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**METERING MANAGEMENT TOOL**


**FUNCTIONAL SPECIFICATION**

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REVISION STATUS / SUMMARY OF CHANGES

REVISION	REVISED CHAPTERS	REVISION DESCRIPTION	REASON FOR REVISION
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## 1. INTRODUCTION

Flow measurement on a production facilities plays an important role on different fronts such as operational control, production performance, contractual targets and environmental emission.

In some units due to local regulations, most critical front becomes the regulatory side. For units operating in Brazil, due to very tight and specific regulations and significantly high fine exposures, a management system must be in place for close watch of the entire metering system.

The lack of a central tool capable of capturing all the nuances of the local regulation and store all data in a central database for future audits may lead to exposures with SBM clients and local regulations.

This specification will capture functionalities and business rules to assist the contractor on delivering a tool capable of managing the entire metering system in the light of local brazilian regulation.

## 2. ABBREVIATIONS


<b>ANP</b>	National Petroleum Agency ( <i>Agência Nacional do Petróleo</i> )
<b>API</b>	Application Programming Interface
<b>CA</b>	Critical Analysis
<b>CT</b>	Custody Transfer
<b>FC</b>	Flow Computer
<b>IFS</b>	CMMS – Maintenance Management Software
<b>MA</b>	Metering Analyst
<b>ME</b>	Metering Engineer
<b>ML</b>	Metering Lead
<b>MMT</b>	Metering Management Tool
<b>MT</b>	Metering Technician
<b>NFSM</b>	Mismeasurement Notification of the Metering System ( <i>Notificação de Falha do Sistema de Medição</i> )
<b>RTM</b>	Metrological Technical Regulation ( <i>Regulamento Técnico de Medição</i> )
<b>SRS</b>	Software Requirements Specification
<b>UAT</b>	User Acceptance Testing
<b>UC</b>	Uncertainty calculation

## 3. GLOSSARY

<b>Critical Analysis</b>	Evaluation of the report against a predefined set of rules and previous reports of same equipment to ensure provided data is within expected limits and previous references
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## 4. REFERENCE DOCUMENTS

- [1] Resolução Conjunta ANP/INMETRO nº 1 – RTM 01/2013
- [2] Resolução ANP Nº 18/2014 – Failure Notification
- [3] Resolução ANP nº 52/2013 - Gas and Oil Sampling

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- [4] Resolução ANP nº 65/2014 - Data Exchange
- [5] Ofício Circular ANP/NFP nº 01/2020 - RTM Clarifications
- [6] ANP/NFP nº 02/2020, 835/2020, 841/2021 - Waivers due COVID-19
- [7] Ofício Circular ANP/NFP nº 02/2021 - Resolução 18 Clarifications
- [8] Ofício ANP/NFP nº 906/2021 – Offloading XML
- [9] ISO 10012:2003 - Measurement management systems – Requirements for measurement processes and measuring equipment

## 5. **SCOPE**

The contractor scope of supply shall include as a minimum requirement the following:

- Development, Deployment, Testing and Hosting of the MMT
- Power BI templates for desired reports integrated with MMT database, including delivery of PBI native files
- Training sessions at SBM Office
- 2 years of technical support and bug fixes
- 1 year of active development after delivery for functionality fixes
- Documents:
  - Detailed SRS
  - Periodic Project Report
  - Project Timeline with deployment date and UAT period for each delivery
  - Training Material
  - User Manual

It is contractor responsibility to detail the software requirements based on the specification provided on this document. Detailed requirements may be submitted for SBM approval prior to development.


## 6. **REQUIREMENTS**

### 6.1 **MAIN FEATURES**

Software will be developed in modules. Each module will be focused on one activity developed under Metering Management System. Modules shall have necessary interconnection in a way that information from one module can be used by the other without users ever needing to input the same data twice. Modules breakdown and specific requirements are presented in the coming sections.

All parameters used throughout the software such as possible instrument types, possible meters classification, calibration, and inspection frequencies, spares locations etc, must be configurable by users with the role “admin” on the control panel, even where not explicitly specified.

Software language for the displays is English. Documents generated on the software (reports, certificates etc.), must be available in both Portuguese and English either in two separated documents or ideally in one document with two languages. All document templates shall be approved by SBM.

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### 6.1.1 Data Access

MMT will be developed using APIs for all functionalities and enabling the users at SBM to collect any data available in the tool. All API endpoints will be accessible for SBM users with an authentication process implemented. Access control on the API will follow the same rules as the web interface.

For each attachment, certificate, uncertainty calculation or any other report/file available on the MMT there will be a permanent hyperlink associated to it which can be shared with other users. User access for accessing attachments links will be the same as for accessing read data for that FPSO. Data must be stored for at least 10 years.

### 6.1.2 Data filtering

Each page will have its own link. If filters are applied, they will be reflected on the page link in a way that if a link is shared, the user who receives it will have the same filters applied.

If at any time the user copies the link from the address bar on the browser and share with a different user, this second user will see exact the same page if it has access to it.

Where applicable, filters will be available to select data per FPSO, system tag, system classification and system fluid. Any filter available on the tool will be stored for that user, automatically or on the click of a button, so when user access that page again it is already applied. A clear filter button will be available and when clicked, the clear filter state will be stored as well.

### 6.1.3 Compliance

Software shall be in compliance with all reference documents.

## 6.2 CONFIGURATION MODULE

This module will gather all parametrization used on the software. No parameter used on the flows or to fill the forms must be hardcoded. Users with 'admin' role will have access to adjust it as needed.

User will be able to model the FPSO on this module, creating all metering systems and associated tags.

The FPSO will consist of a hierarchal tree. The FPSO tree will have the following levels:  
FPSO short name


System description or tag (user defined)

Process variable (pressure, temperature, fluid properties etc)

Device tag and/or description

A metering system may consist of the following equipment:

1. Primary device (turbine, orifice plate, coriolis, ultrasonic, magnetic, cone etc)
2. Secondary device (pressure, temperature, differential pressure, and multivariable transmitters and thermoelements)
3. Straight run
4. Zanker plates

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A metering system may have associated to it:

1. Manual sample point
2. Automatic sample point
3. Gas chromatography
4. BS&W analyser
5. Provers
6. Density Meters
7. Fast Loop/Jet Mixing pumps
8. MOV and Control Valves
9. Strainers
10. Air Eliminators

Except from the primary devices, all items may be associated with one or multiple metering systems.

A metering system will be defined by a tag, description, fluid, type of primary device and classification. Admin will have the ability to create/update/remove new properties on equipment. Properties can be of type text, date, numerical or multiple choice.

A set of rules for data validation must be available for the admin to choose one or many (and the relationship between them being AND or OR), such as:

1. Number between X and Y; greater than X; less than X; greater than or equal to X; less than or equal to X; multiple of X
2. Date between X and Y; greater than X; less than X; greater than or equal to X; less than or equal to X
3. Text length between X and Y; greater than X; less than X; greater than or equal to X; less than or equal to X;
4. Mandatory/Not mandatory
5. Conditionally mandatory (based on values of other properties)

The rule configured by admin will then be applied to that property when it is value is filled by the users.

Properties will have a name, description, and unit of measure.

The types of primary and secondary device will be user configurable and can be created/updated/removed by admins. Each device will have its own properties, which also can be created/updated/removed by admins following the same specifications for metering system properties.


Parameters such as frequencies and intervals will be defined for each FPSO and not for the entire application.

On this module admin will also create and configure wells, users, holiday calendars, stock locations etc.

## 6.3 MANAGING EQUIPMENT MODULE

It is important to learn about the roles played by serial numbers and tags on the metering system.



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A tag is like an address on the process plant. It is a unique identification of where an equipment is installed on the line. You will find the tags for each component mainly on P&IDs. A serial number is a unique identification of a physical equipment. Metrological confirmation is usually applied on a combination of a serial number installed on a tag. The same serial number may have different metrological confirmation criteria depending on which tag it is installed.

Certificates are issued to a serial number and may or may not be linked to a tag by the time certificate is issued.

This module will be where all serial numbers are recorded and tracked. When users create a new serial number, it will select which type of equipment that is (pressure transmitter, temperature transmitter etc), fill the specifications based on the type (nominal size, pressure rating, original tag etc) and select one or more tags where that equipment could be installed.

A tag is unique to an instrument and service in the facility. A serial number is unique to the device (being a transmitter, orifice plate, etc.). Anytime a device is changed out, a new serial number will exist, but the instrument tag remains the same. Certificates and processes associated to the metering systems are associated to the device, therefore to the serial number, where the tag number will only correlate on which metering system that device was installed on a certain period.

Equipment types and the specifications it has will be configurable by users with the role "admin" on the control panel.


When an equipment is created, user will be prompted to reply if a calibration frequency should be set up for it. In case it is, the interval will come from module 6.2. the interval will be based on instrument type and classification of the systems where this equipment may be installed. In case of conflicts, the lowest interval will be considered. These calibrations will appear on module 6.10. It must be possible to configure calibration frequency to be calculated based on installation date and / or calibration date.

MMT will keep track of all certificates issued for a serial number, all certificates related to a tag (showing certificates for all serial numbers ever installed on that tag) and log the dates when each serial number was installed or removed from a tag.

Every time a serial number is set or removed from a tag, or the serial number is replaced on a tag, a document will be issued and store at MMT. A checklist will be shown to the user doing the installation/removal/replacement for the user to confirm mandatory steps are completed. Appendix D has a template suggestion for this report. Contractor may submit other templates for approval. Direct links to execute each step on the checklist inside MMT and/or store evidence of execution will be available.

On this module, user will be able to check the datasheet of the equipment and its historical data, with all its calibration certificates, maintenance reports and the tags where this serial number was installed with the installation and removal dates. User will also be capable of adding certificates to the equipment on this module if equipment is not currently installed on any tag.

User will be able to search for an equipment by its serial number, specification,

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instrument type, possible tags where it could be installed, tags where they are currently installed or tags where they were once installed.

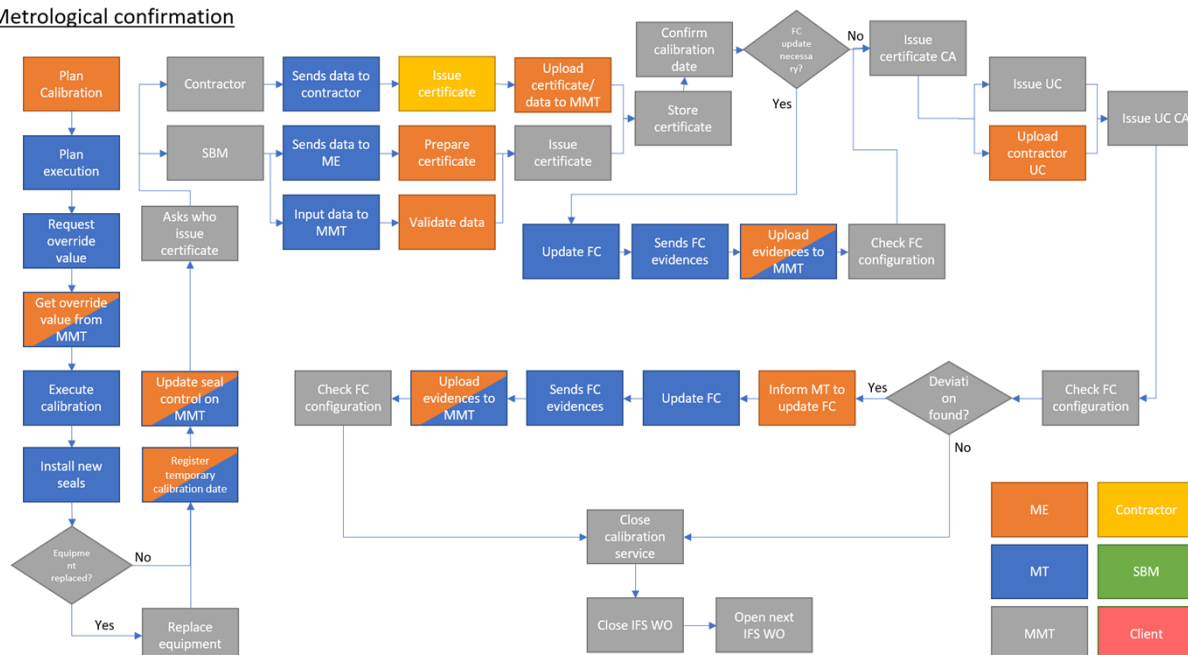
## 6.4 METROLOGICAL CONFIRMATION MODULE

This module will be responsible to manage the metrological confirmation.

Metrological confirmation is a set of operations required to ensure that measuring equipment conforms to the requirements for its intended use. It generally includes calibration and verification, any necessary adjustment or repair, and subsequent recalibration, comparison with the metrological requirements for the intended use of the equipment, as well as any required sealing and labelling. The requirements for intended use include such considerations as range, resolution and maximum permissible errors and calibration frequency.

Module must be capable to manage all steps of the metrological confirmation process described on Figure 1, with all data available inside the software. Below a brief description for most critical steps.

Metrological confirmation




**Figure 1 - Metrological Confirmation Process**

On this module user will be capable of consulting all historical data for each specific tag, including calibration dates, certificates, uncertainty calculation reports, maintenance reports, each time equipment was installed/removed/replaced etc.

### 6.4.1 Planning Calibration

At this step, ME will change calibration activity status from “pending” to “planned” to show leadership service is under control. There must be an integration with spare management module, so ME can link one or more procurement follow up from spare management module with this calibration. This will be used in cases where a spare calibrated flowmeter is required to comply with the calibration, or spare parts such as orifice plates and gaskets are needed.

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#### 6.4.2 Executing Calibration

During execution phase of the metrological confirmation, MT will plan it calibration with offshore leadership and execute it. The calibration may be done “in-situ”, where equipment is calibrated in place and put back in service, or “ex-situ”, where on this calibration date the equipment on the line is replaced with a spare already calibrated.

If the line where instrument is under calibration will be kept under operation, MT will override equipment readings according to reference [2]. MMT must be able to provide to the MT the correct value to be used on the override based on reference [2] requirements.

After finishing the calibration, MT will replace the seals.

After sealing it, MT will send calibration data to shore base (SBM and/or third party) and inform ME of the calibration date and the number of the seals installed.

ME will update MMT with a temporary conclusion date and wait for complete documentation to confirm it is indeed correct. MMT must somehow identify the date is temporary (different colour, label, specific icon). Module 6.8 and 6.10 will have tasks and alerts showing that ME must complete the definitive calibration date.

#### 6.4.3 Seal Control

MMT will keep track of all seals installed per instrument and must be capable to issue Excel reports showing all seals installed on selected tags. Selection shall be made on a filter and should support standard filtering as per 6.

For each tag, report must show type of seal, current seal installed, last seal removed and its respective dates of installation and removal, reason for replacement and responsible for replacement. One tag may have multiple seals. Configuration module will have an option to configure seal location for each tag from a list. List of possible places will also be registered on the configuration module.

#### 6.4.4 Issuing Certificate

Certificates may be issued by SBM or by third party. In case it is issued by SBM, it may be a calibration certificate, valve leak test certificate or sampler function test certificate. MMT will issue all certificates under SBM responsibility.

All certificates must have a unique number. Certificates issued by SBM will have the following number format:

AAA-BBB-CC-DDD where:

AAA – FPSO trigram (ESS, CDA, CDP, CDI, CDM, CDS, SEP, ATD, ADG)

BBB – Type of certificate (PRV - proving, LT – leak test, SMP - sampler)


CC – Year of execution

DDD – Sequential for each certificate type, restarting at 1 every year

ME will have the ability to manually fill the date the certificate is issued.

##### 6.4.4.1 Third party

When a certificate is issued by a third party, ME plays no role on its preparation, only doing CA and the steps that follows it. MMT will keep track of which calibrations are completed and not yet with a certificate registered. ME will have a screen to monitor all outstanding activities, including this one.

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#### 6.4.4.2 Offshore Flowmeter Proving (master/prover)

Oil flowmeters are sometimes calibrated offshore against compact prover or master meters. In this case, certificate is issued by SBM ME. MMT shall be able to import calibration data directly from offshore reports (one standard format per unit) and issue a calibration certificate. Certificate will be shown to ME for approval. After approval, certificate is sent to ML for approval. After both approvals, certificate will be stored on MMT.

Uncertainty calculation shall be completed for each proving run, considering at least compact prover, master meter and all transmitters uncertainty contributions and attached to certificate.

It shall be possible to export a PDF and Excel version of the certificate both prior and after approvals. PDF report prior to approval or Excel file at any state shall have a stamp "FOR REFERENCE ONLY".

Appendix A has a template suggestion for the certificate. Contractor may submit other templates for approval.

#### 6.4.4.3 Valve Leak test

When a valve leak test is completed by SBM, a leak test certificate must be issued.

MMT will have an option to print the certificate template to be able to manually fill the data in the field during test execution.

MMT will be capable of receiving all the data and issuing the certificate. Certificate will have one or more screenshot of the trends on supervisory system during test execution.

After data is completed, MMT will show the certificate to ME for approval. After approved, certificate will be stored.

It shall be possible to export a PDF and Excel version of the certificate both prior and after approvals. Prior to approvals, with a "COPY IN ADVANCE" stamp on it. Excel version will have a stamp "NOT OFFICIAL COPY".

Appendix B has a template suggestion for the certificate. Contractor may submit other templates for approval.

#### 6.4.4.4 Sampler Function Test


When a sampler leak test is completed by SBM, a test certificate must be issued.

MMT will have an option to print the certificate template to be able to manually fill the data in the field during test execution.

MMT will be capable of receiving all the data and issuing the certificate.

After data is completed, MMT will show the certificate to ME for approval. After approved, the certificate will be stored.

It shall be possible to export a PDF and Excel version of the certificate both prior and after approvals. Prior to approvals, with a "COPY IN ADVANCE" stamp on it. Excel version will have a stamp "NOT OFFICIAL COPY".

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Appendix C has a template suggestion for the certificate. Contractor may submit other templates for approval.

#### **6.4.5 Certificate Issued**

Once a certificate is issued, it must be stored on MMT. If the certificate was issued by MMT, it is already stored. If the certificate was issued by a third party, ME shall be able to import an XML and/or PDF file. The XML file will have all data from the certificate to be stored on MMT for future use in the tool. XML may have information of PDF certificate location. In this case, MMT shall import it automatically.

XML template may be developed by SBM or contractor. Details to be evaluated during bid.

#### **6.4.6 Certificate CA Issued**

Each field of the certificate must be validated by a set of predefined rules to be detailed by the contractor and approved by SBM. Validations must be per predefined limits or comparison against other certificates or other data stored on MMT. Some examples of rules:

- certificate tag matches instrument tag and FPSO where certificate is being imported to
- instrument serial number matches last certificate and MMT register
- certificate was issued within RTM time limit after calibration
- errors and uncertainty within acceptable limits
- calibration range matches calibration curve

If any of the rules set are not met, an alert will be sent to ME to evaluate and act, if needed.

#### **6.4.7 Issuing UC**

MMT will be responsible for issuing UC for the metering system every time a change happens on that system (new calibration, instrument replacement, new gas/oil sample result etc).

UC template will be developed by contractor and approved by SBM. Reports must follow best practices for uncertainty calculation, comply with standards, especially ISO GUM and ISO 5167.

Mathematical model used for uncertainty calculation will be shared between SBM and contractor for validation.


The UC must be issued on the date when calibration certificate was issued if calibration was in-situ, or on the date when the equipment was installed, if calibration was ex-situ.

MMT shall also be capable of issuing an UC report by demand as detailed on item 6.4.13.

MMT shall have a detailed document describing all calculations and showing all formulas implemented on the uncertainty calculation.

#### **6.4.8 UC Issued**

After UC is issued, MMT show UC for the user. User will be able to export as PDF with a stamp "COPY IN ADVANCE" on it. User may approve or reject UC.

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After approved, MMT will check for two options:

1. If UC was triggered by some change on metering system, UC will be stored on MMT for future reference. UC may be exported in PDF anytime.
2. If UC was triggered on demand, MMT will ask the user if UC should be stored first.
3. If UC is rejected, it will not be stored.

#### **6.4.9 FC Update**

For a set of equipment (to be configurable by unit and tag on Configuration Module), ME will be prompted to upload a set of files as evidence that FC was updated. The prompt will show one box for each category of file expected (for example, FC backup, audit trail, XML generator screenshot). Categories will be created by ME and linked to metering tags on Configuration Module.

#### **6.4.10 UC CA Issued**

With a different set of rules, UC will also go through a CA step same as 6.4.6. UC CA report will be stored in MMT for future reference. Exporting CA report in PDF will be possible.

#### **6.4.11 FC Checking**

Last step on the metrological confirmation process is to confirm flow computer is configured correctly. A set of rules will be defined and MMT will check FC parametrization. A non-exhaustive list of rules is shown below. Rules will be managed on module 6.8.

- alarm on FC is less restrictive than the UC results
- alarm on FC is more than 5% more restrictive than UC results
- for primary meters, check calibration curve, serial number, diameter
- for secondary meters, check zero, span and serial number
- for oil/gas sampling, check oil density/gas composition

MMT will check FC data based on the data available inside MMT tool, if any (from module 6.7) or directly from the evidence uploaded on step 6.4.9.

If deviations are found, MMT will trigger an alert (see module 6.8) with expected values to be configured and the ones in place.

#### **6.4.12 Closing**

After all previous steps are completed, MMT will ask ME if calibration service may be closed. After closing is approved, MMT will close IFS WO and generate the WO for the next service following predefined frequencies.


#### **6.4.13 On demand UC**

In some cases, ME will need to issue specific UC to evaluate the system or prepare some change.

In this situation, MMT will allow user to replace instruments of the system with other spares from the module described on item 6.3.

ME must be able to select a date in the past for the UC and MMT will preload all last certificates, lab reports and production data, but allow ME to override it if needed, by selecting on a dropdown list (or other search mechanism) old certificates/reports/production data available on MMT database.

The changes will not be saved to the metering system and will just be used to issue the

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UC. The ME will have the ability to export the UC or save it to the internal database as a “standby UC”.

## 6.5 CHEMICAL ANALYSIS MODULE

This module will be responsible to manage all gas, oil, and water sampling on the metering system.

The module must be capable to manage all steps of the chemical analysis, from sampling to updating the flow computer and keep all necessary data available inside the software.

MMT will keep track on the status of each sample, being:

1. Planned
2. Sampled
3. Disembark preparation
4. Disembark logistics
5. Warehouse
6. Logistics to vendor
7. Delivered at vendor
8. Report issued
9. Report under validation\*
10. Report approved/reproved\*
11. Flow computer updated\*

*\* These items are not used on all process as described on the following sessions*

At each status, MMT will track the date it entered the status and a text field for comments. Comments for all status will be compiled together but will have an identification of which step it relates to. User will be able to step back.


Every sample is taken from a specific sample point, which has its own tag. Each metering system will be linked to one sample point. One sample point may be linked to multiple meter systems. The results from a sample will be updated on the flow computer of all metering systems related to that sample point.

Sampling is always done on board, but the analysis of the sample is sometimes done on board and sometimes onshore, in this case, a cylinder with the sample is disembarked.

There is multiple different process on this module, listed below, and detailed later on this chapter.

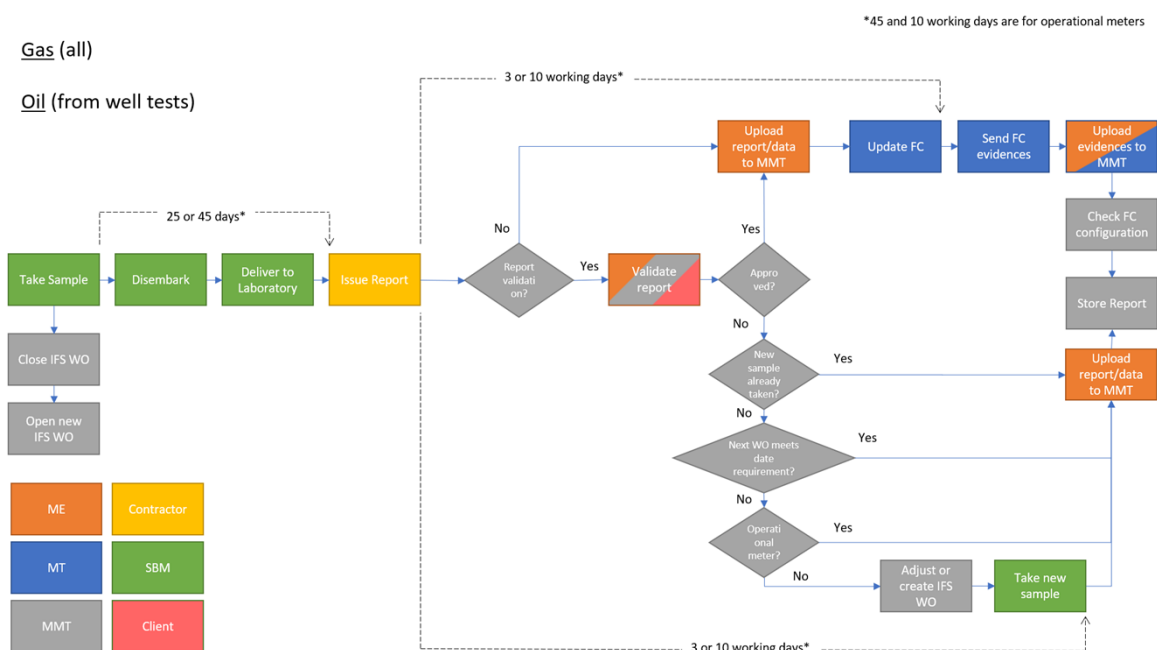
1. Oil from well test or gas in general
  - 1.1. With validation
    - 1.1.1. Validation done by client
    - 1.1.2. Validation done by SBM
  - 1.2. Without validation
2. Oil not from well test
  - 2.1. Fiscal oil (daily)



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- 2.2. Offloading (every operation)
- 3. Oil annual
  - 3.1. Sulphur analysis

## 6.5.1 Oil from Well Test or Gas in General



**Figure 2 – Summary of process – Sampling oil well test/gas in general**

The process starts with the lab tech taking a sample on board on a pressurized cylinder. The sample is then disembarked and delivered to the laboratory onshore. After receiving it, laboratory will issue the report.

The time between taking the sample and issuing the report will be no longer than 45 days for Operational sample points and 25 days for the others. This parameter will be adjustable on module 6.2.

MMT will keep track of the sampling date, disembark date, delivery date to the laboratory and report issue date.


ME will receive alerts about steps close to due date on module 6.8 and will see each of the next steps on module 6.10.

After ME input sampling date, IFS WO will be closed (if it is still open) and WO for next sample, based on sampling interval, will be opened).

After report is issued, process splits in to two possibilities:

- Does this sample point have validation method implemented or not? If it does not have, it will ignore the validation step described on item 6.5.1.1.
- If sample point does not have a validation method implemented or if report was approved on validation, next step is for the ME to upload the report to the MMT as well as input all its data. MMT will be prepared with all fields to receive the data from the



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report and will be capable of importing it all from a spreadsheet.

The MT will update the flow computer and send the evidence to the ME who will upload it to MMT. MMT will then check the flow computer files against the data it has from the report and alert ME if any mistakes found. It will then store the report with all evidence.

The number of days between sample report is issued and flow computer is updated cannot be bigger than 10 working days for Operational meters and 3 working days for the others. These number of days will be configurable on module 6.2. If the sample report is from a well test, it will not be configured on the flow computer.

The interval between samples will be based on sample point classification and fluid and will be configurable on module 6.2.

In case of test separator, the interval will be managed by well, where each well will have its own interval, configurable on module 6.2. All wells will be sampled on the same sampling point.

On this module, ME will be able to manage all steps as described on process flow from Figure 2.


#### **6.5.1.1 Validation Step**

In case a validation step is authorized, it can be done by the client or by SBM. In case it is done by SBM, MMT shall implement the validation algorithm but also allow ME to choose to use the algorithm or to manually input the status approved/reproved. In this case, MMT will issue a "validation report" on a template approved by SBM. The algorithm will be discussed in detail during the development phase. It basically consists of averaging and calculating the standard deviation of some amount of previous sample data to check if currently one falls in between calculated limits.

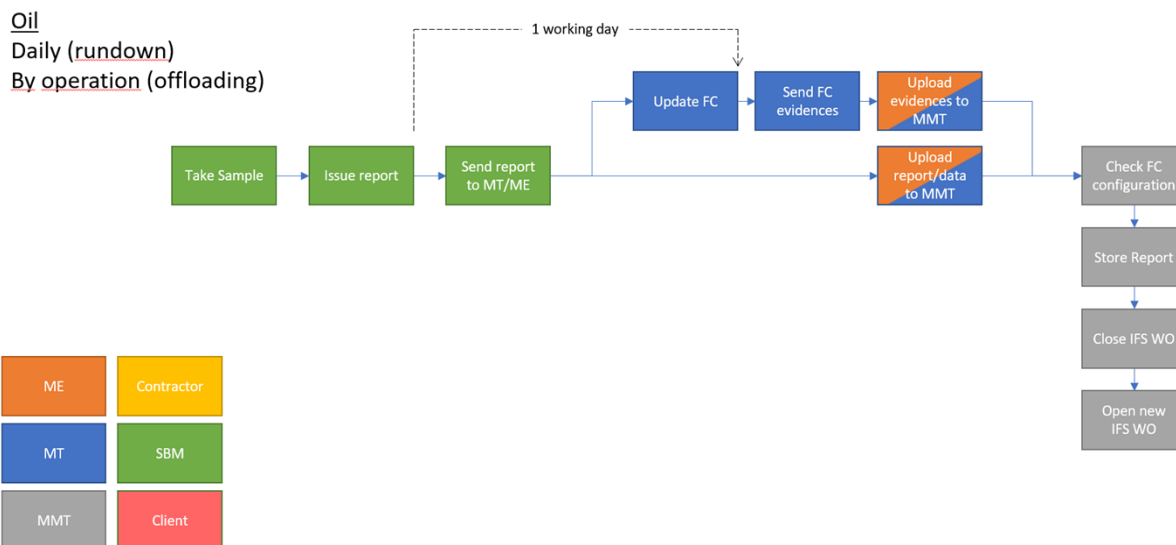
If sample result is approved, then the validation step is finished, and the flow goes back for the same steps described on item 6.5.1.

If sample is rejected, a new sample must be taken within 3 working days (except if the sample is from a well test or operational system). If a new sample was already taken, then no extra sample is needed. If a new sample was not taken already, but the date of the next sample will fulfil this requirement, then no additional action is required, otherwise a new work order must be created for a new sample, unless the sample point is operational, in this case no extra sample is needed.

After this step, ME will upload data/report to MMT same way as described on item 6.5.1, and MMT will store report.

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## 6.5.2 Daily Oil Sample or per Operation



**Figure 3 - Summary of process – Sampling per operation/daily**


This process is valid for the daily samples, usually taken on oil fiscal systems, and “on demand” samples, usually taken on offloading custody transfer systems.

ME will be able to configure which(s) sample point tag from equipment database will have daily samples and MMT will alert ME every time a daily sample is missing. MMT will have a screen where ME can upload daily reports and evidence that flow computer was correctly updated. MMT will check the report against evidence files to confirm flow computer is correctly updated.

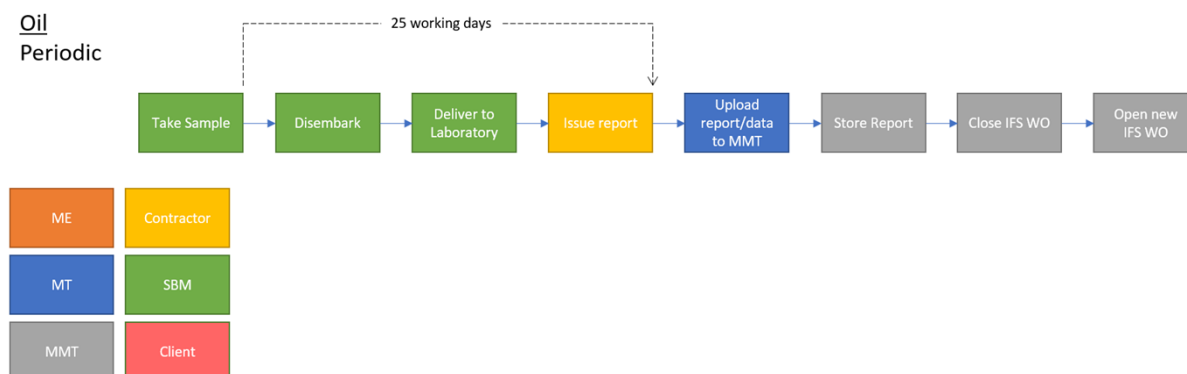
For samples “per operation”, ME will manually create the sample and upload the reports, to follow the same flow as daily samples.

For fiscal sample points, MMT will also validate if BS&W is lower than 1%. In case it is higher than 1%, it will require ME to inform on MMT which is the failure notification from module 6.11 related to this event.

On this module, ME will be able to manage all steps as described on process flow from Figure 3.

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### 6.5.3 Periodic samples



**Figure 4 - Summary of process – Periodic Sampling**

ME will have a screen on module 6.2 to configure periodic samples. On this screen, ME will select sample point tag from equipment database, name the type of sample (sulphur, viscosity etc), the interval at which samples should be taken and the amount of time between sampling and issuing the sample report. ME will be able to upload the sample report to MMT, informing the sampling date and report issue date, so MMT can validate interval is correct and forecast the new sampling date based on configured interval.

On this module, ME will be able to manage all steps as described on process flow from Figure 4.

## 6.6 ONSHORE MAINTENANCE MODULE


This module will be used to keep track of the onshore maintenance and calibration process. A Kanban view should be implemented, a simplified version of Microsoft Planner. Admin will be able to create columns on the Kanban and users will create cards. Cards will have FPSO, labels, status(completed/not completed), title, description, due date and responsible person (one or many). Admin will have the ability to create available labels. Users will add one or more labels to the card. Cards will have a section to add comments. It will be possible to add/edit/remove comments. User will be able to attach files to the card. User will have the option to “connect” cards, so if you open one card there is a place with links to directly open connected cards.

The card will have a way to inform which equipment are being maintained on that card, selecting tags and/or serial numbers from MMT database.

Module will have a filter tool to allow filtering the cards by status (overdue, due next week, due tomorrow, completed), FPSO, equipment (tag and/or serial number), responsible or free text that will be search on title, description or comments.

When accessing module 6.3, user will be able to open directly cards related to that equipment.

Development of specific UI for this module can be replaced with an integration with existing tools such as Microsoft Planner. SBM approval is required.

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## 6.7 SYNCHRONIZE DATA MODULE

This module will be responsible to get data from the flow metering system offshore. Contractor will create a single software to be installed on the HMI running Windows to connect to flow computers Omni 6000, Floboss S600, Floboss S600+ and ABB Flow X and read required data.

The software will be able to automatically share the data through the internet to MMT according to SBM IT requirements and to dump, on demand and daily, the data to a file that can be retrieved from the HMI via flash drive and uploaded to MMT.

For high frequency data such as process variables like flowrates, pressure, temperature etc., contractor will deliver a software that will read data from AVEVA PI system on SBM servers and upload to MMT.

## 6.8 MONITORING & ALERTS MODULE

This module will be responsible for checking if the metering system is in conformity with standards and regulations in terms of deadlines and configuration. In case any deviation is found, ME will be alerted by e-mail, Whatsapp (or SMS) and on a dedicated screen inside MMT. The alerts will be configured on module 6.2 and segregated by FPSO and type of alert (system configuration, metrological confirmation, calibration/inspection deadline, sampling deadlines etc). For each type of alert and each FPSO user will be able to include an e-mail and Whatsapp list and select which users from MMT will receive the alert inside the tool.

On the alerts screen, users will need to acknowledge every alert to confirm it was read and understood. MMT will keep track of which user acknowledged and when. For a set of alerts which will be described later at this section, users will need to write a justification on the alert or link it with other events inside MMT (equipment replacement, failure notification etc). User will have an option, turned on by default, to select if MMT should run the check for that parameter again after acknowledging the error. This can be used for example if a calibration certificate was not loaded into the system and MMT identified a wrong calibration curve, but in fact was a managing problem. After uploading certificate, user may want MMT to check again if calibration curve is correct.

User will be able to filter alerts per FPSO, date, metering system tag, type of alert (system configuration, metrological confirmation etc) and alert status (acknowledged/not acknowledged).


### 6.8.1 System Configuration

MMT will check the flow metering system offshore configuration, with data provided per module 6.7, to confirm everything is configured according to last certificates, uncertainty calculation, laboratory analysis etc. The purpose is to confirm that system is operating according to all metrological data.

These checks must be done on both, system configuration directly and ANP regulatory XML files generated and loaded to MMT.

In these alerts, during the acknowledgement, user will have the option to link it to an existing failure notification or equipment replacement action.

These checks must be done for each production day.

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Rules to be applied may be found on the non-extensive list below:

1. Orifice plate/straight run/cone diameter, expansion coefficient and reference temperature according to last valid inspection certificate.
2. Flowmeter calibration curve (k-factor and/or meter factor) according to last valid calibration certificate.
3. Equipment serial numbers according to information of currently installed equipment on module 6.3.
4. Analogic transmitters range (zero/span) according to last valid calibration certificate.
5. Split range transmitters switch thresholds according to transmitters range.
6. Alarm limits according to uncertainty calculation, operational limits, calibration certificate and legal limits (INMETRO PAM). Rules for calculating alarm limits to be set on module 6.2.
7. Alert for parameters that should not change and changed (reference pressure, reference temperature, atmospheric pressure etc)
8. Alert for parameters that should change every day but did not change (daily production volume if not zero, CPL, CTL etc)
9. Meter factor/k-factor Deviation
10. High Deviation on pipe or orifice plate bore size

#### **6.8.2 Metrological confirmation**

MMT will check for document control gaps. Alerts will be issued if documents that should already be loaded to MMT are still pending, based on calibration/inspection executed date (filled in advance), certificate issue date, etc.

MMT will check if system variables (daily averages for pressure, temperature, differential pressure, and flowrate) are operating inside alarm limits. Flowrate average will be calculated based on daily volume divided by the number of hours system operated.

MMT will check the perpetual totalizers. The value for the totalizer at the end of the day should be equal to the beginning of the day plus the production of the day.

#### **6.8.3 Calibration/Inspection frequency**

MMT will keep track of the calibration/inspection plan and alert users when calibration/inspection is close to expiration date (number of days to be configured on module 6.2), a new alert on the day of the expiration and new alert when it becomes overdue.


#### **6.8.4 Sampling**

MMT will create alerts in advance for each step of the sampling process (take sample, deliver sample to lab, issue report, validate report, issue validation report, configure flow computer). The number of days in advance for each step will be configurable on module 6.2. Alerts will also be created on the last day and one the day it becomes overdue.

#### **6.8.5 Failure notification**

MMT will create alert when failure notification is open by the last day of the month, so user can create an "intermediate" one.

Alert will also be created if a failure notification of type "initial" is open for more than 240

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hours so user can create the “final” type.

### 6.8.6 Oil/Gas properties

Check oil density, gas composition and gas isentropic/viscosity when applicable, against latest approved and validated laboratory report and alert in case of inconsistency.

If case of daily laboratory reports, alert if the report for the day is not available on MMT.

## 6.9 EXPORT DATA MODULE

This module will be responsible of exporting data for auditing purposes.

The intent of this tool is to comply with the audit process, where client and government agencies request all files to be sent on a digital format.

As a basis, MMT will be capable of exporting in Excel and PDF file all lists that are available on the software itself.

On top of that, MMT will export all files and reports available on the tool in a structured way.

ME will have a selection window to inform MMT which files should be exported. The filter will have at least the following parameters:


1. Show the FPSO tree so ME can select FPSO, systems and/or tags.
2. Date interval.
3. Which files should be exported:
  - Calibration certificates
  - Uncertainty calculations uploaded
  - Uncertainty calculations generated by MMT
  - Calibration flow computer evidence
  - Sampling report, validation report and/or flow computer evidence
  - Equipment change report from module 6.3

MMT will export a zip file with folders following the structure below, where the text between quotes means the literal name of the folder and the others are the information to be filled by MMT:

4. FPSO trigram
  - “Metrological Confirmation”
    - System Tag
      - YYYY-MM-DD \* (see below for \* details)
  - Chemical analysis
    - Sample point tag – Sample point name
      - YYYY-MM-DD (sample date)

\* YYYY-MM-DD is the date of the event (calibration, inspection, replacement etc) followed by one or a combination of the letters as per description below:

5. P – Primary – to be used for flowmeter calibrations
6. S – Secondary – to be used for PT/TT/DP calibrations

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7. OP – Orifice plate – to be used for orifice plate inspection/replacement
8. SR – Straight run – to be used for straight run/zanker inspection/replacement
9. UN – Unavailable – to be used when system is made unavailable as per reference [4]
10. AV – Available – to be used when system is made available as per reference [4]
11. R – Removal – to be used when primary element is removed from the line without system being made unavailable

## 6.10 PLANNING MODULE

This module will be where the user will spend most of his time. Its where he sees all outstanding activities, set planned dates, report completion and get shortcuts to upload documentation.

User will be able to quickly alternate using tabs between two views: calendar and list. On the calendar view, it will be possible to select to see a specific day, week or month or a user defined period. On each view, activities will be grouped by day of expiration. A button will be available to export outstanding activities on the view to a Excel or PDF file. User will have the option to export only selected items according to filtering in place or all available items.

A filter will be available to select FPSO, time period and activity. Activities will be the type of work that needs to be done: plan calibration/inspection, execute calibration/inspection, take sample, issue report, issue certificate, issue uncertainty calculation, update flow computer etc.

When the user clicks on the outstanding item, he will have a popup to complete that task. For example, if activity is to plan a calibration, a popup will have required fields such as planned date, so user can complete and save, updating the calendar immediately. Both views will be color coded based on the activity and have a traffic light icon showing if activity is overdue, close to expiration date or there is still time to complete it. The adjustment of each color limit on the traffic light icon will be done on module 6.2.

User will be able to mark tasks as “mitigated”, providing attachments and a new due date will then show this task on a different color and handle it separately on the KPIs.

## 6.11 FAILURE NOTIFICATION MODULE


The specification for this module is ANP Resolution 18/2014. Module must be capable of creating, editing, storing and managing all aspects of the failure notification process according to regulation, except creating XML file and sending it to ANP using web service. But the data necessarily to generate XML file must be available in the tool.

Each failure notification must be approved by ME.

User will be able to save the failure notification report in PDF or Excel.

It will be possible to set up a list for each FPSO for e-mail addresses to receive the report in PDF and Excel format automatically after its approved by ME.



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## 6.12 HISTORICAL REPORT MODULE

This module will be used to store generic report from the unit, which are not necessarily regularly done.

User will just have a window to select the file, date, FPSO and type of report. Tool will keep track of the user who uploaded the file and when.

On module 6.2 admin will configure type of reports available (offloading report, ANP letter, daily HMI file collect etc).

Bulk upload options will be available, so multiple files are uploaded at once.

Each file may or may not be linked to a FPSO, a metering system or a serial number.

## 7. POWER BI REPORTS

Three reports will need to be developed on Power BI using data from the software:

1. Calibration KPI – lagging + leading
2. Sampling KPI – lagging+ leading
3. Outstanding activities
4. Completed activities

Each report will have filters for the period (selectable per month or exact date), units and system classification (Fiscal, Allocation, Custody Transfer, Operational).

The activities report will have a table with at least the following columns: FPSO, system tag, instrument tag, system description, instrument description, due date, planned date, executed date. Report will have an s-curve showing planned versus executed calibration.

## 8. NON-FUNCTIONAL REQUIREMENTS

Software shall be web based with all its functionalities accessible using a web browser without the need of installation of any additional software on end users computers.

## 9. USER ACCESS

Admin will be able to create a user, giving it at least a username, name, password, e-mail and company.

Admin will have the ability to create user “roles” and to each role configure the level of access.

When creating a role, admin will be able to choose for each module if user will have read and/or write access and which FPSOs are accessible.


Admin will then add a role to a existing user. Each user may have one or more roles.

Users will have access to a “forgot my password” link to recover forgotten passwords.

## 10. USER INTERFACE

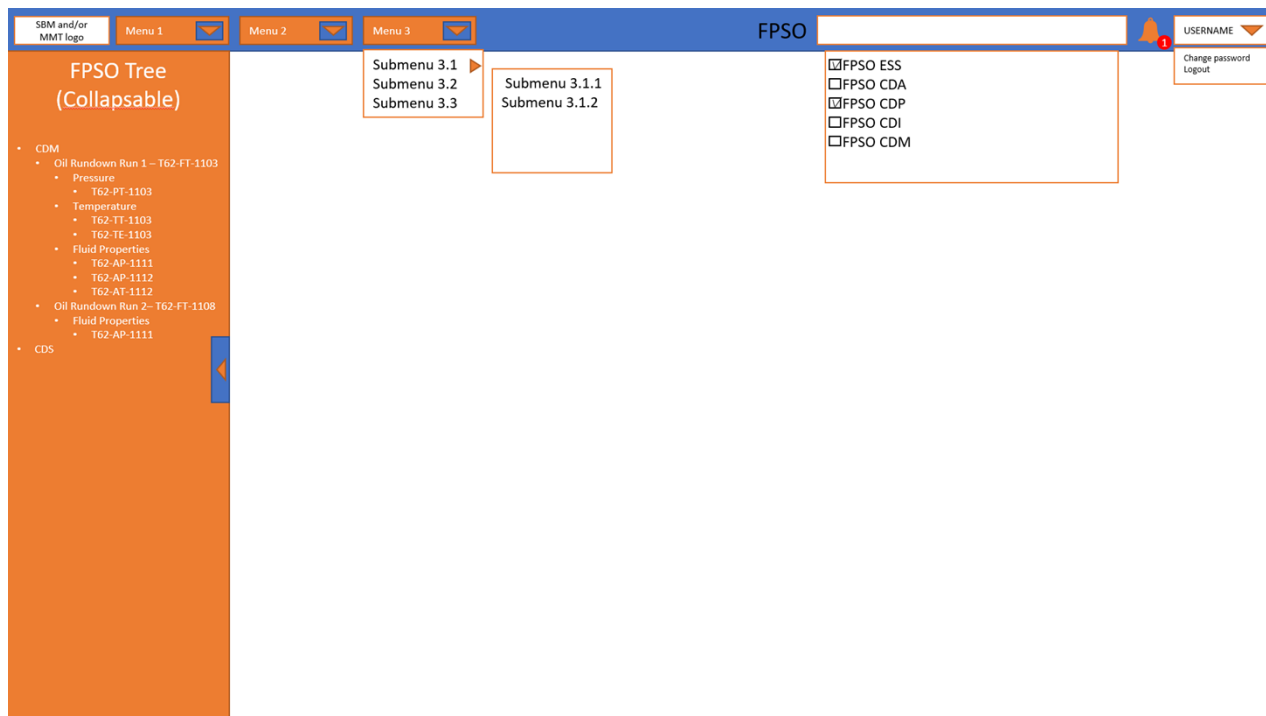
The user interface should be intuitive and all screens must be easy to access. MMT must be developed around the process described in this document in a way that a logical sequence is available on the software to navigate from one step of the process to the



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other without requiring multiple clicks and change of screens.

A general arrangement for the software is shown on Figure 5. This is just a mockup and improvements to it shall be done by contractor. The colors are used just for contrast and are not the required colors for the final application.



**Figure 5 – General MMT Layout**

## 11. DATA REQUIREMENTS

Contractor will liaise with all necessary stakeholders at SBM to guarantee all data requirements are mapped and a plan on how to get the data, store and use it is in place, specially for item 6.7.

## 12. PERFORMANCE AND SCALABILITY

MMT performance will be evaluated for acceptance. No screen loading time should be bigger than 10 seconds. Registering a calibration and issuing an uncertainty calculation report shouldn't take more than 1 minute for a trained user.


MMT must be able to support at least 10 simultaneous SBM users.

## 13. DEPLOYMENT

MMT will be deployed in phases, each phase will consist of an individual module. After each deployment, users will test and provide feedback for the developers. Timeline for repairs to be discussed at each phase.

Deployment plan and procedures to be defined between Contractor and SBM IT.

A suggested prioritization for the modules development is indicated below:

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1. Configuration
2. Managing Equipment
3. Chemical Analysis
4. Planning
5. Export Data
6. Synchronize Data
7. Monitoring & Alerts
8. Metrological Confirmation
9. Failure Notification
10. Historical Report
11. Onshore Maintenance

Care must be taken to ensure that when a module is developed, required features depending on other modules are already implemented. For example, to use Manage Equipment Module, you need Configuration Module to have the features to create equipment.

#### **14. TESTING**

The Contractor's deliverables will undergo UAT to ensure their validity.

Contractor shall issue a UAT document to guide the users on the validation, with test cases and a feedback form that shall be compiled on a final testing report for the application.

The entire solution will be delivered incrementally, allowing for independent deployment and validation.

#### **15. APPENDIX**

<b>APPENDIX A</b>	<b><u>OFFSHORE PROVING CERTIFICATE</u></b>
<b>APPENDIX B</b>	<b><u>VALVE LEAK TEST REPORT</u></b>
<b>APPENDIX C</b>	<b><u>SAMPLER TEST REPORT</u></b>
<b>APPENDIX D</b>	<b><u>EQUIPMENT CHANGE REPORT</u></b>