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Component: Discrete part of the system capable of operating independently, but designed, built and operated as an integral part of the system. Examples of the individual components are wells, pumping stations, storage tanks, dams, pipelines, etc.

Drinking water system: Set of components built and installed to catch, collect, treat, store, and distribute water to the clients. In its broader sense it also includes basins and aquifers.

Emergency: Unexpected situation presented by a threat impact.

Emergency and disaster preparedness program: It includes the emergency and mitigation plan.

Emergency plan: Set of measures to be applied before, during and after a threat as a response to its impact.

Emergency state: Situation declared when facing the imminence of a threat impact or after it has occurred.

Flexibility: It refers to the alternative operation of the components.

Mitigation plan: Set of measures and works to be implemented before the threat impact in order to reduce the vulnerability of the components and systems.

Natural disaster: A natural phenomenon that occurs in a limited space and time causing disorders in the normal life patterns, as well as human, material and economic losses due to its impact on populations, properties, facilities and environment.

Natural phenomenon: Manifestation of the forces of nature such as earthquakes, hurricanes, volcanic eruptions and others.

Operating capacity: Capacity for which the component or system was designed.

Preparation: Set of defined measures that should be implemented before the threat impacts.

Prevention: Preparation actions that reduce the effect of the threat impact.

Redundancy: It refers to the additional parallel operating components or subcomponents. For instance, pumps in a pumping station.

Reliability: Safety of a component or system to bear threats.

Region: The Latin American and the Caribbean area.

Risk: Measure of the threat impact probability.

Sanitary sewerage system: Set of components built and installed to collect, transport, treat and dispose the wastewater and treatment products.

Threat: Natural phenomenon or caused by human activity that turns out to be dangerous to people, properties, facilities and the environment.

Vulnerability: Measure of weakness of a component to resist the threat impact.

Vulnerability analysis: Process to determine the system's critical or weak components and the emergency and mitigation measures regarding threats.

Error! Bookmark not defined. **INTRODUCTION**

The Latin America and the Caribbean region is exposed to natural disasters such as earthquakes, hurricanes, volcanic eruptions, floods, and droughts. Their impact causes death and injuries, serious economic losses, and disorganization of the services. In many cases, they delay the development of the countries, due to the high cost of infrastructure rehabilitation.

Hurricanes impact the Caribbean every year. They destroy the water catchment and the electric power supply systems of the pumping stations. Earthquakes generally occur from California up to Chile causing serious damages to the structures and pipes. Volcanic eruptions generate avalanches that destroy water catchments and pipelines.

Many areas of the Region are cyclically affected by floods and droughts. The first ones destroy catchment works and pipelines located near the watercourses. Droughts lead to the rationing of the service and generate pollution and pipeline ruptures that affect public health.

Recent examples are the disasters caused by earthquakes in Mexico, El Salvador and Costa Rica; the volcanic eruptions in Colombia; and the hurricanes impact on the Caribbean cyclonic period in 1995.

Emergency situations can be catastrophic as the ones described above or apparently simple as the rupture of a main pipeline that may place the utility in a difficult position toward its clients and the public opinion.

The disasters caused by human beings should be added. They occur more frequently and become more dangerous, such as chemical spills that contaminate water supply sources and cause an additional hazard to the already congested disaster scenario.

We recognize that in normal situations, water is essential for the community health and development, but is it even more important during disasters when hygiene, food preparation and cleansing are fundamental to guarantee the health of the population and to enable the rehabilitation operations. The drinking water supply in both cases is a responsibility of the utilities that render the service.

The management of drinking water and sewerage utilities includes a set of programs geared to guarantee a continuous and high quality drinking water service to its clients, without interruptions.

In the routine operation of the systems, however, interruptions are presented due to equipment failures, pipeline ruptures, rationing caused by scarcity and the impact of natural threats, that increase due to population and infrastructure growth.

When a natural phenomenon occurs in a region, the services become disorganized and rehabilitation may take many days, even months depending on the utilities preparedness to face the disaster.

Disasters should not be uncontrollable forces. Experience demonstrates that many actions can be taken beforehand to strengthen the systems, to prepare the utilities supporting mechanisms in order to provide fast answers and to implement alternatives to supply low volumes while the systems are reestablished.

The implementation of an emergency and disaster preparedness program that defines a continuously updated emergency and mitigation plan, is the answer to a responsible and effective action.

Past impacts have allowed to learn the consequences on the drinking water and sanitary sewerage systems. It is now possible to somehow predict the impact and to be prepared to face it. This can be made in three phases: first, through the design of structures away from risks and resistant to the area's usual threat impact; second, through the implementation of mitigation measures to improve the weak or critical structure resistance; and third, through the establishment of measures to be implemented as alternate sources after the impact.

The vulnerability analysis, which is the subject of these Guidelines, provides a simple methodology to determine the most vulnerable components of a given threat in order to strengthen them to resist future impacts. This analysis is headed towards responding the question: Which is the resistance of each system component to bear the threat impact of the area? The answer will define the necessary mitigation and strengthening measures and the emergency or response-to-the-impact procedures if this was presented before implementing the mitigation measures.

This set of simultaneously implemented measures will lead to the services recovery in the least possible time in order to provide the safety that the population requires regarding hygiene and health preservation.

As the routine operation of the services and the preventive and corrective maintenance are planned, the operation in emergency situations and emergency maintenance should also be planned.

Unfortunately, as the experience has demonstrated by the experience, poor people are the most affected by the consequences of the natural disasters impact.

The vulnerability analysis is the basis for the establishment of emergency and mitigation plans required to organize the systems' preparation, the way to proceed during the emergency and rehabilitation, and it gives answers to what should be made before, during and after the threat impact.

These Guidelines are prepared for drinking water utilities engineers. It is expected that they will use them as an analysis tool to enable the systems behavior diagnosis when facing a threat impact and to propose and implement emergency and mitigation measures required to provide the drinking water service.

Error! Bookmark not defined.CHAPTER 1

Error! Bookmark not defined.PLANNING TO FACE EMERGENCIES AND DISASTERS

Error! Bookmark not defined.1. INTRODUCTION

No utility is exempted from the hazards generated by emergencies and disasters in greater or smaller degrees. Even those utilities that operate in regions where natural phenomena such as hurricanes, earthquakes, floods, etc. do not constitute threats, are exposed to pollution accidents and pipeline ruptures that affect the service.

Within the services operation and maintenance strategy, the utilities should prepare mitigation and emergency plans, aiming at reducing the systems vulnerability and at responding to the impact once the threat has occurred. Continuity and quality of the services with the minimum of interruptions and inconveniences for the clients will be maintained, and the public health preservation will be guaranteed.

These plans make up the emergency and disasters preparedness program, which has two objectives:

a. To define the necessary mitigation measures to minimize the threat impact, which results in the mitigation plan

b. To define the necessary procedures, instructions and information to rapidly and effectively mobilize the existing resources in the utility when the threat impact occurs, which results in the emergency plan.

In order to accomplish both objectives, the program preparation uses the vulnerability analysis as a tool. Thus the area's threats and its effects are identified and characterized, and as a result, the physical weaknesses of the system components, the utility's support systems, and the services in terms of quantity, continuity, and quality are determined.

The vulnerability analysis is carried out by stages ranging from very simple to more complex. The first stage is to identify the threats and their impact on time, space and magnitude, its effects over the systems and components, and the necessary mitigation and emergency measures. The second stage corresponds to specialized studies that are required to identify the vulnerability or resistance of complex structures such as basins, aquifers, dams, large pipelines, bridges, plants, etc. The third stage includes the evaluation after the impacts occur, evaluation meetings, etc.

The vulnerability analysis is not only applied to the physical structures of the systems or components, but also to the organization and management of the utilities in order to determine their deficiencies and to establish the corrective and reinforcement measures that should be implemented to eliminate or reduce their vulnerability.

Thus, the utility's financial area should determine for instance if there are sufficient resources available to implement the mitigation measures and emergency plans. On the contrary, if it is a vulnerable area that requires corrective measures aimed at improving finances, so that the mitigation and emergency plans are feasible.

The program should also include emerging situations caused by threats regarding pollution accidents or ruptures of great diameter-pipelines that can leave important sectors of the population without drinking water supply during several days and may cause considerable damages because of leakage. In this case, the notification procedures, to close valves and the population supply through unconventional means, require detailed mitigation and response plans.

This chapter presents the planning process to define the emergency and disaster preparedness program, indicating its content and the stages (in order of priority) that should be carried out to prepare it, to operate it, and to keep it updated.

Error! Bookmark not defined.2. PROGRAM INSTITUTIONALIZATION

In order to achieve the program's success, it should be part of the institutional planning process. The emergency and disasters preparedness should be planned, just as planning is carried out for the programs to face the service demand, to operate and to maintain the systems.

The design area should include vulnerability studies and it should consider the possible alternate sources of production, energy equipment, use of flexible pipelines and antiseismic joints. In addition, the construction area, for instance, should include in its reformulation plans the exact location of the principal valves. The management area should establish procedures to facilitate the procurement of supplies and work and personnel contracts during emergencies and disasters.

This program should be considered as an instrument in continuous process of execution through mitigation and emergency plans. It should be part of the utility's routine operations that complements the corrective and preventive operation and maintenance programs, since the emergency and disasters preparedness is nothing else but accelerated operation and maintenance.

Error! Bookmark not defined.3. STAGES OF THE PROGRAM

The emergency and disasters preparedness program is prepared and institutionalized through the five following stages:

- To institutionalize and to organize the program
- To prepare the vulnerability analysis
- To prepare the mitigation plan
- To prepare the emergency plan
- Training and dissemination.

Error! Bookmark not defined.3.1 Institutionalization and organization of the program

The following aspects should be considered in order to institutionalize and organize the program:

- Legal aspects
- National regulation
- Institutional regulation
- Institutional organization
- Emergency committee
- Commission for the mitigation and emergency plans formulation
- Operation centers
  Alert and emergency declarations
- Institutional coordination
- National emergency commission
- Other service institutions.

a. Legal aspects

The program should be developed within the current legal framework of the country and should be part of the national plan. Thus, the coordination actions for the plan implementation between the drinking water utility and the national institutions such as civil defense or emergency commissions, will be fluent from the beginning.

National regulation

The countries have laws, standards and regulations established by the institutions responsible for the preparedness at national level such as civil defense, national emergency commissions, etc.. and at local level, such as the regional and local emergency and disasters commissions, with clearly defined functions, roles and coordination and financial mechanisms.

This regulation should be consulted before initiating the program preparation process in order to guarantee its agreement, in such a way that there is an adequate support and concatenation of the institutional plan with the national plan. In addition, it should be guaranteed that the regional and local mitigation and emergency plans are developed in accordance with the national emergency plans.

Institutional regulation

The sector institutions also have their own legislation that defines and regulates the area being served with quantity, continuity and quality standards, forcing the establishment of emergency plans to provide the services in these conditions and restore them to their previous condition in the least possible time.

This is a responsibility inherent to the commercial management and it is in these conditions where greater public health risks occur. Hence the need to use alternate sources of drinking water and unconventional means of wastewater disposal.

The first step for the utilities should be to adhere to the national regulation and to agree through resolution of their maximum authority the preparation and later approval of the program. It will thus be under official status as any other institutional program. If a resolution does not exist, it will not be possible to prepare and to implement the mitigation and emergency plans.

b. Institutional organization

The institution that renders the services should be organized internally in order to prepare the program, determine the vulnerability of the systems and their components, implement mitigation measures, and operate the systems during emergencies and disasters. The highest commercial authority has the duty to order the program preparation and subsequently approve it. The president or general manager should be part of the emergency committee.

Emergency committee

An emergency committee integrated by the utility's top administrative authorities, with the responsibility of coordinating the program's activities, should be established for the program development. The following staff members usually integrate this committee:

president or general manager of the utility
- chiefs of the production, operation and maintenance areas
- chief of the planning area

chief of the financial area
- chief of the engineering area
- chief of the supply area

chief of the public affairs area
- representative of the plan formulation commission.

The roles and responsibilities of this committee are:
- integrating the mitigation and emergency plan formulation commissions;

coordinating the plan's formulation, approval, execution, and evaluation process;

establishing and maintaining communication and coordination with public entities responsible of taking emergency measures at local or national level;
- maintaining contact with private organizations, such as equipment and piping suppliers, chemical manufacturers, professional associations and contractors, who may contribute with the emergency and disaster preparedness process;

periodically reviewing and updating the emergency plan;
- formulating and presenting through the corresponding units, the budgets required for the program implementation;
- declaring the alert situation or internal emergency of the utility, when this has not been declared by the State;

establishing and supervising the personnel permanent training in emergency procedures.

Emergency committees integrated by administrative, production, operation and maintenance authorities should also be formed at the regional and local level.

Mitigation and emergency plan formulation commission

This multidisciplinary commission is usually integrated by staff members of the different areas of the utility. The most important ones are the operation and engineering areas, but the planning, management and financial areas cannot be left aside.

The roles and responsibilities of this committee are directed towards:

- preparing the mitigation and emergency plans;
  preparing the terms of reference and coordinating the specialized studies of the vulnerability analysis;
- evaluating the plan's effectiveness through simulations and real situations.

Emergency center

Once the emergency committee is set up, a center or several centers should be established where the committee and key personnel will meet during the plan implementation simulations, the alert periods and during emergencies until they are declared concluded. It is common to adapt and use the daily operation office as an emergency center, but the emergency plan should include at least one place to operate as an alternative center in case the first one is out of operation. The emergency centers should have the following characteristics and conditions:

- minimum damage probability for the most frequent threats in the area;
- expeditious access ways;
- location within the drinking water and sewerage system operation area;
- provision of communication services: telephones, fax, radio transmitter-receiver, television, radio with commercial frequencies, civil and radio ham bands;
- alternate energy system;
- permanent surveillance;
- detailed plans of all the systems, copies of the emergency plan and relevant documents;
- enough equipment and furniture appropriate for meetings and office work;
  transportation and computer equipment;
- strongbox and interventions registry;
- provision of equipment and food for at least one week.

Alert and emergency declarations

The alert and emergency declarations activate the emergency plan in its different stages: emergency and conclusion of the emergency.

The national emergency commissions declare the highest alert and emergency situations, at national or regional level. These declarations should be sufficient for activating the emergency plan of the utility.

But the emergency commission of the utility should also have the faculty to declare its own emergency situations due to damages and failures inherent to their operation, such as temporary loss of catchments, accidents that affect the service, drought, etc. These declarations are very important, since they activate all the procedures established in the plan, even those headed toward fund utilization.

c. Interinstitutional coordination

The interinstitutional coordination is fundamental in the emergency and disasters preparedness. If there is no coordination, it results in a chaos that will affect the system's clients and the rehabilitation capacity.

National emergency commission

The institutional emergency plan should be prepared in coordination with the national plan. The main institution (civil defense, national emergency commission, etc.), usually collaborates in the preparation of the sector plan and may contribute with resources and direct the technical assistance toward the studies and analysis required.

Other institutions

The institutional emergency plan should consider the required coordination with other institutions, such as energy, communications, police, firemen, etc. The establishment of agreements of understanding and mutual assistance between institutions enables the joint action in a planned and efficient way. It is important to know in detail the human, material and equipment resources available at local level.

Error! Bookmark not defined.3.2 Preparation of the vulnerability analysis

Once it has been decided to prepare and implement the program, the vulnerability analysis should be prepared. The vulnerability analysis is the instrument that allows to determine the weaknesses of a system's components to face a threat impact in order to establish mitigation measures to reduce the vulnerability of the component and system as a whole, and the emergency measures to respond to the threat impact once it is underway.

The vulnerability analysis in complex drinking water supply and sewerage systems is carried out in two stages. The first one is the identification and evaluation of the threats for an area or system, the detailed estimate of the vulnerability for every threat, the proposal of mitigation measures in order to face it and reduce the vulnerability, and the establishment of emergency

measures to respond to the impact. It is common to perform the first stage through workshops with broad participation of the personnel involved and experts if necessary.

The second stage consists of preparing detailed terms of reference to carry out specialized studies in order to determine the resistance and mitigation measures for the most complex components, such as basins, aquifers, dams, bridges, large steel and concrete works, large diameter pipelines, outfalls, etc. When preparing these studies and designs it is possible to find special emergency measures or procedures that should be included in the plan.

Error! Bookmark not defined.3.3 Mitigation plan

The first result of the vulnerability analysis will be the mitigation plan, which includes improvement measures and structural reinforcement works to reduce the vulnerability of the system's components.

The detailed mitigation plan will prioritize the activities, the responsible ones, the program of execution and estimated costs, and it is common to arrange it according to the drinking and wastewater flow. It should also consider, if necessary, the strengthening of the selected facilities as an emergency center.

Error! Bookmark not defined.3.4 Emergency plan

Once the first vulnerability analysis stage has been carried out, an emergency plan should be prepared to contain the procedures, instructions, and necessary information for efficiently preparing, mobilizing, and using the utility's available resources when facing the emergency.

The mitigation plan should be designed to face emergencies and disasters with the utility's available resources, as if the threat impact occurred at that instance. In this regard, it should not be an ideal plan, but a realistic one. In the future, while the mitigation measures are being implemented, the equipment for emergencies is being obtained, etc., the plan will be modified. If this process is not followed, the plan will not be applicable.

The plan should be kept updated and should always be available so that it is used by the people involved. It will be successful depending on how simple, practical and easy it is to perform, as well as on the knowledge of the people involved, which is achieved through periodic training activities and simulations.

This plan should at least include the following aspects:

1. Objective: corresponding threats
2. Geographical application area
3. Relation with the national plan (national emergency commission, civil defense)
4. Organization: central, regional and local emergency committee, as well as plan formulation, roles and responsibilities
5. Description and operation of the system (with sketches)

6. Emergency centers
7. Alert and emergency declarations
8. Personnel (training) plan, key personnel and addresses
9 Security and surveillance plan
10. Transportation plan
11 Communications plan
12. Warehouse plan
13. Warehouse for emergencies
14. Institutional coordination
15. Coordination with private utilities
16. Other nearby supply systems operated by other utilities
17. Evaluation of damages
18. Priorities of supply
19. Alternate sources of supplies and wastewater disposal
20 Information to the press and public
21. Procedures for operations in emergency situations
22. Inspection procedures after an emergency
23. Use of tank trucks, portable tanks and other drinking water transportation means
24. Management of funds
    - Emergency committee
    - Emergency formulation, evaluation, and control plan commission
    - Emergency centers
    - Alert and emergency declarations
25. Budgets required for the plan implementation
    - Annex 1: Layout of the system
    - Annex 2: Layout of the system operation
    - Annex 3: Results of the first stage of the vulnerability analysis
26. Client training on the adequate use of water in emergency situations
27. Information handling during the emergency.

Utilities covering several cities or operational regions, usually have their own plan duly integrated at the central level.

Error! Bookmark not defined.3.5 Training and dissemination

This stage will allow the preparation and execution of the program. The broad participation of the utility's staff members in the process will guarantee the success of the program. This stage is achieved through a continuous and ongoing dissemination and training process through simulations, seminars, workshops, etc. and through an evaluation process of the results of these activities and the real threat impacts presented in the past.

Error! Bookmark not defined.4. PROGRAM PREPARATION AND IMPLEMENTATION STRATEGIES

Emergencies and disasters occur each year and in many locations it is thought that they will not happen again or that they will occur with the same magnitude but within many years. Actually, each time the impact is greater, not because the phenomena are increasing in magnitude and frequency, but because the population and the structures riskily increase and because they become more complex.

Many vulnerable situations can be improved with little effort, others require specialized studies and large investments. These investments are economically justified, since the reinforcement is normally less expensive than the reconstruction, even without considering the social cost of a population in need of drinking water over long periods in terms of public health, or the damages, for instance, that can cause the collapse of catchment structures.

The implementation of mitigation measures not only improves the emergency and disasters preparedness, but benefits the routine operation and makes the systems more safe. The redundancy and flexibility measures implemented in order to face emergency and disaster situations also benefit the routine operation.

The strengthening of the facility's routine corrective and preventive operation and maintenance also benefits the effective emergency and disaster preparedness. The utilities that properly operate and maintain their systems and facilities provide adequate answer when facing the threat impact, better services after the impact and rehabilitation in a short period of time. Many of the systems of the Region are currently in emergency situations and if they are affected under these circumstances, the preparedness and rehabilitation will take long periods of time during which the population will remain unprotected.

The projects in financing and execution processes can solve highly vulnerable situations. It is worth mentioning that the bilateral and multilateral financing institutions are not reluctant to include components to solve these situations.

The commercial image will be increased when quickly and efficiently facing an emergency on behalf of their clients. The highest commercial motivation level on this subject, the dissemination of methodologies to prepare the plans and to determine the system's vulnerability, are essential elements to carry out the program as the utility's permanent program.