

A Software Application for the Gas Transport and Distribution Management

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Abstract: The paper deals with a software application of Enterprise Resource Planning type. The presented application is concerned with the gas transport and distribution management inside a large Gas Distribution Company. The application was developed in SAP (System and Applications, Products) environment, using the dedicated programming language ABAP (Advanced Business Application Programming). Details regarding the analysis, implementation and testing of the software application are presented.

Keywords: enterprise resource planning, advanced business application, data bases, gas distribution

1. INTRODUCTION

The term "Enterprise Resource Planning" was introduced in 1990 by the Gartner Group in order to define a new generation of manufacturing resource planning (MRP II) software. MRP II represents a method for producing plans using all the resources involved in the activity of a company's manufacturing (Keller, 1999). This concept includes, but is not limited to, software applications, people skills and abilities, design of specific databases, and all other computer resources. The overall purpose is to manage the resources of the company in order to increase the general performance and especially productivity (Leu and Huang, 2009; Lin and Shih, 2009). Gartner Group is a company that assists its clients in making better decisions regarding IT solutions. The ERP's final target is to integrate all software applications dealing with the management of a business enterprise. These software applications include those regarding planning, manufacturing, sales, and marketing. A short list, containing the most famous ERP software developers, includes Oracle, PeopleSoft and SAP.

Oracle Corporation is an American multinational IT enterprise whose main field of activity is the enterprise software systems developing and computer hardware systems' marketing. From this paper point of view, it represents interest as it produces enterprise resource planning software (ERP), customer relationship management software (CRM) and supply chain management (SCM) software. PeopleSoft, Inc. was a company specialized in software solutions for enterprise performance management, manufacturing, and student administration for large bodies, governments or organizations.

Their list of well-known products includes Human Resource Management Systems (HRMS), Financial Management Solutions (FMS), Supply Chain Management (SCM), Customer Relationship Management (CRM) and Enterprise Performance Management software (EPM). In 2005 the company was acquisitioned by Oracle and their products are now marketed by Oracle. SAP AG is a German multinational software developer whose main field of activity is developing integrated software solution for business operations and customer relations (Weidmann and Teuber, 2009). A not so comprehensive list of company's software products includes enterprise resource planning application (SAP ERP), enterprise data warehouse product (SAP BW), SAP Business Objects software and in-memory computing appliance SAP HANA.

For a gas distribution company, SAP offers important opportunities like solving problems linked with market deregulation, correct management of processes related to gas distribution and sales, thus increasing the company's chances to win the market competition (Chen and Lin, 2008; Zhou, 2009).

2. A GAS TRANSPORT APPLICATION

The natural gases are a part of the mixture (salt water, gas and condensate - crude oil) which is extracted using wells from ores. A short description of the process for gas extraction and transferring into the national transportation network (natural gas and condensate) is presented in Fig. 1.

After making the extraction from probe production, the mixture goes through a mixing line separation in a park where the liquid is separated from the gas. Afterwards, the gases get separated into high-pressure gas and low pressure gas. The next step is for the low pressure gas to pass through to the compressing station, where the pressure

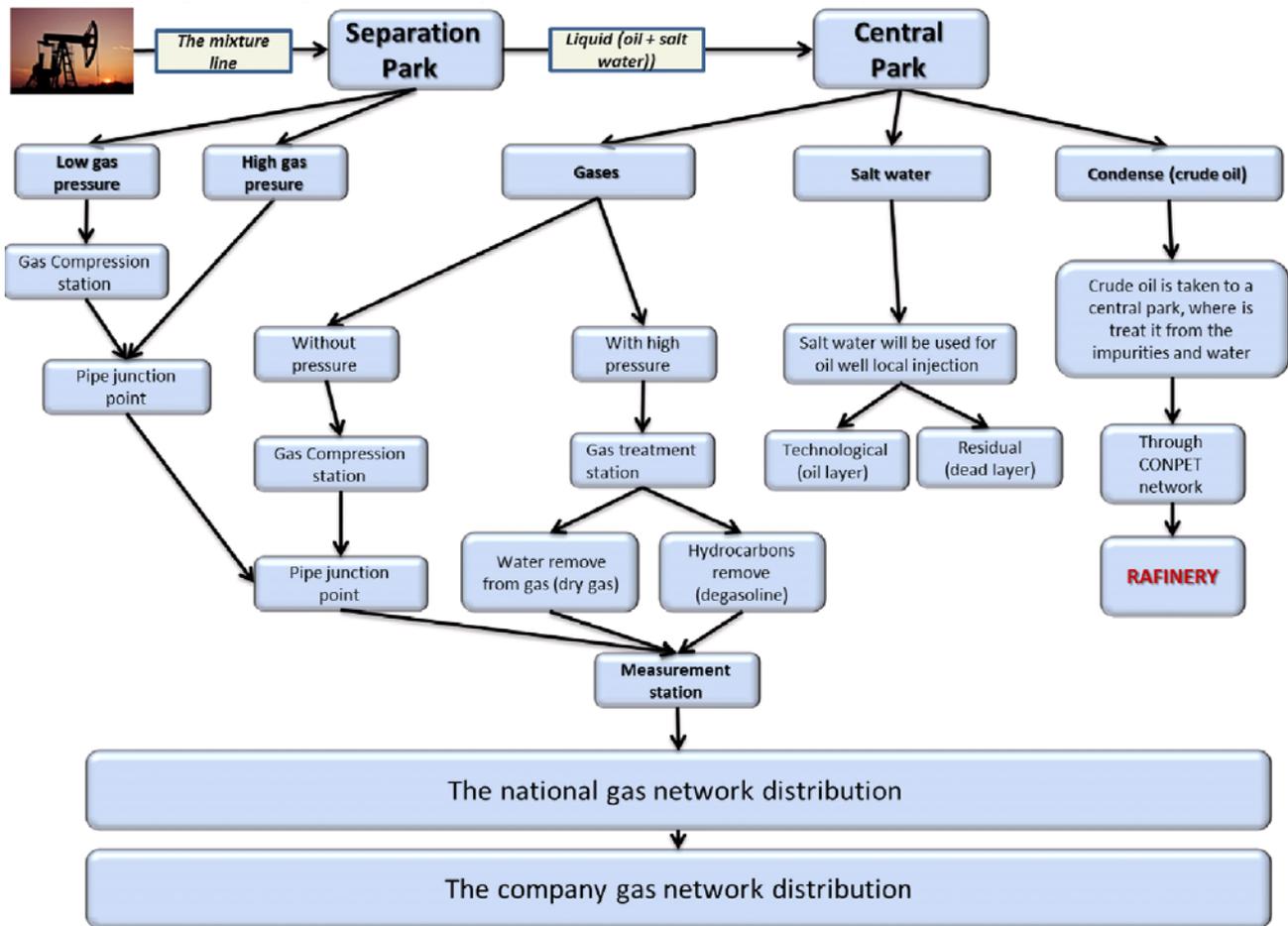


Fig. 1. Application Structure for Gas Distribution

is raised to the accepted level because it must be reintroduced into the main pipe, which in turn goes into the measurement and control station. Here, the delivery parameters will be recorded, amounts to be shipped will be checked, and then the gas will be taken by the national gas transportation network. The resulting liquid from the separation station will go to a central park where it will be submitted to a new separation, the final results of all operations being gas, salt water and condensate.

The gases will be again separated to high and low pressure gases:

- Low pressure gas will be sent to a compressor station, where, using specific processes, its pressure will be increased up to the allowed value in order to pass it to the network distribution;
- High pressure gas will be sent into the treatment plant gas where it will be divided in two: one part will go to gasoline plant (where for example the hydrocarbons will be removed from the gas) and another part will go to drying (where the water will be extracted from the gas).

The gases then go to the measurement and control gas station and then to the national transportation network. Salt water will be used later for local injection into existing wells. There are two types of injection: technological injection (in oil layer directly) or residual injection (injecting water into a dead layer or into a defused probe).

Condensation (crude oil) will go into a central warehouse, where it will be treated for impurities and water. After that it will be sent through a specialized network to a refinery.

3. INFORMATICS APPLICATION

SAP (System and Applications, Products) is the largest ERP in the world (Schäfer and Melich, 2011). SAP is based on a client/server architecture and is used for the developing of integrated systems. SAP focuses on existing integrated processes in the company, from the planning process, development/production tracking and with the purpose of managing the relationships with customers, suppliers or other business partners.

The benefits for a company using SAP are:

- Integrated system (there is a single database, all components are interdependent);
- Open system (independent from the hardware platform and database used, allows correlation with other software and modifications including new functions created by the user);
- Comprehensive system (from an economic perspective, it can cover any sector activities);
- Real-time system (tools and information provided by the system are based on data analysis from operational flow).

Other benefits include: improved reporting capabilities,

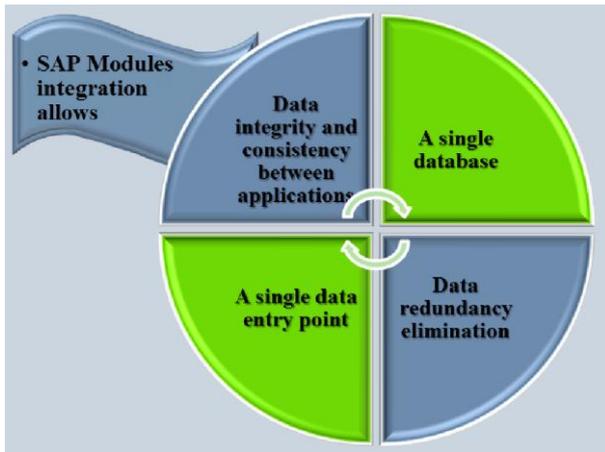


Fig. 2. Advantages of SAP modules integration

possibility to view data at any time, after its saving by the end-user, availability of several standard reports, providing the user with the ability to develop specific reports etc. SAP also provides the auditors with the ability to check all operations (time stamps of data recording, user name etc.) as depicted by Fig. 2. Current information is available for all company divisions anywhere in the country (considering geographic location). System modules integration components of the integrated system are highlighted by Fig. 3.

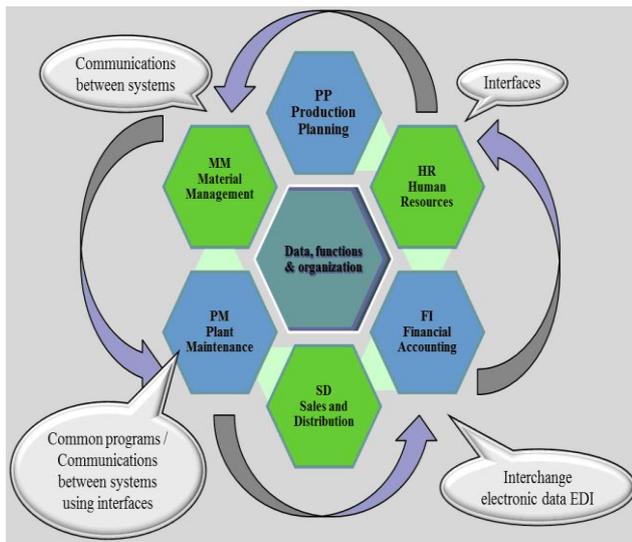


Fig. 3. SAP Integration / SAP and non SAP application interfacing

The SAP company architecture uses an Oracle database, combined with the ECC 6.0 installed SAP version. The company's Technology Information Department's internal development team has created an application inside SAP which controls gas distribution and the maintenance of fixed assets for distribution (from digging the ditch where the pipe is to be placed to the final consumer).

The internal network gas distribution is oriented to its own consumers and to the distribution network. All these sales are done using the rules governed by ANRE (National Regulatory Authority in Energy) which led to dividing

distribution between households and industrial consumers. Dividing these consumers is necessary in order to have clear evidence regarding paid taxes (ANRE requirement).

The GDC (Gas Distribution Company) network is divided into few regions. These regions are divided in turn into cities/villages/consumption points.

Regarding the customer distribution phase (either domestic or industrial), the developed application must be designed to use all the necessary steps in order to follow gas distribution, as follows:

- a new client will be created (in SAP), following the ANRE rules;
- a metrological counter will be assigned (metering will be added);
- a contract will be made for the final customer specifying the number of consumers and the customer type (residential or industrial);
- monthly end-users customer reports will be sent to ANRE.

The type of customer is essential in the distribution/gas consumption, residential or industrial. Taking consumptions into account, the gas prices depend on its usability: unlike the householders, the industrial consumers must pay excises.

Based on the consumption, the price category can be determined. All customers are VAT payers, but the company's domestic customers do not pay VAT. Therefore, it's clear that the customers can be eligible for VAT exemption (those who negotiated the price) and non-eligible (for whom the price is imposed).

A meter, used to measure the gas consumption, must be recorded in SAP and after every monthly field measurement (manual reading), it must be loaded into the system and subsequently reflected as a sale, through an invoice issued by GDC. Data collected in the mentioned field will be centralized at headquarters. The corresponding file has a standard structure which will be provided. It will be mapped to the table submitted to an import operation. Some examples of fields from this file are as follows: date, start meter's reading, final meter's reading etc.

Once introduced and collected by SAP, data are submitted to a "consistency check" process.

The next step is to create sales orders for each customer, this requirement being essential to develop future bills. The invoice issued without an accompanying order is null. Gas is a not-stocked product in terms of SAP, so that the application will register only what it sells. Finally, all the necessary orders can be created (invoicing, billing). Other distribution methods invoices are regular mail and e-mail.

Sending an invoice to a consumer will always take into account the existing pressure in the distribution pipe and the calorific power of the gas used, which are two essential conditions in pricing to the consumer. Therefore the following steps are involved:

- determining the price per kWh depending on the calorific power;

- measuring the quantity in cubic meters (cm) to 15 degrees C;
- converting from cm to 15 degrees C in kWh, as found on the invoice.

The formula used to determine the gas consumed (in cm) includes the following parameters: val_1 = ANRE value at pressure x and calorific power y ; val_2 = GDC value in the same conditions, pressure x and calorific power y .

So the formula used to calculate the amount (in cm) paid at a temperature of 15 degrees C is:

$$\text{The amount paid} = (val_1 * val_2) / 1000 \quad (1)$$

For example, a customer was recorded with a consumption of 393 cubic meters at 15 degrees Celsius. As the price per kWh is set at a value of 4059.30 (by ANRE), the GDC Price List at 1000 kWh is: 141.30 at 1000 kWh. So the price that consumers will pay will be determined by the formula: the final calculation = $(141.30 * 4059.30) / 1000 = 573.58$ RON.

Also, a SAP in-house developed application was introduced as part of the services. As the meters are available from the planning and maintenance module of the existing fixed assets, this application enables an overview of the gas process distribution (including the branching/disconnecting, meter recording, etc.)

In the same application a meter sheet is available. Examples of information stored for meters are: capacity, volume, number of consumers/customers, coefficient caloric price (depending on heat coefficient, which will vary by area and season), etc.

4. APPLICATION IMPLEMENTATION

Fig. 4 contains the GDC gas billing application structure. Programming was done in the programming language ABAP (Advanced Business Application Programming),

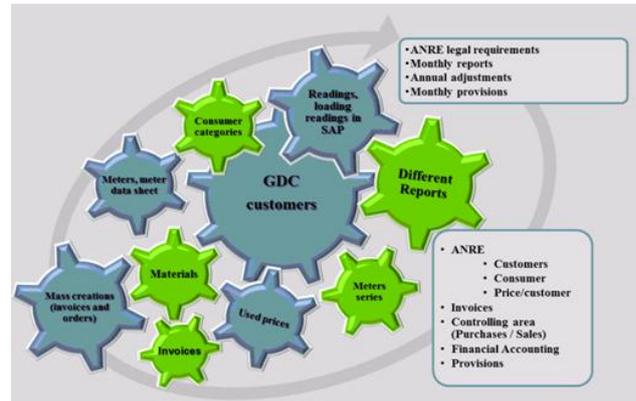


Fig. 4 Gas Management Distribution Application Structure

made by SAP (Helfen and Trauthwein, 2010; Kaplan and Oehler, 2010). This is a 4GL programming language, developed since 1980. ABAP was one of the first programming languages that included the concept of Logical Databases. The latest version of ABAP includes object oriented programming.

In GDC in particular, implementation has considered a detailed analysis of the business environment in the gas division, taking into account all requirements from the GDC business and all ANRE legal requirements. The application menu from Fig. 5 lists, step by step, the solution for all GDC parts' requirements in order to do business in good conditions. Initially a SAP meter was introduced, for meter's configuration and maintenance. After this, the counters were introduced, followed by the reading of the account / billing categories (G1-G6, N1-N6).

Making an "in-house z-application" in SAP using ABAP code can be done using the following steps:

- After the accomplishing of a functional and technical study and the designing of the application's structure, the development center manager assigns a development

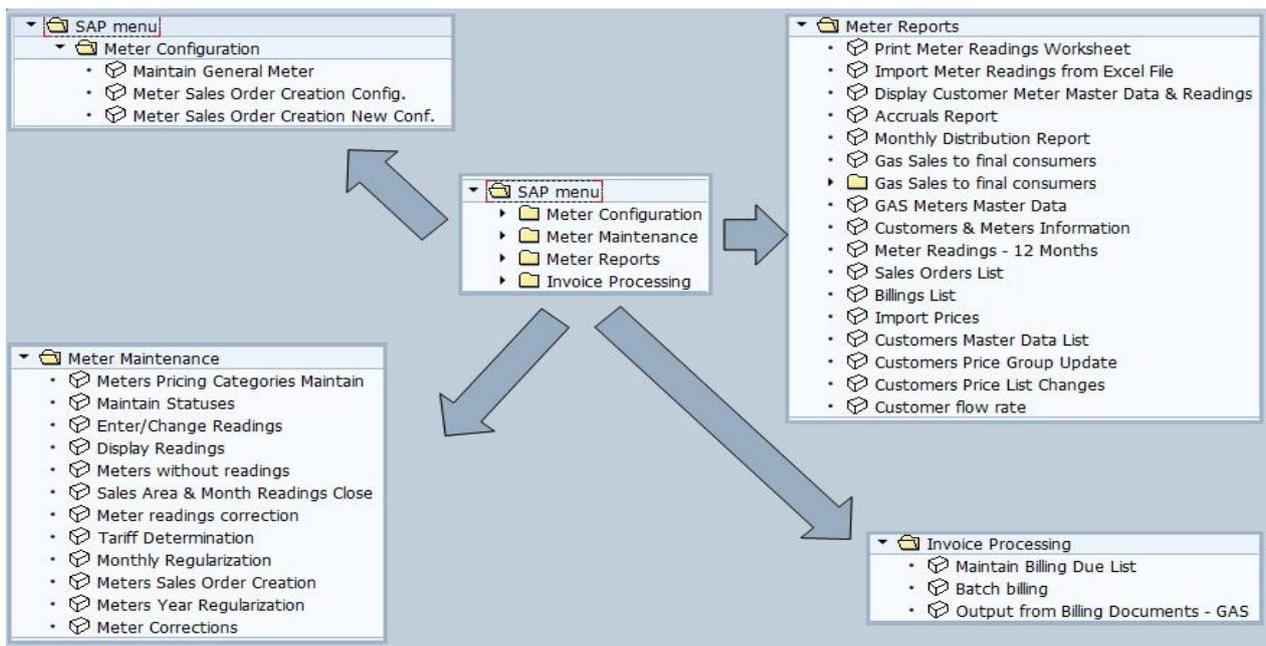


Fig. 5. Application menu

"architect", which, together with programmers, will issue the technical specification. Here, for the entire configuration, major decisions are made, such as: tables to be created, which of the existing tables are to be used, relationship between standard and z-tables, forms to be created, views to be used etc.;

- A Development Guideline established by the company will be used. It contains name conventions to be used for the objects issued by developers inside the application;
- After the decision on which objects to be created is made, the ABAP code is written (se38 transaction is used);
- The se93 transaction will be used to create a z-transaction which will use the previously created z-program;
- The new z-transaction will be added to a z-menu (se43 transaction will be used). This z-menu will be assigned to a z-role and the z-role will be added to an end-user.

Moreover, a z-role can be changed and receive a fine tuning from the SAP security team which can add or delete some authorization (it is possible to hide/unhide some functionalities (buttons) inside the transaction).

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ABAP Editor: Display Report ZRVAX_METERS_TARIFFDET_V2
Report: ZRVAX_METERS_TARIFFDET_V2 Active

565      vweg = p_vweg and
566      darbi ge l_top_last_date and
567      darab le l_top_last_date.
568  loop at l: a015.
569      select single kbezz knwa kpein kmein
570      into :l: a015-kbezz, :l: a015-knwa, :l: a015-kpein, :l: a015-kmein
571      )
572      from knop
573      where knmh = :l: a015-knmh .
574      modify :l: a015 transporting kbezz knwa kpein kmein.
575  endloop.
576  sort :l: a015 by vweg vweg matnr vkgrp.
577  loop at gt_meters.
578      read table :l: a005
579      with key vkgrp = p_vkgrp
580      vweg = p_vweg
581      kunnr = gt_meters-kunnr
582      matnr = gv_METSO_CONF-matnr
583  binary search.
584  if sy-subrc eq 1.
585      if not :l: a005-kpein is initial and
586      :l: a005-kmein = 'M15'.
587      gt_meters-consum_kmh =
588      gt_meters-CONSUM * :l: a005-kbezz / :l: a005-kpein.
589      modify gt_meters transporting consum_kmh.
590  endif.
591  else.
592      read table :l: a015
593      with key vkgrp = p_vkgrp
594      vweg = p_vweg
595      matnr = gv_METSO_CONF-matnr
596      vkgrp = gt_meters-vkgrp

```

Fig. 6. Automatic determination of the tariff meter

All names denoting internal programs (ABAP code) will start with Z (see Fig. 6) or Y. This convention is used as these two letters are not used at the beginning of names for SAP standard programs – this meaning that, when applying the new modifications of standard programs, legal requirements or improving existing standard SAP programs, included in frequently patches – the programs whose names begin with Z or Y will not be altered.

Each year these patches are applied, which means they will be added in the development system (DEV) and an entire test session will be performed inside the SAP internal team. After that, a quality test will be performed in the quality system (QAS), together with business users (after receiving an approval from the business production concerning the patches). In the end, they will be forwarded to the productive system (PRD).

As an example in the “in house” z-application, the transaction ZVAXA_EPS_MM_SES relies on ZVAXR_MM_SES_LIST program (all these objects are included in one application package named ZOIL_ZVAX). This package contains all objects used in the SAP z-application developed by the development team: Embedded Programs, Dictionary Objects, Class Library, Programs, Function groups, “Includes”, Transactions, SET / GET Parameters, Message Classes, Area Menus, Test Objects, Authorization Objects, Enhancements (Lehnert et al, 2010; Orosz , 2011).

The Module Pool for Meter Readings Processing is a collection of screens, fields, menu bars, GUI status, GUI title, transactions, “includes”, flow logic, all used for meter readings processing inside the GDC application. Two types of tables were used:

- SAP standard tables: KNA1 - general data in customer master, KNVV – customer master sales data, OIIGMMIKN – GMM index for customer/sequence number access mode, OIIGMMK – GMM general meter header table, OIIGMMKS – GMM meter description;
- z-tables : ZRVAX_HEAD_MET - meter reading header, ZVAX_METCLOSE – meters month closing, ZVAX_METMD – meter master data and additional information.

All these tables are connected and used for meter readings. All transactions refer to this module pool and to the initial screen number. Therefore, the module pool SAPMZVAX_METERS (Fig. 7) must be used for operations over meter readings like: introducing, change, display, or to maintain statuses.

Several screens are used: 0100 - screen for meters reading, 0110 - meter readings, add data and readings, 0200 - meter maintenance a.o. The screens help the user to add/maintain/display data into system. Each screen has a logic flow referring to one of the following:

- the process before output (the execution of screen-related actions requires a correct “include”);
- the process after input (here all existing fields containing recorded data are connected);
- the process values on request (a validation process must be performed, to issue warnings for out-of-range values).

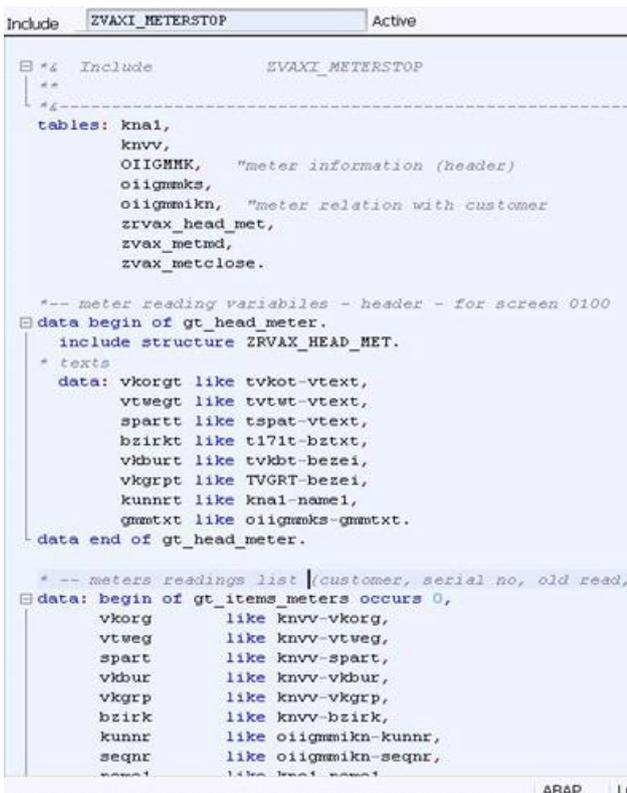
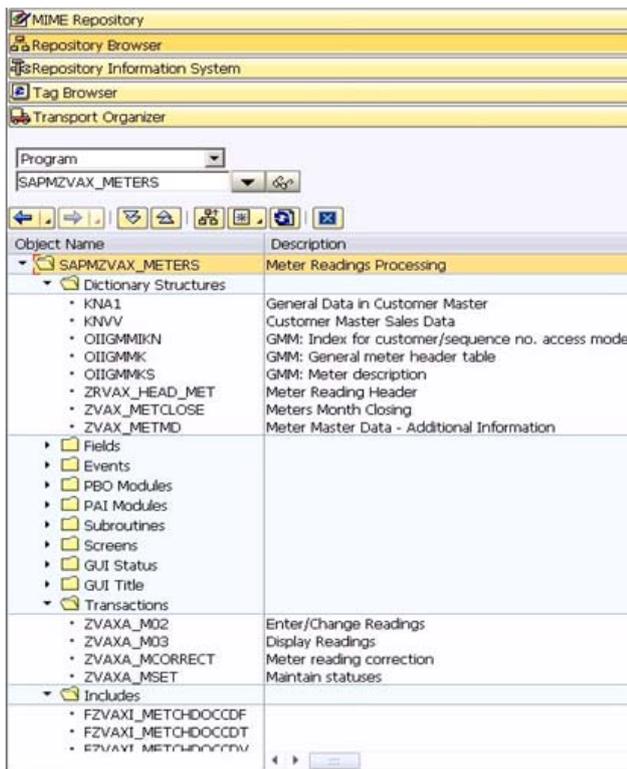


Fig. 7 Module Pool for Meter Readings Processing

Several z - GUI statuses are used in order to add buttons, menu bars, and application toolbars. This way, different sequences of code are linked with additional actions. In this meter reading pool there are four z-transactions which are linked with different activities inside the z-application (enter/change readings, display readings, meter reading correction and maintain statuses). Z-includes (ABAP

code) are used for each action which has to be done during the whole process for this meter readings pool. All initial transactions call the main program SAPMZVAX_METERS. According to different screens, the „include” programs are used separately.

6. CONCLUSION

The authors focused on a software application for Enterprise Resource Planning. The application was developed in SAP environment, one of the largest integrated systems used in major oil companies. Programming was done in the programming language ABAP. The application is related to the gas transport and distribution management, inside a large Gas Distribution Company.

The paper starts by presenting the distribution steps of natural gas from the extraction mixture (condensation) through production wells, up to separation into components and identifies some useful features to the software applicability in natural gas distribution.

Details regarding the analysis, implementation and testing of the software application are presented.

This study presents details on the designing and implementation of an ERP application using an integrated environment as SAP within a large company.

Solving a gas sold management application could be a test in the process of creating a SAP Competence Centre and represents a solide prove for the authors' abilities in solving the global ERP problem for the entire company.

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