The safety implications for offshore maintenance of using proprietary management/scheduling software

Prepared by TÜV NEL Limited for the Health and Safety Executive 2003

RESEARCH REPORT 128
The safety implications for offshore maintenance of using proprietry management/scheduling software

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This report deals with issues relating to the growing use of commercially available software adapted / applied to assist in the management of maintenance activities on offshore production installations. HSE has become aware of potential failings and reliability-related problems regarding the use of this software, and of certain industry-based concerns regarding the automation of maintenance scheduling processes. NEL, in conjunction with its parent TÜV Süddeutschland, undertook a project to investigate these issues for HSE.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.
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EXECUTIVE SUMMARY

This report deals with issues relating to the growing use of commercially available software adapted / applied to assist in the management of maintenance activities on offshore production installations. HSE has become aware of potential failings and reliability-related problems regarding the use of this software, and of certain industry-based concerns regarding the automation of maintenance scheduling processes. NEL, in conjunction with its parent TÜV Süddeutschland, undertook a project to investigate these issues for HSE.

The primary objective was to establish the types and extent of potential and actual failures arising from the use of the software and other problems associated with the software. A two-stage approach was used. In the initial phase a review was undertaken of commercially available packages currently in use by offshore industry to identify general issues. In the second phase specific examples were followed up in greater detail by means of case studies. In general it was difficult to schedule both telephone appointments and formal visits, although the contacts were generally helpful when these activities were finally arranged.

Both general purpose business software and specific maintenance management / scheduling software are used. Overall, users of both types of package appear to be satisfied that the packages assist them in correctly scheduling maintenance, including that of safety-critical items.

However, whilst the packages themselves appear satisfactory, issues such as the integrity of data in databases, confirmation that scheduled maintenance has been correctly carried out and general auditing procedures need to be properly addressed, just as for any non-software based system.

The report has a number of Appendices that summarise the findings and give details on the case studies and the general use of software applied to maintenance activities.

No specific problem areas requiring urgent attention were discovered. However it was concluded that the subject justified further actions. It is proposed that the findings of the report could be disseminated to a wider audience including HSE inspectors and focus groups such as UKOOA and STEP. In addition, it is suggested that an Industry User Guide is produced for the effective use of maintenance software and a Guide Framework has been outlined as part of this report.
HSE has identified a lack of information on (and concerns regarding assurance of) reliability of proprietary software used by offshore operators to schedule and manage maintenance and related functions in their safety-critical high-hazard environment.

Possible problems were highlighted during inspections and subsequently the issue was identified during the Joint Industry/HSE (OSD) seminar and workshop entitled ‘Maintenance: Reducing the Risks’ held in Aberdeen on 17-18 Jan 2001.

Whilst both general-purpose business software and specific maintenance management / scheduling software are being used by offshore operators, HSE has identified a number of potential issues over the use of such packages. Specific areas of concern to HSE include:

- effectiveness of implementation of software solutions,
- effectiveness of the packages, with regard to correct scheduling,
- interaction with the software developers, particularly when modifications are required,
- the potential impact of software design flaws, bugs and IT hardware problems,
- the level of understanding of the importance of safety amongst software developers,
- the commitment of middle management, and
- the difficulties of taking complex organisations through the change process associated with moving to software-based solutions.

To obtain further information, HSE issued a call under its Mainstream Research Programme relating to “The Safety Implications for Offshore Maintenance of Using Proprietary Management/Scheduling Software” as project B7 within the Competition of Ideas theme. In response NEL submitted a proposal which, after further discussions to finalise the scope of work, was agreed with HSE. Subsequently a contract (agreement No D3988) was placed with NEL on 25th September 2001. This report describes the work undertaken and results obtained.

The original project plan consisted of six tasks:

Task 1  Review of Key Issues
Task 2  Project Review
Task 3  Researching the Issues
Task 4  Preparing the Guide
Task 5  Training Seminars / Workshops
Task 6  Formal Report

Subsequent to the project review and discussions with HSE, it was agreed to focus more effort on Task 3 and to consider the preparation and promulgation of an industry guide based on a framework produced by the NEL team.
METHODOLOGY

STRATEGY

A two-stage approach was used. In the initial phase a review was undertaken of commercially available packages currently in use by industry to identify which packages are used, how widespread their use is and to highlight key issues for further study. In the second phase specific examples were followed up in greater detail by means of case studies, focusing on the key issues and seeking out evidence of failures of such software that may have a major influence on the type and extent of hazards and associated risks to safety and reliability.

REVIEW OF KEY ISSUES

A preliminary review and assessment was carried out, in conjunction with suppliers and users, of the range and usage of software for maintenance and related management purposes, particularly software used in safety-critical situations. Although the bulk of the work focused on the use of such software in offshore applications, evidence was also gathered from onshore industries since lessons learned from them could be applicable offshore.

This involved a range of activities including:

- an extensive literature search,
- discussions with individuals, working groups and industry-representative organisations in the offshore sector,
- interaction with a number of organisations in the UK and Germany (who are responsible for land-based major hazard installations and have relevant experience of this type of software),
- following up offshore installation operators leads, provided by HSE, that have relevant experience or specific views,
- interactions with software suppliers to gauge their views on matters related to safety, and
- interaction with Amey Vectra regarding their related project on ‘campaign maintenance’.

The literature search, which was primarily web-based, provided information on the supply and use of maintenance software and trade and professional organisation membership. From this and other background information (including contacts provided by HSE), a working list of around 70 contacts was produced (mainly for Task 3, but with a selected sample being used for discussions in Task 1).

The range of organisations targeted included:

- operators: offshore / onshore
- contractors
- drilling services
- equipment suppliers
- software vendors
• focus groups (STEP, UKOOA, OCA, WSCA, …)
• trade associations (IP, IChemE, …)

For Task 1, this led to contacts with 12 organisations within the UK and five in Germany who either make use of or are potential users of maintenance management / scheduling software. In addition, contacts were also made with the major software suppliers.

The first phase of the discussions with individuals, working groups and industry-representative organisations was carried out by telephone and a script prepared to ensure a consistent approach was adopted. The script is included in Appendix 1 and sample responses in Appendix 2.

RESEARCHING THE ISSUES

The preliminary review confirmed the perceived use and potential problems with maintenance software. Several options were available for the follow-up phase:

• continue the basic survey of target companies, organisations and vendors at a more detailed level and wider range of contacts,
• carry out a more standard questionnaire activity,
• concentrate on a few selected case studies on the use of software

Experience from similar work previously undertaken by NEL had shown that poor return rates are obtained from a questionnaire-based approach. By agreement with HSE it was therefore decided to use a case-study based approach, concentrating on a few selected users of software including:

• one operator with SAP,
• one operator with another package,
• one contractor, and
• one drilling company or equipment supplier.

In addition to the preparation of a key contact list for possible case studies, several additional activities were carried out during the third task of the work:

• continuation of telephone enquiries to a range of companies,
• production of improved telephone script,
• production of briefing note for case study participants, and
• follow up with software suppliers.

Despite the best endeavours, telephone contacts were hard to pin down and arrangements for possible visits were exceedingly difficult to schedule. However, after visits were finally arranged, the participants were generally helpful although there was an occasional suspicion that the team visiting were HSE inspectors in disguise.
The objective was to prioritise the list of issues and problems. The types of failures and problems that were investigated included:

- those relating to the inputting of significant data errors into a database,
- those relating to the outputting of incorrect scheduling or other types of key information which have had severe repercussions (or have had the potential for severe repercussions) for the maintenance of safety critical functions on an installation,
- interfacing problems and issues arising from the integration of different software packages,
- those related to customisation of software packages, and
- examples where upgrading of software packages has led to corruption or loss of data.

The case studies were carried out by means of one or two visits when the key issues arising from the research work identified above were explored in depth with the company staff.
SUMMARY OF FINDINGS

The review of the key issues identified the range and usage of software for maintenance and related management purposes. This produced a series of initial findings that were followed up in the case studies. This section summarises the findings from the review and the case studies. Both the initial and follow-up case studies are reported in detail in Appendices 3 and 4.

REVIEW OF KEY ISSUES

As noted above, the preliminary review confirmed the perceived use and potential problems with maintenance software and these findings are summarised below.

Whilst establishing target contacts was straightforward, contacting the right people at the right time was time-consuming and this phase of the work took much longer than initially anticipated.

In terms of the software used, extensive use is made of SAP R/3, usually as part of overall company strategy including financial, personnel and general business support. Significant use is also made of MAXIMO and IFS with some use of JD Edwards, En-Guard and Passport. However, the biggest use of these software packages is made in asset management rather than maintenance scheduling. In the other software category some contacts mentioned CREDOSOFT as a simpler, but user-friendly package, although once again limited primarily to asset maintenance.

All the packages are complex and although usually good for scheduling, they are less effective for reporting results. In particular, output from the packages is often still hard copy reports, but significant use is made of office tools such as Excel and Access.

In terms of safety implications, the following key points were noted –

- software usually needs customisation, but this can lead to the introduction of errors,
- complex software is difficult to use, leading to possible misinterpretation of results,
- aggregation of results for plants can lead to safety critical areas being difficult to highlight and hence safety being compromised,
- significant learning curves for both users and IT support staff can lead to ‘cutting corners’, and
- financial pressures in the industry are driving the move to RCM / optimisation techniques, giving rise to problems during transition and subsequent use of software.

The operators all appear to use SAP R/3, but were less aware of the other major packages. The general view of SAP was that it was “not perfect, but does most things tolerably well”.

The software is used for maintenance scheduling, but the results are usually transferred to other systems. There was no great evidence of using results as feedback to improve procedures. Even those operators who preferred an alternative, e.g. MAXIMO, for maintenance, used SAP for financial operations. Thus data transfer between the two packages was required, for example in the purchase of equipment.
Process contractors indicated that their actions are driven by the specifications of their clients. For the bigger companies this may mean that they have a basic knowledge of several different systems. In some ways the move to a single well-used system may be beneficial, provided functional requirements rather than business issues drove this development.

Other contractors and support businesses are again influenced by the requirements of their clients, which may be the operator or another contractor in the chain. There is less evidence of the use of specific software at this level and many records are still paper based or incorporated into tools such as spreadsheets.

Equipment suppliers set recommended maintenance periods, but generally do not need to use the software themselves.

**CASE STUDIES**

Over the period from April to November 2002 a series of case studies were carried out to examine in more detail the issues identified in the initial review. These consisted of one or two visits to the companies who had agreed to take part. The findings from the studies are summarised below and presented in detail in Appendices 3 and 4.
Phillips Petroleum

Software: Phillips originally used Passport but moved to SAP R/3, partly for Y2K compliance. They use the PM and MM modules for maintenance. The software is used at a corporate level, but the US->Norway->UK chain of command makes customisation a slow process. Initial customisation was limited, but mainly due to lack of knowledge of SAP. Although the changeover to SAP was abrupt it was judged to have gone reasonably smoothly.

Scheduling: SAP is regarded as good for producing work orders but MS Project is still used extensively for planning schedules. Documentation (including tag IDs) is generally better with SAP.

Data reporting: Data reporting consists of a mixture of manual reports and hand-held devices (for the Credosoft asset management software) used for data logging. Although SAP is good for producing summary management reports there are still a number of areas where flat file transfers are used.

Validation: A number of in-house procedures are used and DNV undertakes internal auditing in preparation for HSE inspections.

Concerns: The original software has some advantages not in SAP.

Recruitment and staff training are issues.

Data transfer is still problematic, but has improved with the new SAP BW module (data warehouse).
BP

Software: BP originally used En-Guard then moved to MAXIMO in late 1990's using the latest version. SAP was considered but is only used for financial modules. The software is used at a corporate level in principle, including mergers or alliances with AMOCO, ARCO and CASTROL. It is driven by the Aberdeen development office, with a major rollout to other sites underway. Use of MAXIMO has allowed streamlining of maintenance procedures. Training modules have been produced.

Scheduling: A number of procedures are used, based around a commercial package named CMS.

Data reporting: Most data entry is done by accessing input screens on a local computer. Trials of hand-held input devices have taken place but none were considered suitable for ‘intrinsically-safe’ operation. Some key data are transferred to SAP for management reports.

Validation: BP has a significant team working on procedures for data validation but no mention was made of outside organisations acting as auditors.

Concerns: Development is due to one or two key staff.

The latest version is state of the art but may be too modern for some field engineers.
Shell-Expro

Software: Shell-Expro originally used in-house software (IMIS) but then moved to SAP R/3, partly for Y2K compliance, making use of the PM and MM modules. Everything is run from a major computer centre in Holland. The software is used at a corporate level with global usage scheduled for 2005-6. Shell-Expro made use of business consultants to implement the system, but currently use Sigma³, a consortium of process contractors, for day-to-day operation. After the acquisition of Enterprise Oil, Logica was appointed to oversee implementation.

Scheduling: SAP is regarded as good for producing work orders and some types of report but is less effective for planning, for which a commercial package is used.

Data reporting: SAP is used to produce all necessary work orders. Results from field engineers are sent back to Sigma³ for manual input.

Validation: In-house procedures and validation methods have been produced by Sigma³. There are regular committee meetings with Shell staff to discuss problems and methods for continuous improvement.

Concerns: Recruitment and staff training are always issues. Although general reports from SAP are satisfactory historical trend reports are more difficult to produce.

Conoco/Brown & Root

Software: Conoco/Brown & Root originally used MAXIMO but moved to SAP R/2 as part of standardisation on one system. They are currently planning to upgrade to SAP R/3, but this has been delayed until the proposed merger with Phillips is clarified. Implementation and operation of the system is carried out by Brown & Root. During the implementation phase there were various problems, including incorrect transfer of tag IDs.

Scheduling: SAP is regarded as good for producing work orders but other activities make use of Excel and Access.

Data reporting: SAP is used to produce all the necessary work orders. Results from field engineers are sent back to Brown & Root for manual input.

Validation: A number of in-house procedures are used and DNV undertakes internal auditing.

Concerns: The MAXIMO software has some advantages not in SAP. The use of the system relies on good response/co-operation from the IT support area. SAP R/2 is relatively out-of-date and may have support problems.
BASF
(Major German chemical production company)

Software: BASF introduced SAP in 1995 (and currently use SAP/R3 version 4.6). However, despite this, and thorough investigation, BASF has not yet found a comprehensive software package which satisfies all its requirements for scheduling maintenance. Nearly all the individual plant use one or more different software packages for maintenance and operation.

Scheduling: Scheduling is done locally with the assistance of individual software packages which, depending on the plant, may be commercial packages or have been written for BASF.

Data Reporting: The local software packages interface with SAP and reporting is provided centrally through SAP.

Validation: An in-house team customises and maintains SAP. This team also interacts with the suppliers of the local software packages. No mention was made however of the use of external auditors.

Concerns: The developer or the supplier of this individual software usually does administration and maintenance for the software at the plants.

Customising and software development of the SAP system is still required when new software is installed locally on plants.
GUIDE FRAMEWORK

As noted in the Introduction, HSE had identified a lack of information on (and concerns regarding assurance of) the reliability of proprietary software used by offshore operators to schedule and manage maintenance and related functions in their safety-critical high-hazard environment. The primary objective of this work was therefore to establish the types and extent of potential and actual failures arising from the use of such software and other problems associated with the software, with the aim of providing HSE with a guide for use by its inspectors when auditing operators.

However, from subsequent discussions with HSE and those companies who took part in the case studies, it became clear that the Guide would be substantially more useful and acceptable to industry if it was prepared in conjunction with the operators and appropriate focus groups such as UKOOA. HSE would then consider the best mechanisms for the production and promulgation of such a guide.

The guide framework is given in Appendix 6. It is intended to provide a structure on which a road map can be drawn for the best practice in specifying, implementing and using management / scheduling software. This will enable experts in the industry to input their experience and knowledge, thus ensuring its industrial relevance and acceptance by all relevant parties. However, it will also ensure that the HSE inspectors and the industrial users are starting from a common understanding of the key issues.

From the case studies it became clear that although a range of software packages are in use, many of the potential issues identified by HSE are common to them all. Indeed many are often not software-based per se but relate to wider issues such as data integrity, confirmation that scheduled maintenance has been correctly carried out and general auditing procedures. This is reflected in the framework, which seeks to place the use of software into the overall operational context.
CONCLUSIONS & RECOMMENDATIONS

SAP is now the most widely used software in the maintenance area, with BP (and its associate companies) being the only exception amongst those companies covered by the case studies. However, whilst most companies have moved to SAP, this has been driven by business rather than engineering needs.

Although maintenance software is to be used across all of a company’s sites, the degree of system roll out and the location of the development centres varied markedly from company to company.

For those companies using SAP, the degree of customisation was limited by a lack of knowledge of SAP. Most companies used consultants for implementation and/or operation. The general perception was that SAP is good for producing work orders, purchasing items, general documentation and some summary reports, but poor for scheduling and producing more specific reports.

Although companies were happy to discuss their experiences with software and general working practices, further discussions and visits to see the operations and to speak to field engineers were required to obtain a more better end-user perspective. Even with this follow-up, it was considered that only an overview of the system (and thus any potential problems) was achieved. Most of the people interviewed were not the main contacts with HSE and the relation of the system to HSE inspection was not covered in detail.

There is a limited use of campaign maintenance, although some pilot studies have been initiated.

Most companies have well defined procedures for generating maintenance activities. When slippages occur, the degree of rectification is usually determined by the safety critical factor assigned to a task. These slippages are notified to HSE in terms of ‘deferment’.

Most companies using SAP thought that it has improved the planned maintenance activity, although there were no quantifiable benefits highlighted as yet.

Companies expressed similar general concerns (training, flexibility), but were reluctant to give examples of failure. The main issue highlighted in the discussions was the traditional one of errors in data transcription.

Whilst the exercise did not highlight problems suggesting specific actions, it was considered that there was sufficient material to justify a presentation to interested parties, including HSE Inspectors and UKOOA/STEP. There is a need for a coherent strategy to facilitate the use of software, particularly generalised packages such as SAP. It is therefore recommended that suitable presentations are made as required to the relevant parties. It is also recommended that the production of a User Guide be produced for the benefit of the industry. In preparation for this, a draft Guide Framework has been outlined in this report.
APPENDICES
<table>
<thead>
<tr>
<th>Q#</th>
<th>Statement or Question to Ask</th>
<th>Objectives / Back-up prompts</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Hello is that Mr/Dr/Ms [client's name] of [client company]?,</td>
<td>Establish that the contact details are correct. Get e-mail if possible.</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>My name is [questioner's name] and I’m calling from NEL. On behalf of HSE, we are carrying out a project to investigate the use of software packages in the management and scheduling of offshore engineering maintenance and to determine the level of any associated problems. Can I confirm that you are the most appropriate person to speak to or could you give me the name of someone more suitable? In either case we are only talking of a 15 minutes or so of your time.</td>
<td>Contact will have been identified through attendance at conference, via HSE input or by selective search of companies/organisations. Introduction about the purpose of the call. Keep short. Emphasise that the results will help to improve industrial practice. If it's not suitable ask for another scheduled date</td>
<td>If not a suitable time, then go to Q18 (table 2) question to re-arrange If not a suitable person try and establish alternative within company.</td>
</tr>
<tr>
<td>Q3</td>
<td>What is your position in the company?</td>
<td>Technical Engineer &lt;br&gt; Project leader &lt;br&gt; Department Manager &lt;br&gt; Information Technology Dept (IT) &lt;br&gt; Business Development / Sales &lt;br&gt; Other</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>Do you use software in the maintenance area?</td>
<td>If YES may be commercial or in-house development</td>
<td>If NO go to Q19 (table 3) for supplementary question</td>
</tr>
<tr>
<td>Q5</td>
<td>(If commercial) Which software package do you use?</td>
<td>SAP &lt;br&gt; MAXIMO &lt;br&gt; IFS &lt;br&gt; JD Edwards &lt;br&gt; EN Guard &lt;br&gt; Other</td>
<td>May be more than one in large company.</td>
</tr>
<tr>
<td>Q#</td>
<td>Statement or Question to Ask</td>
<td>Objectives / Back-up prompts</td>
<td>Comments</td>
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<tr>
<td>Q6</td>
<td>What is the main purpose of the software?</td>
<td>❑ Scheduling&lt;br&gt;❑ Resource planning&lt;br&gt;❑ Reliability information&lt;br&gt;❑ Condition monitoring&lt;br&gt;❑ Equipment inventory&lt;br&gt;❑ Competence of individuals&lt;br&gt;❑ All of these&lt;br&gt;❑ Other</td>
<td>Could be human factors e.g. scheduling, competence, training and/or equipment factors e.g. scheduling, methodology, inventory, reporting.</td>
</tr>
<tr>
<td>Q7</td>
<td>How does the software fit in with your overall maintenance procedures?</td>
<td>Scope&lt;br&gt;❑ Used everywhere&lt;br&gt;❑ Used in many areas&lt;br&gt;❑ Used in some areas&lt;br&gt;❑ Used in only one specific area&lt;br&gt;❑ Other</td>
<td></td>
</tr>
<tr>
<td>Q8</td>
<td>Does your company operate many sites? If so, how widespread is the use of the software?</td>
<td>Corporate usage&lt;br&gt;❑ All sites&lt;br&gt;❑ Some sites&lt;br&gt;❑ One specific site&lt;br&gt;❑ Different software on different sites</td>
<td>Possible follow-up question on whether the software could be used more widely</td>
</tr>
<tr>
<td>Q9</td>
<td>What problems, if any, have been encountered in the use of the software?</td>
<td>❑ Installation&lt;br&gt;❑ Usability&lt;br&gt;❑ Interfacing&lt;br&gt;❑ Validation&lt;br&gt;❑ Report production&lt;br&gt;❑ Training&lt;br&gt;❑ Upgrading&lt;br&gt;❑ Other</td>
<td></td>
</tr>
<tr>
<td>Q#</td>
<td>Statement or Question to Ask</td>
<td>Objectives / Back-up prompts</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Q10</td>
<td>What do you do with the results?</td>
<td>Distribution internally&lt;br&gt;Storage / backup&lt;br&gt;Analysis / feedback&lt;br&gt;Feedback to other organisations&lt;br&gt;Others</td>
<td></td>
</tr>
<tr>
<td>Q11</td>
<td>Scheduling problems: What do you do when the software schedules maintenance on an item but it is not carried out?</td>
<td>Ignore the item&lt;br&gt;Re-schedule later&lt;br&gt;Reorganise priorities&lt;br&gt;Other</td>
<td></td>
</tr>
<tr>
<td>Q12</td>
<td>Feedback: How easy is it to make use of any feedback that the software can generate?</td>
<td>Revise maintenance schedules&lt;br&gt;Look at condition monitoring&lt;br&gt;Other</td>
<td></td>
</tr>
<tr>
<td>Q13</td>
<td>Responsibility: Who is responsible for keeping the software up to date?</td>
<td>Oil company&lt;br&gt;Contractor&lt;br&gt;Other</td>
<td></td>
</tr>
<tr>
<td>Q14</td>
<td>Who does the maintenance?</td>
<td>Oil company staff&lt;br&gt;Equipment supplier&lt;br&gt;Maintenance contractor&lt;br&gt;Other</td>
<td></td>
</tr>
<tr>
<td>Q15</td>
<td>How does the software deal with safety critical item?</td>
<td>Does not differentiate items&lt;br&gt;Priority flag&lt;br&gt;Other</td>
<td></td>
</tr>
<tr>
<td>Q16</td>
<td>Are you, or one of your colleagues, willing to take part in a follow up exercise?</td>
<td>Telephone call&lt;br&gt;Visit&lt;br&gt;Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Q17</td>
<td>Thank you for your time and valuable comments.</td>
<td>Reassure contact that his participation is beneficial and the results may help improve safety issues in the future</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Wrong time for contact to speak

<table>
<thead>
<tr>
<th>Q18</th>
<th>When are you available to receive a call?</th>
<th>Record details of new appointment</th>
<th>Date: Time:</th>
</tr>
</thead>
</table>

Table 3: Do not use software for maintenance purposes

<table>
<thead>
<tr>
<th>Q19</th>
<th>If software is not currently used, is there any specific reason why not?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>❑ Never been tried</td>
</tr>
<tr>
<td></td>
<td>❑ Nothing suitable</td>
</tr>
<tr>
<td></td>
<td>❑ Too high a cost</td>
</tr>
<tr>
<td></td>
<td>❑ Too much training</td>
</tr>
<tr>
<td></td>
<td>❑ Other</td>
</tr>
</tbody>
</table>
Summary of investigation process

Q1. What is your position in the company?
Q2. What problems do you come across using the S/W?
Q3. What is your position in the company?
Q4. Do you use S/Ware for maintenance of equipment?
Q5. Is-S/Ware Commercial
Q6. Is-S/Ware Commercial
Q7. How does the S/Ware fit in with your overall Maintenance Procedures?
Q8. How widespread is the S/W within your company?
Q9. What do you do with the results?
Q10. What do you do with the results?
Q11. Scheduling Problems?
Q12. How easy is it to make use of any feedback of results from the software?
Q13. Which party is responsible for driving the maintenance from the S/Ware point of view?
Q14. Who carries out the maintenance?
Q15. How does the S/Ware deal with safety critical items?

What to Ask

Storage
Analyze/Feedback
Usability
Variability
Report/Protocols
Backup
Interfacing with other systems
Training
Upgrading
Installation
Scheduling
Resource Planning
Reliability Information
Cost/Demand Monitoring
Assembly
OIL COMPANY

The initial discussion was with a contact at the Philips Bacton site, although the follow-up case study was carried out at the Aberdeen office.

The first session confirmed the use of SAP as the main tool for maintenance activities, although there were a number of legacy systems in place. The company had now most of the way towards a standard system. Bacton took it lead from Aberdeen, which in turn followed a wider corporate structure.

At the Bacton site, most usage of the SAP software was for collation of results of equipment inspection. As the reporting capabilities of SAP were not good as standard (and customisation could not be undertaken locally), information was often transferred to spreadsheets. This had the potential for error in transcription. In addition errors may occur in transferring the data into SAP initially. Some difficulties had been encountered in putting the list of inspection items into SAP in the first instance.

PROCESS CONTRACTOR

Wood Group were contacted for their views on the maintenance process and the use of software. The main theme (as confirmed by discussions with other contractors) was that the contractors are a link in the chain and that use of software (or not) is totally driven by the requirements and specifications of their clients.

They had developed a general system in-house for most of the maintenance activities, but although this gave a degree of uniformity internally, it also meant that interfaces still needed to be created to their customers’ systems.

Their interaction with HSE varied according to their involvement with the client’s operation, which could range from a small component to the full servicing of a complete system.

A key problem that was highlighted concerned the degree of closure of the loop following a missed maintenance schedule or a failed component. Sometimes they would highlight the problem, but not be fully involved in its resolution.

SERVICE COMPANY

BJ Services carries out maintenance on small portable equipment used off-shore by bringing the equipment back to base for servicing. They are a medium sized company with about 700-800 people based in the UK.

They are not constrained to use any particular software for keeping maintenance schedules/records etc by any of the offshore operators. They only have to demonstrate their own system's effectiveness.

They use a Lotus Notes based system for maintenance records, which is an implementation of a paper-based system that the company has had for many years. The Lotus system handles Scheduling, Mobilisation of Equipment - including a pre-mobilisation stage, service history and plans for maintenance.
There are no feedback loops that enable maintenance results to be analysed in any detailed systematic way. They keep an archive of everything so that they can supply records of what has been done in the past.

On the whole the solution works well for them and they don't see any major problems using it. They did not know that SAP had a maintenance module but the company could not afford an expensive package anyway.

They were prepared to talk in more detail about the company's maintenance operations and would also be prepared to have someone from NEL visit.

PROFESSIONAL BODY

A contact was established in the sales and marketing department at IChemE. They do not use any software for plant maintenance but they do market and sell a training CD-ROM product which is a text-based package for self-assessment of risks and maintenance issues.

IChemE were chosen to see if they recommend any software for maintenance type activities for their Chemical Engineering membership. Answer is no, they do not recommend any software packages.

The CD-ROM training package works on methodologies and guidance with emphasis on case studies.

Paul Mercer was not aware of anyone else at IChemE who might be able to assist in this information gathering on maintenance software.

INDUSTRY GROUP

Initial telephone discussions and a follow-up visit were made to a key contact in the STEP Change in Safety team based within Shell Expro in Aberdeen.

This project was outlined and further discussions centred on the understanding of the role of STEP in terms of good industry practice. Although STEP were not asked any specific targeted questions, it was indicated that they would be happy to be kept aware of the project findings (subject to agreement from HSE).

SOFTWARE SUPPLIER

CREDOSOFT are a supplier of Inspection and Corrosion Management Software and have a number of major oil companies and service companies among their clients. The contact involved an initial telephone call and a brief follow-up visit.

This software is designed as a very flexible and easy-to-use program. It has links to a number of other packages ranging from office applications to SAP and MAXIMO. Many companies with CREDO will normally have one of the other packages in addition.
Phillips Petroleum (PP) has been involved in the use of software for asset inventory and maintenance planning for over 20 years. They usually act at a corporate level and around 2.5 years ago took the decision to move to SAP R/3. In addition to the general business requirements, one of the key drivers for this decision was the Y2K compliance offered by the product suite. PP took the main financial information modules and two modules related to maintenance (MM and PM). They have not yet taken up the Human Resources or Quality Management modules. The initial work was with release v3.2, but v4.6 was implemented in April 2001.

Their main experience with the product was the need to adapt to the SAP methodology rather than trying to adapt SAP to their existing practices. A minimum amount of customisation was undertaken, but this was primarily due to the lack of experience with the product. A management consultancy was used to assist with the implementation, but left at a fairly early stage.

The early experience indicated that SAP has obvious limitations, particularly in maintenance area. Nonetheless the company adjusted fairly quickly as the limitations were found and work-around were produced. The move to SAP was very abrupt, but the transition was quite smooth after the initial use. Only a limited amount of peer discussion was undertaken as PP considered themselves front-runners in this area.

The biggest issues for concern were the basic understanding of the SAP product, particularly with respect to the maintenance modules, and the training of staff. Generic training information is available, but not very meaningful as most implementations need customisation. The financial module of SAP is the most widely used and therefore it is both easier to understand and there are more qualified people around to provide training.

With respect to the maintenance activities, the use of SAP for planning and scheduling was relatively poor and extensive use is still made of Microsoft Project. In addition, SAP has limited and not easily customised reporting capability, and the transfer of data between modules was not as good as it should have been. The issue of a new SAP module named Business Warehouse (BW) improved the interaction and data transfer between modules, although there are still many areas within the maintenance activity where the use of a flat file is the only practical method of data transfer.

The company has rationalised the agreement on maintenance work practices ('codes') at a company-wide level. A general world-wide agreed customisation of the maintenance modules would be preferable, but in practice these are site specific. In both the development and continued use of the modules, a large number of validity tests are undertaken. The responsibility for SAP development, including the maintenance modules, is given by US (Head
Office), Norway (European Office), Woking (UK office) and hence the approval and implementation of customisations can be a lengthy procedure.

The main strength of SAP is in the detailed work orders for the maintenance engineers. For planned maintenance the orders are printed off and sent manually. For campaign maintenance the system is used as required. This is deemed to be a successful policy provided it is non-intrusive. The maintenance priority is given by a criticality rating.

For asset integrity of pipe work and pressure vessels (overall responsibility of DR), PP have used a number of systems (see initial contact report by A Johns). The current product is a commercial package named CREDO. The inspection orders and subsequent results are transferred to and from the rig engineers using hand-held devices. They are currently in the process of integrating the information from this package with SAP, but this has caused some problems. In addition many of the specialist features of CREDO are not easily duplicated in SAP.

Before SAP, general maintenance activities were initially paper-based, followed by use of a commercial package named PASSPORT. The introduction of SAP has improved some areas – it was noted that the documentation associated with maintenance items (‘tags’) can be accessed more easily through SAP.

Despite some limitations, the introduction of SAP has improved the information flow for management. Monthly reports are produced for business analysis and compliance reports for performance targets are created and reported, particularly for safety-critical items. The above issues have been much improved with the use of the Business Warehouse module.

The production of maintenance schedules for equipment is a major exercise and brings in information from a number of sources ranging from manufacturers recommendations to safety critical usage. Overall the Operational Criticality Assessment System is used (OCAS). As with most operators, PP has large parts of the maintenance activity contracted-out, but they transfer the data to the SAP system.

As part of the ongoing validation exercise, PP uses DNV to oversee and vet the operation of their maintenance activity. This gives an independent review in advance of HSE visits.

In summary, PP concludes that the initial transfer to SAP was not painless, but the lessons have been learned and on balance the system is now better, and has been significantly improved with the SAP BW module. Recruitment and training of staff is a problem, more so since the maintenance modules of SAP are not as widely used as the financial modules. Most other problems occur with data transfer and whilst the production of work orders is straightforward, effective scheduling is more difficult. The situation will be further improved with the complete integration of the CREDO package with SAP.
BP has a very structured approach to maintenance activities and has generally used specialist packages for this purpose. The original software was En-Guard, but in 1996 a decision was made to update the system. A short-list of 8 packages was considered, but the final decision was MAXIMO, which is considered the market leader in this area. SAP was a strong contender, as BP already uses the financial and other modules, but it was concluded that too many changes would be required to convert from the existing system.

Since that time BP has bought or entered into technology partnerships with Amoco, Arco and Castrol. Fortunately these companies are all users of MAXIMO. The initial implementation of MAXIMO was v3.2, but the company has now moved to v4.01 (a client-server version) and intends to upgrade to v5 (internet/intranet version) by the end of 2002.

A big advantage of the BP operation is that all the development of MAXIMO is undertaken at one office in Aberdeen. The system is now running very smoothly and when the MAXIMO system has been proven in Aberdeen, it can be rolled out to sites very quickly. However when BP acquired Amoco and Arco, the urgency to convert these companies to the BP standards meant the implementation of the maintenance module in this case was quick but somewhat unstructured.

Since then there has been a complete rationalisation of the working procedures. Previously there had been 12 different En-Guard systems for different processes, but this has been much reduced with MAXIMO. Additionally a review was made of the working procedures and 64 ‘codes’ were reduced to 4. Following the rationalisation, many workshops were held to explain and to an extent ‘sell’ the new system. In practice all upstream areas now use MAXIMO exclusively, but some downstream operations use SAP directly.

MAXIMO is a comprehensive product, but BP has built up the expertise in Aberdeen. To support its use, training modules, implementation packages and comprehensive validation exercises have been developed. In Aberdeen a team of 8 is devoted to validation of the procedures. In addition, much effort has been expended in careful design of the GUI screens, which make the system easy-to-use for the operators. The move to v5 with its web access should allow further improvements for the end-users, for example the provision of additional training modules accessible via web pages.

In general, the Aberdeen development team considers the current way of working productive and providing a flexible system, although it was conceded that some workers out in the field might have different views. A clearly defined methodology has now been implemented for planning, approval, validation, supply, execution and reporting of maintenance activities. Feedback from the process is to improve and extend the methodology wherever possible.
The system is used world-wide and hence has a large database. In the En-Guard package, 900,000 equipment tags were used. The move to MAXIMO has allowed a degree of rationalisation (e.g. the removal of obsolete equipment), but the new system has over 150,000 tags and this number is rising fast. The master database and associated functions provide a method to get access to any data on any site.

Maintenance planning is based on many factors, but is facilitated with a software package called CMS (Common Maintenance Strategy). This also provides the basis for a hierarchical method for safety critical items to be used with the MAXIMO system. For maintenance incidents related to safety critical data, BP uses the OREIDA database, which is a common repository of such information supported by 9 major oil companies, but primarily driven by BP and Shell.

The MAXIMO system (as implemented within BP) requires every user, including contractors, to be uniquely identified (with user name/password). This is slightly different to the EN-GUARD system where a user could be the ‘job’ or the ‘site’. The BP system currently has over 4000 registered users. Maintenance engineers usually access the system by entering data into input screens on a local computer. Trials of hand-held devices for direct information transfer have been carried out, but none have been though suitable for intrinsically safe operation. Although individual users access the system, MAXIMO allows activities to be signed off at various jobs or sub-job levels.

The operation requires a number of system administrators at key sites. The rationalisations introduced in the changeover to MAXIMO have allowed these roles to be reduced in number from 36 to 8. This is significant with regard to recruitment and training. The skill levels for competence in MAXIMO v4 are reasonably available in the marketplace, but less so with the introduction of v5.

The flexibility of the MAXIMO system makes the development of user interfaces straightforward, but the downside is that there can be many requests for changes. The tracking of the developments needs to be well documented and BP has used two other software tools, Clear case for code development and documentum for document control, although it was noted that improvements could be made in BP’s use of the latter product. Workshops are held to rationalise the developments according to need and frequency of occurrence.

Although the policy has varied over the years, BP is now making increasing use of external contractors. These contractors must use the BP system, i.e. they are registered as users within the BP system, not simply using their own version of MAXIMO. This has been a significant decision; there have been problems with data transfer in the past, even when the same software has been used.

MAXIMO is used wherever possible within the maintenance activities, but there are necessary interactions with SAP, which is used for financial information and purchasing. BP use external contractors to run SAP on their behalf and this approach may be extended to other packages in future, possibly including MAXIMO. It was acknowledged that the current smooth operation of the package across BP was due to the endeavours of one or two key personnel and there would be possible problems if these individuals moved on.

It was claimed that HSE inspections are very happy with this type of commercial product, which is designed specifically for maintenance. The reporting capabilities are very good and the audit trails well understood.
The system has also been well received by operational staff and management. In particular, the system can provide general figures for management review in addition to maintenance reports. The v5 upgrade will also allow these reports to be accessible world-wide over the Internet. BP is keen to pursue new developments and is currently working with Robert Gordon’s Institute of Technology on a project for improved maintenance strategies.
BASF is a world leading chemical company. BASF offers its customers a range of high-performance products, including chemicals, plastics, coatings systems, dispersions, agricultural products and fine chemicals.

BASF has a significant number of plants based in the city of Ludwigsburg. Each plant is different, with often very specific properties. For this reason each plant has its own demands for maintenance and operation. Despite thorough investigation, BASF has not yet found a comprehensive software package which satisfies all its requirements. Nearly all the individual plant use one or more different software packages for maintenance and operation and, due to the organisation of BASF, each plant has its own team which is responsible for operation and maintenance. As a result, scheduling of maintenance (including safety critical items) is also done locally with the assistance of individual software packages. Depending on the individual plant the software may be a commercial product or have been developed by BASF.

For risk minimisation and disaster prevention, in the eighties BASF installed central risk management and central condition monitoring teams. These two teams collect information about maintenance activities and their results, operational data and failure statistics. With this information they determine the safety status of the plants and perform the risk management for the entire site. They deliver regular reports to the management board of BASF.

Prior to 1995 the software used by these two teams had been developed by BASF. In 1995 however SAP was introduced. It was the first commonly installed software system at BASF. For this reason the risk management and condition monitoring teams also migrated to SAP.

Today BASF uses nearly all modules of SAP/R3 (MM, PM, HR, QM, …). The currently installed version is 4.6. There are about 70,000 users (nearly every employee of BASF) and SAP became one of the most important information and business controlling systems within BASF. It is used in all parts of the company and therefore represents a comprehensive data source.

For the purposes of the risk management and condition monitoring teams every plant has to deliver a detailed, defined set of data regarding maintenance, failures and operation into the SAP system. Usually this is done by interfaces between the locally used software and SAP. These data together with the information derived from other units of the company (eg material management, quality management, …) enable effective analysis and reporting to be performed.

Introducing SAP inevitably involved the usual problems inherent in implementing an information system, including basic understanding of the product and training of staff. With respect to the risk management and condition monitoring teams most of the problems arose from the interfaces between the locally installed software at the plants and SAP. A lot of customising and software development had to be done (and has to be done if new software is introduced locally) to obtain smooth co-operation between plant software and SAP.
Additionally, SAP has a limited reporting capability and most of the required analysis functionality is missing. This was also solved by customising SAP and purchasing a few external tools.

All administration, customising and maintenance for SAP at BASF are done by an internal team of specialists. This team co-ordinates and mostly performs all customising and software development in and around SAP. Configuring and developing the interfaces between SAP and the locally installed software at the plant is done in co-operation between this team and the developer of the plant software.

Administration and maintenance for the locally installed software at the plants is usually done by the developer or the supplier of this individual software.

The risk management and condition monitoring teams are pleased with the resultant solution. The system runs properly and all their requirements are met. Missing functionality in SAP can be covered by customising or using external analysis tools which interact well with the SAP data. From the view of the risk management and condition monitoring teams, the biggest advantage of the introduction of SAP for them and of course for BASF as a whole is the mutual and comprehensive database they obtained with it.
This meeting was arranged to obtain analytical views of the software users in maintenance scheduling applications. The meeting was held at Shell-Expro, Aberdeen, with Jim Ross and Diane McGraw.

Jim Ross is a SAP PM (Plant Maintenance) consultant within Shell-Expro in Aberdeen. Diane McGraw is a team leader for the business processes. She is a consultant working for Sigma³, which is a consortium consisting of Amec, Haliburton and Wood Group.

Implementation of SAP/R3 at Shell-Expro happened as part of Y2K remedial actions in 1999. Prior to that they used a text based Integrated Maintenance Information System (IMIS), which was a bespoke in-house development. This system worked quite well and new features could be added with relative ease.

The current SAP system runs from one single source in Holland, the IBM Megacentre, via satellite links. The Megacentre is responsible for hardware, software, disaster recovery, kernel, upgrades and system modifications. The timetable to move everyone onto one ‘Blueprint’ is 2005-2006. Shell recently acquired Enterprise Oil and has hired Logica to do the implementation. Three ABAP programmers are also working for Enterprise Oil.

Over a period of a few years Anderson Consulting, Pricewaterhouse-Coopers and Acceture have been used for various phases of the implementation.

Comparing SAP and IMIS:

<table>
<thead>
<tr>
<th>IMIS</th>
<th>SAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>In late 80s, hardware was slow</td>
<td>Initial transition was terrific.</td>
</tr>
<tr>
<td>Loading was slow</td>
<td>As they got to understand the details</td>
</tr>
<tr>
<td>People did not often have the right</td>
<td>some difficulties began to surface, such</td>
</tr>
<tr>
<td>background</td>
<td>as ease of modification, necessity of</td>
</tr>
<tr>
<td>It was easily modifiable.</td>
<td>constant use of the system to remember</td>
</tr>
<tr>
<td></td>
<td>the details, ease of use, etc</td>
</tr>
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</table>

Shell have now set up MMS Committee, which meets twice a month (consisting of Diane, Jim Ross, plant people and engineering staff) who discuss issues, try to continuously improve and highlight issues arising from users.

Maintenance using SAP/R3 is a priority based system, compliance dependant on criticality (rated from 1 to 5), good for work orders and reports, but possibly not so good on scheduling. It produces work orders which are then fed to Primavera P3. There is a limited use of campaign based maintenance.
SAP groups information of similar type together.

IMIS only showed current job but not subsequent jobs, whereas with SAP it shows current and future jobs. It provides a good print but history reports need to be improved.

Other points noted were:

- Maintenance is generally planned. Shell still uses a frequency-based method, using some predictive maintenance.

- Backup is kept in Holland.

- If there is slippage in maintenance of Safety Critical items, it has to be notified to HSE.

- SAP usage is good for work orders and reports, but not so good for scheduling. SAP output is fed into Primavera.

- Although Shell feel that the implementation of SAP has been beneficial for their maintenance regime, this is a subjective judgement as no hard figures are available to quantify the benefits.

- Training and re-training is always a difficulty.

- Interaction with HSE is mainly done by a designated safety person. This contact will be beneficial if we chose to do a more detailed case study as a next phase.
This meeting was arranged to get the end user perspective of software packages such as SAP/R2, SAP/R3 and other similar products.

Initial contact was established with Miss Ilona Thompson, who is the SAP project co-ordinator at Conoco. She felt that it would be more beneficial to discuss the issues with the SAP implementation team, who in this case are from Haliburton Brown and Root.

Conoco had previously used MAXIMO. They found that MAXIMO used terminologies which were in line with their engineering background. This was very suitable for the user community.

Conoco is currently using SAP/R2. They had plans to move on to SAP/R3 in January 2002 but this may be delayed due to the planned merger issues with Phillips.

SAP/R2 implementation and maintenance is undertaken by Haliburton Brown and Root. They use SAP/R2 for maintenance scheduling and the output is fed into Excel or Access. A number of problems occurred during the implementation phase. Operations people who generally deal with IT operations were expected to work with offshore team (Haliburton Brown and Root) but they did not want offshore people to have anything to do with software.

The SAP/R2 system covers the asset register, work orders, tracks costs and progress etc. The asset register consists of around 100,000 tags, which were not initially entered correctly.

The Internal audit programme is undertaken by ICP (Independent Competent Person). This person is currently employed from DNV. The two people who mainly deal with HSE inspectors are Dave Neil or Mike Spalding.

Other points raised:

- The team have started using Campaign Maintenance, which currently is a pilot project.

- The Conoco team have visited the Shell implementation team and are very impressed by their approach and progress.

- Conoco currently does not do much condition monitoring.

- Conoco uses the Scanned PYE Maintenance system, with the following model: PYE system would progress to distributed control system (DCS) to SAP.

- The quality system is based on ISO9001.
Introduction

This meeting was arranged to follow up the meeting held at Shell-Expro on 23 July 2002. The meeting was held at Shell-Expro, Aberdeen, in two parts. In the first part, with Jim Ross and Diane Thompson (nee McGraw), several of the issues raised in the first meeting were examined in more depth, from their perspective in the development and implementation of the SAP PM system. The second part of the meeting was with Roddy Evans, examining the system from a user perspective.

Team’s aims for the meeting were –

- To have Shell demonstrate the SAP PM system
  - add a unit to the system
  - generate a maintenance schedule
    - generation of work orders, tracking
- discuss data transfer issues
- obtain an example of where something had gone wrong
- discuss ‘closing the loop’
  - what happens when a schedule is missed
- interactions with HSE
  - requirement for safety-critical items
    - mechanism
    - frequency
- performance of HSE inspectors
- validation
  - test procedures
  - simulations

and almost all the points were covered during the meeting.

Background

Diane Thompson is responsible for the business aspects of SAP for the Northern Area (covering 16 installations) and Jim Ross is responsible for the interface between SAP and the engineering aspects. Shell’s policy is to try and maintain the SAP program in as standard a form as possible, with no customisation. The only changes made are via the SAP-supplied ‘user exits’ which allow users to add functionality, without altering the core. The only other modifications are the production of customised reports. Configuration changes are only made by Jim Ross and one assistant. Development, acceptance and production versions of the software sit on three separate computer systems.
Requests for changes are filtered through the Maintenance Management Meetings, a user forum which meets every two months. This group is chaired by Jim Ross and consists of 8 – 9 ‘super-users’ who gather information from the rest of the users. Once a request has been discussed and approved by the MMM it is implemented by Jim Ross.

Sigma3 supply offshore maintenance for 15 installations. Some of this work is carried out by Shell, the rest by the other three companies in the consortium (Amec, Haliburton and Wood Group). In addition, some other services (such as health care) are provided by third-party contractors.

Roddy Evans interacts with the SAP PM system in his role as the engineering and maintenance support manager. Although formal communications with HSE are through the Asset Manager all technical communications are through Roddy and his team.

1.0  SAP Demonstration

Diane Thompson demonstrated the SAP PM system, including adding an item and the generation of work orders. She also supplied a flowsheet summarising the operation of the system and examples of work orders (shop pages).

Work orders are scheduled by SAP. This function runs every Saturday and provides a 35-day forward look. Once the work order is generated the ownership of it transfers offshore. The job is done, signed off offshore and an email confirmation sent onshore. The paper copy follows, with the detailed history, which is then entered into SAP. The confirmation email uses a standard spreadsheet to ‘sign off’ the work each day, with the maintenance planner group number returned as a cross-check. This should provide a degree of data integrity since it should prevent an item on one asset (production platform etc) being mis-assigned. However, only limited auditing of the returned work orders and histories is carried out – it is essentially taken on trust that the work requested has actually been carried out. In recognition of this weakness, Shell are introducing a ‘self-audit’ system on the work orders – this is currently being implemented and draft copies of the revised paperwork were shown.

All routine text for procedures etc is tightly controlled by a limited number of SAP users, to ensure consistency across all assets when work orders are generated.

Work is normally scheduled to be completed within a time window. The duration of the window is a function of the amount of work to be undertaken, since items are grouped together. For safety-critical items, if the work cannot be completed within the scheduled time window, offshore must raise a request for deferment. This is passed back onshore for approval and, if approved, the work is rescheduled. A deferment request must be accompanied by a risk assessment detailing the consequences of the item failing. Rescheduling would not normally affect the next scheduled maintenance for that item, unless it pushed it to a shut-down period.

2.0  Data Transfer

There are currently ~750,000 items in the SAP PM system, grouped in to 50,000 functional hierarchies. Data were migrated from the previous system (IMIS) via ‘cleansing’ databases, to remove duplicate entries and allow restructuring. All items in the new system were checked against the IMIS originals, both in terms of item accuracy and allocation to the correct hierarchy.
Despite this checking process, it was believed that some data may have been lost in the transfer process. To address this concern, additional checks have been implemented via routine and technical integrity audits. The structure and operational strategies of the two systems are different and it is likely that there were data inconsistencies in the IMIS system which was not totally resolved during the transfer process. In addition, since this was done via the cleansing databases, this would bypass any front-end integrity checks in SAP, relying on those specified for the transfer process. To date, no major problems have been encountered and the additional checks should help to improve the quality of the data recorded for each item.

3.0 Examples of Problems

Neither the SAP developer side nor the users could identify an example of a problem caused by the SAP system in the generation of work orders and tracking of jobs. The main problem with the SAP PM system related to the initial structure of the SAP PM databases, arising from design decisions about grouping of items. This resulted in the generation of very large work plans, since these reflect the hierarchies. Furthermore, SAP introduced new rules for calculating compliance with scheduled work and the reporting procedures changed. This lead to a perception that critical maintenance was being missed under the new system. However, the problem was not SAP per se but its particular implementation. Implementation of the same algorithm used in the IMIS system demonstrated that there had been no deterioration in performance.

The only other ‘problem’ mentioned was that the data validation provisions within SAP were felt to be inadequate and, to overcome this, data are pre-processed by EDS before being fed to the SAP PM system.

4.0 Closing the Loop

Roddy Evans explained how planned maintenance fits within the overall structure. For each asset a safety case is developed by the team (Shell / Sigma3 / contractors) and performance standards are derived from it. A strategy is developed and detailed plans derived, for both routine and non-routine maintenance. For safety-critical items a prioritised (risk-based) approach is used. Maintenance is carried out to the plans and the results analysed, to monitor performance. The results from the analysis and monitoring exercise feed back in to the development of the strategy and may result in proposals to change equipment and procedures. Proposed changes which would affect safety-critical items must be assessed by both the technical authority as well as the reliability engineer.

Data from the analysis and monitoring exercise are taken up on a monthly basis through key performance indicators (KPIs), to flag up high level issues across the asset base. In addition, these data form part of the annual management review. Missed maintenance on safety-critical items is picked up by the KPIs.

Technical integrity audits (TIAs) are carried out for all key elements including checks that all the necessary items are included in the maintenance schedules. The internal auditing process ensures that the TIAs are carried out. In addition, a new project is in place to improve feedback between the performance standards requirements and the shop pages (PSAP).

5.0 Interactions with HSE
HSE inspectors are in about once every two weeks, on some asset or other, spending time both on and off-shore. As noted above, formal communications are from HSE to Shell’s Asset Manager. This provides a single point of contact within Shell – previously there were cases where company-wide follow-up actions requested by HSE were missed because they had gone directly to operations level staff.

As noted above, the planned maintenance strategy is derived from the overall safety case for each asset, with safety-critical items being assessed on a risk-based approach. HSE have access to the overall safety case (confirm) and hence can check that scheduled maintenance has been carried out on safety-critical items. In addition, they can check the risk assessments carried out in the case of deferment requests.

6.0 Performance of HSE Inspectors

The performance of the HSE inspectors was satisfactory, both in terms of their direct interactions with Shell during visits and in the feedback provided afterwards.

7.0 Validation

Shell’s interpretation of validation centres on the integrity of the data in the SAP PM databases and considerable effort has been put in to ensuring that the data transferred from the IMIS system was valid. Further checks (the new self-auditing procedure, the TIAs and the PSAP project) are all aimed at improving the quality of data in the databases. As noted previously, modifications to the SAP PM system (including changes to the text of procedures) is tightly controlled and individual modifications tested on the acceptance system before release to the production system. However, there did not appear to be any systematic overall test procedures or simulations carried out.
1.0 Background

John Morrison is the principal maintenance systems advisor in the Upstream Technology Group of BP based in Aberdeen (Dyce). An earlier visit to this contact was made by Alan Scott in April 2002 when it was established that BP were amenable to taking part in the project as a case study.

The purpose of this follow-up visit was to have a closer look at the company's maintenance software in action. BP have been undertaking a new initiative using the MAXIMO software package (this has been tagged the iMAX project – 'Implementing MAXIMO') which has the overall objective of integrating both the company's asset maintenance and its customer supply chain operations under one global electronic system. BP's old asset maintenance software (EN GUARD) is no longer supported and has become obsolete. After a thorough review of the requirements for a new system, the company choose the MAXIMO package. Currently the iMAX project is in the final implementation stage where early adopters of the MAXIMO v5.1 package will be asked to use it and provide the implementation team with concentrated feedback before the rollout to wider audience in the second quarter of 2003. The original deployment date was earlier than this, but some last minute stability problems have had to be overcome.

The software makes use of web-based technology and will be available for all company users and importantly for all contractors. It requires a unique Identifier and Password for every user to gain access and assigns permission levels for each user. The main objectives are seen as:

1. Provision of a common tool for management of maintenance strategy company-wide.
2. A comprehensive database of maintenance assets
3. A mechanism to manage the supply chain and purchasing functions.

The system has an ambitious target of capturing 100 per cent of the company's spend on asset maintenance and supply chain purchasing (currently they manage only about 20 per cent of spend within the extant system).

The system supports a flexible reporting sub-system (Business Objects) which enables analysis of the underlying data to be carried out very easily for both management and technical purposes.
2.0 The iMAX System

2.1 Process map

The complete procedures within the system have been ingeniously represented as a visual ‘process map’ which shows the flow of data and operations for both asset maintenance and supply chain management through MAXIMO. It shows very clearly where other software systems used by BP interface with the project, and the maintenance web-site enables a user to navigate around and zoom in on any area of the process map.

Each work order for maintenance has associated with it a status flag which shows what state an individual request is in. A good deal of forethought has gone into assigning these states and the work flow, resulting in a coherent, easy to understand, system.

The work order will also link into parts ordering and warehousing stock level software systems where this is relevant.

2.2 System inputs

There are two basic types of work order: a routine scheduled maintenance order and a non-scheduled work order (emergency).

Every work order has a category which indicates whether or not it is a safety critical item.

The input screens make use of pre-defined lists of acceptable designations for input. For example the reason for instigating a repair on a pump will be categorised so that it is easier to group maintenance tasks and compare outcomes. Behind each of the short ‘categorised’ text field is a facility for entering more detail if required.

The input screens make extensive use of colour to indicate which input fields are mandatory for a given task (shading of background in the input box). Also, a long description, when activated, causes an associated marker icon to turn red.

The screens are also sized such that they appear on a standard size computer visual display unit without any scroll bars. This means that all key fields are visible at all times when the screen is being worked on.

Because the system is web-based and has specific user identification and passwording, it is possible for an individual operator to query the work scheduled and also enter the details of work carried out directly into the system at the maintenance point (e.g. off-shore on a platform). This reduces the necessity for paper documentation as the system will keep track of who has done what, and when for each work order. Although aiming to have paperless system, the software also allows for printed work order documentation to be supplied, where this is required to support existing systems.

2.3 System outputs

One of the key pre-cursors of the iMAX project was the activity which set out a complete Statement of Requirements for the system before deciding on which specific software package to use. Two important outputs were identified: [1] an interface to Microsoft’s Project software package for the scheduling and planning of work orders that have been raised in the iMAX
system, and [2] to provide a flexible reporting tool which would deliver both technical based and business orientated reports which could be carried out in real-time as required.

Both of these objectives have been met with iMAX. It is possible for a user to create customised reports using the ‘Business Object’ reporting tool on any of the visible fields within the underlying ORACLE databases that iMAX uses.

The interface to Microsoft Project gives the facility to populate a project plan with work orders in various states. (All work orders have a status flag which shows their current state within the system). Scheduling these can be carried out within project.

2.4 Audit trail

Users are assigned permissions to sign off various key actions within the system. The number and type of these permissions vary according to the user’s role and level of authority.

The concept of work order status is used to track the progress of a work order through the system, from initiation, awaiting approval, approved, deferred, in progress, completed and closed.

The system allows for cancellation of a work order at various stages and also for deferment. Items which have been requested for cancellation or deferral must obtain the appropriate approval before progressing.

2.5 Operator training

A great deal of thought has been put into how to train the 4000 plus users of the new system. A separate project was instigated to provide electronic learning. Here, potential users work their way through a web-based learning package which goes through the iMAX system in a structured way. At the end of each module, there is a competency test which the user must take. Only when: [a], all relevant modules have been completed and [b], their associated competency tests have been passed, does a user get issued with an individual user identifier and password. Users also have a real person they can contact (help-line ‘coach’) who is available 24 hours a day on the end of a telephone to assist with the e-learning programme and any follow-on issues with using the system.

2.6 Data migration from legacy system

Each business group has been given the task of asset database clean-up for their own area prior to porting this data over to iMAX. Most of this work has been done and the new system has over 900,000 tags with 1.5 million plus history records.

2.7 Other issues

Organisational cut-backs have reduced the number of planners available per offshore platform (previously there were 6 planners per platform; 5 offshore and 1 onshore). The distributed nature of system makes it possible for various staff to perform planning operations and this raises the requirement for such staff to be adequately trained to do this.
APPENDIX 5  REVIEW OF SOFTWARE (TASK 3)
**Review of software**

As maintenance links production and plant equipment procurement and purchasing, all enterprise business systems are becoming increasingly interoperable. Asset maintenance isn’t simply concerned with historical accounting, but with what’s happening now and what is about to happen.

Plant maintenance software:

- Captures and analyses data for condition monitoring, generates work orders and related material reservations based on equipment condition, elapsed time or Plant Maintenance (PM) schedules
- Enables time and resource constrained critical path scheduling for any project, including all work breakdown structures dependencies. Also has extended workflow functionality including financial approval, safety, safety, hazards, permitting, and settlement review processes
- Connects maintenance and production through ready made integration with leading process automation systems
- Includes life cycle data management, containing holistic view of the life cycle, managing documents, keeping track and exception reporting

The main attributes of the software cover item data, planning data, task list data and the location.

In the cases of system modification the following issues need attention:

**Management issues**

- Allocation of responsibilities
- Development of procedures to back up the quality system
- Implement change control, version control, security procedures and enterprise wide methodologies
- Auditing-internal/external
- Data migration – documentation procedures and allocation of personnel
- Paper based (key-in errors)
- Software based-well defined formation and validation
- Data transfer what/how/by whom
- Data integrity checks
- Cleansing of data/data validation

Software issues to consider could be grouped in the following categories
**Data Input Aspects**

*Procedures*

- Manual/automatic backed up by proforma design. Should be simple and unambiguous
- Data transfer protocols
- Authentication / checking / verification and validation procedures
- Identification and handling data transmission errors

*Input requirements*

- Asset list
- Addition / removal procedures
- Standard text-addition / updates

**Data Output issues**

*Data output options*

- Integrated with other software parts
- Data output formats
- Post-processing, if any

*Output requirements*

- Scheduling
- Generation of work orders / task sheets
- Generation of work procedures
- Reporting(normal)
- Reporting-exceptional which might generate deferment order, if safety critical
- Analysis / post mortem

**Hardware Issues**

- Physical security of the computing and control equipment
- Software security- data and cyber crime
- Backup issues with built-in redundancy
- Server security through having compartmentalised parts for operation/ development/ testing
- Encryption
- Speed and Security of data transmission

**Other issues**

- Feedback mechanisms-internal & external
- Handling of modification- text & data
- Change management
TOP-LEVEL

- Why use software?
  - advantages
  - disadvantages

- Where will / does the software fit within the overall maintenance scheme
  - how are schedules derived
    - safety case -> performance criteria -> strategy -> detailed plans etc
  - interfaces to other software
    - business information systems
    - other specialist packages
    - supply chain

- How does maintenance fit within the overall business structure
  - reporting structures
  - auditing procedures

SPECIFICATION

- Follows from top level review
  - clear statement of purpose including fit within overall business structures

- Scope of coverage
  - asset based / organisation-wide / including supply chain
    - full cycle – database, generation of work orders, tracking of work, confirmation of completion
  - analysis capabilities
  - handling slippages / exceptions
  - reporting

SOFTWARE ISSUES

- Security
  - access control for normal use
  - access control for modifications
  - database integrity
  - modification testing / version control

- Database structures
  - follow from top level review and scope of coverage
    - degree of data aggregation

- Migrating data from existing system
  - how well is the existing system documented / understood
    - specification of what data are to be transferred
    - specification of how data are to be transferred
    - specification of data integrity checks
  - cleaning up / consolidating data before / during transfer
    - validity of existing data
    - relationship to current business structure

55
• Data input options
  ✦ manual
    - form design – clarity / ease of use
    - checking / validation procedures
  ✦ automatic
    - physical interfaces
    - data transfer protocols
    - checking / validation procedures
    - handling data transmission errors

• Input requirements
  ✦ assets / items
    - addition / updating / removal of items
  ✦ work procedures
    - addition / updating / removal of procedures
  ✦ standard texts
    - addition / updating / removal of texts for work orders etc
  ✦ deferment requests
  ✦ work completion reports

• Data output options
  ✦ integrated within main software package
    - ease of customisation
    - control of custom forms / reports etc
  ✦ output and post-processing in additional packages
    - data output formats
    - control of post-processing

• Output requirements
  ✦ work scheduling
    - generation of work orders / task sheets
    - generation of work procedures
  ✦ reporting / analysis
    - routine reporting – performance indicators etc
    - exceptions

HARDWARE ISSUES
• Security
  ✦ physical security of servers
  ✦ redundancy / backup arrangements
  ✦ separate development / testing / operation servers
  ✦ data transmission
    - encryption

• Data transmission
  ✦ bandwidth
  ✦ security

• Interfaces
  ✦ bar-code readers / hand-held devices for item identification
supply chain interfaces

IMPLEMENTATION
- In-house or outsourced
  - in-house
    - resource availability
    - local knowledge
  - outsourced
    - lack of local knowledge
    - management issues

- Migration from existing system
  - paper-based
    - huge data keying exercise
    - well-designed input forms essential
    - robust data validation routines essential
  - software-based
    - use defined validation routines rather than direct database transfers

- Overlap operation
  - ensure new system delivers everything as specified
  - feedback
    - modify forms / reports etc as required

USE
- Normal operation

- Handling exceptions

- Feedback mechanisms
  - local
    - minor modifications to work instructions, procedures etc

- Auditing
  - in-house
  - external

- Continuous improvement
  - input to business processes
  - response to business changes
APPENDIX 7  SAP MAINTENANCE EXAMPLES
Management System

Document Approval Record

Process: Engineering & Maintenance Support
Document Title: PMR Change Request Guidelines
Document No: EMS-GN-701
Revision: A1
Attachments:

Approved on behalf of SIGMA 3 (North Sea) Ltd.

<table>
<thead>
<tr>
<th>Date</th>
<th>Approvals</th>
<th>Name</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/10/02</td>
<td>Process Owner</td>
<td>D. Curry</td>
<td></td>
</tr>
<tr>
<td>07/10/02</td>
<td>Quality</td>
<td>C. Hepworth</td>
<td></td>
</tr>
</tbody>
</table>
CONTENTS

1.0 RAISE SAP NOTIFICATION ................................................. 3
2.0 MINOR CHANGE .......................................................... 3
3.0 MAJOR CHANGE (Maintenance Strategy Update EMS-FC-704) ...... 4
1.0 RAISE SAP NOTIFICATION

Create a Maintenance Request (M1) Notification, entering the following information in SAP:

- A short description of the data change being requested
- Ensure Planner Group is changed to the relevant onshore support code i.e. CXX for Central and GCG, NXX for Northern and BXX for Brent.
- A priority code, usually 3 (Normal)
- Either the Equipment Number or the correct Functional location of the Routine Work Order requiring change
- In the Long text of the Description, thorough details of the change should be entered together with the justification for the change being requested.

2.0 MINOR CHANGE

Minor changes are authorised by the Asset Nominated Authority.

Minor changes include:

No impacts on Safety Critical Elements under Verification / Examination Scheme, Integrity, Safety or Environment

Changes to:

- Title
- System Condition Code
- Maintenance Planning Group (MPG)
- Location
- Activity Type
- Functional Location
- Manhour changes not greater than 12 hours
- Equipment, Sub-Equipment or Object links
- Alignment with existing Maintenance Strategy
3.0 MAJOR CHANGE (Maintenance Strategy Update EMS-FC-704)

Major changes are authorised by the SCE Performance Standard Owner

Major changes include:

- Significant change to Safety Critical Element under Verification / Examination Scheme
- Impacts on Integrity, Safety or Environment impact
- Text changes which changes the overall scope of the Task List
- Not in accordance with Maintenance Strategy
- Manhour changes in excess of 12 hours
- Task list packages (frequency)
- Changes to Strategy, static/ dynamic
- Change to Category
- Change to System Criticality
# Northern Integrated Services Limited

## Request for Deferral of Planned Maintenance

<table>
<thead>
<tr>
<th>Title:</th>
<th>Deferment Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H.4) GENERATOR G-1040 INSTRUMENT CHECKS</td>
<td>757366</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Platform:</th>
<th>Date Raised:</th>
<th>Function Location (IDCC):</th>
<th>MPG (Responsibility):</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRENT CHARLIE</td>
<td>23 OCT 2002</td>
<td>BC.E.01.02.001</td>
<td>BCH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Order:</th>
<th>Cat:</th>
<th>Frequency:</th>
<th>Type:</th>
<th>System Condition (B/U):</th>
<th>Original Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10495557</td>
<td>2</td>
<td>180 Days</td>
<td>TNF</td>
<td></td>
<td>18 SEP 2002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title:</th>
<th>Band Start Date:</th>
<th>Proposed Start Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H.4) GENERATOR G-1040 INSTRUMENT CHECKS</td>
<td>04 AUG 2002</td>
<td>01 DEC 2002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reasons for Non-Compliance:</th>
<th>Band End Date:</th>
<th>Proposed End Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUE TO LIMITED ACCESS TO MACHINE, (AVON CHANGED TO AND BREAKDOWNS ON OTHER MACHINES TAKING PRIORITY), COMBINED WITH POB LIMITATIONS, THIS ROUTINE CANNOT BE COMPLETED PRIOR TO BAND END, THEREFORE REQUEST DEFERMENT FOR APPROX 4 WEEKS TO 1ST DEC 2002.</td>
<td>02 NOV 2002</td>
<td>31 DEC 2002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Originator:</th>
<th>Department:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANDY NEIL</td>
<td>ALSTOM POWER SHIELD CONTRACT</td>
</tr>
</tbody>
</table>

## Risk Assessment

RISK OF FAILURE BEFORE CHECKS CARRIED OUT IS SEEN AS VERY LOW.

### Asset Operator / OIM’s Comments:

<table>
<thead>
<tr>
<th>Name:</th>
<th>Signature</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Operator (Cat 3 &amp; 5 Endorsed):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OIM (Cat LG 1) (Endorsed):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Onshore Comments:

Non-Compliance Agreed:

<table>
<thead>
<tr>
<th>Name:</th>
<th>Signature</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Services Team</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29 OCT 2002

Sigma 3

---

Page 1 of 1

TOTAL P. 84
1.0 Identify change requirement.

2.0 Raise SAP Notification.

3.0 Review content with respect to type of change requested.

4.0 Provide sufficient information to carry out review.

5.0 Will change effect maintenance strategy? i.e. frequency, workscope, original schedule, start date, increase manhours?

6.0 Will change effect POPMs?

7.0 Will change effect Safety Case, QRA or PFEER?

8.0 Authorise / Reject Change

9.0 Update status to closed in SAP and inform originator

10.0 Implement changes in SAP and complete Notification.

Note 3.0

List of Technical Authorities

Managing PMR Change Requests
EMS-GR-781

Note 4.0

Maintenance Strategy Update
Process EMS-FC-784

Note 7.0

POMP PROCEDURE

Note 10.0

AUTHOR/REVISED BY: C. Hepworth

APPROVED BY: (Process Owner) D. Curry

DATE: 7-Oct-02

PAGE: 1

REVISION: A2
1.0 Raise Deferment Request Form (DRF)

2.0 Issue completed DRF to Asset Operator for endorsement.

3.0 Carry out risk assessment

4.0 Can DRF be endorsed?

5.0 Endorse and send to SAP Snr Technical Assistant.

6.0 Allocate and log deferment (notification) number in SAP.

7.0 Onshore 1st line approval / rejection asset nominated Reliability Engineer.

8.0 Approve / Reject deferment & send to SAP Sr Technical Assistant.

9.0 Implement in SAP.

10.0 Notify originator and file copy.

11.0 Update SAP deferment status and file for reference. Notify originator and file copy.
**Work Order 10444225 - Replace lube oil filters in K-21016?**

**REFERENCE INFORMATION**

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/T</td>
<td>CA.B.03.11.013</td>
</tr>
<tr>
<td>Equipment</td>
<td>CA.K.21016</td>
</tr>
<tr>
<td>WR5</td>
<td>XCOAB03+MXX</td>
</tr>
<tr>
<td>Order type</td>
<td>PMNR</td>
</tr>
<tr>
<td>Main Num/No</td>
<td>677559</td>
</tr>
<tr>
<td>MFG</td>
<td>CAM</td>
</tr>
<tr>
<td>Main Wk ent</td>
<td>MECH</td>
</tr>
<tr>
<td>Basic start</td>
<td>22-Apr-2002</td>
</tr>
<tr>
<td>Tag list</td>
<td>No</td>
</tr>
</tbody>
</table>

**GAS LIFT/EXP COMPL PKG A 21016 (K-21016)**

<table>
<thead>
<tr>
<th>Part</th>
<th>Equ classes</th>
<th>Safety Critical</th>
<th>ABC Ind</th>
<th>B Short Term Cc Crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GASLIFT EXPORT COMPRESSOR</td>
<td>CARM4E1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**SUMMARY OF WORK**

- **Oper Sub Cat Trade**: Mail PRT
- **Trade**: CAT3 MECH
- **Description**: Replace lube oil filters in K-21016

**Electrical work?** Yes / No

**Permit required?** Yes / No

**PREPARATION**

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Hazard</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tripping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slipping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vibration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dust/noise</td>
<td></td>
</tr>
</tbody>
</table>

**Controls & Precautions**

- Isolation: YES / NO
- Safety System: ELEC / MECH

**WORK AUTHORIZATION**

<table>
<thead>
<tr>
<th>Authorization</th>
<th>Conflict check by PC</th>
<th>Acceptance by PICWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auth by neg. PPE</td>
<td>This work does not conflict with any other ongoing activities:</td>
<td>As person in charge of worksite I accept responsibility for the work and worksite:</td>
</tr>
<tr>
<td>Name</td>
<td>PC initials</td>
<td>Name</td>
</tr>
<tr>
<td>Signed</td>
<td>Date</td>
<td>Signed</td>
</tr>
<tr>
<td>Position</td>
<td>(Asset Operator/Delegate)</td>
<td>Name</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signed</td>
</tr>
</tbody>
</table>

**Endorsement**

- Initials, time and date are required by Area Authority/NRP for work start and PICWS for shift or work completion.

**AA/NRP**

- Name:
- Sign:
- Date:

**Work start**

- Name:
- Sign:
- Date:

**Worktop**

- Name:
- Sign:
- Date:

**PICWS**

- Name:
- Sign:
- Date:

**Follow up work required**

- Include work orders/notification raised if applicable

**Job started**

- Name: 
- Position: 
- Sign: 
- Date: 

**Job completed**

- Name: 
- Position: 
- Sign: 
- Date: 

**Work done by**

- (Print name & company)
- Completion/approval

**Worksite clean & safe**

- De-Isolations are complete

**Signature**

- Date: 

**WORK ORDER PRINT (Client 300): Page 1**
NOTIFICATION HEADER TEXT
Notification "Equipment" and "Assembly" fields changed on 15/06/02.
2 x Filters removed from platform stores and left onsite for
opportunity change out during gas comp S/D.
2 x new filters for stock have been requested.
G. McIntosh 15/06/2002

ORDER HEADER LONG TEXT
Replace lube oil filters in K-21016?

OPERATION DETAIL
Oper Sub Cat Trade Short description
0010 CAT3 MECH Replace lube oil filters in K-21016?
Work Order 10444225 - Replace lube oil filters in K-21016?

NOTIFICATION HEADER TEXT
Notification "Equipment" and "Assembly" fields changed on 15/06/02.
2 x Filters removed from platform stores and left onsite for
opportunity change out during gas comp S/D.
2 x new filters for stock have been requested.
G. McIntosh 15/06/2002

ORDER HEADER LONG TEXT
Replace lube oil filters in K-21016?

OPERATION DETAIL
Oper Sub Cat Trade Short description
0010 CAT3 MECH Replace lube oil filters in K-21016?
### HISTORY CODES

**Tag/sистема** CA-K-21016

<table>
<thead>
<tr>
<th>Breakdown start</th>
<th>Breakdown end</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAMAGE CODES</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1010 No fault found</strong></td>
<td>1110 Drift high/low</td>
</tr>
<tr>
<td><strong>1020 Worn</strong></td>
<td>1120 Out of span</td>
</tr>
<tr>
<td><strong>1030 Broken, bent</strong></td>
<td>1130 RPM hunting</td>
</tr>
<tr>
<td><strong>1040 Corroded</strong></td>
<td>1140 Low/high output valve/valve</td>
</tr>
<tr>
<td><strong>1050 Eroded</strong></td>
<td>1150 Short/open circuits</td>
</tr>
<tr>
<td><strong>1060 Fouled, blocked</strong></td>
<td>1160 Spurious oper (false alarm)</td>
</tr>
<tr>
<td><strong>1070 Overheated, burnt</strong></td>
<td>1170 Signal trans fault</td>
</tr>
<tr>
<td><strong>1080 Fatigued</strong></td>
<td>1180 Electrohydraulic power failure</td>
</tr>
<tr>
<td><strong>1090 Intermittent fault</strong></td>
<td>1190 Injection failure</td>
</tr>
<tr>
<td><strong>1100 Worked loose</strong></td>
<td>1200 Other (specific in text)</td>
</tr>
</tbody>
</table>

**CAUSES OF DAMAGE**

| **CH10 Mechanical failure** | **CH20 Operational failures** |
| **1010 Worn** | **1010 Fail to start** |
| **1020 Leakage** | **1020 Stopped whilst running/trip** |
| **1030 Vibration/noise** | **1030 Low output** |
| **1040 Blocked/filtered** | **1040 Operating outside design** |
| **1050 Stuck out/overloaded** | **1050 Poor startup procedure** |
| **1060 Overheated/burnt** | **1060 Poor shutdown procedure** |
| **1070 Impact** | **1070 Stuck open/close** |

| **CH20 Material failures** | **CH30 Instrument failures** |
| **1010 Corrosion/erosion** | **1010 Out of adjustment** |
| **1020 Fatigue** | **1020 Leakage** |
| **1030 Fracture** | **1030 Control failure** |
| **1040 Durability/plastic deform** | **1040 No sig/ind/alarm** |
| **1050 Incorrect materials** | **1050 Setup/safety equip** |

| **CH30 Instrument failures** | **CH60 External causes** |
| **1010 Out of adjustment** | **1010 External environment** |
| **1020 Leakage** | **1020 Blockage/plugged** |
| **1030 Control failure** | **1030 Contamination** |
| **1040 No sig/ind/alarm** | **1040 Unprotected surface** |
| **1050 Setup/safety equip** | **1050 External cause** |

| **CH40 Electrical failures** | **CH80 Miscellaneous causes** |
| **1010 No power/voltage** | **1010 Unknown case** |
| **1020 Earth fault** | **1020 Combined causes** |
| **1030 Short circuit** | **1030 New cause - describe** |
| **1040 Open circuit** | **1050 Burnt** |
| **1050 Contact welded** | **1060 Combination of repair activities** |

### A - ACTIVITIES

| **A100 General repair activities** | **A200 Replacement** |
| **1010 Replace** | **1020 Rotor/repair** |
| **1030 Adjust/align/brake** | **1040 Modify/retrofit** |
| **1050 Check/monitor/cool** | **1060 Combination of repair activities** |

### B - OBJECT PARTS

| **P020 Compressor unit - centrifugal** | **P035 Compressor unit - reciprocating** |
| **FREE TEXT HISTORY** | **DISCUSSION WITH RENNE JARVIS SHERWIN** |

It was observed that the filters have been fitted incorrectly. By the date a job was not completed correctly. No further action needed.
**Work Order 10497348 - (H) TEST ZONE 26 GAS SMOKE DETCRS & GPAs**

### Reference Information
- **Reference**
  - BAF.01.01.026
- **Equipment**
  - X/BR:+++/XXX
- **Location**
  - BALSE
- **Eq. classes**
  - ABC
- **A Safety/Integ Critic**
  - Yes
- **Safety Critical E**
  - Yes
- **Revision**
  - 1
- **Priority**
  - 1
- **System condition**
  - Yes
- **Meas pts**
  - 180 days
- **Plan no.**
  - BAZAP100125
- **Plan date**
  - 16-Oct-2002
- **Strategy**
  - SN300V
- **Baseline**
  - 28-Sep-2002
- **Meta Activ Typ**
  - FPF
- **Tag list**
  - Yes
- **Start date**
  - 16-Oct-2002
- **End date**
  - 02-Nov-2002
- **FPEER**
  - Yes
- **MaIn Wk cent**
  - INST
- **Base Inst**
  - 16-Oct-2002
- **Opn List**
  - Yes

### Summary of Work
- **Oper Sub**
  - Cat Trade
- **Cat Inst**
  - 0010
  - 0020
  - 0030
- **Trade**
  - Mat PRT
- **Short description**
  - Req (H) TEST ZONE 26 GAS DETECTORS
  - Req (H) TEST ZONE 26 SMOKE DETECTORS
  - Req (H) TEST ZONE 26 GBA BREAK GLASS UNITS

### Electrical Work
- **Yes / No**
- **Permit required?**
- **Yes / No**
- **RPE initials**

### PREPARATION

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Permit</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripping</td>
<td></td>
<td>Tick</td>
</tr>
<tr>
<td>Sharp object</td>
<td></td>
<td>Tick</td>
</tr>
<tr>
<td>Trapping</td>
<td></td>
<td>Safety barrier</td>
</tr>
<tr>
<td>Portable radio</td>
<td></td>
<td>Goggles</td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td>Hearing protection</td>
</tr>
<tr>
<td>Failing objects</td>
<td></td>
<td>Dust mask</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Gloves</td>
</tr>
<tr>
<td>Adverse weather</td>
<td></td>
<td>Gas detector</td>
</tr>
<tr>
<td>Metaxisc flame</td>
<td></td>
<td>Safety harness</td>
</tr>
</tbody>
</table>

### WORK AUTHORISATION

**Auth by resp. person**
- Worksite preparations may proceed.
- Work may proceed after endorsement by Area Auth/NRP:
- **Name**
  - Name
- **Signed**
  - Signed
- **Date**
  - Date
- **PC initials**
  - Name
- **Position**
  - (Asset Operator/Delegate)
- **Signed**
  - Signed
- **Date**
  - Date

**Endorsement**
- Initials, time and date are required by Area Authority/NRP for work start and PICWS for shift or work completion.

### AA/NRP
- **Name**
  - Name
- **Site**
  - Site
- **Work start**
  - Date
- **Time**
  - Time

### Workstep
- **Name**
  - Name
- **Site**
  - Site
- **Date**
  - Date
- **Time**
  - Time

### PICWS
- **Name**
  - Name
- **Site**
  - Site
- **Date**
  - Date
- **Time**
  - Time

**Work order content - improvements**
- (Please list any improvements required to this routine.)

**Follow up work required**
- (include work orders/items/clarification raised if applicable)

**Repair Fault**
- 2G-160-134
- JW 1056/86/5

**Job started**
- 12/10/04
- **Job completed**
- 17/10/04
- **Work done by** (Print name & company)
- **Completion approval**
- **Worksite clean & safe**
- Desolvations are complete
- **Name**
  - Name
- **Position**
  - (Asset Operator/Delegate)
- **Signed**
  - Signed
- **Date**
  - Date
ORDER HEADER LONG TEXT
(H) TEST ZONE 26 GAS SMOKE DETECTORS & GPAs

OPERATION DETAIL
Oper Sub Cat Trade Short description
0010 CATI INST (H) TEST ZONE 26 GAS DETECTORS

(H) TEST ZONE 26 GAS DETECTORS

STEP: 1
Check location of installed detectors against current layout drawings.

STEP: 2
Function test and calibrate if necessary the following Gas Detection Heads using test Procedure Guide T7G210.

STEP: 3
L5 EAST AREA.
6 MSA 410 FRP Detector Heads.
26-GD-138 %
26-GD-139 %
26-GD-140 %

Reference:
26.01.A.01
26.01.A.02
26.01.A.03
26.01.A.06

ROUTINE REF - BA005111

PROCEDURE(S)
T7G210-GAS DET’T‘N CAL-MSA 410 FRP

<table>
<thead>
<tr>
<th>PRT</th>
<th>Qty</th>
<th>UoM</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFEER</td>
<td>1</td>
<td>PC</td>
<td>PFEER Work Indicator</td>
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</table>

<table>
<thead>
<tr>
<th>PRT</th>
<th>Qty</th>
<th>UoM</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-SCE</td>
<td>1</td>
<td>PC</td>
<td>SAFETY CRITICAL ELEMENT</td>
</tr>
</tbody>
</table>
H - Order 10497348 - (H) TEST ZONE 26 GAS SMOKE DETCRS & GPAs

Detailed Work

Oper Sub Cat Trade Short Description
0030 CAT1 INST (H) TEST ZONE 26 GPA BREAK GLASS UNITS

(H) TEST ZONE 26 GPA BREAK GLASS UNITS

STEP: 1
GENERAL
Operate Platform alarm from manual alarm point or automatic device and verify audible and visual signals operate normally.

STEP: 2
TESTING OF GPA
Prior to commencing test isolate the audible alarms using the key switch on the operators panel.

STEP: 3
This Routine relates to the following alarm test points.

LS AVON GT HALL AREA.

TERM ROW.

26-GPA-19 B3 35 & 36
26-GPA-20 B3 37 & 38

Reference:
26.03.A.01

STEP: 4
Test each alarm point according to the following procedure:
Remove glass bezel and check alarm has functioned by observing change in Platform Status Lights. Replace glass and reset system. Isolate GPA by opening associate knife connectors in the I/O termination racks. Overhaul GPA. Clean and grease coverplate check electrical connections check cable gland check cable and plant ident are affixed. Fit inspection tag.

STEP: 5
Re-close knife connectors in the I/O termination racks.
Record GPA tested.

STEP: 6
On completion of test re-instate the audible alarms.

ROUTINE REF - BA005113

PROCEDURE(S)

BIDP91-GPA BOUS FUNCT CHK.

TEXT NAME: BF0001-ECR/UNR VERIFICATION
TEXT ID: ZB0F

SAP EQUIPMENT VERIFICATION
On completion of this routine, ensure that the information held in SAP Equipment Register is confirmed as being correct for all Tag Nos listed.

THE TECHNICIAN CARRYING OUT THE ROUTINE WILL COMPLETE THE FOLLOWING DETAILS LISTED BELOW AND FORWARD TO THE SAP OPERATOR FOR REGISTER UPDATE.

<table>
<thead>
<tr>
<th>SUB EQUIPMENT NO</th>
<th>MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE AND MODEL</td>
<td>SERIAL NO</td>
</tr>
<tr>
<td>LOCATION</td>
<td></td>
</tr>
</tbody>
</table>

DxTED WORK (Client 300): Pag
NOTE: REMOVAL/CHANGE-OUT OF EQUIPMENT FROM THE INSTALLATION MUST BE COVERED BY COMPLETING AN AMENDMENT NOTIFICATION FOR MAINTENANCE PLANNER GROUP ECE.
REGULAR MONITORING OF THESE CHECKS WILL BE CARRIED OUT BY UEDB/5411.

<table>
<thead>
<tr>
<th>PRT</th>
<th>Qty</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-SCE</td>
<td>1</td>
<td>PC</td>
<td>SAFETY CRITICAL ELEMENT</td>
</tr>
<tr>
<td>Item</td>
<td>Func Locn</td>
<td>Equip</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>---------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>BA.F.01.01.26</td>
<td>*BA-GD-138</td>
<td>DETECTION - MODULE LS EAST</td>
</tr>
<tr>
<td>2</td>
<td>BA.F.01.01.26</td>
<td>*BA-GD-139</td>
<td>GAS DETECTOR</td>
</tr>
<tr>
<td>3</td>
<td>BA.F.01.01.26</td>
<td>*BA-GD-140</td>
<td>GAS DETECTOR</td>
</tr>
<tr>
<td>4</td>
<td>BA.F.01.01.26</td>
<td>*BA-GP-19</td>
<td>GPA (BREAK GLASS UNIT)</td>
</tr>
<tr>
<td>5</td>
<td>BA.F.01.01.26</td>
<td>*BA-GP-20</td>
<td>GPA (BREAK GLASS UNIT)</td>
</tr>
<tr>
<td>6</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-60</td>
<td>SMOKE DETECTOR</td>
</tr>
<tr>
<td>7</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-61</td>
<td>SMOKE DETECTOR</td>
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<tr>
<td>8</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-62</td>
<td>SMOKE DETECTOR</td>
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<tr>
<td>9</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-63</td>
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<tr>
<td>10</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-64</td>
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<tr>
<td>11</td>
<td>BA.F.01.01.26</td>
<td>*BA-SD-65</td>
<td>SMOKE DETECTOR</td>
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</table>
### HISTORY CODES

<table>
<thead>
<tr>
<th>Town/system</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown start</td>
<td>Breakdown end</td>
</tr>
<tr>
<td><strong>DAMAGE CODES</strong></td>
<td>Please complete at least one section so we can improve our maintenance.</td>
</tr>
<tr>
<td>8010 Damage codes</td>
<td>(Object list items)</td>
</tr>
<tr>
<td>1010 No fault found</td>
<td>1110 Drift high/low</td>
</tr>
<tr>
<td>1020 Worn</td>
<td>1120 Out of span</td>
</tr>
<tr>
<td>1030 Broken, bent</td>
<td>1130 RPM hunting</td>
</tr>
<tr>
<td>1040 Corroded</td>
<td>1140 Low/high output volt/freq</td>
</tr>
<tr>
<td>1050 Broked</td>
<td>1150 Short/open circuit</td>
</tr>
<tr>
<td>1060 Fouled, blocked</td>
<td>1160 Spurious oper (false alarm)</td>
</tr>
<tr>
<td>1070 Overheated, burnt</td>
<td>1170 Signal trans fault</td>
</tr>
<tr>
<td>1080 Fatigue</td>
<td>1180 Electro/hydraulic power failure</td>
</tr>
<tr>
<td>1090 Intermitent fault</td>
<td>1190 Injection failure</td>
</tr>
<tr>
<td>1100 Worked loose</td>
<td>1200 Other (specify in text)</td>
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</table>

### CAUSES OF DAMAGE

<table>
<thead>
<tr>
<th>CAUSE CODES</th>
<th>Mechanical failure</th>
<th>Operational failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1010 Worn</td>
<td>1010 Fail to start</td>
<td></td>
</tr>
<tr>
<td>1020 Leakage</td>
<td>1020 Stopped whilst running/stop</td>
<td></td>
</tr>
<tr>
<td>1030 Vibration/noise</td>
<td>1030 Low output</td>
<td></td>
</tr>
<tr>
<td>1040 Blocked/foiled</td>
<td>1040 Operating outside design</td>
<td></td>
</tr>
<tr>
<td>1050 Stuck open/closed</td>
<td>1050 Poor startup procedure</td>
<td></td>
</tr>
<tr>
<td>1060 Overheated/burnt</td>
<td>1060 Poor shutdown procedure</td>
<td></td>
</tr>
<tr>
<td>1070 Impact</td>
<td>1070 Stuck open/closed</td>
<td></td>
</tr>
<tr>
<td>1080 External leak</td>
<td>1080 Internal leak</td>
<td></td>
</tr>
<tr>
<td>1090 Internal leak</td>
<td>1100 External environment</td>
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</tbody>
</table>

### A - ACTIVITIES

<table>
<thead>
<tr>
<th>A010 General repair activities</th>
<th>(Object list items)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1010 Replace</td>
<td></td>
</tr>
<tr>
<td>1020 Restore/repair</td>
<td>1120</td>
</tr>
</tbody>
</table>

### B - OBJECT PARTS

<table>
<thead>
<tr>
<th>OBJECy PARTS</th>
<th>Function checked end elements operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATISFACTORY</td>
<td>APART FROM 2G = 138 FORCE WOULD</td>
</tr>
<tr>
<td>NOT RESPOND</td>
<td>TO TEST GAS</td>
</tr>
</tbody>
</table>

**HISTORY CODES (Client 300): Page 1 a**
APPENDIX 9  MAXIMO EXAMPLES
MAXIMO 5.1 Start Centre; showing ‘traffic-light’ KPIs; Workflow IN-box business activities; Main Module Links; Start Centre allows switching to other Site Operations and information and KPIs relevant to that site.
Main Work Order tracking screen for detailed planning of Work Order
Desktop Requisition screen shot – showing the ‘Map’ tab which allows the viewing of the business process history of this request for Parts and Services.
MAXIMO’s Web-Architected report engine showing a ‘drill-down’ KPI of overdue Preventive Maintenance Work Orders.