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Development of Computer-Based Database Module for AMS-RBI Application

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ABSTRACT

The creation of a computer-based inspection database was brought about by the introduction of the Risk Based Asset Management System to Philippine National Oil Co.-Energy Development Corp. (PNOC-EDC). This management system shows the efficiency of using risk-based inspection methods in assisting asset management decision makers.

The ultimate objective of the management system is to ensure the availability of geothermal energy throughout the lifespan of the Fluid Collection and Reinjection System (FCRS) of PNOC-EDC's geothermal fields despite the onset of age and associated wear and tear on the equipment and ancillary facilities.

The database was designed as a digital repository of data for geothermal pipelines, valves, separator vessels and power plant inspections. This database uses an Oracle Relational Database Management System (RDBMS) as its platform.

Collating and analyzing these data provides valuable information on the predicted life expectancy of the geothermal equipment and facilities. The collated information provides basis for determining preventive or remedial actions, prioritization of activities, and cost-benefit analyses of alternative methods.

1. INTRODUCTION

The Asset Management System - Risk Based Inspection Methodology (AMS-RBI) was introduced to the Philippine National Oil Co. – Energy Development Corp (PNOC-EDC) by the Materials Performance Technologies (MPT) of New Zealand.

The application of Risk Based Inspection (RBI) method to the maintenance work system for geothermal facilities and installations has led to the creation of an additional module in the Integrated Geochemistry Information System (IGIS) of PNOC-EDC's Geoscientific Department, called the FCRS (Fluid Collection and Reinjection System) application module.

This database was designed as a digital repository of all pipelines, valves, separator vessels and power plant inspection data. These data are collated and analyzed to generate computer-based FCRS inspection reports, which are used to formulate and determine cost effective strategies and techniques.

2. RISK BASED INSPECTION

Risk-based inspection is a preventive maintenance method for predicting potential operational problems. Once these problems are identified and classified, remedial solutions are implemented, thus preventing major disruption in operations and consequent revenue losses.

This system is divided into 3 phases, namely phase 1: risk assessment, phase 2: condition assessment and phase 3: monitoring problem assessment.

The first phase is the data collection stage, where the structure, limitations (temperature and pressure) and plant designs of the separator vessels, brine, steam and condensate lines are catalogued. The internal environment of the pipes and vessels are also characterized. This phase further includes measurement of physical parameters, chemical analysis of fluids and prediction of the theoretical corrosion and scaling rates.

On the basis of the maintenance history and initial data evaluation, a life prediction risk profile is established.

The second phase, condition assessment, involves internal and external inspections on areas or components with high-risk profile classifications. During this phase, scale and corrosion samples are collected on the areas of interest, which are then megascopically and petrologically analyzed. After which, an evaluation of the resulting data is made, a risk assessment is forwarded and the probable time of component failure is predicted.

During the third phase, monitoring and problem assessment, follow up inspections are made and parameters such as wall thickness, infrastructure conditions, pressure, temperature, flow rate, chemistry changes are monitored and the risk assessments are updated.

The current assessments are then used in the formulation of mitigating measures to prolong the lifespan of the geothermal components.

3. DEVELOPMENT OF THE FCRS MODULE

The FCRS database module was designed as a digital storage facility of risk based inspection data for easy retrieval and processing. This module contains tables that are needed to accurately describe the internal and external conditions of the components of interest. Tables were created for the components data, brine, steam and condensate chemistry, inspection data, petrologic data, well output and flow-rates.

Storing these data in a precise format enables the Oracle relational database management system to turn the data into useful information through many types of output, such as queries and reports.

The relationships of these tables are given in the entity-relationship diagram (Figure 1). The description of the content of each table is as follows:

- **FCRS COMPONENT TABLE** – The table that stores component name from the Process and Instrumentation Diagram with corresponding component code.
- **ASSET MANAGEMENT SYSTEM LOOKUP TABLE** – The table that stores data from the Process and Instrumentation Diagram as designed and as built from AMS.
- **BRINE SAMPLING TABLE** –The table that stores all brine sampling data from geothermal pipelines in the FCRS
- **BRINE CHEMISTRY TABLE** –The table that stores all brine chemistry from geothermal pipelines in the FCRS
- **STEAM SAMPLING TABLE** –The table that stores all steam sampling data from geothermal pipelines in the FCRS
- **STEAM CHEMISTRY TABLE** –The table that stores all steam chemistry from geothermal pipelines in the FCRS
- **CONDENSATE SAMPLING TABLE** – The table that stores all steam condensate sampling data after passing through the power plant
- **CONDENSATE CHEMISTRY TABLE** – The table that stores all condensate steam chemistry after passing through the power plant
- **INSPECTION DATA TABLE** –The table that stores inspection data, including megascopic analysis of collected samples
- **INSPECTION PHOTO REPOSITORY** –The table that stores the inspection photos for all sites.
- **INSPECTION PETROGRAPHIC ANALYSIS TABLE** –The table that stores the physical and petrogaphic description of the samples
- **FCRS TFT ANALYSIS TABLE** –The table that stores enthalpy, mass flows and steam flows

Once the data to be stored are identified, forms were constructed for easy encoding, review and modification of data. Forms are graphic interfaces for viewing and updating values in the database. Input forms for the component information, brine, steam and condensate chemistry, inspection data, petrologic analysis and tracer flow test results were created.

A sample of the inspection input form is given in Figure 2. This form displays the inspection data such as the project or location, component codes (item of interest), physical environment and other related data needed for assessing the reliability of the component for continued usage.

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To navigate through all the data, queries were created to retrieve only the desired parameters from the tables. The brine, steam and condensate chemistry that passes through a pipeline or component could be easily be queried for evaluation purposes.

The collated data can then be printed or viewed on the screen. The reports that can be generated by the FCRS module are the Inspection reports, process chemistry reports (silica saturation indices, non-condensable gases, steam quality) and the well measurement reports (enthalpy, mass flows, output). An example of a FCRS generated Inspection report is given in Figure 3.

These reports are used in the risk-based inspection assessment of the FCRS component. Based on the chemistry, the corrosion and deposition rates can be predicted. Based on the inspections the actual rates are determined and the risk profile refined.

4. DATA FLOW DIAGRAM

With the construction of FCDS database module, the processing of inspection and chemistry data are streamlined and the components with high risk of failure are easily determined and monitored. The flow of data to the FCDS module and its output can be summarized in Figure 4.

The sampling data from the Inspectors/ samplers are given to the encoders for processing, the samples are given to the petrologist / chemist for analysis. The results of the analysis are then given to the encoders for encoding to the FCDS module. Once inputted, the data can then be viewed and evaluated by the geochemists, maintenance, production and quality assurance personnel and the reports and recommendations submitted to their superiors for action.

Using the snapshots capability of the Oracle database system, all project sites from different parts of the country are virtually linked and consolidated in the main office. Online status of the FCRS line as well as the inspection details could be viewed by decision makers in the head office through the interface provided by the system. The overall snapshot design of the system is provided in Figure 5.

5. CONCLUSION

The integration of FCRS application module with the RBI method and Asset Management System (AMS) would help in the management and optimization of geothermal energy throughout the life span of the FCRS, despite the onset of material and equipment wear and tear associated with age.

The FCRS database module reduces the amount of time it takes to determine the operational history and current status of geothermal pipelines and facilities.

The effectiveness of the database in determining the component lifespan depends on the quality and accuracy of the inputted data.

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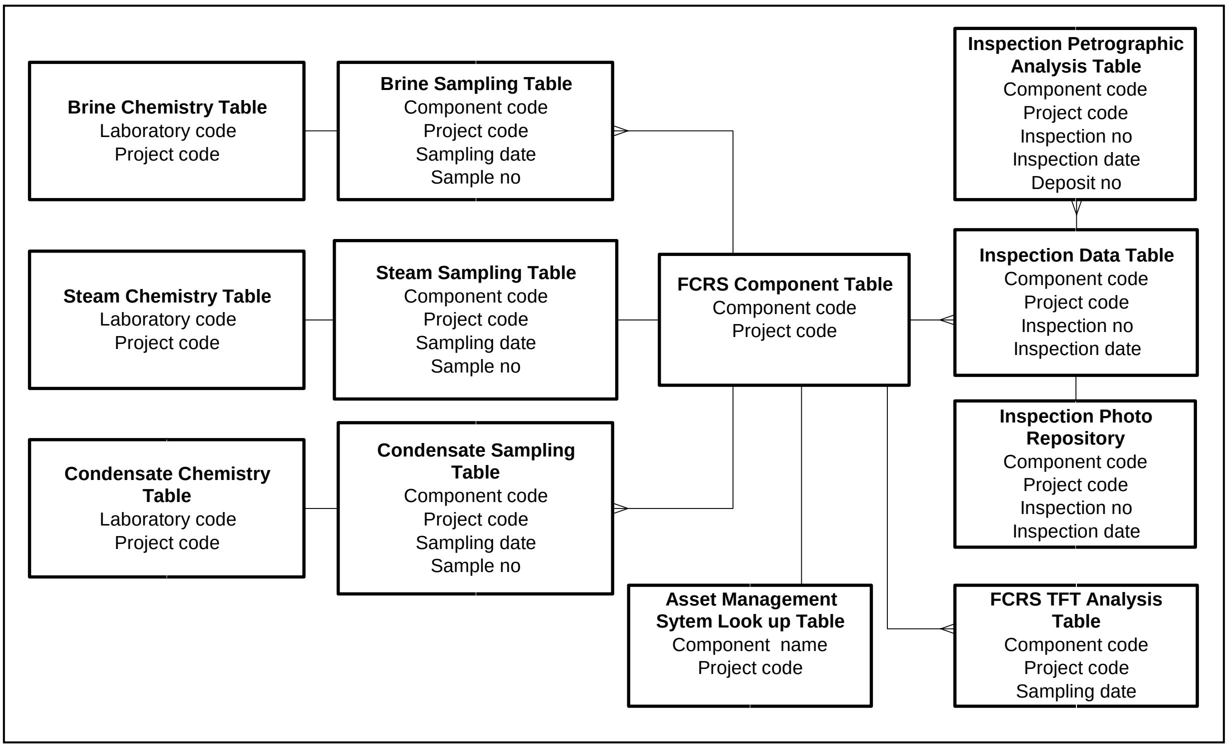

Figure 1: Entity Relationship Diagram For the FCDS Database

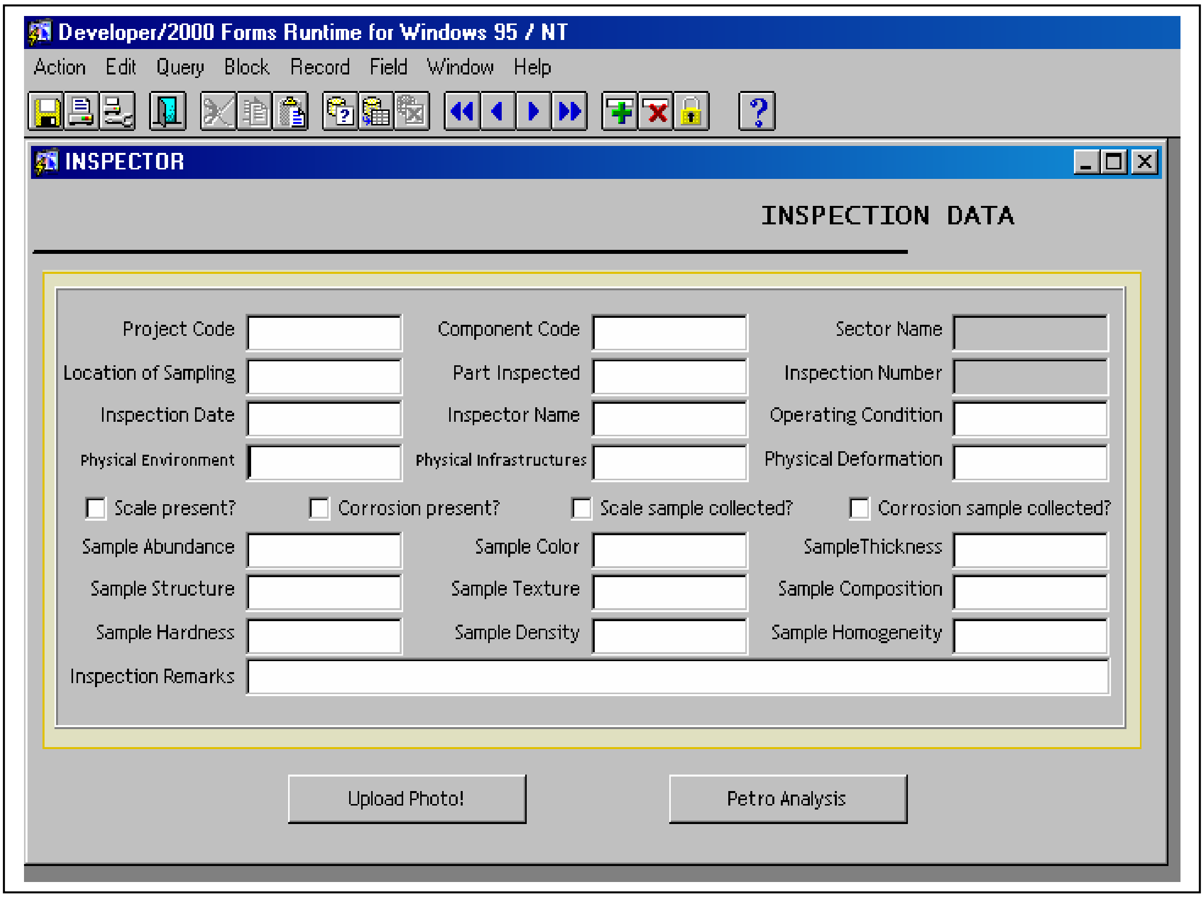

Figure 2: Data Input Form for Inspection Data

DETAILED DESCRIPTION

Inspection ID : PA2001-0001I
Inspector : AVM
Inspection Date : 2002-11-21

Component Name : RI318BRL24IS2
Name of Part : 24" RI 318 IS2

Operating Conditions:
Last inspected 1999, Intermittent use since August 2003

Mechanical Effects and Cracking
None observed.

Photograph

Corrosion and Scaling
Abundant silica deposits 12.76 mm at midpoint of pipe
Gray deposit overlain with silica gel colloidal deposition
Banding present, signifying different stages of deposition
Irregular shaped ridges, rough texture
Inner wall highly corroded

Megascopic Analysis
90% of sample consists of amorphous silica products.
,sand-like particles
105% pyritized chips (1 cm. In diameter)

Microscopic Analysis
Amorphous silica – 90%; magnetite – 5%; rock cuttings – 5%

Figure 3: FCRS Module Generated Inspection Report

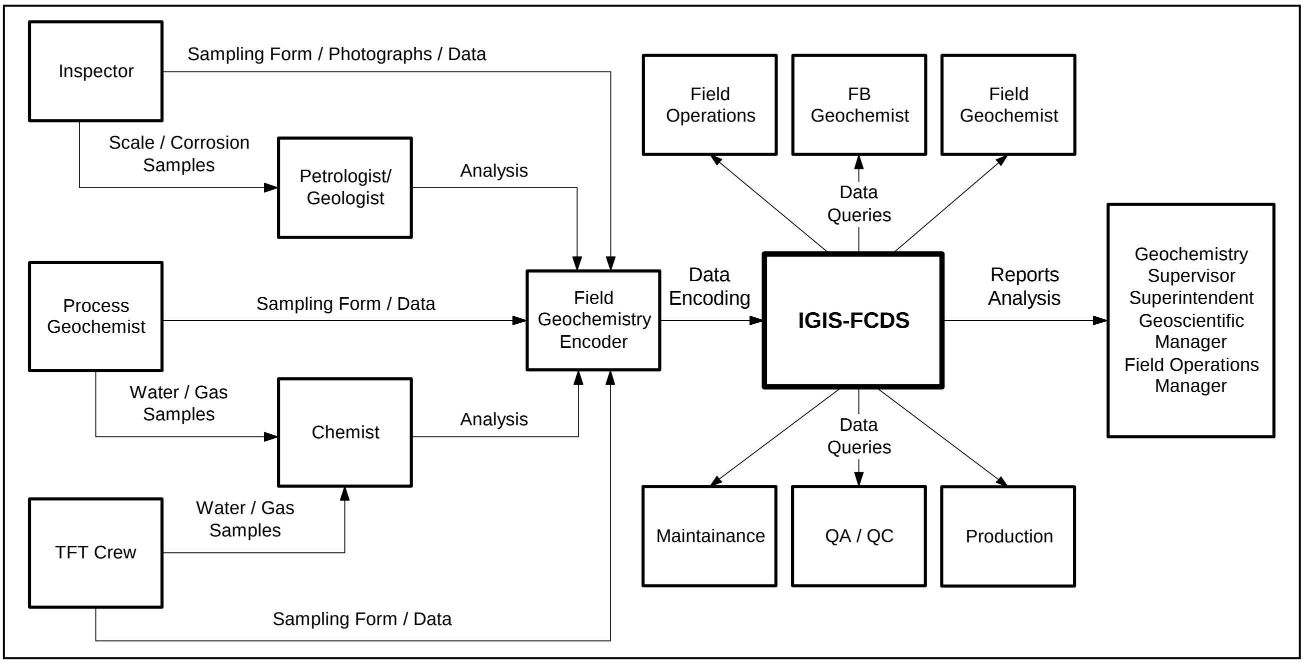

Figure 4: FCRS Module Data Flow Diagram

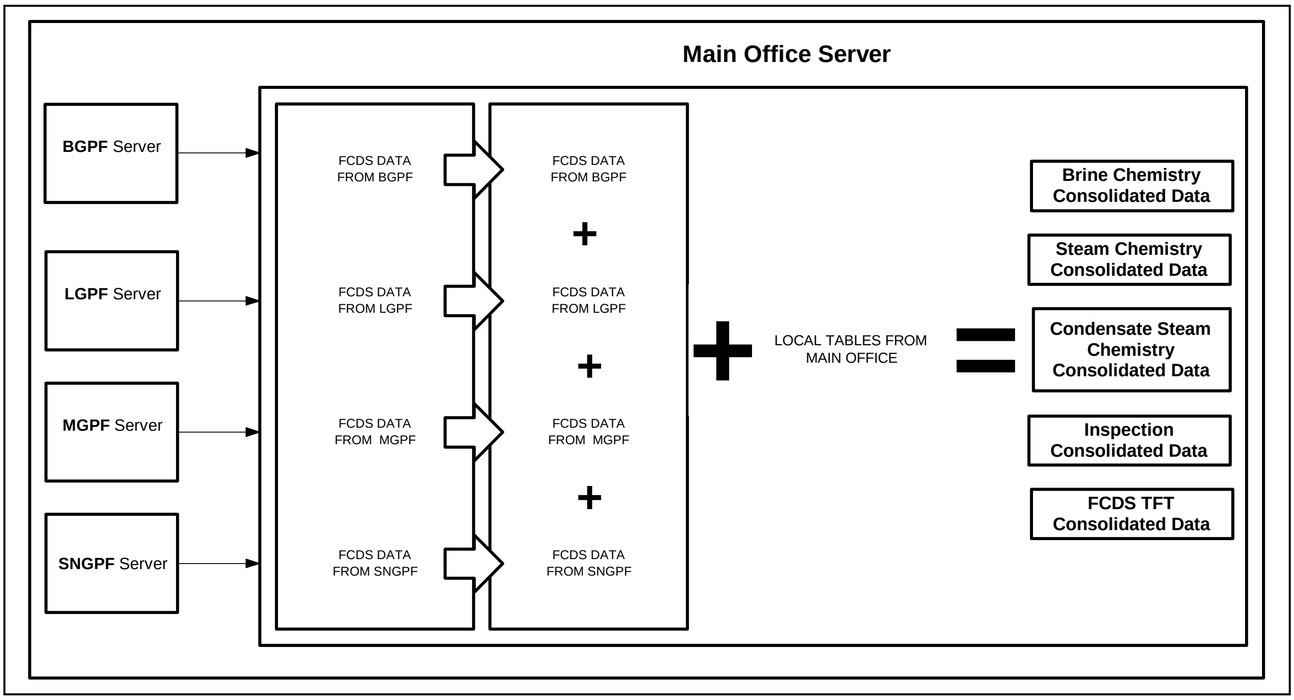

Figure 5: FCRS Module Snap shot