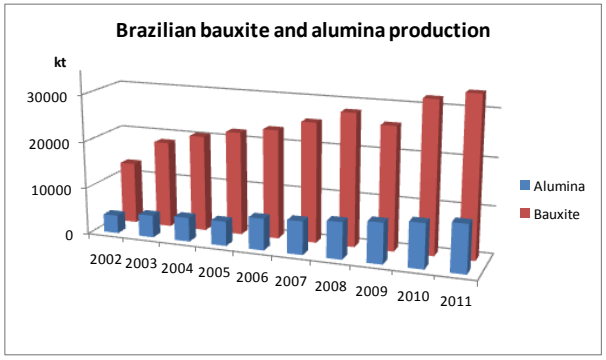
The large Trombetas bauxite mine is famous worldwide for its high bauxite quality and its successful mine rehabilitation program. Bauxite from the Trombetas and Jurutí mines is shipped over the Amazon River and processed at the Alunorte and Alumar refineries as well as exported.

Since its recent expansion, the Alumar refinery has a total alumina production of 3.5 Mt/y, using two huge digestion units.

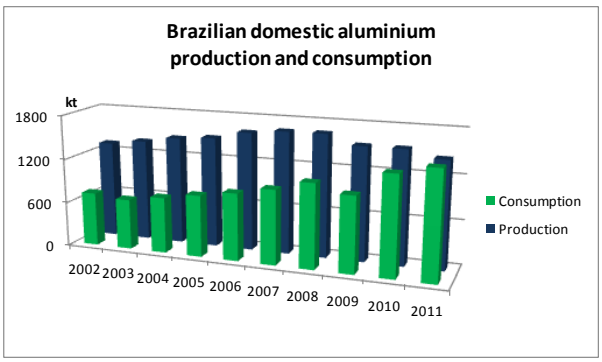
The 8,400 MW Tucuruí hydroelectric facility in the Tocantins River, feeding the Albras and Alumar aluminium smelters, is the world's fourth largest facility

Brazilian aluminium in the world market

The continuing growth of Brazil's production of bauxite and alumina is illustrated in below graph.



Regarding primary aluminium production however, the development shows a decline in production since 2008, whereas consumption continues to rise. The production decline is caused by increasing power prices in Brazil.



Brazil has an extensive downstream industry and currently Brazil is turning from a net exporter of primary aluminium into a net importer. Yet the trade balance of the Brazilian aluminium industry is still positive, due to the export of bauxite and alumina.

Future outlook and challenges

Brazil's untapped bauxite resources are massive and could serve as a basis for future industry developments. However, the development of the bauxite deposits is complicated by their location in remote areas requiring new transportation infrastructure.

A new 7.7 Mt/y mine, with expansion to 15.4 Mt/y is planned to supply bauxite to Votorantim's Alumina Rondon Project in Pará state. The expected alumina production, 3 Mt/y in 2016 and 6 Mt/y in 2020, will be transported to a port near Barcarena.

Although construction for the CAP project, Companhia de Alumina do Pará, has already started, the owners Hydro (81%) and Dubal (19%) are delaying project implementation. Main reasons are uncertainties in the short- and medium-term aluminium supply/demand balance and the development of the world economy. The new alumina refinery, receiving bauxite from an expansion of Hydro's mining operation in Paragominas, was originally planned to start production in 2015.

In due course, implementation of the above projects will develop Pará state into the world's largest bauxite & alumina production centre.

As mentioned above, the Alumar and Albras smelters were brought to life as large, new power consumers, as required to make the Tucuruí hydroelectric facility viable. However, due to the integration of the national electricity grid and increased regional industrial and civil use of electricity, the initial low power prices for Albras and Alumar smelters were not sustained.

The Santa Cruz and Aratú smelters have closed, and under the current conditions of high power prices and low aluminium prices, the continuation of aluminium smelting in Brazil is under pressure, as in other regions with similar conditions.

Although the rivers in the Amazon basin could provide additional hydro electricity, the environmental impact it may cause, such as breaking bio connectivity between Andean waters and coastal basin, loss of forest and disturbance for indigenous people, has held back the development of major, new hydroelectric facilities.

The challenges faced by the Brazilian aluminium industry can be summarized as follows:

1. The cost of new transportation infrastructure, due to remoteness of bauxite deposits.
2. Rising electrical power prices due to increased demand and restricted availability.
3. Environmental impact complicating construction of new hydroelectric facilities.

The above challenges are by no means unique for Brazil. The cost of new infrastructure for remote bauxite deposits and the clash between power generation and environmental impact are highly relevant for many places in the world.

Because the challenges faced by the Brazilian aluminium industry are of interest for most global industry participants, and in recognition of Brazil's achievements, ICSOBA decided to have its 2012 symposium in October in Belém, the capital of Pará state. Selecting Brazil follows ICSOBA's practice to rotate the venue of its International Meetings to countries that are important for the global aluminium industry.

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ICSOBA MATTERS

Presidency and Council

ICSOBA is a non-profit organization with over 200 members. Members of Presidency and Council contribute to ICSOBA as volunteers. Current Presidency and Council members are:

Presidency:

President	Dr Frank Feret	Canada
Sr. Vice-President	Dr Li Wangxing	China
Vice President	Dr Andrey Panov	Russia
Secretary General	Dr Jeanette See	Canada
Executive Treasurer	Ms Marja Brouwer	Netherlands
Executive Directors Bx,Aa,Al	vacant	
Executive Secretary	vacant	

Council:

Prof. Arthur Pinto Chávez	Brazil
Dr Yang Jianhong	China
Mr George (György) Bánvölgyi	Hungary
Mr Michael Emond	Australia
Ms Rita Vaseur-Madhoeban	Suriname
Mr Parris Lyew-Ayee	Jamaica
Mr Ashish Jog	Dubai
Mr Stef Sep	South Africa
Mr Leslie Leibenguth	USA
Mr Jan Kotte	India
Mr Fabio Araujo Mendes	Brazil
Dr Peter Smith	Australia
Dr Yiannis Pontikes	Belgium
Mr Dominique L. Butty	Switzerland

ICSOBA's legal seat is in Canada and its executive office is in India. Ms Dipa Chaudhuri is contracted via her company to staff the executive office and perform tasks such as communication with the outside world, sending mailings, managing members and delegate administration, follow-up on speakers and sponsors, supervising and updating the website etc.

The upcoming symposium in Brazil will present a superb opportunity to validate, refresh and complement both Presidency and the Council. On October 31st, at the end of ICSOBA-2012 in Belém, there will be General Assembly of all ICSOBA members present. The agenda includes adoption of the New Bylaws and (re-)elections of Council and Presidency members, presentation of ICSOBA's strategy & policy for the next 2 years. It is the intention of the Presidency to reinforce the Presidency and the Council and some candidates have already been approached. As you can see from the list of names above, we are still looking for qualified and motivated candidates to fill the vacancies in Presidency. Instead of the customary single Executive Director, we hope to welcome 3 Directors – for bauxite, alumina and aluminium, who will share the work load of organizing the speaker program of future events. Contact Frank Feret at feretfr@gmail.com

In addition to the above, we must try to fill the white spots in the Council. ICSOBA would benefit from representatives from Australia, China, Brazil, and more carbon/aluminium professionals. Due to Canadian law, the statutory role of the Council changes from advice and supervision to advice and support.

Internal organisation

The International Committee for Study of Bauxite, Alumina & Aluminium is an independent association that unites industry professionals representing major bauxite, alumina and aluminium producing companies, technology suppliers, researchers and consultants from around the world.
ICSOBA belongs to its members and since the members elect the Presidency and Council in the Annual Meeting during an ICSOBA Event, members determine the policy and success of ICSOBA.

New Bylaws and Rules & Regulations

With the legal registration of ICSOBA as non-profit organization in Canada, Canadian law governs the organization and functioning of ICSOBA. ICSOBA's Statutes, as adopted by the General Assembly in 2008 in Bhubaneswar do not suffice and new Bylaws have to be submitted before the end of 2012 according to Canadian law. A Canadian law firm has been contracted to prepare draft Bylaws for the Presidency to modify and agree on. The result will be sent by email to all members for their consideration, in order to enable adoption of final Bylaws during the Annual Meeting that will be held in conjunction with the ICSOBA-2012 symposium in Belém, Brazil.

All procedures and resolution that will be agreed on from time to time, will be collected in a Rules & Regulations (R&R) document. When applicable, additions to this document will be published in the Newsletter.

Membership

ICSOBA provides members with a platform to exchange technical information with each other. Upon their request individual members who are consultants or advisors to the aluminium industry, will be enlisted with their expertise on the designated Consultants page on the website. Digital versions of past proceedings are available at no cost for members.

Companies can support ICSOBA by becoming Corporate member. Corporate members are shown in every Newsletter and listed on ICSOBA's web site. Corporate members can nominate two employees who have the same rights as individual members, such as reduced event delegate registration fee, Newsletters and voting rights. Digital proceedings can be made available to all employees at the company's intranet, and corporate members can sponsor ICSOBA events at the reduced sponsor fee.

	INDIVIDUAL MEMBERS	CORPORATE MEMBERS
Reduced Sponsor rates at ICSOBA Events		Yes
Reduced delegate registration fee for ICSOBA Events	Yes	Yes for 2 nominated employees
Name listed in ICSOBA's website	In Consultants page upon request	In Corporate Members page with link to web site
Right to vote on ICSOBA matters and eligibility for Presidency and Council	Yes	Yes for 2 employees
Receive a digital copy of a full paper or full proceedings of a past ICSOBA Event	Upon request	Upon request
Biannual Newsletter with articles from members, news and statistics	Yes	Yes to 2 employees. Company mentioned in Newsletters
Annual fee (from July to July)	C$ 100	C$ 500

You can find an application form for individual membership and corporate membership on ICSOBA's website. You can also renew or apply for individual membership together with your registration for an ICSOBA event.

Public relations and Communication

Website

As an organization's web site is it's first and foremost presentation to the world, it was decided early 2012 to overhaul ICSOBA's website with new features, such as a public and a members-only section, online registration and payment options, etc. The contracted web design company finally delivered a website that did not meet our requirements and in particular turned out to be unstable. In the process of creating a basic but suitable new website fast, ICSOBA acquired a new domain name: www.icsoba.info.

The plan to have a website built under the original domain name (ICSOBA.org) that is both stable and state-of-the-art is still there. ICSOBA would welcome members who could drive this process and would be able to enhance ICSOBA's presence in the (social) media – in short who would take up the role of PR Officer.

Printed proceedings of past ICSOBA events, the so-called Travaux volumes, are being scanned to separate searchable pdf files. The tables of contents of the Travaux volumes will be made public on the website and ICSOBA members can obtain digital versions at no cost. As long as our web site does not have a members-only area, members can obtain such digital papers of past proceeding only by sending an email request.

ICSOBA's executive office

Not only requests for past proceedings, but all inquiries sent to ICSOBA, whether by email to icsoba@icsoba.info or by phone to + 91 982 328 98 17, are addressed by Ms. Sudipta (Dipa) Chaudhuri in Nagpur, India.

Also mailings and the underlying database of ICSOBA's contacts are taken care of by Ms Dipa Chaudhuri in the executive office.

ICSOBA in the (social) media

A report on ICSOBA's Bauxite Residue Seminar in Goa including the formal *Summary and Conclusions* documents has been published in Aluminium International Today (February 2012), Brasil Mineral (March 2012) and Minerals and Metals Review (January 2012).

An article on ICSOBA has been published in International Aluminium Journal (June 2012), China Aluminium (May 2012) and Brasil Mineral (June 2012).

Digital copies of above articles can be downloaded from the web site.

As a consequence of ICSOBA's 2011 Bauxite Residue Seminar and related publications, ICSOBA is frequently contacted by researchers, students and government organisations with questions related to bauxite residue management.

ICSOBA is now present on LinkedIn, thanks to ICSOBA's Council Member Mr. Stef Sep in South Africa.

Corporate members

Currently ICSOBA has the following Corporate Members. For more details including links to the company's website, please refer to the member section of the website: http://www.icsoba.info/about-us/corporate-members.

ALUCHEM INC 1 Landy Lane, Reading, Ohio USA
221BK Tarabaigarden Rd, Pleasant Homes, BS 5-6, Tarabai Park Kolhapur, 416003, Maharashtra India www.aluchem.com

AMBER DEVELOPMENT 846 Chemin Saint Pancrace 84800 Isle sur la Sorgue, France www.amber-development.com

BAUXITE RESOURCES LTD Level 2, Building E, 355 Scarborough Beach Rd, Osborne Park WA 6017 , PO Box 1800, Osborne Park, DC WA 6916 www.bauxiteresources.com.au

BOKELA GmbH Tullastrasse 64,DE-76131 Karlsruhe, Germany www.bokela.com

COLT Korte Oijen 4, NL-5433 NE Katwijk, Netherlands www.coltsmelters.com

DUBAL Aluminium Co Ltd. P.O Box 3627, Dubai, UAE www.dubal.ae

Hangzhou New Time Valve Co Ltd Linglong Industrial Zone, Lin'an, Zhejiang Province, China http://newtime.en.alibaba.com www.hzntfm.com

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MBE Coal & Mineral Technology India Pvt Ltd Ecospace 11F/12, New Town Rajarhat, North 24 Parganas, Kolkata – 700156, India www.mbe-cmt.de

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