Introduction

This article surveys the functions of the Israeli Standards Institute, with extensive reference to current activities that include the adoption of Standard 5452 which defines the requirements for adjustment of products that come into contact with drinking water with reference to their impact on water quality. The aspects covered are: taste, appearance, development of aquatic microorganisms, toxic activity, mutagenic activity and secretion of metals. This standard is based on and is in part identical to, the Australian/New Zealand Standard AS/NZS 4020; 2002, which is currently under revision and which, upon its completion, will be considered for official publication.

Activities of the Israeli Standards Institute and the official nature of the standard

The Israeli Standards Institute is a statutory corporation operating on the authority granted it by the Standards Law of 1953, prepared by the Ministry of Industry, Trade and Employment. Its operations are sanctioned by this law and include preparation of standards and ensuring the quality of various products. Over the years, in accordance with the developing needs of the market and Israeli society, the Institute’s activities have been extended to encompass all sectors. Today, its divisions include representation from all sectors in the market and society: state authorities, scientific and research institutes and the business, industrial and consumer sectors and more. To execute the tasks for which it is responsible, the Institute operates in three main fields: standardization, testing and quality assurance. Basically, Israeli standards are voluntary, but some are converted into a binding standard, either by proclamation as official standards by the Minister of Industry and Trade or by publication of a decree or directive by the minister responsible for the particular sector to which the standard applies. A standard is declared official when it is required or ordered:

- to protect public health
- to protect public safety
- to protect the environment
- to provide information when there is no alternative source of information that safeguards consumers or
- to ensure the replacement compatibility of products.

The Standards Institute has initiated thousands of standards (some of which have been adopted as international standards) in all fields of market operation and in all spheres of life. For example, there are standards dealing with the well-being of an individual in terms of his/her safety, health and welfare; standards for products and production processes; standards for service processes; standards for management of quality systems; standards for the computer and Internet era and more.

Essence of Standard 5452 and background regarding its adoption

The initiative for an Israeli standard for testing of products for use in contact with drinking water arose from the Israeli Ministry of Health; its main reason for initiating the standard was related to health aspects. Until 5452, there was a lack of uniformity regarding the requirements for drinking water accessories and devices. In some cases, there is reference to American standards; in others there is reference to American standards; in others there is reference to the requirements of the Israeli Ministry of Health. The Standardization Committee decided to prepare a broad-based standard that refers to all products that come in contact with drinking water and to adopt the model of the Australian/New Zealand standard.

Standard 5452 defines the requirement for compliance of products that come into contact with drinking water in a system that supplies water via pipes, fixtures, components, electrical water heaters, kettles, containers and devices for water treatment, as well as materials used to coat, protect, connect, seal and lubricate water supply systems and products from the plumbing industry. The standard requires that products designed to come into contact with drinking water will be tested by exposure to water and will include testing their impact on the quality of water based on the follow-
ing aspects: taste, appearance, microbial activity, mutagenic activity and secretion of metals.

Participating in the preparation of this standard were representatives from the Ministry of Health, the Ministry of the Environment, the Federation of Israeli Chambers of Commerce and the Manufacturers Association of Israel. Preparation of the standard took approximately one and a half years and it is currently under revision.

**Parameters tested**

The following is a review of the background and rationale behind selection of the parameters included in the standard. The first section refers to the possible impact on the taste of the water; then a survey of five additional parameters is presented.

**Taste**

In general, taste can be the result of numerous factors: salts, organic compounds originating from the decomposition of biological substances, byproducts of plants and microorganisms, byproducts of disinfection materials, growth of microorganisms in the water system, segments of the water network in which there is standing water or the use of various devices and fixtures unsuitable for use in water.

To examine the impact of the use of devices and fixtures on the taste of water extracted from them, testing is conducted using two different water qualities: non-chlorinated water and chlorinated water (with a concentration of one mg/L free chlorine). This was done due to the need to simulate water in a system that usually contains chlorine that, when combined with certain substances, may cause a chlorine-like taste similar to the disinfectant.

Tasting is performed by a panel of expert tasters, required to undergo a process of calibration and training. Since sensory perception of taste is given to personal interpretation, the panel (usually composed of five tasters) must be tested individually. Panel members are required to be able to distinguish between various basic flavors (sweet, sour, salty and bitter) at various concentrations. On a scale of seven, the maximal permitted error is in the range of ±two units for each concentration. Tested taste types and concentrations are presented in Table 1.

Technologically, the efficiency of the test is limited. It serves as a laboratory simulation of product usage in the field, but the precision of the taste test is lower than that of the results of physical or chemical tests. Nevertheless, this type of test enables (and relies upon)

<table>
<thead>
<tr>
<th>Chemical composition for standard taste test</th>
<th>Taste</th>
<th>Percent concentration</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>Sweet</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Citric salt</td>
<td>Sour</td>
<td>0.05</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0.1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>Salty</td>
<td>0.4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0.7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Coffee</td>
<td>Bitter</td>
<td>0.05</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0.1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Quinine hydrochloride dehydrate</td>
<td>Bitter</td>
<td>0.001</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.004</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
good coordination between laboratories and experienced 
tasting panels. If an experienced tasting panel identifies 
an undesirable flavor in the 
water extracted from a par-
ticular product, it is possible 
that the product adds this fla-
vor and may be rejected for 
use with drinking water.

**Appearance**

The second parameter 
tested according to the standard refers to 
the possible change(s) in color and turbidity that may be caused due to the de-
vice coming into contact with water. These parameters provide an immediate 
indication of a possible and noticeable change in the water quality and this 
increases the sensitivity of customers to 
these aspects.

In general, color enters water 
through penetration of dissolved sub-
stances and turbidity can be caused by 
penetration of suspended matter, such as 
clay, silt, finely divided organic and in-
organic matter, plankton and other mi-
croscopic organisms.

In addition to the impact on the 
water’s appearance, there are additional 
reasons to preclude color and turbidity 
due to the fact that compounds that cre-
ate color may reduce the available con-
centrations of disinfecting materials, thus 
preventing the eradication of microbes. It 
may even supply nutrient materials or 
shading for these microorganisms. In 
both cases, the demand for disinfection 
may be increased. The requirements of 
the Australian/New Zealand standard 
specify that the color in extracted water 
must be lower than five Hazen Units 
(HU)† and that the turbidity level must 
be lower than one NTU—the Israeli Stan-
dards Institute has set a more stringent 
demand for turbidity of 0.5 NTU.

**Growth of aquatic microorganisms**

A third parameter tested by this 
standard is the impact of de-
vices (coming into contact 
with the water) on the in-
crease in the quantity of mi-
croorganisms. When a device 
comes into contact with 
water, its impact (or lack thereof) on the microbial 
aspect can be expressed as fol-

- Its presence does not 
effect the growth of 
aquatic microorganisms.

- Its presence may cause the secre-
tion of dissolved organic substances, with 
a significant increase in total organic car-
bon (TOC).

- Organic substances on the surface 
of the device may encourage growth of 

biofilm.

- The organic substances may en-
courage the growth of plankton and 

biofilm.

Again, the apprehension is that de-
velopment of microorganisms from 
products coming into contact with wa-
ter may damage the disinfection capac-
ity, causing an increase in the turbidity 
of drinking water or adding substances 
that may affect their taste. Growth of 
aerobic microorganisms requires oxygen 
for biochemical disintegration of organic
substances/oxidation of inorganic compounds. The consumption of dissolved oxygen is directly proportional to the microbial activities and constitutes an indication of its existence.

In 1979, researchers Colbourne and Brown, working with 50 substances in the United Kingdom, developed the MDOD index (Mean Dissolved Oxygen Difference), used to assess the link between microbial growth in the laboratory and microbial problems ‘in service’. This surrogate test determines the growth of microorganisms in the free-floating planktonic form and in the biofilm attached to the surface of the test product, as shown in Table 2.

This study provided the foundation for the test. When the MDOD between the extract and the control group is larger than 2.4 mg/L, it is possible that substances that encourage growth of microorganisms will be released and the product will be considered as unsuitable for uses that involve contact with drinking water.

Activity of mutagenic factors

This parameter (the Ames Test) tests the possibility that substances that may be secreted into drinking water may cause a mutagenic effect that occurs with genetic changes in the existing DNA of the cell’s nucleic substance, which constitutes the code for creation of amino acids. Amino acids are the building blocks of proteins that control and enable the basic functioning of the cell. A change in the basic pairing can create a frame-shift mutation or deletion of basic DNA pairs that may create base pair substitution. Certain chemical structures can serve as clues with regard to possible mutagenic activity. For example, a mutagenic change can be caused due to chemicals that:
- Mimic the structure of the nucleotide bases.
- Contain benzene rings.
• Have a nitrogen-containing structure.
• Are known as oxidizing or alkalinizing agents.

In this test, water extracts are added to a system that contains bacteria that have been brought to a condition in which they are incapable of using a certain amino acid. The tested bacterial cell (Salmonella typhimurium) is brought to a condition in which it cannot use the same acid. The existence of a mutagenic factor causes a mutation that preserves the cell’s ability to use this amino acid and this is observed in the tested system.

### Toxic activity of water extract cells

The basis for this test is a cytotoxic evaluation of the substances found in the product extract. Basically, cell tissue contains healthy cells of a circular shape. In this test, the effect of the water extract on the growth of the cell line is examined. In general, toxic activities can prevent healthy growth of cells and can even kill them. The test is conducted on kidney cells of the African green monkey. Findings do not necessarily indicate toxicity for humans, but do indicate the existence of secretion of substances from the product to the water and require further testing in order to approve the product for use with water.

Cytotoxic faults are usually linked to one or more of the following factors:
• Surface activity that inhibits cell growth.
• Alkali changes.
• Biological activity of compounds

### Table 3. Guidelines for inorganic chemicals—metals

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Guideline value mg/L</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony (Sb)</td>
<td>0.005</td>
<td>Exposure may rise with increasing use of antimony—tin solder</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>0.005</td>
<td>Derive from natural sources and mining/industrial/agricultural wastes</td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>0.1</td>
<td>Primarily from natural sources</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.0005</td>
<td>Indicates industrial or agricultural contamination from impurities in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>galvanized (zinc) fittings, solder and brass</td>
</tr>
<tr>
<td>Chromium as Cr (VI)</td>
<td>0.005</td>
<td>From industrial or agricultural contamination of raw water or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>corrosion of distribution system/plumbing</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.001</td>
<td>Occurs in water via dissolution from natural sources or from</td>
</tr>
<tr>
<td></td>
<td></td>
<td>distribution systems/ household plumbing containing lead (e.g. pipe,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>valves, solder)</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.0001</td>
<td>Generally from industrial emissions/spills. Very low concentrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>occur naturally</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.07</td>
<td>From mining, agriculture or fly-ash deposits from coal-fueled power</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stations</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.005</td>
<td>Up to 0.5 mg/L reported after prolonged contact of water with nickel-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>plated fittings</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>0.001</td>
<td>Generally very low concentrations in natural water</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>0.001</td>
<td>Concentrations very low. Silver and silver salts occasionally used for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disinfection</td>
</tr>
</tbody>
</table>
such as pesticides and catalysts.

- Presence of secretions from dissolved substances in the water.

The process of testing the extract and the relevant parameters are presented in Figure 1.

**Extraction of metals**

The sixth parameter tested according to the standard is extraction of metals. In general, treated drinking water does not contain (or contains only minute traces of) metals that constitute a health risk to the public. In production processes, metals may originate from residues of various materials, such as the use of lubricants that contain antimony. The extraction process for conducting the metal extraction test is executed with a hardness of 50 mg/L (as calcium carbonate). The Israeli Standard for maximum permitted concentrations of metals is one-tenth of the maximum level permitted according to the Israeli Public Health Regulations for Drinking Water, which is based on the fact that the water supply system contains numerous components and each component may serve as a potential contributor and add its part—the sum of all the contributions can reach the maximum permitted level. In the revision of this clause, a demand will be added for additional elements, such as: iron, copper, zinc, aluminum, manganese, tin, beryllium, thallium and phthalates in plastic piping. Table 3 presents the types of metals and the recommended values, including comments referring to the possible secretion sources of the metals. This test is not designed to examine corrosive aspects.

**Summary**

The Israeli Standards Institute, acting in accordance with the Standards Law of 1953, has for dozens of years been working conscientiously to prepare standards and ensure the quality of products. Work on Standard 5452 is designed to ensure the quality of products coming into contact with water, while examining the possible effects on taste, toxicity, mutagenic activity, appearance and growth of microorganisms. The standard’s complexity and its commitment to test the entire range of aspects reviewed, is an expression of the standardization staff's constant efforts to protect public health.

**References**

2. The Standards Institution of Israel, Organization profile, Tel-Aviv. www.sii.org.il/

**Glossary**

† Hazen Units: Water’s color is expressed in units of the platinum-cobalt scale proposed by Dr. A. Hazen (1892). A unit of color is produced by one milligram per liter of platinum in the form of the chloroplatinate ion.

‡ Ames Test: Developed in 1975 by Bruce Ames and his colleagues at the University of California at Berkeley. The Ames Test is based on inducing growth in genetically altered strains of the bacterium Salmonella typhimurium. The test yields a number—specifically, the number of growing bacterial colonies—which is a measure of the mutagenic activity (potency) of a treatment chemical.

**Acknowledgments**

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