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Cleaner Production Techniques in the Peruvian Mining Sector Based on ISO 14001 Audits

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Técnicas de Producción más limpia en el sector minero en el Perú sobre la base de auditorias de la certificación ISO 14001

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Resumen

En El sector minero es uno de los de más rápido crecimiento en el Perú y actualmente es responsable de más del 50% de las exportaciones totales peruanas donde más del 30% de la inversión directa extranjera ha sido colocada. Asimismo, es el sector más regulado en el Perú debido a la presión que ejercen diversos grupos de interés. Debido a ello, entre otras razones, muchas empresas mineras decidieron lograr la certificación ISO 14001. Este estudio presenta evidencia a partir de once auditorias ambientales referidas a la norma ISO 14001 y efectuadas a cuatro empresas mineras y siete subcontratistas mineras dedicadas a la labor de exploración, explotación y extracción. Se encontraron desviaciones significativas relacionadas con los controles operativos que conducían a impactos medioambientales negativos. Desafortunadamente la respuesta más común a estas desviaciones fue la adopción de tecnologías que buscan remediar el daño ambiental efectuado (end-of-pipe) en lugar de tecnologías de producción mas limpia. Finalmente, algunas tecnologías de producción más limpia son sugeridas para las empresas que operan en el sector minero en el Perú. .

Palabras claves: ISO 14001, minería, tecnologías de producción mas limpia

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CLEANER PRODUCTION TECHNIQUES IN THE PERUVIAN MINING SECTOR BASED ON ISO 14001 AUDITS[a]

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Abstract

The mining sector accounts for more than 50% of the Peruvian total exports and it is the fastest growing industry in Peru where more than 30% of the foreign direct investment has been allocated. Furthermore, it is the most regulated sector in Peru, so it faces, more than ever, pressure from regulators as well as stakeholders. Given this situation, several mining related companies decided to comply with the ISO 14001 standard. In this study one presents findings from ISO 14001 environmental audits performed to 11 mining related companies (4 mining companies and 7 mining subcontractors dedicated to blasting, exploration and extraction). One finds several deviations related to *operational controls* that lead to negative environmental impacts. Unfortunately, the most common response to these deviations was the adoption of end-of-pipe technologies instead of cleaner production techniques. Hence, one also suggests some cleaner production techniques that could be adopted in order to cope with these deviations.

Keywords: Cleaner Production Techniques, Mining, ISO 14001

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SECTION 1: INTRODUCTION

Peru is currently one of the favorites destinations for mining investment in South America. In fact, the mining industry has experienced a remarkable growth during the last decades. Nowadays, Peru is the second biggest producer in silver; the third biggest producer in copper, zinc and tin; the fourth biggest producer in lead and the sixth biggest producer of gold in the world. Exports from mining account to 55.8 % of total exports and they largely responsible of the positive current account balance for the economy (MEM, 2005). The economic impact of the mining industry in Peru is really meaningful, the mining sector represents 5.8% of the Peruvian Gross Domestic Product (GDP) and it currently generates more than 375,000 jobs (MEM, 2005). The Fraser Study (McMahon, 2005) stated that Peru is in the seventh place according to its 'best practice mining potential index' out of 64 surveyed regions. Hence, mining activity in Peru seems also promising in the future.

Due to its growing activity, the Peruvian mining sector is subject to several laws such as the Environmental Protection Code, the environmental quality standards: maximum levels for contamination (air, water, and noise), the law for closing mines, the law for the treatment of solid waste, the law for environmental liabilities, and so forth.

Given the stricter regulation and the bigger pressure from different stakeholders (specially from potential affected populations in the last two years), several mining firms have decided to implement the ISO 14001 environmental standard (Glave and Kuramoto, 2002). Of course, there are also other reasons that have played an important role in adopting the ISO 14001 certification. For instance, Mongrut and Tong (2006) conducted a survey among 50 firms operating in different economic sectors in Peru that had an ISO 14001 certification as December 2004 or earlier. The seven mining firms that were included in their sample agreed that the most important reasons to adopt an Environmental Management System (EMS) were its accordance to their environmental charter and the potential improvement of their environmental performance. Hence, they seem to have a true concern for the negative environmental impacts of their operations.

As September 2005, 18 (27%) out of 65 existing certified firms according to ISO 14001 are related to the mining or metallurgical sectors (11 are mining or metallurgical companies and 7 are mining subcontractors). It is also important to note that ISO 14001 certification in the Peruvian mining sector is relatively new, so the oldest certification for a mining operating unit was issued in 2001 (CONAM, 2005).

From the technical point of view, many companies still work with old machineries for extraction, transportation and concentration plants. Hence, more efficient use of resources such as water, oil, lubricants or chemical additives can be achieved. Hence, there is plenty of room to apply Cleaner Production (CP) Techniques in order to reach higher efficiency in the consumption of resources and in their management.

CP is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase overall efficiency and reduce risks to human beings and the environment. CP can be applied to the processes used in any industry, to products themselves and to various services provided in society (UNEP, 2001a).

Although, the concept of CP is currently widely known, implementation of CP techniques in the Peruvian mining sector is very scarce. Mining companies have adopted a passive strategy of complying with the current regulation called PAMA (Program to Adequate the Environmental Management of the firm to a good environmental practice). According to this program, mining firms are obligated to mitigate or eliminate their environmental liabilities.

In order to accomplish this task, several mining companies have adopted end-of-pipe technologies instead of CP techniques (Mongrut and Valdivia, 2006). Hence, the main objective of this study is to identify possible applications of CP techniques, instead of end-of-pipe technologies, given the deviations found in operational controls through ISO 14001 environmental audits. Furthermore, this is the first study where results from ISO 14001 environmental audits to mining related companies in Peru are presented.

The remaining part of the work is divided in five sections. In the next section one introduces the sample of mining related companies that have been audited, while in the third section one explains the methodology and focus of the research. In the fourth section, one discusses the results from environmental audits and in the fifth section one proposes different CP techniques in order to reduce the deviations found. The last section concludes the study.

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SECTION 2: SAMPLE OF MINING RELATED COMPANIES

According to an official inventory of certified EMS based on ISO 14001 (CONAM, 2005) and to supplementary information handed by Germanischer Lloyd Certification Company in Peru (Valdivia, 2005), there are 65 certified companies according to ISO 14001. From them, 18 companies are related to mining sector. Specifically, 9 companies are mining units, 2 are metallurgical units and 7 are mining subcontractors. Units that belong to the mining or metallurgical sectors are medium or big ones that are mostly located in the Andean region of the country.

According to the Ministry of Mining, Energy and Oil (MEM), medium size mining units are those whose production is between 350 and 5,000 tons of minerals per day, while big mining units produce more than 5,000 tons of minerals per day (Ley 27851, 2002: Art 10). The seven subcontractors are companies with less than 100 employees. Table 1 shows the 18 certified mining related companies and the sample of 11 companies for this study. As one may see, the two metallurgical units have been excluded from the sample in order to deal only with primary mining activities.

TABLE 1: Sample of mining related companies

Type of company	Companies	Minerals	Sample
Mining unit	Minera Milpo S.A.A	Au	No
Mining unit	Minera Sipan	Au	No
Mining unit	Orcopampa	Au	Yes
Mining unit	Uchuchaccua	Ag	Yes
Mining unit	Inversiones Mineras del Sur S.A.	Au	Yes
Mining unit	Minera Cerro Verde S.A.A.	Cu	Yes
Mining unit	Minera Barrick Misquichilca S.A.A	Au	No
Mining unit	BHP Billiton Tintaya S.A.	Cu	No
Mining unit	Minera El Brocal S.A.A.	Ag, Zn, Pb	No
Mining unit	Consorcio Minero Horizonte S.A.	Au	No
Metallurgical	MINSUR S.A. - Planta Fundición	Sn	No
Metallurgical	Cajamarquilla	Cu	No
Subcontractor	Minera Coalme S.R.L.	Au	Yes
Subcontractor	Empresa Especializada Serminas E.I.R.L.	Cu	Yes
Subcontractor	Sonda Sur Contratistas Generales S.A.	Au, Cu	Yes
Subcontractor	Inversiones Mineras del Centro S.R.L.	Au, Ag	Yes
Subcontractor	E.E. Minera Edisa S.A.C.	Au	Yes
Subcontractor	Congemin J.H. S.A.C.	Cu	Yes
Subcontractor	J.H. Ingenieros S.A.C.	Cu	Yes

Source: Own elaboration

One interesting feature from the sample of 7 subcontractors is that they are linked to the same main client, who supported the implementation of the EMS in each one of them (Valdivia, 2005).

SECTION 3: METHODOLOGY AND SCOPE OF THE RESEARCH

The sample is composed of 11 mining related certified companies. The EMS of the 11 companies was audited according to the ISO 19011 (2002) auditing procedures and deviations from the ISO 14001 (2004) were identified. It is important to note that the use of the ISO 9011 (2002) standard for auditing is required by the ISO 14001 (2004) to perform internal audits and certification processes. For the purposes of this research, only findings that lead to non-conformities were studied.

Although, 17 aspects (elements or items) may be audited according to the ISO 14001 (2004), one decided to detect deviations related only to operational controls (item 4.4.6) because it is the element where more deviations were found and where more applications of CP techniques can be suggested in order to prevent negative environmental impacts and to reduce the consumption of resources[1].

[1] There are other elements where the application of CP techniques could be also appropriate such as Emergency Preparedness and Response (4.4.7).

The requirement attached to item 4.4.6 states the following: “the organization shall identify and plan those operations that are associated with the identified significant environmental aspects in a consistent way with its environmental policy, objectives and targets. The organization can work on this by implementing procedure(s) to control situations where their absence could lead to deviation from the environmental policy, objectives and targets, by stipulating the operating criteria in the procedure(s), and by implementing procedures related to the identified significant environmental aspects of goods and services used by the organization and communicating applicable procedures and requirements to suppliers, including contractors”.

Given this requirement, it is important to identify techniques that are able to reduce the negative environmental impacts of the firm. In order to do this in the next section, one starts by identifying deviations in item 4.4.6 using the information collected by the 11 environmental audits.

SECTION 4: DETECTED DEVIATONS AND FAILURES IN OPERATIONAL CONTROLS

Table 2 shows the number of deviations related to each element (item) required by the ISO 14001 (2004). As one may see, the greater number of deviations is associated to the operational controls element. (4.4.6).

TABLE 2: Number of deviations detected by element of the Standard ISO 14001:2004 per company

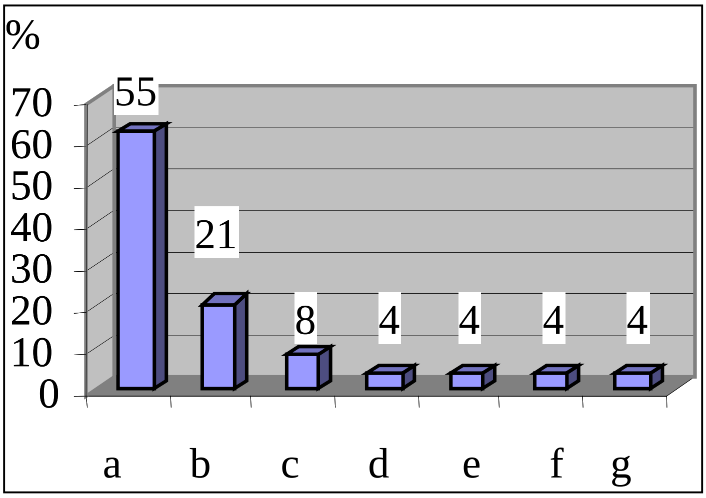
Company Element of the Standard	1	2	3	4	5	6	7	8	9	10	11	Total
4.2 Environmental policy	-	-	-	-	-	-	-	-	-	-	-	-
4.3.1 Environmental aspects	-	1	-	2	-	-	1	2	-	-	-	6
4.3.2 Legal and other requirements	-	-	-	-	2	-	1	-	-	-	-	3
4.3.3 Objectives, targets and programme(s)	-	-	-	-	1	-	-	-	-	-	-	1
4.4.1 Resources, roles, responsibility	-	-	-	-	-	-	1	1	-	-	-	2
4.4.2 Competence, training and awareness	-	-	-	-	1	-	4	3	2	2	3	15
4.4.3 Communication	-	-	2	-	-	-	-	-	-	-	-	2
4.4.4 Documentation	-	-	-	-	-	-	-	-	-	-	-	-
4.4.5 Control of documents	-	-	-	-	1	1	4	3	1	-	-	10
4.4.6 Operational controls	1	1	4	-	5	3	2	2	-	-	-	18
4.4.7 Emergency preparedness and response	1	1	-	2	4	4	1	-	-	4	-	17
4.5.1 Monitoring and measurement	-	-	-	-	-	5	3	-	5	-	1	14
4.5.2 Evaluation of compliance	1	-	2	-	2		-	-	-	-	2	7
4.5.3 Nonconformity and preventive action	-	-	-	-	1	2	-	1	3	1	2	10
4.5.4 Control of records	-	-	-	-	3	-	-	1	2	1	-	7
4.5.5 Internal audit	-	-	-	-	1	1	1	1	-	-	-	4
4.6 Management review	-	-	-	-	1	1	1	-	-	-	-	3

Source: Own elaboration

Other important deviations were associated to the elements Emergency Preparedness and Response (4.4.7), Monitoring and Measurement (4.5.1), Control of Documents (4.4.5), and Nonconformity, Corrective and Preventive Action (4.5.3). However, most of the applications of CP techniques can be suggested in relation to item 4.4.6.

Figure 1 looks inside the item 4.4.6 in order to show the types of deviations that were found.

FIGURE 1: Types of operational controls' deviations



Source: Own elaboration

Where:

a) 55% of the deviations are related to inadequate management of solid waste (i.e.: wrong classification of hazardous and non-hazardous disposal of recyclable rests)
b) 21% of the deviations can be traced to non-efficient consumption of electricity (at offices in the fields)
c) 8% of the deviations are related to non-efficient consumption of water (over consumption, leakages or filtrations in the tailings)
d) 4% of the deviations are due to non-efficient consumption of fuel for transportation
e) 4% of the deviations are due to spillages of oil
f) 4% of the deviations are due to emissions of dust when transporting mineral
g) 4% of deviations are related to wastewaters without treatment

Other relevant findings related to other elements of the ISO 14001 (2004) were the lack of contingency plans for detected risks or were not implemented or tested (element 4.4.7), the lack of appropriate training for workers or employees, training needs were no identified or training plans do not include all relevant areas (element 4.4.2), and some relevant environmental aspects (such as water consumption, energy consumption, waste generation, etc.) were not monitored (element 4.5.1).

Although these aspects are important, one shall concentrate in the deviations related to element 4.4.6. In order to reduce these deviations it is important to apply CP techniques that one discusses in the next section.

SECTION 5:CLEANER PRODUCTION TECHNIQUES IN OPERATIONAL CONTROLS

According to guidelines established by the Cleaner Production area of the Production and Consumption Branch of UNEP (UNEP, 2001b), the following alternatives can be considered as cleaner production techniques:

CPT1: on-site reuse and recycling
CPT2: good operating practices
CPT3: technological change
CPT4: change in raw materials
CPT5: product changes

When discussing the potential to implement "change in raw materials" (CPT4) and "product changes" (CPT5) as cleaner production techniques, one must realize that "concentrated minerals or gained metals" are considered final products in the extractive mining industry. As part of a product chain these minerals and metals are delivered to next processes. The only possibility to undertake a preventive strategy is by increasing the level of concentration of metals in the input mineral, in other words, working in richer areas with higher degrees of metal. In what follows, one discusses the application of CPT to reduce the identified deviations in operational controls.

a. In order to solve inadequate management of solid wastes one may apply CPT 1 related to the on-site reuse and recycling strategies. Specifically, one may accomplish the following tasks:

   Task 1: *Analysis and quantification of the wastes stream* (origin and destination). In this respect, firms and the Ministry of Energy in Peru do not have a policy of storing and quantification.

   Task 2: *Classification of generated wastes*. One may classify generated waste in four (4) groups: hazardous ones/non recyclable ones (i.e. oils with PCB[2], rests of explosives, used cans and packaging materials), hazardous ones/recyclable ones (i.e. used oil), non hazardous/non recyclable ones (i.e. old tires, rests of ceramics glasses for metal tests), and non hazardous/recyclable ones (i.e. plastics, paper, organic wastes, glass, debris, tailings). In this respect, it is important to find out whether one may send used cans and packaging materials as well as rests of chemical substances (i.e. oil with PCB) back to suppliers. Some providers are already assuming product chain responsibility and are able to receive their used products or packaging materials back (i.e. toner for printer machines).

   Task 3: *Adequate separation of hazardous and non hazardous wastes on-site.* This task would reduce the amounts of final wastes to be disposed of in "disposal sites for hazardous wastes". Savings are around US$ 100 per each ton of correctly separated waste (Valdivia, 2005).

[2] Poly-chlorinated biphenyl that is going to be worlwide prohibited according to the Stockholm Convention.

Task 4: *Research on recycling possibilities in the country for hazardous and non hazardous wastes.* In case of used oil and cars' batteries, recycling options already exist and they are normally located in the capital city and far away from mining sites. By recycling, disposal costs in landfills for hazardous wastes can be saved to about of US$ 150 per ton of waste (Valdivia, 2005).

b. In order to reduce energy consumption at field offices one may follow good operating practices (CPT2) such as:

Task 1: *Quantification of energy streams (by generation and machines or offices with the highest consumed amounts)*

Task 2: *Analysis of energy requirements and real consumption (quantities and periods of time).* Do requirements match with real consumption? What are the differences? Why? An answer to these questions can lead to better planning.

Task 3: *Establishment of optimal periods of time for energy consumption for each relevant machine or place*

c. To reduce water consumption, leakages or filtrations in the tailings. The following tasks are related to CPT1 and CPT2.

Task 1: *Quantification of water streams (sources of water and processes or areas with the highest consumed amounts)*

Task 2: *Analysis of water requirements and real consumption (quantities and periods of time)*

Task 3: *Establishment of the optimal amount of water for each relevant place*

Task 4: *Permanent monitoring of water consumption*

d. In order to foster efficient fuel consumption for transportation, one may consider applying CPT2 in relation to the optimal logistic planning for transportation and CPT3 related to the improvement of roads' surfaces. The specific tasks are the following:

Task 1: *Quantification of transportation requirements and capacity for personnel and materials*

Task 2: *An increasing construction and use of pedestrian ways with appropriate signaling and lightning systems.*

Task 3: *An increasing use of clean energy vehicles such as bicycles for personnel.*

Task 4: *Optimal logistic planning in coordination with personnel, suppliers and guests of the mining unit.*

e. CPT2 can be applied in order to reduce spillages of oil or fuel. The specific tasks are the following:

   Task 1: *Improvement of storage systems*

   Task 2: *Improvement or replacement of connection systems*

f. CPT2 can also be used to reduce the emissions of dust when transporting mineral. The following tasks may help:

   Task 1: *Filtering of dust and dropping water when transporting or even building in key areas.*

   Task 2: *To train people in specialized tasks such as reuse and recycling*

g. CPT1 and CPT2 can be applied in order to increase the treatment of wastewaters: such as the implementation of secondary treatment processes (biological treatment) and reuse of water to increase vegetation.

   Task 1: *Implementation of secondary treatment processes (biological one).*

   Task 2: *To reuse water in order to increase vegetation*

   Task 3: *To train people in specialized tasks such as reuse and recycling*

SECTION 6:CONCLUSION

In this study one has shown meaningful deviations in operation controls in mining related companies operating in Peru. In particular, one has performed 11 environmental audits with respect to the ISO 14001 (2004) and found that deviations can be traced to inadequate management of solid waste (hazardous and non hazardous waste), to non-efficient consumption of electricity, water, oil, and fuel for transportation, to spillages of oil, emissions of dust and wastewater without a proper treatment. Some CP techniques have been discussed in order to mitigate these deviations.

Although it is crucial to apply CP techniques, a more comprehensive solution needs the construction of environmental and eco-efficient performance indicators so mining related companies could monitor their performance and improve it precisely using CP techniques. Furthermore, the reporting of these indicators can inform better stakeholders improving the image of the company among them.

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