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Knowledge management on safety and security: evaluation of a seminar using concept map

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ABSTRACT

This paper aims to show the application of a Knowledge Management (KM) tool to evaluate a seminar on Radiological Safety, held by the students of the Postgraduate Course in Radiation Protection and Safety of Radiation Sources (PGEC), offered by the Institute of Radiation Protection and Dosimetry (IRD) in partnership with the International Atomic Energy Agency (IAEA). The tool in question was the Concept Map (CM), that can gather knowledge of individuals and groups, facilitating the process of learning construction, acting as an appliance for discussion and communication, and assist in the organization of information within an organization. Immediately after the seminar, a class on CM was given, since most of the students did not know the tool. The students prepared a summary and a CM of the seminar, in order to verify if they had identified the main concepts discussed, as well as the relation between them. It was then verified that they were able to understand the applicability of the tool, and many of the students will adopt the CM as a learning tool.

Keywords: **Knowledge Management, Concept map, Radiological Safety and Security, Seminar.**

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1. INTRODUCTION

1.1. Justification

It can be said that the population, in general, has already heard something about "Nuclear Energy". However, the majority of the population does not understand the effects of nuclear energy on living organisms, especially in humans, showing the need to build more accurate and informed knowledge about radiation in a formal learning situation [1].

In addition, the general population has already heard of X-rays and ultraviolet rays, for example, but does not understand their effects on living organisms, because they do not know the difference between ionizing and non-ionizing radiation. They are not fully aware of the damages and benefits of radiation, ignoring much of their industrial applications. Therefore, these preconceptions point to the need to construct a more precise and grounded knowledge about radiations in a formal learning situation [2].

As nuclear solutions like nuclear power are an integral part of society, the best method of gaining the public´s confidence is through increased protection. Thus, there is a growing need for the nuclear area to promote a more open dialogue with the public, increasing the public acceptance of nuclear energy, mainly due to the fact that it is a risk technology. Therefore, risk communication is directly associated with risk perception, which considers the difference between how the risk is perceived by the public versus how the risk is actually assessed and measured by the specialists [3].

Indeed, the purpose of risk communication is not to force a shift between the divergent views of the specialist and the public, but it is a question of developing an understanding of these factors so that they can be considered and treated. And one possibility that opens up for this risk communication, as well as for a better understanding of the uses of nuclear energy, would be through Knowledge Management (KM). This is because the KM has been applied to create the necessary conditions for greater access to communication clearly and richly. Therefore, KM aims to promote an integrated approach to identifying, capturing, evaluating, retrieving and sharing information, which in this case may be databases, documents, policies, procedures and an institution [4].

1.2. The seminar

The Institute of Radiation Protection and Dosimetry (IRD), an institute linked to the Brazilian Nuclear Energy Commission (CNEN), responsible for radiation protection procedures, has been carrying out various teaching activities to improve the understanding of nuclear energy concepts, as well as offering continuing education courses for professionals in the area.

One of these activities is the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC), offered by IRD, in partnership with the International Agency of Nuclear Energy (IAEA) [5].

The course is free and has been designed to meet the needs of professionals with higher education equivalent to the university degree in physics, chemistry, health and earth sciences or engineering and have been selected to work in the field of radiation protection and safety of sources of radiation in their countries. The course provides the basic tools needed for who will become instructors in their area. Divided into modules, it includes theoretical part and practical training, with demonstrations, laboratory exercises, case studies, technical visits, simulation exercises and seminars. Some theoretical topics and exercises use the virtual classroom of the course [5].

One of these modules in question is an one-day seminar, always with topics that are relevant to knowledge in the nuclear area. In the year 2017, with the objective to contribute to human resource development, the theme was "Safety and Security: Harmonization and Action" (Figure 1).

At the seminar, the main concepts related to radiological and physical safety applied to radiative installations were discussed, argued the applicability of these concepts in the industrial and medical areas and proposed actions to harmonize the performance of professionals, as well as presentations on the issue of radiological threat and its consequences potential, and the Brazilian structure of radiological safety and physical security [6; 7].

The idea of the theme of this seminar arose from the fact that an international concern about radioactive sources after the September 11, 2001 event has led to a strengthening of security. There is evidence that the illicit use of radioactive sources, such as “radiological terrorism”, is a real possibility and may result in harmful radiological consequences for the public and the environment [6; 7].

Figure 1: *Folder of the seminar "Safety and Security: Harmonization and Action".*

Source: IRD website

In addition, specifically with respect to Brazil, there are about 1800 medical, industrial and research installations with radioactive sources and 400 are IAEA Category 1 and 2. Industrial gamma irradiators and industrial radiography occupy a prominent position due to very high radioactive sources activities. Safety conditions are well established in these facilities, due to the intense work of regulatory authority in the Country. But security conditions, according to the basic concepts of Deterrence, Detection, Delay and Response are not yet fully established and incorporated in medical and industrial installations. The main cause observed was the workers' lack of knowledge on safety concepts that must be established at the facility [6; 7].

The seminar was intended for the following participants: undergraduate and postgraduate students in nuclear and radiation protection areas; radiation protection officers; industry and medical radiation workers; security workers and general workers. For this challenge, because it was the first general seminar about security, special lecturers were chosen to talk about the main security aspects. Seven lectures were given [6; 7]:

1) New Global Scenario of Radiological Threat and its Potential Consequences;
2) The Importance of Physical Protection from Radioactive Sources;
3) International Consensus and the CNEN Physical Protection Office;
4) A New Brazilian Regulation for Security of Radioactive Sources;
5) Definition of Threats and Conception of a Physical Protection System;
6) Safety and Security Concepts applied to Radioactive Sources in Medical Facilities;
7) Radiological Accidents with Radioactive Sources Involving Security.

In addition to the PGEC students, the seminar was open to the public. Participated as listeners to the seminar a total of 151 participants divided in 26 undergraduate students (medical and industry radiology); 51 postgraduate students (nuclear engineering; medical physics; radiation protection, radiotherapy, dosimetry; security of radioactive sources) and 74 workers of radioactive installations (industry; medical, occupational safety engineering, radiation protection, radiological and nuclear safety, dosimetry, metrology, nuclear area) [6; 7].

1.3. Relation between Knowledge Management and Concept Map

1.3.1. Knowledge Management

With the increasing importance of information within organizations, to the point that some authors classify as the new capital, a new area of research emerged and quickly gained strategic importance, the so-called Knowledge Management (KM) [8; 9].

KM would then be a corporate process, focused on business strategy and involving skills management, intellectual capital management, organizational learning, business intelligence and corporate education [10].

In addition to the advancement of information and knowledge, new technologies are also being developed to facilitate process development and information flow, so that knowledge representation is defined as "the field of study concerned with the use of formal symbols for represent the beliefs of an individual" [11].

Therefore, the representation of knowledge must enable new knowledge to be inferred from the knowledge already represented, or to reproduce the knowledge that is represented. Thus, the representation of knowledge must obey five essential rules: 1. it is a substitute for knowledge, not knowledge itself; 2. it provides a representation for the organization of information aiming at reaching a conclusion; 3. it uses together concepts and their interrelationships within a domain; 4. it is a fragmented theory of human reasoning; 5. it is a means of human expression [8; 12].

One fine example of knowledge representation is the Concept Map (CM), defined as an artifact for knowledge organization and representation, whose purpose is to represent the relationship between concepts in the form of propositions, also being understood a visual language for the representation [12].

1.3.2. Concept Map

Concept Map (CM) is a graphical representation similar to diagrams, which indicates relationships between concepts linked by words. They represent a structure that ranges from the most comprehensive to the least inclusive. They are used to assist in the ordering and hierarchical sequencing of didactic content, in order to provide appropriate stimuli to the student [8; 13].

In the area of education, for example, the CM is used to facilitate the learning of concepts, based on the student's prior knowledge in creating new knowledge. This process is then called significant learning [8; 14].

CM is dynamic, constantly changing in the course of meaningful learning. The analysis of CM is essentially qualitative. The teacher, instead of worrying about assigning a score to the map drawn by the student, should try to interpret the information given by the student on the map in order to obtain evidence of significant learning [15].

The CM theory was developed in the 1970s by researcher Novak, based on Ausubel's theory of significant learning. Novak then defines the concept map as a tool for organizing and representing knowledge, where concepts appear in boxes and the relationships between them are specified by linking phrases that unite each of the concepts [15].

Learning is said to be significant when new information (concept, idea, proposition) acquires meanings for the learner through a kind of anchoring in relevant aspects of the individual's pre-existing cognitive structure, that is, in concepts, ideas, propositions already existing in his knowledge structure (or meanings) with a certain degree of clarity, stability and differentiation [15].

These relevant aspects of the cognitive structure that serve as anchorage for the new information are called by subsunitors. In meaningful learning, there is an interaction between new knowledge and existing knowledge, in which both are modified. As prior knowledge serves as a basis for assigning meanings to the new information, it also changes, thereby, the subsunitors acquire new meanings, becoming more differentiated, more stable. New subsunctions are being formed and subsunitors interact with each other. The cognitive structure is constantly restructuring during meaningful learning. The process is dynamic, so the knowledge is being built [15].

In meaningful learning, new knowledge is never literally internalized, because the moment it becomes meaningful to the learner, the idiosyncratic component of meaning enters the scene. Learning significantly means assigning meanings and these always have personal components [15].

As meaningful learning necessarily implies the attribution of idiosyncratic meanings, concept maps, drawn by teachers and students, will reflect these meanings. That is, both maps used by teachers as a teaching resource and maps made by students in an assessment have idiosyncratic components. Thus, concept maps - both of the student and the teacher - have personal meanings [15].

2. MATERIALS AND METHODS

This work aims to show the application of a KM tool, the CM, to evaluate the seminar "Security and Protection: Harmonization and Action", offered to PGEC students at IRD.

Immediately after the seminar, a class on KM and CM was given. After that, the CmapTools app was presented (Figure 2).

Figure 2: *Cmaptools App.*

Source: https://cmap.ihmc.us/

The Cmap app allows users to build, browse, share and create knowledge models represented as CM. Students were also allowed to build the CM by hand.

PGEC students then individually evaluated the seminar, presenting a summary of each presentation, as well as a CM of the entire seminar, in order to verify whether they had identified the main concepts discussed, as well as the relationship between them.

3. RESULTS AND DISCUSSION

After students delivered the summary and CMs, a discussion was opened to evaluate both the seminar and the CM tool.

In discussion with the students, was possibly verify the importance of the seminar. For example, for the student T., *"Participation in this seminar has contributed positively and enrichingly to knowledge related to radiological and physical safety. It was possible to have an overview of what has been happening in Brazil and in the world in relation to aspects of radiological safety and to*

know a little more about the experience of the lecturers in their areas of practice. It is extremely important that events such as these can be perpetuated by professionals in the areas, in educational institutions, organizations, regulatory bodies, facilities, etc. so that there is a constant dissemination of knowledge".

For the student G., *"There must be an integration of teams working in physical safety and radiological safety as the areas are closely related. The non-integration of teams can weaken the physical and radiological barriers since the disciplines are complementary. The norms that deal with the themes must foresee the integration of the disciplines".*

For P., *"Given the above facts, there are a number of perspectives on what constitutes the nuclear and radioactive safety field. And he's way beyond weapons, guards and gates to safeguard an installation. Nuclear safety also involves concerns about the illicit or malicious use of nuclear or radiological materials that could pose a potential threat to the individual, the environment and national security. Therefore, measures must be taken to ensure the integrity, safety and responsiveness of such sources in the event of an accident, theft or theft".*

And for A, *"With all the above mentioned in the lectures, it is seen that the need to adopt security policies in the field of physical and radiological protection is necessary due to the potential risk generated by a radiological / nuclear source when employed in a deferential action of which it was designed to act".*

Other conclusions wrote by postgraduate students about the seminar are presented as results:

• “Safety and security are relevant issues, generating discussions at an international level. Ensuring public safety and security should be the goals of all regulatory authorities.”;

• “The seminar was important for updating nuclear workers on concepts, definitions and requirements of safety and security.”;

• “The importance of security was well explained and emphasized by several lecturers. They explained how the security lack entails accidents and other damages, not only for radiation workers but for members of the public, such as Goiania accident. The constant training of workers is an important aspect for the implementation of safety and security in a facility.”;

• “The seminar was enlightening and fundamental for learning about safety and security of radioactive sources and met my expectations.”.

Regarding the elaboration of CMs, most students had never heard of either KM or CM. At first, most confused the CM with the elaboration of an organization chart. After discussing with the class, they began to understand that the tool can be used with great potential for the study of any discipline.

According to student G, "*This application and the concept map tool are very interesting, as it is possible to organize and hierarchize the knowledge of a given subject, in addition to relating the concepts to each other. It serves both to understand the whole and to summarize the content. I believe that through the conceptual map it is possible to better organize knowledge, thus making knowledge management.*".

Regarding the maps developed by the students, some examples are found in Annex I.

4. CONCLUSION

It is possible to verify the importance of the seminar, with the participation not only of the students of the PGEC, but also of external participants.

Regarding the students' learning, it was verified that many did not know some concepts discussed at the event, showing the importance of discussing topics relevant to the area.

About Concept maps, students understood it as a powerful tool for the concept learning process.

It is understood that Concept maps are a tool that can gather knowledge from individuals and groups, facilitate the process of knowledge creation, function as a means of discussion and communication, and assist in the distribution of knowledge and learning processes within an action of the organization.

As this seminar was the first on security, the main objective of presenting the concepts of safety and applicability in radioactive sources and installation was fully met.

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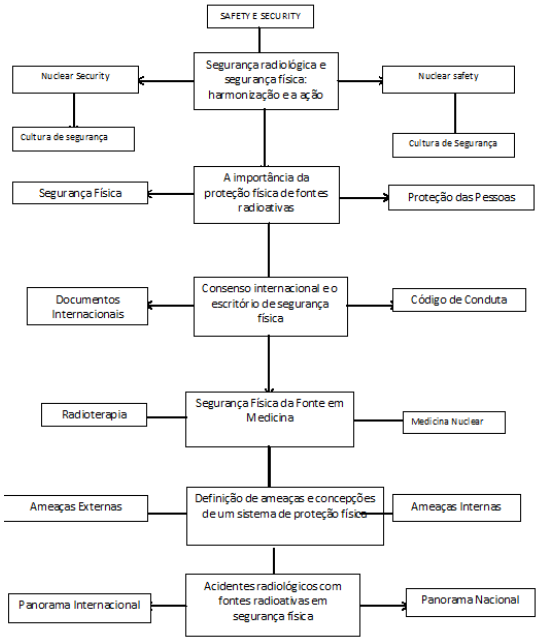
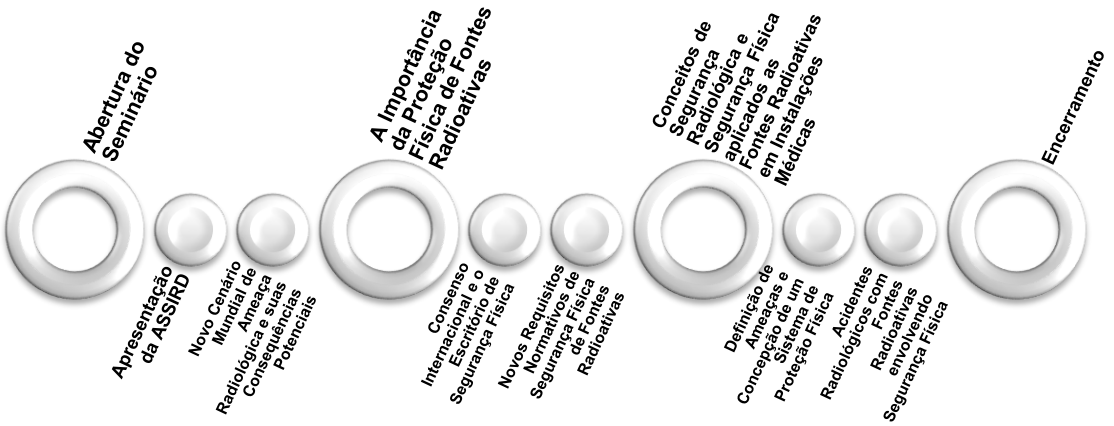
ANNEX I - Examples of Concept maps developed by studentes

A



B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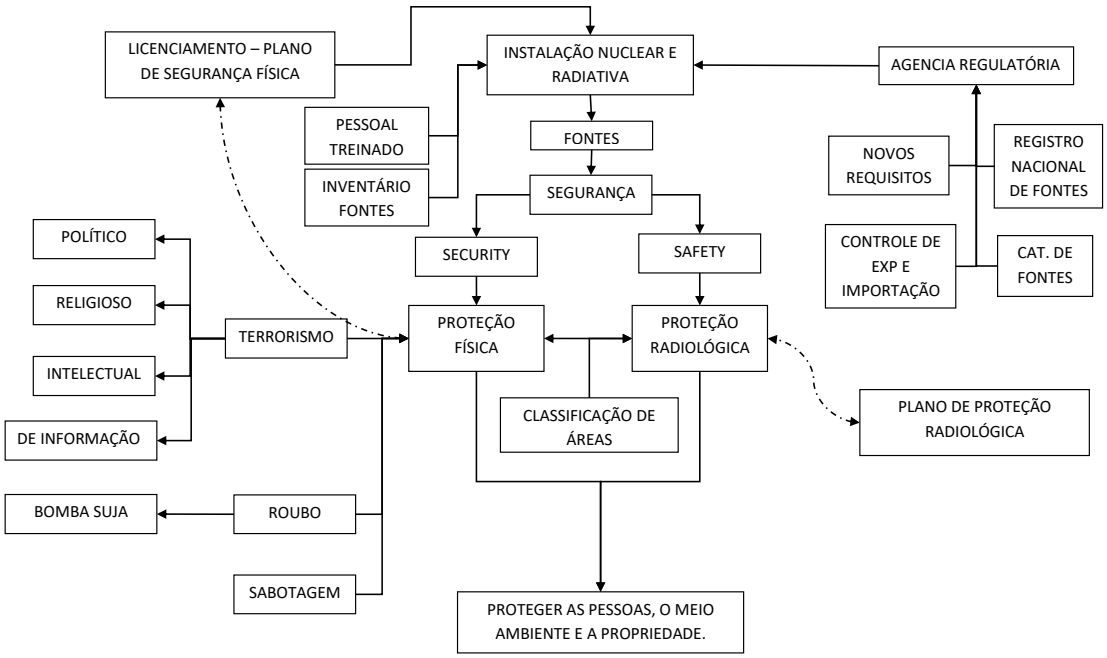
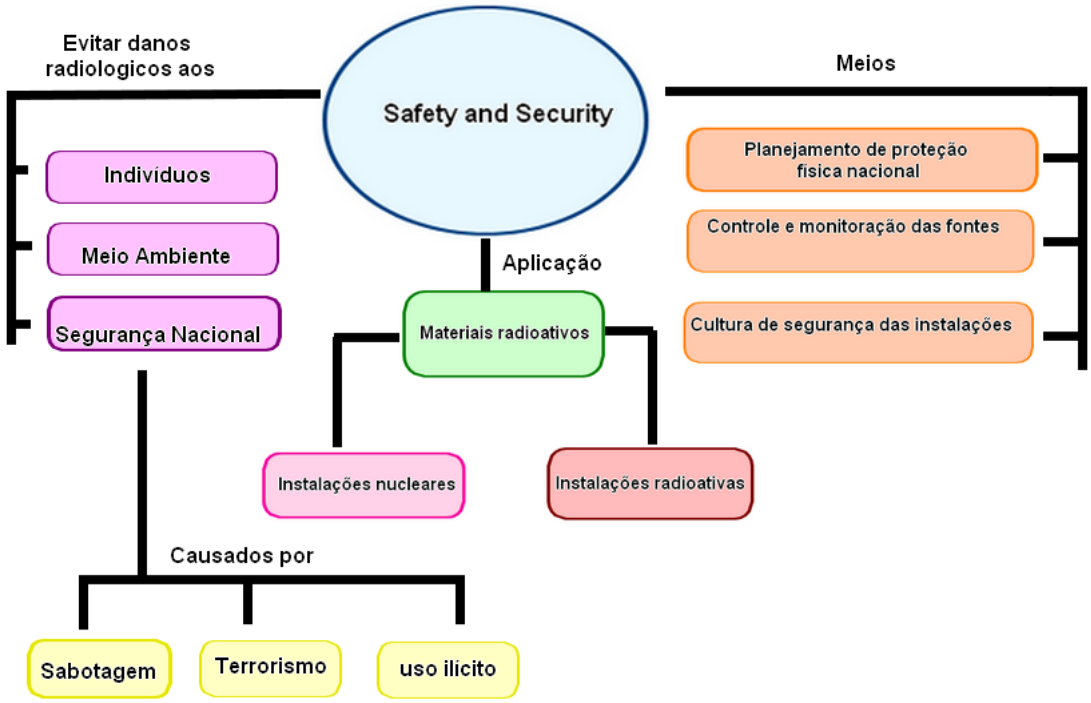
Apresentação da ASSIRD
Novo Cenário Mundial de Ameaça Radiológica e suas Conseqüências Potenciais
A Importância da Proteção Física de Fontes Radioativas
Consenso Internacional e o Escritório de Segurança Física
Novos Requisitos Normativos de Segurança Física de Fontes Radioativas
Conceitos de Segurança Radiológica e Segurança Física aplicados as Fontes Radioativas em Instalações Médicas
Definição de Ameaças e Concepção de um Sistema de Proteção Física
Acidentes Radiológicos com Fontes Radioativas envolvendo Segurança Física
Encerramento

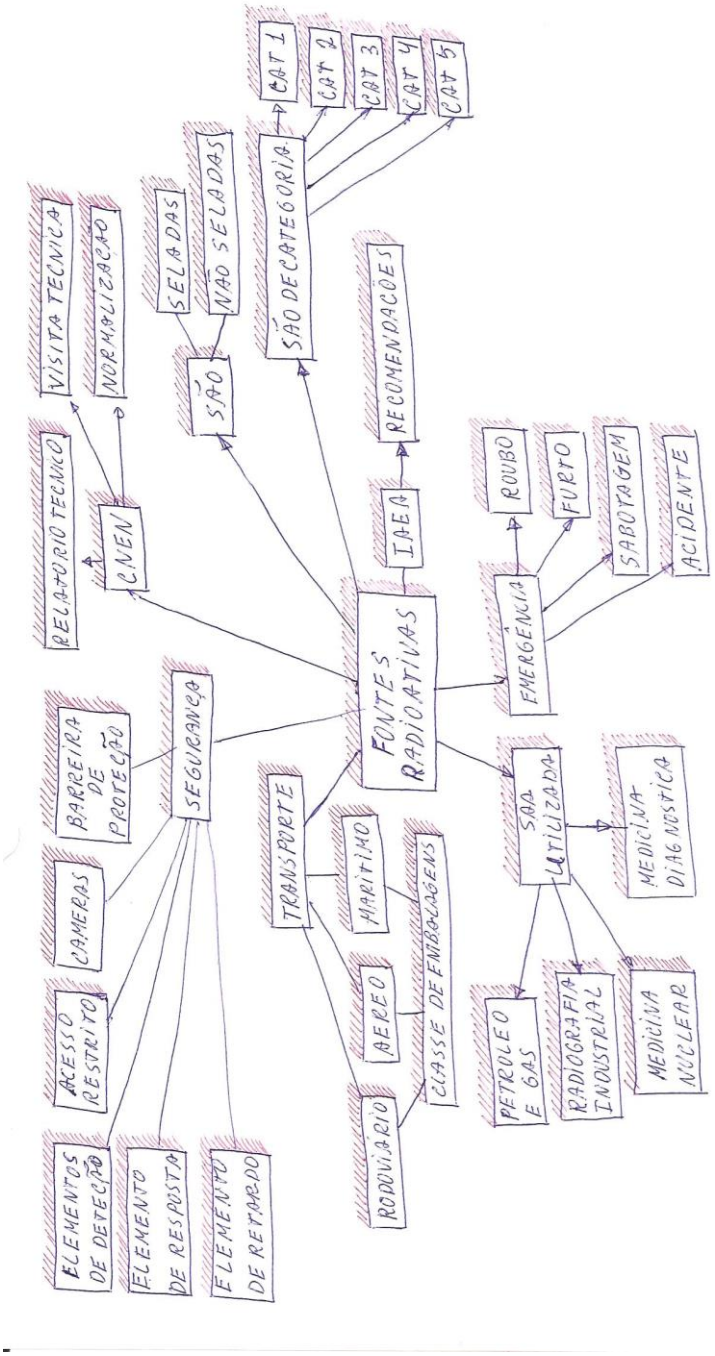
C


LICENCIAMENTO – PLANO DE SEGURANÇA FÍSICA
INSTALAÇÃO NUCLEAR E RADIATIVA
AGENCIA REGULATÓRIA
PESSOAL TREINADO
INVENTÁRIO FONTES
FONTES
SEGURANÇA
NOVOS REQUISITOS
REGISTRO NACIONAL DE FONTES
CONTROLE DE EXP E IMPORTAÇÃO
CAT. DE FONTES
SECURITY
SAFETY
POLÍTICO
RELIGIOSO
INTELECTUAL
DE INFORMAÇÃO
TERRORISMO
PROTEÇÃO FÍSICA
PROTEÇÃO RADIOLÓGICA
CLASSIFICAÇÃO DE ÁREAS
PLANO DE PROTEÇÃO RADIOLÓGICA
BOMBA SUJA
ROUBO
SABOTAGEM
PROTEGER AS PESSOAS, O MEIO AMBIENTE E A PROPRIEDADE.

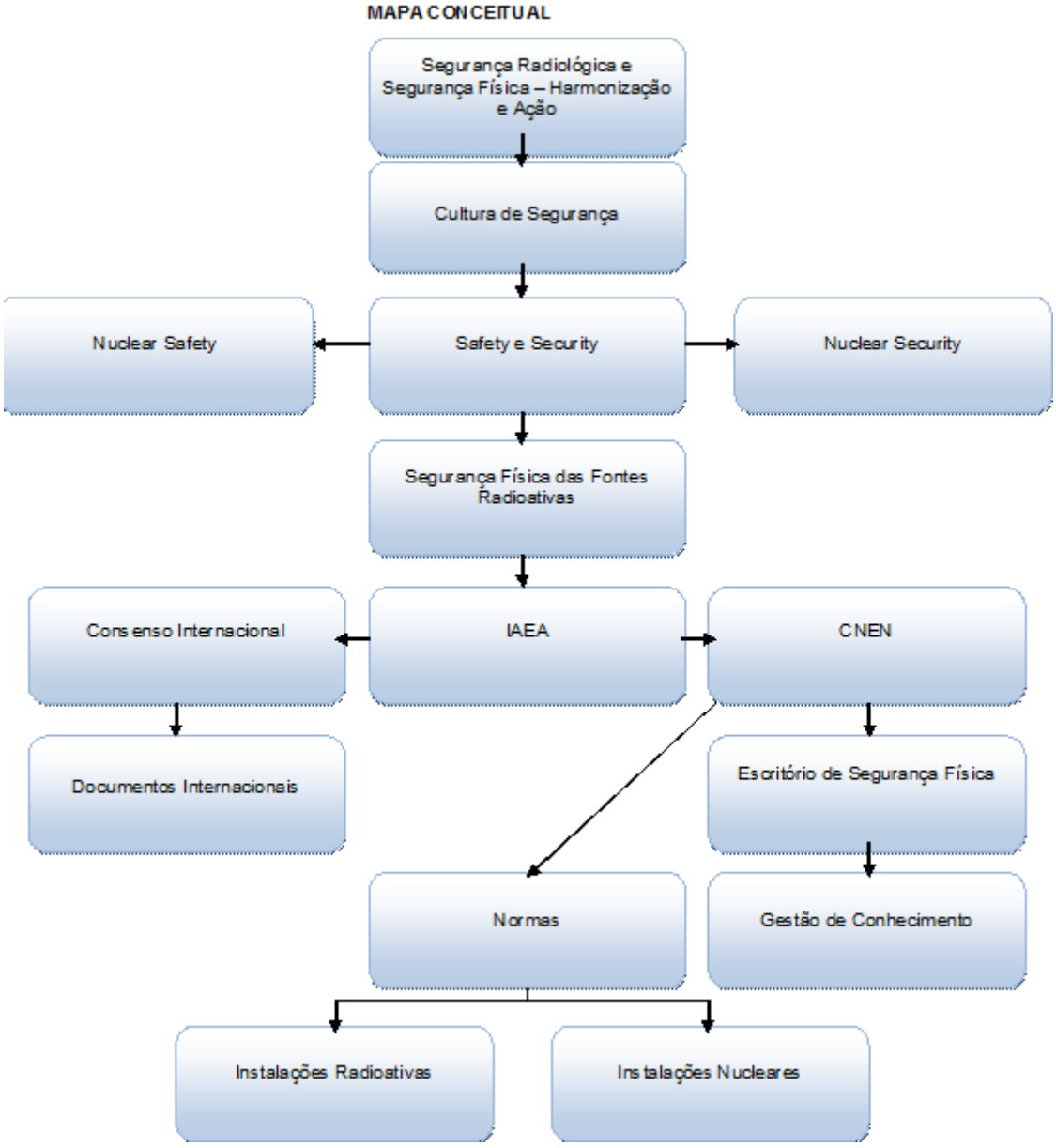
D


Evitar danos radiologicos aos
Safety and Security
Meios
Indivíduos
Meio Ambiente
Segurança Nacional
Planejamento de proteção física nacional
Controle e monitoração das fontes
Cultura de segurança das instalações
Aplicação
Materiais radioativos
Instalações nucleares
Instalações radioativas
Causados por
Sabotagem
Terrorismo
uso ilícito

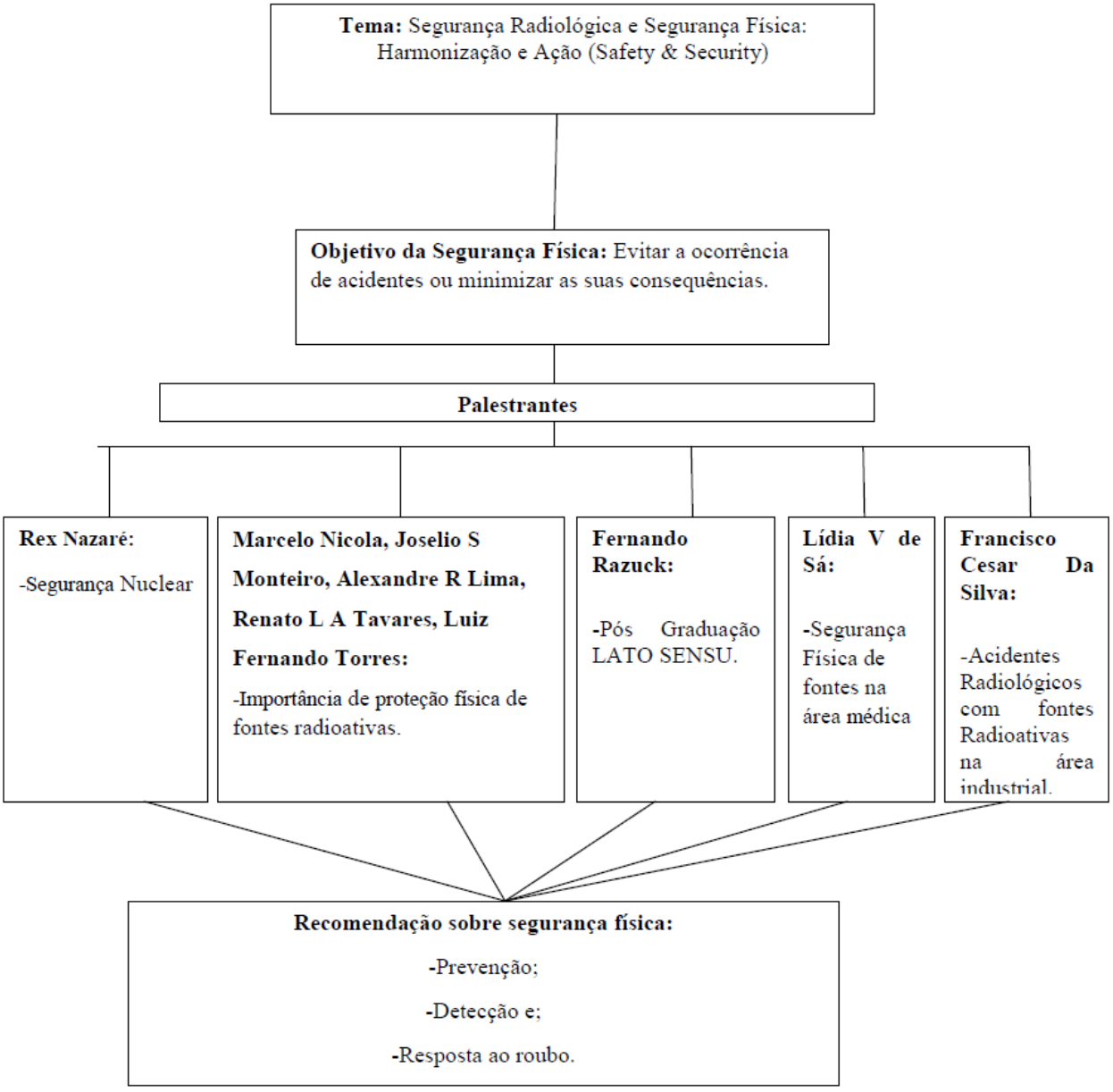
E


MAPA CONCEITUAL
Marcos Antonio Bozaud Pezarini.
FONTES RADIOATIVAS
SEGURANÇA
BARREIRA DE PROTEÇÃO
CÂMERAS
ACESSO RESTRITO
ELEMENTOS DE DETECÇÃO
ELEMENTO DE RESPOSTA
ELEMENTO DE RETARDO
RELATÓRIO TÉCNICO
VISITA TÉCNICA
NORMALIZAÇÃO
CNEN
SÃO SELADAS
NÃO SELADAS
SÃO
SÃO DE CATEGORIA
CAT 1
CAT 2
CAT 3
CAT 4
CAT 5
IAEA
RECOMENDAÇÕES
TRANSPORTE
RODOVIÁRIO
AÉREO
MARÍTIMO
CLASSE DE EMBALAGENS
EMERGÊNCIA
ROUBO
FURTO
SABOTAGEM
ACIDENTE
SOA UTILIZADA
PETRÓLEO E GÁS
RADIOGRAFIA INDUSTRIAL
MEDICINA NUCLEAR
MEDICINA DIAGNÓSTICA

F


MAPA CONCEITUAL
Segurança Radiológica e Segurança Física – Harmonização e Ação
Cultura de Segurança
Nuclear Safety
Safety e Security
Nuclear Security
Segurança Física das Fontes Radioativas
Consenso Internacional
IAEA
CNEN
Documentos Internacionais
Escritório de Segurança Física
Normas
Gestão de Conhecimento
Instalações Radioativas
Instalações Nucleares

G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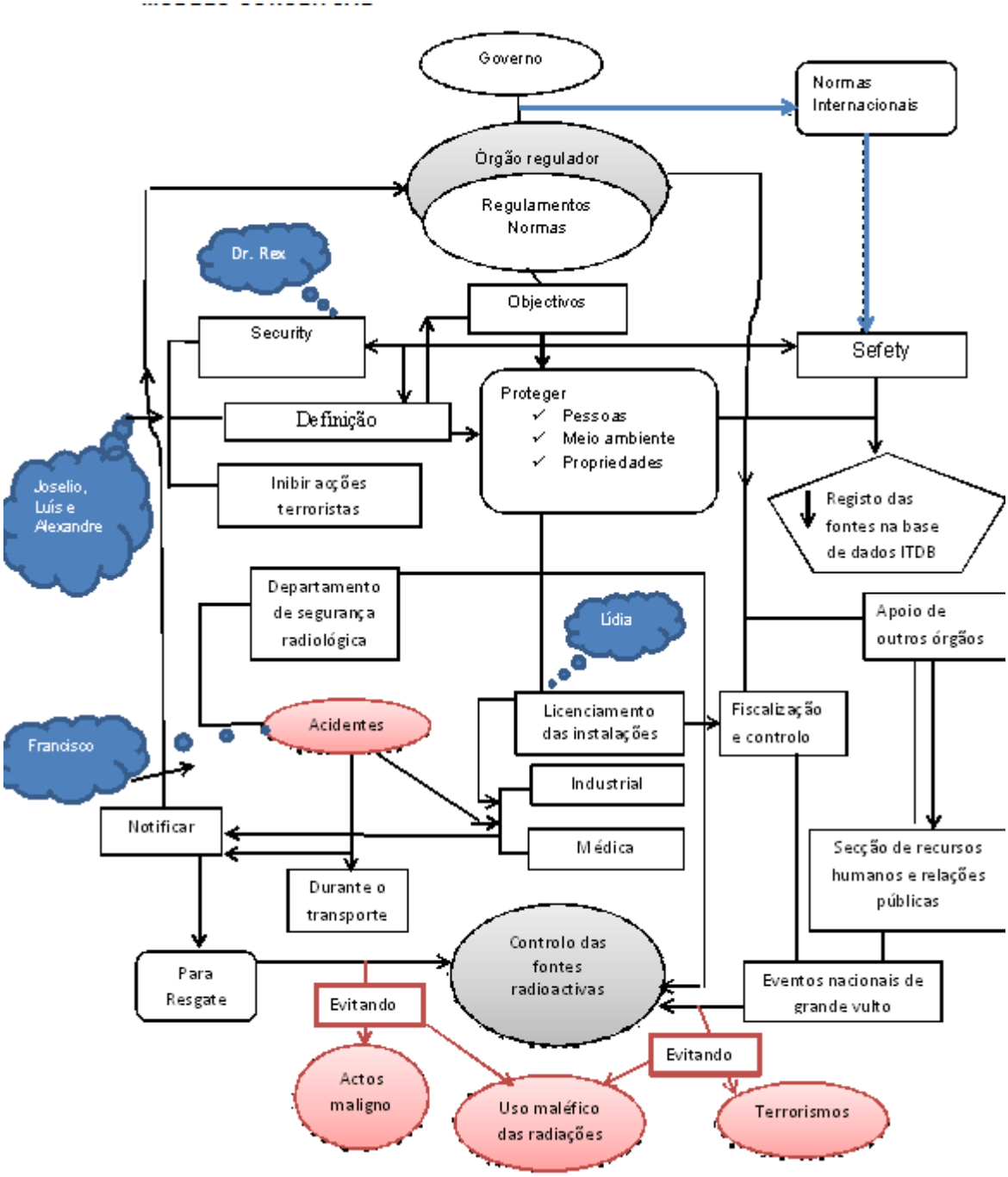
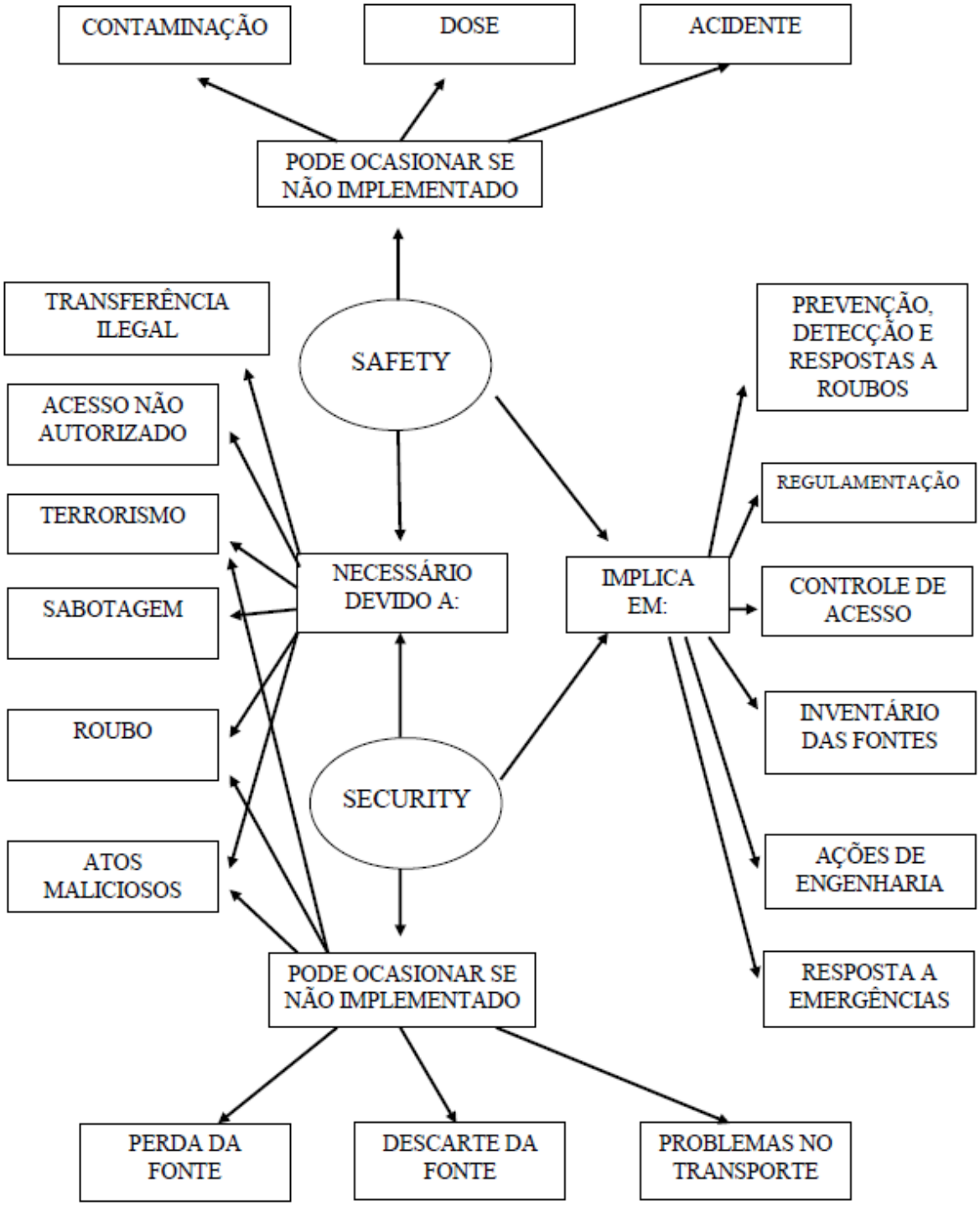
Objetivo da Segurança Física: Evitar a ocorrência de acidentes ou minimizar as suas consequências.
Palestrantes
Rex Nazaré:
-Segurança Nuclear
Marcelo Nicola, Joselio S Monteiro, Alexandre R Lima, Renato L A Tavares, Luiz Fernando Torres:
-Importância de proteção física de fontes radioativas.
Fernando Razuck:
-Pós Graduação LATO SENSU.
Lídia V de Sá:
-Segurança Física de fontes na área médica
Francisco Cesar Da Silva:
-Acidentes Radiológicos com fontes Radioativas na área industrial.
Recomendação sobre segurança física:
-Prevenção;
-Detecção e;
-Resposta ao roubo.

H


Governo
Normas Internacionais
Órgão regulador
Regulamentos Normas
Dr. Rex
Objectivos
Security
Sefety
Proteger
✓ Pessoas
✓ Meio ambiente
✓ Propriedades
Definição
Joselio, Luís e Alexandre
Inibir acções terroristas
Registo das fontes na base de dados ITDB
Departamento de segurança radiológica
Lídia
Apoio de outros órgãos
Acidentes
Licenciamento das instalações
Fiscalização e controlo
Francisco
Industrial
Notificar
Médica
Secção de recursos humanos e relações públicas
Durante o transporte
Controlo das fontes radioactivas
Para Resgate
Evitando
Eventos nacionais de grande vulto
Evitando
Actos maligno
Uso maléfico das radiações
Terrorismos

I


CONTAMINAÇÃO
DOSE
ACIDENTE
PODE OCASIONAR SE NÃO IMPLEMENTADO
TRANSFERÊNCIA ILEGAL
ACESSO NÃO AUTORIZADO
TERRORISMO
SABOTAGEM
ROUBO
ATOS MALICIOSOS
SAFETY
NECESSÁRIO DEVIDO A:
SECURITY
IMPLICA EM:
PREVENÇÃO, DETECÇÃO E RESPOSTAS A ROUBOS
REGULAMENTAÇÃO
CONTROLE DE ACESSO
INVENTÁRIO DAS FONTES
AÇÕES DE ENGENHARIA
RESPOSTA A EMERGÊNCIAS
PODE OCASIONAR SE NÃO IMPLEMENTADO
PERDA DA FONTE
DESCARTE DA FONTE
PROBLEMAS NO TRANSPORTE