3.3. Maintenance of the systems

Technical Specification ANQIP ETA 0701 contains a maintenance schedule table.

It is analogous to that in the Brazilian standard and less comprehensive than the one in the German standard.

4. Conclusions

The efficient use of water is an environmental must for every country in the world. Some countries, like Mediterranean countries, must develop measures to ensure this as a matter of urgency, since water availability could be significantly affected in the short-medium-term.

Even though the Mediterranean climate is not really suitable for proper rainwater harvesting this should still be considered in the context of the 5R of water efficiency in buildings.

This is why ANQIP, a non-profit Portuguese NGO composed of companies and universities decided to draw up a technical specification for the harvesting of rainwater in buildings, similar to those developed in other countries.

Some aspects still have to be clarified in these systems, especially in relation to the design of storage tanks and, more importantly, in relation to the issue of quality associated with the possible uses of this water.

The matter of tariffs related to rainwater drainage could also be relevant to the implementation of these standards. Note that in Germany, for instance, impermeabilization of the ground is subject to a tax (not yet the case in Portugal) and this can encourage the development of harvesting systems by weighting the recovery of rainwater against such a tax.

It is felt that, despite the different climates occurring in Europe, it should be quite easy, and even desirable, to draw up a European standard for this domain.

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6. Presentation of Author

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IV.3 Water conservation at International Airport of São Paulo in Brazil: the Hidroaer Project

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Abstract

The International Airport of São Paulo - AISP, in Guarulhos, presents the water and the energy consumption as the similar way to the one of a medium city. It annually takes care of 17 million passengers and with forecast of amplification for 29 million. Brazil is one of the countries with largest water resources with 33,000 m^3/hab.ano, but spite of that it suffers water scarcity in some regions, especially in the places of bigger urban concentration, as the state of São Paulo, whose water resources is of 6,607 m^3/hab.ano. This scene demands greater investment in the efficient management of the water. The AISP has about 200 sanitary, beyond the frozen water central and of the sector of food. To make possible a management adjusted with reduction of water consumption is being developed the Project called HIDROAER that aims to promote the efficient water use with water saving technologies and, also, the amplification of water offers to an airport

plant. To reduce the water demand it is necessary to know the standard of water consumption of the various sectors of the airport, what it makes possible to specify efficient systems and components more adjusted. Therefore, the aim of this work is to present an overview of the water supply system and the water consumption at the AISP and the plans
for a survey of the water consumption pattern of one sanitary composed by six restrooms of the international terminal of passengers. The results, beyond directly subsidizing the water demand management, from the control of water losses, can influence the development of water supply systems designs in similar airports and other public plants.

Keywords

Water conservation; airport; HIDROAER; water consumption pattern.

1. Introduction

Brazil presents a favorable average value of water availability, about 33000 m^3/person/year. However, this value varies from 1145 to 533096 m^3/person/year and in the state of São Paulo, where the International Airport of São Paulo - AISP is located, the water availability presents about 2209 m^3/person/year [1], which is a critical situation. This situation implies the necessity of reduction of the water demand in the AISP to make it possible the future construction of the third air terminal.

There is a world-wide interest in reducing the environmental impact from the part of the airport administration, in special those related to the energy and water uses. One of the first initiatives was verified, according to Chouthai et al. [2], in the International Airport of Stapleton, Denver, Colorado, U.S.A. where a laboratory and field research was conducted with the aim to verifying the performance of WC cistern of 6 liters and, mainly, and its ability to transport solids in the sewage system in an efficient way without high costs of maintenance and/or blockages in horizontal branches.

The San Francisco Airport shall minimize potable water use by deploying water saving equipment and facilities and shall contribute to improving water quality in the lower San Francisco Bay through state-of-the-art wastewater treatment and enhanced storm water management. For this, one of the goals is to maximize water conservation and minimize water use and waste [3].

The INFRAERO – Brazilian Airports is responsible for the administration of 67 Airports and 81 Air Navigation Support Units throughout Brazil. Aware of its environmental responsibilities, INFRAERO maintains an Environmental Policy compatible with the planning, construction and operations of its activities in accordance to national and international regulations and laws. INFRAERO’s environmental management system is supported by the Environmental Programs developed by the Superintendence of Environment and Energy, the environmental units of the Regional Superintendence and airports, one of them being the Water Resources Program [4].

The objective of the Water Resources Program is to systematise procedures in order to reduce and optimize water consumption at airports, protect watersheds, and preserve springs and bodies of water in ways compatible with airport activities. Another objective is to stimulate the adoption of water saving technologies that reduce water use in new constructions and make current buildings more efficient.

Thus, the International Airport of São Paulo (AISP) is the object of study of the HIDROAER Project - Efficient water use at airports, which has been developed by the Instituto Tecnológico de Aeronáutica (ITA) in partnership with the University of São Paulo and the University of Campinas and financed by the FINEP - Financiadora de Estudos e Projetos e Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). The objectives of the HIDROAER Project are to specify saving water technologies as well as the implement of non-potable water systems for the reduction of water consumption, from a diagnosis of the water use at the AISP, carried out in 2006 by AISP.

The aim of this work is to present an overview of the water supply system and the water consumption at the AISP and the plans for a survey of the water consumption pattern of the restroom 93 of the international terminal of passengers, one of them for men and another for women. There are also small restrooms for children and for people with special needs in this restroom 93.

2. Characteristics of water supply and drainage system of AISP

The International Airport of São Paulo (AISP) is located in the city of Guarulhos, about 20 kilometers from the city of São Paulo, in an area of 14000 km^2. It has been managed by the Brazilian Airports (INFRAERO), since 1985, when it started operating.

The AISP can attend about 17 million passengers per year with two air terminals. However, it takes care of about 12 million of users annually and the construction of the third terminal of passengers is been prepared. After this, the AISP will increase its capacity for 29 million passengers per year. It is important to mention that it is one of the main modes of logistics of air cargo, with the largest cargo terminal in South America [5].

2.1 Water supply and drainage system

In accordance to the Report of the Action Plan [5], the water supply in the AISP is carried out by underground water through wells provided with water meters, which allow the management of the volume of water consumption. The collected water is conveyed to a treatment plant and later distributed to three reservoirs with 199 m^3 of capacity each. From these reservoirs the water is conveyed by gravity to the airport.

The average static head of the water supply system, in the six areas of the AISP, presents a range of 30 kPa to 640 kPa, being that in the four of them the average value of hydraulic head is about 600 kPa, which is considered a high value and, in this way, it contributes to higher values of flow rates in the water taps.

The drainage system conveys the effluents from the AISP to two biological treatment plants. After the treatment the water is conveyed to lagoons and to a stream.

2.2 Water consumption distribution in the AISP

The estimative of monthly water consumption is of 49907 m^3 and the main uses are distributed in the following points of use [5], as presented in Figure 1. Note that only the water consumption estimated for the WC, the faucets and the urinals corresponds to 73% of the total water consumption. This implies that the restrooms are critical points of water consumption in the AISP.

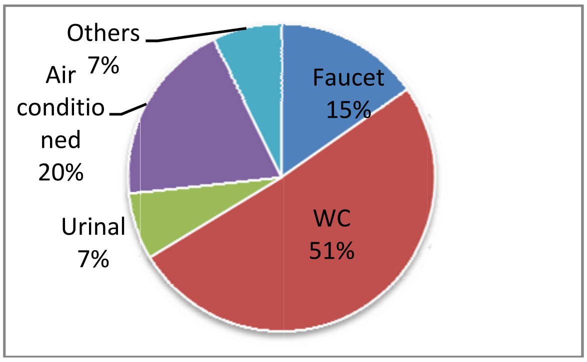


Figure 1: Water consumption distribution in the International Airport of São Paulo [5]

3. Methodology

For the study and specification of the water saving technologies to be replaced in restroom 93 of the AISP, which was chosen as a pilot, located in the superior level of the Terminal of Passengers and the international section. Restroom 93 is composed of two restrooms for adults, one for women and the other for men, two small restrooms for children, one for boys and the other for girls. In addition, two special needs restrooms, one male and another female. Figure 2 shows the plant of the studied environments.

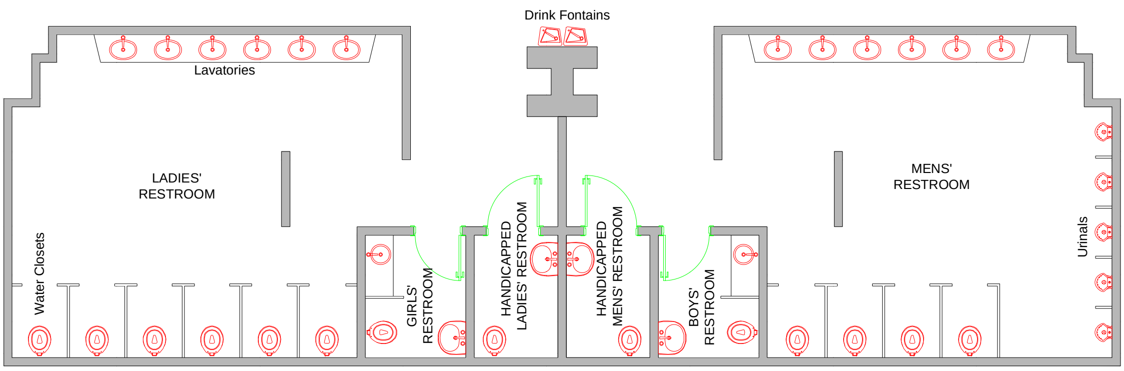


Figure 2: Plant of Restroom 93 monitored at the International Airport of São Paulo

The water consumption of the appliances is being measured by 12 water meters connected to their respective branches, as shown in Table 1.

Table 1 – Water meters installed in restroom 93 of the AISP

Water meter	Type and Metrological class	Appliances monitored
H2	Volumetric, class D	1 wash basin with metering faucet + 1 faucet for cleaning - girls' restroom
H3	Volumetric, class D	5 wash basins with electronic faucets - men's restroom
H4	Volumetric, class D	1 wash basin with electronic faucet - men's restroom
H5	Volumetric, class D	1 water faucet for cleaning - men's restroom
H6	Volumetric, class C	1 wash basin with metering faucet + 1 faucet for cleaning (boys'restroom)
H7	Multi jet, class B	6 valve operated water closets(1) - 4 in the men's restroom, 1 in the boys' restroom and 1 in the special needs restroom (male)
H8	Volumetric, class D	2 drinking fountains - outside hall
H9	Volumetric, class D	1 faucet for cleaning - ladies' restroom
H10	Volumetric, class D	1 wash basin with electronic faucet - ladies' restroom
H11	Volumetric, class D	5 wash basins with electronic faucet - ladies' restroom
H12	Multi jet, class B	8 valve operated water closets(1) - 6 in the ladies' restroom, 1 in the girls' restroom and 1 in the special needs restroom (female)
H13	Volumetric, class C	5 urinals (electronic) - men's restroom

(1) The duration of flush depends on the user, i.e. the volume is variable.

The water meters are instrumented for remote metering and the data are presented in electronic sheets. The local of the water meters was chosen considering the branches that feed just one type of sanitary appliance and also considering the specific difficulties to install them.
Isis

3.1 Steps of the research

Five steps of monitoring, in function of the water saving technologies, have been defined to be installed in the water taps, as presented in Table 2. Each step of measurement is about a period of 15 days. At this moment, step 1 is being implemented, with the objective of evaluating the water consumption with the existing sanitary appliances. This step has a greater number of days than the other steps of the study.

Table 2 - Steps and respective water save technologies to be implemented in restroom 93 of the AISP

Step	Activity
1	Installation of water meters and instrumentation **Measurement 1: data collect and data analysis**
2	Adjustments in the water taps: flow rates, duration of discharges, volumes **Measurement 2: data collect and data analysis**
3	Installation of: a) electronic valves in the water closets - ladies and men's restrooms; b) electronic faucets in the wash basins – special needs ladies´ and men's restrooms; and in the boys and girls' restrooms c) foot faucet - boys and girls' restrooms **Measurement 3: data collect and data analysis**
4	Installation of: metering faucets in the wash basins - all restrooms **Measurement 4: data collect and data analysis**
5	Installation of: double flush toilet valves (3/6 L) – all restrooms **Measurement 5: data collect and data analysis**
6	Installation of conventional faucets with aerators and flow rate regulator valves in all water taps (all restrooms) to compare the results **Measurement 6: data collect and data analysis**

The population is being controlled by the number of passengers of each international flight which has been provided by AISP. The average number of passengers per day in the influence area of the Restroom 93 was estimated in 3227 in May and 3796 in June (100024 and 113889 passengers per month, respectively).

3.2 Development of the data acquisition system

The development of a system of data acquisition is also objective of this research which is being used to collect the data in restroom 93. This system operates from electronic modules of communication in net, connected to the water meters that generate pulses in an output pre-established. The system operates in high frequency and data communication short bands.

The net is dimensioned to overcome prompt failures of transmission, providing highly reliable data security. Moreover, the system counts on coordinator modules, generating a positive redundancy for the operation. Each device has a storage capacity to accumulate registers in case of temporary failure of the net, with the guarantee of recovery of the accumulated information when the operational conditions return.

The use of this technology brings some comparative advantages for this type of application, such as:

- cost of installation and implementation of the reduced net. Therefore the data are transmitted without cables, not being necessary the installation of cables and connectors between the modules and the remote central office;
- low cost of the modules, once it deals simple technology, that uses low transference tax of (up to 250 kb/s), more than enough for the application in question;
- low consumption of power, which allows the modules to be fed by common batteries, functioning per years without the necessity of exchange of batteries.

4. Results and discussion

The total daily water consumption (all restrooms) in the first step was 42.4 m^3, on average, with a standard deviation of 19.9 m^3, as shown in Figure 2.

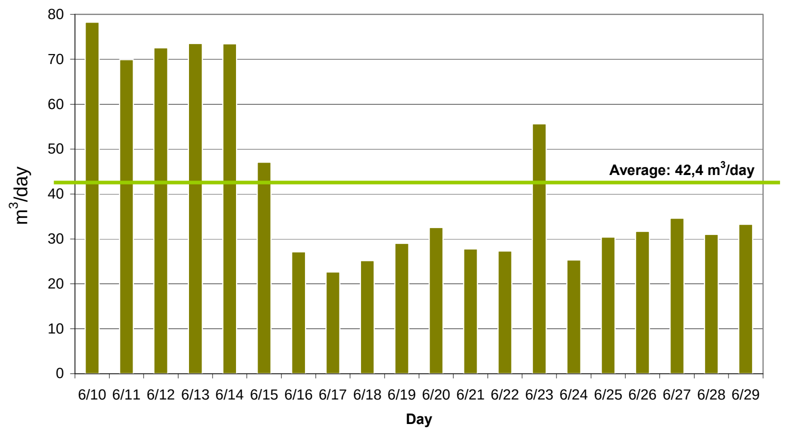
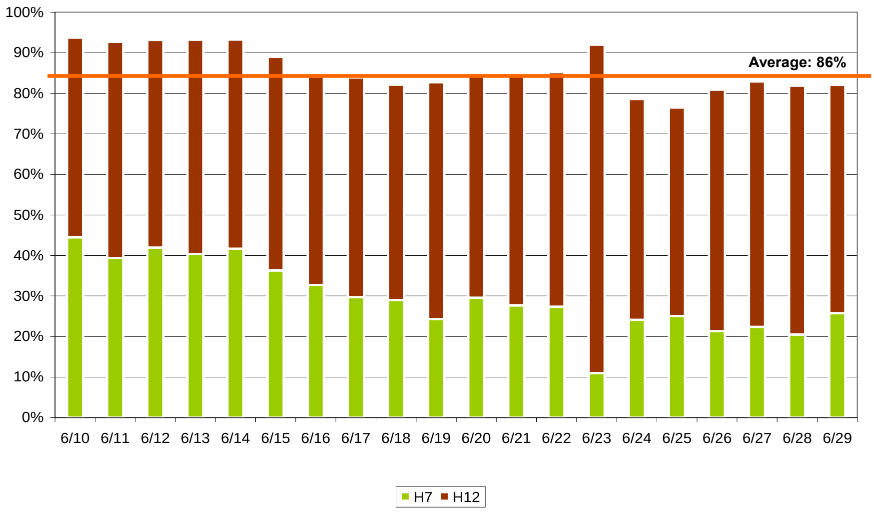


Figure 2: Daily water consumption in the restroom 93 of the AISP

In this period, 86% of the water consumption, on average, has been occurred in the WC, as it illustrates in the Figure 3. The distribution of the water consumption of the other sanitary appliances is presented in Figure 4.

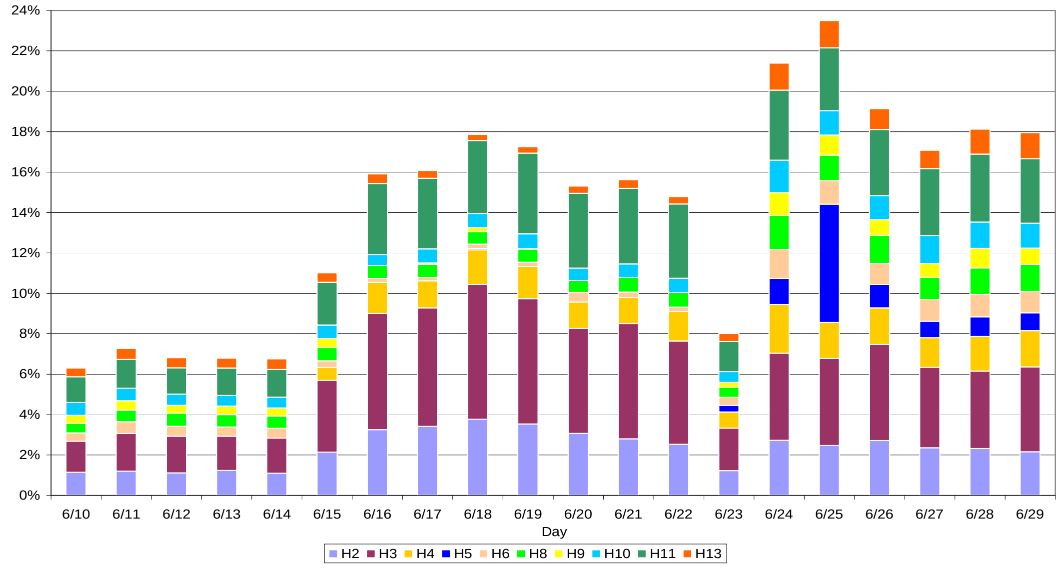
Considering only the water consumption at the ladies and men's restrooms, the WC consumption represents between 80 and 90% of the total consumption of each restroom.



H7 – 6 water closets - 4 in the men's restroom, 1 in the boys' restroom and 1 in the handicapped men's restroom.

H12 – 8 water closets 6 in the ladies' restroom, 1 in the girls' restroom and 1 in the handicapped ladies' restroom.

Figure 3: Distribution of the water consumption in the WC of the restroom 93 of the AISP



H2 -1 wash basin with metering faucet + 1 faucet for cleaning - girls' restroom
H3 - 5 wash basins with electronic faucet - men's restroom
H4 - 1 wash basin with electronic faucet - men's restroom
H5 - 1 faucet for cleaning - men's restroom
H6 -1 faucet for cleaning - men's restroom
H8 - 2 drinking fountains - outside hall
H9 - 1 faucet for cleaning - ladies' restroom
H10 - 1 wash basin with electronic faucet - ladies' restroom
H11 - 5 wash basins with electronic faucet - ladies' restroom
H13 - 5 electronics urinals - men's restroom

Figure 4: Water distribution consumption in the other sanitary appliances of the restroom 93 of the AISP

The water consumption at the urinals is less than 1% of the daily consumption. This may be due to the lack of wall division between these appliances, with no privacy for the use. Also, the valve operated WC and the urinals are operated by electronic sensor with about 1 liter per flush. To illustrate this fact, Figure 5 shows the water consumption pattern for the WCs and the electronic urinals for a same day and Figure 6 shows the water consumption in the other appliances on the same day.

Another important piece of information was the peak period (Tp), defined in terms of the consumed maximum volume in each hour of the day. Considering all the sanitary appliances of the men´s restroom, it was verified that the peak of water consumption on this day was between 5 and 6 h (2674 liters in 1 hour). In the ladies´ restroom, 5 periods of one hour with similar consumption was verified: between 5 and 6 h (2600 L), between 11 and 12h (2659), between 13 and 14h (2637 L), between 17 and 18h (2346 L) and between 22 and 23h (2166 L).

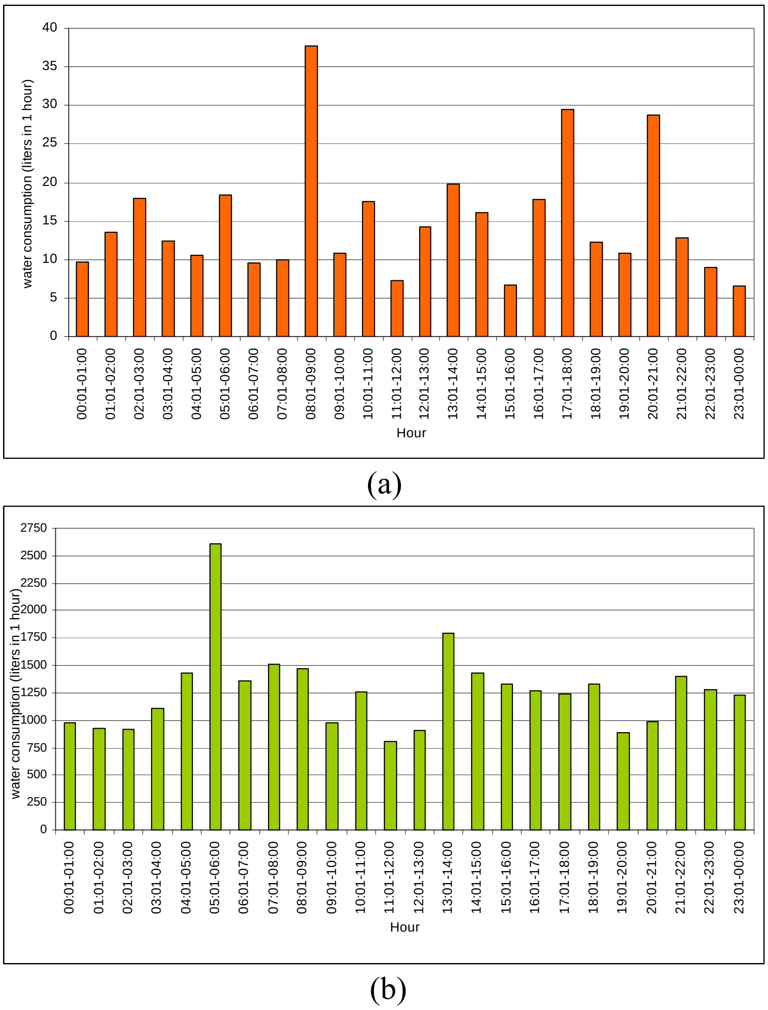


Figure 5: Water consumption (a) in the five electronic urinals appliances and (b) in the six WC of men's restroom during June, 12th, 2009 day

The water taps are also being monitored with the aim to determine the number of uses; however these results are not available yet.

5. Final considerations

This paper presented a survey of the water consumption pattern of one sanitary of the international terminal of passengers in the International Airport of São Paulo, Brazil. This restroom is composed of six restrooms, including installation for children and for people with special needs. The study is right now at first step 1.

The main objective of this study is to evaluate water saving components that represent major water consumption decrease for other restrooms of the airport. Also, it will make a proposal for other similar airports in the country.

The results obtained so far (step 1) indicate that the WCs represent 86% of the water consumption, on average. It is due to the fact of the discharge volume of all WCs depends on the users. It is also true for the men's restroom, which has urinals. Urinals