2014

Newly Automated System For Integrated Assessment Of The Conditions Of Underwater Gas Pipelines

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11th International Conference on Hydroinformatics
HIC 2014, New York City, USA

NEWLY AUTOMATED SYSTEM FOR INTEGRATED ASSESSMENT OF THE CONDITIONS OF UNDERWATER GAS PIPELINES

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ABSTRACT

The newly automated system "PodvodGasExpert" consists of a set of functions that implement information technology applications to effectively service underwater gas pipelines. This automated system simplifies the assessment of the technical condition and decision making processes relevant to preventive and repair work for underwater gas pipelines.

The basis of the mathematical analysis of this newly automated system uses principal component analysis method. The advantage of this method is that it is the only mathematically sound method of factor analysis. [5]

The system "PodvodGasExpert" consists of the following components: an Oracle database, several formal Excel templates, a PCA module of the program Statistica and a client application developed by the author in Borland Delphi 7.0. It is recommended that this automated system "PodvodGasExpert" be implemented to increase the effectiveness of diagnoses of the physical conditions of underwater gas pipelines.

The results of the study demonstrate that the principle indicator of reliability theory, (i.e. is the mean time between failures as quantified in T_0) indicate the effectiveness of the introduction to the gas industry the new, automated system.

PRINCIPLE AIM OF THIS RESEARCH

This work aims to develop a new system of automated monitoring which would simplify the process of evaluating the technical condition and decision making for planning preventive maintenance and repair work on the underwater gas pipeline**.**

Objectives:

1. Creation a general model for a new, automated system via IDEF3;
2. Development of a new database system which would store all information about underwater gas pipelines.
3. Development a new application that works with database servers, and provides an explanation of the results obtained from the server, and which provides them to the user in an accessible form.
4. Calculation of the values MTBF T_0 for specified pipelines based on quantitative data obtained from tests of this system.

An underwater gas pipeline is the portion of the pipeline that crosses a river beneath its bottom. Underwater gas pipelines are subject to increasing dangers as time goes by. An accident at a single underwater gas pipeline can lead to technological and environmental disaster on the scale of an entire region. Therefore, timely troubleshooting of all underwater gas pipelines in order to prevent any potential accidents will remain a pressing task for the industry. The most important aspect of resolving this challenge is the quality of the automated system in question. This system must be designed to help to maintain underwater gas pipelines in proper working order.

The newly automated system “PodvodGasExpert” has been developed for timely and qualitative determination of the physical conditions of underwater gas pipelines. The newly automated system "PodvodGasExpert" performs the following functions:

1. Loading, storage and processing of field data in databases is implemented in DBMS Oracle;
2. Calculation of the coefficients of various factors is made by principal component analysis;
3. Analysis of the technical condition of the object is based on the data from the database;
4. Recommendations for repair work are given based on the data provided.

The figure 1 shows a general model for the newly automated system in IDEF3:

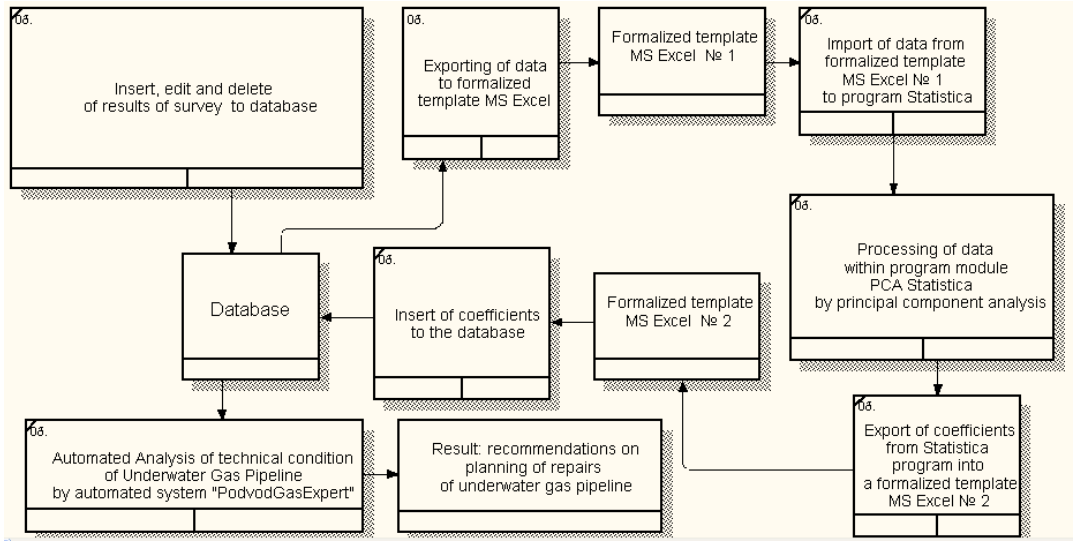

Figure 1. Model for a new, automated system via IDEF3.

The architecture of the new, automated system PodvodGasExpert is a two-tiered "client-server". A main component of a new, automated system is the database PPMG (Figure 2):

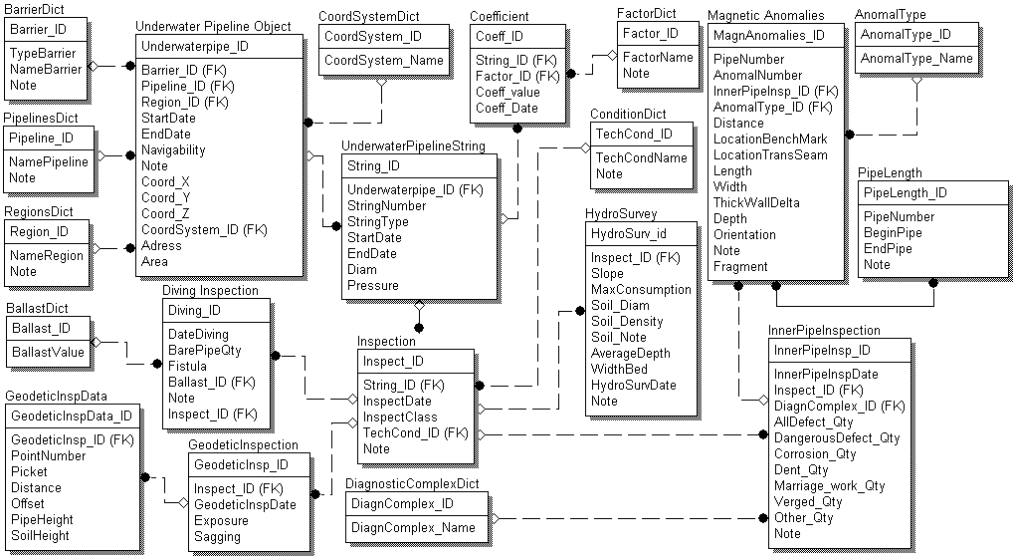

Figure 2. Database diagram PPMG

The new database PPMG has a relational model and is in the third normal form.

Explanation of the diagram PPMG

Main table in the diagram is PPMG Underwater Pipeline Object. (Основной таблицей в схеме PPMG является Underwater Pipeline Object). The key attribute of this table is the field Underwaterpipe_ID (the ID of the underwater gas pipeline). The Table of the Underwater Pipeline Object has connections with the 4 tables of the type M: 1 (many to one): BarrierDict (Directory water hazards), PipelinesDict (Reference of pipelines), RegionsDict (Reference regions), CoordSystemDict (Reference coordinate systems) and 1 connection type 1: M (one to many) with table UnderwaterPipelineString (Line of Underwater Gas Pipeline). Also UnderwaterPipelineString table has a connection type 1: M with table Coefficient. Table Coefficient is connected by type M: 1 with the table FactorDict (Reference factors). The Table UnderwaterPipelineString has else connection of type 1: M to the table Inspection (Survey), which is the base table to store information on all types of surveys. The table 'Inspection' contains general information about the survey and evaluation of the technical condition of the PPMG as determined by the survey data. Table ConditionDict (Reference of technical states) associated with a table Inspection by type 1: M. Also the table 'Inspection' has a connection by type 1: M with tables of all four types of surveys referred to in the industry: Diving Inspection (Underwater inspection), GeodeticInspection (Geodetic Survey), HydroSurvey (Hydrological survey), InnerPipeInspection (pigging). The table 'Diving Inspection' is connected by type M:1 with the table 'BallastDict' (Reference types ballasting). The table 'GeodeticInspection' is connected by type 1: M with table GeodeticInspData (geodetic survey data), that records data

of elevations of the soil and pipes on each point of the survey. The table 'InnerPipeInspection' is connected by type M:1 with the table 'DiagnosticComplexDict (Directory diagnostic complex). Also the table 'InnerPipeInspection' is associated by type 1 M with table Magnetic Anomalies (magnetic anomalies). The table 'Magnetic Anomalies' is connected by type M: 1 with the table 'AnomalType' (Reference types of anomalies).

Also table Magnetic Anomalies associated by type M: M (many to many) with table PipeLength (pipe length), which stores information about the lengths of pipe sections, which revealed anomalies.

The scheme of the database PPMG allows users to store information on the results of all kinds of surveys of PPMG: diving inspection, geodetic Survey, hydrological survey, internal diagnostics.

The effect on the reliability and safety resulting from the introduction to the industry this newly automated system "PodvodGasExpert" is justified by the main indicator of reliability theory, MTBF T_0:

$$T_0 = \int_0^{\infty} t * f(t)\,dt \qquad (1)$$

, t-time from the start of the operation of the facility before it switches to emergency condition , f (t) - the probability density of the random MTBF. T_0 is measured in units of time. [7]

The newly automated system "PodvodGasExpert" was tested on a software and hardware set of electronic computers in the center of the International Social Academy of Ecological Safety And Nature Management (ISAESNM).

Testing of the new system was carried out in two stages:

1. The analysis as modelled and defined by TS PPMT absent the use of the newly automated system "PodvodGasExpert."
2. The analysis as modelled and defined by TS PPMT with the use of the newly automated system "PodvodGasExpert."

Test results:

Step 1. The total time determined by the technical condition of a particular line of PPMG without using the newly automated system "PodvodGasExpert" was: 151 min. 23 seconds. or 2 hours 31 min. 23 seconds.

Step 2. The total time determined by the technical condition of a particular line of line PPMG using the new AS "PodvodGasExpert" was 24 minutes. 58 seconds. or 0 h 24 min. 58 seconds.

The difference between steps 1 and 2 of the study was 126 min. 25 sec. or 2 hours 06 min. 25 sec. I.E. MTBF in the case of the introduction of the new AS "PodvodGasExpert" above was a factor of 8.18 greater than without the use of a new system.

CONCLUSIONS

1. The newly automated system PodvodGasExpert has been developed for timely and qualitative determination of the physical conditions of underwater gas pipelines;
2. The basis of the mathematical analysis of this newly automated system uses principal component analysis method;
3. The process of determining the physical condition of an underwater gas pipeline with this newly automated system increases the factor of MTBF by 8.18 above the existing system used today in the industry.

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