



## Statoil & PiMSlider Software – An operator’s experience of using PiMS software

This paper Statoil discuss their experience using the PiMSlider software solution for the integrity management of pipelines in operation. The tool includes a series of base objects that contains data related to design and inspection input, called “Views”. These Views are used as a form of input data for all other PiMSlider different modules. The ability to choose data from these “views” gives the user a comprehensive overview of pipeline integrity management.

It can also be seen as a database where new pipeline information is registered and then made available for further integrity analysis. In addition, it comprises of several modules for managing various specialized integrity areas of a pipeline. The modules used in Statoil are Threat and Mitigation Expert, Reporting Expert, Internal Condition Expert (for corrosion management) and Inline Inspection Expert module.

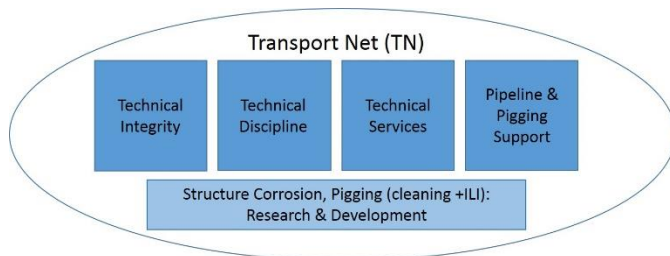
### INTRODUCTION

Within Statoil, the center for pipeline integrity management is represented by an organization entitled “Transport Net”, in short “TN”. The technical structure of TN is described in Fig. 1.

### PiMSlider Software

The PiMSlider software from Associated Technology Pipeline Ltd is one of the most powerful PIMS software solutions on the market. Our software . . .

- Is an off-the-shelf software solution developed specifically for pipeline experts.
- Is a suite of integrated modules that can process any pipeline, population and or environmental-related information in an integrated way for all phases of the pipeline integrity management process.
- Has highly specialised modules which can integrate data from any sources available to a pipeline operator, such as PODS, APDM, GIS, SAP, Maximo or any other proprietary database
- Can implement local, federal and state standards which your company may uses as part of your its integrity processes.
- You can have access to a working system at the beginning of the project and try it before you buy.



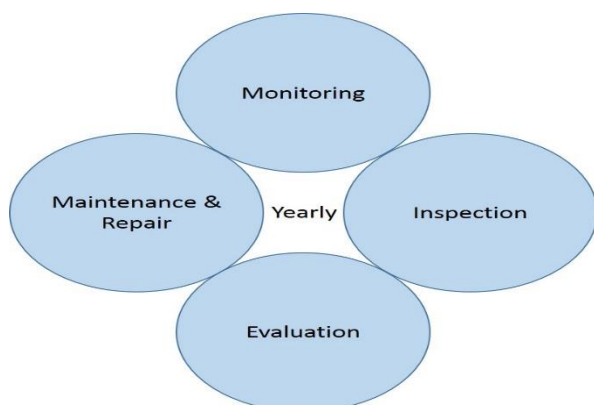
*Fig. 1 Technical structure of TN*

TN has in its portfolio about 10.000 km pipelines transporting gas, condensate, oil and chemicals. The pipelines are mostly subsea lines but some reach shore and have an onshore section. The size of the lines is from 8" up to 44" and in water with depth up to 580 meters.

TN organization comprises of four departments which are covering the entire cycle of pipeline integrity management (Fig. 2) as follows:

Technical integrity department is responsible for planning and coordination of different work and inspections. In addition, it has the responsibility of updating pipeline data, various events along the year that are connected to pipeline integrity, the overview for contracts and various conditions and the issuing of annual reports to all customers.

Technical Discipline department is responsible for the technical evaluation of pipelines. The technical evaluation includes corrosion monitoring, following up cathodic protection (CP) for offshore / onshore, product monitoring, chemical injection, structural evaluation, flow assurance, pipeline protection systems, subsea valves and leak detection for oil pipelines and follow up of operational pigging.



*Fig. 2 Integrity management cycle*

Technical services department is responsible for operational support to short time limit / ad-hoc activities; technical support for modifications and project development; execution of maintenance (on behalf of both TN and others); experience in tunnel projects; TN Pipeline stock.

As part of the integrity management cycle, Fig. 2, PiMSlider is used by TN for administration, collection, monitoring and inspection data, analyses of inspection data, and also in risk analysis activities related to pipeline integrity.

The risk assessment used is based on Statoil internal technical requirement, Preventive activities for Rigid Pipeline Systems (2015), which is related to external standards and recommendations as DNV-RP-F116 (2014), DNV-OS-F101 (2014), ISO 13623 (2009) and ISO 15589 (2009). PiMSlider performs risk assessment based on threats associated with pipelines (i.e. internal and external threats), and evaluates the inspection data in comparison with design data and furthermore evaluate the overall risk for the pipeline. The software helps to perform a quick screening evaluation over the whole pipeline and if deeper evaluations are required other specialized tools are used, i.e. buckle tool, corrosion prediction models.

It is valuable that all the parties responsible for pipeline integrity management use a common platform, as pipeline integrity involves various technical disciplines for specific areas. However, at the same time, the platform needs to serve specific technical areas. Therefore, information sharing within the same platform and cross disciplines is highly important for a lean work process. As such, the PiMSlider solution was chosen by TN in 2012. The tool has a friendly graphical user interface (GUI), which incorporates all work within the same software and is satisfying the different technical discipline needs. It can also be seen as a data model for storing and organizing pipeline data in a database to implement PIMS.

In the following sections, various features of PiMSlider software are presented, and also give insights of the TN methodology for pipeline integrity management.

## PIPELINE INTEGRITY MANAGEMENT SYSTEMS (PiMSlider) SOFTWARE

### PiMSlider Views

Within PiMSlider tool, an important part of the software interface is the “Views” section. These views represent a variety of base objects that contain data related to design and inspection input. In addition to views, the tool works as a database where new pipeline information is easily registered and then made available for further integrity analysis.

Some data input is imported automatically in PiMSlider for ex. data from external surveys and some other data input are manually registered, for examples evaluations that are performed for reports.

Various events that have influence on the pipeline integrity can be logged in the view called “Events List”, this is introduced manually. The Views can be used as input data to various PiMSlider modules; Fig. 3 presents the HOME view.

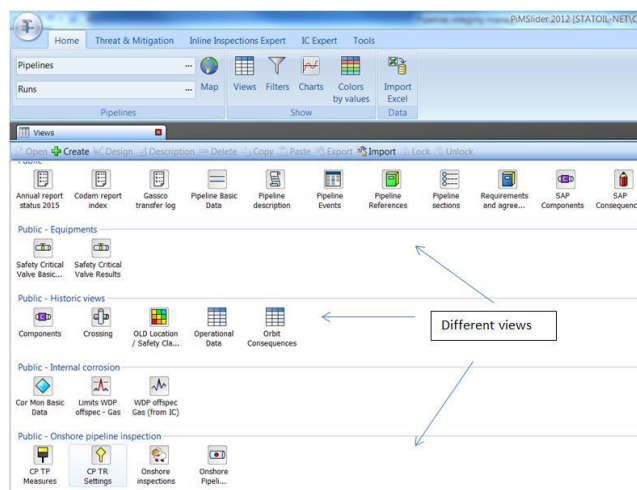


Fig. 3 Home view of PiMSlider

In addition to views, PiMSlider consists of several modules for managing integrity issues of a pipeline. The modules used in Statoil are: Threat and Mitigation Expert, Reporting Expert,

Internal Condition Expert (for Corrosion management) and Inline Inspection Expert module (ILI). In the following sections the modules are described.

### Threat and Mitigation Expert module

This is the main module for overall integrity evaluations and receives input from the other modules such as Internal Condition, ILI and also from views such as Corrosion probe and onshore pipeline inspection (in regards to CP protection). Threat and Mitigation Expert module, presented in Fig. 4, allows the user to describe relevant threats, build integrity models and follow up-to-date authority requirements.

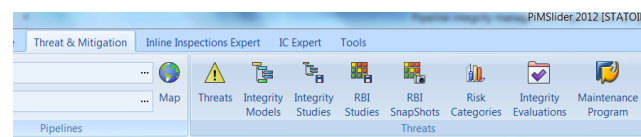


Fig. 4 Threat and Mitigation module

In Fig. 5 it is sketched a step by step methodology (workflow) for data input and integrity assessment of pipeline structure for a specific line with in Threat and Mitigation Expert module.

The workflow for pipeline structure evaluation was developed by TN engineers, and describes the methodology for data input and integrity assessment for a specific pipeline with in Threat and Mitigation Expert module. Other disciplines are using similar workflows.

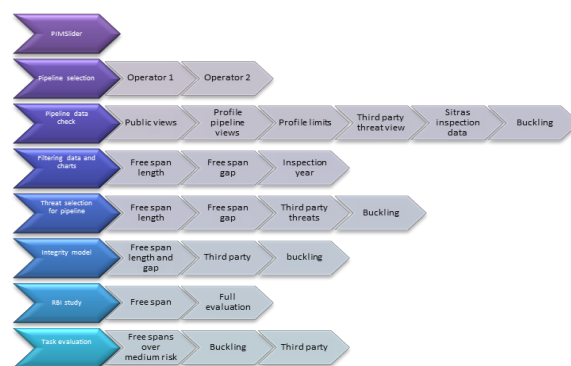


Fig. 5 Workflow for pipeline structure evaluation

In Threat and Mitigation Expert module a significant amount of inspection data, from external survey made by Remote Operated

Vehicles (ROV), is compared with the design data. The pipeline threats are defined for each individual pipeline systems i.e. free spans, buckling and trawling. An integrity model is established for individual threats defined for the pipeline system to calculate the probability of failure (POF) by comparing the survey data with the design limits. Once POF is established for individual threats, a total integrity model is established for the entire pipeline system by summing up the POF from threat integrity models. The Consequence of Failure (COF) for the pipeline systems is defined based on DNV-OS-F101 combined with technical requirements of the company. Once POF and COF are established for the pipeline system, a Risk Base Inspection (RBI) study will be carried out for each pipeline section based on calculated risk. Engineering judgment is used alongside the assessment that is performed in PiMSlider. The action or mitigation plan for a pipeline system typically includes external inspection, detailed studies, seabed intervention etc.

Integrity evaluation for the whole system is performed under Threat and Mitigation Expert module. Integrity evaluation gives an overview over all evaluations that are completed for a pipeline. Threats for the pipeline system can be defined in integrity evaluations. Internal/External assessments can be documented here based on data screening from PiMSlider, and also from other integrity tools that are used for deeper assessments. Templates for the various reports are created and evaluations are performed for specific areas / sections as it can be seen in Fig. 6. Previous evaluations are easily available just by filtering the data, if needed for comparison reasons.

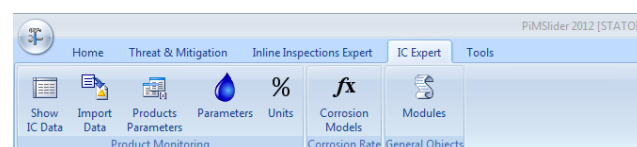
The screenshot shows the PiMSlider software interface. On the left, there is a 'Task List' pane with columns for 'Task Type', 'Task Name', 'Start Date', 'End Date', 'Status', and 'Owner'. It lists various tasks like 'Report: Corrosion', 'Report: Buckling', etc. The main area displays 'Evaluation Details' for a specific task, showing a table with columns for 'Task Description', 'Year', 'Pipeline', 'Section', 'Start', 'End', 'POF', 'Risk Score', 'Calc. Status', and 'Status'. The table contains several rows of data for different pipeline sections. Below the table, there are sections for 'General' information and 'Draft Notes'.

*Fig. 6 Integrity evaluation in Threat and Mitigation Expert module*

As a conclusion, in Threat and Mitigation Expert module the threats are analysed and mitigation actions are undertaken.

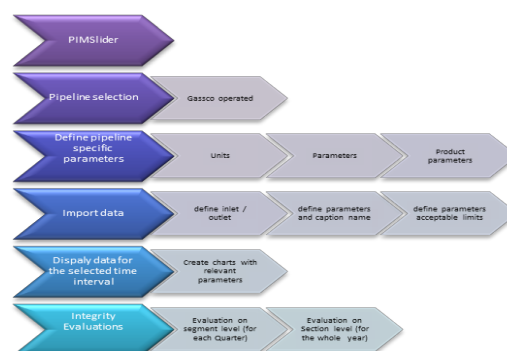
### Internal Condition Expert

The Internal Condition Expert module (IC), Fig. 7, provides corrosion management which is used to assess the internal condition of a pipeline, by displaying corrosion/integrity related parameters of the transported product. For the moment the module is implemented for gas pipelines and is ongoing for liquid/multiphase pipelines.



*Fig. 7 Internal Condition module*

Online measurements are recorded for parameters related to corrosion/integrity and stored in an excel data base template. This data is imported and mapped with the sensors logged in IC module. Monitoring of relevant parameters is performed following the work flow presented in Fig. 8.



*Fig. 8 Work flow for IC module*

In IC module one can define and describe:

- an unlimited number of type of parameters (such as Temperature, Pressure, Flow CO<sub>2</sub>, H<sub>2</sub>S etc.) and assign captions for them (i.e. units, acceptable limits, etc.)
- an unlimited number of type of product (Dry gas, Rich gas, Liquid, Multiphase etc.), which



have reference to a subset of parameters, which will be monitored for this particular product type. A snapshot of the process of importing product monitoring data is shown in Fig. 9.

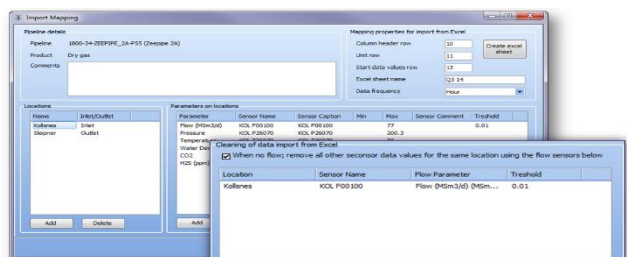


Fig. 9 Product monitoring data

IC module can present the data in tables or maps for any parameter or set of parameters for each parameter the user can set acceptance limits such that the off spec hours (if any) are displayed for an immediate integrity assessment over the data.

### Inline Inspection Expert

The Inline Inspection Expert module (ILI) is used to evaluate features and anomalies reported after an internal inspection of the pipeline. The module is presented in Fig. 10.

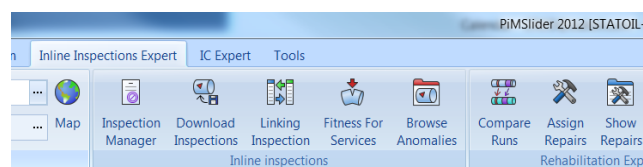


Fig. 10 Inline Inspection module

Standardization work to have a common delivery for Pipe tally excel report (template) has been made in order to upload the data in PiMSlider. The template is based on (Pipeline Operators Forum Specification, 2009). A specific classification is given for the feature (such as "Anomaly", "Corrosion", and "Dent") and this enables the data to be correctly used in the software. Even if the provided data is from a different ILI vendor the template can be quickly uploaded into PiMSlider. A schematic work flow used in TN in regards to work flow is presented in Fig. 11.

*PiMSlider can be used for most of your integrity needs including In-Line Inspections, Structure, Internal condition evaluation, corrosion probes/ coupons results, and many others aspects.*

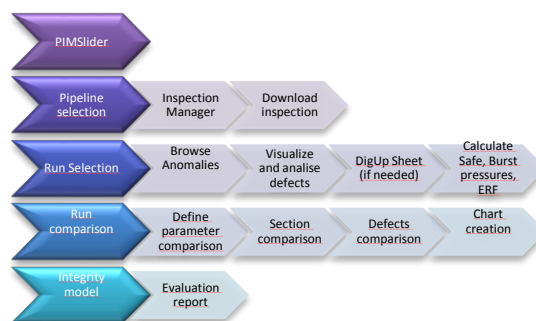


Fig. 11 Work flow for ILI module

PiMSlider ILI Expert module helps the integrity engineer to interpret and manage a large amount of data related to in-line inspections. It can be determined whether the defect is dangerous on its own, how close the defect is to other defects, how the proximity of the defect can affect the pipeline integrity at that location, and how far girth and longitudinal welds are from the defect, as shown in Fig. 12.

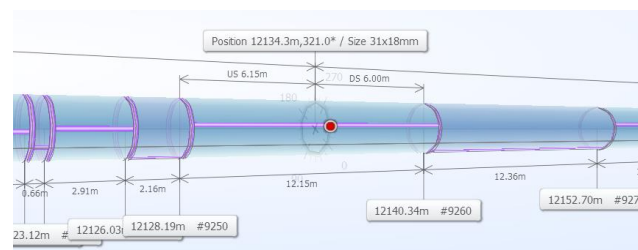


Fig. 12 Dig up sheet

With Browse Anomalies function of the ILI Expert module, integrity engineers can conveniently visualize and analyse defects as well as calculating safe and burst pressures, and Emergency Repair Factor (ERF) based on industry standards, such as ASME B31G (2009), B31G Modified (2009), DNV RP F101 (2014).

The Run Comparison function is very useful when multiple inspections are available for a pipeline in order to compare reported defects from inspections carried out at different times by different ILI vendors. This enables integrity engineers to track the development of these defects over time. The weld numbers are taken into account in the comparison algorithm amongst other things.

Different odometer distances can appear from one inspection to another, also some pipe

section with welding (e.g. a valve section or welds for buckle arrestors) can be reported differently and then need special attention. The challenge can be to align the uploaded odometer distances and be able to identify the anomalies found in the previous run and the anomalies found in the latest run are actually describing the same defect.

The Defect Comparison result, presented in Fig. 13, is automatically finding all the matching (and non-matching) defects between the two ILI runs and generates a report. The reports can include compared and non-compared defects, a list of the omitted or newly discovered joints, and the statistical corrosion rate over the entire length of the pipeline with the calculation of average values and the mean distribution.

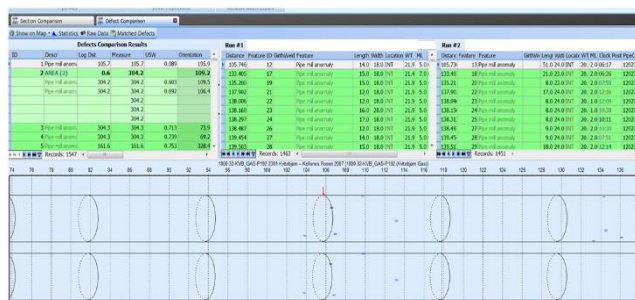


Fig. 13 Defect Comparison result

With PIMSlider ILI Expert module, high data volumes from ILI runs are quickly visualized and analysed in order to make key decisions regarding the safe upkeep of a pipeline network.

### Reporting Expert module

The Reporting Expert module, presented in Fig. 14, is used for management of pipeline integrity reports, in summary form or any level of detail.

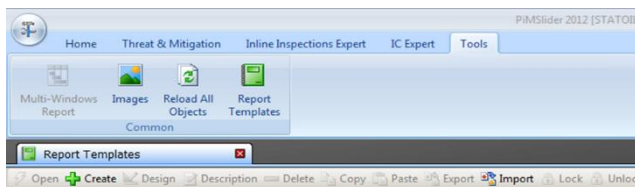


Fig. 14 Reporting Expert module

A report template can be done both for single and multiple pipelines and the work flow to generate these reports is shown in Fig. 15.

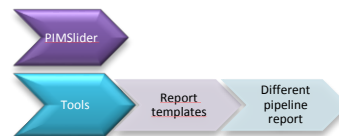


Fig. 15 Work flow for Reporting Expert module

For example, the annual integrity summary reports are made by implementing all technical evaluation, events and background information and exported to a custom-made Microsoft Word report. In Fig. 16 a risk matrix shows an aggregated internal and external risk picture for the pipeline based on the highest PoF and CoF. The evaluation criteria are according to Statoil governing documents and DNV-RP-F116.

System: xxxxxx	Size: xxxxxxxx	Length: xxxx km	Product: Dry gas
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**Integrity**  
The structural integrity of Pipeline xxx from the xxx installation to xxx has been evaluated and found to be acceptable.

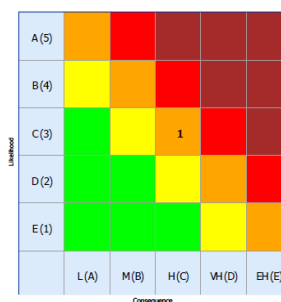


Fig. 16 Custom-made Microsoft Word report

The Reporting Expert module is a comprehensive module that is completely integrated into the PiMSlider application and it allows engineers to generate integrity reports in a very efficient way.

### PRESENT AND FUTURE DEVELOPMENT OF PIMS USING PiMSlider

As pipeline integrity management is a multidisciplinary and vast process, it implies continuous optimization and improvements. Implementing new integrity features and integrity processes requires thorough planning and testing before set into production. In TN an improvement group of engineers and IT personnel are working together with supplier to find the best solutions. For each module dedicated persons were assign from TN

department (5 persons) and IT department (2 persons).

Development in regards to assessment of intelligent pigging inspection

It has been identified that not all the ILI vendors are reporting consistently with Pipeline Operators Forum specifications (2009, figure1). For example some of them are reporting the clock position being the end of the feature and other are reporting the clock position being the beginning of the feature in pipe tally report. This is a challenge when there are multiple inspections to be matched from different ILI vendors. TN has taken an initiative toward ILI suppliers to deliver the pipe tally ILI reports on a commonly standardized format. This work has spanned over many months of discussions, but the results are promising thanks to a good collaboration.

Another example is related to development of a quality assurance (QA) process for ILI inspections, as a QA process is not standardized for ILI inspection data. Thus, it has been proposed the possibility to visualize the raw data obtained by ILI tools before the data is processed by the service companies. In order to achieve this goal close cooperation with ILI vendors and ATP is performed to develop a standard CSV (comma separated value) template that should be used by all vendors to report the raw data obtained by the ILI tools. In this way using PiMSlider there is possibility to perform the QA process for the ILI raw data, before the raw data is processed and delivered in the final inspection report.

Another direction related to development is for new “views” for corrosion probes/ coupons, result inspection from cathodic protection (CP) and for safety critical valves. This development it is in implementation phase. In addition to specific development within a narrow discipline, optimization process is performed for integrating PiMSlider with other databases used in the company, such as geographical information system (GIS).

## **Concluding remarks regarding the use of PiMSlider as a PIMS tool**

Since 2012, PiMSlider has been chosen by TN as the PIMS tool. A continuously familiarization process with the software has been performed and consequently trust within the tool has been achieved. During this time the tool has been tuned and continuously improved, becoming a reliable and versatile integrity system which can adapt to the operator needs, as presented in the above sections.

PiMSlider can be used for most of the integrity needs including In-Line Inspections, Structure, Internal condition evaluation, corrosion probes/ coupons results, and many others aspects. The software enables an efficient screening status over the whole pipeline and highlights specific area where further analyses are required. As such, at the present PiMSlider is a suitable tool for most of the standardized integrity evaluation processes.

In addition to the possibility of performing integrity management using the standardized technical evaluation, PiMSlider is also flexible and versatile to adapt to new integrity needs. However, as a normal innovation process, developing new capabilities for the tool requires resources and sustained development work for testing and implementation.

In today situation, tools area which are most developed are Home view and Threat and mitigation having in consideration that the portfolio majority is offshore pipelines.

Tool strengthen is given by all the modules because each module treats a different part, and in this way the user has complete picture in regards to pipeline integrity.

The degree of performance given by PiMSlider was the result of a continuous work and resources from software supplier, Statoil, other PiMSlider users and also providers of technical integrity services. As such, developing PiMSlider as a reliable and sound PIMS implies continuous collaboration and development.



A lot of this collaboration has been performed through the PiMSlider periodical forum, the PiMS User Group.

## REFERENCES

ASME B31G and B31G Modified Standard (2009): Manual for Determining the Remaining Strength of Corroded Pipelines

DNV RP F116 Standard (2014): Integrity management of submarine pipeline systems

DNV RP F101 Standard (2014): Corroded Pipelines

DNV- OS-F101 Standard (2009): Submarine Pipeline Systems

ISO 13623 Standard (2009): Pipeline Transportation System

ISO 15589 Standard (2009): Cathodic Protection of Pipeline Systems

Pipeline Operators Forum Specification (2009): Specifications and requirements for intelligent pig inspection of pipelines

## PiMSlider®

Developed by Associated Technology Pipeline (ATP) Ltd, PiMSlider® software is suite of integrated modules to support the entire pipeline integrity management process. PiMSlider® is an off-the-shelf software solution, having been developed over a number of years, and installed in many clients around the world. The software includes all the advantages described above, but it also contains a large number of configurable tools that make the software solution truly unique. These tools allow the pipeline operator to further adjust the functionality to meet very specific needs.

The PiMSlider® offering allows operators to adopt a working system at the beginning of the project, and not just at the end (like conventional software projects). There are many advantages of doing it this way:

- The client gets access to a working system that is used today in the market, very early

in the project (the same software base will be delivered)

- The client and ATP can start educating the user base with the philosophies and ideologies of using PiMSlider® software – often a small culture change when accepting new software
- The client gets access to a feature rich software application that will meet a very high percentage of requirements. In addition, the client will get access to a range of features not previously considered during the internal client activities of data and feature gathering
- The client's user base gets access to a real working system, with real client data very early in the project, to help the various levels of the company to see a lot of data from many different sources (GIS, ERPs, Inline Inspections, Cathodic Protection, Survey data, Document Management Systems) – all visible from a single integrated software system.
- As this working PiMSlider® system is the same software that is currently in use in the market today, the Testing Phases would focus more on the feature-availability, rather than the stability of the system.

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For more information about ATP and PiMSlider® Software please contact the Marketing Dept.

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