

IMPLEMENTING WORKFLOW SOLUTIONS TO IMPROVE GAS DISTRIBUTION MAINTENANCE PROCESSES

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Abstract

This paper describes the results of a pilot project where the Pacific Gas and Electric (PG&E) Gas Distribution department has applied workflow technology to improve certain maintenance-related business processes. The pilot is testing the developed applications to manage district regulator station maintenance at one of the local offices.

“Workflow is the IT supported simplification and automation of a business process”, [1]. Modern workflow engines can enhance operations efficiency through simplifying and automating execution of business processes that interact with people and computer applications.

There are many potential applications for workflow in the utility industry, and utilities are beginning to explore the potential applications of workflow [2]. Reported applications mostly involve simple document routing and approval processes. Application of workflow to mission critical areas, such as emergency corrective maintenance has yet to emerge.

This paper describes a pilot application of workflow to improve the efficiency of: 1) a corrective maintenance process, and 2) an order completion process at PG&E Gas Distribution department. These processes involve many steps that are performed by field technicians, maintenance supervisors, and clerks. The corrective business processes involve emergency as well as non-emergency work.

The two workflows were implemented using the SAP workflow engine, with tight integration with the work management module of SAP, Microsoft Outlook, SAP Enterprise Portal, and PG&E ePage paging system.

The two workflows span the full cycle of corrective maintenance and work completion, and are seamlessly integrated with each other by events generated in one triggering activities in other. The notifications for different steps are sent as emails in outlook with all necessary information and a hyperlink to a portal. In the portal all executable steps appear as Work Items. When the Work Items are executed, the corresponding screens appear to perform the function. The information entered is visible to other users in the enterprise application in real time. Several manual activities involving navigation through many screens have been simplified with background jobs. User experience has been enhanced with portal-based screens and forms with built-in validation checks.

The paper describes the results of the pilot obtained so far and the lessons learned.

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Introduction

PG&E provides natural gas and electric service to approximately 14 million people in northern and central California. The Gas Distribution department serves 3.7 million gas customer accounts through PG&E's 45,800 miles of natural gas pipelines.

In June of 2004, PG&E embarked on a workflow pilot project to manage unscheduled work (Corrective Maintenance) as part of PG&E Gas Preventive & Corrective Maintenance (GPCM) project. Subsequently the scope of the pilot project was expanded to 1) apply workflow technology to the Work Completion process, and 2) to explore benefits of applying (enterprise) portal technology in conjunction with workflow technology. The workflows for Corrective Maintenance and Work Completion processes were put in production in San Francisco Division in June of 2005. They were focused on district regulator station maintenance. Other features included in the pilot are Preventive Maintenance processes for regulator stations and enterprise portal. The pilot project is successfully continuing as of this writing.

Background

The objective of the GPCM Project is to implement an electronic asset management system for gas facilities maintained by PG&E Gas Department that will be fully integrated within PG&E's enterprise systems. SAP (www.SAP.com) will be the asset system of record, directing capital projects, and both the preventative and corrective maintenance. The system will utilize a mobile technology to collect field data and communicate with SAP. Primary benefits will be realized from the synergy of information system integration and data input time reduction.

GPCM uses SAP Work Management to process notifications and service orders. It enables supervisors and supervisor's clerks to take work requests from others (notifications), and create Plant Maintenance (PM) orders in SAP, for prioritization, scheduling or same day assignment. Handling unscheduled work is an important part of the GPCM process that could significantly benefit from applying SAP workflow.

Workflow technology applies IT to simplify and automate the execution of business processes that interact with people and systems, both within and across organizations [1]. As it is described in [2], workflow can improve operations by providing the following benefits:

- Automation of manual tasks
- Consistent execution of business processes
- Improved user interfaces
- Timely event/task notification
- Active deadline monitoring
- Managing substitution and delegation
- Detailed documentation of business processes
- Facilities to monitor and evaluate business processes to quickly identify weak spots and potential improvements
- Facilities to efficiently implement, administer, and modify business processes

The SAP workflow orchestrates triggering of workflow, execution of different tasks, auditing of execution and post processing activities.

Workflow Project Objectives

The objective of the GPCM workflow pilot project was to explore and prove that workflow technology could indeed provide the following expected benefits:

- Effectively automate processes that improve consistency and reduce cycle time
- Handle local unscheduled work scenarios for both emergency and normal notifications.
- Provide interfaces that are intuitive and require minimal user training.
- Provide increased visibility of the notification process to everyone involved.
- Effectively integrate processes between SAP, Outlook and PG&E's e-page system.
- Provide a flexible tool to modify process steps as the GPCM process gets refined
- Effectively assign different statuses to notifications based on review
- Provide flexible approval scenarios with substitution and delegation
- Reduce approval cycle time through deadline assignment and monitoring
- Centralize maintenance of users and routing rules
- Make training easier

The Gas Preventive and Corrective Maintenance Processes

The GPCM pilot is composed of several processes including preventive maintenance, corrective maintenance, and work completion.

Preventive Maintenance Process

Preventive maintenance occurs on a periodic basis to keep equipment operational and meet code compliance requirements. Notifications and orders are created to document the work required and later performed. Capacity planning and scheduling are performed in SAP Work Management. Key requirements of this process are:

- Consistent process and auditable process
- Visibility of resource utilization in real time
- Flexibility for scheduling

The Corrective Maintenance Process

The corrective maintenance process includes emergency response, requiring the immediate dispatch of a field technician, and non-emergency work that goes through an approval-permit-schedule cycle. Both cases require creating a notification and a corresponding order in SAP, with all relevant data. Key requirements of this process are:

- Timeliness
- Effective communication of relevant information to resolve the problem
- Consistent and auditable process

Work Completion Process

Completed work needs to be documented. Problems identified during the completion process need to be resolved with further scheduling, and additional work completed need to be captured. Maintenance data need to be entered for each of the component worked on. Key requirements of this process are:

- Ensuring that all relevant information is entered
- User friendly data entry forms
- Automated triggering of further notifications
- Validation of input data
- Automated closure of related notifications and orders

Managing the Maintenance Processes

Effective management of these maintenance processes requires computer tools that can meet the following requirements:

- Flexible design tools to accommodate changing processes
- Modeling the business process to reflect real life situations
- Getting the right information to the right person, at the right time, in the right form
- Minimal ongoing maintenance
- Full integration with business applications such as SAP, Microsoft Outlook, and ePage
- Minimal training
- User friendly interface

Workflow Models

The workflow models used in the PG&E Corrective and Preventive Maintenance involved approval and cross application integration scenario. The Work Completion workflow involved process simplification and web-based data entry forms.

The diagram in Figure 1 describes the process for handling emergency as well as non-emergency notifications. Different persons (actors) involved in the process are identified by icons in different colors (shades of grey). Each step in the process is numbered and each email/ePage is numbered. When an emergency notification is identified, the supervisor and clerk are alerted through ePage. Supervisor identifies the suitable field technician to handle the problem and informs the clerk. The clerk follows the link in the email to create order. Assigning the order and sending ePage to field technician LanID is handled in the background automatically.

In non-emergency cases, the supervisor is notified through Outlook email that a notification has been created, to log into the portal and takes the necessary action. The notification can be deferred, cancelled or processed for creating an order. If approval is required, an email is sent to the approver and subsequent information provided to supervisor. Decision on permit and schedule are entered as part of the process.

Figure 1 also explains how a corrective maintenance notification identified during preventive maintenance is completed and closed.

The diagram in Figure 2 depicts how the work completion for preventive and corrective maintenance is managed. Preventive maintenance work completion forms are filled in and checked for validity. Any problems identified or additional work completed during preventive maintenance is used to create further notifications.

Corrective maintenance work completion provides a corresponding notification screen for completion and closure of notification and associated order.

The diagram in Figure 3 explains how the two workflows interact. Corrective Maintenance workflow calls the Work Completion workflow after setting the order to a constructions completed (“cons”) status. The Work Completion workflow calls the Corrective Maintenance workflow for additional work completed, problems identified or other equipment maintenance done.

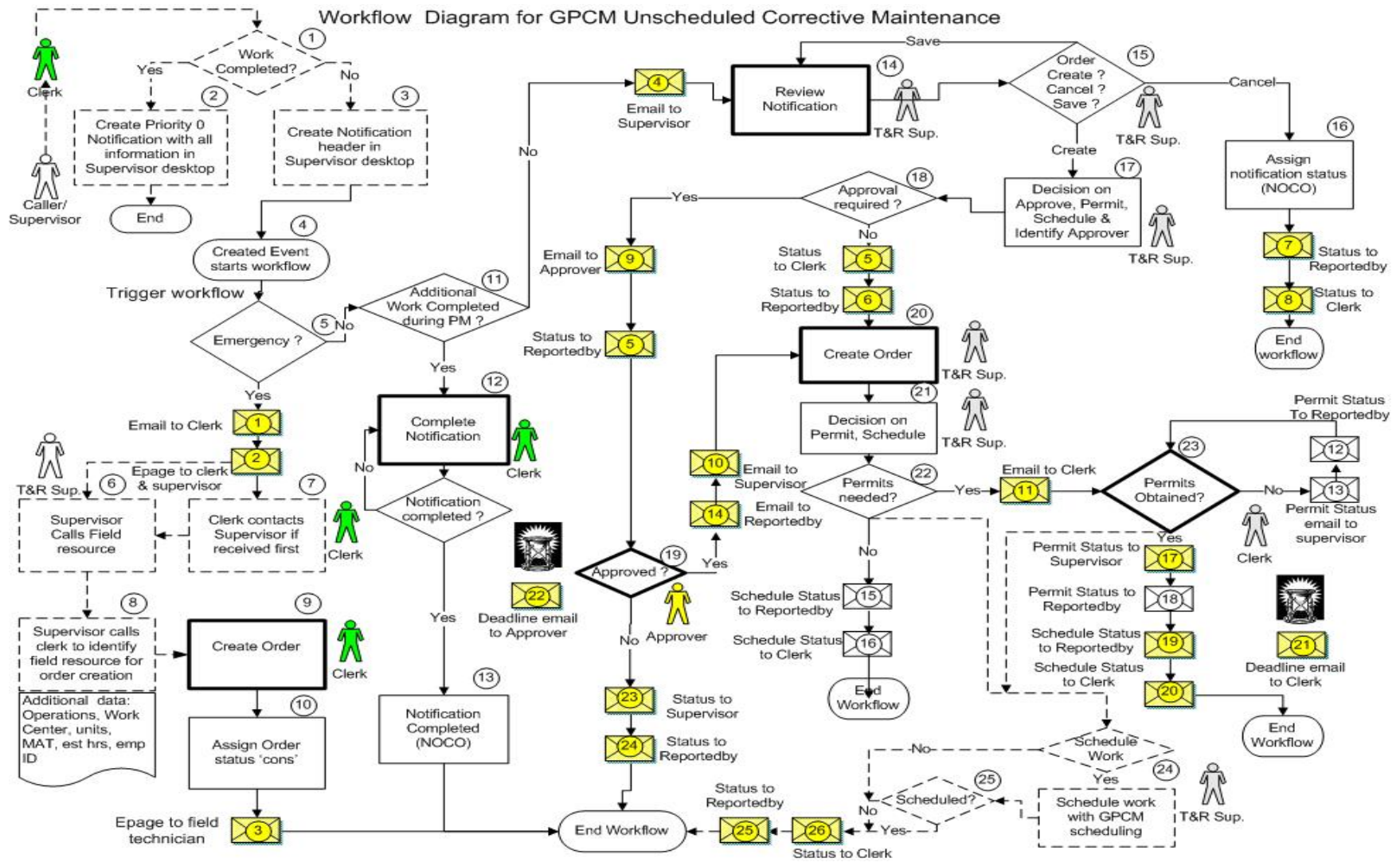


Figure 1: Corrective Maintenance workflow

Workflow Diagram for GPCM Work Completion of Corrective & Preventive Maintenance

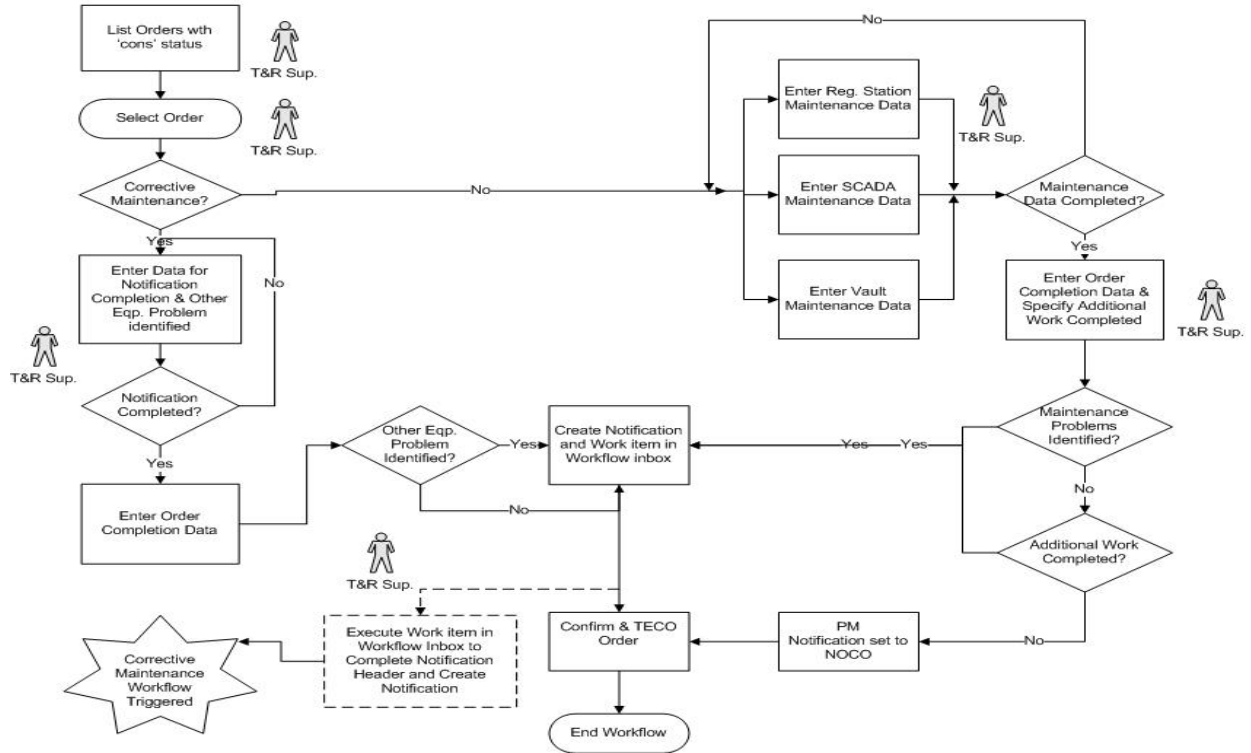


Figure 2: Work Completion workflow

Integrated Workflow Diagram for GPCM Corrective and Work Completion Process

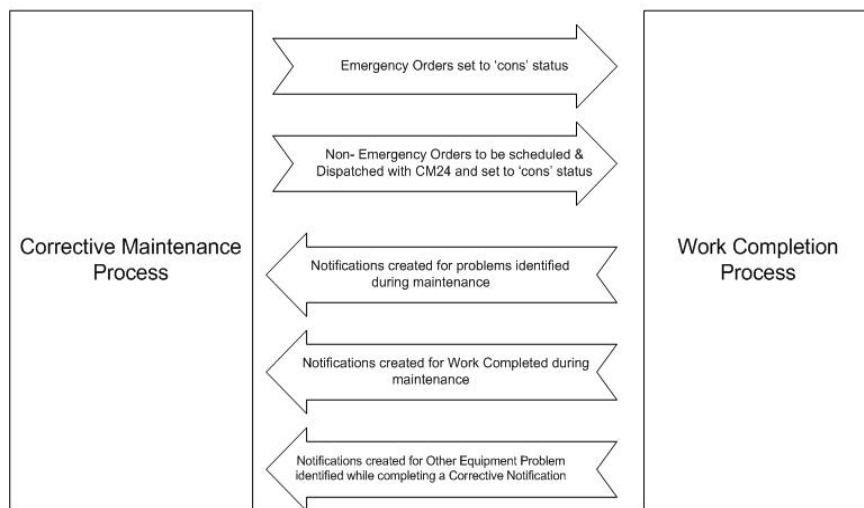


Figure 3: Integrated workflow Diagram

Implementation

Some noteworthy features of the workflow implementations for the pilot project are:

- User friendly Web interface for execution of Work Items (Process steps)
- Intelligence in forms for validation and triggering further processes based on data
- Web portal for work item execution and Work Completion
- Notifying people through Microsoft Outlook email and PG&E ePage application
- Maintenance forms mimicking current paper forms for intuitive Data Entry
- Actual orders and notifications are attached for review and drill down for details
- Iterative business process modeling & rapid prototyping with frequent input from users

Some of the main workflow screens are presented and described below.

SAP Inbox on Portal

Figure 4 shows the screen for Universal Workflow List (UWL) inbox. The work items and the details are shown for execution and review.

The screenshot displays the SAP Enterprise Portal 6.0 interface. The browser title is "SAP Enterprise Portal 6.0 - Microsoft Internet Explorer provided by PG&E". The user is logged in as "Kamaraj Shankar". The main content area shows the "Universal Worklist" with a "Tasks (7)" tab selected. Below the tabs is a search bar and a "Refresh" button. The task list table is as follows:

	Subject	Priority	From	Sent Date	Due Date
<input checked="" type="radio"/>	Edit GPCM Notification 100031741 DR-175, 36 AVE & PACHECO	Very High	USKXST	Dec 14, 2004 4:30:14 PM	
<input type="radio"/>	Review GPCM Notification 100031732	Normal	USJCO1	Dec 14, 2004 8:41:54 AM	
<input type="radio"/>	Review GPCM Notification 100031734	Normal	US1612	Dec 14, 2004 9:24:14 AM	
<input type="radio"/>	Review GPCM Notification 100031735	Normal	US1612	Dec 14, 2004 9:44:23 AM	
<input type="radio"/>	Review GPCM Notification 100031738	Normal	US1612	Dec 14, 2004 10:26:00 AM	
<input type="radio"/>	Review GPCM Notification 100031739	Normal	US1612	Dec 14, 2004 10:29:28 AM	
<input type="radio"/>	Review GPCM Notification 100031737	Normal	USKXST	Dec 14, 2004 10:34:43 AM	

Below the table is an "Item Preview" section for the selected task:

From: USKXST | Priority: Very High
Subject: [Edit GPCM Notification 100031741 DR-175, 36 AVE & PACHECO](#) | Sent Date: Dec 14, 2004 4:30:14 PM
Attachment(s): [Maint. Notification](#)

Buttons: [Launch SAP Task](#) [New Ad Hoc Request](#) [View All of Same Category](#) [View Detail](#) [View Detail in SAP Gui](#)

Figure 4: SAP Inbox

Email Notification of Emergency Work

The Outlook email has all the details of the notification and a hyperlink to portal for review and execution, as shown in Figure 5.

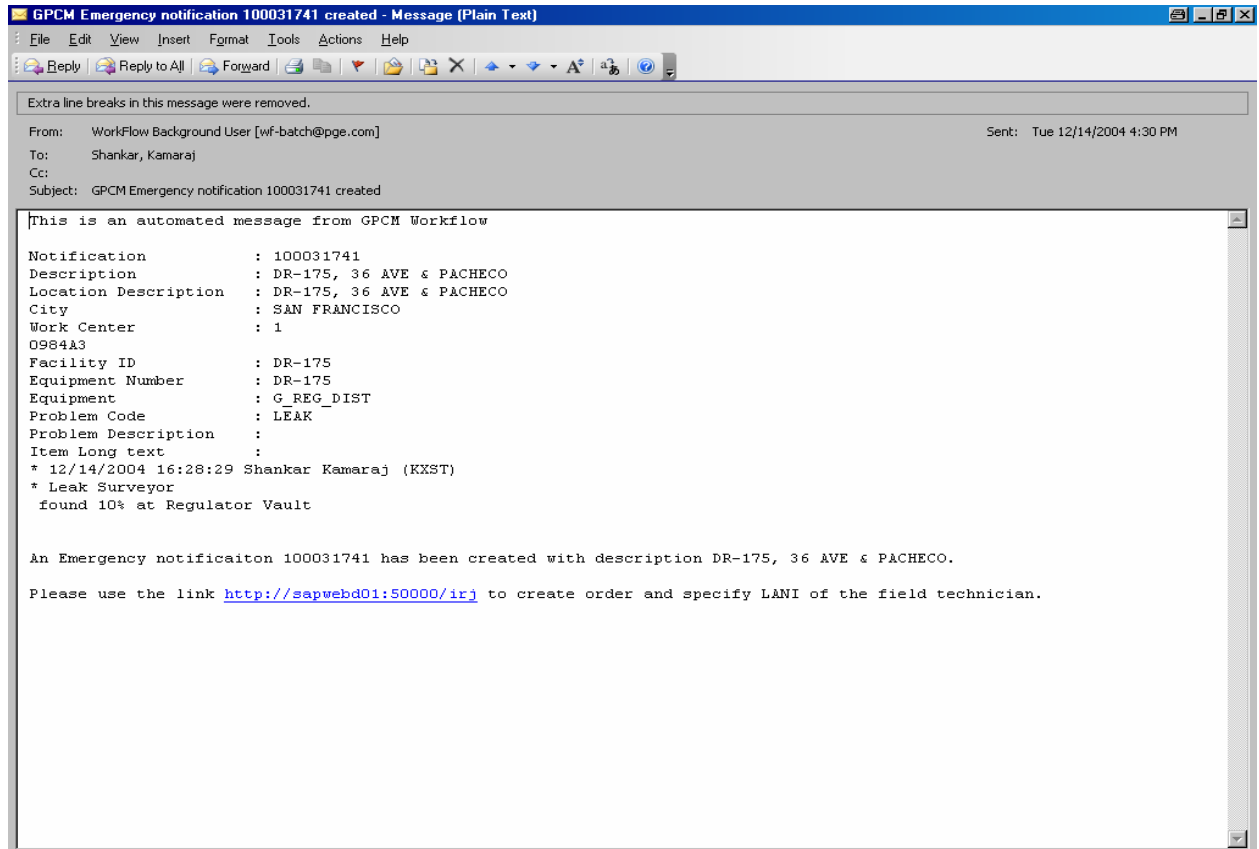


Figure 5: E-Mail Notification

Portal Screen for Order Creation

Figure 6 shows the screen for creating order and entering the field technician information.

Notification Number: 100031756
Description: DR-175: G_FILTER F-1
Maint. Activity Type: FIB
Priority: 3
End Date: 12/31/2004
Field Technician: XXST

Oper	STxKey	Description	Work Ctr	Work	Unit	Dur	Unit
0070	INSP	Inspection	??	.1	Hrs	1	WEEK
0080	GCNST	Gas Construction	??	2	Hrs	1	WEEK
0090	GMAINT	Gas Maintenance	??	1	Hrs	1	WEEK
0100	ENDC	End Construction	??		Hrs	0	WEEK
0110	GMAP	Gas Mapping	??	.1	Hrs	1	WEEK

Comments

Accept

Figure 6: Order Creation Portal Screen

Portal Screen for Work Completion

Figure 7 shows the list of orders for entering work completion information. The selection can be done by entering specific information on the first line of the table.

ORDER SELECTION Division: Planner Group:

ORDER LIST

Order	Type	Priority	Description	MPG	MAT	Equipment	Work Center	Start Date	End Date	Operation Short Text
<input type="checkbox"/>										
<input type="checkbox"/> 40008145	GR80	3	REG STA 138 28 AVE & KIRKHAM ST	1RG	FHB	R-0324	10984A3	12/29/2004	01/28/2005	
<input type="checkbox"/> 40008209	GR80	3	RECURRING ORDERS FOR 1RG/001	1RG	FHB	R-0324	10984A3	11/24/2004	12/31/2004	
<input type="checkbox"/> 40008523	GR80	3	RST 175 36 AVE & PACHECO	1RG	FHB	DR-175	10984A3	11/08/2004	12/03/2004	Dist Reg Sta A insp
<input type="checkbox"/> 40008632	GR80	3	RST 144 TARAVAL ST & WAWONA AVE	1RG	FHB	144	10984A3	10/30/2004	01/20/2005	
<input type="checkbox"/> 40008705	GR80	3	DR-175: G_VALVE V-5 STATION VALVE	1RG	FIB	V-5	10984A3	11/24/2004	11/30/2004	
<input type="checkbox"/> 40009100	GR80	3	DR-175: G_FILTER F-1	1RG	FHB	F-1	10984A3	12/24/2004	12/30/2004	
<input type="checkbox"/> 40009182	GR80	3	RST 138 28 AVE & KIRKHAM ST	1RG	FHB	138	10984A3	01/18/2005	03/01/2005	Dist Reg Sta A insp
<input type="checkbox"/> 40009183	GR80	3	RST 82A HARVARD & SILVER HP REGS	1RG	FHB	082A	10984A3	01/18/2005	02/14/2005	Dist Reg Sta A insp
<input type="checkbox"/> 40009185	GR80	3	RST 39 MISSION ST & SANTA ROSA	1RG	FHB	039	10984A3	01/18/2005	02/14/2005	Dist Reg Sta A insp
<input type="checkbox"/> 40009187	GR80	3	RST 87 MIRAMAR & WILDWOOD	1RG	FHB	087	10984A3	01/18/2005	02/14/2005	Dist Reg Sta A insp
<input type="checkbox"/> 40009189	GR80	3	RST 78 OAKDALE & SELBY	1RG	FHB	078	10984A3	01/18/2005	02/18/2005	Dist Reg Sta A insp

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Figure 7: Work Completion

Portal Screen for Maintenance Data Entry

Figure 8 shows the Portal Screen for Maintenance Data Entry. This screen provides a user friendly intuitive way of entering maintenance data for a regulator station. This form replicates the paper form being used and has intelligence built-in for drop down values and validation of data entry.

Content Administration | Welcome | GPCM | Home
 Inbox | Work Completion | Equipment
 Portal Content > Work Completion | Back | Forward

Order Detail | Regulator Station Maintenance Record | SCADA | Water Discharge Record | Order Completion

District Regulator Station Maintenance Record

Old Gas FM No. Division: SF | Wall Map, Plot, Block: C8 - 3 - 1.00
 Location: 28 AVE & KIRKHAM ST | Stage: STAGE1
 Station Number: 138 | Associated Station Number:

Run : Looking downstream Left to Right (1,2,3,4) | RUN1
 Employee Initial : AXPJ
 Date : 01/25/2005

DCS Standard	Task Description	Result
A1A	Fire Valve Accessible and Operated	<input checked="" type="radio"/> Yes <input type="radio"/> No
A1B,C	Vault Cover and Surroundings	<input type="radio"/> Good <input checked="" type="radio"/> Bad
A1D	Gas Leak Test (% LEL)	12.2 %
A1F	Vault Inspection	<input checked="" type="radio"/> Good <input type="radio"/> Poor
A1E	Ventilating System & Relief Stacks	<input checked="" type="radio"/> Good <input type="radio"/> Poor
A1H	Locking Devices Present And Operational	<input type="radio"/> Yes <input checked="" type="radio"/> No
A2G	Station Valves Checked	<input checked="" type="radio"/> Yes <input type="radio"/> No
A1G	Piping Condition	<input type="radio"/> Good <input checked="" type="radio"/> Poor

DCS Standard	As Found As Left Settings	AF	AL
A2B	Filter Differential	12 PSIG	PSIG
A2C	Regulator Pressure Setting	12 PSIG	12 PSIG
A2C	Secondary Pilot Setting (Regulator)	PSIG	PSIG
A2E	Regulator Lockup	<input checked="" type="radio"/> Yes <input type="radio"/> No	
A2E	OPP Upstream or Downstream	<input checked="" type="radio"/> U <input type="radio"/> D	<input checked="" type="radio"/> U <input type="radio"/> D
A2D	Monitor Control Pressure	PSIG	PSIG
A2E	Monitor Lockup	<input type="radio"/> Yes <input type="radio"/> No	
A2C	Working Monitor Pilot Pressure	PSIG	PSIG
A2D	Secondary Pilot Setting (Monitor)*	PSIG	PSIG
A2D2	Relief Cracking Pressure	PSIG	PSIG
A2D3	Automatic Shutoff Overpressure Setting	PSIG	PSIG
A2D3	Automatic Shutoff Underpressure Setting	PSIG	PSIG
A2F	Inspect and Clear Vent Lines	<input checked="" type="radio"/> Yes <input type="radio"/> No	
A3B,C	Pressure Recorder - 2pt	2	
MAOP Station Drawings and Data Sheet Been Updated		<input checked="" type="radio"/> Yes <input type="radio"/> No	

Type B Maintenance

A2B2	Station Filter - Internal	<input type="radio"/> Yes <input type="radio"/> No
B4A,B,C,D	Regulator	<input type="radio"/> Yes <input type="radio"/> No
B4A,B,C,D	Overpressure Protection Device	<input type="radio"/> Yes <input type="radio"/> No
B3B	Pressure Test Vent & Diaphragm (L.P.)	<input type="radio"/> Yes <input type="radio"/> No
B2A,B,C,D,E	Regulator Pilot Control Loop(s)	<input type="radio"/> Yes <input type="radio"/> No
B2A,B,C,D,E	OPP Pilot Control Loop(s)	<input type="radio"/> Yes <input type="radio"/> No
B2A,B,C,D,E	Working Monitor Pilot	<input type="radio"/> Yes <input type="radio"/> No

SAVE

Figure 8: Maintenance Data Entry Portal Screen

Portal Screen for Work Completion Status

Figure 9 presents the portal screen for work completion status. This screen displays the progress of data entered in a table at left lower corner so that any missing form can be filled in. This screen also provides a check box to identify any additional work completed. Pressing the 'Complete Order' button triggers the Work Completion workflow.

Code Group	Work Type	Work Type Text	Entry Status
STAGE1	RUN1	Run 1 Gas Equipment	NOT ENTERED
VAULT	VA-1	Vault 1 Inspection	NOT ENTERED
VAULT	VA-2	Vault 2 Inspection	NOT ENTERED

Figure 9: Work Completion Status Portal Screen

Benefits

The pilot project reaffirmed the following benefits of workflow:

Automation

Many of the essential work steps, such as creating and closing notifications and orders were automated, eliminating manual processing steps. Consistency of application and cycle time was greatly improved.

Effective Modeling of Business Processes

Workflow effectively modeled PG&E maintenance processes such as corrective maintenance for emergency and non-emergency work and work completion.

Intuitive User Interface

The data entry forms have been designed to minimize the transition experience from the existing paper forms. The drop downs and validation checks ensure the data entry errors are minimized. Built in calculations pre-populated dependent fields based on the values initially entered.

Order creation screens minimized the user input and transaction experience from “standard” SAP.

Deadline Monitoring

Monitoring the time elapsed for interactive workflow steps requiring user action can be implemented through deadline monitoring. Once the deadline is reached notification and escalation ensures that tasks are executed efficiently.

Consistent Process

Workflow ensures that the processes followed remain consistent for all the scenarios. The universal process worked in the local environment.

Process Integration

Effectively integrated processes between SAP, Outlook and PG&E’s e-page system.

Easy to Modify/Change

Modern workflow tools allow process changes to be implemented quickly by “drag & drop” operations using graphical displays as opposed to coding. As such a process change may be implemented very quickly (e.g., same day in most cases).

Substitution and Delegation

Planned and unplanned absence of the person performing the tasks can be handled through the functionalities of Substitution and Delegation. Any workflow user can select one or more persons with similar authorizations as possible substitutes.

Detailed Documentation & Auditable Processes

Workflow provides detailed documentation for processes and how they are executed (e.g., who executed what work step and when), making audit easy.

Easy Training

As the processes are well documented and all possible outcomes are well defined, training new users becomes easy.

Other Lessons Learned

Other lessons learned during the pilot project were:

- A rigorous project management framework in line with Project Management Body of Knowledge (PMBOK) best practices can help with successfully managing a workflow implementation project [3].
- Sufficient time should be allocated in a workflow project to detailed definition of the business process. The project team should expect that the definition of the process will continue to evolve throughout the project. If the workflow technology used could simulate the To-Be Process, it can shorten the implementation time by making some the problems visible early on.
- Rigorous testing methodology and defect tracking tools are needed for quality assurance of the workflow implementation.
- All the user roles involved in the implementation need to be developed and tested before moving to production environment.
- A test environment replicating the production environment is needed for testing of the workflow including user roles. Differences between the test and production environments introduce risk of prolonging the implementation schedule since potential production issues may not be visible in the test environment.

Conclusions

Workflow technology provide an effective tool for automating and streamlining business processes that involve people and computer applications, such as gas distribution Corrective Maintenance and Work Completion. PG&E GPCM pilot workflow project has thus far confirmed the expected benefits of workflow as a promising technology for creating business processes that are consistent, repeatable, documented, auditable, manageable, and compliant with internal business rules and external regulations such as Sarbane Oxley.

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