WATER RESOURCES

MANAGEMENT OF WATER RESOURCES IN THE CONSTRUCTION INDUSTRY

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THE EFFICIENT USE OF WATER IN RESIDENTIAL BUILDINGS

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FOREWORD

Having Water as a primary subject in its strategic actions, the Environment Commission of the Brazilian Chamber of the Construction Industry – CMA/CBIC has the honor of sharing the first publication with guidelines regarding the subject are provided. It addresses the subject "The efficient use of water in residential buildings" bringing the Construction Industry Sector in to context of the water scarcity current scenario. It brings up the discussion about the management of the demand and the new scenario post-COP 21. Besides that, it also sets standards on how to operate for all of those involved in the water management of buildings, suggesting tolls, implementation of systems and pointing out future perspectives regarding the hydraulic vulnerability in city centers. The main goal of this publication is to give proper attention on how the Construction Industry can contribute to an efficient and conscious use of water, besides having an impact on society´s behavior in the matter, thus, moving forward in its aim of achieving a better quality of life for all.

About CBIC

The Brazilian Chamber of Construction Industry was founded in 1957, in Rio de Janeiro State. Based in Brasília, it represents 81 Unions and employers associations in the construction sector, in all the 27 Brazilian States.

About QIT Engenharia

QIT Engenharia technical team works, since 1978, with Building Systems Engineering, with focus on Supply Preservation. The team has participated in the development of the method in the Rational Use of Water Programme1, in the creation of the Brazilian Plan of Action Against Water Waste documents and in researches and implementation of practices for efficient use of water in various types of buildings.

1 Programa para o Uso Racional da Água (Rational Use of Water Program – (PURA)) developed for Sabesp, São Paulo, 1996.

2 Plano Nacional contra o Desperdício de Água (Brazilian Plan of Action Against Water Waste) – PNCDA, developed for the Federal Government Special Office of Urban Development in 1999, readapted for the Ministry of Cities in 2003.

PREFACE

Practicing sustainability entails implementing actions of economic, social and environmental nature that contribute to the quality of life of the generations to come.

The urge of rethinking the future of cities and their sustainable growth increases by the day and the Construction Industry plays a major role in the matter considering that buildings (both old and new) interfere in the urban environment in the long run.

Regarding the necessary materials for making buildings operational, a lot has been researched about and implemented in the field of renewable energy and energy efficiency. On the other hand, when it comes to water, very little has been accomplished and implemented, even with the evolution of knowledge and technologies in the area. Although, there is not much of a choice: we either have water supply or life can not exist.

Each new construction of a building in a city can be combined to the eficiente use of water or to promote its waste. Each renovation done in an already existing building can either contribute or not to the efficient use of of water, by providing the necessary technical conditions for it.

This document provides guidelines to the construction of buildings that will promote the efficient use of water, as a way to contribute to the viability of cities. The residential buildings, which comprise all citizens, have been, primarily taken into consideration in this publication. However, the actions presented throughout the text are related to the use of water in human´s essential task routine, and they must be taken into consideration in any type of building in where there are toilets, kitchens, or even a floor that demands washing.

1. INTRODUCTION

Using water efficiently means using only the necessary and sufficient amount of water to meet the expected outcome of a certain task or equipment having no waste nor affecting the outcome of the task and preserving the health of the users. To its limits, all the water provided (measured) is used in its least possible amount to fulfill the task final purpose.

The amount of water used to carry out a specific task or for equipment use is related to behavior and technological matters.

The actions based on behavior that contributes to the efficient use of water can be acquired mainly through educating, raising awareness campaigns, procedures, qualification and training. The results of these actions depend entirely on the users and on the way they make use of the water.

Technological-based actions that facilitate the efficient use of water do not depend on the users´ behavior or habits, but on the characteristics and conditions of the Hydraulic Systems in Buildings

The purpose of this document is to present technological actions that contribute to optimized water use efficiency throughout the residential buildings´ lifespan.

Water vulnerability in urban centers

The "Universal Declaration of Water Rights", published by the UN in 1992 states, among other things, that "the water shouldn´t be missed, polluted or poisoned. In general, their use should be made with awareness and insight to not reach a state of exhaustion or deterioration in the quality of the reserves currently available."3.

The water scarcity in Urban Centers it's not only a consequence of the recent shortage of rainfall in several locations in Brazil, but also, and specially, of the population growth that demands increasing amounts of water for supplying systems and usage.

In 2013 the National Water Agency in Brazil (ANA), carried out an analysis of the water availability and the water demand by which they assessed the situation of the main Brazilian basins and the regions of most water stress, according to Figure 1. It can be observed that the main Brazilian urban areas are already indicated water stressed conditions.

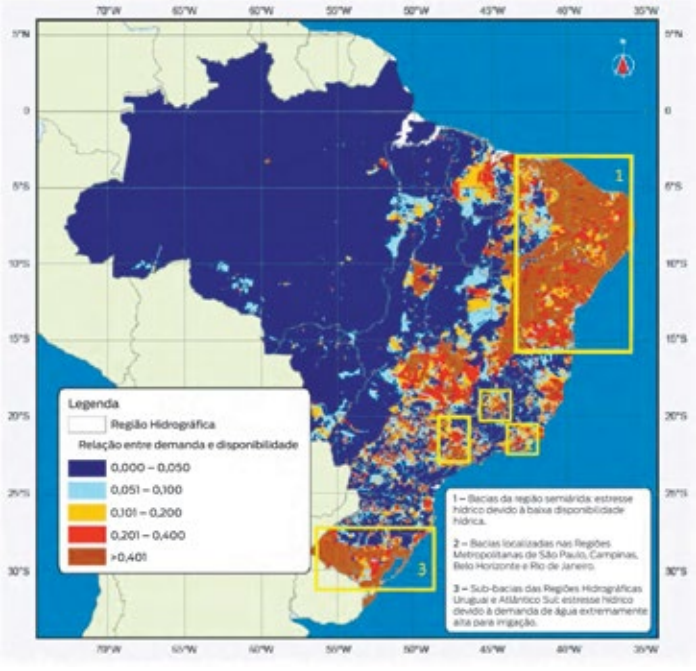


Figure 1: Analysis of the availability and demand of water. Source: ANA[5]

3 http://www.direitoshumanos.usp.br/index.php/Meio-Ambiente/declaracao-universal-dos-direitos-da-agua.html.

4 Conjuntura dos Recursos Hídricos, ANA, 2013.

5 ANA. Conjuntura dos recursos hídricos no Brasil: 2013. Brasília: ANA, 2013.

In urban areas with population density a significant share of the water is used for human supply. In São Paulo´s macro metropolis, for instance, the total demand of water in the year of 2008 had approximately 50% of its demand for human supply as shown in figure 2[6]:

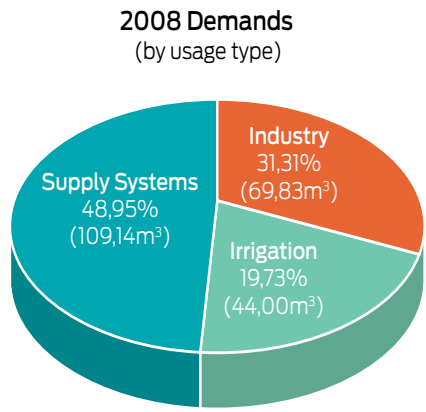


Figure 2: Water consumption by usage type in the year of 2008
Source: DAEE[4]

The answer to guarantee the viability in the cities entails both sides of the equation: the increase of supply and the decrease of water demand.

Many actions have been listed in the states´ hydraulic resources master plans in terms of increasing the water supply and on the other hand, reducing the demand.

The increasing supply, which is not the focus of this document, happens by the addition of new water sources, through new water abstractions and through the implementation of actions like the reuse of treated wastewater and the harvesting and harnessing of rainwaters.

Reducing the demand of water can occur in many ways. In the scope of utility companies, it happens mainly through the reduction of water loss in the public water supply network.

6 Plano Diretor de Aproveitamento dos Recursos Hídricos para a Macro metrópole Paulista, outubro de 2013, DAEE, http://www.daee.sp.gov.br/macrometropole/sumario_executivo_recursos_hidricos_final.pdf

At the citizen's level, a reduction in water demand can be obtained through behavior-based actions and the use of technologies that contribute to the efficient use of water.

In 1992, with the enactment of the Energy Policy Act - EPA, an American federal law, there was a significant push with the efficient use of water in the United States. According to Yoshimoto7, EPA "has established maximum standards of water use for hydraulic equipment – which were implemented by the American Industry from 1994 on – and it suggested the promotion of incentive programs of volunteers exchange at the city and state level". EPA has brought up many categories of information and test to promote the energy and water conservation and it has established limits for maximum use of water for showers and faucets (9,5 l/min at 562 kPa), toilets (6 l/flush) and urinals (3,8 l/flush).

In Brazil, the Water Demand Management in Buildings, especially the ones in urban centers, is already considered a matter of emergency, despite the occasional rainfall shortage in a specific period of year or specific region. Insuring the necessary and sufficient quantity and quality of water is vital for the maintenance of the current existing tasks and of the promotion of new investments under the risk of threatening the economy of the urban centers. The construction of buildings capable of providing an efficient use of the water is part of the necessary actions that should be undertaken for more sustainable cities.

Encouraging the construction of buildings in which the project, execution and operation parameters favor the water use efficiency (and a consequent reduction in sewage production and energy consumption) means, furthermore, that these different conditions and services applied to buildings can increase added value among those of the same purposes.

Finally, having an efficient use of water depends on all parties involved, throughout the life cycle of a building.

7 Yoshimoto, P.M.; et alii. Uso Racional da Água: programa de economia de água em edifícios. In: Congresso Brasileiro de Engenharia Sanitária e Ambiental, 19, Rio de Janeiro, Brasil, 1997. Anais. Rio de Janeiro: ABES, 1997. P.1296-1307. 1 CD-ROM.

Efficient use and water conservation

The 3 Rs Principles of Sustainability summarize the conscious consumption in three words: “Reduce, Reuse, Recycle”.

Actions aimed at the reduction of water use promote the Efficient Use of Water. Actions that result in reusing or recycling water are considered actions of Water Conservation.

The Efficient use of water in buildings is understood as a collection of actions combined that optimize the operation of the building system in a way that the necessary amount of water for carrying out tasks is reduced, keeping the same level of performance in services – with a focus on the water demand. This management aims at a reduction in the amount of water used, with a permanent monitoring of the consumption variation markers and an active management of the building system so that these indicators will be kept in expected levels – demand management with the focus in the amount of water.

Water Conservation in buildings is defined as a set of actions that it not only optimizes the building system operation in terms of reducing the amount of water used, but also promotes the supply of water produced in the building originated from alternative sources opposed to the potable water provided by the public supply system – focus on internal demand and supply of water. Besides focusing on the amount of water consumption, the managing system must permanently monitor the variation of quality standards of the water provided by alternative sources and it must avoid the possibility of contamination in the potable water system of the building which might lead to the risk of having non-potable water being use for potable purposes – management of demand focus on water quantity and quality.

The main difference between the implementation of actions aimed at the Efficient Use of Water, and Water Conservation is the risk of users being contaminated.

Under the perspective of the public health, the sanitary risks associated to Water Conservation demand that the managers involved have technical qualifications that overcome the ones needed in the Efficient Use of Water programs. They become accountable for the distribution of the non-potable water and, therefore, they are responsible for the occasional incidence of contamination in the potable water or the inappropriate use of non-potable water.

In technological terms, to avoid the possibility of contaminations in potable waters or the inappropriate use of non-potable waters, the implantation of actions of Water Conservation require specific observations for the non-potable water supply system, such as independent water storage and hydraulic system, separated from the potable water, avoiding the interchangeability between both potable and non-potable systems, water use outlets with restrictexc access, for usage, visual signs that indicate where the non-potable system is located for users awareness, description of procedures, managers qualifications, among others.

The sustainability of a While taking into account Ao considerar a building, in terms of water use, actions taken based on water conservation with the use of alternative sources to the public system must be reviewed after the implementation of actions taken for the lowest consumption indicators possible as a result of the Efficient Use of Water.

Check annex 1 for remarks regarding the use of non-potable water systems.

The life cycle of a Building

A building is planned, designed, and built for a specif type of use, and into a specific location.

Based on its purpose, location, target people, installed equipment, the entrepreneur guidelines, its legal framework, the Architecture design project determines the necessary spaces and settings, the Structure and Foundation Design provide the bases for the structure and the Building Systems Design provides the infrastructure for the use and operation of services related to supplies and of utilities like water, energy, etc.

All the different stages of planning, design and building make up for the process of the construction of a building and they all require professionals and experts of different fields, with the specific qualification and knowledge to carry out the respective stages of the building process.

The decisions and actions taken by these professionals during the building process determine the level of the building performance and the specifications of the use, operation and maintenance throughout its lifespan.

And these are the moments; the planning, designing and building stages where technology-based actions can be taken that will determine the possibility of an efficient use of water during the whole lifespan of the building.

The table 1 shows some examples of characteristics of the Building Hydraulic System determined in the Design Project, which can affect the building´s water consumption indicators:

Table 1. Examples of the Hydraulic Building System characteristics determined in the Design Project and which can lead to water waste

Characteristic	Event	Situation
An excessive water flow in water output	Hands washing	Part of the water is used for washing the hands and the other part splashes and it may get the clothes and the countertop basin wet, besides the fact of the unpleasant situation of all the water splashed. It leads to an excessive use of water for some of its water was not used for its final purpose. Restricting the flow in that water output avoids water waste.
	Taking shower	Due to type of shower installed. The dispersion of the water jet can splash way more water than necessary and lead to water waste, for some of the water splashed doesn´t even touch the users´ skin and, therefore, is not used in the users´ bath. Restricting the flow of the shower jet avoids water waste.
Inappropriate Sanitary Equipment for the purpose	Turning off the kitchen faucet	The hand full of grease may not be capable of turning off the faucet all the way through if the faucet handle is round (for the hands can slip in its surface), which results in water drip. Specifying a faucet with a lever handle, for example, would avoid water waste.
Equipment and its components not manufactured according to the regulations	Hands washing	If the flow of the water jet is used above the maximum amount specified in the equipment regulations, some of the water will not reach the users´ hands and, therefore it is not used. Installing metals that are manufactured in accordance with the technical regulations of the product avoids the waste of water.
	A visible or invisible leakage in sanitary equipment or pipe.	A dripping faucet caused by the non-sealing of the internal parts of the sanitary equipment. A rupture in pipeline, caused by a lack of resistance in the material due to the loads produced by the hydraulic system.

Wrong positioning of the System Components	Overflow in water tank	Positioning the overflow warning pipe, the warning sound or the warning light to indicate tank overflow in places with high circulation or presence of people result in a faster detection of tank overflow and it reduces water waste.
	Taking a shower	A gas heating system without a hot water recirculation pipe can result in cold water flow for a significant period of time until the hot water comes out. The cold water is wasted.

After the building delivery process, the usage, operation and maintenance conditions can also have an impact in water consumption indicators

The Table 2 presents some examples:

Table 2. Example of situations that can lead to water waste in an occupied building

Component	Situation	Consequence
Pressure Reducing Station	Loss of the regulated pressure adjustment specified in the Design Project, due to lack of preventive maintenance or due to maintenance performed by a non-qualified professional	An excessive use of water in the outlets caused by the eventual increase of the water flow
Float valve	Bad functioning.	Water tank overflow.
Water Supply System of the Building	A crack in the pipeline or coupling misalignment.	Water loss.
Torneira	Dripping.	Water loss.

The characteristics of the design project, the construction usage, operation and maintenance of a Hydraulic Building System in a building contribute to a higher or lower indicator of water consumption. The examples above describe the design or operation conditions that result in an increase of the indicators of water consumption, despite user's habits or behavior, regarding the use of the water in daily tasks.

2. WATER DEMAND MANAGEMENT

According to Silva[8], 2004, "... economic, environmental and political issues have triggered a process of paradigm shift in dealing with the water scarcity issue: it is not only about searching for water in farther places anymore, in clear attempt of taking hold of water supplies", but also of reducing the amount of water that is considered by the people, to be necessary, without affecting the quality of tasks performed with water consumption. This new management, called Management of Demand, aims at using the locally available water in a more efficient way".

Technological actions make the use of water become more efficient and it provides better consumption indicators. However, it is the Water Demand Management that will guarantee that these indicators don´t go up over time and prevent the consumption increase. This happens through a continuos monitoring and the immediate correction when a non-expected or unwanted increase in consumption occurs.

The Management of Demand enables the quick perception of a not expected increase of water consumption, which makes the correction return the indicators to its original marks in a shorter time.

Reading the water meters, at the same time every day enable the direction of irregularities in the water consumption (leakings, for example) which would only be noticed, otherwise, in the raise of the bills, that are issued every 30 days and, therefore, avoiding a significant amount of water loss.

The University of São Paulo is an example of a successful case in Management of Demand due to the actions taken to optimize the water consumption besides keeping continuos management of the demand of water in Cidade Universitaria da

8 Silva, G.S., Programas Permanentes de Uso Racional da Água em Campi Universitários: O Programa de Uso Racional da Água da Universidade de São Paulo. Dissertação (Mestrado em Engenharia) – Escola Politécnica, Universidade de São Paulo, São Paulo, 2004.

USP[9] since 1998. Despite the increase in over 10% Como caso de sucesso de Gestão da Demanda podof the population and the campus constructed area since then, the water consumption was reduced by roughly 52%, going from 137 thousand m³/month in 1998 to 66 thousand m³/month in 2014.

Whereas, in some of the existing buildings in where these actions for consumption reduction were taken but that were not combined with the continuos management of the water demand, the consumption indicators had an immediate and significant drop but after a while the consumption marks increased again.

According to Silva, "if one aims at increasing the correlation between the consuming unit and its water consumption, the meters can be placed by sector as a toll for a better Water Demand Management". It can be done by placing water meters in strategic points of the hydraulic system, in addition to the one, located in front of the building, placed by the utility companies.

Making the residents aware of the proceedings for operating the systems and the maintenance routine and preventive programs that are in the Manual for Use, Operation and Maintenance, and in the Owner´s Manual can not only provide them guidance on how to proceed but also allow the residents on redsidential buildings to participate in the Water Demand Management in their apartment units and in common areas joining the efforts to achieve the efficient water use indicators and maintain those marks.

9 Actions taken based on the PURA-USP effortst for the optimization of the water consumption, USP Rational Use of Water Program, carried out in association with Sabesp.

3. HYDRAULIC SYSTEMS IN A BUILDING AND THE EFFICIENT USE OF WATER

"A System is an interacting group of items that form a unified whole"[10].

The Building System is made of a group of Subsystems (Figura 3):

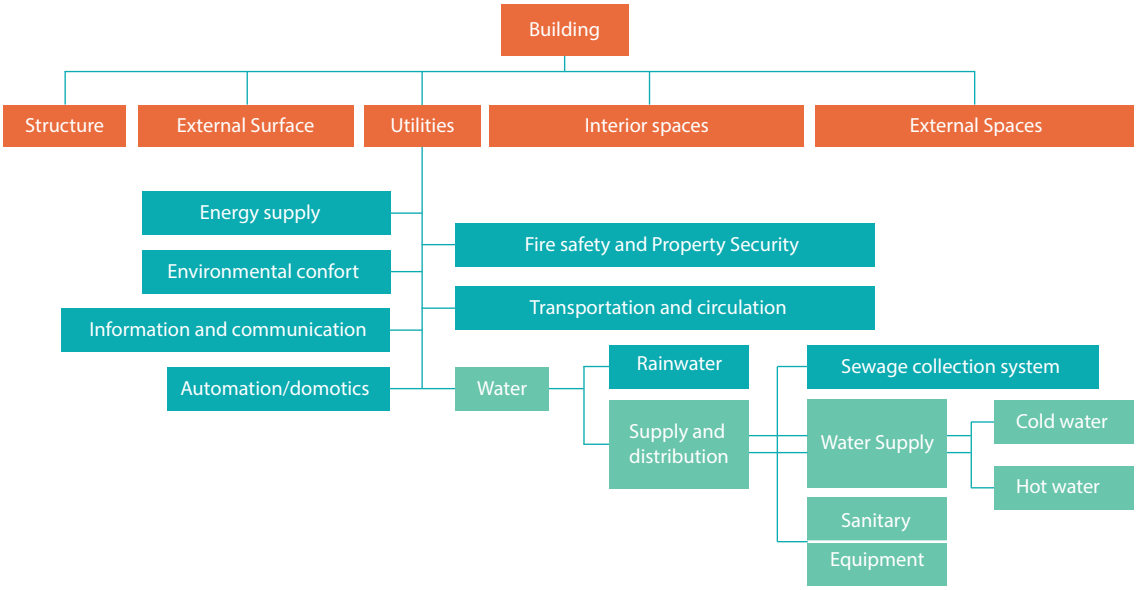


Figure 3 – Subsystems that form the System of a building. Source: Tamaki[11]

"Systems of a building are physical systems integrated into a building that have the purpose of providing users with the necessary utilities support"[12]. Systems of a building are the ones that provide the necessary infrastructure for the use and operation of the utilities in a building. Among the Systems of a Building the "hydraulic Systems" stand out, which are the system related to water supply and wastewater (sewage), potable ou non-potable.

10 Kaufmann Jr, D.L. Sistemas Um: Introdução ao pensamento sistêmico. Minneapolis: A. S. Carlton Publisher, 1980. The Innovative Learning Series. (Tradução de: Systems 1: Na Introduction to Systems Thinking.

11 Tamaki, H.O. A Medição Setorizada como instrumento de gestão da demanda de água em sistemas prediais – estudo de caso: programa de uso racional da água da Universidade de São Paulo. São Paulo, 2003. Dissertação (Mestrado em Engenharia). Escola Politécnica da Universidade de São Paulo.

12 Gonçalves, O.M., Contribuições para a economia e qualidade dos sistemas prediais. São Paulo, 1997. Concurso de Livre-Docência. Escola Politécnica. Universidade de São Paulo.

The Hydraulic Systems in a building are made of the Rain Waters Systems and the Water Supply and Distribution System.

The Water Supply and Distribution System, pictured in Figure 4, includes the Water Supply Systems, Sanitary Equipment and the Sanitary Sewer Systems.

The constructions of buildings that provide means for an efficient use of water require a special attencion to the Water Supply Systems and the Sanitary Equipment.

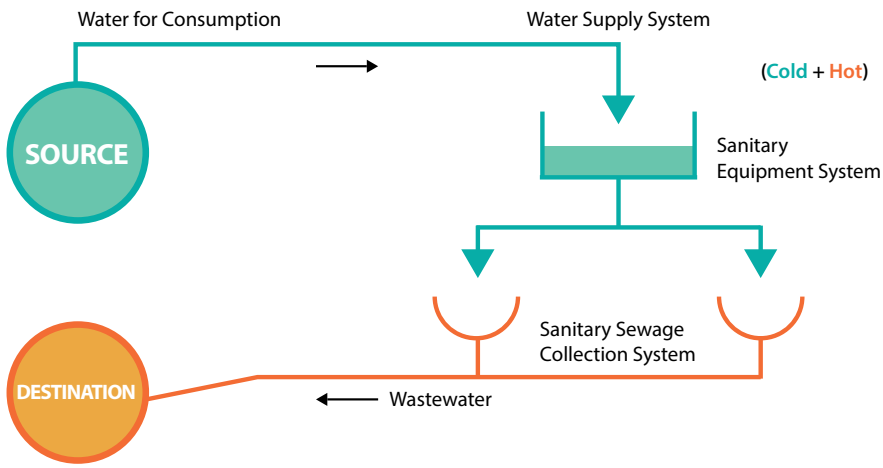


Figure 4 – Water Supply and Distribution Systems. Source: Gonçalves[13]

The Water Supply System[14] starts with the public water supply network or private sources, then it goes to subsystem of supply and it ends up in the distribution system. The Water Supply System must provide water as needed with the required quality for its main purpose in a manageable amount and temperature.

13 Gonçalves, O.M. Notas de aula da disciplina PCC-2465 Sistemas Prediais I. São Paulo: Escola Politécnica da USP, Departamento de Engenharia de Construção Civil, 2002.

14 Ilha, M.S.O.; Gonçalves, O.M. Sistemas Prediais de Água Fria. São Paulo: Escola Politécnica da USP, Departamento de Engenharia de Construção Civil, 1994. (Texto Técnico. EPUSP. TT/PCC/08).

The Sanitary Equipment System makes water available through their water outlets.

Normally, the Water Supply System is included in the Building Systems Engineering Project and the Sanitary Equipment System is included part in the Architecture Design Project and part in the Building Systems Engineering Project.

The technical regulations and legal requirements in effect, in general, favor the construction of buildings that meet the minimum quality standards focused on the operation considerer to be the most suitable for building systems, technically speaking. To construct a building in accordance with technical regulations and legal requirements does not necessarily make the efficient use of water a reality.

Oliveira (1999)[15] has determined the following definitions:

- **Loss**: the water that gets out of the system without being used for a specific purpose. Usually, water loss happens due to leakages (water escape from the Hydraulic System through pipelines – pipes and connexions – operation components, tanks, equipment – motor-pump sets and others), a bad functioning of the system (for example recirculation of hot water system functioning badly, that is, taking a long time to work thus resulting in cold water loss until the hot water comes out and can be used) or the user´s[16] carelessness (not turning off faucets all the way through after using in, either due to inattention or to disregarding of replacing it for a new faucet).

- **Excessive use**: when the water is used in a specific task in a wasteful way[17] (inappropriate way to proceed) or due to a bad functioning of the system (water outlet with a water flow amount beyond necessary for the purpose, or the wrong sanitary equipment for its purpose).

- **Waste**: all the water available in a hyderaulic system that gets lost without being used for a specific pur-

15 Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Tese (Doutorado em Engenharia) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999.

16 Ocorrência comportamental, não é objeto deste documento.

17 Ocorrência comportamental, não é objeto deste documento.

pose but in an excessive way. The concept of waste comprises both water loss and the excessive use of water.

NBR 15575 - Edificações Habitacionais-Desempenho (in Portuguese), in its Section 6 - Requisitos para os Sistemas Hidrossanitários (Requirements for Hydro-Sanitary Systems), has established the "National use of water" Requisite, for the water demand reduction in the public supply system and consequently resulting in reducing the sewage for treatment. When drafting the regulations text for a project, specific criteria and assessment methods should be included in it in order to promote actions against the waste of water.

The Construction Project, of all the aspects of a building, is the main instrument that will provide the necessary technological conditions for the Efficient Use of Water in the building, particularly the Engineering Building Systems and the Architecture Design projects.

The Ownwer´s Manual is the one that allow the users to get to know about the technology installed in the building and all the use, operation and maintenance conditions necessary for achieving the eficiente water use indicators.

The Criteria and Parameters of the Project determine the result in the consumption indicators during the occupancy of the building, which can increase the prevention of water loss (leakages), it can determine how fast the detection and correction of a water waste situation can occur, it establishes the pressure and flow of water in the outlets and what will be the guidance provided in the Owner´s Manual on how to make a better use of water.

Throughout the Design Processo f a Building Construction, the interaction of the multiple áreas of knowledge working togheter is of vital importance. Having the Efficient Use of Water as its the main focus the joint work between the Architecture and the Engineering Building Systems professional is decisive for the Systems good functionning after being occupied. And that happens through establishing the criteria and parameters of the project in a joint effect.

Water Supply System

The Water Supply System comprises the cold and hot water systems regarding the supply, storage and distribution of it. Figure 5 pictures the basic structure of the Water Supply System tha is usually used in vertical residential buildings in Brazil.

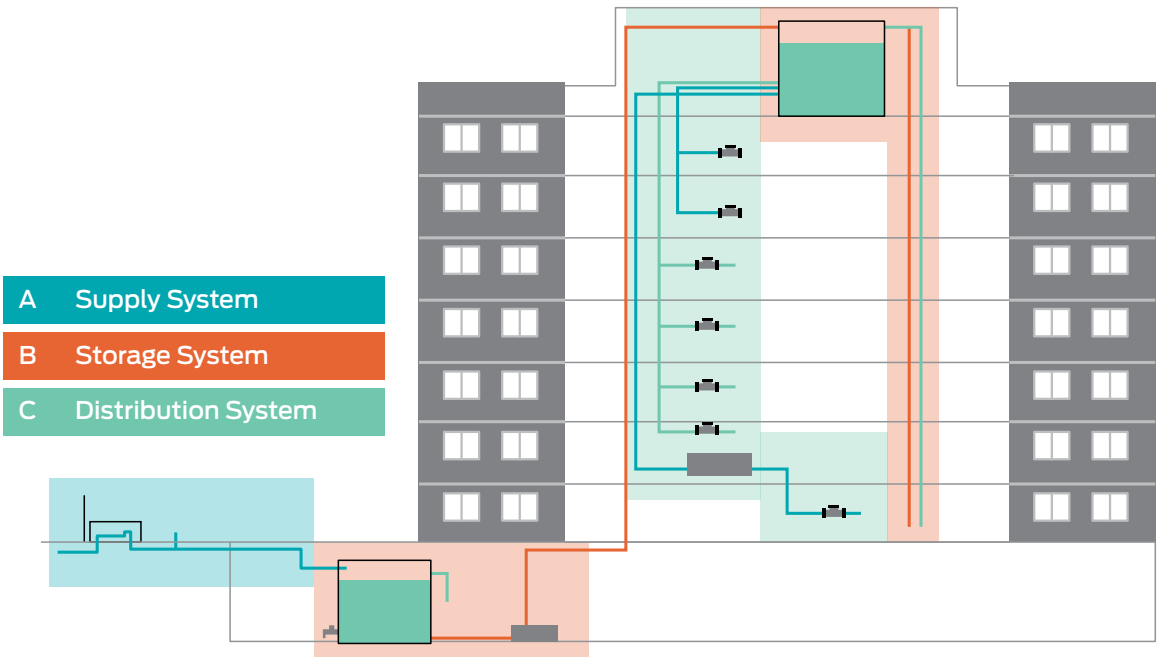


Figure 5 – Water Supply System esqueme

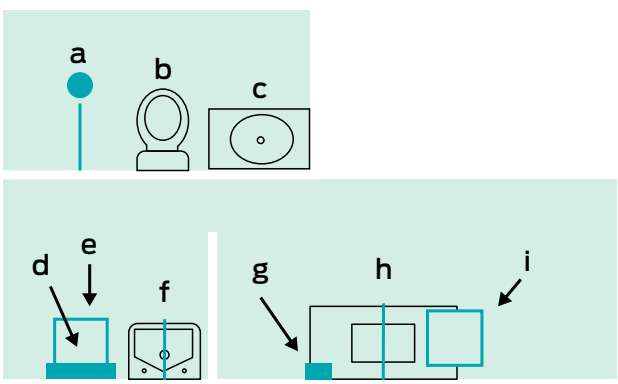
- Supply System: brings the water from the supply source, usually the public supply system, to the Storage System.
- Storage System: stores water for human consumption and other purposes (fire protection systems, for example).
- Distribution System: com the storage system to the water outlets.

With the Eficient Use of Water and the Demand Management in mind, it is also important to bring to attention the Measurement Systems (Annex 2), which is meant to quatify the consumption of water of the building or of parts of the building.

Sanitary Equipment System

The Sanitary Equipment System, installed as the users and the Water Supply System interface, includes bathroom fittings, metal sanitary ware and equipment that allow the water to flow or to be interrupted from the water supply system whenever needed.

Figure 6 describes the main water outlet points that are usual in an apartment.



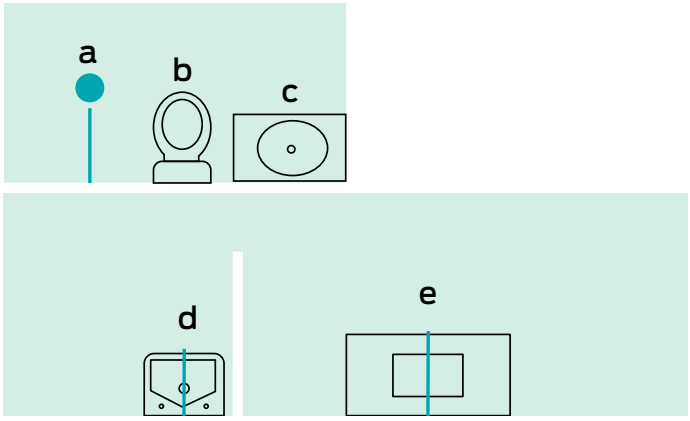
a shower or bath
b toilets
c washbasin
d continuos gas heater
e washing machine
f sink
g water filter
h kitchen sink
i dishwasher

Figure 6 – Main water outlets in apartments

It is important to point out that not all the points of water outlets in apartments require specific technology to offer better efficiency in water use. Specific actions taken in the Project Stage won´t alter the water consumption indicators in an apartment due to the use of washing machine, for example. A greater or lesser flow of water in this type of outlet will only have an impact on the time required to fill up the washing machine. Having an efficient use of water in this kind of outlet depends solely on the equipment efficiency (used purchased and installed by the user) and the frequency of use. In this case, an efficient consumption of water is a result of the user´s behavior when choosing the equipment and in the way it is handled.

With this in mind, the Owner´s Manual should provide guidelines for the users regarding the purchase of efficient equipment and on how to use them for an optimized use of water. That information can be obtained from the manufacture companies.

The outlet points that require some technological intervention in the Project Stage, in order to enhance efficient use of water, are described in Figure 7.



a shower or bath
b toilets
c washbasin
d sink
e kitchen sink

Figure 7 – Water outlet points in apartments that require technological interventions in the Project Stage for an Efficient Use of Water.

Despite the user's habits, the outlet points described in Figure 7 contribute to either increase or decrease the water consumption indicators in apartments regarding the prerequisites and criteria adopted in the Building Project, in the Owner´s Manual and the correct use, operation and maintenance proceedings.

4. HYDRAULIC SYSTEMS PERFORMANCE

The ABNT NBR 15575 – Edificações Habitacionais–Desempenho (Residential Buildings Performance), Parts 1 to 6, published in February 19, 2013, effective from July 19, 2013 on, defines Performarce as the "performance of a building and its systems under use".

Considering Performance, for the user, turning the shower handle and taking a bath with comfort and sanitation, is all that matters. At first, the user won´t be concerned about what kind of material was used in the pipeline that brings the water, or the way the pipeline was installed in order to carry the water all the way to the shower or even the process the heats up the water. Taking the water from the supply source all the way to the shower outlet, and provide the user with quality and efficiency in terms of water, which means necessary quality, quantity and temperature for the activity of a shower that is the result of the building process.

The user wishes to reclive the water in adequate quantity, quality and temperature for the shower, once he turns the shower handle and based on these conditions, he will either be satisfied ou unsatisfied. The result of this satisfaction will determine the quality of the System Performance according to the principles in NBR 15575.

A Heating System that provides water with the necessary quality, quantity and temperature for a shower is a subsystem that fits in to the "comfortable bath requisite".

If the water flow provided for the shower is greater than the necessary flow amount for a comfortable bath, there will be waste of water despite the duration of the bath.

Providing water with the necessary and sufficient quantity and temperature means that the system meet the requisite of a "confortable bath" and it also promotes the efficient use of water.

The performance of a system is related to its capability of fulfilling its purpose and of keeping its good results throughout the period for which it was meant to. The criteria for a good Performance of a System may vary depending on the location where the building will be constructed. It may also vary according to its user in a same apartment, or due to the climate, or the kind of user and his cultural habits, among others. It can even vary according to the conditions to which the System was exposed to, be it external (environment) or as a result of the occupation (usage, operation and maintenance).

Being aware of the characteristics of the users that will reside in a certain building, their demands and needs, and the conditions to which the systems will be exposed to, may allow a better description of the Performance Requiments during the construction process.

According to Graça; Gonçalves (1986)[18], the Performance of the Systems is directly related to their compatibility to the users demands and needs, regardless of the items that will be installed. In addition, these items performance are directly related to their longevity and capability of working as part of a System and contribute to the whole system good performance during the period determined to do so.

In order to approach the Systems based on the Performance Concept, Graça; Gonçalves (1986) suggests the following stages:

- Describe the users of the system;
- Determine what are their needs and demands;
- Identify what will be the conditions to which the System will be exposed to;

18 Graça, M.E.A.; Gonçalves, O.M. Desempenho de Sistemas Prediais: Conceitos Fundamentais. Revista Engenharia Mackenzie, São Paulo, p.7-13, jan./fev. 1986.

- Establish the performance requirements of the System;

- Establish the criteria of Performance of the System;

- Determine the methods for the performance assessment of the System.

The Construction Project is the key instrument for meeting or not the Performance Requirements established for a specific building. And it is throughout the Owner´s Manual that the user will receive the necessary information to know how to proceed in order to get, and maintain, the Performance intended originnaly, by the project.

Characteristics of the Users

The characteristics of the users are directly related to the building typology. A single person may have different needs in a residential building and in an office building, for exemple. And also, different users in the same building will have different kinds of behaviors and habits.

In its wide sense, the group of “users” of a residential building is made of all of those considered “interested” in a way, in the results of the building construction process (stakeholders): Builder, solicitor, agent/sales staff, certifier, structural engineer, designers, architects, owner´s, managers, neighbours, residents, visitors, employees, service providers, animals and vegetation, etc.

When it comes to the occupation of the building, the group of users to be described for establishing the Performance Requirements is comprised by: residents, visitors, staff, maintenance professionals, animals, vegetation and equipment.

Such groups of users present the following specific characteristics that affect the use, operation and maintenance of the system in a residential building:

- **Education**: the residents have different education levels;

- **Purchase power**: the purchaising power of the potential clients to whom the building was destined, will determine the range of prices of the condominium fee which will also affect the operational and maintenance procedures that the building manager will be able to afford.

The operational and maintenance dynamics of residential buildings can also be described by:

- **Responsabilities:** the responsabilities and onuses of the operation and maintenance of the apartments and their owners or tenants. The responsibility of operating and maintaining the common areas is the manager´s with the costs split among all the residents. Neither owner´s, or tenants, nor managers actually have the specific technical qualifications for the necessary decisions on determining the operation and maintenance routine of the many Systems in the building. In general, the "manager´s" position is rotating, with constant changes over time;

- **Decision-making Dynamics**: the decisions that have an impact in the condominium fees or that alter the original characteristics of the building are necessarily taken in Condominium meetings. Condominancial priorities and power;

- **Water management**: in general, managers, residents and janitors of residential buildings are not aware or do not keep track of the water consumptions in the building. Concerning the water bills, they perceive some impact when they see a difference in increase over month, every 30 days, the moment the bill arrives, in case the figures have a significant raise compared to what was expected, the manager may take an action regarding the matter. Residents tend to pay for the water consumption by the equal share of the bill and which is usually added to the other expenser of the condominium. Residents usually don´t have access to the water consumption bills and may not even perceive the increase in consumption or the raise in the cost of the bills.

- **Condominium Administrators**: most of the condo administrators do not offer technical sataff to give assistance to managers or reditents in the decision-making process regarding systems operation and maintenance.

The profile of this specific user can´t really operates and maintains the building systems correctly. It is very common to see in residential building pressure reducing valves that are not regulated inappropriated changes in the hydraulic system, wrongful cleaning in water tanks, high water flow in outlets, etc.

The users need support, information and guidance so that they will be able to get and maintain the Performance of the Systems thar were originally designed to be.

Users Demands and Needs

A building is designed to meet the targeted users´ specific demands and needs.

Such demands and needs are related to the kind of activities that will be carried out by the users in that building.

The building typology, its location and its user's characteristics constitute the main factors that will determine the demands and needs of these users.

The activities or tasks that require cold and hot water in a residential building indicate the Performance Requirements that need to be fulfilled by the Water Supply Building System and the Sanitary Equipment.

The activities that require cold and hot water in an occupied Residential Building basically cover:

- **Food**: food washing, preparation of food and beverages, dish washing;
- **Personal hygiene and health**: body washing (children and adults, both partially or complete), caring for the sick;
- **Cleanning personal objects**: clothes washing and similar activities;
- **Environment cleanning**: conservation and cleaning of floors, furniture, utencils and decorative objects, waste removal;

- **Leisure and others**: cleaning and maintenance of swimming pools, water tanks cleaning; gardes watering; pets bathing, etc.

The Hydraulic Systems in Buildings are designed to provide the necessary conditions for carrying out these activities and tasks.

Exposure Conditions of the System

The condictions that a system can be exposed to are related to:

- Impacts to the system due to its use;
- Impacts in the system due to the environment;
- Impacts of the system over the environment.

It can be pointed out, for example:

- Impacts over the System due to its use: damage caused by accidental situations, damage caused by the incorrect use of the system, heat transmission effects, water pressure, static and dynamic charges cracking, erosion and wear;
- Impacts over the system due to the environment: climate; construction, changes in temperature, static and dynamic charges, corrosion;
- Impacts of the System over the environment: damage caused by water, static and dynamic charges, damages due to repair and maintenance, decrease on strength structural elements, bacteria and fungus growth.

An underground metal pipeline, for instance, requires protection described in the Construction Project in order not to be damaged by corrosion. Underground pipeline located in a site with the impact of heavy loads, requires protection to avoid cracking, and it is described in the Construction Project.

Performance Requirements

The NBR 15575-Edificações Habitacionais-Desempenho-Parte 1 (Residential Buildings-Performance Part 1): General requirements, provides a general list with the Requirements for Users used as a reference for the establishment of Performance Requirements for the many subsystems that form the residential constructions (Figure 8).

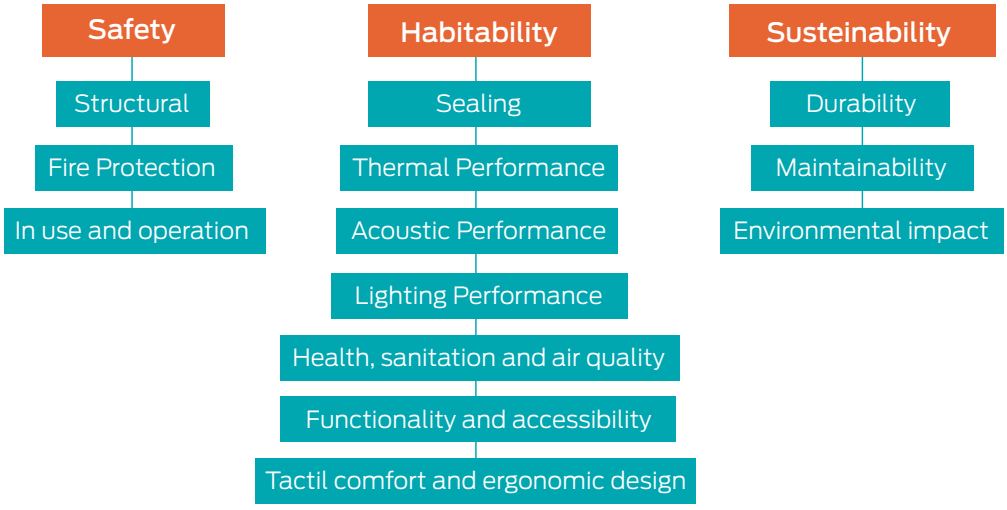


Figure 8 – User requirements of residential buildings
Source: ABNT NBR 15575-Part 1

The Figure 9 points out the User Requirements to be met by the Water Supply Systems and Sanitary Equipment for an Efficient Use of Water.

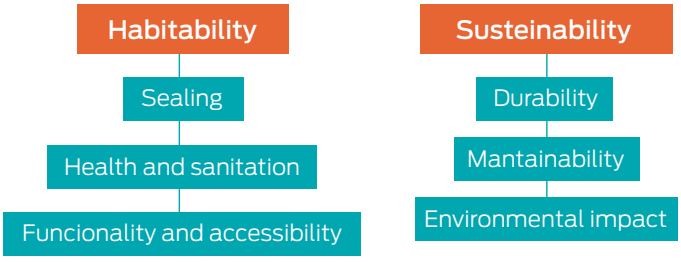


Figure 9 – User Requirements with an impact in the efficient use of water

Based on the Efficient Use of Water efforts, such User Requirements take into account:

- **Sealing**: prevent the occurrence of leakage.
- **Health and sanitation**: to ensure the quality of the activity – preventing from contamination and burn injuries.
- **Functionality and accessibility**: to allow and facilitate the appropriate use and operation of the systems.
- **Durability**: to reach the lifespan planned in the project.
- **Maintainability**: To allow and facilitate the appropriate maintainability of the systems
- **Environmental impact**: To minimize the environmental impacts caused by the building; to favor the demand management.

Based on the User Requirements the following Performance Requirements can be established having an impact in an efficient use of water as a result. (Figures 10 and 11):

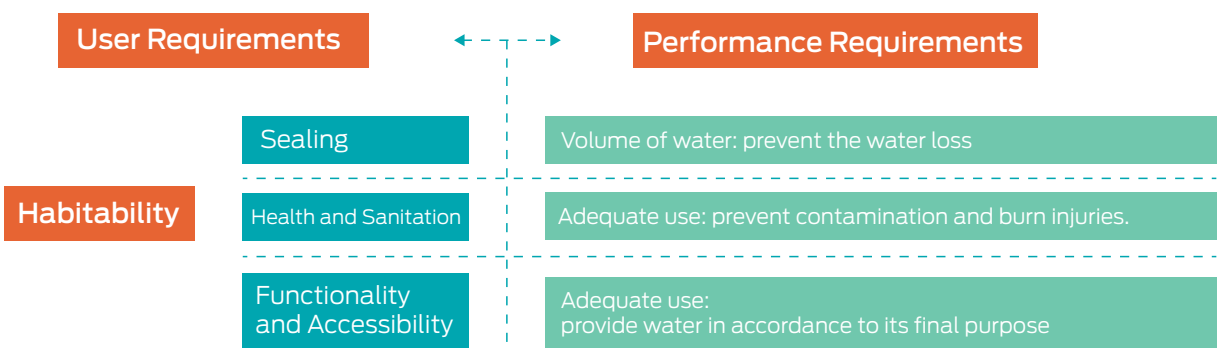


Figure 10 – Habitability: Performance Requirements for the efficient use of water

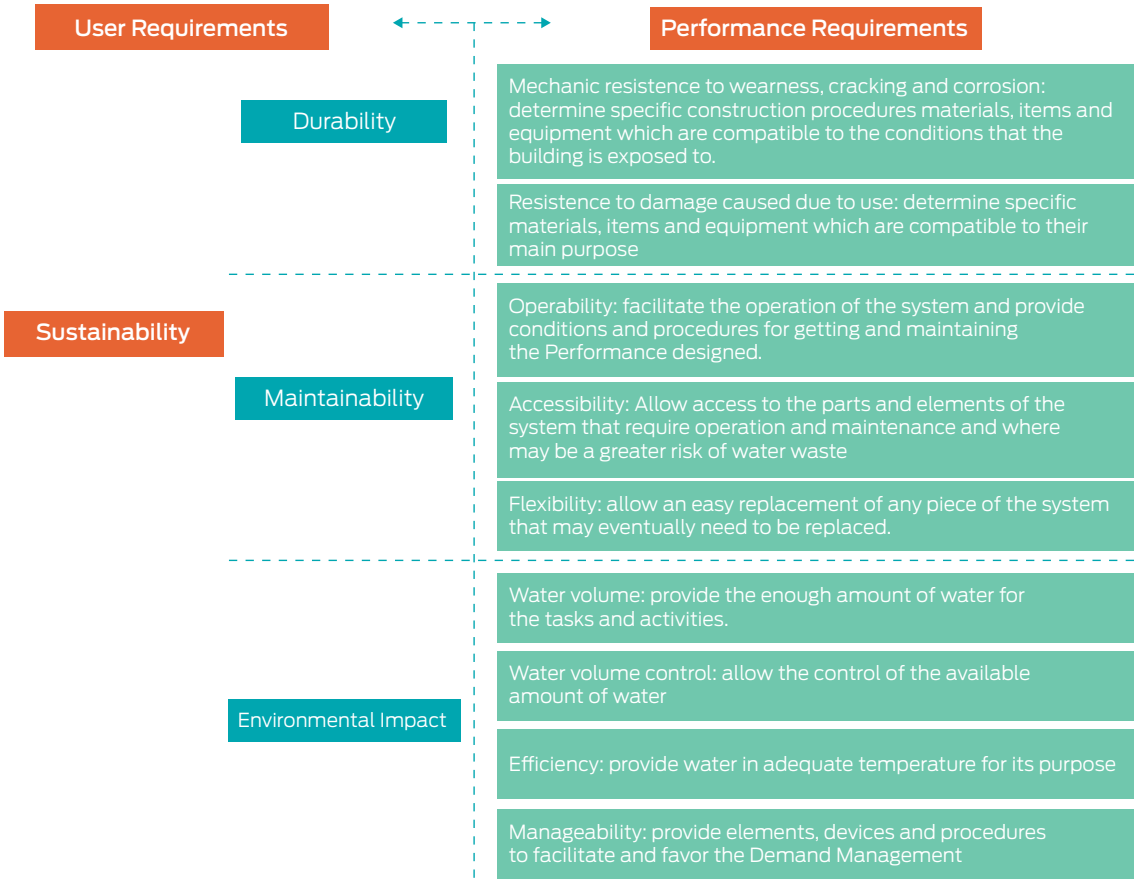


Figure 11 – Sustainability: Performance Requirements for an Efficient Use of Water

Each Construction Project is designed for a specific building located in a specific land, for a specific group of users and specific local characteristics of legal requirements. Based on the utilities that will be offered and the activities that will consume water, other Performance Requirements may be established. Each of these requirements will have an impact on one or more subsystems of the water supply Systems and Sanitary Equipment.

Performance Criteria and Evaluation Methods

At each Performance Requirement, Performance Criteria, that translate such requirements in to prerequisites and parameters that will be considered in the construction process (plan, design, and construction (use, operation and maintenance) are added. The way to identify if the Performance Requirements are being met is through the use of Evaluation Methods that make it possible to evaluate if the specified Performance Criteria are followed. The Table 3 describes this process.

Table 3. Example of the Evaluation Method applied for the Performance Criterion. This will be established in order to fulfill the Performance Requirement which translates the Requirements for Users.

User Requirements	Environmental Impact
Performance Requirement	Water volume: supply water in enough volume to fulfill its main purpose
Performance Criterion	Limit the water flow in the shower, in the Project
Evaluation Method	Measure the water flow in the shower, in the installed system, valid between 0,15 ± 0,02.

5. PROJECT OF WATER SUPPLY SYSTEMS AND OF SANITARY EQUIPMENT

The Water Supply Systems and Sanitary Equipment, or Water Systems in Buildings, are designed to meet the pre-determined Performance Requirements. The Water Systems Project for Buildings is created based on a certain Architectural and Structural Project in order to carry and provide water in the outlet point at the right pressure, flow and temperature conditions, according to the technical requirements and legal regulations.

The Project can still result in a building that consumes more water that the necessary amount for the activities carried out, even if it is in accordance to the technical requirements and legal regulations.

Making the Efficient Use of Water a reality in a building means adopting specific criteria (pre-requisites and parameters during the Project stage, that by meeting the stablished performance requirements will provide the building with the necessary technological conditions in order to avoid water waste.

The Water Supply Systems Project must consider solutions that will minimize the risk of water waste and that, in case it happens, it should be of easy detection and repair.

In order to meet the Performance Requirements aiming at the Efficient Use of Water, the Project for the Water Supply System in a building should consider:

Sealing	Water volume: prevention of water loss

- Specify materials, items, elements, and equipment that are compatible to the exposure, use, operation and maintenance conditions.

- Specify construction procedures that will ensure the perfect coupling alignment in pipelines and equipment.

Sanitation and Health	Appropriate for use: avoid contamination and burn injuries

- Provide the sufficient amount of water for carryng out the tasks and their main purpose, without the submitting the user to health or hygiene risks due to the insufficient use of water.

It is worth to point out the "dangerous" combination of "water volume reduction" and "temperature raise". The temperature of the shower must be limited to 43o.C degrees to avoid burning incidents in users. Acording to the American Society of Sanitary Engineering, ASSE[19], for showers that have a small flow of water (about 6 l/min) it is required that they have protection devices that avoid the raise in temperature above 43o.C degrees is a requirement (automatic compensating type shower valve).

- To avoid crossed connexions[20] during the construction or any future renovation of the system.

Funcionability and accessibility	provide water in accordance to its use purposes

- Specify equipment and devices that are compatible to the use purposes.

- Anticipate areas and spaces that allow the correct use and operation of the systems and their elements.

19 ASSE, American Society of Sanitary Engineering, "Scald Hazards Associated with Low-Flow Showerheads", março/2012, at www.asse-plumbing.org/ScaldHazards.pdf

20 Cross-connexion: croos-connexion or the risk of "connexion", either physical or not of the potable water system to the non-potable water system.

Durability	Mechanic resistence to wearness, cracking and corrosion: determine specific construction procedures materials, items and equipment which are compatible to the conditions that the building is exposed to.
	Resistence to damage caused due to use: determine specific materials, items and equipment which are compatible to their main purpose

- Specify materials, items, elements, and equipment that are compatible to the exposure, use, operation and maintenance conditions.

Maintainablity	Operability: facilitate the operation of the system and provide conditions and procedures for getting and maintaining the Performance designed.
	Accessibility: Allow access to the parts and elements of the system that require operation and maintenance and where may be a greater risk of water waste
	Flexibility: allow an easy replacement of any piece of the system that may eventually need to be replaced.

- Anticipate areas and spaces that allow the correct use and operation of the systems and their elements.

- Allow the partial or complete replacement of the systems and its equipment pieces.

- Determine, in the Owner´s Manual, procedings for use, operation and maintanence of the systems in order to achieve and maintain the Performance Designed.

Environmental Impact	Water volume: provide the enough amount of water for the tasks and activities
	Water volume control: allow the control of the available amount of water
	Efficiency: provide water in adequate temperature for its purpose
	Manageability: provide elements, devices and procedures to facilitate and favor Demand Management

- Restrict water flow in water outlets and provide the sufficient amount of water for the adequate accomplishment of the water comsuming tasks.

- To enable quick detection and correction of water waste incidents.

- Specify the Sanitary Equipment that are compatible to its outlets water flow which promote the efficient use of water.

- To enable the Water Demand Management in order to keep the water consumption indicators equivalent to the ones that result from an efficient use of water.

The following items describe recommendations to fulfill the Performance Requirements for each subsystem in order to favor the efficient use of water.

Or all the subsystems, the quality of materials, items and equipment installed is paramount to avoid water waste incidents (Annex 3). They have an impact in both the prevention of water loss (leakages due to materials cracking) and the reduction of an excessive use of water (use of greater amount of water than the necessary due to equipment installed not manufactured in accordance with the respective technical requirements).

Supply System

The supplying system of a building is designed to transport water from a Water Supply Source (usually the public supply system) to the Storage System and its mais characteristic is permanently submitted to high pressures and pressure variation. As a consequence, any small crack in the pipeline, or coupling misalignement that ruptures the sealing can lead to a significant amount of water loss, which is not always perceived and in general it is hard to be detected for usually part or all of the water supply system is underground.[21]

Leakages in a Water Supply Systems in a building may happen due to corrosion, cracks, badly installed connexions, break done by some action that hit the pipeline or by all of thses aspects combined.

If such leakages exist since the beginning of the occupation the water losses may not even be perveived throughout the years.

Mechanic resistence to wearness, cracking and corrosion: determine specific construction procedures materials, items and equipment which are compatible to the conditions that the building is exposed to.
Resistence to damage caused due to use: determine specific materials, items and equipment which are compatible to their main purpose.

The construction, the specification of materials and the installation processes must take into account the exposure conditions(-soil conta, area of vehicles circulation, etc) in a way that they over the time they will be able to endure the loads and agressions to which they will be exposed.

Optimizind the Supply System layout, avoiding ramifications as much as possible, to minimizing the number of connexions and fittings and avoiding or minimizing underground parts of pipeline are a few Project assumptions that minimize the possibility of leakage incidents.

21 The hydrants or hose riels system when submitted to high static pressures can also lead to a significant water loss through invisible leakages. The Project must contain preventive measures for them, similar to the Supply System.

Flexibility: allow an easy replacement of any piece of the system that may eventually need to be replaced.

The pipeline layout and materials specifications must always take into account their partial or total replacement.

Operability: facilitate the operation of the system and provide conditions and procedures for getting and maintaining the Performance designed.

The elements of the system must be described in the Owner´s Manual in order to facilitate its location when maintenance procedures are required – Procedures for routine inspection of the system must be established in order to detect any water loss incidents (Annex 4).

The Supply System usually has ramifications for garden taps, leisure area (barbecue area, swimming pool, and playground) and, sometimes a bathroom in the Sentry House[22]. On the one hand when there is a water disruption from the Utility Companies, such ramifications do not use water from secondary water supplies. On the other hand, they can increase the water waste due to the high pressure to which they are exposed when receiving water from the Supply System.

Water volume: provide the enough amount of water for the tasks and activities . Enable a quick identification and repair of the incident of water loss.

Control of the volume of water: Make possible the control of the volume of water

Sanitary equipment that are installed in water outlets coming straight from the supply system, which are usually destined for

22 It is not recommended to have the water supply for the sentry-house lavatory coming straight from the supply system since this toilet won't be available for use when there is interruption of the water supply by the Utility Company.

washing floors and garden watering, must be of restricted access to avoid the improper use and have its water flow restriction described in the Project as well as its constant monitoring for a quick detection and correction of water waste incidents (Annex 5).

Manageability: enable elements, devices and procedures in order to facilitate and favor the Demand Management.

Considering that it is a system subject to a significant amount of water loss, the positioning of its parts must be clearly described in the Project, in the Owner´s Manual and on-site. The future manager will need information on underground pipelines and the maximum load allowed in the area, materials that will need to be used in case of replacement, identification of the water outlets that are supplied straight from the Supply System procedures for checking the sealing of the System, among others, in other to work on the maintenance of the System performance.

Water Storage System

The water volume that should be stored for consumption must be calculated based on the population estimated for that building. According to IBGE[23], in the past two decades there was a substantial drop in the size of the Brazilian families (an average of 3 residents, according to PNAD[24] 2011).

Water storage System: prevent form of contamination.

To determine the size of water tanks to a volume greater than the needed may entail in storing water for a long period, which facilitates the risk of contamination of the water due to bacteria and fungus development (legionella, for example).

23 Brazilian Institute for Geography and Statistics, www.ibge.gov.br

24 National Household Sample Survey - PNAD

Operability: facilitate the operation of the system and provide conditions and procedures for getting and maintaining the Performance designed
Accessibility: Allow access to the parts and elements of the system that require operation and maintenance and where may be a greater risk of water waste
Flexibility: allow an easy replacement of any piece of the system that may eventually need to be replaced.

The storage tanks specifications and locations either built or prefabricated, demand attention to the installation, operation and maintenance necessary conditions in order to avoid water contamination, as well as materials that won´t compromise the water quality. The need for replacement when necessary must also be considered. The Project requirements must cover access conditions for inspection, cleaning and maintenance of the underground and rooftop water tanks, pump rooms, water barrels and tank replacement conditions when needed.

Mechanic resistence to wearness, cracking and corrosion: determine specific construction procedures materials, items and equipment which are compatible to the conditions that the building is exposed to.
Resistence to damage caused due to use: determine specific materials, items and equipment which are compatible to their main purpose

The storage tanks specifications and locations, either site built or prefabricated, must consider the system exposure conditions during its operation and also its partial or complete replacement when needed.

Water volume: provide the enough amount of water for the tasks and activities . Enable a quick identification and repair of the incident of water loss.
Control of the volume of water: Make possible the control of the volume of water

The systems of overflow control and overflow warning must provide mechanisms against overflow and in case overflow happens, it must provide a quick detection and correction. A device[25] for water entrance control must be compatible with the daily waterflow consumption and at an accessible location for routine inspection and maintenance, for prevention or correction, when needed. Overflow warning pipes must make the water flow out to places where they are visible for people or they must have a warning light and/or warning alarm in a place where there are people present.

Manageability: provide elements, devices and procedures to facilitate and favor the Demand Management

Water tanks overflow lead to a significant amount of water loss. The Project descriptions must determine conditions for the immediate detection and interruption of the overflow (easy access to it), and the Owner´s Manual should contain these procedures.

Distribution System

Water flow and pressure are the main aspects to be considered in the Project for Water Distribution System, in order to give attention to the Efficient Use of Water during its use and operation:

- The higher the pressure to which the hydraulic system is subjected to the higher the water loss, even for a single sized outlet. Under a higher pressure, a crack in the pipeline or connexion will result in a greater leakage.

- The greater the water flow in the water outlet, the greater the amount of water provided, which can lead to an excessive amount used (using over the necessary amount of water for accomplishing a specific task).

25 Float valve or water control valve.

The ABNT NBR 5626/98 restricts the maximum static pressure in the system to 40 mca. The regulation was revisited and it reduced the static pressure to a maximum of 30 mca. This reduction happened due to the inclusion of the efficient use of water concepts to its requirements: in case there is a leakage in the system, the higher the static pressure is the more water is lost.

Water volume: provide the enough amount of water for the tasks and activities

Probabilistic methods that use dimensioning have been greatly used in water use contexts, since they provide the information on characteristics and local habits in water use, the number of users in each place where there are sanitation facilities and the frequency of use. They should be preferably used for these purposes (Annex 6).

Efficiency: provide water in adequate temperature for its purpose

Water heating systems, whether central or private, of circulation or accumulation, can generate significant loss of cold water at water outlets[26,27]. The Project should be designed to avoid the loss of cold water when the system is activated at the outlet, regardless of the type of heating system selected. Water Heating Systems, including gas-fired water heaters, must contain recirculation pump pipe connecting the heater and the farthest water outlet[28]. For gas flow Heating Systems, the distance between the heater and the farthest outlet point should be, on the other hand, as shorter as possible, with the necessary isolation to avoid heating loss while the water runs in the pipes.

26 When the system is activated, it first eliminates the cold water in the pipe, and then the hot water comes out

27 This does not happen when the water is heated by an electric shower.

28 The system can be specified as a whole or in parts, as far as the required infrastructure is provided. The gas flow water heaters industry provide equipment with recirculation pump incorporated to the heater and an automated system that allow programming. The system components can also be specified separately, which allow the buyer, in general the user, to decide whether or not to purchase the complete system.

Accessibility: Allow access to the parts and elements of the system that require operation and maintenance and where may be a greater risk of water waste

Flexibility: allow an easy replacement of any piece of the system that may eventually need to be replaced.

Operability: facilitate the operation of the system and provide conditions and procedures for getting and maintaining the Performance designed.

The places where the elements of the system are located must be clearly described in the Project, in the Owner's Manual and physically, in strategic points of where the system is located, in order to facilitate the location of water losses and to correct them, when necessary. Including in the Project the provision of appropriate spaces for operation and maintenance of the system (eg. the replacement of flexible hose pipes is necessary over time and they should be located in places that allow their access).

Manageability: provide elements, devices and procedures to facilitate and favor the Demand Management

Provide guidance in the Owner's Manual so that the access to the elements of the system is not obstructed by the subsequent installation of cabinets, for example. Describe in the Project, in the Owner's Manual and on site, in a clear and permanent way, the specific characteristics of how the pressure reducing stations, the pressurizers and the flow restriction devices (pressure input and output) should be set. Specify materials that are accessible for purchase and replacement.

Water Metering

Manageability: provide elements, devices and procedures to facilitate and favor the Demand Management

The main instrument for the Water Demand Management is the continuous monitoring of consumption, through measuring separate sectors. In order to enable the efficient use of water, the Project should establish the necessary conditions for separating the consumption of water into sections (Annex 2) and the Owner's Manual should establish procedures for the monitoring of such consumption (Annex 4).

Sanitary Equipment System

The efficient use of water in buildings is directly related to the water flow at water outlet points, according to the sanitary equipment installed.

Traditionally, in Brazil, part of this equipment is supplied by the construction company (faucets, faucet handles, sanitary basins) and part of it is purchased and installed by the user (showers, water heaters, washing machines, dishwashers). And still, another part of the Sanitary Equipment is determined by the Engineering of Building Systems (water supply valves, heaters) and the Architecture professionals (taps, sanitary basins).

Water volume: provide the enough amount of water for the tasks and activities.

The restriction of water flow at the water outlet points will be determined by the selection of the Sanitary Equipment and the provision, if necessary, of flow restrictor devices, according to the pressure determined in Project for each water outlet (Annex 5).

Water volume control:
allow the control of the available amount of water

Water volume:
provide the enough amount of water for the tasks and activities

Each sanitary equipment is manufactured to operate under certain conditions of water pressure and flow. The technical specifications for operating this equipment (flow and pressure) must be requested from the manufacturers and observed for that specific Sanitary Equipment. Facilitating the efficient use of water requires selecting the specific Sanitary Equipment manufactured to operate, at a good performance, with a lower water flow.

Resistence to damage caused due to use: determine specific materials, items and equipment which are compatible to their main purpose

Flexibility: allow an easy replacement of any piece of the system that may eventually need to be replaced.

Specifying the appropriate Sanitary Equipment requires taking into consideration the exposure conditions to which they will be submitted during occupancy and the maintenance required over time, with replacement of parts or all equipment. Procedures for the proper use, operation, and maintenance of Sanitary Equipment must be established in the Owner's Manual.

Operability: facilitate the operation of the system and provide conditions and procedures for getting and maintaining the Performance designed.

Manageability: provide elements, devices and procedures to facilitate and favor the Demand Management

In order to achieve and maintain the designed performance, the Owner's Manual must provide the technical specifications of the selected Sanitary Equipment for each water outlet point, whether purchased by the construction company or the user, and establish procedures for use, operation and maintenance.

Annex 5 describes in detail the general aspects for specifying and purchasing sanitary equipment compatible to the efficient use of water. Annex 3 provides guidance for specifying and purchasing sanitary equipment that was manufactured in accordance with the respective technical requirements.

6. INSTALLATION OF WATER SYSTEMS IN BUILDINGS

The Project Development Process of a building is where the conditions for meeting several requirements are determined, such as the performance requirements, the developer´s directives, technical requirements, legal regulations and utility companies´requirements, besides connecting all of the different areas involved in the construction process.

The execution of the systems must be carried out in accordance with the Project in order to achieve the designed conditions when the building is finished and during its occupation, as well. Unexpected need for changes in the Project might come up during its execution, and when that happens, they must be consulted and approved by the Project Designer in charge, who must check for possible impacts that may compromise the results initially expected.

With the efficient use of water in mind, achieving the designed performance depends on:

- The supervision of execution stage by a qualified professional.
- The purchase, receipt, storage and the installation of materials, equipment and items, in accordance with the Project descriptions and specifications, the manufacture technical requirements and the manufacturers´ recommendations (Annex 3).
- Qualified manpower.
- Execution of the systems in accordance with the Project.
- Execution of the system accordind to the best practices, which are established in the technical requirements.
- Determining control mechanismos and checking specifc and strategical aspects, specially the verification for leakages sealing before closing walls, plasters or trenches according to the verifications suggested in the technical requeriments.
- The accurate observation of the correct regulation of pressure control mechanisms (regulators and pressurazers) and of the water flow in water outlets if they are in accordance in the project after the conclusion of the building.

7. USE, OPERATING AND MAINTENANCE – OWNER´S MANUAL

The NBR 14037 lays down the guidelines for the creation of manuals for the operation and maintenance of buildings and the Brazilian Chamber of the Construction Industry CBIC makes available the Brazilian Guide for the Creation of the Manual for Use, Operation and Maintenance of constructions[29].

Delivering the residential unit, having the designed performance, including the construction lifespan determined in the project will only be able of certain conditions of use, operation and maintenance are met.

Taking into account the characteristics of the users in residential buildings, the Owner´s Manual has a significant importance in the efforts for achieving and maintaining the designed performance of the building.

In general, after their residential building is occupied, its use, operation and maintenance hardly ever remain under the responsibility of the professionals who were in charge of its Project Design. And furthermore, it is very unlikely to remain under the responsibility of the personnel who worked the civil construction. Even if the manager is an Engineer or an Architect, he does not have the necessary knowledge for the correct use, operation and maintenance for all of the systems in a building.

Therefore, even technologies considered to be simple in the eyes of the professionals in charge of the Project, they demand proper guidance in order to be understood by the users. And the greater the complexity the technologies installed, the greater the need for information, guidance, recommendation and procedures, in order to obtain the designed Performance.

The Owner´s Manual, as its main purpose, must clarify user's doubts and guide through the use, operation and maintenance aspects that have an impact in the various Systems Performance. It is through the Owner´s Manual that the necessary information for the attainment and maintenance of the Performance designed over time is provided.

29 http://www.cbic.org.br/guiamanuais/CBIC_Guia_de_Elaboracao_de_Manuais.pdf

Under the vision of the efficient use of water, the Owner´s Manual should specify the procedures for the Demand Management which will result in the achievement and maintenance of the water consumption and its indicators in an efficient way (Annex 4).

The Owner´s Manual must contain all the conditions for use, operation and maintenance of the various elements, itams and equipment that are part of the systems in the building, Besides that, it should aldo contain specific and general recommendations for the preventions of malfunctions and accidents that may occur due to the wrongful use. In addition, it should also provide the procedures for the performing and record of preventive and corrective inspections and maintenance in order to achieve and maintain the designed performance.

Besides the guidelines already made available in the Brazilian National Guide published by CBIC with focus on the efficient use of water, the Owner´s Manual must include:

- Descriptions with the necessary characteristics so that the owner may purchase, appropriately, the equipment that are of his responsibility, such as douches, showers, water heaters, washing machines, dishwashes, etc.

- Information for the owner about the importance of meeting the technical descriptions contained in the Owner´s Manual (installing a gas heater with a higher or lower power capacity may result in not obtaining the efficiency required for the water, heater system in all its water outlets, simultaneously).

- Guidance for the owner regarding the hiring of qualified personnel, according to the manufacturers´ recommendation, for installing, regulating and maintaining the specific equipment like gas water heater.

- Description of the Sanitary Equipment that were chosen by the construction company, with all the characteristics that contribute for the efficient use of water (water flow restriction).

- Thus, in case of replacement the owner will have the necessary information to choose new equipment for purchase and installing properly.

- Information about the structure available for the water measuring individualization and procedures for the purchase and installation of the individual water meter, in case it hasn´t been made available by the construction company.

- Necessary guidance and procedures for the condo management to install the individual warter meter system in accordance to the local utility company requirements, in cities that are supplied by utility companies that adopt the individual measuring and issue of bills.

- Description of the installed systems/equipment with the necessary technical information and with the necessary recommendations for routine inspection and preventive or corrective maintenance.

- It is also suggested that all the information related to the common and provate areas is provided in singular Owner´s Manual: Therefore, besides contributing to the owners and residents better understanding of the installed systems, the risk of losing the information and knowledge about it when the manager is replaced, is minimized.

8. SOCIAL INTEREST HOUSING FACILITIES

According to the preliminary data from the survey carried out by CBIC and FGV and released in 2016, the housing deficit surpasses the 6 million housing facilities. From this total, roughly 85% refers to the population segment of up to 3 minimum wages family income per month, and about 7% from 3 to 5 minimum wages family income.

The effective development in Brazil depends on the public policies that promote the construction of Social Interested Housing – (HIS). And reducing the housing deficit is not enough. The users require housing facilities that were designed and built in a way that it offers them safe habitability, durability and sustenability.

When considering the construction of housing for the population share with the greater financial weakness, the costs with operation and maintenance take up the highest importance.

The water expenses are related to the operational costs which: the lower the consumption indicator of the residential unit, the lower the bill.

The technology chosen for the building, the quality of execution, materials and equipment installed are related to the maintenance costs.

The Ministry of Cities, at the end of 2015, published several documents[30] in the Sistema Nacional de Avaliação Técnica de Sistemas Inovadores e Convencionais – SINAT, (Brazilian National Technical Evaluation System of Innovative and Conventional Systems) from the program Programa Brasileiro de Produtividade e Qualidade do Habitat – PBQPH (Brazilian Program of Habitat Productivity and Quality) with the aim of guiding the Performance Concept determined in ABNT NBR 15.575.

30 http://app.cidades.gov.br/catalogo/

Such documents were created with the contribution of many entities of the Construction Industry, including CBIC, and they approach the vertical ground and roof sealing systems although the water subject is not directly approached, the principles of these documents may be applied to the other systems in the HIS.

The efficient use of water in Social Interest Housing Facilities makes use of the same guidelines afore mentioned: Actions agains water waste (water loss and excessive use) through technological and behavior actions.

Technological actions that enable the efficient use of water in a constructed building are a result of the pre-requisites and criteria of the Project, which are determined by the Performance Requirements that fulfill the Users Requirements.

The achievement and maintenance of the Performance designed depend on the use, operation and maintenance conditions informed in the Owner´s Manual.

The Performance Requirements that should be fulfilled in order to have an efficient use of water in Residential Buildings involve (figures 12 and 13):

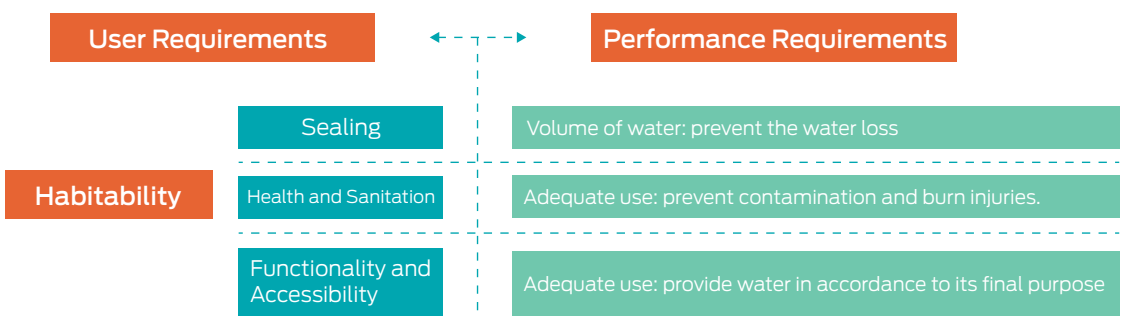


Figure 12 – Habitability: Performance Requirements for the efficient use of water

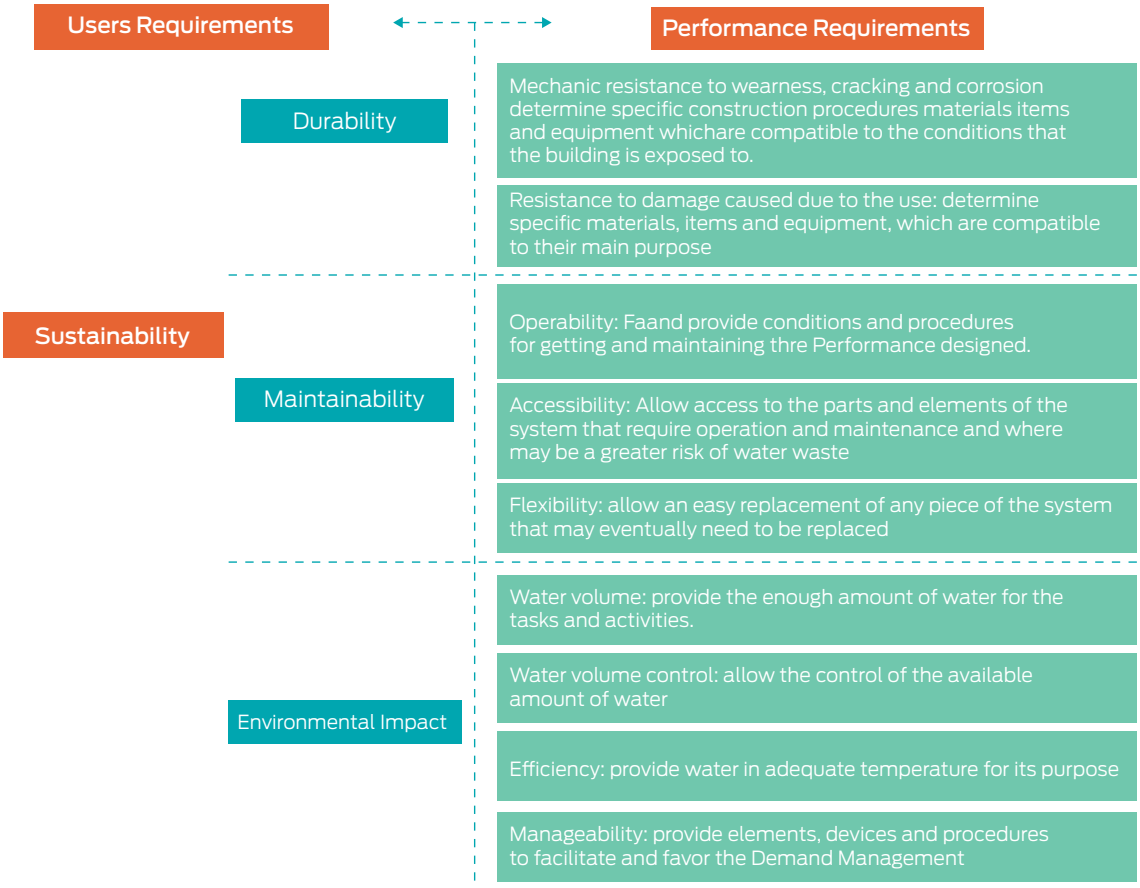


Figure 13 – Sustainability: Performance Requirements for the efficient use of water

HIS (Social Interest Housing) users present an extra characteristic in comparison to the users of other Residential Buildings: a financial limitation, which is actually a pre-requisite for earning the right to a subsidized housing.

As a result, besides the environmental issue that demands an efficient use of water, the consequent reduction in water and energy bills has a much greater importance for HIS. Besides that, costs related to the operation and maintenance of the systems should be as low as possible, which is why fulfilling the Performance Requirements has an even greater importance (figure 14):

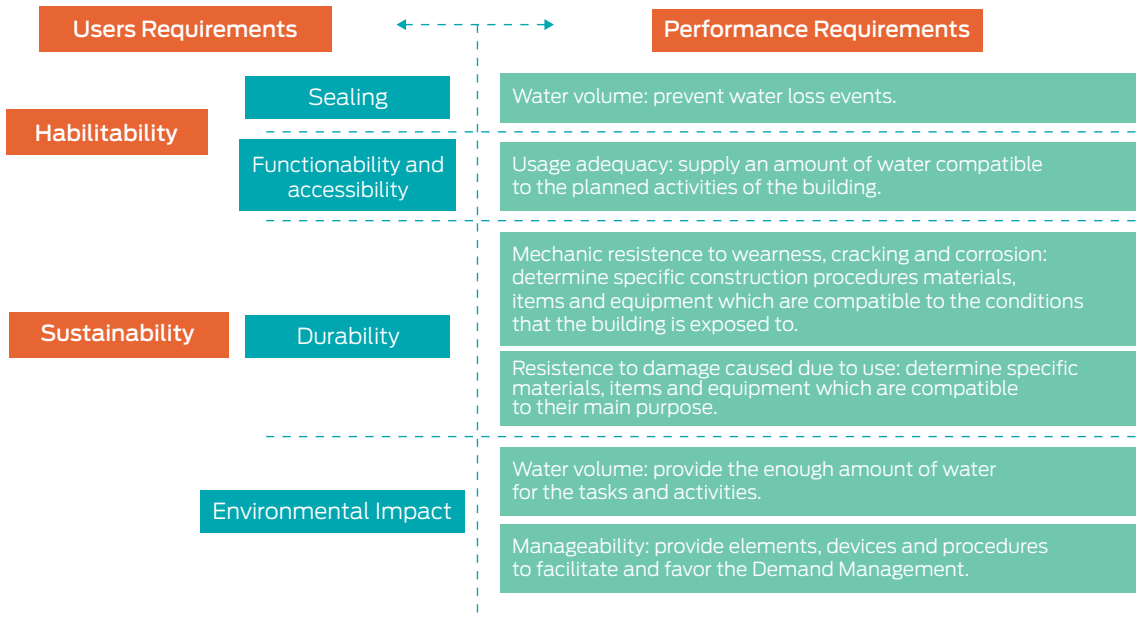


Figure 14 - Performance Requirements with special importance to HIS.

The construction company must give a special attention to the materials, components and equipment specifications, in order to offer technologies of easy replacement, and choose manufacturers that will offer further support to the user in the after-sale.

9. BEST PRACTICES AND INCENTIVES IN WATER MANAGEMENT

- The need to reduce the demand of water in metropolitan areas entail the construction of new buildings that fulfill the Performance Requirements aimed at the efficient use of water and also in the modernization of the Hydraulics Systems in buildings that already exist.

Based on what has been done in other countries in the matter, it will depend on the establishment of public policies related to the Demand Management in Brazil:

- The city of New York, for example, has policies on efficient use of water since 1989, when the sales of showers and high water flow taps were banned. Between 1994 and 1997 1.3 million of traditional toilets were replaced for 6 l/flush toilets. According to United States Environmental Protection Agency-EPA, 393 million dollars were invested in a rebate program for toilets which reduced the demand and the production of sewage in 342 million liters per day, approximately 4 m3/s. At the beginning of 2014 a new program was released, with the expected duration of two years, and that provides a voucher of $125 to replace old toilets for highly efficient ones. The New York City Department of Environmental Protection (DEP/NY) predicts that this program will save more than 0.43 m3/s.

- On the West Coast, the California Water Code requires that the water utility companies that directly or indirectly supply water for more than 3000 consumers create plans for the urban use management at least every 5 years. These plans should address actions for the Demand Management as well.

- The United States Environmental Protection Agency (EPA), in a joint effort with the Water Sense, provides the search of economic incentive programs ("rebate programs") geared to the efficient use of water considering water taps, flush valves, showers, toilets, urinals and garden irrigation in several states.

- In the province of Alberta, Canada, a program for residential users reimburses up to $150 for the purchase of new basins that use 6 liters per flush or less, if the basins to be replaced have been manufactured before 1995 or consume more than 6 l/flush. The costs cover not only the purchase of toilets, but also the accessories and the installation service of the equipment, and the refund is made through credit on the water bill. For commercial consumers, the refund is $90 for each toilet replaced under the same conditions of the residential program.

- Australia, which is located in the driest inhabited continent of the planet, used to present a high per capita of consumption, over300 l/inhab per day in 2000, according to the Department of the Environment. The Government of Australia offers a wide range of programs to encourage the replacement of components. The State of Victoria, for example, pays a $100 refund for dual-flush toilets, $20 for water efficient showers and douches, $1300 for rainwater tanks to be used in toilets and $150 for hot water recirculation systems.

Commonly the financial incentives for components replacement programs are either offered through discounts on the purchase of products or free provision of the component. In cases where the equipment is purchased by the consumer, the discount will be given through a voucher or reimbursement after presenting the purchase receipt. In both cases, the purchased component must follow the criteria of the program.

Optimizing water use in existing buildings involves the following actions:

- Documentation inventory: Architectural Project design (if available), the Project for the Building Hydraulic Systems (if available), water bill (consumption history of the last 12 months), population (number of residents over the last 12 months); knowledge of the Water Supply Systems, Sanitary Equipment and the consumer indicator of the previous term.

- In field: recognition of the Water supply systems and Sanitary equipment; assessment of currently existing one; identifying and determining the necessary replacements;

- Searching for visible and non-visible leaks; determining the necessary corrections that need to be done;

- Equipment Suitability: identifying and determining the necessary changes;

- Restriction of flow in water outlets: system dimensioning, through a probabilistic method and based on of the diameters of pipes already installed, to determine the need for new regulators in pressurizers and pressure reducing stations ; identify water outlets that need water flow restriction devices;

- Verifying the viability of individualizing the water consumption meters in apartments, and pointing out the necessary modifications when possible to be carried out;

- Establishing procedures for the Water Demand Management.

It should be noted that apartments in buildings constructed before 2002 that maintain the original sanitary ware do not have toilets of low volume consumption. The replacement of toilets in these apartments will, by itself, reduce the flushing volumes by about 50%.

The capacity of water reducing consumption in existing buildings is at least about 20-30%.

10. FINAL CONSIDERATIONS

Using water efficiently means using only the necessary and sufficient amount of water required for carrying out a certain activity or using certain equipment, without waste, nor compromising the quality of the activity and preserving the users' health.

The amount of water used in an activity or equipment is related to behavior issues and to technological matters.

Technological actions that enable the efficient use of water do not depend on the users' behavior or habits, but rather on the characteristics and conditions of the Building Hydraulic System and are established in the production process of the Building: conception, design and execution.

The construction of buildings that allow the use of water in an efficient way is part of the necessary set of actions for the sustainability of cities. The implementation of technological actions aimed at this issue can make the use of water more efficient and enable better consumption indicators.

The decisions and actions taken by the professionals in charge of the building construction determine the effectiveness of the efficient use of water while operating the systems. The continuous Water Demand Management, based on procedures and guidelines established in the Use, Operation and Maintenance Manual of the Building, guarantees that the consumption indicators will remain compatible to the efficient use of water markers, over time.

The Construction Project, in which the many different aspects and areas of a building are found, specially the Engineering of Building Systems and Architecture, is the most important instrument to provide the necessary technological conditions for the Efficient Use of Water in its occupation. However, the residential building users are not necessarily capable of properly operating and maintaining the building systems. The users need support,

information and guidance that will bring forth the Project specificities, in order to achieve, and maintain, over time, the originally designed performance. The Use, Operation and Maintenance Manual is the instrument that provides the users with the information about the technology installed in the building and the required conditions of use, operation and maintenance so as to obtain the efficient water consumption indicators.

Constructing buildings that will provide the right circumstances for the Efficient Use of Water requires giving a special attention to the Water Supply Systems and the Sanitary Equipment. The technical standards and legal regulations in effect promote, in general, the construction of buildings within minimum quality standards, oriented towards the operations that are considered to be technically appropriate to the Building Systems. Constructing a building in accordance with technical standards and legal regulations does not necessarily promote the Efficient Use of Water.

The NBR 15575-Edificações Habitacionais-Desempenho--Parte1 [Residential Constructions-Performance-Part 1]: The General Requirements, published on February 19, 2013, brings the User Requirements as a reference for establishing the Performance Requirements for the various subsystems that make up the residential constructions. Out of the User Requirements, the Performance Requirements can be established aiming at the efficient use of water, considering the activities that require water in a residential building.

The Construction Project of a building determines the conditions for fulfilling the Performance Requirements. Carrying out the execution of the systems in accordance with the Construction Project enables such conditions not only to be obtained during the construction of the building but also to be maintained during the occupation. Making use of the building systems based on the Use, Operation and Maintenance Manual facilitates achieving water consumption indicators that translate the Efficient Use Water throughout the time.

By using the concepts presented in this document and considering the technological necessary actions for the Efficient Use of Water, the Construction Company plays its role of contributing to the implantation of sustainable buildings in the urban centers, in the Water Use aspect of these buildings.

Just like technology, this document has an evolutionary aspect, based on the development of new materials, equipment, dimensioning methods, among others.

ANNEX 1

NON-POTABLE WATER SYSTEM

The Decree 2,914 of the Ministry of Health[31], dated December 12, 2011, establishes the procedures for controlling and supervising the quality of water for human consumption and its potable standard. It also establishes the responsibilities of the water supply through the public supply system or through alternative means.

Potable water is the one that meets the standards established in the Decree 2,914.

Non-potable water may have various characteristics, and based on its characteristics, it can be used for certain activities under certain conditions, that won't lead to contamination or to equipment damage.

Preventing contamination and equipment damage from happening entails establishing specific pre-requisites and criteria in Projects and it requires the continuous Management of the quality of water and the Hydraulic Systems in a Building.

In general, a Non-Potable Water System must be:

- Completely separate from the Potable Water System;
- Clearly identified;
- Of Restricted access, to avoid the inappropriate use of it;
- Designed with material other than the one used for the Potable Water system to avoid and prevent an interconnection between them during future renovation constructions.

The use of water, whether potable or non-potable, requires the continuous Management of its quality and making corrections whenever necessary.

When using water provided by Utilities companies, whether potable or non-potable, they are in charge of supervising the water quality and of taking the necessary actions to maintain its characteristics. By using water from other sources, the supervision and maintenance of the water quality becomes the responsibility of whoever is producing or supplying it.

31 Available in http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt2914_12_12_2011.html

The water that is supplied to residential buildings is mainly used for drinking, personal hygiene, food preparation, leisure and cleaning, which means that it is basically for human consumption. Human water consumption is not only related to water intake, but also to any activity in which the user may have contact with the water.

For example, floor washing and garden watering, which are common activities in residential buildings, do not require using potable water to achieve the expected result (clean floor and watered garden). However, if these activities are performed with non-potable water and without the use of appropriate EPIs[32], the user who carries out these activities may be contaminated. In this same context, if the water outlet that provides non-potable water for floor washing or garden watering is accessed by another user, who is unaware of the source of the water, this user may be contaminated. Another possibility of using non-potable water in residential buildings is for toilet flushing. At first, there is no obstruction for providing a non-potable water system for flushing toilets: the toilet-flushing activity itself does not require the use of potable water. In practice, however, the possibility of contamination, especially of children, should be taken into account since the water contained in the toilet pit is accessible for them.

The provision of non-potable water systems for use in residential buildings requires greater attention and care. Both due to users' common sense which do not make them question the quality of the water received at water outlets, as well as the attributes of the managers in these buildings.

Furthermore, the closer the potable water hydraulic system is to the non-potable system the greater the risk of cross-connection.

32 Self-protection equipment

Cross-connection means the occurrence of physical or non-physical "connection" of the potable water system to any non-potable water or to any kind of substance that may contaminate the potable water system.

The ways of preventing cross-connection are: atmospheric separation or the installation of “backflow preventers”, which should not be mistaken by restriction valves, at the system points where there is a risk of occurrence.

In addition to the issues associated with the risk of contamination, the decision of installing non-potable water systems should take into account the associated costs of installation, operation and maintenance. The system is not always economically justified.

In August 2009, the Brazilian Council for Sustainable Construction (CBCS), through its Water Committee, published a document entitled "The Use of Alternative Water Sources in Buildings"[33], with guidance and warnings for the Construction Company that chooses to implement the systems for Water Conservation in buildings.

33 http://www.cbcs.org.br/_5dotSystem/userFiles/posicionamentos/CBCS_CTAgua_Posicionamentos_Aproveitamento%20de%20fontes%20alternativas%20de%20agua%20em%20edificios.pdf

ANEXX 2

MEASUREMENT SYSTEM

Surveys were carried out to evaluate what was the impact on water consumption[34] due to monitoring, after having installed individual consumption meters in apartments, with results varying between 15% and 30% in consumption reduction. Residents in apartments that are able to monitor their own consumption tend to use water in a more moderate way and to react quicker when identifying an increase in consumption, usually motivated by the possibility of reducing their monthly costs with water bills.

The main instrument for Water Demand Management is consumption measurement.

The water meter provided by the Utility companies allows the establishment of a daily reading procedure for monitoring the water consumption in the building. This monitoring enables the identification of an unexpected increase in consumption as soon as the incident leading to water waste occurs. Without its daily monitoring, the increase in consumption would only be noted when the water bill is received, which can occur almost 30 days after the incident started. However, the monitoring of the Utility Company's water meter in a condominium that has many buildings in an extensive territory and several leisure areas that use water, for example, does not facilitate the identification of the origin of the waste of water, even though it points out when there is an increase in consumption.

Separating the consumption into individual sectors, by installing water meters in strategic points, facilitates identifying the section of the building in where the waste of water is happening. It also facilitates establishing procedures related to the use of water in specific areas, activities or spaces. For example:

34 MALAN, G.J; CRABTREE, P.R. The effect of individual meters on the water consumption in apartment buildings. In: CIB W62. International symposium on water supply and drainage for buildings, Proceedings, 1997.
YAMADA, E.S., Os impactos de medição individualizada no consumo de água em edifícios residenciais multifamiliares. Dissertação (Mestrado em Engenharia) – Escola Politécnica, Universidade de São Paulo, São Paulo, 2001.
ZEEB, W. A holist approach to metering value. In: ANNUAL AMRA SYMPOSIUM, 11th 1998 Washington. Proceedings. Washington, 1998.

- A water meter at the entrance of a party room allows the measurement of water consumption at each party;
- In condominiums with several buildings, a water meter at the entrance of each building allows identifying where the consumption is higher;
- Supply of other common areas in the condominium.

An individual Water Metering System, which is separating the water consumption into sections through the installation of at least one water meter in each apartment unit, allows users to monitor the amount of water used in each apartment over the time. The individual billing allows the user to pay only for the water actually used in their apartment and it corrects consumption distortions by preventing apartments with fewer residents, or with residents that are more aware of water use, from paying for the water of apartments that consume more. Individualized Metering encourages the efficient use of water.

The individual billing, when carried out directly by the Utility Companies, can also allow the interruption of water supply to defaulting users, rather than saddling all residents of a condominium due to users that do not pay for their water consumption.

Although it is not mandatory in most Brazilian cities, the individualized water metering system in residential buildings is already perceived by Construction Companies as something their future clients look forward to, which adds a plus to the business in the market[35]. Therefore, there are Construction Companies that deliver buildings with the necessary hydraulic infrastructure for the installation of individual water meters, including with the standards required by some Utility Companies to issue individual bills.

The option of installing individualized water metering systems is directly related to the pre-requisites and criteria of the Project. Characteristics of the Water Distribution System (the number of plumbs that supply water for each apartment) may make it impossible to install the metering system in the future, due to the rebuilding required to do so.

35 Brazilian Law nº 13.312, from 2016, July12th - "Changes the Law nº 11.445, from 2007, January 5th, which sets the national directives for the Sanitation, and enforces the individualized measuring for new construction, effective in 2021".

On the other hand, providing the infrastructure for individual consumption and, if possible, delivering the condominium with the system already installed, including water meters will increase its added value.

Due to the users' characteristics of residential buildings, condominiums often have a hard time to implement decisions such as contracting the installation of individualized water metering systems. Even when the hydraulic infrastructure is provided, the non-technical profile of the ones responsible to carry out the decisions and the decisions dynamics in condo meetings make it difficult to identify qualified service providers, making the technical assessment of budgets and supervising the system installation process. Providing the already installed individualized metering system enables the efficient use of water and it can also be used as a sales differential in business by the Construction Companies.

For buildings constructed in cities where the Utility companies have not yet established its standards for issuing individual bills, it is suggested the installation of a maximum of two water meters per apartment, in common areas. And by doing so, owners will be able to request an individual issue of bills in the future.

Besides providing the proper water infrastructure for individualized water consumption in the Project, it is also suggested to provide, in the Project, electrical infrastructure (dry pipeline) to enable the installation of remote reading systems.

ANNEX 3

MATERIAL SPECIFICATION AND PURCHASE

Standarization

Technical standards rule a specific activity and establish the characteristics, technical parameters and applications for materials, construction systems, processes, methods, projects and engineering practices. Standards specify materials, methods, or procedures for manufacturing, operating, maintaining or testing equipment or instruments besides specifying the acceptable limits and methods so that a product or procedure can meet the purpose for which it was designed.

ABNT main standards that directly affect the design and execution of Water Systems are ABNT NBR 15575, parts 1 and 6 (performance standard), ABNT NBR 5626 (cold water standard) and ABNT NBR 7198 (hot water standard)[36]. In addition to these, which provide specifications for the design and execution of systems, there are also a number of specific technical standards for the manufacture of materials and components, as well as standards specifying test methods for materials, components and construction systems[37].

Technical standards specify minimum conditions to be met in order to obtain the expected performance of the various systems and their components. Designing, specifying or executing Hydraulic Systems in Buildings without meeting the technical standards specifications can contribute to the waste of water.

The installation of pipes and connections, which were not manufactured in accordance with the standards, for example, contributes the outbreak of leaks, since the material used may not withstand the pressures of the Hydraulic Building System or the way it will be installed.

36 The Normative Instruction ABNT NBR 5626 and the NI ABNT NBR 7198 are being reviewed. They will be unified.

37 The complete list of Normative Instructions regarding the products use in Building Hydraulic Systems can be found at the ABNT website: www.abntcatalogo.org.br.

Figure 15 illustrates another possibility of increase in water waste, due to installation of a component not manufactured in accordance with the technical standards. The dispersion of water created by the jet, pours out an overflow of water, beyond the necessary for the activities carried out, which means that part of the water will not even touch the user and will be wasted during all the years of operation of the building or until the first renovation happens, where the faucet can be replaced by another one that causes an even greater waste, due to the lack of guidance on purchasing the proper component.

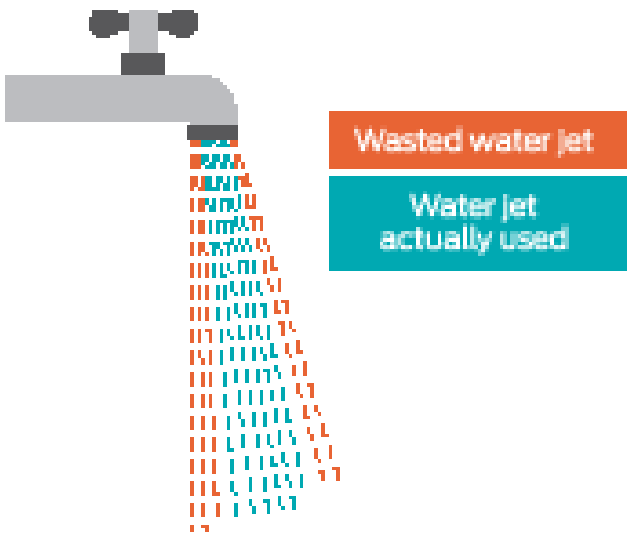


Figure 15 - Example of waste of water in component not manufactured in accordance with the technical standards specified for it.

There are specific instruments to guide the Construction Company in the process of purchasing materials, components and equipment that were manufactured in accordance with their respective technical standards.

Quality of the materials and components

The Ministry of Cities coordinates the Brazilian Quality and Productivity of Habitat Program (PBQP-H). One of the programs carried out by the PBQP-H is called Qualification System of Materials, Components and Constructive Systems Companies (SiMaC)[38]. In it, Industry Sector Quality Programs (PSQs) are developed.

38 http://pbqp-h.cidades.gov.br/projetos_simac.php

The PSQs are continuous programs; some of them are operating for almost 30 years, as it is the case with the PVC Pipes and Fittings for Hydraulic Building Systems Program, started in 1989.

Each PSQ is carried out by industry entities which are manufactures of Civil Construction products, and its technical management is carried out by Technical Management Entities (EGTs) which are licensed by SiMac and certified by INMETRO.

The manufacture of the products is continuously supervised, with an evaluation to check for standards fulfillment by running tests on samples of the product, obtained at resale and at factory audits.

Every quarter, an Industry Sector Report is published on the PBQP-H website containing a list of the qualified manufacturers and those that do not comply with Brazilian Regulations and Technical Standards[39]. The reports are public and available to citizens.

For products that are submitted to the PSQs, their quality assurance is associated to the manufacturer's certified qualification in the last Sectorial Report and it can be verified directly by the professional in charge for the budgeting and purchase of the products.

Specially regarding the Hydraulic Systems for Cold and Hot Water in Buildings (i.e. Water Supply System and Sanitary Equipment System), which are directly related to the efficient use of water in buildings, the following PSQs are applied:

- Water Saving Appliances;
- Sanitary ware for Building Systems;
- Sanitary Metal Ware;
- Polyolefin tanks for potable water up to 2,000L (as well);
- PVC Pipes and Fittings for Building Hydraulic Systems.

For products which are not certified by the PSQ, the PBQP-H also provides instruments to ensure the quality of what will be purchased and installed.

39 http://pbqp-h.cidades.gov.br/projetos_simac_psqs.php

According to the document "Specifications of HIS Construction Developments based on ABNT NBR 15575 - Residential Buildings - Performance", published on the Ministry of Cities[40] website:

> "All products or systems specified in the Construction Project and applied during construction must fulfill respective technical standards, or in case they are innovative, fulfill DATec standards, which are certified by the technical certification institution in SINAT in the PBQP-H – Brazilian National System of Technical Certification for Innovative Products.
>
> The materials and components specified and used in the Project must be from companies that were qualified by SiMaC's PBQP-H's Quality Programs and PSQ-submitted products. The construction company is forbidden to purchase materials and components from suppliers that are considered to be in noncompliance to standards in the PBQP-H SiMaC Industry Sector Quality Programs listed in the portal MCidades[41].
>
> In the case of non-existent PSQ certification to the target product, products certified by the Brazilian System Assessment to Compliance (SBAC), by the Product Certification Organization (OCP) certified by INMETRO, or products tested by batch trial-test, according to the specification standard or in accordance with ABNT NBR 15575. "

Specification, Quotation and Purchase

The specification, quotation and purchase of materials, components and equipment are technical activities and, as such, must be performed by qualified professionals. In general, the specification of materials is done by the Project team and the purchase by the Execution team, which may lead to a loss in quality due to the inaccuracy in the transmission of information.

The selection of materials, components and equipment have an impact in the design of the systems, hence the importance of establishing, in Project, the specification of each product, with their

40 http://app.cidades.gov.br/catalogo/

41 http://pbqp-h.cidades.gov.br/projetos_simac_psqs.php

description, technical characteristics, purpose, function, application, technical standards applied and expected performance.

Material specifications can be presented in different ways, according to the information needed to clearly describe the product that will be purchased and the guide on how to install it. A list of materials, or a descriptive definition, may be provided from a group of drawings in the execution memo of the building. These specifications can be simply described by the standard reference (in the case of pipes and fittings, for example) or by the characteristics determined in the Project (temperature, inlet pressure, outlet pressure, etc.).

For the cases where specifications are made based on the product designation, with brand, model and reference, it is up to the person responsible for the specification to ensure that it meets the requirements of the respective product technical standard as well as the ABNT NBR 15575.

In order to obtain its designed performance, aimed at the efficient use of water, the selection and specification of sanitary ware, sanitary metal ware and other hydraulic components / equipment should consider:

- Building typology; minimum space required for installation, use and maintenance; pressure conditions; requirements of the respective manufacturing standards;

- Spaces and location that allow the user to use it properly. For example, the specification of kitchen faucets should consider the dimensions of the tank (in order to choose from a countertop or wall faucet) and the length of the spout (compatible with the tank dimensions).

- Site-built water tanks require, besides the specific space for its placement, the necessary space for its installation and future repair, besides the possible need for replacement.

- New piping technologies (pipes and fittings) have specific characteristics and peculiarities. Each technology requires

specific qualified labor work and appropriate tools for its proper installation, under the risk of not achieving complete leakage sealing.

- The manufacturers offer several equipment that promote the efficient use of water: single-lever and one-turn taps with built-in aerators and flow restrictors; dual-flush activation mechanisms (for toilets with coupled flush-tank and for toilets with flush valve); taps for irrigation and washing with restricted flow; Modular flame water heaters (temperature output set by the user, despite its flow).

Project Specifications, which are initially determined by qualified professionals, must be fulfilled. Any need for modification must be submitted to the professional in charge of the Project designer, who may or may not approve it, based on the impact that such change may cause in the performance of the system.

When the device is purchased and installed directly by the user, the Owner's Manual must provide the necessary guidance to enable achieving the designed performance at the water outlet points.

The person in charge of purchasing the material must be a qualified professional, capable of identifying and correctly drawing the information to check if it is compatible to the Project specifications.

The buyer should pay attention to the compliance assessment mechanisms of materials and require from each potential supplier:

- The technical specifications of the product, in which includes: performance characteristics provided both in its specification standard (should mention what standards are being met) and in ABNT NBR 15575; it should point out the necessary conditions to live through its life span, regarding the product installation (capability of being handled in a construction) and its use and maintenance (limitations of use, conditions of use described in the product design); specifications about maintenance fre-

quency and how to perform it as well as its replacement date; guidance on maintenance under normal circumstances of use and operation.

- Confirmation of compliance to the standards, in the case of a product or system that is not subject to any of the Industry Sector Quality Programs (PSQ). When it is a PSQ-submitted product, the compliance can be confirmed by the purchaser himself in the Industry Sector Report.

The professional in charge of the construction, if not the same professional who chose the material supplier, must be provided with all the necessary information for checking the purchased products, including information on handling, storage and installation. For products that will be subject to batch testing, the person responsible for the construction must be informed, be aware of the size of the sample and require proof of achievement.

ANNEX 4

DEMAND MANAGEMENT – OWNER´S MANUAL

The Efficient Use of Water in a building can be inferred taking into account a number of behavior-based and technological actions.

The construction process (conception, design and execution) of a building that considers the efficient use of water is not enough in terms of effort, if we aim to achieve and maintain compatible consumption indicators that match the supplied technology. In order to use water efficiently and to achieve and maintain good rates regarding water consumption, the users need guidance all the way to ensure their comittment with Water Demand Management, both in common areas and in private areas (apartments).

The responsibility for the Demand Management in common areas is the manager's. Regarding private areas, it relies upon all the apartment residents.

This Annex points out information, guidance and minimum procedures to guide the Water Demand management in residential buildings.

It is suggested to include this information in the Owner´s Manual.

The Demand Management is basically consituted by the following activities:

- Setting a number of water consumption indicators.
- Monitoring the water consumption on a regular basis.
- Assessing and carrying out preventive maintenance in the systems and their components.
- Correcting the components whenever there is a non-expected increase in consumption indicators.

Water Consumption Indicators in Residential Buildings

Setting water consumption indicators is applying a ratio between water use and population. To residential buildings, the suggested indicator for consumption mesurement is liters/resident/day.

Water meters readings done on a daily basis, at the same time every day, allow the consumers to monitor the consumption indicator of a building and identify non-expected increases in consumption.

It is important to point out that the consumption indicator in residential buildings fluctuates, among other reasons, due to:

- Location (climate, consumption habits).
- Season (climate, holidays).
- Ratio between staff/residents (in buildings with fewer residents, the water consumption impact due to staff usage is naturally higher).
- Number and usage of sanitary areas located in common areas.
- Leisure activities that use water in common areas.
- Landscaping design: garden area and types of vegetation.
- Flow of visitors.

The condo manager will be able to determine compatible consumption indicators regarding water use characteristics by using information provided in the Owner´s Manual.

Example: considering a 10-story building, 4 apartaments per floor, with 130 residentes and a daily reading of the Utility Company water meter according to the Table 4.

Table 4. Example of daily consumption in a fictitious building

Date	Reading	Consumption (m^3)	Daily Consumption (l/Resident)
Day 1	300	-	-
Day 2	330	30	230,77
Day 3	355	25	192,31
Day 4	383	28	215,38
Day 5	463	80	615,38

The analysis of the daily consumption allows us conclude that:

- The consumption indicator (the average consumption between days 1 and 4) was 212.82 l/resident/per day.

- There was an increase in consumption between the Day 4 and the Day 5, it remained constant between the Day 5 to the Day 6.

Without monitoring, in case there is an increase in consumption due to an invisible leakage (some sort of crack in the buildings supply pipeline, for instance), the situation will remain unsolved, until, at least the Condominium receives the water bill, 30 days after.

The Owner´s Manual must provide the manager with instructions to allow him/her to monitor water consumption in the building daily, as a management tool that will offer the possibility to set up and monitor water consumption indicators, and quickly identify any non-expected increases in water consumption and repair the damage.

In buildings with individualized metering system, it is possible to apply the same procedure to each apartment: monitor the water meter on a daily-basis, combine to the other actions against the waste of water (both technical and behavior) and then, provide the user with enough information in order for him to be able to determine an indicator that is compatible with his consumption profile or the building.

Understanding the water consumption indicator allow the consumer to make decisions in order to achieve and maintain the efficient use of water.

Water Loss

Water losses occur due to visible or invisible leaks.

According to Oliveira (1999)[42], "leaks can be perceived due to an expected wear of the parts in use, mostly because the life span of the hydraulic[43] system is shorter than the building's. The Hydraulic Systems installed in inaccessible areas of the building result

42 Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Tese (Doutorado em Engenharia) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999.

43 VUP – vida útil de projeto

in water losses that stand for long without being detected, and as a consequence, water waste and damages to other building´s subsystems happen, such as structural, final touching materials and the painting".

The Demand Management requires constant inspection in specific parts of the system, as a course of action to identify possible water loss events, specially the invisible ones:

Water Loss in the Supply System:

Water loss in the Supply System can be identified by perfoming some simple tests. A member of the building staff, previously qualified to perform it will be enough.

When water loss in the Supply System is identified, in order to locate the leakage without breaking a floor or a wall, it is necessary to use the services of a qualified professional, using special equipment. The condominium should inform the location of the leakage as soon as possible. The professional hired to locate the leakage should be informed about the tests performed and their results.

Once the leakage is located, in order to repair it, the material used in the reconstruction must be the same as the used in the original system meeting the specified dimensions described in the Project.

Water meter test[44]: This test is oriented to identify water flows in water meters after the outlets that are connected to public supply system are turned off. It shows if there is a water loss in the Building Supply System. It is suggested to performe this test every 6 months or when the water meter reading from the Utility Company presents unexpected increase in the water consumption.

44 Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Thesis (Engineering PhD) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999

Instructions:

- Turn off the flow in the outlets that are connected straight to the Public System and make sure that they remain closed during the performance of the test (the outlets with access to the public supply system can be identified with signs and messages, i.e. “Do not use. There is a test in course”;

- Close the water tank supply from the Public System in order to restrict the incoming of water (even when there is a flow valve in the water tank supply pipeline, interrupt the float valve or the level control system, since the water can bypass the valve and interfere in the test results;

- Make sure that the water supply valve is completely open;

- Read the water meter every 60 minutes, for a minimum time of 120 minutes, then log into a specific spreadsheet;

- If there are any variations in the water meter readings, then there is water loss in the system.

Water Loss in the Water Storage System:

Leakages in water tanks may occur due to cracks, inadequate water sealing, sealing loss due to expiry time, or water flow to the cleaning pipeline. In case of underground water tanks the water flows and infiltrates the soil and therefore the loss is not easily detected[45].

It is suggested that the tests below are performed at least every 6 months at the same moment of the water tanks scheduled cleaning, or whenever the Utility company meter indicates a non-expected increase in consumption and the possibility of water loss in the building water system is excluded.

45 Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Thesis (Engineering PhD) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999.

Leakage detection in lower water tank[46]:

Procedures:

- Keep the water system valve completely;
- Turn off the valve in the cleaning pipeline and in case there is any water outlet supplied by this pipeline, it must be turned off as well;
- Turn off the pump-engine booster system;
- When the water reaches its maximum level, stop water input (it is not necessary to reach its maximum level in order to perform this test. However, the higher the water level the higher the hydraulic pressure in the system, which makes the detection of leakages easier);
- Measure the water level in the water tank using a piece of wood – wooden slat – marking it with pencil or chalk;
- Wait for at least 2 hours and measure the water level again with the wooden piece;
- In case the second mark is lower than the first one, there is a leakage in the system.

Valves inspection:

Through visual inspection, verify the existence of dripping in valves, pipes and fittings and in the boost pump system. Inspections such as these ones are recommended at least in a monthly basis.

The valves of the System, which are not used to control the volume of water supplied, should be either totally open or totally closed. In the case of wall valves, if they are wrongly used, the internal mechanism can be damaged, which results in possible leakage and, eventually, hinders its perfect use when necessary (it won´t close fully).

46 Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Thesis (Engineering PHD) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999.

Cases in where residents partially close the wall valves, in common areas, intending to reduce the water flow in the water outlets of their apartments, are often seen. The Owner's Manual must inform and guide the users regarding the correct use of wall valves.

A regular inspection (every half-year) of wall valves in common areas, is recommended, by completely opening and closing them, according to their respective functions. If any valve is partially opened or closed, once detected, the manager should be informed and he must take the necessary measures (notify the residents, restrict the access to the valves, etc) to avoid the occurrence. Apartments that have a heavy flow in water outlets must be identified and correction proceedings must be scheduled (regulation on pressurizers, regulation on pressure reducing stations, restricting the outflow in water outlets).

Cleaning Pipeline Valve: keeping the valve completely closed, go to the outlet location and verify eventual water loss.

Water Loss in the Sanitary Facilities Systems:

Sealing hydraulic activation devices:

Incomplete sealing in hydraulic activation devices (faucets and valves) can represent a significant water loss, as shown in Table 5[47].

47 Table assembled from the data available in Oliveira, L.H., Metodologia para implantação de Programa de Uso Racional da Água em Edifícios, Tesis (Engineering PhD) – Escola Politécnica, Universidade de São Paulo, São Paulo, 1999.

Table 5. Daily loss of water due to sealing loss in hydraulic activation devices

Leakage	Frequency (drops/min)	Daily loss (l/day)	Montly loss (l/month)
Slow dripping	Up to 40 drops/ min	6 to 10	180 a 300
Medium dripping	40 < nº drops/ min < 80	10 to 20	300 a 600
Fast dripping	80 < nº drops/ min < 120	20 to 32	600 a 960
Very fast dripping	Impossible to count	> 32	> 960
2 mm trickle (aprox.)	----	> 114	> 3420
4 mm trickle (aprox.)	----	> 333	> 9990

It is recommended to regularly inspect the hydraulic activation devices located in common areas and in apartments for sealing. The residents should be instructed to immediately repair the outlets in their apartment.

Toilets sealing: the use of toilets with toilet tanks is usual in apartments. For the users, the most common and imperceptible leakages are those that take place in the connection between the toilet tank and the toilet and, because the toilet pit is usually full, the extra amount of water flows to the sewage pipeline. The main causes of this type of leakage are:

- Bad fixing in the chain connected to the flush valve (common in the older flush devices, those that come with the white float valve), resulting in an permanently opened flapper;
- The flush mechanism lacks a proper sealing;
- The float valve is adjusted into a level higher than the flapper (the water is flushed through the open flapper).

The leakage from the toilet tank into the toilet (between the toilet tank and the toilet) is also very common. It occurs when the sealing ring is not fully installed or when it lost its sealing capacity. In this case, the user usually notices the leakage.

The PQS Sanitary Ware Quality provides for free of charge download, the Installation, Use, Operation and Maintenance Manual for Sanitary Ware[48]. This Manual provides instructions regarding possible types of leakage, causes and solutions. It must be provided to the users, as well as, specific recommendations from the manufacturer who installed the toilets in the building.

Excessive Use

The excessive use of water is perceptible when:

- the available waterflow is higher than the amount needed for the performed activities purpose ("when the faucet wets ones clothes" or "a bath that leaves us with a painful shoulder", for instance);

- The installed sanitary equipment is not compatible with the flow specified in the Project or it was manufactured in non-conformity to the technical standards (jet dispersion higher than necessary, for example, where only part of the water released is used by the user).

The elements of the system to be inspected and that require maintenance is the Pressure Reducing Stations, the pressurization systems and the outlets.

Pressure Reduction Station

Pressure Reduction Stations are systems that demand continuous verification for adjustment and regular maintenance which must be performed by a qualified professional (also for the cleaning of the filters).

The Owner´s Manual should indicate the pressure rates both for the water input and output for which the pressure Reductions Stations were designed and instruct the user to:

48 http://pbqp-h.cidades.gov.br/projetos_simac_psqs2.php?id_psq=75

- read, regularly, the pressure of the system during its operation (at least every 15 days) and call the manufacturer if a variation regarding the Project is noticed;

- schedule a preventive maintenance for the pressure reduction stations, according to the manufacturers specification;

- do not allow any procedure or repair in the pressure reduction stations except those performed by the manufacturer itself or by a qualified company or professional pointed out by the manufacturer.

It is recommended that a preventive maintenance be performed in the pressure reduction stations if the higher water tank is cleaned or the manufacturer suggests that maintenance is necessary.

Pressurization Systems

The same regulations applied for the Pressure Reduction Stations are valid for the pressurization devices.

Water Outlets

The Onwer´s Manual must provide the user with:

- Information about the waterflow chracteristics regarding the amount of waterflow and pressure of each Sanitary Equipment, either of those supplied by the building entrepreneur or those purchased and installed by the user;

- Instructions to perform a regular measuring of the waterflow (whenever an increase in water volume is noticed).

- List of the procedures to be adopted if an increase in waterflow is noticed, according to the guidelines given by manufactures of the installed equipments;

- List of the waterflow restriction devices locations, if that is the case;

- Instructions about the periodic cleaning procedures of the devices according to the guideline given by its respective manufactures;

- Instructions regarding the replacement of the Sanitary Equipment, the acquisition of new ones compatible to the specifications detailed in the Project, in order to satisfy the expected

performance;

- Instructions to purchase washing machines and dishwashers with compatible performance rates to the Efficient Use of Water designed in the Project.

Corrective and Preventive Maintenance

The Owner´s Manual should present guidelines in order to instruct the preventive and corrective maintenance, with information regarding the systems features, the specification of the displayed materials, the manufactures identification, the pressure and the waterflow in the outlets and, mainly, guidelines on which proceedings can be performed by the residents (in the apartments) or by the buildings staff (in the common areas) when prepared for the task, and also, the specification of the procedures that should be implemented only by qualified professionals. Such information is essential to achieve the best solutions and results in maintenance and also helps to keep the Construction Company warranty in place in terms of value.

For those interventions that need a qualified professional, it is re-co-mmended that some building authorized personnel follow the entire proceeding in order to assess the performance of the maintenance staff and to ensure the solution of the problem.

It is recommended, as well, that the user keep a sort of registration regarding the maintenance performed in the building, with the following information:

- Date;
- Company in charge;
- Name of the professional in charge;
- Reason for intervention (if it was a repair);
- Description of the proceedings.

By doing so, the Maintenance Report can always be used, either for retrieve informations of some sort of problem or in order to support the next maintenance schedule.

Common Area

In order to make the operation possible and to keep the common areas systems functioning an amount of information regarding the Water Supply System in a very easy to understand way is necessary.

The Figure 16 presents an esquematic regarding a building system and its characteristics:

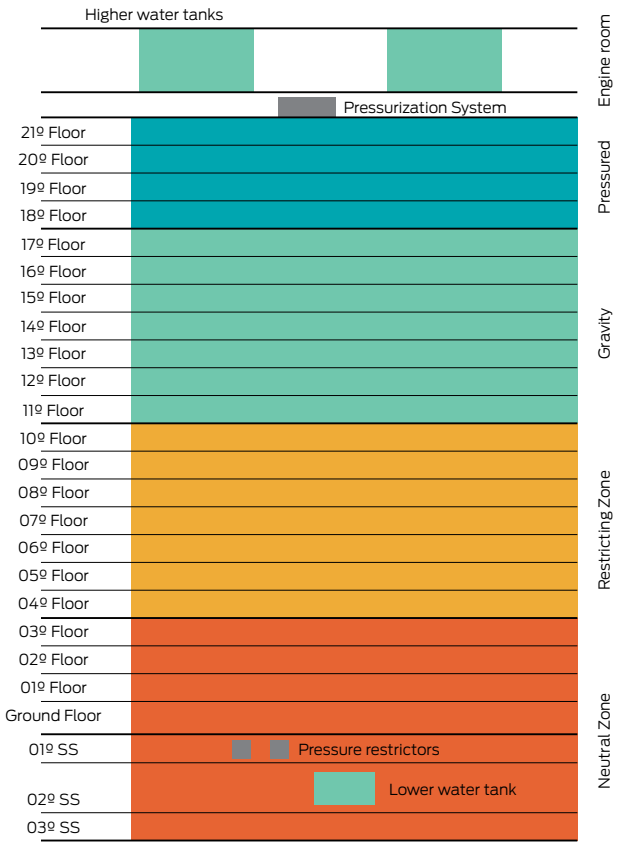


Figure 16 – Example of distribution of a Water Supply System in a Residential Building

From the water meter of the Utility Company, the water is conduced to the ground water tank (2nd underground floor) through the pipeline described as building supply system.

The washing underground taps and the ground floor garden taps are supplied straightly from. From the underground water tank, through the boost pump system the water is conduced to the head water tank. The water stored in the head water tank is distributed to the other water outlet points through horizontal pipeline ramifications, located right above the 21st floor.This pipeline system is called barril. From it, the water is conduced to the vertical pipelines, called distribuition plumbs

From these plumbs, and at each floor, there are pipeline ramifications called branch lines, which supply the water outlets inside the apartments. In each branch there is a wall valve installed which can be accessed through the apartments, and that allow the interruption of the water supply in the outlets supplied by the branches.

Due to the building's heights, in order to ensure the necessary pressure in each water outlet the cold water distribuition system is divided into four pressure zones. This is a necessary condition so that all the floors receive water with enough pressure for carrying out activities (users comfort when using it, greater duration in pipeline, metals and accessories and providing the right circumstances for the efficient use of water).

The necessary information must also be provided for the identification of manufacturers, equipment models and design regulation conditions. Table 6 exemplifies a form for providing this information for the above-mentioned fictitious building.

Table 6. Description of the equipament and installed devices

Location	Equipment	Manufacturer	Model	Adjustment
2nd Basement - Underground water tank	Boost pump	XXXXXX	XXXXXX	It does not aplply
1st Basement	Pressure Reducing valve	XXXXXX	XXXXXX	47,4 mca
	Pressure Reducing valve	XXXXXX	XXXXXX	47,4 mca
	Pressure Reducing valve	XXXXXX	XXXXXX	26,3 mca
	Pressure Reducing valve	XXXXXX	XXXXXX	26,3 mca
Barril	Pressurizing pump	XXXXXX	XXXXXX	10,9 mca
Sanitary areas - Common Areas	Dual-flush activation device toilet	XXXXXX	XXXXXX	It does not aplply
	Tap restrictor 6 l/min With one-turn device	XXXXXX	XXXXXX	6 l/min
	Water Restrictor valve with a 40cm hose reel	XXXXXX	XXXXXX	4 l/min

And, finnally, the Owner´s Manual must contain information about the inspections and preventive maintenance according to the buildings characteristics. The Tables 7 to 11 indicate the Supply System for the same building:

Table 7. Preventive Maintenance – 2nd basement

Location	Activity	Frequency	Responsible
2nd Basement – Underground water tank	Check in the boost pump screen if the malfunction light alarm is on. If it is the case, position the selection key to make the pump that is not badly functioning start and call qualified company to perform the repair of the pump.	Daily	Local Maintenance Staff
	Check in the boost pump screen if the selection keys are positioned in ALT and AUT. If that is not the case, adjust them to the right positions.	Daily	Local Maintenance Staff
	Check the sealing of the pipeline. In case there is any leakage, call qualified company to perform the repair.	Daily	Local Maintenance Staff
	Test the function of the floating valve. If is not well placed, call a qualified company to repair it.	Weekly	Local Maintenance Staff
	In the Boost Pump System check for sealing and the operation of the activation device, the warning lights, and command buttons, the selection keys, the level valves in the water tanks, the electric safety devices, and proceed to the repair of the necessary aspects.	Every 6 months	Profissional qualificado
	Perform the maintenance of the boost pump system.	Every 6 months	Profissional qualificado
	Wash the water tanks, alternating, and provide potability certification.	A cada 6 meses	Profissional qualificado
	Check for functioning of the pipe overflow	Every 6 months	Local Maintenance Staff
	Open and close completely the register to avoid the canting and keep the conditions of maneuver	Every 6 months	Local Maintenance Staff

Table 8. Preventive Maintenance – 1st Basement Floor – Pressure Reducing Valves

Location	Activity	Frequency	Responsible
1st Basement floor – Pressure reducing valves	Check if the regulating pressure in the valves output is correct. If that is not the case, call qualified company to perform the regulation.	Daily	Local Maintenance Staff
	Clean Filters.	After cleaning the higher water tank	Local Maintenance Staff
	Completely open and close the valves to avoid rust and to maintain the handle conditions	Every 6 months	Local Maintenance Staff
	Internal cleaning and verification of all components, including the command circuit.	Every 12 months	Qualified Professional
	- Diaphragm valve and command diaphragm valve - Pressure gauge - Internal driver spring - Pointer Register	Every 36 months	Qualified Professional

Table 9. Preventive Maintenance – Common Area – Ground Floor and Basements

Location	Activity	Frequency	Responsible
Common area - groun floor and basements	**Geral** - Verify the water outflow in places where there are restriction water flow devices. In case the outflow is different from expected In the outflow guidelines, proceed to the clea-ning, or device replacement.	Montly	Local Maintenance Staff
	Main Water Meter - Do the reading of the main water meter, Preferably in the same time everyday. Log the reading figures.	Daily	Local Maintenance Staff
	Toilet with connected tank. - Verify if the level of water inside connected tanks is leveled at a point lower from the out-flow after a flush. In case it is not, proceed to the equipment regulation.	Montly	Local Maintenance Staff
	Verify the internal flush devices	Montly	Qualified Professional

Table 10. Preventive Maintenance – Common Area – Ground Floor and Basement

Location	Activity	Regularity	Responsible
Common area –groun floor and basement	**Wall valves** - Check the state of conservation of the o-rings and gasket of the registers. These are internal parts of the registry that undergo wear over time, which may compromise the seal.	Every 3 years	Qualified Professional
	- Check for leaks in the registers when fully opened or closed. In the event of a leak, actuate qualified professional for correction.	Every month	Local Maintenance Staff
	- Check for leaks in the registers when fully opened or closed. In the event of a leak, actuate qualified professional for correction.	Every month	Local Maintenance Staff
	Pressure record (shower records) - Check for leaks in the pressure registers when fully open or closed. When the logs are closed, check for drips / showers. In the event of a leak, actuate qualified professional for correction.	Every month	Local Maintenance Staff
	Washbasins / Faucets / Sinks - Remove the aerators (removable nozzles) and clean with running water in the direction opposite to the normal flow.	Every month	Local Maintenance Staff
	- Check for leaks in the registers when fully opened or closed. If they present a leak, call a qualified professional to correct.	Every month	Local Maintenance Staff

Table 11. Preventive Maintenance – Barril – Higher Water tank

Location	Activity	Regularity	Responsible
Barrilete - Head Water Tank	Check if the regulating pressure in the valves output is correct. If that is not the case, call qualified company to perform the regulation	Daily	Local Maintenance Staff
	Clean Filters	Daily	Local Maintenance Staff
	Completely open and close the valves to avoid rust and to maintain the handle conditions	Every 6 months	Qualified Professional
	Internal cleaning and verification of all components, including the command circuit	Every 6 months	Qualified Professional
	Internal cleaning and replacement of the following components:	Every 6 months	Qualified Professional
	- Diaphragm valve and command diaphragm valve	Every 6 months	Local Maintenance Staff
	-Pressure gauge	Every 6 months	Local Maintenance Staff

Apartaments

Similar to the common area, the Owner's Manual must provide the necessary information for inspection and maintenance of the installed equipment, and also identify the location of pipes (if available), and provide information on the materials used. Table 12 indicates guidelines for apartment maintenance;

Table 12. Preventive Maintenance in apartaments

Component	Activity	Regularity	Responsible
Wall Valves (area valves)	Verify the conservation of the connections/rings and of the retentor. Those internal parts of the valve tend to wear in time, which compromises its sealing characteristics.	Every 3 years	Qualified Professional
	Verify the existence of leaks in the valve either when totally open or closed. In case of leakage in douches or showers, if the valve is closed, call a qualified professional to repair it.	Every year	Resident
	Verify if the valves in use are tottlay open. Those valves can´t operate in a semi-open mode	Every year	Resident
Pressure valves (Shower valves)	Verify the existence of leaks in the valve either when totally open or closed. In case of leakage in douches or showers, if the valve is closed, call a qualified professional to repair it.	Every year	Resident

Component	Activity	Regularity	Responsible
Douches and showers	Clean the douche holes and the flow restrictors (if available)	Every year	Resident
	Verify the flow of the installed equipment that is equipped with restriction devices. Measure the equipment flow In case the flow is not as specified on the apartments guidelines, make the adjustment, the cleaning or the devices repair.	Every year	Qualified Professional
Faucet aerators (removuable parts of the spout)	Remove and clean the aerators with current water in the opposite direction to the normal flow	Every year	Resident
Toilet with toilet tank	Verify if the water level inside the toilet tanks after a flush reach or not the overflow level. In case that it doesn´t, call a specialized company or qualified professional to repair it	Every year	Qualified Professional
	Verify the internal devices from the toilet tanks	Every year	Qualified Professional
Washbasin/ Faucets/Sinks	Verify the existence of leaks in the valve either when totally open or closed. In case of leakage, call a qualified professional to repair it.	Every year	Resident
	Verify the flow of the installed equipment that is equipped with restriction devices. Measure the equipment flow. In case the flow is not as specified on the apartments guidelines, make the adjustment, the cleaning or the devices repair.	Every year	Qualified Professional

ANNEX 5

ATER FLOW IN WATER OUTLETS

The base-text of the new Technical Standard for Hot and Cold Water, still to be voted, determines that the "The Cold and Hot Water Building System Project can be designed in such a way as to make the use of water and energy as efficient as possible, which means reducing water and energy consumption to the minimum necessary, enough for the proper functioning of sanitary equipment and to meet the users' needs". Table 13 presents suggestion on maximum flow rates at water outlets.

Table 13. Maximum flow in sanitary appliances

Sanitary appliance		Using device	Maximum flow rate (l/min)
Water dispenser		Pressure valve	4,8
Bidet		Pressure valve/Mixer	4,8
Shower	Mix shower	Pressure valve/Mixer	12
	Electric shower	Pressure valve	7,2
Douche shower		Pressure valve/mixer	4,8
Washbasin		Faucet/mixer	6
Sink (residential use)		Faucet/mixer	7,2
Faucet	Garden	Sprinkler	15
	Washing	Faucet	15
	Tank	Tank faucet	9

Source: Created out of data obtained in Annex D of the base-text regarding the new Technical Standards on cold and hot water.

Also in the base-text of the new standard:

- It is recommended to provide means to limit the maximum outflows in water outlets in order to prevent water waste in buildings.
- The dynamic pressure of water in water outlets cannot be less than 1mca.
- The static pressure in the building distribution system cannot exceed 30mca.

The recommendations in the new standard aim to promote the construction of buildings that enable the efficient use of water.

Part of the equipment installed at the water outlets is delivered by the Construction Company to the user and part is purchased and installed by the user. And also, part of this equipment is specified by the Architecture team and part is specified by the Engineering of Buildings Systems. The Table 14 describes this aspect for the main equipment usually used in residential buildings.

Table 14. List of the people who usually specify and purchase equipment.

Equipment	Who specifies	Who purchases
Metal Sanitary Ware	Architecture team	Construction Company
Showers and Baths	Architecture team	User
Sanitary ware	Architecture team	Construction Company
Gas water heater (circulation or accumulation)	Engineering team	User
Washing Machine	----------	User
Dishwasher	----------	User

Considering that:

- each water outlet must be dimensioned in order to provide a certain flow volume under a certain pressure, compatible to the efficient use of water; and that

· Sanitary ware, sanitary metal ware and equipment are, in general, manufactured to operate efficiently under certain conditions of pressure and flow,

The interaction between Architecture, Engineering of Building Systems, Construction Company, Manufacturers and Users is vital for achieving and maintaining the designed performance, with the necessary and sufficient flow volume for the activity purpose.

The interaction with the User happens through the Owner's Manual. The interaction between the others involved, happens during the process of the Project.

The manufacturers offer a wide range of sanitary ware and sanitary metal ware, which may or may not enable the efficient use of water. To be able to determine the correct specification it requires knowledge about the technical characteristics of the existing products.

Faucets

The correct specification of taps requires the observation of some characteristics:

· Dimensions: The distance from the axis of the fixation point of the device (thread), whether in the countertop or wall, to the water outlet point can make the installation of a certain type of faucet in a certain place impossible (the water jet may not be in an adequate position in relation to the basin).

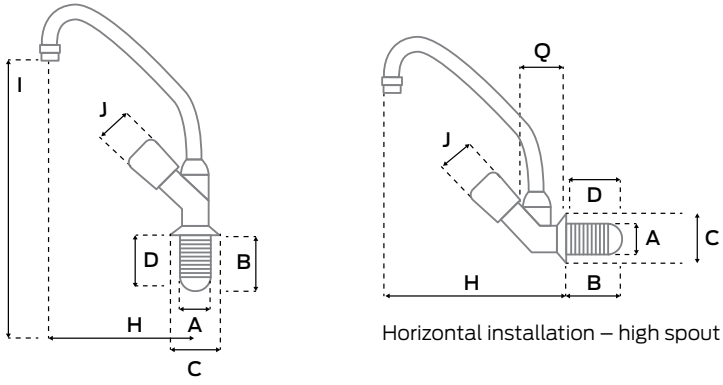


Figure 17 - Example of dimensions to be considered when specifying taps

· Flow Restriction: the flow control is obtained by incorporating a flow reducer into the equipment. There are several models of taps, for different uses, with flow restriction device already built-in. In this condition, users cannot interfere in the flow, since these taps only allow turning on and off the water flow. In other words, once the system pressure is regulated, the flow of water that comes out of the tap may have a fixed and adequate flow, without waste as a result of excessive use of water.Verifica-se que a vazão máxima em torneiras, em geral, pode ser limitada em 6 l/min. Em lavatórios de lavabos, é possível limitar a vazão em até 4,5 l/min para o desempenho das atividades fim (basicamente a lavagem de mãos).

· The maximum flow rate in taps, in general, can be limited t o 6 l / min. In wash basins, it is possible to limit the flow rate by up to 4.5 l / min in order to meet the activity purpose (basically, hand washing).

· For the correct specification, the pressure x flow ratio curve of the equipment must be requested from the manufacturer.

· Common area: Restrooms and changing rooms: provide water activation controls with hydro mechanical operation, with the activation time of the water flow regulated in an appropriate way so that the activities are performed without repetition and without excessive use of water. The time should not be too short to avoid multiple activations in a single wash operation. It should also not be too long to prevent the user from completing the activity with the water still flowing. Ideally, the process of washing hands with soap in this type of equipment should be done with a maximum of two cycles. In the first cycle the user wets his hands and in the second cycle he rinses.

· Common area (washing and garden taps): taps installed in common area, for floor cleaning or garden watering, should be of restricted access to avoid misuse. These taps are characterized by the obstruction of turning on the water directly on the equipment. The water flow occurs with the use of a specific device, fitted to the control rod of the part. At the end of use, the device is removed.

- Example of technical specification of a lavatory tap in a party room:

  Maximum flow: 6 l / min with flow restriction built in the equipment
  Operating pressure: 100 - 400 kPa
  Type of activation: Hydro mechanical control
  Meets ABNT NBR 14390 standard.

Showers

They are sanitary equipment consisting of two components: the screen through which the water comes out (usually called a shower or douche) and the water flow control system.

This equipment is one of the most delicate to reduce water consumption, since the bath activity is the activity for which the user presents greater perception regarding changes in flow.

- Flow limitation: Flow limitation is obtained by incorporating a flow reducer into the equipment. Manufacturers have developed technologies and offer a wide variety of types and models of showerheads with limited maximum flow rates that ensure comfort to the user during the shower. However, showers that consume large amounts of water and cause excessive use are also available.

- The maximum flow rate in showers may be limited to 12 l / min.

- For the correct specification, the flow x pressure curve of the equipment must be requested from the manufacturer.

- Example of technical specification of a shower:

  Maximum flow: 12 l / min with flow restriction built into the equipment
  Operating pressure: 100 - 400 kPa
  Meets ABNT NBR 15206 standard.

Toilets

The necessary amount of water to flush a toilet is determined by the "design" of the equipment. Since 2002, as a consequence of a sector agreement made by the industry of sanitary ware in Brazil, toilets that require a volume of 6.8 liters for flushing have been made available[49], regardless of the type of flushing mechanism (valve or tank). Old toilets, manufactured until 2002, used from 9 to 15 liters of water for flushing solids. With the development of dual activation devices, it is possible to optimize even more the use of this equipment, with less water disposal for flushing liquids.

Sanitary basins are the object of an Industry Sector Quality Program. Ensuring the efficient use of water in toilets means specifying, in the Project, toilets produced by manufacturers certified in the PSQ.

The specification, purchase and installation of toilets not manufactured in compliance with the respective product standard may imply the need for successive flushes for total cleaning.

The specification of toilets, aiming at the efficient use of water, requires the compatibility between the type of toilet and the type of flushing mechanism.

- Conventional toilet: can be used with flush valve or with flush tank (raised or overlapping).
- Toilet with tank attached.
- Fixed flush volume valve: releases fixed volume of water (6.8 liters) regardless of the user's activation time. To release a new flow, the valve must be pressed again.
- Dual-flush activation valve: partial activation for flushing liquids and total activation for flushing liquids and dragging wastewater with solids.

49 Já são objeto de pesquisa as bacias sanitárias que requerem aproximadamente 4,8 litros de água para descarga. Ainda não estão estabelecidos os critérios e condições a serem atendidos pelo Projeto do Sistema de Esgotos Sanitários para que não ocorra obstrução de condutores horizontais (entupimentos) causados pela menor quantidade de água na descarga.

- Connected tank with dual-flush activation mechanism: partial activation for cleaning of liquids and total activation for cleaning and dragging wastewater with solids.
- Example of technical specification for toilets:

  Toilet: for connected flush tank Connected tank:

  with dual-flush activation.

  Meets ABNT 15097-1 and 15097-2 standard

  PSQ Certified manufacturer

Aerators

Devices designed for connecting to faucet spouts that introduce air in the water jet, reducing the superficial tension of the water during the activation of the faucet, providing greater comfort at a smaller flow of water.

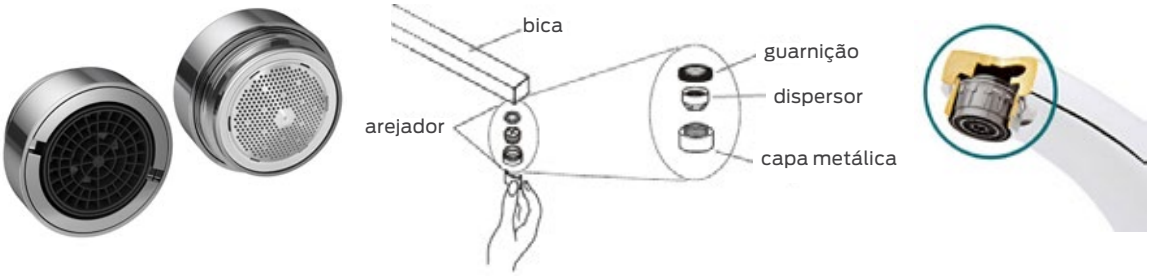


Figure 18 – Examples of types of aerators

The aerator controls the jet dispersion and reduces the water flow through the spout. Some of the models restrict the maximum water flow coming from the outlet at a constant rate. There are aerators withor with a spray jet. Aerator with the spray jet present maximum water flow bellow the conventional ones.

Figure 19 - Example of types of water

Savers aerators are suitable for all kinds of faucets, apart from the ones for cleaning and the laundry sinks, in which the user will need a greater water flow to reduce the time taken to perform the taks.

Usually, faucets already have an aerator installed in their device, or at least, a thread to connect the aerator. However, in general, these aerators do not offer a continuos water flow.

- Example of technical description of a Washbasin faucet in a party room

Maximum flow: 6 l/min with a water flow restrictor connected to the device
Operating pressure: 100 - 400 kPa
Activation type: hydromechanics command
Meets ABNT NBR 14390 Requirement

Aerator: with a continuos water flow up to 3,6 l/min and a spray jet (the description of the aerator is necessary since it's a Washbasin faucet, where a smaller water flow fulfills the need. This equipment is not available in the market with this description of water flow).

Water Flow Restrictor

They are specific devices for controlling the water flow in water outlets.

There are several types of flow restrictors that can be purchased and installed next to sanitary equipment, such as douche showers and faucets.

- **Water Flow restrictor**

Mechanism with a small orifice with a variable diameter that restricts the maximum available flow of water in a pressure area, in general, from 100 to 400 kPa (10 to 40 mca). The devices should be specified according to their flow characteristics, with the flow that is appropriate for their purposes and equipment.

Figure 20 – Example of types of flow restrictors

Some devices are similar to “pads” and it is possible to place them in the water passage inside the shower. Others are threaded inside equipment, in the water outlet, before connecting the faucet´s hose.

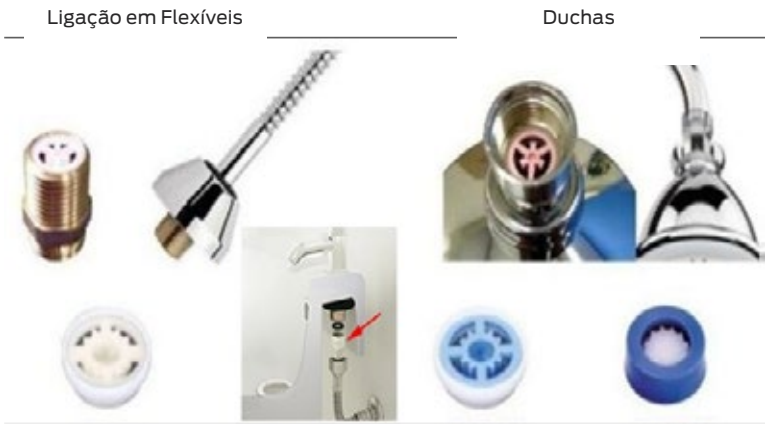


Figure 21 – Example of types of connexion

- **Water Flow Regulator**

These pieces of equipment are adaptable for a specific flow of water or for its regulation by the switching it to a suitable water flow. They are threaded in the wall at the water outlet point before introducing the faucet or they can also be installed between the shower connexion and the outlet in the wall.

Figure 22 – Water Flow regulator

ANNEX 6

DISTRIBUTION SYSTEM – DIMENSIONING USING PROBABILISTIC METHOD

The correct specification for water flow in a project guarantees its Efficient Use of Water.

Probabilistic methods for dimensioning take into consideration that water flow determined in a project depend on users' activities, which takes into account the type of building, the users characteristics, the building residents, the population distribution, the peak periods and the characteristics and frequency of use of sanitary equipment.

Iha M.S.O., Oliveira L.H. and Gonçalves O.M. published in 2010 a technical article[50] proposing a comparative evaluation of project flows in three different sections (one column and two feed branches) achieved by using the probabilistic method proposed by Gonçalves (1986)51 and also by using the empirical method of the square root suggested by ABNT NBR 5626/1998.

In order to verify project water flow results obtained through deterministic and probabilistic methods, in a specific section of the system, Gonçalves (1986) proposes a simulation tested in several of those sections, and the results show great variability: from 1.2 l/s to 30.2 l/s.

Deterministic methods, among them the square root, recommended by ABNT NBR 5626/1998, are "closed" models, with an non-specific approach that do not always reflect the particularities of each project and also do not allow engineers to make more acurate decisions. In an "open" model, the engineer can set statistical imput standards for each project aspect, set the criterion for admissible faults and, by doing so, represent, more accurately, the real aspects of each of the situations found in the project.

50 At http://www.scielo.br/pdf/esa/v15n2/a10v15n2.pdf, Eng. Sanit. Ambient.[online]. 2010, vol.15, n.2, pp.177-186. ISSN 1413-4152.

51 Gonçalves, O.M., Formulação de Modelo para o estabelecimento de vazões de projeto em sistemas prediais de distribuição de água fria. 1986. Thesis (Engineering PhD Civil Engineering) – Escola Politécnica da Universidade de São Paulo, São Paulo, 1986.

Figure 23 presents us with an example of two situations in Architecture that are approached equaly by deterministic methods and differently by probabilistic methods.

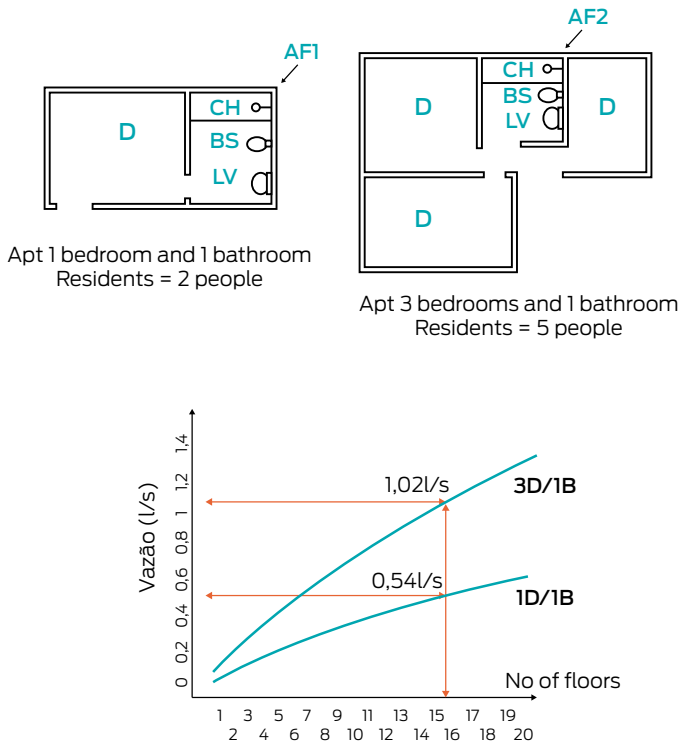


Figure 23 – Example of bathroom dimensioning in two different situations in Architecture, by probabilistic methods and by deterministic methods. Source: CIB W62[52]

52 Gonçalves, O.M., Influence of the users behavior in determining the water flowrates in water supply systems in buildings, Proceedings of CIBW062, Water Supply and Drainage for Buildings, September, 1989, Gavle, Sweden

Probabilistic methods combine simultaneously the apparatus of the building hydraulic system, through a binomial distribution of probabilities. In order to establish dimensioning parameters, specificities regarding to the type of occupation of the building, behavior and habits of the users, regional climatic conditions, period of usage and pause between them, among others, are considered, for each sanitary facility in each environment.

This methodology shows better results when a single distribution branch feeds different hydraulic spaces, for instance, kitchens, bathrooms and laudry, in the case when the peak of the water usage does not coincide.

Probabilistic methods allow the designer to scale the systems according to the reality of the water usage at the points where the water is needed, which favors the efficient use of water.

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