2013 International Nuclear Atlantic Conference - INAC 2013
Recife, PE, Brazil, November 24-29, 2013
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN

EVALUATION OF MANAGEMENT OF COMMUNICATION IN THE ACTIONS OF PREPAREDNESS AND RESPONSE TO NUCLEAR AND RADIOLOGICAL EMERGENCIES

Mauro Otto de Cavalcanti Mello Filho[1], Marcela Tatiana Fernandes Beserra[1], Maria Angélica Vergara Wasserman[2] e Julio Cesar de Faria Alvim Wasserman[3]

[1] Centro Federal de Educação Celso Suckow da Fonseca (CEFET-RJ)
Av. Maracanã 229 - Maracanã - CEP:20271-110
Rio de Janeiro - RJ - Brasil
maurootto@cefet-rj.br, maurootto@gmail.com
mbeserra@cefet-rj.br

[2]Instituto de Engenharia Nuclear (IEN/CNEN)
Rua Hélio de Almeida, 75 - Cidade Universitária - Ilha do Fundão
CEP: 21941-906, Rio de Janeiro, RJ. Brasil
mwasserman@ien.gov.br

[3] Universidade Federal Fluminense (UFF)
Rede UFF de Meio Ambiente e Desenvolvimento Sustentável.
Centro. CEP: 24020-149 - Niterói, RJ.Brasil.
geowass@vm.uff.br

ABSTRACT

The use of practices involving the use of ionizing radiation in diverse areas of knowledge increases every day. This growth warning about the increased probability of accidents, radiological and nuclear emergencies, with possible consequences for the public, workers and the environment. Within this scenario, it is clear that studies and reassessments of the emergency response actions, receive proposals for continuous improvement. The achievement of the objectives of the response must be sustained by tactical, operational and logistics optimized processes. The articulation through communication between the teams involved in the response must be adaptable to each accident or emergency, respecting its size. The objective of this study is to perform an assessment on the management of communication in the actions of Preparedness and Response to Nuclear and Radiological Emergencies. This assessment is supported by best practices of the Incident Command System (ICS) and the Institute of Project Management (Project Management Institute - PMI). For this purpose, based on models referred were established performance indicators supported by the BSC (Balanced Scorecard). These indicators allowed to evaluate more objectively the performance of the communication processes associated with each phase of the response. The study resulted in the proposed model documents aiming to assist planning of communications exercises in preparation and response actions, supported and adapted the best practices of PMI. These methodologies were evaluated by real cases selected from radiological and nuclear emergencies published by the International Atomic Energy Agency (IAEA).

1. INTRODUCTION

Due to the extension of the use of ionizing radiation in the radiological and nuclear areas in Brazil and around the world, one cannot neglecting to consider that this scenario leads to increased probability of accidents with possible consequences for the public, workers and the environment.

In the context of the nuclear and radiological area, an accident occurs when any event, including operating errors or equipment failures, consequences, actual or potential are relevant from the point of view of radiation protection (1). Are considered possible scenarios for accidents involving radioactive sources: loss, theft, damage or fire from a radioactive source, re-entry of satellites containing radioactive sources in the atmosphere; accident in transporting radioactive sources; overexposure in the medical area, contamination of food fountains and water (2).

Currently, also exists a major concern with criminal or terrorist acts using radioactive materials as these may cause panic and important psychological impacts, economic and social disruption (1,3). Given these events, radiological or nuclear emergencies, especially in terrorism will continue to be serious and continuing threat.

In the scenarios mentioned above, an accident can lead to an emergency. The response to a nuclear or radiological emergency is a set of actions intended to mitigate the consequences of the accident to restore security and human health, quality of life, property and the environment. The answer is performed by people, stakeholders, who use communication to be informed about facts, understand how to perform tasks and fulfill the objectives outlined in the plan (4,5). Therefore one must first understand before implementing what are the expectations of stakeholders. This process shall include the information and communications needs of the parties, for example, who needs what information, when they need it, how it will be provided, by whom, and what are the means (5).

So communication through the exchange and sharing of resources, promotes mutual understanding, the proper dissemination of information, the key elements in managing any emergency response (3, 5, 6,7). Therefore, communication must be clear. There must be no elements that may interfere with or distort the process of communicating information, affecting or impairing the correct understanding between sender and receiver. These elements are called barriers to communication, which can be knowledge, behavioral, organizational or technical (8).

In a response are identified some of the possible barriers to communication between members of the emergency team (8,2): (a) belonging to different institutions, with their own technical and organizational aspects, (b) different cultures, (c) specific language depending of the area; (d) Behavioural aspects distinct, (e) belong to different geographic regions, (f) power relations at different levels. In scenarios radiological emergencies of great magnitude is more evident this aspect, given the nature interdisciplinary and interinstitutional required by this type of response.

It is clear that studies and revaluations of communication planning for emergency response actions receive proposals for continuous improvement. The objective of this article is to present a methodology for evaluating the communication management actions in preparedness and response to nuclear and radiological emergencies. This assessment is supported by best practices of the Incident Command System (ICS) and the Project Management Institute (PMI), as these methodologies have in their structure chapters specific to communication management. Were evaluated in this article real cases selected nuclear and radiological emergencies published mainly by the International Atomic Energy Agency (IAEA), and indicators created by the Balanced Scorecard (BSC). This article presents a brief literature review, the methodology used, as well as discussion of the results.

2. THEORETICAL FOUNDATIONS

2.1. Project Management under PMI perspective

A project is a temporary endeavor undertaken to achieve a specified objective. The projects are performed by people, usually have limited resources and are planned, executed and controlled (8,9). These characteristics have synergies to nuclear and radiological emergencies responses, because both are temporary, involve teams, are planned, executed and controlled (10, 11,12).

From the perspective of the PMI, project management is the application of knowledge, skills, tools and techniques to project activities in order to meet their requirements. The project manager is the person responsible for conducting the project objectives (13).

The projects are divided into process groups, Figure 1. The combination of these stages is known as the life cycle of the project.

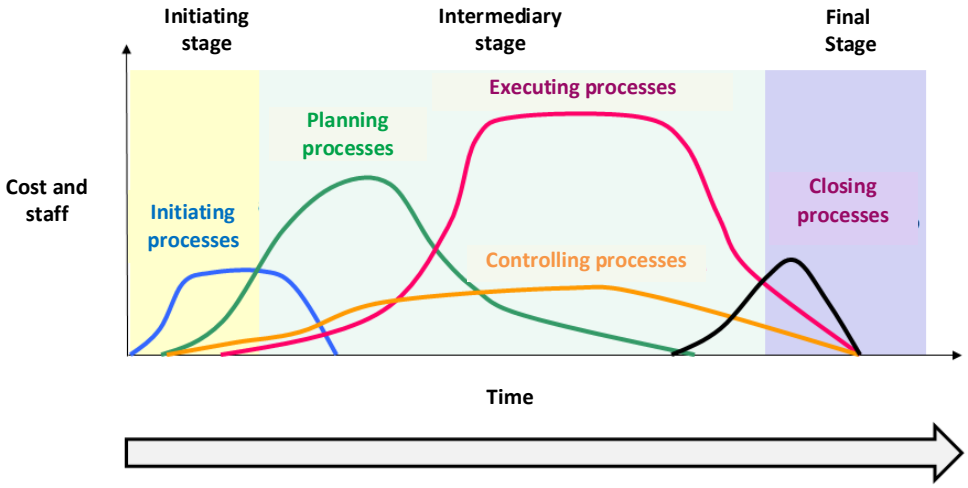


Figure 1. Relationship between process groups, the level of activity required by the stakeholders and the life cycle of the project (14)

Generally a project is divided into five process groups (12):

(a) **Initiation**: Defines and authorizes the project or a project phase.
(b) **Planning**: Defines, refines the goals and action plans necessary to achieve the project scope.
(c) **Implementation**: Integrates people and other resources to accomplish the project.
(d) **Monitoring and control**: Measures and monitors progress regularly to identify changes in relation to the project management plan and taking corrective actions.
(e) **Closure**: formalizes acceptance of the product, service or result and leads the project or a project phase to an orderly end.

The PMI organizes the project into nine knowledge areas, namely (14, 15, 16): Integration, Scope, Time, Cost, Quality, Human Resources, Communications, Risk and Procurement.

Each knowledge area is made up of specific processes. As the focus of this dissertation is to study communications management, will be presented in the next section the fundamentals inherent in this area of knowledge from the perspective of PMI (17).

2.1.1. Communications management in projects

Figure 2 shows the main processes related to communication management.

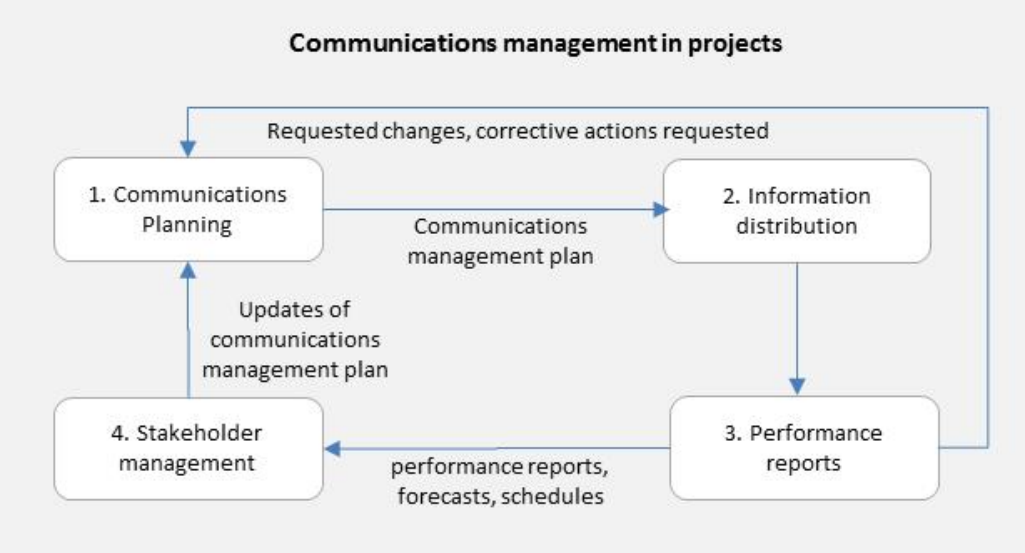


Figure 2. Representation summarized of Communications management in projects (8)

The main objectives of the process 1 are: identify in advance the stakeholders communication needs, as well as methods of communication and the most appropriate way of the distributing information. Such requirements must be documented in a Communications Management Plan. This plan shall contain the information required in the "how to" information distribution, performance reporting and stakeholder management (17, 18).

All planning is put into practice in the execution of the project and should be disseminated to stakeholders in the process 2. The third process aims to keep stakeholders updated on project performance, as fulfillment of deadlines, updating risks, estimates (17,18). As for the process 4, projects involve a wide range of stakeholders, whose interests and demands need to be considered in making management decisions to mitigate possible failures that may impact the success of the project (19). In this sense, the communication requirements of the stakeholders should be identified, assessed and resolved.

According to PMI 57% of failures in projects is given by miscommunication between stakeholders, 72% of organizations indicate the communication management as one of the main problems in projects. Still, communication is the fourth item less considered in project management (20).

2.2 Incident Command System - ICS

The SCI was developed in the 70s in response to a series of forest fires that almost destroyed the southwest of California. At that time, the authorities of municipalities, counties and state government itself helped to form the Firefighting Resources of California Organized for Potential Emergencies (FireScope) (21).

In the nuclear area, the IAEA adopted ICS as a reference model for the formation of the new version of TECDOC-953 (22). The construction of this document took into account the lessons learned from the nuclear and radiological accidents occurred. This is the method adopted by the IAEA for the training and preparation professionals of emergency, more specifically the first responders in the area radiological or nuclear (16).

The ICS is a highly formalized, characterized by extensive rules, procedures and instructions. The work within the system is specialized, based on standardized routines and require skilled professionals (23, 24). The jobs are arranged hierarchically and each team member reports and receives work assignments only a designated person (25). The objectives of the response, as well as the plans are set at the top of the hierarchy or the functions near the top (22). In Figure 3 is shown an example of an organizational structure of ICS (26).

The commander of the emergency / incident is the person who holds the position of highest hierarchy of the ICS. This functional position should always be busy (29). The person occupying this position is responsible for coordinating the activities at the emergency site, the development and implementation of strategic decisions and the ordering and release of resources (31). The commander may delegate emergency activities subordinate to the four sections, and they shall report directly to the commander (33).

The operations section is responsible for the development and execution of all tactical operations directly related to the primary objectives of the ICS (21, 22).

The logistics section provides facilities and support services staff response (26). This section is responsible for medical support, food, supplies, facilities and field support personnel for emergency care (21). Like other sections, this section has sub-sections called units. The units are elements of the structural organization of the ICS who have a functional responsibility for a specific incident to sections of planning, logistics and finance (22). One of the units involved in the logistics section is the unit of communication.

In the planning section, the action plan is developed to achieve the objectives of the emergency response. Therefore, in this section are collected, evaluated and disseminated informations about developing of the incident. Also available are information resources for response (21, 24, 26). ICS calls this plan the Incident Action Plan (IAP) (21).

Already section Finance and Administration performs accounting, procurement and cost analysis of the response (21, 27).

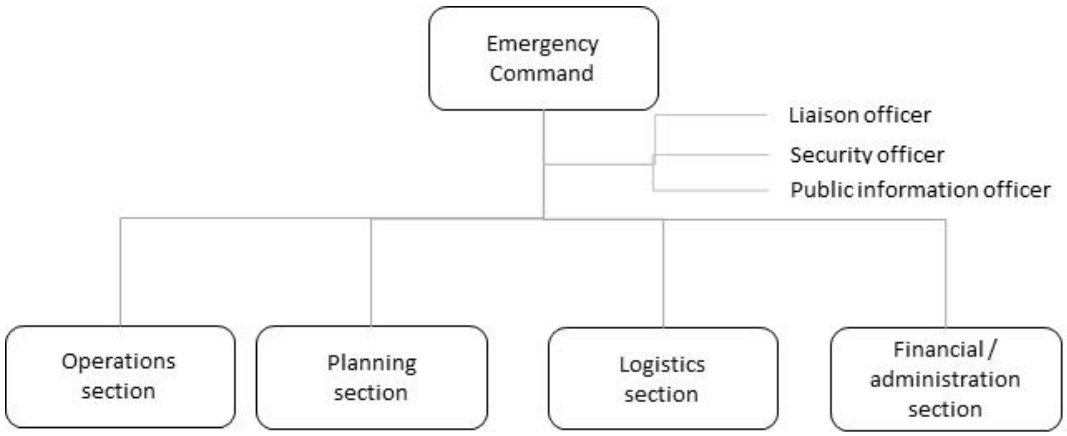


Figure 3. The Organizational Structure of ICS (24, 25)

Finally, the liaison officers are the professionals responsible for assisting the commander to coordinate response actions that occur at the crash site with other institutions (23). Security officers are the professionals responsible for maintaining safe conditions for workers at the scene of the accident (26). Already the official public communication are responsible for determining the processes, procedures and systems for communicating timely and accurate information to the public during a crisis or emergency (23, 25).

3. METHODOLOGY

3.1 Analysis Units

In the selection of units of analysis, this article entitled *case*, for application of the method we selected four accidents, whose characteristics and references are presented in Table 1.

The choice of the reported accidents took into account several factors: cut the timeline in order to allow a retrospective view (28, 29), the type of accident (radiological or nuclear) and; accidents that have been widely cited in references, in order to assist a better argument results.

Table 1. Publications that were taken as references to documentary Assessment Management Communication.

Accident	Year	Emergency type	Documentary evidence
Three Mile Island	1979	Nuclear	30,31, 32
Chernobyl	1986	Nuclear	33, 34, 35
Goiânia	1987	Radiológica	36, 37
Nueva Aldea	2005	Radiológica	38

3.2 Data Analysis

The data analysis was to examine the references listed in Table 1, seeking information related to the processes of Communication Management for each case. All indicators developed are found in (17).

3.3 Method of Evaluation

The proposed method to support critical evaluation Communications Management Actions in Response to Nuclear and Radiological Emergencies was based on BSC (Balanced Scorecard). BSC stands out as a tool to implement a system of performance measurement that starts with strategic planning and defining indicators that can be organized in a hierarchical manner, linking the operational and tactical levels to strategic (38,39).

The BSC has been used in the evaluation of emergency management in the disaster area, as well as plans for crisis communications in support of emergency management. There is a growing interest of public organizations in evaluating their emergency response plans, especially in regard to communication. This is due to the threats and failures observed through lessons learned (40, 41, 42).

3.4 Performance Indicators

The development of performance indicators, called KPIs (Key Performance Indicators), were taken into account shall: (1) be established before the response, (2) serve to measure acceptance of communication processes in the response, (3) indicate if the communication management response has the expected performance.

The indicators developed were characterized by a connection between the processes of managing communication established by PMI and the organizational structure adopted by ICS applied to the management of the response. It was considered that a response can be compared to a project. The answer as well as a project has a life cycle, related time domain process-specific communication management discussed in PMI and ICS, as can be seen in Figure 4.

In addition, sought to link the steps in the time domain with the phases of a response. According to (15) the management of an Emergency Response Radiological or Nuclear resembles the response to emergencies involving hazardous materials. Thus, it can be considered that mitigation is the reduction or limitation of the risks and impacts of disasters related (43,44). The preparation is to ensure that mechanisms have been previously established for the response to a radiological emergency or nuclear is immediate, effective and coordinated at both the local and national levels (10,22). The answer is the provision of emergency services and public assistance during or immediately after a disaster to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of those affected (10, 22, 44). Finally, the phase of recovery is the restoration and improvement of appropriate facilities, livelihoods and living conditions of the communities affected by the disaster, including efforts to reduce the risk from disasters (10,44).

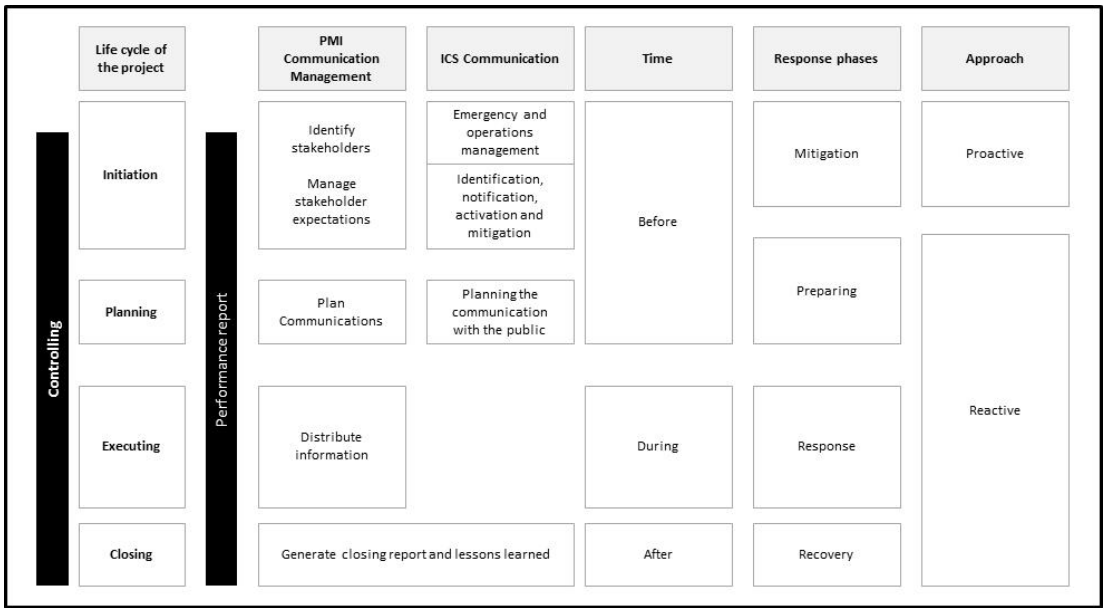


Figure 4. The integration between the processes of Communication Management by PMI, ICS and phases of the Management Response to Nuclear and Radiological Emergency (17)

3.5 Proposed Criteria used to evaluate the indicators

In this stage it was proposed criteria for evaluation of indicators in a qualitative way, and developed an evaluation scale in color, being graded, (17), in order to provide a more rapid and the results of the comprehensive communication management. Each indicator is coded notes, Table 2, and colors, Table 3, on scales categorized. To determine the classification of categories was used Likert scale, employing five categories, ordered and equally spaced.

Table 2. Grading scale for the Evaluation of Performance Indicators

Grade	Criteria
0	There is no evidence that the task was accomplished.
1	There is no evidence that the task was accomplished, but there is evidence that stakeholders (members of the response) recognize the need for achievement.
2	There is evidence that the task has been partially performed, but without considering an established method within the communications planning.
3	There is evidence that the task has been partially performed, considering an established method within the communications planning.
4	There is evidence that the task was accomplished, considering an established method in the communication planning

The response divided into phases, was then verified the relationship between the processes identified and the areas of the BSC, or better as they are aligned with the strategic objectives of the response. Thus, each case was classified as: Targeted Beneficiaries (TB) Internal Process (IP) and Learning and Growth (LG). The indicators associated with TB aim to qualify how much was answered the expectations of all stakeholders. The indicators linked to IP intended to identify the appropriate use of knowledge, skills, tools and techniques. Finally, the indicators associated with LG, are related to the learning derived from lessons learned.

Associated to the note (score) it was calculated relative deviation of this in relation to the maximum agreed (note 4). It is hoped that the results allow a qualitative assessment of how much in percentage terms the indicators developed for the management of communications response deviate from the agreed maximum. Each indicator developed by the author has been classified as the application of the model ICS or PMI. Each process was divided into tasks (activities), to better discriminate the items to be checked. For each case, the set of indicators developed was evaluated by grades (scores) as classified according to Table 2 and Table 3.

Table 3. Color scale associated with the notes in the Evaluation Indicators

Average grade of the indicators	Color	Description
< 2	Red	There are serious deficiencies in communication management response and corrective actions to be implemented.
≥ 2 - <3	Yellow	The performance of the communications management partially meets good practice and stakeholder expectations, improvements need to be implemented.
≥ 3- ≤4	Green	The performance of the communications management best practices and meets stakeholder expectations

The final evaluation and management phases of communication in response was by averaging the grades (scores) of the indicators developed.

4. RESULTS

This study developed 60 indicators to evaluate the communication management, distributed 23 indicators for the mitigation phase (initiation), 28 indicators for the preparation phase (planning), 5 indicators for the response phase (execution) and 4 indicators for the recovery phase (closure). These indicators are associated with a set of indicators as shown in Table 4.

Table 4. Summary Table of Group Indicators for each phase of the response.

Phases of the Response	Key Performance Indicators (KPI)	Model	BSC Area
Mitigation (Initiation)	Management of Emergency Operations	ICS	IP
	Identification, Notification and Activation	ICS	TB
	Mitigation Actions	ICS	IP
	Conduct opening meeting of Response	PMI	IP
	Identification of Stakeholders	PMI	TB
	Stakeholder Management	PMI	TB
Preparing (Planning)	Communications Planning	PMI	IP
	Plan Communication with Public	ICS	TB
	Communications Management Plan	PMI	IP
Response (Execution)	Distribute Information	PMI	IP
Recovery (Closing)	Lessons Learned	PMI/ ICS	LG

The following are the results of the evaluation of the Communication Management for each phase of the response.

4.1 Assessment of Management Communication Phases of Response

The initiation phase (mitigation) is the strategic moment of the response. It is known that adverse dangers of sources, often cannot be completely prevented, but their scale or severity can be substantially lessened by various strategies and actions. As can be seen in Figure 5 (a), it is estimated that approximately 25%, 28%, 42% and 70% of the activities related to the management of the communication were identified as held for cases TMI, Chernobyl, Goiânia and Nueva Aldea respectively for the Inception phase. Many indicators of this stage are related to ICS. This phase undergoes a national response structure well defined and trained, with good coordination between public agencies, non-governmental agencies and local response plans that documents are "alive", ie, exercised and under constant reassessment. These are the starting points for a good Communication Management.

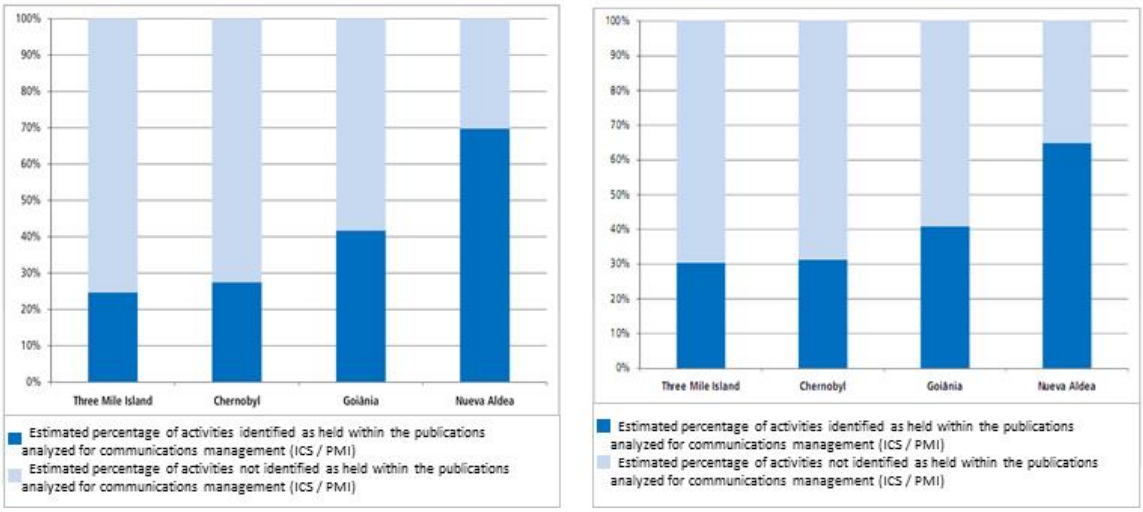
Mitigation phase were not identified documentary evidence of the existence of an Emergency Response Plan for Nuclear Regional or National for TMI and Chernobyl. For both cases, there was an appropriate setting in the matrix of responsibilities, lack of communication between the authorities and other responsible agencies. This justifies the low notes (scores) for Indicator *Management of Emergency Operations*. Goiânia presented better results than the cases TMI and Chernobyl, at this stage, due to a structure adapted to deal with emergencies Radiological and Nuclear. In addition, the emergency coordinator used the lessons learned from the radiological accident occurred in Ciudad Juarez in Mexico, occurred in 1983.

Still in the Mitigation, TMI and Chernobyl showed serious deficiencies as the indicator *Identification, Notification and Activation*. This indicator is strongly correlated with the ability of the command to take the first steps for mitigation, and provide instructions stakeholders as a team and supporting organizations, States and the IAEA.

The case Goiânia had a better performance than TMI and Chernobyl, for indicator *Mitigation Actions*, as was identified in the Institute of Radiation Protection and Dosimetry (IRD) had a control room for emergency equipped with a communications network.

No evidence was found of designating responsible for managing inter-team communication, for any of the cases analyzed. Only if the Nueva Aldea no evidence of the meeting's opening response. The identification of stakeholders to TMI, Chernobyl and Goiânia could have been better conducted. Nueva Aldea had a definite structure to deal with emergencies Radiological and Nuclear, this can justify better results when compared to other cases.

In the Planning phase (preparing), Figure 5 (b) it appears that the estimates are similar to those found in the Mitigation phase. All cases showed the need for improvements in the communication planning specifically TMI, Chernobyl and Goiânia.



(a) Mitigation (Initiation) (b) Preparing (Planning)

Figure 5: Estimated Percentage of activities identified as realized and unrealized in the analyzed publications - Phases: Mitigation and Planning

It was not possible to identify Substantial evidence that there was a *planning communication* employing a specific methodology for the development of messages for all cases. However, using the indicators developed, we found that the case Nueva Aldea, showed satisfactory results for the same indicator. The command named a single spokesperson to communicate with the media, in addition to drafting messages, instructions, information and warnings to individuals of the public. Regarding the indicator *Planning Communication with the Public* cases TMI, Chernobyl and Goiânia had critical deficiencies. This indicator is quoted as an improvement on the lessons learned from publications. Where TMI, Chernobyl and Goiânia is no clear evidence was formally defined a press or single spokesperson to communicate with the media. Regarding the indicator *Communication Management Plan*, there is strong evidence that there was a plan for TMI, Chernobyl and Goiânia. As for the case Nueva Aldea,

presented evidence that some tasks in this plan were not fully carried out, indicating the need for improvement.

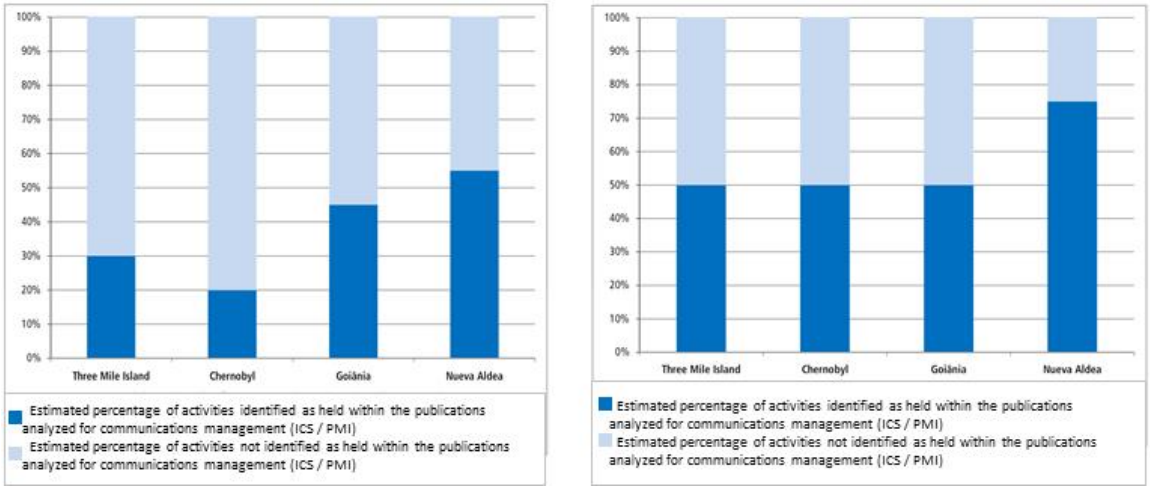
Analyzing Figure 6 (a), phase response, it is estimated that approximately 30%, 20%, 45% and 55% of the activities related to the management of the communication were identified as made on the basis of reports analyzed for cases TMI, Chernobyl, Goiânia and Nueva Aldea, respectively.

In TMI case there is strong evidence that central command did not received on time performance reports for the answer. What corroborates this finding was for the ordination of planning the evacuation of 650,000 people in around the plant, based on fragmentary information and partially wrong. Chernobyl had a worse index, since there were a lot of evidence of conducting activities related to *Information Distribution indicator*.

In case of the emergency coordinator Goiânia set the frequency that should be presented on the progress of the response. Nueva Aldea if there were no evidence that all activities related to the *Information Distribution indicator* were completed successfully.

Analyzing Figure 6 (b), to the stage of recovery (Closure) is an estimate that approximately 50%, 50%, 50% and 75% of the activities related to the management of the communication were identified as made on the basis of reports analyzed for all cases.

In the case TMI, it was found that shortly after the incident there were strong evidence of initiatives of the American authorities to generate learning and growth with this accident. The Chernobyl case, through the internet channel called "Chernobyl in Focus" IAEA, one can find a number of documents related to the accident, as well as its consequences.



(a) Response (Execution) (b) Recovery (Closing)

Figure 6. Estimated percentage of activities identified as realized and unrealized in the analyzed publications - Phases: Response (Execution) and Recovery (Closing)

In the case Goiânia, it was identified that the lessons learned after the accident were generated by a report conducted by specialists of the National Commission of Nuclear Energy (CNEN) who participated in the response and personal meetings with members of the IAEA. The case Goiânia, originated the first publication as a formal and systematic description of a radiological accident.

The case Nueva Aldea, showed better results than TMI, Chernobyl and Goiânia. It should be noted that this case was the participation of experts from IAEA. There was participation from IAEA experts, consisting of a multidisciplinary team to assist those responsible for the closure of the response in the preparation of a final report. This also denotes a maturing by the IAEA to conduct, preparation and publication of lessons learned.

4.2 Overall Management Communication for Analysis Units

In Figure 7 there is the communication management of all responses, requiring the study and implementation of corrective measures. Overall the item in case Nueva Aldea no serious deficiencies regarding the management of the communication, since the estimate of the activities identified as made on the basis of publications, was approximately 66%.

Response phases	Resumo dos indicadores de desempenho (KPI) para o gerenciamento da comunicação	Results of evaluations			
		Three Mile Island	Chernobyl	Goiânia	Nueva Aldeia
		(USA, 1979)	(Ukraine, 1986)	(Brazil, 1987)	(Chile, 2005)
Mitigation (Initiation)	Management of Emergency Operations Identification, Notification and Activation Mitigation Actions Conduct opening meeting of Response Identification of Stakeholders Stakeholder Management	◆ ◆ ◆ ◆ ◆ ◆	◆ ◆ ◆ ◆ ◆ ◆	▲ ▲ ▲ ◆ ◆ ▲	▲ ▲ ● ● ▲ ●
Preparing (Planning)	Communications plan Plan Communication with Public Communications Management Plan	◆ ◆ ◆	◆ ◆ ◆	◆ ◆ ◆	▲ ● ▲
Response (Execution)	Distribute Information	◆	◆	◆	▲
Closure (Recovery)	Recovery	▲	▲	▲	●
Estimated percentage of activities not identified as held within the publications analyzed for communications management (ICS / PMI)		66%	68%	56%	34%
Estimated percentage of activities identified as held within the publications analyzed for communications management (ICS / PMI)		34%	32%	44%	66%
General evaluation		◆	◆	◆	▲
Label	Symbology	Color	Evaluation	Range score	Maximum score
	●	Green	Good performance	≥ 3 until ≤ 4	4
	▲	Yellow	Need improvements	≥ 2 until < 3	
	◆	Red	Critical	< 2	

Figure 7. Summary of Reviews of Communication Management for the actions of the Emergency Response Radiological and Nuclear cases selected (17)

Cases of Three Mile Island and Chernobyl showed serious deficiencies in the management of communication for all indicators. Goiania now also made generally critical deficiencies, but in some indicators show activities by publications such as partially carried out.

Analyzing the amount of planned tasks inherent in Communication Management proposed for assessment of cases, it is noticed that there was an improvement over time.

Communication specialists and psychologists suggest that many of the sources of conflict, problems and misconceptions observed in response to the Chernobyl accident appeared because of lack of information. There was lack of communication from the former Soviet Union with neighboring countries, such as Italy and Denmark, the dissemination of information of potential risks inherent in radiation exposure (45).

Although the Three Mile Island case was not considered an accident as serious as Chernobyl, this happened about 7 years ago. Also was a nuclear accident that had critical deficiencies communication. In (46) we can verify that communication was one of the most serious failures observed during the response at TMI. Given the above, TMI has brought many lessons learned in the communication referred. However, it is observed that the notes of the indicators approach in much the Chernobyl, denoting that the lessons learned have not been fully addressed and properly absorbed.

The case Goiânia shown improvement in some indicators, highlighting the mitigation phase, compared to cases TMI and Chernobyl. However, it was found in (36), which after 8 and 1 year, respectively, the TMI and Chernobyl accident indicator *Planning Communication with the Public* continued to have severe disabilities. In contrast, it appears that in Nueva Aldea the same indicator evolved past nearly two decades, indicating that the lessons learned may have been better applied to this indicator.

Should be considered that Chernobyl and Goiânia were accidents involving many stakeholders and had a strong social and economic impact for their respective countries, with strong influence from the public and media. The Goiânia accident is rated at Level 5, of the INES scale. Accidents at TMI and Nueva Aldea had a coverage within the limits of its facilities, which has not occurred in Chernobyl and Goiânia. However, TMI took a much higher, partly due to lack of stakeholder management, highlighting the unmet expectations of the public and the media.

Were not identified clear evidence in (30), (34), (33), the existence of a Plan of Managements of Communications at the time of occurrence of accidents at TMI, Chernobyl and Goiânia, respectively. This may explain the low notes in the preparing stage (planning), specifically the Communication Management.

5. CONCLUSION

The methodology allowed us to conclude that the communications management response actions could have been better if performed previously established and followed management models optimized for scenarios of accidents analyzed.

The PMI methodology associated with ICS proved complementary in the evaluation of management's communication response to radiological or nuclear emergencies. This allowed a good connection between the organizational requirements affects the ICS with the planning of communication contained in PMI, for all phases of the response.

However, it should be noted that this assessment of Management Communication is limited to selected publications referenced accidents, being of vital importance to the improvement of the evaluation methodology proposed its application to practical exercises. Passed decades since the occurrence of the accidents studied, emergency actions need continuous formal treatment of Communications Planning, following an explicit methodology.

As suggestions for future work envisioned the need for a deepening of the issues and improvement of indicators, as well as the criteria used for the scores (notes). This improvement can be achieved through the application of the proposed methodology in preparation exercises to nuclear and radiological emergencies. As well as conducting a similar study, which includes the recent Fukushima accident, can give a contribution to the constant process of growth and learning within the Communication Management applied to Radiological and Nuclear Emergencies.

REFERENCES

1. INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD CUSTOMS ORGANIZATION, EUROPOL, INTERPOL, *Combating Illicit Trafficking in Nuclear and other radioactive Material*, Vienna, IAEA Nuclear Security Series (2007).
2. DISASTER, 2011, Available in: http: //www.disaster-info.net/lideres/portugues/ .../RaulEmergnucle.doc> (Accessed at: 12/11/2009)
3. VALVERDE, N. MARMO, A., *Manual de Ações Médicas em Emergências Radiológicas*, ELETROBRAS, Rio de Janeiro, (2010).
4. INTERNATIONAL ATOMIC ENERGY AGENCY, *Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency*, EPRMETHOD, Vienna, IAEA (2003).
5. PROJECT MANAGEMENT INSTITUTE, *A Guide to the Project Management Body of Knowledge – PMBOK®*, Pennsylvania-USA(2008).
6. PINTO, R. S. M., *Exercícios de Resposta a Incidentes de Poluição por Óleo: Uma Proposta de Modelo de Avaliação*. Tese de Mestrado, UFF, Niterói, RJ, Brasil (2005).
7. SOUZA FILHO, A. M., *Planos Nacionais de Contingência para Atendimento a Derramamento de Óleo: Análise de Países Representativos das Américas para Implantação no Caso do Brasil*. Dissertação de M.Sc, COPPE/UFRJ, Rio de Janeiro, RJ, Brasil (2006).
8. CHAVES L.E, NETO, F.H.S., PECH, G., CARNEIRO, M.F.S., *Gerenciamento de Comunicações em Projetos*, 1ª. Edição, FGV, (2006).
9. PMI, 2011 (EUA), <http://www.pmi.org/ >, (Accessed at: 21/12/2011).
10. INTERNATIONAL ATOMIC ENERGY AGENCY, *Preparedness and Response for a Nuclear or Radiological Emergency*, IAEA Safety Standards Series GS-R-2, Vienna, IAEA (2002).
11. SISK, T., 2011, *History of Project Management*. http://office.microsoft.com/downloads/9798/projhistory.aspx, (accessed at: 20/01/2011).

12. HELDMAN, K., *Gerência de projetos: guia para o exame oficial do PM*I. Tradução: Luciana do Amaral Teixeira. 3. ed. (Revisada e Atualizada), Rio de Janeiro, Elsevier, (2006).
13. MUNDO PM, http://www.mundopm.com.br/default.jsp (Accessed at: 12/10/2011).
14. PROJECT MANAGEMENT INSTITUTE. *A Guide to the Project Management Body Knowledge – PMBOK® Guide 2004 Edition*, Pennsylvania-USA (2008).
15. TURNER, J.R., MULLER, "Communication and Co-operation on Projects Between the Project Owner As Principal and the Project Manager as Agent", *European Management Journa*l, **22**, 3, pp. 327–336 (2006).
16. VARGAS, R., 2003, Projeto Novas Fronteiras, www.rodrigorocha.net.br/.../Projeto%20Novas%20Fronteiras.pdf (accessed at: 20/02/2012).
17. MELLO FILHO, M.O.C., "*Avaliação do Gerenciamento da Comunicação nas respostas a emergências radiológicas e nucleares*", dissertação de mestrado, Instituto de Radioproteção e Dosimetria- Rio de Janeiro (2012).
18. GALVÃO, M., *"Planejamento de Comunicações em Projetos"*, Mundo PM, **Volume 6**, pp. 70-75 (2006).
19. DIALLO, A., THUILLIER, D., "*The success of international development projects, trust and communication: an African perspective*". International Journal of Project Management, Volume 23 (3), pp. 237-252 (2005).
20. PMI SURVEY, http://www.pmsurvey.org/ (accessed at: 12/01/2012).
21. NATIONAL RESPONSE TEAM - NRT, "Incident Command System/UnifiedCommand (ICS/UC) - Technical Assistance Document", http://www.nrt.org (accessed at: 20/01/2012).
22. INTERNATIONAL ATOMIC ENERGY AGENCY, "*Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency"*, EPRMETHOD, Vienna, IAEA (2003).
23. BIGLEY, A.G., ROBERTS, H.K., "The Incident Command System: High-Reliability Organinzing for Complex and Voltile task environments". *Academy of Management Journal*, **Volume 44** , pp. 1281-1299 (2001).
24. ANNELLI, J.F., "The national incident management system: a multi-agency approach to emergency response in the united states of america", *SCI. Tech*., **Volume 25**, Número 1, pp. 223-231(2006).
25. FEMA, http://www.fema.gov/emergency/nims/ IncidentCommandSystem.shtm (accessed at: 12/01/2012).
26. LINDELL, M.K, PERRY, R.W, PRATER, C.S., "*Organizing Response to Disasters with the Incident Command System/Incident Management System* (ICS/IMS)", In:International Workshop on Emergency Response and Rescue (2005).
27. FEMA,(EUA). http://www.fema.gov/ (accessed at: 21/12/2011).
28. MIGUEL, P.A.C., "*Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução*".Volume 17, Número 1, pp. 216-229 (2007).
29. YIN, R.K., *Estudo de Caso: Planejamento e Métodos (Tradução do Original)*, 3ªEdição, Bookman (2006).
30. KEMENY, J.G, The Accident at TMI, 1979. Report of The President Comission on The Accident in Three Mile Island, 1a. Edição,Washington, EUA (1979).
31. NUCLEAR REGULATORY COMMISSION,"*TMI-2 LESSONS LEARNED TASK FORCE FINAL REPORT*". In: Office of Nuclear Reactor Regulation U. S. Nuclear Regulatory Commission Washington. D. C, Accidente in Three Mile Island, 1[a.] Edição.Washington, EUA (1979).

32. SANDMAN, P.M, *Seven Lesson Learned In Three Mile Island*, Boletin the IAEA, 47, 2, pp.9 -14(2006).
33. INTERNATIONAL ATOMIC ENERGY AGENCY, "*The Chernobyl Accident: Updating of insag-1insag-7 a report by the international nuclear safety advisory group"*, SAFETY SERIES, 75, INSAG-7. Vienna, IAEA (1992).
34. INTERNATIONAL ATOMIC ENERGY AGENCY, "*One Decade After Chernobyl. Summing up the Consequences of the Accident"*. Proceedings of an International Conference, Vienna (1996).
35. INTERNATIONAL ATOMIC ENERGY AGENCY, The International Nuclear and Radiological Event Scale, Vienna (2008).
36. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, Vienna, IAEA (1988).
37. INTERNATIONAL ATOMIC ENERGY AGENCY, GOIANIA, TEN YEARS LATER-Proceedings of an International Conference Goiania, Brazil, 26-31,October 1997, Organized by CNEN in co-operation with the IAEA (1998).
38. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Nueva Aldea, Vienna, IAEA (2009).
39. GUSBERTI, T. D.H., DE PAULA, I. C.; ECHEVESTE, M.E., "*Alinhamento dos indicadores de desempenho com planejamento estratégico em empresas de baixa a moderada maturidade: um estudo de caso em empresa farmacêutica*". In: VI Seprosul - Semana de Engenharia de Produção Sul-América, Florianópolis (2006).
40. MOE, T. L, GEHBAUER, F.,SENITZ, S., MUELLER, M."*Balanced scorecard for natural disaster management projects*", Disaster Prevention and Management,**Volume 16**, Número 5, pp.785 – 806 (2007).
41. PALTTALA, P., VOS, M., "Testing a methodology to improve organizational learning about crisis communication". *Journal of Communication Management*, Volume 15(4), pp. 1-18 (2011).
42. PALTALLA, P., VOS, M., "Quality Indicators for Crisis Communication to Support Emergency Management by Public Authorities", *Journal of Contingencies and Crisis Management*, pp. 1-13 (2011).
43. INTERNATIONAL ATOMIC ENERGY AGENCY, "*Preparedness and Response for a Nuclear or Radiological Emergency*", IAEA Safety Standards Series GS-R-2, Vienna, IAEA (2002).
44. UNISDIR (United Nations Internacional Strategy for Disaster Reduction), Terminology on Disaster Risk Reduction Geneva, United Nations (2009).
45. INTERNATIONAL ATOMIC ENERGY AGENCY, Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine, The Chernobyl Forum: 2003–2005, 2 ed., Vienna, IAEA (2005).
46. SANDMAN, P.M. "*Seven Lesson Learned In Three Mile Island*", Boletin the IAEA, 47, 2, pp.9 -14 (2006).