THE USE OF WATER AT COMANDANTE FERRAZ ANTARCTIC STATION

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Abstract

The Brazilian Antarctic Program has been developing technological studies in order to amplify the Comandante Ferraz Antarctic Station (EACF) environmental performance, with the optimization of constructive actions and also the complementary systems, such as water supplying, sanitary drain system, solid residues management, air quality evaluation, electricity management and others.

In this context, the current work is the development of a diagnosis about the use of water at EACF and the proposal of policies for the Water Conservation Program (PCA) implantation, aiming to reduce the resource waste and consequently to reduce the production of sanitary drain.

Introduction

The Brazilian occupation in the Antarctic Continent takes place in the Antarctic Peninsula, the only continental region located out of the Polar Antarctic Circle and it is not freezing permanently. It is in this distant place that the Brazilians develop their scientific research activities, more specifically, in King George Island, South Shetland Archipelago, where it is located the main Brazilian building in Antarctic: The Comandante Ferraz Antarctic Station.

Considering the Antarctic Continent legislative requirements and the environmental restrictions, it is necessary some actions in order to the environmental conservation and preservation, mainly for its ecosystems great scientific value what makes the continent the biggest natural laboratory of the planet.

Brazil started its occupation in Antarctic in the summer of 1984. At that time the station had an eight containers with accommodations for twelve people structure (ALVAREZ, 1996). Until 2002 there was not a formal concern about building changes and amplifications and rare initiatives were specifically based on environmental character. From 2002 on, a big infra-structure reorganization has been done at EACF, the physical area as well as the complementary systems with emphasis in the water supplying, the sanitary drain, the solid residues management, the internal air quality evaluation, the electricity management and others.

A diagnosis about the use of water at the Station was made during this reorganization period in order to elaborate and implant a Water Conservation Program, so that the consume of this resource can be reduced and also the sanitary drain production.

Nowadays the water consuming activities at EACF are done without any worrying about the volume, since there are no financial costs bonded to it. Although the direct

consequence from this action is the production of sanitary drain what requires a suitable treatment before the final disposal.

The water supplying system at EACF can be classified as conventional. It begins by caching water from two snowbreak lakes, located near the main building, following by the water storage in a tank. Before the final distribution, the water pass through two treatment stations – one through fast filtration in land bed and filtration through activated charcoal.

Till 2006, it was believed that the water got at EACF could be considered inexhaustible, since the snowbreak lakes have supplied the demand since its implantation, however from mid-winter 2007, the EACF users have been suffering with water scarcity for the first time, what requires urgent issues of water rationalization.

Objectives

To diagnose the water using at the Comandante Ferraz Antarctic Station and to present alternatives that aim the water consume reduction and consequently the reduction of sanitary drain production.

Methodology

This research was realized as part of the ARQUIANTAR project (Technological Development to the Brazilian Installations in Antarctic: emphasis in corrosion, residues and acoustics studies), that has as objective to improve the technology used in the Comandante Ferraz Antarctic Station buildings and equipments (figure1), aiming to reduce the environmental impact, to optimize the maintenance sources and to improve the existing installations. This work took place at the Laboratório de Planejamento e Projetos (UFES) and the field activities, at EACF, from Nov/2006 to Junho/2007. The Laboratory analyses were made, part at EACF, by the researcher Cristina Rossi Nakayama, from MICROPOLAR project of the São Paulo University and the other part by the Núcleo Água of Espirito Santo Federal University.

Figure 1 – Comandante Ferraz Antarctic Station in June 2007.

For elaborating a diagnosis of the use of the water in the EACF, it was necessary the accomplishment of an auditorship of the consumption, where it was observed the data that involve the use or loss of the water in the construction beyond the consumption pointers. In such a way, it was made a survey of the Station built infrastructure and of its hydro-sanitary system, observing the available hydrous sources, the developed activities, the number and type of users, the hydro-sanitary equipments, the distribution of the consume points in the architectural plan, the getting of energy, the climate conditions, the cultural, psychological and comfort aspects. In this way, it was made the Station cold and hot water nets, the "as built", where the water consumption points were identified, besides of characterizing and localizing the hydraulic pieces and equipments that compose the system (table 1). Also some "in loco" measures were taken in order to determine the equipments output and hydraulic pieces through pre-determined water volume collection, using a chronometer and a graded test tube. Thus, the system pouring visible points were localized and calculated.

Table 1: Water Consumption points at EACF.

COLD WATER POINTS	QUANTITY	HOT WATER POINTS	QUANTITY
Lavatory	10	Lavatory	10
Shower	07	Shower	07
toilet (flush)	10	Hygienic douche	07
Hygienic douche	07	Kitchen sink	05
Kitchen sink	06	Laboratories and infirmary sink	08
Laboratories and infirmary sink	12	Industrial washing machine	01
Distiller	03		
Boots washing	01		
Washing machine	04		
Washhouse Tank	01		
Filter	01		
Aquarius faucet	09		
Aquarius Tank	15		
TOTAL	**87**	**TOTAL**	**38**

Considering that the results should be evaluated according to the population, another important aspect was the average number of users at EACF. In this way it was defined a period of 5 (five) years to calculate the average population – from 2002 to 2007-, all the data were provided by the Inter-ministerial Commission Secretary for Sea Sources (SECIRM), which is the coordinator of the Brazilian Antarctic Program (PROANTAR).

According to Table 2, we can observe that the population at the Station is quite different during the summer and the winter. Being 52 inhabitants in the summer time and 21 in the winter time.

Table 2: Average Occupation at EACF, from 2002 to 2007.

YEAR	SUMMER (INH)	WINTER (INH)
2002	46	16
2003	45	16
2004	44	13
2005	54	27
2006	52	23
2007	70	30
Average (2002 a 2007)	**52**	**21**

Tests about the quality of water consumed at EACF were also realized through microbiologic analyses and physics-chemistry essays, in a partnership with the Projects MICROPOLAR (USP) and Núcleo Água (UFES). Samples from the water tank, from the kitchen faucet and from the potable water filter were collected. Some parameters were observed, such as, total coliforms, thermal-tolerant coliforms, potential of hydrogen (pH), turbidez, apparent color and real color, and total nitrogen Kjeldahl (NTK).

Based on these data, it was possible to elaborate the scenery that shows the current situation of the use of water at EACF during the summer and the winter. It was observed that these initial sceneries represent the conventional consume, considering the current way of water using at the Station. After that, some economical alternatives were proposed, in order to reduce the volume of water consumed at the Station.

Results

Among the main results, we can stand out the accomplishment of a hydro-sanitary map culminating with the elaboration of the Station hydrous plant, with details about the pipes, from the water entrance into the building to the consumption water points (figure 2).

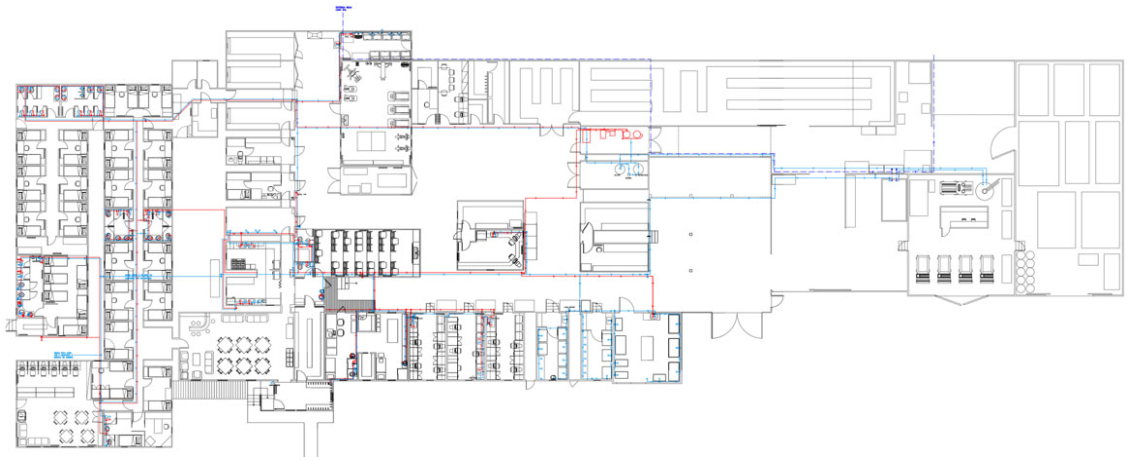

Figure 2 - EACF hydraulic Scheme.

The Hydraulic plant represents a very useful document which will help in the process of system evaluation and also in the implantation of the PCA, as well as guiding eventual Station projects of improvement or amplification.

About the water quality essays, we can stand out that the collected and analyzed samples are according to the aimed quality standards, considering the Ordinance MS 518/2004, which determines the water potability standards, as well as the Resolution CONAMA 20/86 which classifies and regulates the water quality according to its use (table 3).

Table 3: Comparison between the water analyses and the specific legislation.

PARAMETERS	RESULTS	WATER LEGISLATION	
		POTABLE	SUPPLYING
Total Coliforms	<2* (NMP/100 ml)	Absent	Absent
Thermo-tolerating Coliforms	<2* (NMP/100 ml)	Absent	1000/100 ml
Ph	6,94 a 7,32	6,0 a 9,5	6,0 a 9,0
Turbidez	0,31 a 0,73 UT	5 UT	40 UT
Apparent Color	0 a 0,007 uH	15 uH	15 uH
Real Color	0 a 0,002 uH	10 uH	10 uH
NTK	0,027 a 0,067 mg/l	1 mg/l	1 mg/l

** it was analyzed according to the more probable number (NMP), in this technique, the result <2 means absence.*

The Hydraulic plant was divided in sections, considering the environment dispositions and the water consumption activities developed in each one of them (figure 3). In each pre-determined sector was installed a hydrometer to effectively quantify the consumption and also to permit a continuous controlling of water using at the Station.

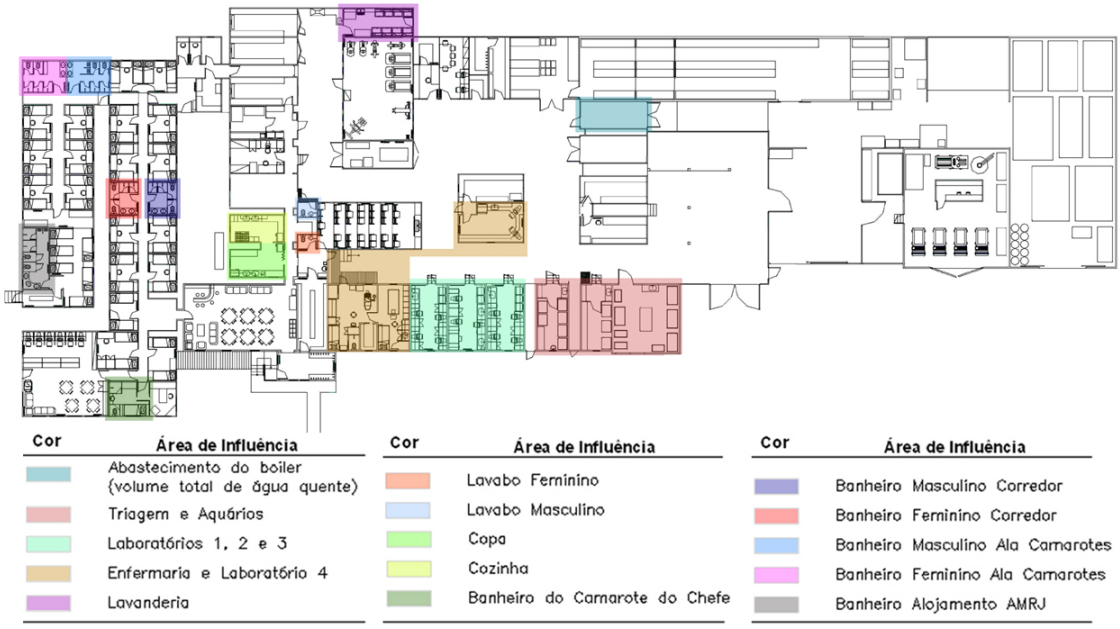

Figure 3 - The water consumption in sections at EACF.

Afterward, it was elaborated a theoretical scenery, considering the data from initial auditorship, with the amount of water consumed from different equipments and pieces that compound the hydro-sanitary system at EACF. This initial prospect presents an average consumption about 35 m³/day in the summer – biggest consumption period -, with a domestic consumption per capita about 213 l/inh.day, correlating to the consumption produced without any criteria of rationing on equipments and pieces available today (Table 4).

Table 4: Current water consumption estimated at EACF considering the summer occupancy.

WATER CONSUMPTION POINTS	QUANTITY	CENÁRIO 1 - CONVENCIONAL				
		Q UNIT		FREQUÊNCY		TOTAL Q (L/Day)
Shower	7	12,41	l/min	7	min/inh.day	4517,24
Lavatory	10	9,06	l/min	4	min/inh.day	1884,48
Flush	9	8,27	l/flush	4	flush/inh.day	1720,16
Hygienic Douche	7	5,98	l/min	1	min/inh.day	310,96
Kitchen sink (sink 1)	1	24,84	l/min	129	min/day	3193,71
Kitchen sink (sink 2)	1	10,49	l/min	129	min/ day	1348,71
Scullery sink (sink 1)	1	25,22	l/min	257	min/ day	6485,14
Scullery sink (sink 2)	1	25,01	l/min	171	min/ day	4287,43
Scullery sink (sink 3)	1	12,45	l/min	24,5	min/ day	304,85
Barbecue sink	1	6,87	l/min	5,71	min/ day	39,26
Infirmary sink	2	9,17	l/min	12,21	min/ day	223,93
Laboratory sink 1	1	8,25	l/min	6,13	min/ day	50,57
Laboratory sink 2	2	9,98	l/min	85,50	min/ day	1706,58
Laboratory sink 3	1	10,37	l/min	24,5	min/ day	253,24
Laboratory sink 4	1	8,82	l/min	6,13	min/ day	54,07
Distiller	3	10,51	l/min	61,07	min/ day	1925,54
Boots-washing	1	21,47	l/min	24,5	min/ day	524,30
Washing machine LF90	1	171	l/min	2,14	min/ day	365,94
Washing machine LF90	2	171	l/min	8,57	min/ day	2930,94
Washing machine LQ11	1	154	l/min	8,57	min/ day	1319,78
Industrial Washing machine	1	171	l/min	0,43	min/ day	73,53
Washhouse Tank	1	8,81	l/min	36,7	min/ day	323,50
Filter	1	0,09	l/min	214	min/ day	19,29
Aquarius sink 1	2	9,11	l/min	6	min/ day	109,32
Aquarius Tank 1	6	25,31	l/min	0,5	min/ day	75,93
Aquarius sink 1	3	9,98	l/min	1	min/ day	29,94
Aquarius sink 2	1	11,05	l/min	6	min/ day	66,30
Aquarius Tank 2	3	17,14	l/min	0,5	min/ day	25,71
Aquarius sink 2	6	14,27	l/min	1	min/ day	85,62
Assortment sink	1	17,06	l/min	6	min/ day	102,36
Assortment tank	6	36,61	l/min	0,5	min/ day	109,83
Assortment Tank 7	1	14,89	l/min	10	min/ day	148,90

In a urban traditional system, the residences have an average consumption per capita of about 200 l/inh.day, and the same consumption in Brazil, considering the general average, it is about 141 l/inh.day (GONÇALVES et al, 2006). Adopting these values in order to compare – since the users have the same habits, we can verify that the consumption at EACF is according to the admitted variation per inhabitant, although it is high in relation to the Brazilian average.

A second scenery was elaborated, considering the conventional equipment and pieces replacement by similar economizers easily found in the market and considered of medium economy. These provisions are, mainly, hydro-mechanic operating, where the

users set the equipment in a manual way and the provision determines the closing time, as for example the sink and showers temporizing and the urinal. In this second scenery, the water consumption of the current hydro-sanitary system can be reduced in about 41%.

To draw up the third scenery, considered the maximum economy, advanced provision for water economy were used, such as the presence sensors, dry urinal e and composed toilets (table 5).

Table 5: Water estimated consumption at EACF considering summer occupancy and the installation of water advanced economizers.

WATER CONSUPTION POINTS	ECONOMIZER EQUIPMENTS	SCENERY 3 – MÁXIMUM ECONOMY					
		ECONOM %	Q UNIT		FREQUÊNCY		TOTAL Q
Shower	Shower with determined flood time	40	7,45	l/min	7	min/inh/day	2710,34
Lavatory	Faucet with sensor	75	2,27	l/min	4	min/ inh/day	471,12
Toilet	Dry urinal	100	0,00	l/desc.	4	desc/ inh/day	0,00
Hygienic Douche	-	0	5,98	l/min	1	min/day	310,96
Kitchen sink (sink 1)	Faucet with sensor	75	6,21	l/min	128,6	min/ day	798,43
Kitchen sink (sink 2)	Faucet with sensor	75	2,62	l/min	128,6	min/ day	337,18
Scullery sink (sink 1)	Faucet with sensor	75	6,31	l/min	257,1	min/ day	1621,29
Scullery sink (sink 2)	Faucet with sensor	75	6,25	l/min	171,4	min/ day	1071,86
Scullery sink (sink 3)	Faucet with sensor	75	3,11	l/min	24,49	min/ day	76,21
Barbecue sink	Faucet with sensor	75	1,72	l/min	5,71	min/ day	9,81
Infirmary sink	Faucet with sensor	75	2,29	l/min	12,21	min/ day	55,98
Laboratory sink 1	Faucet with sensor	75	2,06	l/min	6,13	min/ day	12,64
Laboratory sink 2	Faucet with sensor	75	2,50	l/min	85,50	min/ day	426,65
Laboratory sink 3	Faucet with sensor	75	2,59	l/min	24,42	min/ day	63,31
Laboratory sink 4	Faucet with sensor	75	2,21	l/min	6,13	min/ day	13,52
Distiller	-	0	10,5	l/min	61,07	min/ day	1925,54
Boots-washing	Restraining	60	8,59	l/min	24,42	min/ day	209,72
Washing machine LF90	-	0	171	l/min	2,14	min/ day	365,94
Washing machine LF90	-	0	171	l/min	8,57	min/ day	2930,94
Washing machine LQ11	-	0	154	l/min	8,57	min/ day	1319,78
Industrial Washing machine	-	0	171	l/min	0,43	min/ day	73,53
Washhouse Tank	Faucet with sensor	75	2,20	l/min	36,72	min/ day	80,88
Filter	-	0	0,09	l/min	214,3	min/ day	19,29
Aquarius sink 1	Faucet with sensor	75	2,28	l/min	6	min/ day	27,33
Aquarius Tank 1	Restraining	60	10,1	l/min	0,5	min/ day	30,37
Aquarius sink 1	Faucet with sensor	75	2,50	l/min	1	min/ day	7,49
Aquarius sink 2	Faucet with sensor	75	2,76	l/min	6	min/ day	16,58
Aquarius Tank 2	Restraining	60	6,86	l/min	0,5	min/ day	10,28
Aquarius sink 2	Faucet with sensor	75	3,57	l/min	1	min/ day	21,41
Assortment sink	Faucet with sensor	75	4,27	l/min	6	min/ day	25,59
Assortment tank	Restraining	60	14,6	l/min	0,5	min/ day	43,93
Assortment Tank 7	Faucet with sensor	75	3,72	l/min	10	min/ day	37,23

In this scenery, the theoretical water consumption presents itself reduced in about 53% in relation to the observed conventional scenery. The use of such maximum economy equipments, modifies considerably the users habits and the sanitary residues quantity and characteristics at EACF, what requires a detailed study of its viability. However, due to a significant water consumption reduction and its consequent reduction of sanitary drain production, it is an option to be considered in future actions of optimization of EACF environmental performance. It is yet, it is important to say that,

independent on the suggested systems adoption at EACF, the equipments can be considered to the new Brazilian building projects in Antarctic.

Conclusion

Based on the results, and with the intention of continuing the in-progress researches, a controlling program of raw and treated water quality at EACF is being elaborated, according to the specific legislation, aiming to preserve the users' health. It will be also done a hydrous balance at EACF focusing the reduction of material loss and waste in the system. In parallel, the quality and quantity of sanitary drain production control is being done, aiming to reduce the environmental impacts.

It is important to say that any proposal of changing in the users' habits, requires environmental educational actions, not only to make them conscious about the importance of eliminate the waste but also to conduct the correct way of using the installed economizer equipments. (ALVAREZ et al, 2004).

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