# International Workshop Agreement

# IWA 6

## Guidelines for the management of drinking water utilities under crisis conditions



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*Lignes directrices pour le management des services de l'eau potable dans des conditions de crise*

Reference number
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# Foreword

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Workshop Agreement IWA 6 was drafted at a workshop held in Tel Aviv, Israel, in October 2007, which was organized jointly by Israel's Water Authority and The Standards Institution of Israel (SII).

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# Background

The Standards Institution of Israel (SII) has identified the area of water technologies and water security as critical and crucial for communities, countries and society as a whole. To address this issue, SII proposed to develop an ISO International Workshop Agreement (IWA) on water security, producing a framework which would constitute a basis for the justification of establishing a subcommittee within the framework of ISO/TC 224 or for developing standards in other technical committees. This request was approved by the ISO Technical Management Board (TMB).

This International Workshop Agreement is based on SII's proposed draft IWA on water security and consists of an introduction, a framework for the management of water crisis, and proposals for technological instruments and means for ensuring drinking water security, and on models for water distribution systems security.

This International Workshop Agreement includes the introduction and the description of the management elements required for a drinking water utility or facility. The second part of this International Workshop Agreement contains proposals for products and means and models.

Within the scope of the activity of the Standards Institution of Israel to be the leader in the standardization on the subject of water security, two working groups were appointed to examine the possibility of standardization on the subject of water security as preparatory activity for the Tel Aviv workshop in 2007:

— working group on the subjects of means and models;

— working group on the subject of management of a water crisis.

This International Workshop Agreement attempts to examine and select those possible standardization subjects on the topic of management of a water crisis.

It was decided at the Tel Aviv workshop to consider standardization with regard to two aspects:

a) examine the possibility of preparing a standard on the subject of a water crisis management system for a water utility;

b) identify possible standards for technologies, means and procedures.

A water utility that is interested in adopting a standard for management of a water crisis should first determine what is the minimum level of service that it wishes or is required to provide to its consumers and as a consequence, define the activities and measures meeting this level of service in emergency and crisis situations. These activities should comply with the requirements established by the relevant authorities and with existing standards and common practices.

Parts of this International Workshop Agreement are consistent with the following three guidelines developed by ISO/TC 224 on drinking water and wastewater services:

— ISO 24510, dealing with assessment and improvement of service to users,

— ISO 24511, dealing with management of wastewater utilities and assessment of wastewater services, and

— ISO 24512, dealing with management of drinking water utilities and assessment of drinking water services.

Appreciation is extended to Israel's Water Authority and The Standards Institution of Israel for both the organization of the workshop and the preparation of this International Workshop Agreement.

# Introduction

## 0.1 General

Water is the source of life, the most precious and important of all natural resources, without which the human species cannot survive. Nevertheless, many countries do not know how to maintain the desired level of water quantity and water quality.

Impairment of the drinking water would change the level of life of the affected population in the immediate period while in the medium-term period, it would affect their ability to survive.

Any incident involving drinking water systems that caused massive illness or unplanned interruption in the water supply in a large area would have enormous economic impacts and complicated psychological effects on the relevant population, creating a public panic situation requiring the local drinking water utilities and the authorities to operate extensive emergency systems in the affected area.

Severe damage resulting from an intentional disruption or destruction caused by a natural disaster or an accident, having an impact on the quantity or the quality of drinking water and causing a major disaster, would severely interrupt the living quality in the affected area and in its vicinity.

The destructive influence of such damage to drinking water could significantly deviate from the damaged geographic area and have a widespread effect, mainly in terms of creating panic and feelings of insecurity amongst the population.

Water utilities act within the context of increasing security risks and threats, more stringent legislation and regulation, heightened awareness of the need for adequate emergency response and remediation planning, concerns of interested and affected parties, and the need to assure operational continuity.



## 0.2 Main threats to the drinking water supply systems

The result of the occurrence of any of the many types of threats on the partial or full sudden interruption of the drinking water supply for an extended period of time would constitute a water crisis requiring the operation of local and national emergency systems at various extents and levels, depending on the actual damage and assessment of possible damages. In extreme occurrences, the possibility exists that the water crisis could continue for a long period of time, during which the supply of drinking water to the residents would come from alternative sources that were not damaged or contaminated.

The effects of the threats may be local, regional or national, depending on the preparedness and the professional and operational capability of the parties responsible for reducing the extent of the water crisis, its severity and its length as much as possible.

Potential threats to drinking water supply systems can be natural or man-made, intentional or non-intentional, and they are characterized by an interruption of essential infrastructure, materials, service or personnel, without which the locally agreed level of service cannot be attained.

## 0.3 Preparedness

Water utilities supplying drinking water have a primary function to be prepared for providing a continuous response during all stages of the crisis. The preparedness of drinking water utilities that bear the responsibility of preventing impairment to the water installations and their level of vigilance is a necessary condition for providing an appropriate and effective answer to dealing with water crises. It is advisable that drinking water utilities be prepared to provide a response at all times through coordination with local and/or national bodies, in order to minimize damages and to ensure the continued supply of water to the users. The scheme illustrated in Figure 1[1)] demonstrates the value of being prepared for the consequences of a water crisis.

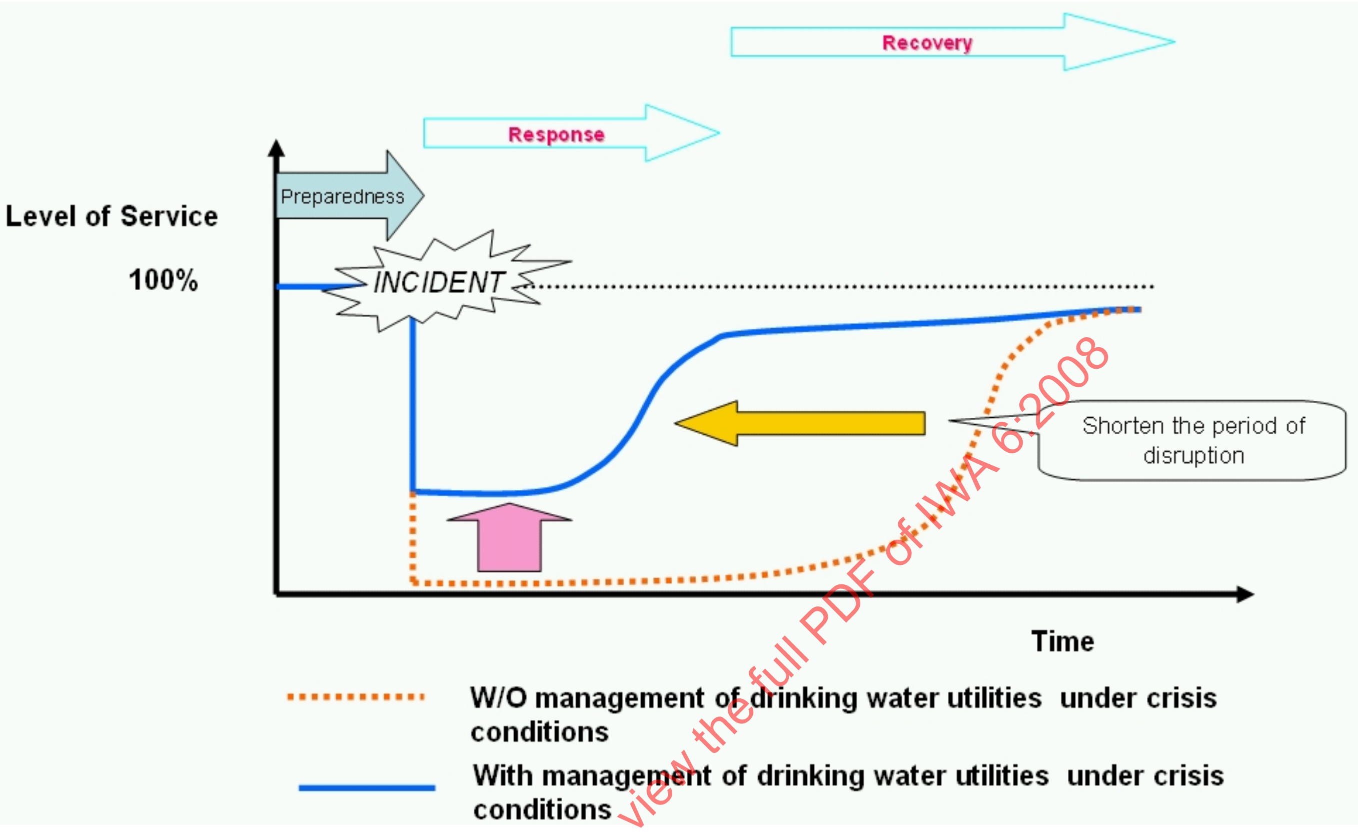


**Figure 1 — Effectiveness of crisis management**

## 0.4 Standardization in drinking water supply security issues

Comprehensive guidelines, in the form of International Standards for the management of drinking water utilities under emergency and crisis conditions, may be desirable and are currently under development.

NOTE 1 CEN/TC 164 are developing a standard on the security of drinking water supplies.

NOTE 2 Standardization for water security takes into consideration processes and procedures as defined in the documents of other international organizations, e.g. the World Health Organization.

While the management of drinking water utilities under crisis conditions needs to meet national or regional requirements of relevant authorities, the development of International Standards could provide assistance.

Some terminology standards on these issues are under development and it is advisable that they be considered when developing water security standards.

Other standards covering technologies, means and processes may need to be developed.

1) Taken from ISO/PAS 22399.

# Guidelines for the management of drinking water utilities under crisis conditions

## 1 Scope

This International Workshop Agreement is intended to identify and chart the critical elements that are of great significance to drinking water security. Its purpose is to set in motion a continuous process for the establishment of guidelines on management systems for drinking water utilities under crisis conditions.

This International Workshop Agreement provides the guidelines for a water utility, or any body responsible for the management of parts of the water supply system, to be prepared and ready to manage a water crisis. It also provides a roadmap for possible relevant International Standards that could be useful and could be developed.

## 2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**2.1**
**consequence**
outcome of an event

NOTE 1 There can be more than one consequence from one event.

NOTE 2 Consequences can range from positive to negative.

NOTE 3 Consequences can be expressed qualitatively or quantitatively.

NOTE 4 Adapted from ISO/IEC Guide 73:2002, 3.1.2.

**2.2**
**crisis**
any incident, human-caused or natural, that can result in water supply disruption or contamination and that requires urgent attention and action to protect life, property or environment

**2.3**
**disaster**
event that causes great damage or loss

**2.4**
**disruption**
incident, whether anticipated or unanticipated, which disrupts the normal course of operations at a water utility

NOTE 1 A disruption can be caused by either positive or negative factors that will disrupt normal operations.

NOTE 2 An example of an anticipated disruption is a hurricane.

NOTE 3 An example of an unanticipated disruption is a blackout or an earthquake.

**2.5**
**emergency**
sudden, urgent, usually unexpected, occurrence or event requiring immediate action

NOTE An emergency is usually a disruptive event or condition that can often be anticipated or prepared for, but seldom exactly foreseen.



 

**2.6**
**exercising**
evaluating programmes, rehearsing the roles of team members and staff and testing the recovery of an organization's systems

NOTE 1 An organization's systems include, for example, technology, telephony and administration.

NOTE 2 Exercises include activities performed for the purpose of training and conditioning team members and personnel in appropriate responses, with the goal of achieving maximum performance.

NOTE 3 An exercise can involve invoking operational response and recovery procedures, but is more likely to involve the simulation of an incident, announced or unannounced, in which participants role-play in order to assess what issues might arise prior to a real invocation.

**2.7**
**event**
occurrence of a particular set of circumstances

NOTE 1 The event can be certain or uncertain.

NOTE 2 The event can be a single occurrence or a series of occurrences.

NOTE 3 The probability associated with the event can be estimated for a given period of time.

[ISO/IEC Guide 73:2002, 3.1.4]

**2.8**
**impact**
evaluated consequence of a particular outcome

**2.9**
**incident**
event that might be, or could lead to, an operational interruption, disruption, loss, emergency or crisis

**2.10**
**incident management plan**
clearly defined and documented plan of action for use at the time of an incident or disruption, typically covering the key personnel, resources, services and actions needed to implement the incident management process

**2.11**
**mitigation**
limitation of any negative consequence of a particular incident

**2.12**
**prevention**
measures that enable an organization to avoid, preclude or limit the impact of a disruption

**2.13**
**probability**
extent to which an event is likely to occur

NOTE 1 ISO 3534-1:1993, definition 1.1 gives the mathematical definition of probability as "a real number in the scale of 0 to 1 attached to a random event. It can be related to a long-run relative frequency of occurrence or to a degree of belief that an event will occur. For a high degree of belief, the probability is near 1."

NOTE 2 Frequency rather than probability may be used to describe risk.

NOTE 3 Degrees of belief about probability can be chosen as classes or ranks, such as

— rare/unlikely/moderate/likely/almost certain, or

— incredible/improbable/remote/occasional/probable/frequent.

[ISO/IEC Guide 73:2002, 3.1.3]

**2.14**
**response programme**
plans, processes and resources to perform the activities and services necessary to preserve and protect life, property, operations and critical assets

NOTE Response steps generally include incident recognition, notification, assessment, declaration, plan execution, communications and resources management.

**2.15**
**risk**
combination of the probability of an event and its consequences

NOTE 1 The term "risk" is generally used only when there is at least the possibility of negative consequences.

NOTE 2 In some situations, risk arises from the possibility of deviation from the expected outcome or event.

NOTE 3 Adapted from ISO/IEC Guide 73:2002, 3.1.1.

**2.16**
**risk acceptance**
decision to accept a risk

NOTE 1 The verb "to accept" is chosen to convey the idea that acceptance has its basic dictionary meaning.

NOTE 2 Risk acceptance depends on risk criteria.

[ISO/IEC Guide 73:2002, 3.4.10]

**2.17**
**risk assessment**
overall process of risk identification, analysis and evaluation

NOTE Risk assessment involves the process of identifying internal and external threats and vulnerabilities, identifying the likelihood of an event arising from such threats or vulnerabilities, defining critical functions necessary to continue the organization's operations, defining the controls in place necessary to reduce exposure, and evaluating the cost of such controls.



**2.18**
**risk management**
coordinated activities to direct and control an organization with regard to risk

NOTE Risk management generally includes risk assessment, risk treatment, risk acceptance and risk communication.

[ISO/IEC Guide 73:2002, 3.1.7]

**2.19**
**risk reduction**
actions taken to lessen the probability, negative consequences, or both, associated with a risk

[ISO/IEC Guide 73:2002, 3.4.4]

**2.20**
**risk communication**
exchange or sharing of information about risk between the decision-maker and other stakeholders

NOTE The information can relate to the existence, nature, form, probability, severity, acceptability, treatment or other aspects of risk.

[ISO/IEC Guide 73:2002, 3.2.4]

**2.21**
**threat**
potential cause of an unwanted incident, which can result in harm to individuals, a system or organization, the environment or the community

**2.22**
**top management**
directors and officers of an organization which can ensure that effective management systems, including financial monitoring and control systems, have been put in place to protect assets, earning capacity and the reputation of the organization



# 3 Framework for management of a water crisis

## 3.1 Importance of a management system

### 3.1.1 General

An appropriate supply of water is essential to the maintenance of public health, safety and the economy. Contamination or disruption of the water supply system may become a health, economic and environmental danger.

Applying appropriate management standards would enable organizations to manage and improve their security performance and, at the same time, meet their legal obligations. A high-level management standard should be applicable to all types and sizes of water utilities and to accommodate diverse geographical, cultural and social conditions.

An appropriate management standard for water crisis management would provide a broad approach to the need of a water utility to receive the assurance that its security and continuity preparedness, emergency contingency plans and performance not only meet, but will also continue to meet, its legal and policy requirements.

The application of such a standard for water crisis management would provide a framework for the development of tools to help water utilities to prepare for, cope with and manage an incident or event occurring as a result of a water emergency situation.

A standard for water emergency management would be intended to provide a minimal baseline for developing and implementing incident preparedness and operational continuity within a water utility, and to provide confidence in organization-to-community, business-to-business and organization-to-customer/client dealings.

Such a standard would include the elements of the different stages of a water crisis, i.e. the stages of preparedness, response and recovery.

### 3.1.2 Elements involved in management of a crisis in a water utility

The essence of management of a water crisis by a water utility includes several stages and components, which should be independent of the specific water utility or the environment in which it operates. The stages should be suitable for both sophisticated and conventional water utilities in developed or developing countries.

In analysing a water crisis, four stages have been identified. Definition of the stages in a logical manner serves as the basis for determining the requirements of a water utility to cope with a water crisis in an effective manner (i.e. the extent of the resources required, the establishment of a suitable organization infrastructure, the writing of procedures for each of the stages, characterization of the communication channels necessary for internal communication within the organization and with those having an interest outside the organization, characterization and procurement of means).

The four stages are

a) preparedness,

b) response,

c) recovery, and

d) lessons learned and review of the whole management system [then return to the first stage (preparedness)];

The management methodology should be based on the PDCA (Plan-Do-Check-Act) model (see Figure 2), comprising the following stages:

— **Plan**: establish the objectives, procedures and processes necessary to deliver improvements in accordance with the organization’s security needs and should be based on the threat definitions and risk assessment;

— **Do**: implement the procedures and processes;

— **Check**: monitor and measure procedures and processes against the relevant risks;

— **Act**: take actions to continually improve the preparedness of the water utility.

The PDCA model is sometimes referred to as the APCI (Assess-Protect-Confirm-Improve) model.



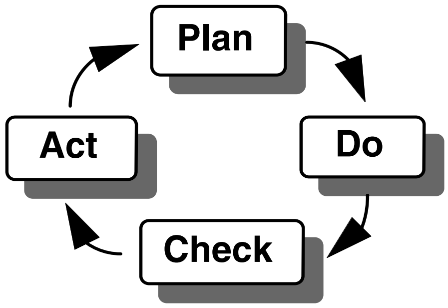


**Figure 2 — PDCA model**

The adaptation of the PDCA model to water security is as shown in Figure 3.

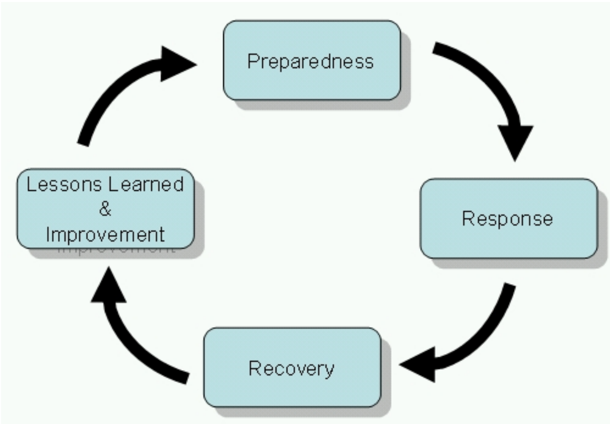


**Figure 3 — The water crisis management cycle**

## 3.2 Stages in a water security incident

### 3.2.1 Threat definition and risk assessment

The basis for constructing a plan to contend with a water crisis in a water utility is by identification and definition of the threats and conducting a survey of the effect of the threats on the operation of the water utility, on its interest parties and on the environment, while being concerned with adhering to the requirements of the regulator and any other additional requirements.

A threat can be defined as anything (action, material, etc.) that may endanger and/or harm people and the organization, including its goals and level of service to consumers, interested parties and the environment, and it should be handled in accordance with existing accepted practices and standards.

Defining and acknowledging a threat involves establishing the following:

a) the type of threat, i.e. technological failure, human error, natural disaster (severe weather or earthquake event), vandalism, criminal act, terrorism or wars;

b) the various components of a particular threat, i.e. chemical, biological and/or radioactive components, interruption of regular water supply, etc.;

c) level of concentration of a particular threat and the risk class;

d) possible scenarios of the occurrence of the incident and its significance for the water supply system, for consumers and for the community and societal services;

e) assessment of the initial dangers and tools for assessing the dangers according to the above scenarios.

The output of this stage is a list of threats (natural or man-made) to the water supply system, prioritized by a risk analysis and vulnerability assessment.

### 3.2.2 Preparedness

Preparedness does not depend on a specific crisis, or a type and character of crisis, but is a stage that begins with establishment and design and an entry of the water utility into its routine activity, and ends when the operation of the company deviates from its routine activity regardless of the reason. When a crisis occurs, the preparedness is halted and the water utility passes onto the response stage. After the stages of recovery and lessons learned have been completed, the utility returns to the preparedness stage. The stage is not always the same in the various departments in the water utility, but is unique to the department level or possibly to the function. In addition, one group in a water utility may be in the preparedness stage, whilst another group may simultaneously be dealing with a crisis.

The preparedness stage in a water crisis is defined as being the time when a crisis in the organization is not being dealt with. A water utility in which there is awareness of the serious effects that can occur due to the occurrence of a water crisis that was not dealt with within a short time and in a proper manner, uses the preparedness to reinforce the organizational policy in preparation for a water crisis. Strengthening the policy can be accomplished by establishing targets and goals, by preparations and combining suitable controls, maintaining a process of lessons learned and constant improvement.

In the preparedness stage, the water utility should make use of the preparation, inspection and implementation time of appropriate management systems that provide support not only in the routine operation of the water utility systems, but also with elements related to water security. Suitable procedures should be prepared for prevention, reaction, treatment and recovery of the water utility from a water crisis, while fulfilling regulator and other requirements and meeting the service levels established by the water utility.

The top management of the water utility should take action:

— to characterize, purchase and install technologies that support the management culture and the procedures prepared;

— to establish appropriate technologies for the physical and logical security of the water utility's facilities and water monitoring;

— to establish a routine for monitoring the various means installed to deal with a water crisis;

— to prepare plans for training personnel and for drills of the water utility in anticipation of a water crisis.

In order for the water utility top management to decide what means are required, it should consider the reference threats, policies, targets and goals. The sequence for dealing with a crisis in order to minimize its consequences should be established as follows:

a) prevention of a water crisis;

b) acts of confinement, cleansing and recovery of the system;

c) response to the situation, requiring assistance of external bodies, e.g. neighbouring water utilities, authorities or governing bodies.

A (non-exhaustive) list of elements that should be considered in the preparedness stage is given in Annex A.



### 3.2.3 Response

The response stage should put into effective implementation the procedures defined during the preparedness stage. A comprehensive list of relevant elements is given in Annex B.

### 3.2.4 Recovery

It is important that recovery management follows a procedure that sets reasonable recovery goals (cleanliness levels, etc.), intermediate goals (if necessary), application of a recovery process in an effective and responsible manner, and the establishment of actions and necessary recovery means. A comprehensive list of relevant elements is given in Annex C.

### 3.2.5 Lessons learned and review of the whole management system

In order to improve the level of competence of the water utility regarding its preparedness for a water crisis, it is essential to identify the lessons learned and to implement them within the management framework. The elements of this stage should include, among other elements, management reviews, and the establishing of a process for preventive and corrective actions. Following a review of the whole management system on the basis of the lessons learned, the utility returns to the first stage (preparedness).

# Annex A
(informative)

# Preparedness stage — List of elements

## A.1 Management and operational procedures

The water utility should prepare and maintain a folder of procedures for management of all stages of a water crisis incident, based upon those set out in this International Workshop Agreement. The procedures should be customized to suit the utilities structure, infrastructure and services.

## A.2 Physical protection systems

In order to prevent unauthorized persons from accessing sensitive areas within the water utility, protection is necessary. The protection will block the physical access of those who are not authorized and, therefore, to reduce the probability of damage to the water utility. Physical and electronic means are available that provide protection to the various components of the water supply system, i.e. pools, reservoirs, drillings, accessories, piping, etc. The considerations in the selection of means for physical protection should be risk assessment, as well as proven and approved means recommended by an authoritative technical expert or conforming to the appropriate standards. In addition, the performance of the water utility workers and the forces that respond on an immediate basis should be taken into consideration. Some of the electronic means may be used to document the incident, in order to locate the reasons for the fault and to constitute part of the basis for the lessons-learned process after the incident.

## A.3 Warning systems for water contamination

The water utility should supply water of a quantity and quality required for its customers and verify that unfit water does not reach the public. The possible factors for contamination of drinking water are many and varied, e.g. an accident in the chlorine system, a malicious act (terror) and natural disasters. In the preparedness stage, there is need for the installation of continuous monitoring instrumentation within the water supply system while considering all its components (reservoirs, tanks and pools, pumping stations, transport piping, etc.). The purpose of this instrumentation is to check, detect, identify and provide a warning. The instrumentation should operate for the detection of pollutants in relation with the reference threat and risk assessment performed by the water utility. Installation and use of this instrumentation should be supported by appropriate operation procedures to be executed upon receipt of a warning. The procurement, installation and maintenance specifications of these means should be in accordance with the recommendations of an authoritative technical expert, or in accordance with standards for instrumentation of this type.

## A.4 Emergency operations centre

The water utility should set up a control centre for water security incidents that will comprise a means for effective management of an incident. The centre should be capable of activating both those responsible and the decision makers 24 hours a day, as well as maintaining communication and control means, etc. The function of the centre should be defined for the various stages of a water incident depending on the type of activity of the water utility. The water utility should rely on standards or definitions prepared by certified professionals who have been approved to deal with the matter by official parties.

## A.5 Redundancy of the essential components of the system necessary for the supply of alternative water through the water supply system.

Based on the water utility risk assessment, it is necessary to prepare plans for an alternative supply of water. The water utility should check and prepare plans that resume its capability to supply water, on the basis of the existing system, during a water security incident based upon the back-up of alternative water sources, of fuel oil generators, of flexible and portable piping, fuel, etc. Appropriate procedures and skilled personnel should be available and exercises should be conducted to maintain the necessary level of capability.

## A.6 Contingencies

Furthermore, the water utility should prepare contingency plans and make all the necessary preparations for the distribution of water without going through the existing water supply system. The plans should include the definition of procedures, allocation of resources and means, timetables, service measures and the level of preparedness and level of means storage required in order to supply alternative water in such a situation. It might not always be possible for the water utility to maintain the necessary preparedness; consequently, the water utility should act to create a network of external organizations and bodies which have the capability to assist in the water distribution. Water distribution in situations where the existing network cannot be used should be carried out by means of tankers, tanks, bottles of water, etc. One of the solutions is to make the customers of the water utility aware of the possibility of disruption and to explain to them the need to store water in their homes, in bottles or tanks, in case of an emergency.

## A.7 Interfaces with other emergency and environmental and public safety and health organizations

If a water security incident is not confined in time, it has a tendency to develop into a disaster with serious consequences for the population and for the environment. The water utility should do its utmost to confine the incident at the stages of initial inception, and to limit the amount of damage to the population and the environment. However, this is not always possible, and so the involvement of the authorities with its agencies and organizations is often necessary. The water utility should prepare lists of external parties and organizations within its information network, including means of communicating with them, contact person(s), fields of responsibility and in what instances contact should be made, etc. This list should be updated periodically, in accordance with the decision of the water utility top management, and should be checked within the routine periodic exercises.



## A.8 Identification and care of critical customers and critical service areas

Critical costumers (e.g. handicapped persons) and critical service areas (e.g. old people's homes, hospitals, prisons, etc.) should be identified and mapped. Plans for alternative water supplies to these critical costumers and service areas under crisis conditions should be prepared and exercised, in order to be able to supply them with water.

## A.9 Interface with users and citizens

The customers of a water utility are many and varied, and all are concerned about the capability of the utility to supply drinking water during an attack. Besides the physical effect of the lack of drinking water, there is also a psychological effect of development into a panic situation. The water utility needs to be organized to reduce the psychological effect by providing reliable and reassuring information to its interested parties of the readiness and capability of the utility to prevent and deal with a water security incident. Circulation of the information to the interested parties and to the public in general should be done through proper publicity. The water utility should act to implement the definitions on the basis of existing infrastructures, or by establishing infrastructures in accordance with the procedure. In any case, the public relations mechanism of the water utility should be drilled within the framework of the periodic exercises.

## A.10 Model for effective placement of water monitoring systems and for indicating the spread of contamination in the water supply system

In order to take advantage of the water monitoring systems effectively and efficiently, a definition of the manner of determining their location within the water systems is necessary. There are a large number of parameters, some generic (e.g. the water system structure and regulation) and some dependent on the policies of the water utility (e.g. a budget and confidence level). The water utility should use an optimization model for placement of the monitoring equipment, such that a suitable level of contamination control in the water and its location within the preparedness is ascertained, in order to ensure an immediate indication that contamination has occurred together with an indication of the contamination location and a reliable conjecture of the pollutant source. Preparation of a standard for models that establish the contamination location, and the number of instruments required for it, might constitute a tool that aids the water utility in its groundwork for a water security incident. In addition, when contamination occurs within a water system, the water utility should be prepared to hamper the spread of the contamination, to confine it and simultaneously to continue to supply water of suitable drinking quality for its consumers. In order to develop an infrastructure for handling a water contamination incident, the water utility is required to plan the water transport systems and the systems for control of the water flow, such that the contamination can be contained within a reasonable period of time and the harm to the customers and its interest parties is minimal. In order to plan its systems, a water utility needs to make use of a model for forecasting the contamination spread within the water systems of the water utility. Preparation of a standard to model the definition of a contamination stain, and forecast its spread as a function of time, constitutes an important tool for the water utility in its preparedness to perform actions for handling an incident where the contamination has spread to the drinking water system.

## A.11 Training programme and qualification

The water utility should verify that there are plans for personnel training on the subject of preparation for an incident and its management. The training sessions should match the various functions, in addition to general training, given to all utility employees. The water utility should maintain a list and follow-up of the qualification level of the various staff members, and of the personnel in general.

## A.12 Exercises

The water utility should prepare and maintain programmes for simulations and for drilling the systems and personnel at the various levels. The programmes should contain details of the drills for personnel, reports and the participants in the drill (including external organizations), in accordance with the qualification level required. The extent and frequency of the drills should be defined by the water utility, bearing in mind regulator and other requirements, and the risk analysis conducted by the water utility in accordance with the water utility policy.

# Annex B
(informative)

## Response stage — List of elements

The water company should define the requirements to deal with the immediate response and complementary stage of the incident, which should include (but not be limited to) the following areas:

a) means and trained personnel required to present an immediate and complementary response to an event, at staff level and at field operations level;

b) operations procedures for the above-mentioned personnel and means;

c) procedures for supervision and control centre;

d) a procedure for establishing the incident manager and chain of command in the water supply utility and the directives to manage the incident;

e) a procedure for communications and interaction with bodies external to the water company that are involved in the handling of an incident at its various intensities, at staff level and field operations level;

f) a procedure for directing sampling teams, field tests and specific laboratories during an emergency;

g) operation and application models to reduce the spread of the contamination area in the water supply system, wherever applicable;

h) methods to perform periodical and final risk assessment;

i) a procedure for supplying alternative water through the existing water supply network, including priorities for implementation;

j) a procedure for water distribution without going through the existing water supply network, and priorities, e.g. critical customers, etc., including means of securing the water distribution points;

k) methods of communication and alternative communication, in case communication networks collapse.

# Annex C
(informative)

# Recovery stage — Relevant procedures

## C.1 General

Depending on the intermediate phase of the recovery stage, the relevant list of procedures is given below.

## C.2 Procedures for planning the recovery stage



Procedures for planning the recovery stage should include those listed below.

a) **Characteristics of the contaminated site/system**: these characteristics should be obtained by means of a survey that determines in detail the extent and boundary of the contaminated area. The survey will define the risks involved in the specific type of pollutant and its stability in a water system. Furthermore, the survey will describe the contaminated system components (pipes, sediment in the system, etc.).

b) **Definition of the restoration goals**: depending on the results of the survey, an assessment should be conducted of the sanitary and environmental dangers as a result of the contamination. The main purpose of the restoration should be defined together with intermediate goals, if necessary.

c) **Restoration alternatives**: based on the goals defined, a restoration method should be selected with emphasis on the prevention of harm to public health and the minimization of environmental damage. The restoration method should suit the type and concentration of the pollutant, the purification requirements and the character of the restored system. The knowledge and equipment gap should be complemented, as required, together with a practical examination of the treatment technology on a small scale.

d) **Selection of restoration method**: based on the technological review and the most suitable restoration method, the parties responsible and the work teams should be selected. The various stages and the contamination/cleanliness levels to be achieved at each stage should be defined. As required, alternative solutions for supplying water on an intermediate and long term basis should be found.

e) **Planning procedure**: the planning procedure should contain clear criteria for determining the order of priorities in the restoration process. These criteria should include, among others, the risk to public health and the environment due to the contamination, the resulting panic, obtaining alternative sources and ways to supply water, the affected population size due to the lack of capability to supply water to a specific section, the time estimated for restoration, etc.

## C.3 Drainage, cleaning and disinfecting procedures

Following the contamination of the water supply system, in most cases, the supply system will have to be drained and the contaminated water removed. Already in the preparatory stage, physical means should be available for draining the water supply pipelines.

The draining procedure should include decision tools for draining, obtaining approvals and the cooperation of the regulator. The procedure should define the maximum contamination levels of the water to be drained. These levels should be consistent with the health and environmental risks involved in the draining and the type of pollutant (e.g. draining contaminated water can endanger the aquifer). Where the contamination levels exceed those established, the procedure should define the method of treatment and reduction of the concentrations to levels that permit their removal. The cleansing and disinfectant procedure should define the levels to be achieved in order to complete the restoration process at the different levels. These levels should be set according to the type of use of the water and of the pollutant. In addition, cleanliness grades, disinfection time after restoration, and concentration of the disinfecting material should be established. The cleanliness level and the method of disinfecting should comply with the requirements.

## C.4 Procedures for activating the work team to repair the damaged water supply systems, including methods to establish repair priorities

Following a contamination incident, it is important to return the system to normal as fast as possible. The recovery operations and the repairs are, in general, complex operations requiring a concentrated effort of a relatively large number of skilled personnel. The procedures for directing the work teams should define the teams for operation during an incident and the party responsible for directing these teams. The procedures should define the basic equipment that should be constantly available for these teams. This equipment should include, among others, antiseptics, sections of lines, pumps, etc. The water utility should maintain stock of equipment necessary for recovery of a supply system. The order of priorities should depend on the risk assessment in the design stage. All the activities should be planned in the design file, whose content should be defined by the procedures.

## C.5 Procedures for establishing the use of external resources as reinforcement for the repair teams of the water supply system

The recovery process can be a complex one, requiring means beyond those existing in the water utility. In order to restore the system, support of external parties might be needed to assist in the repair of the supply system. The procedures should establish the means of communication, arrange (in advance) backup teams to contact according to the type of incident, and to ensure that these teams are available when needed. The procedures should define, among others, the manner of working with neighbouring water utilities, engineering companies and contractors. All the activity should be prepared in a planning file, whose content should be defined by the procedures.

## C.6 Procedures for sampling water following the recovery and the transfer of these samples to the relevant laboratories

After completion of the recovery stage, the water system should resume normal operation, only after the contamination levels in the system have been checked to ensure they do not endanger public health in the short and long terms and do not cause unnecessary dangers to the environment. The sampling procedures should include the methods and the extent of system sampling prior to resuming normal operation, and should include sampling of all sections of the contaminated system. The procedures should define the manner of collecting and testing the samples. Collection and testing of the samples should be in accordance with accepted sampling and analysis standards of water samples and in accordance with the requirements of the certified party. The procedures should define the laboratories authorized for water testing according to the type of contamination (chemical, biological and radioactive), and should define the means of communication, manner of delivering the samples, manner of receiving the results, etc.

## C.7 Procedure for receiving approval to operate the system in stages and/or full operation (approving authorities, permission for partial use, etc.)

In order to resume the water supply of various qualities, water fit for drinking at the end of the treatment and water unfit for drinking at the intermediate stage, permits should be issued by the authority. Receipt of the permit should be in accordance with the procedure that will arrange the activities and the data to be transmitted to the authority.

## C.8 Procedures for the public relations system

The recovery process requires effective and continuous communication with the population. The recovery process is complex and may take a long time and necessitate long water interruptions. In some cases, cooperation might be required of the public for the drainage and rinsing of the lines. In other cases, low quality water might be supplied for an interim period. The public relations process has an important function in maintaining the cooperation of the public, reduction of interference to the normal life routine and prevention of unnecessary panic. The procedures for directing the publicity campaign should define the authorized/responsible levels for contact with the public, the operating methods of the public relations process, when to put this process into operation, the type of information to be transmitted depending on the cases, etc.

## C.9 Final risk assessment

At the end of the recovery activity, a final risk assessment should be conducted that includes the effectiveness of the recovery operation, the cleanliness levels of the system after the recovery and rinsing operations, the risk levels to the public health in the short and long terms, the risk level to the environment, etc. This assessment should be based on an extensive and comprehensive sampling survey that includes all the sections of the restored system. A final risk assessment procedure should establish, depending on the contamination level, the level of responsibility for management of the assessment, the regulatory parties that should take part in this assessment and the approvals for resuming the water supply, subject to the agreement of the regulatory authorities.

# Annex D
(informative)

# Subjects for which detailed standards could be prepared

## D.1 General

This annex consists of a roadmap of standards that might contribute to a water utility in crisis management and crisis preparedness. The standards are divided into management standards and equipment standards.

## D.2 Management standards

### D.2.1 Standard for management of a crisis

A standard for a crisis management system should be general and encompassing. This type of standard should determine the activities and their order, so as to be able to manage a water crisis in an effective manner.

A standard for a crisis management system refers to the requirements of a water utility during the various stages of handling the incident, i.e.

a) preparedness,

b) response,

c) recovery, and

d) lessons learned and review of the whole management system [then return to the first stage (preparedness)];

A standard for a crisis management system should define the components that have to be dealt with within the framework of the standard, and also the level of all the components from the standpoint of their indispensability for meeting the standard. The levels of indispensability are as follows:

— essential;

— desirable;

— worthwhile.

### D.2.2 Standards for water pollutant detection and identification equipment in the field (field kits and others)

In order to speed up the handling of a water crisis incident, it is desirable to receive quick answers, as far as possible relating to the quality of the water suspected of being contaminated in a water crisis incident.

For this purpose, there are several field kits for testing water in the field, and there are also additional kits under development around the world.

The performance and requirements of field kits relative to water security and the quality of water due to water incidents need to be characterized. The optimum way to characterize them is by preparing a standard that defines the requirements of kits depending on the purpose of the tests.

### D.2.3 Definition of the requirements for the control and operation centre (command and control centre)

Management of a water crisis incident should be conducted from an operations centre that is at a geographic site where all the functions taking part in management of the incident are concentrated and where all the relevant data of the water crisis is concentrated and analyzed.

At such an operations centre, there needs to be appropriate space for the function of the incident manager and the staff assisting him. Furthermore, there should be appropriate space for the creation of a situation report and evaluation of the operational picture including action plans to follow up.

All the necessary equipment for receiving and transmitting raw or processed information, and giving operational directions to the teams in the field, should be available in the operations centre.

There is a need to define the structure and the elements of the operations centre in accordance with the various levels of the water utilities and the threat to them. This should be done in an optimal manner by writing standards for the operations centre.

### D.2.4 Definition of public relations requirements during an incident (including means)

Public relations requirements during a crisis should be defined, including the means involved; e.g. the preparation for public relations during an incident could take the form of

— an information centre;

— a telephone centre for receiving calls from the public.

One of the most problematic elements in the management of a water crisis incident is to reduce the element of panic in the public. This element arises from public uncertainty as to whether water will continue to be supplied to homes.

If the public panics, the work of the incident management team increases sevenfold due to the turmoil and harm to the public order. It is therefore very important to keep panic as low as possible by means of an effective and quick public relations process.

Consequently, appropriate means and personnel should be made available in advance for rapid operation of the above-mentioned public relations system, including a public information centre, a telephone centre for receiving calls from the public, and employing mass communication means to transmit the messages to the public by means of careful and regular announcements, as deemed necessary.

A standard should be prepared that

a) defines the elements to be taken into account when seeking to establish effective public relations procedures, and

b) describes its functions, the situations in which it is applicable, techniques of operation and personnel training.

### D.2.5 Risk assessment

Within the framework of water utility preparations to deal with a water crisis incident, risk surveys and the establishment of the vulnerabilities in the system are necessary.

Likewise, teams and procedures for conducting risk assessment during and after the occurrence of an incident should be prepared in advance.

### D.2.6 Planning for an alternative water supply by means of the existing water network including setting priorities

During a water crisis, the need may arise to supply alternative water to the consumers through a water supply network from water sources other than those normally used. For this purpose, emergency water supply situations should be defined, as well as the amounts supplied per individual in each situation and the alternative means to be prepared to supply water from alternative sources. Furthermore, plans for the operation of an alternative water supply should be prepared in advance and tested. All the above-mentioned definitions can be written in a standard that establishes the requirements to plan and enable an alternative water supply to consumers during a water crisis.

### D.2.7 Procedures for water distribution avoiding the existing water network, and priorities (e.g. critical customers) including means to secure the water distribution points

During a water crisis, a need may arise to supply alternative water to consumers without going through the existing water supply network, but by external means, e.g. water distribution from tankers and bottles or other containers. In order that such an operation can take place during a water crisis, there is a need for planning, organizing and testing prior to the occurrence of an incident. Distribution stations, temporary distribution points, warehouses with a water stock, warehouses with water containers and tankers, vehicles, human resources, a distribution system, etc. need to be prepared.

The requirements for distribution procedures during a water crisis can be defined through an appropriate standard.

### D.2.8 Means of communication and alternative communication methods in case of collapse of the communication network

The utility in concert with public authorities should develop a means of communicating with the customers in the event of a collapse in the conventional communication systems. Such systems could involve the use of mobile loud-hailer systems capable of travelling through customer areas.



## D.3 Equipment standards

### D.3.1 Standards for on-line monitoring instrumentation

These are standards for on-line monitoring instrumentation installed in a water supply system for detection and identification of pollutants (specific, experimental, biological, algorithmic for detecting deviations in the water quality, etc.). Continuous monitoring instruments for detection and identification of pollutants in water may be of several types, e.g.

— instrumentation for monitoring of specific materials in water;

— instrumentation for “water toxicity (experimental, biological)” monitoring;

— algorithms that learn the relationships between changes occurring in the reading of “routine” parameters for water quality, measured in water systems by commercial instrumentation available today.

The considerations for the selection of the types of instrumentation to be installed, or of the possibility of combining some of the above-mentioned types of instrumentation, depends on the characteristics of the water system and the threats being considered.

Since the principles of detection and identification pollutants in water vary according to each of the above-mentioned groups, the performance and requirements from the instruments for water security purposes are different from the requirements from the same instruments when used for monitoring the quality and water supply during normal operation.

Given that there is currently intense activity worldwide in the quest to develop instrumentation and software for a water supply system that is suitable for detection and identification of those parameters in water that imperil water security, the time is right to set standards for the development of this kind of instrumentation.

### D.3.2 Models for setting the locations and the number of instruments to be assembled in the water supply system in accordance with their characteristics

There is a need to decide on the most desirable location for installation of instrumentation for detection and identification in water. It is clear that it is economically unfeasible to install an unlimited number of instruments.

It is desirable that an optimization model should determine the number and location of the various instruments to be installed in the water supply system.

The specifications of the requirements from such a model may be achieved by preparing standardization that defines the essence of the model, the answers expected from it, the level of accuracy desired, etc.

### D.3.3 Models for the definition of the contamination area and forecasting its spread as a function of time, and the performance of actions to limit its coverage

One of the most important actions in the case of a water contamination incident is to reduce the size of the contaminated area in the water supply system and to confine it.

This kind of action is essential for reducing both the damage that may occur due to occurrence of the incident, and to reduce the geographic extent of the water supply system that has to be cleansed, rinsed and decontaminated after occurrence of the incident. These actions are complex and take a long time and, therefore, reduction of the damaged area reduces the time that a water supply system cannot supply water to the consumers.

Decreasing the time that water does not reach consumers through the system is of utmost importance in the management of an incident and in controlling the affected population.

In order to achieve a reduction in the spread of the contaminated area in the most effective manner, hydraulic models should be developed to plan for hydraulic functions that reduce and confine the area as much as possible.

The municipal water supply systems are complex because of the many possibilities of flow through the municipal piping. There are few instruments that are capable of feeding essential information for the operation of a model in real time.

There is, however, a reason to define through a standard the minimum requirements from a hydraulic model that can predict the spread of a contaminated area and the location of a contaminated area in a municipal water supply system with a reasonable level of accuracy.

### D.3.4 Models for the cleansing, disinfecting and recovery processes of the water supply systems affected

If a water crisis occurs, one of the important things in handling the incident effectively is the speed with which the water supply system can return to routine operation.

The operations involved in rinsing, cleansing, disinfecting and verifying the serviceability of sections of the water system affected by the incident are difficult, time-consuming and involve massive human resources and means. It is therefore important to ensure that the actions involved in dealing with an incident are efficient, by using hydraulic models that can guide the water utility management in the preparation of an efficient programme for draining and rinsing the water supply systems.

There is, however, a reason to define through a standard the minimum requirements from a hydraulic model intended to improve the efficiency of the water drainage actions in order to clean sections of the water supply system that were affected by pollutants in the water crisis incident.

# Annex E
(informative)

# Technological instruments, means and models for ensuring drinking water security

## E.1 Technological instruments and means

### E.1.1 General

**E.1.1.1** The purpose of this annex is to describe in detail a series of recommended standards of technological instruments and means for ensuring drinking water security, within the framework of the overall document presented at the Tel Aviv workshop.

**E.1.1.2** The field of drinking water security in a water supply system is divided into three essential parts:

a) **water source**: groundwater; surface water;

b) **water installations**: treatment plants and utilities and companies, open water reservoirs, drinking water pools, pumping stations and water wells;

c) **water supply network with all its components**, from water reservoirs, wells and pools, to the customers themselves; the overall water supply system, in the majority of cases, is handled by several jurisdictions.

**E.1.1.3** Analysis of the initiated threats (terror and war) on drinking water (as presented in the Introduction) shows that the main weak points are in the various types of water installation arrangements and in the water supply distribution network in the circles nearest to the end users.

**E.1.1.4** The short-term actions should strive to improve significantly the protective arrangement of the various water installations. In parallel, a multi-year plan and large investment in resources should be implemented to ensure the protection of the water supply lines.

**E.1.1.5** Analysis of the critical implications of a response to a water contamination event clearly indicates that the first priority should be to invest resources to prevent an incident and to minimize the extent of damage as much as possible.



### E.1.2 Main insights

**E.1.2.1** There is considerable difficulty in accomplishing effective contamination of large water reservoirs (natural and constructed), due to the small ratio between the quantity of contaminant and the volume of water in the reservoir, the type of contaminant and its solubility. However, it is obvious that various steps need to be taken to prevent/obstruct the possibility of contamination in these reservoirs. Attempts to contaminate these reservoirs, even if ineffective, can cause mass panic.

**E.1.2.2** A variety of means exists today to detect and identify contaminants in water, some by technological means of continuous monitoring and others where water samples need to be taken for laboratory testing, which may take a time of between several minutes to several hours, respectively. Viable integrated Early Warning Systems (EWS), which meet all the desired characteristics (detection of both chemical and biological threats in real time) and can be routinely used, are several years away. Some individual components are available currently; however, others need further development.

An EWS can be an important tool for avoiding or mitigating the impacts of an intentional contamination event in time to allow an effective local response that reduces or eliminates adverse impacts. An integrated EWS includes sensors to detect the contaminant, systems to transmit, compile and analyse data, links for communication and notification, and protocols for decision making and emergency response.

Certain regulations (e.g. Homeland Security Act of 2002[17]) specifically call for the investigation and use of EWS for water security reasons. The EWS serves as a screening tool for detecting changes in source water and distribution system water quality.

Because a Biological EWS (BEWS) measures toxicity, it provides an important complement to available chemical monitoring technology. While the detection of chemical substances in environmental samples does not necessarily indicate toxicity or biological hazard, the absence of specific chemical analytes does not necessarily indicate the absence of toxicity. Biological measures of water quality may detect materials that analytical chemistry techniques cannot detect, because of inadequate detection limits or methodological limitations. More importantly, biological measures can detect unsuspected materials and evaluate the toxic action of mixtures of multiple chemicals. As noted by Cairns and Mount (1990)[13]: ''No instrument has yet been devised that can measure toxicity! Chemical concentrations can be measured with an instrument but only living material can be used to measure toxicity.''

Neither traditional toxicity tests nor chemical-specific sensors can provide comprehensive, real-time information on toxic events in an aquatic system. A suite of time-relevant biological and physical/chemical water quality monitors applied in an EWS can provide timely information to aid decision-makers in the management and protection of water resources.

Current biological water quality monitors use fish, bivalves, arthropods and bacteria, and are capable of detecting contaminants at relatively short time periods (minutes to hours). Strategic placement of water quality monitors at both source water and distribution system locations of high vulnerability (likely targets) and control points may detect the presence of unsuspected chemicals or toxic interactions occurring as a result of spills, legal or illegal discharges, or intentional introductions.

**E.1.2.3** The second security tier includes the rapid detection and identification of contaminants in drinking water, especially in water pools and supply lines, prior to reaching the consumers. However, this line of security cannot prevent contaminated drinking water from reaching some of the consumers, nor the contamination of parts of the drinking water supply network. The conclusion is, therefore, to test and give high priority to technological instruments and means that can effectively support the first security tier, whose aim is to prevent/disrupt the contamination of water installations and to completely prevent the supply of drinking water to consumers from installations that show a positive indication of a contamination attempt.

**E.1.2.4** The necessary response to an incident of contamination of a water installation should be immediate. In most cases, this requires the complete obstruction of the emergence of water from the affected installation to prevent the flow of contaminated water (or water suspected of being contaminated) to the consumers. The capability to create an assembly of technological instruments and means that identify the contamination attempt or actual contamination of the pool, and to immediately and confidently prevent the continued supply of water from this drinking water installation, is a strategic capability. Together with effective and reliable publicity, panic and anxiety of the population can also be prevented.

**E.1.2.5** It is of great importance that this immediate response system be autonomous, without any conditions of "remote decisions", due to the response time factor being critical and, based on experience, due to the inevitable interruptions to the communications between the individual installation and the control centre. Experience shows that during large scale incidents, even where there is no intentional attack on the wireless/cellular communication infrastructure, the function of the communication systems is disrupted and, in some cases, ceases to operate for various periods of time.

**E.1.2.6** The technological response of making drinking water installations secure should be through defining priorities in accordance with an analysis of the risk levels, and determination of criteria that refer to the geographic location of the water installations and the exact location of the individual water installation (at a distant point, open field, within a community/an installation, in proximity to security forces, population, size of installation, redundancy of water installation). This should be performed by the authorized parties in cooperation with the water utilities.

**E.1.2.7** The inference from the above is that there is great importance in advancing the protection and security of drinking water installations by means of establishing appropriate International Standards within the ISO framework for technological instruments and means. Their application, within the overall preparation for making drinking water secure, should bring a significant improvement in the preparedness against the threat of contamination to drinking water, through the use of severe standards as required in this sensitive and problematic field.

### E.1.3 Table of technological tools and means

**E.1.3.1** Technological tools and means are divided into two essential groups:

a) **primary security tier** – physical protection:

1) perimeter fence:

i) distance from the installation/pool;

ii) gate-locking mechanism, control and entry;

iii) depth of fence in the ground;

iv) concrete base strip;

v) fence height;

vi) type of fence;

vii) warning sensors;

2) locking control room;

3) lock/obstruction of stairway/ladders to roof of installation/pool;

4) fence around installation/pool roof;

5) protection of personnel entrances;

6) protection of ventilation openings;

7) volume/motion/ray/acoustic/magnetic and other sensors in the installation/pool/yard, stairway, ladders, roof and openings;

8) day/night visual systems of the outer/inner perimeter of the installation/pool;

9) optimal linkage between the various sensing systems and establishment of redundant operations;

10) visual and other sensing systems for early identification of attempts to penetrate the installation (at locations with a high security sensitivity);

11) communication systems to distant control rooms;

b) **secondary security tier** – on line/off line monitoring systems:

1) various types of monitoring systems for continuous/non-continuous control of the water quality;