Bika Tribos 1 - LIMS for tribology

Functional specification and use cases. New functions only

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Table of contents

1 Purpose of this document

This document is used to establish a common understanding of what is required from the LIMS application at the laboratory. Cases and functionality in the LIMS are described in layman's language here. In this version, functionality new to Bika LIMS 2 only

It also serves as a functional specification for programmers working on the project and quality management tool

It is used to estimate development cost and establish a quote for the LIMS

2 Document history. Notes to version 1.0

Version bump to 1.0 'Final'

Earlier, v 0.9

- First stab at Diagnostics
- Specifications and its implications expanded, on
  - Profiles
  - ARs lists and views
  - Worksheets
- Instrument Interfaces added
- Worksheets and flow detailed

All texts in red require specific attention. Blue texts will be expanded in future editions

Earlier versions of this document

V.08 Simplified Order items in first expansion. Changes after feedback

V. 0.6 Changes after feedback from the lab

V. 0.5 first early draft

3 Definitions

Analysis Request (AR) is the collection of analyses requested for a specific sample, the most important building block in Bika Tribos

Analysis Service is the term used to describe the analyses, or tests, offered by the lab and are configured in the LIMS set-up with titles, units, methods etc..

Lab Technicians, or analysts, are responsible for analysing the samples in the lab

Work sheet, a collection of analyses grouped together for a logical purpose, e.g. to be executed at the same work station, on the same instrument or by the same analyst

TAT, turn around time

3.1 Tribology terminology

CC, Circulating Currents

Dissolved Gas Analysis (DGA), the single-most comprehensive asset condition assessment and management tool for oil-filled transformers. DGA offers advanced detection of incipient fault conditions

Flame Ionization Detector (FID), one of the many methods by which to analyse materials coming off of gas chromatography column. The detection of organic compounds is most effectively done with flame ionization

OH, Over Heating

PD, Partial Discharge

TDGC ppm/day, Total dissolved gases

Thermal Conductivity Detector (TCD), another method by which to analyse materials coming off of gas chromatography column

C2H2, Acetylene

C2H4, Ethylene

C2H6, Ethane

CH4, Methane

CO, Carbon Monoxide

CO2, Carbon Dioxide

H2, Hydrogen

4 Clients and Owners

Lab Clients are maintained as per standard Bika Organisation and Contacts structure

They are not to be confused with 'Owners' that own transformers and machines that are sampled for oil analysis

The Lab provides tribology analysis to lab clients that service the machines owned by Owners

Machine Owners may appoint different service companies, lab clients, at different times

Machines, called Sample Sources here, may also change hands. They include transformers, road tankers, production tanks, etc.

4.1 Client tabs thus

Client views has an extra tab leading to a page listing all the Sample Sources the client has requested analyses for

Authorised users may drill down onto the Sample Source's data

Only the Sample Sources listed for the client are available for selection when editing Samples or Analysis requests

Client Sample Sources are populated from a global list of Sample Sources maintained in the System Set-up

4.2 Owners in the set-up

A list of Sample Source Owners are maintained in the system set-up,accessible by lab managers only

Owners are maintained in the standard Bika organisation and contacts design

5 Orders

Ideally the advanced Order batching system specified earlier for Benchmark laboratories should be developed, please see the Addendum A

The inheritance of AR, Worksheet and Analyses statuses in managing all of the the order workflow, especially for data failing verification, makes for a lot of programming.

For cost objectives this specification here, customisations are proposed to standard data objects to group ARs together for the same Client Order but without providing workflow management at Order level

No Orders object/table is used in this simplified execution, all actions are carried out referencing the Order field on ARs. Order statuses and audit logs can therefore not be maintained

At the lab' current volumes this should be feasible. The full Order batching could be considered in a phase 2

5.1 Customisations required for Orders

The Client Order ID fields are added to all ARs and can be used to take certain actions per order:

5.2 Create worksheets

On the form where search parameters are specified for finding analyses to include on a worksheet. an extra order number field is provided for to be included in the search parameters

Since no order object as such exists, a look-up list of order numbers for a specific client for which the analyses have not been done, will degrade performance of the form and it won't be included. Order numbers are short enough for users to key in

5.3 List Client Order ARs

On the Client's set of action tabs, e.g. |ARs|, |Imports|, etc., an extra tab, |Orders| is displayed

It opens a list of the Client's Orders from where the user can drill down to list all the ARs per Order, including their statuses. The ARs in turn are hyperlinked to their detail pages

No Order status or audit log is available. Since the AR statuses are shown, these lists can be used to visually assess the overall status of the order

Clients have access to their own Order list. As per Bika standard, only verified results are ever available to Clients

5.4 Order details view

There is no detail view per Order but the list of ARs per Order that can be reached from the Orders list described above

5.5 Global Order list

Similar as the list per Client but available from the global menu bar available to lab staff

It has an extra column for Clients

5.6 Query Order Analyses

An extra parameter for Order number is available on the AR Query form

5.7 Reports per Client Order

An extra parameter for Order number is available on AR and Analyses report forms

5.8 Invoices per Client Order

The invoice batching functionality is enhanced to group ARs per order number on invoices. One invoice is issued per Order

This does leave the opportunity for incomplete orders to be invoiced if only some of the ARs on it have been published. The others will be included in a next Invoice batch and the ARs were completed. The Client will then eventually end up with more than 1 Invoice per Order

If inconvenient, Lab staff will have to visually manage this by only publishing ARs for an Order when all of them are ready

5.9 Supply orders

Supply Order refers to the Clients' ability to order supplies directly from the lab. This is currently called Orders in Bika 2.1 and has to be renamed not to be confused with Client Analysis Orders as described above

6 Sample Sources and Sample point

A main departure point from Bika LIMS trunk functionality, is Bika Tribos' treatment of Sample origin in a 2 tier structure where

1. a Sample Source indicates a 'machine/container', typically a transformer, engine, road tanker, production tank, etc.

2. Sample Points indicate a further differentiation of sample points on the transformer, e.g. sump, selector, conservator etc.

A Sample Source is a collection of Sample points

6.1 Sample Sources

These can be transformers, tankers or any other collection source where oil and lubricant samples are taken for tribology analysis

Since different lab clients may service the same Sample Source at different times, Sample Sources are maintained centrally in the system

With attributes:

Class – populated from a global list

Owner – populated from a global list

Location – populated from a global list

Serial Number

Transformer. Make – populated from a global list

KVA

HV/LV

Remarks/ Comments

Spec Oil Capacity - Kg

Spec Oil Capacity – Lt

List of Sample Points – populated from a global list

6.1.1 Sample Source Sample Points

Each Sample Source, e.g. a transformer, has a number of physical Sample Points on it where samples can be taken

A global list of all possible Sample Point Types is maintained in the LIMS set-up, it includes values such as:

Buchholz

Bottom main tank

A-Phase Diverter

Selector

B-Phase Diverter

Conservator

C-Phase Diverter

When a new Sample Source is created or edited, its collection of sample points is populated from this global list

6.2 Viewing a Sample Source's results

Like the standard AR lists, Sample Sources are listed from tabs globally, and also per Client

An important difference is that, results for a sample source could be listed for more than on Client if different Clients brought in samples from the particular source at different times. In such a case, Clients still gets to see only the data they own themselves

The lists contain columns for:

Transformer make

Class

Owner

Location

Serial Number

When the user clicks on the Sample Source listed, he/she is led to a list ARs attributed to that Sample Source. These conform to other AR lists in the LIMS, and can be similarly listed per status by clicking the desired radio buttons

6.3 Query results per Sample source

In addition to the standard query parameters already in place, the Query screen includes a lookup field from where the Sample Source can be specified as parameter for the Query

6.3.1 Sample Source types

Sample Sources are classified in the system and maintained on a global Types list as

Transformers

Tankers

Diesel engine

Gearbox

Aeroplanes

etc.

6.3.2 Location, Make

Sample Source Location and Makes are maintained in the LIMS set-up for global use on selection lists

6.4 Ownership change

When a Sample Source, e.g. a Transformer changes ownership, the lab manager navigates to it and edits the ownership field. Owners already in the database are available for selection, new ones automatically added

6.5 Location change

When a Sample Source, changes location, the same procedure is followed - the lab manager navigates to Sample Source and edits the location field. Locations already in the database are available for selection, new ones automatically added

7 Samples

Labs may create multiple Analysis Requests (ARs) per sample, say secondary analyses or re-tests

99% Of samples will however remain in a 1 – 1 relationship to ARs. Sample records are created automatically per AR and have the same serial number as the AR but with a different prefix and a postfix to indicate the sequence of the AR on that specific Sample

Samples can be looked up in a sample list, but not created there. Sample records are only created when a request for analyses on the sample is created

Use case:

When an Analysis Request is created, it is given an ID of AR09-001-**01**. A corresponding Sample record is created with ID SR09-001

If the user wants to create a secondary AR for the same sample at a later stage, she is offered a button to select the Sample off the database. For the above sample S-001 the system then produces an ID of AR09-001-**02**

7.1 Samplers

A global list of staff, internal and external, who are authorised to do sampling at Sample Sources, is maintained in the system set-up

These Samplers are then made available for selection when Sample objects are created or edited

The value defaults to 'client' when created – to take care of instances when the client did not note the Sampler's name

8 Analysis Requests. ARs

An Analysis Request is the collection of analysis services ordered to be executed on a Sample. Clients and lab staff use this facility to create, edit and manage ARs per sample

Standard Bika workflow is followed with additional information captured for ARs and Samples

1. Client Order # (not compulsory as not all clients provide order numbers)
2. New field Sample Source (compulsory, looked up from the Client's Sample Sources)
3. Subsequent Sample points presented for look-up at AR creation, are restricted to those on record for the Sample Source specified
4. Analysis priority (defaults to 'Routine')
5. Sampler (compulsory, looked up from set-up list)
6. Sample temperature at sampling (optional)
7. Sub contractor (default to the default subcontractor assigned in the Analysis set-up but a look-up provides alternatives from the full list of subcontractors approved for the analysis. If the analysis is set-up for the lab to do the analysis themselves, this field is presented blank)

8.1 Analysis prioritisation

the lab prioritises analysis requests as:

Routine – as per standard TAT set in the analysis' set-up

Urgent - 12 to 24 hours depending on the number and the type of test requested

Immediate - while the client waits approximately 1 to 2 hours (Instrument max time plus 40 min)

Clients pay a price premium for prioritised service

The LIMS facilitates:

1. Configuring the levels of urgency and their premiums percentages in the LIMS set-up
2. Allowing the urgency of new ARs to be set, calculating pricing per AR and due dates accordingly
3. Sorting ARs on their due dates and highlighting the most urgent analyses on both the lists and views
4. When a parent object, like an AR, gets set with a certain priority, all children objects, Analyses, immediately inherits the same priority and the new priority is reflected in all lists and views

8.2 Calculated and dependent analysis results

Calculated analyses and their dependent analyses are maintained by labmanagers in the set-up

When a user selects an a calculated analysis at AR creation, the system includes all dependent analyses on the form if the user neglected to do so him/herself and asks the user to confirm due to the cost implications

When the dependent results are all available, the calculated result is determined and included. The calculated results track the status changes of their dependencies

8.2.1 Acid Number

The acid number depends on the following analyses:

Titration (ml)

Sample weight

Weight of PHP (weight of oil sample)

KOH

The formula applied:

$$\text{Acidity (mg KOH/g)} = \frac{56.1 \times \text{Titration (ml)} \times \text{Normality}}{\text{Sample weight (g)}}$$

$$\text{and the factor Normality} = \frac{\text{weight of PHP (g)}}{0.20422 \times \text{KOH (ml)}}$$

8.2.2 Relative paper saturation as an effect of temperature

IEC 60422

From OILRESUN REV4_23_08_08.xls

For samples taken at temperatures less 20 °C use the formula below to establish the water saturation in paper

Ws = Solubility of water in unused mineral insulating oil

Log Ws=7.0895 – (1567/TK)

TK is the temperature in Kelvin

% Saturation = (H20 ppm / Ws)*100

For samples taken at temperatures higher than 20 °C use:

f = correction factor for moisture of a sample taken at a temperature higher than 20 Deg C

f = 2.24*exp(-0.04*ts)

ts is the sample temperature

% Saturation = H20 ppm / f

8.3 AR lists and views, results publication

Extra fields Sample Source on lists and view headers, hyperlinked to its corresponding detailed view

On AR views, a new column indicates which Diagnostic Specification applies per Analysis row. Values are hyperlinked to the Specifications

A footnote indicates which Analyses were sub contracted including the subcontracting lab's name

8.4 AR edits

All the new fields are available on the AR's edit tab too

8.5 AR publications per Sample Source

Since each sample source requires an individual report, the LIMS publishes analyses results grouped per Sample Source

For the case of results of unreferenced results, the user is offered the option to toggle this functionality off, default on, on the AR lists. Not on each individual AR, it does not make sense there

No more than 4 results column per fax, 5 per print, all columns per e-mail. Results exports per csv are also done per Sample Source, 1 Sample Source per spreadsheet

Standard Bika 'pre -publishing' rules apply, partial results may be published per Sample Source, but only verified results. Results due are indicated as such on the reports

9 AR Profiling

In the laboratory workflow, it regularly happens that the same collection of analyses are requested for samples. As an efficiency measure, these ‘standard’ ARs are saved as AR profiles in the LIMS, per client, and are accessed when ARs are created

In addition, users may specify which specifications to be applied, per Analysis Service. In Bika Tribos it is possible to also include which specification to apply on Profile. These are available from a lookup maintained in the LIMS set-up and typically include, IEEE, ISO, etc.

Clients may edit and create their own profiles while the lab maintains its own set. The same lookup for specifications are available to them

The AR created from a Profile can still be edited at runtime with analyses added or removed

The runtime edited AR can be saved as profile for later use

In the lab' case, a profile can be created once for the DGA Dissolved Gas group of analyses and used every time it is required to request those analyses for a sample

9.1 Profiling per Sample Source

Samples are analysed for all the different sample points on a Sample Source separately per individual ARs, It makes sense to extend AR profiling to auto-complete both all the Source's sample points and analyses routinely requested for that type of transformer

When a user selects such Sample Source profile at AR creation, the LIMS creates ARs for all the Sample points and Analyses specified in the profile template and presents it to the user for submittal. The AR form remains editable and the user may add or remove analyses or sample points

10 Analysis Specifications

This module enables the system to keep minimum and maximum allowed values for each analytical service offered, used to highlight and report on out of range values during data capturing

These values may differ between sample types and Diagnostic Specification applied in the lab' case. Furthermore, different specifications may apply to the different tests carried out on the same sample and reported on on the same AR

These specifications are set-up and maintained in the LIMS set-up

Per Analysis Service

per Sample Type

per Diagnostic Specification

E.G. The latter can be any of SNAS, IEC, IEEE, ASTM, IEC, IEEE, ASTM, Dunenburg, UC or Duval

After data capturing, say on ARs or Worksheets, out of range values are shown in bold red and an error icon displayed

An extra column on AR and Worksheet views and prints, indicates per Analysis which Diagnostic Specification applies

A set of specifications is maintained for the laboratory's own use by the labmanager – also per sample type and analysis

On pages where results are shown, users have the option to switch between the different Lab's and the different Diagnostic Specifications available – out of range alerts are correspondingly adjusted on the pages after a new and different specification was selected

11 Diagnostics

The goal of this functionality, is to provide advice to the client for maintenance on the Sample Source (transformer, etc.)

The LIMS presents possible faults deducted from the analysis result for the Sample Source from a look-up table, and report a corresponding instruction from the table

These are presented to the user, authorised to carry out the diagnostic interpretation, when the AR is in the 'to be verified state' in an editable free text field

Relying on his/her experience, only senior chemists should typically be assigned this role, the user may edit the field before verifying the AR

Since the AR should not be published before this field entry has been approved, a 'Diagnostics verified' checkbox next to the field has to be checked before the AR can be verified

It makes very good sense to introduce a **new state** for results meaning 'results are verified, diagnostics awaiting approval'

Ditto a **new role**, 'diagnostician' – this would make for more efficient management as users assigned this role can be alerted to pending results

1. this allows for different staff members to be authorised for results verification and diagnostics approval
2. both steps can be properly logged
3. the extra check box could be done away with
4. it won't introduce costly coding for an extra state on individual analyses, it only applies to ARs

The Fault is dependent on

Analysis results and combinations thereof

Sample type

Sample Source Type (type of transformer etc.)

Specification (NRS-079, SECR, CEGB/ANSI/IEEE, etc.)

11.1 Applying diagnostics

Use case 1: Editing and approving diagnostics without additional state and role

Role player: labmanager, verifier

1. the user navigates to the AR in to be verified state, from an alert, AR list or elsewhere
2. he/she scans the results and subtract the AR if any needs re-testing
3. if the results are in order, the user sets about interpreting the results
4. the system offers 'probable causes and most likely' reasons from its look-ups in a free 'Diagnostics' text field that the user may edit
5. a look-up list of causes and reasons is presented for the user to select texts from to include in the Diagnostics field
6. when done, the user checks, and 'Interpreted' checkbox to indicate that the diagnostics have been completed
7. the user verifies the AR per standard procedure
8. if the Interpreted checkbox was left unchecked, the AR does not get verified and the system returns the user and asks him/her to complete the results interpretation

Use case 2: Editing and approving diagnostics. New Interpretation role and status

Role player: labmanager, interpreter

to be expanded

11.2 Causes and reasons look-up

11.2.1 Normal Gas

Nitrogen and Oxygen as captured (ppm)

Carbon Dioxide must be bigger than IEC max limits, or set to 0 otherwise

Calculated field: Total Normal Gas ppm = Nitrogen + Oxygen + Carbon Dioxide

11.2.2 Combustable Gas

Hydrogen, Carbon Monoxide, Methane, Ethane, Ethylene, and Acetylene (ppm)

All set to 0 unless bigger than IEC max limits, in which case the captured value is retained

Calculated field: Total Combustible Gas (ppm), totals all of the above

Diagnostic: If the Total Combustible Gases > 750 ppm, then “highly combustible” canned text is displayed

11.2.3 TDGC ppm/day

Currently calculates daily average for same transformer from 2 samples in the same batch. This could be developed to include a default date range or number of historical analyses and plotted

Calculated field: TDGC ppm/day

11.2.4 Gas Generation Rate

Currently the system calculates the daily gas generation rate for the same generator's from 2 samples, 1 historical. This could be developed to include a default date range or number of historical analyses and plotted

Calculated fields: Gas generation rate = increase incombustible gases / number of days between samples

For Hydrogen, Carbon Monoxide, Methane, Ethane, Ethylene and Acetylene

Diagnostic: If the daily average TDGC could be calculated earlier, canned diagnostic texts can be looked up for the gas generation rate and combustible gases

The gas generation diagnostic is tried first but if the result falls outside the specified range, the combustible gas result is tried. If the value still fails to produce a text, 'Abnormal value' is reported

Assumption: Daily average TDGC not empty

	Gas generation rate		Combustable gas
Hydrogen	<=0.1	>=2	>35; <135
Carbon Monoxide	<2	>=10	>260; <1060
Methane	<=0.05	>=6	>10; <135
Ethane	<=0.05	Currently =6 ?	>5; <90
Ethylene	<=0.05	>=6	>32; <146
Acetylene	<=0.05	>=1	>=0

Canned text	Normal	Serious!	Normal gas levels
		else **Abnormal value**	

11.2.5 Gas Ratio IEC 60599

Where combustible gas values are bigger than IEC max limits, gas ratios can be calculated

Calculated fields:

Gas Ratios

Acetylene/Ethylene, C2H2/C2H4

if C2H2 and C2H4 both >10 and C2H4>0, then C2H2/C2H4 else 0

Methane/Hydrogen, CH4/H2

if CH4 and H2 both >10 and H2>0, then CH4/ H2 else 0

Ethylene/Ethane, C2H4/C2H6

if C2H4 and C2H6 both >10 and C2H6>0, then C2H4/ C2H6 else 0

Ethane/Methane, C2H6/CH4

if C2H6 and CH4 both >10 and CH4>0, then C2H6/ CH4 else 0

Carbon Dioxide/Carbon Monoxide, CO2/CO

if CO > 0, then CO2/CO, else 0

Ethane/Acetylene, C2H6/C2H2

if C2H2 > 0, then C2H6/C2H2, else 0

Acetylene/Methane, C2H2/CH4

if CH4 > 0, then C2H2/CH4, else 0

11.2.6 Ratios codes

These seem currently to be set to 0, 1 or 2 to be used in further table selections. Could be simplified

Calculated fields

Acetylene/Ethylene, C2H2/C2H4

= 0 if >0 and <0.1

= 2 if >3

= 1 if >=0.1and <3

= 0 else

Methane/Hydrogen, CH4/H2

"= if (AND(D41>0;D41<0.1);1; if (AND(D41<1;D41>0.1);0; if (D41>1;2;0)))

= 1 if >0 and <0.1

= 0 if <1 and > 0.1

= 2 if >1

= 0 else

Ethylene/Ethane, C2H4/C2H6

"= if (D42<1;0; if (D42>3;2; if (AND(D42>=1;D42<=3);1;0

= 0 if <1

= 2 if >3

= 1 if >=1 and <=3

= 0 else

11.2.7 % Combined Gas

Calculated fields: If the Total combustible gas is bigger than 0, then for each of these gases, if result bigger than IEC max limits, calculate its percentage of the total:

Hydrogen

Carbon Monoxide

Methane

Ethane

Ethylene

Acetylene

e.g., % Hydrogen = Hydrogen / Total combustible gas

11.2.8 % Gas Extracted

Calculated field: Adds up all gas values, regardless of IEC max limits, including Nitrogen and Oxygen

H2, O2, N2, CH4, CO, CO2, C2H2, C2H4 and C2H6

11.2.9 Diagnosis – Water, Acid, Dielec

Diagnostics

Water

>20 " TOO HIGH"

<20 "OK"

=20 "ON LIMIT"

Acid

>0.2 " TOO HIGH"

<0.2 "OK"

=0.2 "ON LIMIT"

Dielectric

If spec is SANS

>=30 "OK"

<30 " TOO LOW";

If spec is ESKOM

>=70 "OK"

<70 "TOO LOW"

11.2.10 Code of Ratios

Use the Ratio code obtained earlier, and look up a potential fault from this table:

Code	Fault	Typical Possible faults
000	No fault	Normal Ageing
010	Partial discharge Low Energy Density	Discharge in gas-filled cavities resulting from incomplete impregnation , or super-saturation or cavitation or high humidity, leading to tracking or perforation of solid insulation.
110	Partial discharge Low Energy Density	Discharge in gas-filled cavities resulting from incomplete impregnation , or super-saturation or cavitation or high humidity.
101	Discharge of Low energy	Continous sparking in oil between bad connections of diferent potential or to floating potential. Breakdown of oil between solid materials.
202	Discharge of Low energy	Continous sparking in oil between bad connections of diferent potential or to floating potential. Breakdown of oil between solid materials.
102	Discharge of High energy	Discharges with power follow-though Acing-breakdown of oil between windings or coils to earth. Selector breaking current.
001	Thermal fault of Low Temperature < 150°C	General inslated conductor overheating
020	Thermal fault of Low Temperature 150°C to 300°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.
021	Thermal fault of Medium Temperature 300°C to 700°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.
022	Thermal fault of High Temperature > 700°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.

11.2.11 IEC max Limits

The IEC max limits are applied in many places here, if a value is smaller than the limits, it is often considered to be 0

Different limits corresponding to the type of transformer Power, Distribution or Furnaces are applied

Calculated Fields: Foe each of Hydrogen, Carbon Monoxide, Methane, Ethane, Ethylene, Acetylene and Carbon Dioxide, lookup a value corresponding the transformer type in the shaded area of the table below. If no Transformer type is available, use the Distribution value

IEC 60599

ul/l	Power Min	Max	Distribution	Furnaces	Power ppm	Distribution ppm	Furnaces ppm
Acetylene	2	20	5	0	16	4	0
Carbon Dioxide	3800	14000	5000	6000	10906	3895	4674
Carbon monoxide	400	600	200	800	467	156	623
Ethane	20	90	50	150	70	39	117
Ethylene	60	280	50	200	218	39	156
Hydrogen	50	150	100	200	117	78	156
Methane	30	130	50	150	101	39	117

11.2.12 CSUS Guideline

Diagnostics

For all values bigger than IEC max limits:

Hydrogen	if >1000 display "Corona arc" else nothing
Methane	if >80 "Sparking" else nothing
Ethane	if >35 "Local over heating" else nothing
Ethylene	if >100 "Severe over heating" else nothing
Acetylene	if >70 "Arcing" else nothing
Carbon Monoxide	if >1000 "Severe over loading" else nothing
Carbon Dioxide	if >15000 "Severe over loading" else nothing

11.2.13 Rogers Ratio method

Gas ratios C2H2/C2H4, CH4/H2, C2H4/C2H6 and C2H6/CH4 are used in the following formulas to provide canned texts

Normal Ageing

if (and (and (and (and (CH4/H2 >0.1; CH4/H2 <1); C2H6/CH4 <1); C2H4/C2H6 <1); C2H2/C2H4 <0.5)

Corona Partial Discharge

if (and (and (and (CH4/H2 <=0.1; C2H6/CH4 <1); C2H4/C2H6 <1); C2H2/C2H4 <0.5); if (and (and (and (C2H2/C2H4 <>0; CH4/H2 <>0); C2H4/C2H6 <>0); C2H6/CH4 <>0)

Partial Discharge Corona with Tracking

if (or (and (and (and (and (CH4/H2 <=0.1; C2H6/CH4 <1); C2H4/C2H6 =1); C2H2/C2H4 >=0.5); C2H2/C2H4 <3); C2H2/C2H4 >=3)

Continuous Discharge

if (and (and (and (and (CH4/H2 >0.1; CH4/H2 <1); C2H6/CH4 <1); C2H4/C2H6 >=3); C2H2/C2H4 >=3)

Arcing with Power

if (or (and (and (and (and (and (CH4/H2 >1; CH4/H2 <1); C2H6/CH4 <1); C2H4/C2H6 >=1); C2H4/C2H6 <=3); C2H2/C2H4 >=0.5); C2H2/C2H4 <3); C2H2/C2H4 >=3)

Arcing without Power

if (and (and (and (and (and (CH4/H2 >1; CH4/H2 <1); C2H6/CH4 <1); C2H4/C2H6 <1); C2H2/C2H4 >=0.5); C2H2/C2H4 <3)

Slight Over Heating 150 °C

if (and (and (and (or (and (CH4/H2 >=1; CH4/H2 <3); CH4/H2 >=3); C2H6/CH4 <1); C2H4/C2H6 <1); C2H2/C2H4 <0.5)

Over Heating 150-200 °C

if (and (and (and (or (and (CH4/H2 >=1; CH4/H2 <3); CH4/H2 >=3); C2H6/CH4 >=1); C2H4/C2H6 <1); C2H2/C2H4 <0.5)

Over Heating 200-300 °C

if (and (and (and (and (CH4/H2 >0.1; CH4/H2 <1); C2H6/CH4 >=1); C2H4/C2H6 <1); C2H2/C2H4 <0.5)

Conduct Over Heating

if (and (and (and (and (and (CH4/H2 >0.1; CH4/H2 <1); C2H6/CH4 >1); C2H4/C2H6 >=1); C2H4/C2H6 <3); C2H2/C2H4 <0.5)

Circular Current – Windings

if (and (and (and (and (and (CH4/H2 >=1; CH4/H2 <3); C2H6/CH4 <1); C2H4/C2H6 >=1); C2H4/C2H6 <3); C2H2/C2H4 <0.5)

Circular Current – Core/tank

if (and (and (and (and (CH4/H2 >=1; CH4/H2 <3); C2H6/CH4 <1); C2H4/C2H6 >=3); C2H2/C2H4 <0.5)

In a table

These conditions can be summarised in the table below. Due to the various Boolean operators used in the original formulas, this table needs to be reviewed by an experienced chemist....

Canned text	CH4/H2	C2H2/C2H4	C2H4/C2H6	C2H6/CH4
Normal Ageing	>0.1; <1	<0.5	<1	<1
Corona PD	<=0.1	<0.5		<1
PD Corona withTracking	<=0.1	>=0.5; <3; >=3	=1	<1
Continuous Discharge	>0.1; <1	>=3	>=3	<1
Arc with Power	>1; <1	>=0.5; <3; >=3	>=1; <=3	<1
Arc without Power	>1; <1	>=0.5; <3	<1	<1
Slight Over Heating 150 C	>=1; <3; >= 3	<0.5	<1	<1
Over Heating 150-200	>=1; <3; >= 3	<0.5	<1	>=1
Over Heating 200-300	>0.1; <1	<0.5	<1	>=1
Conduct Over Heating	>0.1; <1	<0.5	>=1; <3	>1
Circular Current -Windgs	>=1; <3	<0.5	>=1; <3	<1
Circular Current-core/tank	>=1; <3	<0.5	>=3	<1

11.2.14 Dornenberg method

Diagnostics:

Hot Spots

if (and (and (and (CH4/H2 >1; C2H2/C2H4 <0.75); C2H6/C2H2 >0.4); C2H2/CH4 <0.3);;" ")

Electrical Discharges

if (and (and (and (and (CH4/H2 >0.1; CH4/H2 <1); C2H2/C2H4 >0.75); C2H6/ C2H2 <0.4); C2H2/CH4 >0.3)

Corona

if (and (and (CH4/H2 <0.1; C2H6/C2H2 >0.4); C2H2/CH4 <0.3)

----------8<---------

To be tabled

11.2.15 Damage

Dornenberg/Strittmatter. B.Boveri Rev.5-74

Diagnostics:

Local Over Heating

"if (and (and (and (and (D110=6; CH4/H2 >1); C2H2/C2H4 <0.7); C2H6/C2H2 >0.4); C2H2/CH4 <0.3)

Dis-Gas phase Possible

if (and (and (and (D110=6; CH4/H2 <0.1); C2H6/C2H2 >0.4); C2H2/CH4 <0.3)

Electrical Discharges

if (and (and (and (and (and (D110=6; CH4/H2 <1); CH4/H2 >0.1); C2H2/C2H4 >0.7); C2H6/C2H2 <0.4); C2H2/CH4 >0.3)

----------8<---------

To be tabled

11.2.16 Key Gas Analysis

Diagnostics:

Corona

if (and (Total Combustible Gases >0; % Hydrogen >0); if (and (Total Combustible Gases >300; % Hydrogen >0.25)

If Total Combustible Gases >300

Cellulose if % Carbon Monoxide >0.25

Heat if % Methane >0.25

High Heat if % Ethane >0.25

Severe Heat if % Ethylene >0.25

Arcing if % Acetylene >0.25

11.2.17 Note on TDCG content

Diagnostic: Using Total Combustible Gas

Code	min	max	Canned text	
1	0	500	Normal Ageing	6 to 12 Months
2	501	1200	Decomposition may be in excess of normal aging	3 Month
3	1201	2500	More than normal decomposition	1 Month
4	2500		Excessive decomposition	1 Week

11.2.18 Recommended resampling date

Look up from the above table using Total Combustible Gas

11.2.19 Typical Possible faults Code Ratio

Use the Ratio code obtained earlier, and look up a typical possible fault from this table:

Code	Fault	Typical Possible faults
000	No fault	Normal Ageing
010	Partial discharge Low Energy Density	Discharge in gas-filled cavities resulting from incomplete impregnation , or super-saturation or cavitation or high humidity, leading to tracking or perforation of solid insulation.
110	Partial discharge Low Energy Density	Discharge in gas-filled cavities resulting from incomplete impregnation , or super-saturation or cavitation or high humidity.
101	Discharge of Low energy	Continous sparking in oil between bad connections of diferent potential or to floating potential. Breakdown of oil between solid materials.
202	Discharge of Low energy	Continous sparking in oil between bad connections of diferent potential or to floating potential. Breakdown of oil between solid materials.
102	Discharge of High energy	Discharges with power follow-though Acing-breakdown of oil between windings or coils to earth. Selector breaking current.
001	Thermal fault of Low Temperature < 150°C	General inslated conductor overheating
020	Thermal fault of Low Temperature 150°C to 300°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.
021	Thermal fault of Medium Temperature 300°C to 700°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.
022	Thermal fault of High Temperature > 700°C	Local overheating of core due to concen-rations of flux. Increasing hot spots temperatures; varying from smal hot spots in core, overheating of copper due to eddy current, bad contacts/joints (pyroliti carbon formation) up t core and tank circulating currents.

12 Worksheets

12.1 Creating Worksheets

A new parameter, 'Sample Source' is available to select analyses for

12.2 Lists and views

On Worksheet lists, a Sample Source column indicates which Sample Source the collection of samples are form – that's if they are all from the same Source

Worksheet views include Diagnostics and Specifications information

Specifications are complicated, as it could be possible that different Specifications apply per Sample. Bear in mind that the specifications are applied per individual Analysis service

An extra column is shown from where the Specifications can be set for all of the Samples on the worksheet, per Analysis row

If different Specs apply the user drills down to AR resolution to see which applies and the Spec name is shown in a mouse over

12.3 Diagnostics workflow

The worksheets' workflow tracks that of its contained analyses and vice versa. Discussed at Diagnostics

13 Instrument interfaces

The instrument interfaces are implemented per comma delimited (. csv) text files in templates formatted for the instruments themselves

Sample information can be exported from worksheets. Imports are entirely governed by the import files generated by the instruments and results are matched per sample ID and AR analysis

13.1 Export

Use case: Export data to instruments

Role players Lab technician, Lab manager

1. The user opens a work sheet compiled earlier with analyses intended for a specific lab workstation or instrument
2. The user presses and [export] button
3. The system offers a look-up of instruments that are set-up for imports
4. The user selects an instrument
5. The browser presents the standard Linux/Mac/Windows 'save as... ' dialogue where the user selects a folder where the exported file must be saved
6. The user gives the export a meaningful name
7. and presses [save]
8. The system looks up the template for the selected instrument and saves the data to be exported in the designated folder with the name specified and using the template
9. The user may now import the file from the instrument's console

13.1.1 Export Templates

To be provided

13.2 Import

Use case. Import data to instruments

Role players Lab Technician, Lab Manager

1. The user navigates to the instrument import page

2. He/she selects the import template to be used for the instrument which produced the results from a look-up
3. He/she selects the file to be imported using the standard Linux/Mac/Windows browse function
4. The user clicks [import]
5. The system picks up the file and validates it while importing the data, matching it to sample ID and analyses on ARs. These might also appear on work sheets
6. To be verified, Verified and published data cannot be overwritten - only sample received and assigned
7. Where instruments by default deliver results for analyses not requested by the Client Contact, these get imported to but kept out of view for the purpose of the Client Contact Report and Invoices. If they request it later in may then be pushed into the standard workflow
8. The systems writes a log of the import and exceptions encountered

13.2.1 Import Templates

At the lab, GC downloads comprise of two separate sheets, one each from TCD and FID detectors

The results can be imported independently or as per combined sheet produced by the instruments

13.2.2 TCD

See attachments for true format, this here is an explanatory lay-out

Galaxie Chromatography Data System Summary Report

Summary : Samancor_Summary_DGA_TCD.SUMR **Date : 21/04/2008 03:46:12 PM**

User : Exertus **Group : Exertus**

Project : Exertus

File name, type, date time stamp	Run Info	Chromatogram Name	Quantity/H2	Quantity/O2	Quantity/N2
rhubarb	rhubarb	18740461	22.01	22302.91	55919.73
rhubarb	rhubarb	18740451	12.44	20460.68	55806.77
---	---	---	---	---	---
rhubarb	rhubarb	18740141	16.62	58305.64	181951.6
rhubarb	rhubarb	18740061	52.44	20963.59	54796.34
		Mean	105.09	38001.92	122955.18
		Std Dev	206.62	42131.51	139573.36
		Rsd %	196.61	110.87	113.52

13.2.3 FID

See attachments for true format, this here is an explanatory lay-out

Galaxie Chromatography Data System Summary Report

Summary : Samancor_Summary_DGA_FID.SUMR **Date : 21/04/2008 03:46:12 PM**
User : Exertus **Group : Exertus**
Project : Exertus

File name, type, date time stamp	Run Info	Chromatogram Name	Quantity/ CH4	Quantity/ CO	Quantity/ CO2	Quantity/ C2H2	Quantity/ C2H4	Quantity/ C2H6
rhubarb	rhubarb	18740461	2.38	30.75	355.62		0.06	0.27
rhubarb	rhubarb	18740451	3.69	217.45	2256.76		4.92	2.55
rhubarb	rhubarb	18740441	4.52	90.21	2884.07	0.84	10.76	8.03
---	---	---	---	---	---	---	---	---
rhubarb	rhubarb	18740171	14.5	601.46	5606.95		26.52	
rhubarb	rhubarb	18740141	2.11	165.46	1999.52		1.23	
rhubarb	rhubarb	18740061	3.22	54.74	1494.14		1.62	9.64
Mean				**202.65**	**2462.37**		**1.68**	**0.73**
Std Dev			**7.66**	**179.54**	**1891.71**	**0.84**	**4.03**	**10.03**
Rsd %			**14.27**	**164.97**	**1238.91**	**0**	**5.72**	**17.3**
Rsd %			**186.29**	**91.89**	**65.49**	**0**	**141.9**	**172.53**

13.2.4 TCD and FID combined

See attachments for true format, this here is an explanatory lay-out

User : Exertus **Group : Exertus**
Project : Exertus

Run Info	Chro matogrm	H2	O2	N2	CH4	CO	CO2	C2H2	C2H4	C2H6
qwerty	1874001-2		46782.21	87203.59		46.82	1927.94		1.08	
qwerty	1874002-2	42.41	25692.06	65945.52	4.94	113.98	2316.88		2.01	9.37
qwerty	1874003-2	38.75	35781.04	80934.37	3.81	146.05	1828.49		2.18	3.33
---	---	---	---	---	---	---	---	---	---	---
qwerty	1874059-1	11.07	11022.93	42132.09	3.78	180.3	1657.24		6.4	2.35
qwerty	1874060-1		146681.82	474756.11	1.78	9.31	724.59		0.46	
qwerty	1874061-1		55410.65	189383.97	0.94	14.27	323.82			
	Mean	49.07	60364.86	183094.51	3.65	96.42	1472.43	0	2.52	10.08
	SD	62.76	44956.04	147917.52	2.96	74.29	628.83	0	2.41	18
	RSD	127.91	74.47	80.79	81.02	77.05	42.71	0	95.54	178.6

The last three rows are only meaningful if multiple repeats of the same sample are summarised in the report

14 Subcontractors

the lab sub contracts some analyses and this information needs to be recorded and reported to clients

14.1 Subcontractors and their contacts

Sub contractors are captured and maintained in the LIMS in a similar Organisation and Contacts structure to the Client and Suppliers structure, with all relevant addresses and contact information, VAT numbers etc.

14.2 Assigning analyses to subcontractors

To maintain flexibility, Analyses Services are set-up to be subcontracted to any number of 'approved' sub contractors and a default one is specified. If no subcontractor is required, this field is left blank

Use case: Setting up subcontractors per Analysis Service

Role player: Lab manager

i. the user navigates to the Analysis Service set-up in the System set-up and selects an Analysis Service

ii. on the Analysis Service's configuration page, a multi select box displays all the Subcontractors in the system

iii. the user selects all the Subcontractors approved to do the analysis

iv. 1 option available is 'the lab' which may be selected too

v. if only 1 subcontractor is selected, it becomes the default sub contractor for the analysis

vi. if more than one Subcontractor is approved, the user may set one of them as the default. The other approved Subcontractors will be also presented at AR creation or edit time

15 Reports

Please add / edit

Various management reports are built into the system. These are used on ad hoc basis for any date range provided

General

Analyses totals (incl. turnaround summary)

Analyses totals per client

Analyses requests per client

Analyses totals per sample type

Analyses totals per Analysis Service type

Efficiency

Analyses repeated

Control analyses

must allow for expected value to be captured

Turn around times not met

Accreditation

Analyses out of range

Accounting

Analysis Requests not invoiced

Client statuses, balances & credit limits

ARS without Client Order Numbers

Analyses subcontracted

16 Optional

Bulk import modified for sample source structure

Analyses per sample source report

16.1 Instrument interfaces

Standard Bika .csv instrument data import template be customised to fit the lab' consolidated spreadsheets currently under development. Bi-directional

17 Addendum A. Full-tilt Order Batching

17.1 Overview

Labs receive multiple samples to be processed, reported, and invoiced together per Client Order Number or Client Reference. Bika Tribos requires a one to many relationship between Orders and Samples/Analysis requests

A Bika Order is a collection of samples and ARs per single Client Order ID. Single samples, or large batches of samples, are treated as 1 Order

The purpose of this module is to manage Orders. As such a single sample or multiple samples associated with 1 Order will produce 1 report and 1 invoice

17.2 Order statuses

Orders have the statuses similar to existing ARs system and status changes to ARs per sample within that Order Number affect the ARs in the Order and vice versa

One exception is that New Order require approval from either the Client Contact or the Lab personnel depending on who ordered the new Order. This additional status of “pending approval” is required before being elevated to “sample due”

Object statuses				
Orders	**ARs**	**Samples**	**Analyses**	**Work sheets**
pending	pending order	pending order	pending order	
samples due	sample due	due	sample due	
samples received	sample received	received	sample received	
assigned to work sheet	assigned to work sheet		assigned to work sheet	open
to be verified	to be verified	to be verified		to be verified
verified	verified		verified	verified
published	published		published	
		expired		
		disposed		

Orders cannot have a higher status than that of the AR with lowest status in the Order - that ensures that orders cannot be published if all the ARs in the Order have not been verified

Similarly, when all ARs in an Order Number gets promoted together, the Order will automatically change status. This is a very real scenario as it cannot be advised that an Order Number representing a number of samples requiring ARs is verified blindly without inspecting the results on the ARs themselves

17.3 Order Alerts

Alerts are raised for Orders that are pending approval, sample due, sample received, verified, published or late to keep TAT down to a minimum

17.4 Order Entry

Both Client and Lab users execute the same form with the difference only in how alerts and notifications are addressed to the counter party

It is important to allow clients to track their order as it moves through the lab by viewing its status as well as seeing the name of the lab staff member assigned to it

Use case. Creating Order entries

User: Client Contact, Lab clerk and manager

i. The user navigates to the Client's Orders folder list of Orders
ii. The user click son **[add new order]**
iii. An Order entry screen opens with unique order ID and status 'open'
iv. The user enters:
v. Contact Name - defaults to the client contact
vi. Sampled By - defaults to the client contact

Submitted By - defaults to the client contact. “The person submitting the samples may not be the person entering the data. For example, a contact listed for a client may be tasked with entering a number of analysis all together even though only a few jobs relate just to them. Their colleagues, who are also listed as client contacts, may prefer to have their name associated with the actual entry. That way if Lab staff have a question, they call the right contact who is listed on the form, not just the person who actually entering the form”

Select [Profile] analysis if required. From drop down as per normal AR creation

Client Order ID

Client Sample ID

Client Reference ID

Client Project ID

Sample Date

Sample Type. From drop down

Sample Point

# of Sample Containers

Preservative (drop down Yes or No)

'Date results needed' from look-up with options
- same business day
- next business day
- within 5 business days
- to be determined

Name of staff member assigned to Order (drop own)

cc emails. Defaults to contact's as set up in his/her preferences

vii. The AR creation form is shown successively until all samples are captured for the Order. The User has the opportunity to press **[complete the order]** to stop order entry

viii. The user may at any time press **[submit]** to quit the entry process and all edits up to that stage will be saved and the Order status left 'open'

ix. The system runs an alert portlet to him/her that there are open orders to be completed

x. The system populates all AR and Sample records required for the Order, and reference the order via hyperlinks

xi. The Order's status advances to 'pending' when completed

xii. The user is returned to the new Order lists

17.5 Receiving an Order's samples

i. Once Samples are Received, the user clicks on Order ID listed on “sample due” Table

ii. Clicks on '**Arrival date**' and enter date and time - the field defaults to current system date time

iii. Clicks on '**Temperature at sampling**' and enter temperature in degrees Celsius

iv. Click **[receive]**

v. The system prints the sample labels – see sample labels section

vi. The Order's status changes from 'sample due' to 'sample received'

17.6 Order lists and views

Similar to ARs, Order lists are available from an **|Orders|** tab - per client in the client folders and globally for all Orders in the system. The lists are likewise available per status or 'All', selected by radio button:

LIMS Order ID	Client Order #	Order date	Due date	Priority	Status	Assigned to

All of these are hyperlinked where possible. Clicking on the Order ID takes the user to the corresponding Order view that displays:

All order header attributes

LIMS Order ID	Client Order #	Order date	Due date	Priority	Assigned to

and lists all children AR and Sample data:

LIMS Sample ID	Client Sample #	Client Reference #	Sample Type	Sample Date	Date received	Sample Expiry Date	Sample status	AR ID	Due date	Date published	AR Status

Order views have tabs for

|edit|

|view|

|manage results|

|export|

|import|

|QC|

|final report|

|pro forma invoice|

17.7 Order Exports and Imports to Lab instruments

Sample and AR information associated with a specific Order can be exported to Lab instruments where the samples are to be analysed. This is done from the Order |export|tab where the instrument can be selected from a look-up.

Conversely, Bika Tribos will accept imported data from Lab instruments following a prescribed template. Data imported is associated with specific Bika Order ID. This is done from the existing **|import instrument|** tab. Detailed information is provided in the Instrument interfaces section

17.8 Order publication

With Orders often including many samples and ARs it is possible that mistakes can be made which are not determined until after the Order has been published

In such cases only the Administrator has the power to retract a published report, edit an AR for that Order and submit that Order to be re-published. All changes are recorded in the touched objects' logs

Use Case - Fixing an error on a published Order

Role players: Administrator

i. The lab is advised of an error that has been detected in a report after publication

ii. After confirming the error, the user logs in as Administrator and navigates to the Order

iii. The user retracts the Order - its children ARs and analyses are automatically retracted

iv. The user navigates to the AR that contains the error

v. The user fixes the error on the AR's **|manage results|** or **|edit|** tab

vi. The user describes the action on the AR's Remarks field

vii. When done, the user submits the AR for verification

viii. Another user with verification rights may verify the AR and Order

ix. The Order results can then be published again

x. Listed in the Order's log is the name of the Administrator, date, and time. A copy of the original report is also saved as a hyperlink to the original report

17.9 Order logs

Same as for ARs

17.10 Results reports and Invoices per Order

Overview

At publication per Order, a collection of information associated with the Order is put together and published to the Client contact and his/her cc'd recipients:

all samples & sample information

all analysis results

QA and QC data

list of methods used

instrument detection limits

responsible lab manager

It does not make sense to issue multiple invoices and reports to a client who has submitted >1 sample under the same order number. These are grouped and submitted under the same invoice. Invoices are only paid on Order number - therefore it must be integral to the invoice itself

Invoices must also have unique Invoice ID to track and trace payment in relation to the Bika Order ID, Client Order ID, Client Reference ID, Bika Sample ID, Client Sample ID, Date Sample Received, and Client Contact requesting analysis

Reports and Invoices should reference all samples and analysis performed on a specific Order ID and should look similar to traditional invoices

It includes company information such as address, business tax number, contact information, date of report, name and signature of lab manager

17.10.1 Invoice exports

Overview

Invoices can be exported and printed individually from Orders' Proforma invoice tabs, or at the end of the month in a month end run. As in existing Bika flow, orders individually printed once and exported are excluded from month-end runs

17.10.2 Worksheet per order

A [create worksheet] button is provided on the Order. See the Worksheets paragraph