

COMPUTER SYSTEM ON WATER RESOURCES AND EFFLUENTS AS A SUPPORT TOOL FOR PLANNING A RATIONAL USE OF WATER IN THE OIL AND GAS PRODUCTIVE CHAIN

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Abstract

Petrobras, as a great user of water, developed tools of environmental management of water resources, establishing a management plan grounded on corporate guidelines and based on management intern standard of these resources. One of the instruments is the Corporate System on Water Resources and Effluents - DATA HIDRO. Designed to work as a database, the system, among other functions, allows the recording and the consulting of qualitative and quantitative data of water currents that comprise the overall global water balance of facilities such as refineries, thermal power station, waterway and highway terminals, administrative buildings, ships and platforms, enabling the fast access to information in an integrated way. This paper aims to demonstrate the applicability of the proposed concepts for the development of the system with the objective of allowing it to act as a support tool to the planning of rational use of water in all segments of the oil and gas productive chain.

Keywords: Water resources, water effluents.

Introduction

People of past generations grew up learning that water is a free access asset. Even nowadays, this is how most people think. Fresh water, however, is an increasingly rare asset and provided with economic value, not to mention other values: ecological, cultural and even religious ones.

There are several forecasts of conflicts over water use for the next two decades, as the demand increases sequentially, and it is expected for the trends to continue to increase.

Brazil is worldwide known as a country rich in water, as it has approximately 12% of all freshwater on the world surface. Despite the large offer, about 70% of this resource is in the Amazon region, where about 10% of the population resides. The northeast region, due to low rainfall, finds difficulties related to water supply, and the most developed region in the country, the Southeast, has locations where the social availability of water points to a shortage situation due to high demand.

The agricultural sector is the largest user of water in Brazil, followed by industrial and urban water supply. As the demand grows, so does the need for a more effective public management, in order to regulate the distribution of water among users and to ensure water quality in water bodies. In situations of shortage, the supply of the population is a legal priority in Brazil. Food production has strong political appeal and the trend is that this activity supply is seen by the population as a priority. Therefore, at first, the responsibility to search for the efficient use of water in its processes rests on the industrial sector.

The oil industry is an important industry user of water, especially in refining activity. The water bodies are used as a water supply source for use as input for production and as a mean of assimilation of their effluents. It is, therefore, essential that water is used efficiently, particularly in regions where water availability is low.

Petrobras withdrew 187 million m³ of fresh water in 2010 in Brazil (84%) and other countries (16%). Rivers are the main sources of supply, and provided 129 million m³. Groundwater contributed 37 million m³. 173 million m³ of industrial and sanitary effluent were disposed in water bodies of fresh water and in the sea in 2010.

Considering the management of water tools introduced by the Brazilian Water Resources Law, adopted in 1997, and the increasing water demand in various regions of the country, the company decided to develop and install a corporate system on water resources and effluents (DATA HIDRO), with basis and part of the management system of water resources and effluents that has been implemented for the past ten years.

Methodology

A large oil company usually has several operating units that capture water from water bodies, surface and underground, and dispose of their effluents in the same water bodies. Oil and gas productive areas, refineries, terrestrial and marine terminals of transfer and storage, thermal power stations, and fuel distribution bases are examples of operations that use water resources.

The productive chain "from well to the gas station" is interconnected. The water which is along with oil in the rock formation, for millions of years, known as formation water or produced water, is extracted together with oil and gas, and is not entirely separated in the production regions. A small part of it is transported along with the oil up to the refineries. This implies that, besides their own operating units of production, both the transfer and storage terminals and refineries also need to manage the produced water. This is one of the examples of interconnection of the production chain. Such interconnections generate demand for data and information on quantity and quality of water and effluents in areas of production, transfer and storage terminals and refineries.

Another characteristic of a large company is the centralization of strategic environmental management activities, research and development and major engineering projects. Due to the nature of these activities, it is important that data and quantitative and qualitative information on the captured water flow are available, as well as the generated effluent and the ones disposed by the various operating units of the company.

The management of water and effluents in the various operating units of a large company implies the execution necessity of monitoring the captured water currents generated and discharged. The generated amount of quantitative and qualitative analytical data is significant; however, they usually are available only in the operating units that generated them.

The great demand for data and information and the enormous amount of analytical data on water and effluents dispersed through the uncounted operating units of the company were the two main motivations for the development of DATA HIDRO. The initial proposal was to develop and install a database of water and effluents.

The development of the System did not come from existing methodologies and models. The system was not customized based on an existing system either. It was developed exclusively due to the nature of the existing internal demand, considering the specificities of the company.

Table 1 shows the stages of DATA HIDRO development.

Table 1 - Stages of development and implementation of computerized corporate system of data on water resources and effluents (DATA HIDRO).

Date	Fact	Notes
2002	- Project is presented to the governance of health, safety and environment (HSE) of the company by the HSE department.	The HSE governance consists of a parallel structure composed of HSE managers of the company departments.
2003	- Work group composed of technical professionals from various departments is created by the HSE department.	The work group, coordinated by the HSE department, aims to make the general specifications of DATA HIDRO.
2004	- IT department prepared the 1st version of the system.	Department technical professionals of the company suggest changes
2005	- Project is paralyzed.	Reason: priority to the development of the corporate project of excellence in HSE management
2006/ 2007	- IT department prepares the 2nd version of the system.	HSE Department suggests changes
2007	- HSE department introduces to the HSE governance system; makes presentations about the system to the technicians to the various departments; and conducts pilot tests on some operating units.	Improvement opportunities are identified.
2008	- IT Department implements suggestions for improvements. - HSE department initiates implementation of the system in operating units and training of users	-
2010	- System is installed in more than two-thirds of the company's operating units.	-
2011	- System compatibility with pre-existing systems and development in departments of refining and exploration and production enter into the planning stage.	-

The originality of the project, the lack of similar systems that could be taken as a starting point, the lack of structure and experience of the HSE and IT departments with complex environment computerized systems, the emergence of other priorities and the need to negotiate the project in the HSE governance of the company resulted in long time for development and implementation of the system.

Table 2 summarizes the various obstacles found during the development stages of the system and the solutions to implement them.

Table 2 - Obstacles identified and transposed for the development and implementation of the computerized corporate system of data on water resources and effluents (DATA HIDRO).

Obstacles	Adopted measure
Impact related to the time to be spent by the technicians of the operating units in the data record in the system.	Demonstration to the HSE governance that the cost/benefit ratio would be positive, that in the medium term the system would provide time saving and that the implantation of the system would not be mandatory, but a management option in each department.
Fear of providing information of the operating units on effluents in a corporate system.	User's access to the system would be at the criteria of each department's management, and the user should have access password.
Difficulty of the departments technicians in understanding the need for a database, and give preference to the development of a management corporate system.	Incorporation to the project of management tools such as: calculation of corporate indicators of water and effluents, water balances per operating unit, department and for the company as a whole and the possibility of reports customization.
Lack of structure (especially manpower) and experience of the HSE and IT department technicians in developing a similar system.	Constant negotiation between the HSE and IT departments to establish work routines and compatible structures in both departments.
Prior existence of computerized systems of water and effluents management in some departments, already implemented or under development.	HSE department negotiates with technicians and managers of other departments for compatibility of the corporate system with the pre-existing ones, the corporate system working as a database and the pre-existing systems as management systems of the departments.

The Corporate System of Water Resources and Effluents – DATA HIDRO was developed initially from the ASP programming language and updated for the Dot NET technology (C# and ASP.NET). Its architecture is based on logical layers, using the FCorp.Net framework with and Oracle 10g database. This structure was designed to operate in a Web platform, allowing system access via the company's internal network (intranet).

The system's administration is exercised by the HSE department, which maintains ongoing work relationship with the IT department to the permanent maintenance and improvement. The HSE department maintains a staff of two chemical engineers and one systems analyst dedicated exclusively to the system. The dedicated staff specifies maintenance and system improving needs for subsequent implementation by the IT department, and checks the work performed. The user support is performed, in an initial level, by a standardized corporate system of phone service. A team specialized in DATA HIDRO and in other computerized corporate systems assists in the second level. The third level support is provided by the dedicated staff of the HSE department.

Users' training is conducted by the HSE department through the staff dedicated to DATA HIDRO, with the support, in some situations, of the company's recruitment and training department.

The system has a user's manual. It is planned for 2012 the development of a system management standard, to be approved by the HSE governance of the company.

Results and Discussion

- Characteristics and functionality of DATA HIDRO

DATA HIDRO's main objective is to be a repository of quantitative and qualitative data from all input and output water currents of the company's operating units, in order to allow quick access to information.

The system's basic cell is the operation unit's input or output water current. The main water currents are classified according to their origin, physicochemical characteristics and pertinent activities, as follows:

- water withdrawn;
- effluent discharged;
- waste water received;
- water received for reuse,
- water from exploration and production processes;
- transferred water;
- ships ballast; and
- clean rainwater discharged.

The system is arranged with four (4) menus. The first menu is intended for the implementation of the system in the operating units. The implementation process comprises survey of the operational unit's input and output water currents, as well as of the parameters that are or will be monitored, with their respective measure units and applicable legal standards of effluents final disposal. Input and output water currents are named and registered within the system. Then, tables are elaborated to allow registration of daily, weekly or monthly data, quantitative and qualitative, on water currents. That is when the system is also prepared to allow the registration of administrative data, fresh water effective consumption, amounts paid for water use, information on participation in external forums regarding water resources and brief description of water and effluent treatment systems. From this moment on, the system is able to receive data and information of the operation unit where it was implemented. The implementation is led by a technician from the dedicated team of the HSE department, visiting the operational unit.

The second menu is used by the system's user and allows the data registration and consultation. Users are previously registered in the system according to a specific profile, which allows only consultation or consultation and registration. The system automatically records date, time and identification data of the user who accesses the system to record data. The system totalizes the volume data calculating the average of concentration data, and presents the data in the form of a table. The user can include past data. The system's consultation is allowed to be made if the user is registered and authorized to consult data from departments different of their own. In this menu, besides the water currents quantitative and qualitative data, it is also possible to consult administrative data (name, phone number and technicians work places from the various operational units that works in water and effluent managing), freshwater effective consumption (approximately the difference between the abstracted and discarded volumes), amounts paid for water use, information on participation in external forums regarding water resources and brief description of water and effluents treatment systems of operating units.

The third menu allows the issuance of data and information reports registered in the system.

The fourth menu provides the user useful information on the use of the system: demonstration on the system, related links, means of contact the system's management and supporting team.

DATA HYDRO is, basically, a database, but also comprises features that allow its use as an effluent and water resources management system. The key features of the system are summarized below:

- Administrative data: The module for registration and consultation of administrative data is arranged to allow, rapidly, contact with employees who perform activities related to managing water resources and effluents in the operating units. Information on employees' identity, position, assigned body and telephone number, as well as the address of their respective operational unit, are available. Representatives of the operating units in external forums of water resources can also be registered in the system.

- Water currents data: After implementing the system in a given operational operating unit, the register tables remain available for inclusion of data until the monthly closing date. When the closing date expires, the system's administrator, of each department of the company, can release the system for subsequent inclusion of data. The system also allows recording data from previous years. For the currents of effluents release, the system automatically calculates the pollutant load of each parameter present in this effluent current released.

- Data of amounts paid for water use: Costs related to water resources utilization are assessed by the system. The system allows recording and consulting amounts paid by direct capture of fresh water from surface or ground sources, effective consumption of water (approximately the difference between amounts abstracted and discarded) and pollutant load of effluents discarded, as well as the amounts paid by the water received from public water supply companies and from disposal of effluents into the public sewage network.

- Fresh water effective consumption data: The user can record and consult data on the actual consumption of fresh water in the operating units. The consumption of fresh water corresponds to the fresh water losses occurred during processes and operations, mainly through evaporation in cooling towers and steam circuits. The filling of this module is optional and the data are recorded directly by the user; the system does not perform this calculation. These data are presented in the water balance reports.

- Flowcharts: The System will enable the registration and consultation of interactive flowcharts of the operating units' effluent and water treatment systems. The consultation on water and effluents treatment facilities and its performance and process data can be made at any facility of the company with access granted to the internal computer network (Intranet). Currently, this module is under construction.

- Reports: DATA HIDRO comprises a specific module for the consolidated issuance of data: quantitative and qualitative water currents data, amounts paid for water use, water balance, information on participation in external forums regarding water resources and brief description of the operating units' water and effluents treatment systems. Reports can be issued covering only the operational unit, a department or the company as a whole. The system also has the option 'Business Intelligence' (BI), developed on the SAP Business Objects platform, which is a data management tool. BI is an environment for analysis and cross-referencing of data, where results can be expressed through reports adapted for the needs of each particular user. The system is designed to consolidate the data as tables and graphs.

- Implementation and Applications of DATA HIDRO

As the **DATA HIDRO** implementation progresses in the company, the system's objectives are achieved.

The current status of the system's implementation in the company is presented in Table 3.

Table 3: Current status of DATA HIDRO's implementation in the company.

Activities	Operating units with DATA HIDRO implemented	Registered users	System implementation	
			Start	End
Transportation	109	71	2/20/2008	8/27/2008
Research Center	4	9	9/27/2007	8/27/2008
Engineering and construction	53	81	8/07/2007	6/09/2011
Management buildings	29	78	4/14/2008	8/28/2008
Gas and Energy	15	61	4/22/2008	4/06/2011
Fuel distribution	83	269	6/9/2008	5/12/2011
Activities outside Brazil	45	126	9/13/2008	5/30/2011
Biofuel	3	19	6/9/2009	6/23/2009
Refining	--	12	under planning	
Exploration and production	--	4	under planning	

DATA HYDRO allowed the generation of a water and effluent database and made such data available in an easy and fast manner for all users working on water and effluent management in the company's operating units, as well as at the departments' headquarters. Research Center Technicians working in technology development at the engineering department, as well as in projects for water and effluent treatment systems and at the corporate HSE department, performing strategic and management standardization tasks may have access to water and effluent data and information, in a fast and trustable manner, in order to being able to perform their tasks satisfactorily.

DATA HIDRO has also been used for issuing the annual company's water resources and effluents report. From 2007 on, the company has been consolidating, annually, its effluent and water resources report, as stated in its water resources and effluent management standard. It concerns the survey of a wide range of data and information. Such data and information constitute a form in an excel spreadsheet. This spreadsheet is annually filled by all operating units of the company. The HSE department is responsible for the final consolidation of the report. The data consolidated in the annual report are used to the annual publishing of a sustainability report of the company, which is disclosed to the public. Besides its use at others external white papers of the company, these data and information are also used in internal management of water and effluents by technicians of the various operating units and departments' headquarters. The annual water and effluent report is being issued via DATA HIDRO for the activities of Transportation, Research Center, Engineering and works, Management buildings, Gas and energy, Fuels distribution, Biofuels and Activities outside Brazil (partially).

DATE HIDRO may also be applied to verify the corporate indicators related to water and effluents. Indicators verification is made by the HSE corporate department, as determined by the water resource and effluents management standard of the company. The data is sent to the HSE department by other departments via Excel spreadsheets and other means. Verification through DATA HYDRO saves time of the operating units and departments' technicians, since the data are already routinely recorded in the system. It also saves the time of HSE department technicians in the consolidation of data and calculation of indicators.

Conclusion

The development and implementation of the corporate computerized system of data on water and effluents in a large company requires the HSE senior management commitment with the project, clear definition of the project priority level, constant negotiation with managers and technicians from various departments and organizational units that are users and a structure previously arranged for project management. The development usually demands time and many obstacles may arise. The negotiation with managers and technicians of the various departments tends to be intense and prolonged. Generally, the data confidentiality paradigm is a major obstacle to overcome. Data and information generated by a particular operational unit should be considered as company data, and, taken the necessary precautions concerning the security of information, such data and information must be disclosed corporately. The structure of the HSE body to manage the project and of the computer body to develop this project comprises points of attention that can be overcome with advance planning.

A project of this nature does not generate immediate results, and this is, ultimately, the main obstacle, but when the results begin to emerge, there are several positive findings among users, managers and technicians.

Being able to access, through teleinformatics, water and effluents databases and water and effluent treatment systems flowcharts, with respective process data, anywhere in the company, or even outside the company, brings incommensurable benefits. Users' time savings and data quality and reliability comprise other two important benefits. Customized reports for each nature of demand, which typically take days to be prepared, may be issued extremely rapidly. These are usually demands of external reports, for the general public, answers to questions from the press or public authorities and agencies, reports to support managerial or technical meetings, etc.

The development and implementation of the computerized corporate system on water and effluents data in a large company is, unquestionably, a project with a positive cost/benefit ratio, comprising the basis for programs that seek to achieve efficient water use.

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