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ENVIRONMENTAL MANAGEMENT SYSTEMS TOOLS APPLIED TO THE NUCLEAR FUEL CENTER OF IPEN

Luís A. Terribile de Mattos[1], Nelson Leon Meldonian[2], Tufic Madi Filho[3]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN-CNEN/SP)
Diretoria de Segurança/Assessoria Técnica
Av. Prof. Lineu Prestes 2242
05508-000 São Paulo-SP
mattos@ipen.br

[2] Instituto de Pesquisas Energéticas e Nucleares (IPEN-CNEN/SP)
Diretoria de Segurança/Assessoria Técnica
Av. Prof. Lineu Prestes 2242
05508-000 São Paulo-SP
meldonia@ipen.br

[3] Instituto de Pesquisas Energéticas e Nucleares (IPEN-CNEN/SP)
Centro de Engenharia Nuclear
Av. Prof. Lineu Prestes 2242
05508-000 São Paulo-SP
tmfilho@ipen.br

ABSTRACT

This work aims to identify and classify the major environmental aspects and impacts related to the operation of the Nuclear Fuel Center of IPEN (CCN), through a systematic survey data, using interviews questions and consulting of licensing documents and operational records. First, the facility processes and activities, and the interactions between these processes were identified. Then, an analysis of potential failures and their probable causes was conducted to establish the significance of environmental aspects, as well as the operational controls, which are necessary to ensure the prevention of impacts on the environment. The results obtained so far demonstrate the validity of this study as a tool for identification of environmental aspects and impacts of nuclear facilities in general, as a way to achieving compliance with the ISO 14001:2004 standard. Moreover, it can serve as an auxiliary method for resolving issues related to the attendance of applicable regulatory and legal requirements of National Nuclear Energy Commission (CNEN) and Brazilian Institute of Environment (IBAMA).

1. INTRODUCTION

The Nuclear and Energy Research Institute (IPEN-CNEN/SP) has been undergoing a process of environmental compliance of its radioactive and nuclear facilities.
The process of adjustment is being made through a legal agreement called “Conduct Adjustment Agreement” (TCAC) [1] , between IBAMA (Brazilian Institute of Environment) and IPEN (Nuclear and Energy Research Institute) , with the participation of CNEN (Brazilian Nuclear Energy Commission).

The agreement is a legal instrument under the Environmental Crimes Law (Federal Law 9605/98) [2], Article 97-A, which is intended, exclusively, to enable those responsible for facilities and activities that use environmental resources, and/or those who are considered effective or potentially polluting agents, to make the necessary corrections related to their activities, so that the requirements imposed by environmental authorities are complied with.

It was established that IPEN should fulfill twenty seven requirements to be met in different periods, within a maximum period of three years from its signature. It included several actions, thus typified:

- short-term actions: renovations and repairs; lists of facilities and laboratories; plans and maps;
- identification and treatment of environmental liabilities;
- conduction of environmental assessment;
- proposition of a project for effluents (liquid and gas) control systems plus conventional and radioactive wastes;
- creation and implementation of programs for effluent monitoring and radioactive and conventional waste control.

The experience accumulated in the pursuit of meeting IBAMA environmental requirements showed that, among the difficulties encountered in achieving the objectives agreed with that institute, the lack of a methodological tool for systematic characterization of the environmental aspects and impacts prevailed as major barriers to be overcome by IPEN, which in addition to having to meet the environmental legislation, aims at the implementation of ISO 14001:2004 [3] as a way to consolidate its Integrated Management System (IMS).

2. OBJECTIVE

The proposed work presented here intends to identify and classify the major environmental aspects and impacts related to the operation of the Nuclear Fuel Center of IPEN (CCN), through a systematic survey data, using interviews questions and consulting of licensing documents and operational records

The applied methodology provides a tool, whose application may contribute to overcome the barriers that currently exist regarding IPEN environmental compliance activities.

The proposed application to the CCN aims to establish a way to test and validate the methodology for future application to other facilities of IPEN

3. OBJECT OF STUDY

The Nuclear Fuel Center - CCN is deployed within the limits of the Nuclear and Energy Research Institute, which is housed on the campus "Armando de Salles Oliveira", University of São Paulo - USP. The region surrounding the CCN is predominantly urban and distinguishes USP main geographical limit to IPEN. In the district of Butantã, where it operates, the university shows characteristics of land use and occupation strictly urban, consisting, basically, of areas with residential, commercial and industrial features, in this order of importance [4].

The CCN is the facility responsible for producing nuclear fuel for the operation of the IEA-R1 research reactor, also located at IPEN. The development of new technologies for nuclear fuel is also an ongoing goal.

The program for developing the production of fuel element began in the 80s. It was motivated by a policy of containing this fuel purchase abroad and, at the same time, maintaining the IEA-R1 reactor in operation.

The fuel element was developed based on U_3Si_2-Al dispersion with a bulk density of 3.1 g/cm^3. The core of the IEA-R1 was then gradually changed from U_3O_8-Al-Al to U_3Si_2 [5]. Operating with the capacity of producing 10 fuel elements per year, the CCN comprises five distinct areas, three Divisions and two Advisory bodies. In the three Divisions, specific activities are performed: chemical activities (Division of Chemical Processing – CCR; metallurgical activities (Division of Special Alloys - CCL) and fuel fabrication (Division of Mechanical and Metallurgical Processing - CCP). The advisors coordinate the activities of quality management (Office of Quality Assurance - QC) and R & D (Research and Development Consultancy - CP). Each of the three divisions is divided into sections, according to the type of activity and goals of each one.

The productive activities of the Nuclear Fuel Center (CCN) use the Uranium Hexafluoride (UF6) as raw material to produce the fuel elements based on Uranium silicide (U_3Si_2). The fuel manufacturing process is based on the dispersion of uranium compound in aluminum (Al), as shown in Figure 1.

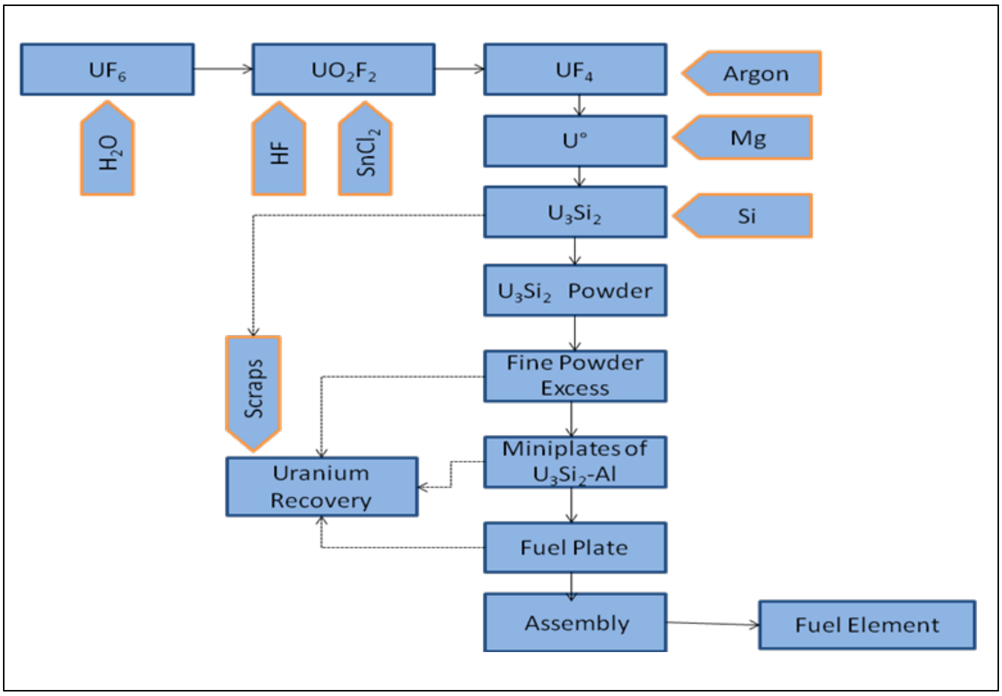

Figura 1: Flowchart of fuel element manufacturing process of the CCN/IPEN [6]

4. METHODOLOGY

This work is characterized as a Case Study through which it was sought to identify, systematically, the real nature of environmental aspects and impacts related to the activities of the IPEN Nuclear Fuel Center.

Initially, a literature survey was conducted focusing on the various applications of the FMEA [7;8] as a way to situate the subject matter in time and assess its scope, with emphasis on the development and application of the technique in question, including the identification of similar studies applications.

Then, a composite method was developed, based on the methodological precepts contained in tools and techniques from the Failure Mode and Effects Analysis - (FMEA) and in the implementation methodology of environmental management systems based on NBR ISO 14001 standard [3].

Through the evaluation of documents and studies on the installation, interviews with experts, technical visits and questionnaires, a systematic identification of the various sources of contamination and their environmental risks was conducted, seeking to define their nature and degree of importance as to the severity of the potential harm to the environment. Figure 2 shows the diagram of the applied method.

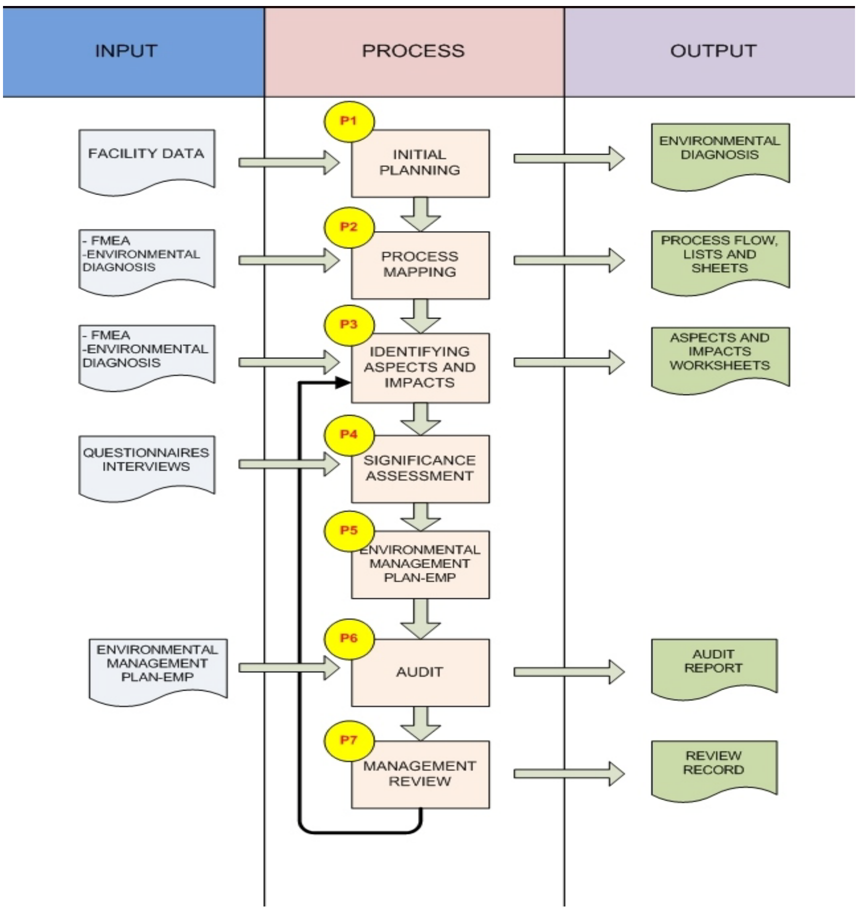

Fig. 2 - Flowchart of Proposed Methodology

5. RESULTS AND DISCUSSION

Below, the results obtained for each step of the proposed method (P1 to P7[1]) to date. (see Figure 2)

P1: INITIAL PLANNING

The considerations presented below resulted from readings and analyzes of available documents on the installation studied, as well as from meetings and interviews with CCN officials and employees.

Environmental Licensing: As it is a nuclear facility in Brazil, the environmental licensing of a nuclear fuel plant is the responsibility of the Federal Government, in accordance with the Complementary Law No. 140 of December 8, 2011 [9] and CONAMA Resolution No. 237, of December 19, 1997) [10].

In principle, the CCN do not need a specific environmental license to operate, since, from the point of view of IBAMA, IPEN should be licensed taking into account the joint operation of all its facilities, including, in this case study, the CCN.

Currently, IPEN, and therefore the CCN, has only a permit to operate issued by IBAMA, as evidenced in Letter No. 776/2012/DILIC/IBAMA, dated August 7, 2012.

The validity of this permit is subject to the commitments enshrined in an agreement, the TCAC (“Conduct Adjustment Agreement”), signed between IPEN and IBAMA, on July 17, 2012, effective for three years.

According to the above mentioned Office, the TCAC is a "tool that allows IPEN/CNEN to continue operating, maintaining environmental controls of its effluents (conventional and radioactive), according to the precepts of environmental laws and regulations of the CNEN”.

Management System: The CCN is included in the Integrated Management System of IPEN (IMS), with a process of implementing a Quality Management System based on ISO 9001:2008, not complete yet. The facility does not have an Environmental Management System and it was not possible to evidence any initiative to implement the ISO 14001:2004 standard [3].

An important finding of this part of the study is that there is a tendency in Brazilian environmental laws to consider the environmental licensing as a management tool, a trend evidenced in the First Clause of the TCAC [1], as seen in the text reproduced below:

"Section One - This Conduct Adjustment Agreement aims to define the obligations to be fulfilled by the National Nuclear Energy - CNEN / IPEN, in form, terms and conditions agreed upon by this instrument in order to take corrective measures and preventive measures to regularize the environmental licensing of activities. *These obligations will consolidate the Environmental Management, following the guidelines and structure of the Integrated Management System (IMS) of IPEN / CNEN-SP*. "(Emphasis by the author)

[1] About the current status of the steps P5, P6 e P7 , see item 6. Conclusions.

P2: PROCESS MAPPING

In this step, a detailed evaluation of the object of study, defined in the planning phase, was performed in order to collect data that would allow all processes to be characterized and identified. The data collection was done through readings and analysis of the existing technical documents about the object of study, interviews and questionnaires with those responsible for conducting the proceedings and / or selecting activities in the case study. Complementarily, contacts were made with experts to obtain specific technical information for the installation.

The results of this phase were consolidated into four worksheets related to each of the following operational processes:

- Chemical Process: UF_6
- Chemical Process: Recovery of Uranium
- Special Alloys Process
- Mechanical and Metallurgical Processes

P3: IDENTIFYING ASPECTS AND IMPACTS

Through the application of techniques based on the assessment of the FMEA method, this step was performed to identify each of the possible environmental impacts associated with processes and environmental factors defined in the previous stage, besides verifying possible causes which may have been the reason for these effects.

As a result, the worksheets of the Survey on Environmental Aspects and Impacts, in the four operational processes mentioned previously, were prepared.

P4: SIGNIFICANCE ASSESSMENT

Then, the criteria of significance were defined and the Severity (S), Coverage (C), Occurrence (O) and Detection (D) indexes were applied. For each impact, an Environmental Risk Index (ERI) was used. This parameter allows each of the processes listed in the case study to be viewed, according to a hierarchical scale of environmental relevance.

The ERI is obtained by the following relationship:

ERI = (S x O x H x D) + L

Where
S = Severity Index
O = Occurrence Index
C = Coverage Index
D = Detection Index
L = 0 if there is no environmental legislation. Otherwise, L = 1

If **ERI ≥ 9**, the environmental aspect is considered significant. In this case, it is mandatory to implement its operational control.

The Environmental Risk Indices were calculated and recorded in the respective worksheets prepared in step P3.

Hence, the Worksheets of Environmental Aspects and Impacts become important tools for the environmental management and are regularly updated as the solutions of environmental pending evolve.

6. CONCLUSIONS

The identification and evaluation of environmental aspects and impacts of the CCN/IPEN demonstrated that the waste control process is quite significant, deserving actions towards its improvement.

The result of the gaseous emissions significance evaluation is also remarkable, due to the low rate of detection related to this environmental aspect.

And despite the fact that it is less significant, the qualification control of raw materials, products and services suppliers can be improved.

Currently studies are being conducted correlating the environmental aspects identified with the applicable environmental legislation, aiming to improve the results of the Environmental Risk Scores obtained so far. To date, P5, P6 and P7 steps have not been accomplished yet. With the complementation of these remaining steps, the process of validation of the methodology proposed in this paper is aimed to be consolidated.

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