



Bika Tribos 1 - LIMS for tribology

Functional specification and use cases

version 1.0 , lemoene, 1 September 2009

Analysis and Design sponsored by

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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

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

Full Tribology LIMS specification – Bika 2 Inkosi integrated with new requirements

3 Document convention

All use cases are acted out by role players which can be the LIMS itself, other interfaced systems or any user authorised as *admin*, *Labmanager*, *Labtechnician*, *Labclerk* or *client*

In most cases *client* refers to the client's *contact* as their representatives are known in the system

For each use case it is assumed the role players are logged-on and authorised to execute the actions required by them

Text in square brackets denotes on screen clickable [push buttons]. Text in between vertical lines, denotes on screen clickable [tabs]

4 Definitions and Acronyms

AR - Analysis Request. The collection of analyses ordered per sample, the most important building block in Bika Tribos

AS - Analysis Service, 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.

CMS - Content management system, a system that allows the owner of the website to be able to change, edit, add content without the need of a web developer or web skills

COC - Chain of custody

CR - Change request

CSV - Comma-separated value. A non proprietary comma-delimited file used to transfer data into spreadsheet programs.

DB – Database

Labclerks have only administrative rights in the system, like checking in samples and filling out analysis request forms

Labtechnicians, or analysts, are responsible for analysing the samples in the lab

LIMS - Laboratory Information Management System

QA - Quality Assurance

QC - Quality control

SD - Standard deviation

TAT - Turn around Time. Measured for analyses from import to publication

WS - 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

4.1 Tribology terminology

CC, Circulating Currents

Dielectric, A dielectric is a non-conducting substance. The term is more often used when considering the effect of alternating electric fields on the substance

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

5 Not in the Scope of this document

5.1 Development items

Some analysis and design went into items that are not currently considered for Phase 1 development

5.1.1 Full Order functionality

Please see [Addendum A. Order Batching](#)

5.1.2 Diagnostics

For more information, please see [Addendum B. Diagnostics](#)

5.1.3 Instrument interfaces

Please see [Addendum C. Instrument interfaces](#)

5.2 Internet Connectivity

The laboratory has an ADSL connection which is sufficient Bika's hosting purposes. The laboratory must take out a dynamic name resolution service, currently \$25 pa

5.3 Proof of email delivery

Impossible with current SMTP mail serving technology. Instead the responsibility to report non-delivery are shifted to clients by informing them to "Please contact laboratory if results are not posted within 7 working days"

5.4 Faxing

Not included but can easily be implemented via on-line email to fax services

5.5 Laboratory specific LIMS set up configuration

The populating the database with 'static' data such as the laboratory's analytical services and prices, Client Ids, address and contact details is not in the scope of this project. Bika will quote if required – client data could be imported from spreadsheets

5.6 Data conversion

Importing earlier result data from legacy systems – needs research, Bika will quote if required

5.7 Corporate Mail server

If required Bika will specify and quote. The LIMS's mailing itself is included with purchase

5.8 Manuals

Manuals to be quoted on separately. The system is browser based and intuitive while lots of information and help forums are publicly available

5.9 Implementation

Per separate contract, SaaS system rental is the most likely roll-out

5.10 AR Imports

The AR import from .csv for bulk orders are not customised for the lab in this edition but remains available in generic format

6 General

6.1 Web portal

Bika Tribos is a web based system and all user and management access takes place via web browsers and internet connections

The System is built on a mature and widely used web platform and CMS (Content management system) and this functionality is maintained. Authorised users manage and edit documents and the publication thereof via their browsers

They may edit web pages, news items, the calendar, folders, etc.. using text, images, files, links, animation, video and sound

6.2 Folder structure

Information logically belonging together is grouped together in a folder structure much like popular windowing operating systems such as Apple, Microsoft or Ubuntu and email programs. This structure can then be navigated from a collapsible structure in a familiar navigation column at left of all screens

This practice has two big advantages - new users are instantly up to speed and maintaining security and privacy becomes much easier. Clients for instance, get access to their own folders only (and other information pages explicitly declared public elsewhere in the portal)

6.3 Password expiry and auto log-offs

As added security measures, the system allows the manager to set password expiry periods, after which user must change their passwords, say every 3 months

The manager may also set an auto log-off period. After such length of inactivity, the portal will automatically log a user off to prevent unattended session be used to enter the system

6.4 Lost passwords

An incorrect password results in the user being offered the option of having a link to a password renewal form mailed to her. The user may also click [Forgot your password?] to the same effect

If the system is set up to generate user passwords, a system generated password will be emailed to the user. The user is instructed in the email how to go about changing her password

6.5 Search

The web portal includes a strong Google like search engine to find singular data with. The system authorisation profiles apply and users only see search results they are allowed to

A query form is available elsewhere in the system for looking up data or ranges based on specifying search parameters

6.6 Column wise sorting

Tabular data on screens can be sorted dynamically per column by clicking on the column header. Clicking the column header a second time reverses the order

6.7 User preferences

Users can change their passwords and other preferences

6.8 Accessibility and web standard compliance

The system offers acceptable levels of web standard and browser compliance and accessibility functions for sight and motor impaired individuals as per the guidelines of the [World Wide Web Consortium \(W3C\)](#)

6.9 Translation

The system can be translated into any language from a central dictionary for texts and tags used in its user interface

6.10 Prefixes

Generically ID prefixes are designated like this in the LIMS set-up:

abbreviation | year | serial number, i.e. the first sample of 2009 will be ID'd S09-001

Suggested prefixes:

Sample	S
Analysis Request	SR
Worksheet	WS
Order	O
Invoice	I

6.11 Links to sensitive information

The Bika Tribos strives to put as much information possible at the minimum click away for both lab client and personnel, i.e. where analytical services are listed on ARs, they are hyper linked to a page about the service

This access is regulated, clients only get to see public information, unit, method & standards description, interpretation tables and prices & discounts applicable to them

6.12 General lay-out – Tabbed pages per item

Many items are managed on tabbed pages dedicated to editing, viewing, managing data, logs and where applicable invoices

In the case of ARs:

Edit tab – while the AR is still status 'sample due', clients might still edit ARs' header details and add or remove analyses. Once in a higher status, this tab is not available to clients any more

Manage results tab – all results entry and analysis status management are done on this tab

View tab – this is effectively the Analysis results 'report'

Pro-forma invoice tab - prices are not shown with analysis results, only when the AR is created and on a 'pro-forma' invoice tab

Log tab – the log for the AR itself

6.13 Logs

Audit logs are not only kept for 'main' objects, i.e. ARs & Worksheets, but also for individual analyses on ARs. The analysis' log is reached via clicking on its status on the AR page itself

Logs are kept for Labmanagers to view and print

Log items include:

- the username
- action
- date/time stamp
- duration – the time the object spent in the state

6.14 'All' listings

On many pages where items are listed the items displayed are selected from according there statuses, i.e. ARs, by clicking the corresponding radio button at the top of the page

The first option will always be 'All' which is not a status. 'All' will list the most recent ARs regardless its status. An extra column is then displayed for the status in the listing

The 'All' selection is an aid to clients wanting to find their freshest data quickly

7 Client management

Clients must be defined in the system before they can submit data. The LIMS differentiates between Client organisations and their people, ClientContacts. Results processing is requested by and published to a Client's Contacts

A Clients folder lists current lab clients. ClientContacts do not see the client listing, but only their own folder containing their instruments, results and contact information

They are allowed to modify only their own contact details and preferences. Authorised lab personnel may edit all clients' data

7.1 Client folder content

Each client folder contains sub folders for

General information like phone numbers etc.

Contacts - the Client's Contact personnel, some of whom are system users

Imports

Sample Sources

Samples

Orders

ARs

Each of these may contain further sub folders

7.2 Adding and editing clients

Use Case – Adding and editing clients

Role players: Labmanager, Labclerk, ClientContact

NB Only lab personnel are authorised to create new clients

Clients should however be encouraged to maintain their address information and preferences once it has been created to reduce the lab's admin load

ClientContacts are allowed to create more contacts at the same Client organisation

- i. The user clicks on an existing client to navigate to their pages or push the [add new client] button on the clients list to add a new client
- ii. The user enters the client name and contact information
 - Client company name (compulsory)
 - Phone number (compulsory)
 - Fax number
 - Client number (compulsory, not editable by ClientContacts)
- iii. An email address for the client company may be added. Please note that analysis results are emailed to the ClientContact requesting the data processing and the additional addresses they include to be cc'd. Email addresses for Contacts are maintained on their pages
- iv. An address may be added for each of Physical, Mailing and Billing addresses. The user completes fields for each:
 - Address
 - City
 - State
 - Postal code
 - Country
- v. She clicks [save] to save the edits, or [cancel]
- vi. The system displays a confirmation message for the action executed

7.3 Deleting clients

To maintain database integrity, clients that have data attached to them in the system cannot be deleted

Use Case – Deleting Clients

Role players: Labmanager

- i. The user checks an existing client and pushes the [delete] button
- ii. The system confirms the deletion or provides a reason why it cannot be executed

7.4 Adding and editing ClientContacts

Adding and editing ClientContacts, their publication preferences and their logins

Client organisations may have multiple contacts and contacts may request data processing for colleagues who will then receive the results, and also include colleagues to have results copied to colleagues by default

The |contacts| tab on client page shows the current ClientContact persons, and allows the addition of new contacts with the [add new contact] button

Use Case - Adding and editing ClientContacts

Role players: Labmanager, Labclerk, ClientContact

NB ClientContacts are allowed to create more contacts at the same Client organisation. Only lab personnel may create users in the system

- i. The user clicks on an existing Contact to navigate to their pages or push the [add new contact] button on the contacts list to add a new one
- ii. The user enters the contact name and contact information

Title

First name (compulsory)

Surname (compulsory)

Email address (compulsory). The contact's email address is important as it will be used for the contact's emailed results as well as lost password requests

Phone (compulsory)

Fax (compulsory)

Phone - mobile

Job title

Department

- iii. An address may be added for each of Physical, Mailing and Billing addresses. The user completes fields for each:

Address

City

State

Postal code

Country

- iv. The user selects the Contact's publication preferences, the media by which the contact wishes to receive processed results. The system offers the options

email - the results are embedded in an email

file - the results are attached as .csv formatted file to an email

- v. The user may select any of the other contacts already in the system for this particular client, to be copied by default for results intended for the contact being edited.
- vi. If the contact's login was created earlier, it cannot be edited any further. Nobody is allowed to edit any user's password but the user itself from his/her personal preferences settings
If it is a new contact, lab personnel may create a user for him/her by providing a user name and password. Alternatively, the system can be configured to generate a password and email it to the Contact
- vii. The user clicks [save] to submit the edits or [cancel]
- viii. The system displays a confirmation message for the action executed
- ix. The Contact may now login to the system to submit data for processing and view results

8 Clients and Owners

Lab Clients 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.

8.1 Client tabs thus

Client views has a 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

8.2 Owners in the set-up

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

Owners are maintained in the standard Bika organisation and contacts design, similar to that describe for Clients above

9 Subcontractors

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

9.1 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.

9.2 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: Labmanager

- 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

10 Methods

Most methods are saved as .pdf files which contain images and calculations in addition to text. Some calculations include symbols that are not supported by plain text

Methods are kept in a folder in the navigation portlet where they are available as reference to both ClientContacts and Lab personnel. They are linked to Analysis Services via a look-up in the Analysis Services configuration

Use Case - Maintaining methods

Role players: Labmanager

- i. The role player navigates to the methods folder where all the methods currently in the system are listed
- ii. To modify a method the user clicks on it or [add method] to add a new one
- iii. On the method screen, the user may edit its name and short description and upload its file
- iv. If he/she is editing an existing method, there are options to replace the current file
- v. The user clicks [save]. A log is created with date / time and name of user who has made this modification.
- vi. To assign methods to an Analysis Service the user navigates to these in the system set-up and opens on by clicking on it
- vii. In the Analysis Service's method field he/she selects methods from a look-up. More than one method can be selected

viii. The user clicks [save]

11 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 - Creating a Sample

Role players: LIMS

When an Analysis Request is created, it is given an ID of AR09-001-01. A corresponding Sample record is created with ID S09-001

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

11.1 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

11.2 Sample disposal

Without properly managing the disposal time for samples, a lab can quickly become overrun with old samples. Periodic purges of “old” samples may also risk the disposal of recent samples. Therefore, a process of accurately determining the “expiry date” of samples is required

A sample “disposal date” is created when AR status is changed from “sample due” to “sample received”. The expiry periods are maintained per sample type in the LIMS set-up

A “disposal date” field is added to sample views and lists and the lists can be sorted on this field. When a sample expires and has not been disposed, a 'samples to be disposed' alert is raised to lab staff and clerks who may then dispose of the sample

Use Case - Sample disposal

Role players: Labclerks and technicians

- i. The system automatically promotes samples from status 'received' to 'expired' once they pass their disposal dates
- ii. Users may also expire samples manually, at any time, by selecting them from the samples received list and clicking the [expire] button
- iii. Or on individual sample screens, selecting the 'expire' option from their status drop downs

- iv. The disposal date was set earlier at sample reception, calculated from the service life period configured for the sample type
- v. Sample views include a 'disposal date' field and sample lists a similar sortable column
- vi. When a sample expires, the system raises a 'samples to be disposed' alert in a portlet at left, hyper-linking the specific sample
- vii. The user may click on this link to navigate to the sample
- viii. Or navigate to the samples list and clicking the 'expired' radio button for a list of expired samples
- ix. Samples to be disposed can be selected from the list by ticking their check boxes and pushing the [dispose] button at the bottom of the screen
- x. Or if the user is on an individual sample screen, he/she can select the 'dispose' option from its status drop down

11.3 Sample Labels

With a vast variety of sample points and sample types to manage within a lab, the use of well defined and easy to read labels are required to ensure that samples are properly marked and processed. Bika Tribos currently provides for the printing of labels that include AR, Sample Date and Sample Number utilizing a stand alone label printer

However, a medium sized lab, may receive hundreds of samples representing 1 job, and may therefore require additional information on the label to ensure that samples are not confused with samples from another Order.

11.4 Printing Labels

Labels are printed in two forms, on long and short

The long label contains all information that is relevant to the original sample and is placed on the original sample jar. It is normally printed in automatically upon 'receiving' the samples in the LIMS

As samples may arrive in more than 1 container, the ability to print individual labels is also required and can be done from the long label icon displayed where applicable

LIMS Order ID : _____ Client Order ID : _____
 LIMS Sample ID : _____ Client Sample ID : _____
 Preservative: [Yes / No] : _____ Date Received: _____
 Analyst Name: _____ Disposal date: _____

An original sample may be divided into separate containers and each of those containers must contain the sample information too. The short label is used for these. They can be printed at sample reception or individually too

LIMS Order ID : _____
 LIMS Sample ID : _____
 Disposal date: _____

12 Sample Sources and Sample points

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

12.1 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

12.2 Sample Source's 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

12.3 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

12.4 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

12.5 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.

12.6 Location, Make

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

12.7 Ownership change

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

12.8 Location change

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

13 Analysis Requests. ARs

Once samples have been received, most labs use worksheets to capture and process results per lab work station, analyst or instrument. Discussed under [Worksheets](#)

The use cases here follows the simplest route for a single sample and Analysis Request through the lab

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

13.1 Analysis descriptions and instructions

The lab maintains two free text fields per analysis service in the LIMS set-up, a description and instructions. These texts are available as pop-ups hyperlinks from analysis names on several places in the system

It assists clients requesting analyses on-line to determine which to select. Clients only get to see the analysis description, not the instructions, and it is important that the lab make sure these texts are meaningful

The instructions are shown to lab staff only and serve to assist them performing the analyses

13.2 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

13.3 Requesting Analyses. AR registration

13.3.1 On-line at www.the.lab.co.za

Use case - On-line analysis request

Role players: ClientContact, Sampler, Labclerk, Labmanager

- i. the user writes the sample identification on the sample container - either her own number or all of the information required to identify the sample, date and source uniquely
- ii. she logs onto www.the.lab.co.za
- iii. she navigates to the Client requesting the analyses' AR list and [add]s a new AR by filling out the displayed form
- iv. the form is laid out to accommodate more than one request, 1 AR per column.
- v. In the form header, the client, contact and cc recipients names are shown pre completed with their default values. These may still be edited
- vi. per individual AR, the following attributes are captured
 - Client sample ID (Required)
 - Sample type (Required, look-up)
 - Sample Source (Required, look-up restricted to the Client's)
 - Sample point (Required, look-up restricted to those for the Sample Source specified)
 - Sampler (Required, look-up)
 - Client Order number (Required)
 - Sample temperature (Optional)
- vii. the user might want to check check the box to set the AR for invoice exclusion - ARs can be checked to be excluded from invoices, typically re-tests done on the lab's own account
- viii. often the batch of ARs being created will have the same header attributes, i.e. sample types. In these cases, the user clicks the 'All' button on the row under consideration, i.e. next to 'Sample type', and provides that entry only for the first AR in column 1. The value then gets repeated for that field for all AR columns. These remain editable and the user may want to edit any deviations
- ix. the user must select at least one analysis from the list of analyses available. These are presented alphabetically on rows below the AR header properties
- x. the 'All' button is also available for the analyses selected
- xi. should the user select a calculated analysis, the system includes all dependent analyses on the form if the user neglected to do so and asks the user to confirm
- xii. pre-configured templates, Profiles, of frequently ordered analysis sets are available for the user to auto complete these forms
- xiii. the profiles can also be configured for common sample sources, say a popular transformer
- xiv. the user then sets the priority of the ARs, default is 'Routine' see AR prioritisation
- xv. the user edits the sub contractor field if necessary, it defaults to the sub contractor 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. Also see [Sub-Contractors](#)

- xvi. another column indicates which Diagnostic [Specification](#) applies per Analysis row. Values are hyperlinked to the Specifications
- xvii. users logged in with Labmanager authorisation may edit prices on the form
- xviii. if the client qualifies for a discount and is set up as such, the discounted prices are used and a 'A Discount of x% applies' text is displayed
- xix. the form totals the cost for each the AR at the bottom of the form: total, VAT total, total total incl VAT
- xx. the user submits the form
- xxi. the system returns a unique AR number and the user writes that on the sample too
- xxii. the user ships marked sample to the lab

13.3.2 Manually requesting analyses

Use case - Manually AR per form

Role players: ClientContact, Sampler, Labclerk, Labmanager

- i. the user prints an analysis request form from www.the.lab.co.za or gets one at reception in the lab
- ii. she might also get AR stickers from the lab
- iii. the user fills out the analysis request sticker / form
- iv. the user signs the form
- v. the user delivers labelled sample (or sample and form) to the Labclerk
- vi. the Labclerk registers the new sample in the the lab LIMS as per use case above, completing the AR for the user in the system

13.3.3 Analysis requests per CSV data import

Lab clients may request analyses by mailing the requests per predefined csv formatted file attachment to the lab. Lab staff then import the file and the ARs enter the system with status 'Sample due'

When the samples arrive at the lab they are received in the normal Bika workflow

The CSV import format is illustrated in [Addendum D](#) and an OpenOffice (or MS Word) file that include some look-up automation can be requested from lemoene@bikalabs.com

Use case – Importing bulk Analysis Requests

Role players: Labclerk, Labtechnician, Labmanager

- i. the lab receives the Client's bulk CSV request (most likely by email) and saves the file
- ii. the user navigates to the Client's folder and selects the [import] tab
- iii. the user presses [import analysis requests]
- iv. the user selects the file to be imported and presses [import]

- v. the system picks up the file and read it into temporary space while validating the data
- vi. when, don it lists the import and indicates whether it is valid or not
- vii. if invalid, the user may drill down on it and fix the indicated error using look-ups of valid entries available on the DB
- viii. once all errors are fixed, the system offers the user a [load] function
- ix. the user presses [load] and the ARs are created from the import and enter the system workflow like standard ARs

13.4 Editing Analysis Requests

ARs may still be edit by clients before the samples have been received at the lab in the system. Labclerks and Labmanagers may edit ARs before publication – e.g. add or remove analyses after telecomms with clients, or add remarks pertaining to the sample or analyses

13.5 Receiving the Samples

Use case – Sample receipt

Role players: Labclerk, Labmanager

- i. the sample arrives at the lab
- ii. the user logs onto the the lab LIMS
- iii. the user verifies that sample has been registered remotely
- iv. the user verifies sample identification data on the actual sample to be correct and legible
- v. the user submits the sample to the lab in the lab LIMS by pressing [receive]
- vi. multiple samples can be [receive]d from the Sample due lists
- vii. the LIMS changes the status of the ARs to 'sample received'
- viii. the LIMS creates a Sample record in the background, hyperlinked to the AR, with the status 'received'. See [Samples workflow](#)
- ix. the LIMS offers the user the opportunity to print sample labels, see [Labelling samples](#)
- x. the user sticks the sample label on the sample container(s)
- xi. the user hands the sample to the Labtechnicians for analysis

13.6 AR status monitoring

Clients may only see verified analysis results. All ARs are listed for her with status indicated, but she is only allowed to drill down on verified results.

The client is only allowed to edit ARs with status 'sample due'

Lab personnel see all results data, only those sufficiently authorised are allowed to edit results

13.7 Results capturing

Most labs would use worksheets to capture results. The use case here follows the simplest route for a single sample and Analysis Request

Use case – Manual AR results

Role players: Labtechnician, Labmanager

- i. the user opens the previously created AR and navigates to its | manage results| tab
- ii. the user enters the results and presses [submit]
- iii. when their dependent results are all available, calculated results include in the request, are resolved and their values displayed
- iv. singular analyses have statuses of their own – all analyses with results submitted, are promoted to 'to be verified'
- v. the LIMS alerts the user of any out of range values
- vi. suspect values may be re-tested and the user can indicate this on the form for managers and clients to know
- vii. once all results have been submitted, the status of the AR changes to 'to be verified'
- viii. an alert is shown to users authorised to verify ARs

13.8 Calculated and dependent analysis results

Calculated analyses and their dependent analyses are maintained by Labmanagers in the set-up. Bika LIMS includes standard weight calculations and includes the Acid Number calculation detailed below

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

13.8.1 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:

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

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

13.9 Results verification

Users authorised to verify results, usually Labmanagers or senior analysts, may do so from individual ARs, e.g. drilling down from an alert, or AR lists. The latter is not recommended as no results are shown in the lists

NB The LIMS does not allow the same user to submit and verify the same results. As per good laboratory practice results are entered and verified by different staff members to minimise human error

Use case - Results verification and retraction

Role players: Labmanager, Verifier

- i. the user is alarmed by the the lab LIMS when there are results to be verified, displaying a message to that effect.
- ii. the user navigates to the ARs to be verified
- iii. the LIMS compares the results against the lab's own 'out of range' levels and displays alarms where necessary
- iv. the user verifies result values to be acceptable and pushes the verify button
- v. the LIMS changes the status of the AR and all it's analyses to 'verified'
- vi. unacceptable results do not get verified, the user sends the sample back to the lab and pushes [retract]
- vii. the LIMS changes the status of the AR and its analyses to 'in the lab'
- viii. the results may then get recaptured as per the results capture use case and then enters the verification workflow again

13.10 Results publication

Use case – AR publication

Role players: Publisher, Labmanager

- i. the user drills down to the AR to be published and pushes the [publish] button
- ii. bulk publishing can also be done from verified AR lists
- iii. the LIMS reads the ClientContact's preferred publication media off the database and proceeds to publish her results
- iv. the LIMS repeats the process for each of the recipients to be cc'd
- v. the LIMS promotes the AR and its analyses' statuses to 'published'

13.10.1 Pre-publication of ARs

An AR might include an analysis method taking much longer than the others. It is possible to 'pre-publish' these results

The same workflow as described above is followed but the results publications will only include verified results and indicates the others as 'too follow'

The AR's status does not change to 'published', only the singular analyses for which results

13.10.2 Re-publication of ARs

Users often require that results they lost be resent. This can be done via the [republish] button on previously published AR or from the published AR lists

13.11 Publication media

ClientContacts may edit their own publication preferences, or lab staff might do it for them

13.11.1 Email

Emailed results are styled to contain the lab's logo and results grouped one AR per column, containing both AR and Sample header information and their remarks, as well as their analyses, their units, results and measure of uncertainty.

Results out of range are indicated as such, and the specification used indicated

All items are hyperlinked to their corresponding pages on-site

The email includes a footer of canned text reading:

1. Analysis results relate only to the samples tested
2. Results are reported for the samples 'As Received' unless specified otherwise
3. Test results are at a 95% confidence level
4. This document shall not be reproduced except in full, without the written approval of the lab Laboratories

If you have any questions regarding this analysis please contact your analyst

Manager: <manager name> <manager telephone number> <manager email address>

The manager details are read from the set-up where each analysis is assigned to a department and manager

If ARs are published in bulk, they are listed chronologically, maximum 5 per email. If the publication is done per Sample Source, all its ARs are published in a singular email

13.11.2 Fax

Faxed results are essentially the same as emailed results (but without the hyperlinks;-). Because of the fax text becoming unreadable otherwise, a maximum of 4 ARs are ever included per fax

13.11.3 Printed results

Contents and layout are the same as for emails but also include a printed signature read from the scan uploaded for the responsible Labmanager

13.11.4 Results publication per CSV data file

Clients may want to receive results in tabular format on publication for import into downstream systems. They do so by selecting 'file' as a publication preference - the LIMS then publishes the results as a CSV attachment to their emailed results

The report format is similar to the format used to import analysis requests but include results and final prices as well as the lab generated Sample and AR identification information

An example can be requested from lemoene@bikalabs.com

13.12 Authorising users to verify and publish results

In peak periods labs find it necessary to authorise senior Labtechnicians to verify results and clerks to publish verified results. Under normal conditions only Labmanagers are allowed to do so

Use case – Authorising Verifiers and Publishers

Role players: Labmanager

- i. the user logs on and navigates to the LIMS's user set-up
- ii. she opens the user to be promoted's record and assigns adds her to the verifier or publisher groups
- iii. the new verifier or publisher inherits all the authorisations associated with the group
- iv. the user at a later stage revokes these rights from the same page

13.13 AR lists. Bulk processing

List views are available for ARs, both client specific and globally. All the actions described above can be executed of more than one AR when selected off the lists. It is not advised to verify ARs off the lists as the actual analysis results are not shown in the lists

The ARs are listed per status, selectable from radio buttons at the top of the lists, for:

- Sample due
- Sample received
- Assigned to worksheet
- To be verified
- Verified
- Published

An 'All' listing is also available – this listing has an extra column to indicate the status of the AR. Global AR listings also carry a column for the Client name

Whenever bulk processing of ARs are to be carried out, the ARs are selected and the appropriate [button] pressed at the bottom of the list. Only buttons applicable in the context are displayed by the system

13.14 More about AR views

AR views carry more information that are not included on list views:

Individual analyses statuses are shown and linked to their logs

Designated manager. In the system set-up, a table of departmental managers is maintained. All the LIMS publications are related to a department and responsible manager. On the AR, the responsible manager is shown to everybody incl. Clients. If an AR is made up of analyses from more than one department, all responsible managers are listed. Their hyperlinked email addresses are also displayed, this is done to speed up communications between lab and client

In results fields still empty (not verified) for client AR view, an hourglass icon is displayed, indicating results 'to follow'

Remarks field for capturing notes. This field is visible to both client and lab

13.15 AR publications per Sample Source

The lab often publishes results as an individual report per sample source and the LIMS is set up to this by default

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 email. 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

13.16 Results not available yet

Where analyses were requested but results not ready for the particular user, i.e. cannot be shown to clients before verification, corresponding fields are filled with an hourglass icon

This is because in some tabled views, i.e. WSs and query results, table cells for both unavailable and not requested analyses will be shown empty otherwise and cause confusion

13.17 Re-testing of suspect values

At times analyses maybe repeated to confirm suspicious results. These are then marked as re-tested and this tag is also shown to the client to indicate that the value is correct

If the client insist on further retesting, a separate AR is made out for the same sample and the client charged

13.18 Turn around times not met

When an analysis is taking longer than its targeted turnaround time, a notification to Labmanager and technicians is raised

13.19 Worksheet links on ARs

On AR views, hyper linked Worksheet IDs are shown for analyses assigned to Worksheets. This is mainly to assist lab staff trace analyses in the lab

14 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

14.1 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

15 Worksheets

Worksheets are used in the lab to group analyses together, from different Analysis Requests for which the samples have been received and the analyses not assigned to other worksheets already

Work sheet 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 or from the same sample source

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

15.1 Specifications on Worksheets

Displaying Specifications on Worksheets 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

15.2 Creating worksheets

Worksheets can be created using templates or programmed types too – detailed creation of worksheets are discussed here. See [Worksheet templates](#) for more information on the former

Use case – Creating worksheets

Role players: Labclerk, Labtechnician, Labmanager

- i. the user navigates to worksheets and presses [add new worksheet]
- ii. the user may search the database for analyses to be included per analysis, client, order or sample source to be included on the worksheet by looking up these parameters and pressing [search]

- iii. the LIMS lists the analyses found and the user may add them to the sheet
- iv. the user may also add control samples such as reference samples, blanks and duplicates to the sheet
- v. the LIMS gives the worksheet a unique serial number
- vi. for ISO 17025 purposes, a look-up is available to select the designated analyst from
 - Position
 - Client
 - AR ID
 - Due date
 - Analysis
 - Result
 - Retested
 - Status
- vii. the worksheet displays columns for
 - Control samples are indicated with icons
- viii. a remarks field is available to capture remarks for the worksheet

15.3 Results capturing per worksheet

Use case – Capturing results to worksheets

Role players: Labtechnician, Labmanager

- i. the user navigates to the worksheets list and opens the worksheet for which data must be captured
- ii. the user enters the results and presses [submit] to write them to the DB
- iii. any suspect values may be re-tested and indicated as such to make it clear to both client and Labmanager
- iv. the user selects the analyst responsible for the worksheet from a look-up
- v. the user captures and remarks deemed necessary
- vi. when all data are captured, the worksheet offers the option to submit the worksheet for verification
- vii. the user presses [submit for verification]
- viii. the worksheet status changes from 'open' to 'to be verified'
- ix. all the individual analyses on the worksheet are promoted from 'assigned to worksheet' to 'to be verified'
- x. the system produces on-screen alerts to all users authorised to verify results, hyperlinked to the worksheet

15.4 Verification of results per worksheet. Retraction and rejection

Use case – Verifying or retracting and rejecting worksheet results

Role players: Labmanager, Verifier

- i. the user navigates to the worksheet to be verified and opens it
- ii. if the worksheet's control results, reference samples, blanks or duplicates, are out of their specified ranges set up, the results cannot be verified but only retracted or rejected. This would normally indicate a faulty calibration or method
- iii. if any of the client results are out of range, the user need to make an informed decision whether to have the results retested or verified
- iv. if the user retracts the worksheet, its status changes back to 'open' and the Labtechnicians may re-test the analyses
- v. if the user rejects the worksheet, it gets the status 'rejected'
- vi. the system copies the rejected worksheet to a new one with own unique number and it restarts the workflow with status 'open'
- vii. the rejected worksheet and its copy are hyperlinked in their headers for users to easily browse between the two
- viii. if everything is in order, the user may [verify] it – the worksheet status changes to 'verified'. As does the statuses of all the individual analyses collected on it
- ix. 'verified' is the final state of worksheets – worksheets cannot be published. All its analyses being promoted to 'verified' will reflect as such on their ARs and these may move to 'verified' themselves if all their analyses are in verified status. This will alert users to ARs ready for publication

16 Worksheet Templates

To speed up Worksheet creation, worksheets laid out similarly, e.g. in their analyses services, use of control samples and destined for the same instrument, can be made-up from templates configured in the system set-up

These templates are then available at worksheet creation. The user selects a template and the system will build the worksheet using the template and available analyses and standards fitting the template

Use case – Creating Worksheet templates

Role players: Labmanager

- i. the user navigates to worksheet templates in the system set-up and presses [add worksheet template]
- ii. the user gives the new template a title and description
- iii. the user sets the number of positions for the worksheets to be created from the template – the form refreshes and displays the number of position selected. This normally correlates to the physical number of positions on an instrument's tray
- iv. each of the positions can be specified to obtain an analysis, control, blank or duplicate. The user selects one from a drop down
- v. the user specifies which standard to use where a control or blank was selected
- vi. the user specifies which sample to be duplicated in the duplicate positions
- vii. the user specifies which analyses to be done on the worksheet – the list of available analyses are displayed to select from. More

than one may be specified to facilitate instruments capable of more than one analysis in the same run

viii. the user [save]s the template

17 Analysis 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

17.1 Customisations required for Orders

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

17.2 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

17.3 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

17.4 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

17.5 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

17.6 Query Order Analyses

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

17.7 Reports per Client Order

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

17.8 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

17.9 Supply orders

Supply Order refers to the Clients' ability to order supplies directly from the lab and are not to be confused with analysis orders

18 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 Specifications 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

Sample Type

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 the different Diagnostic Specifications available – out of range alerts are correspondingly adjusted on the pages after a new and different specification was selected

Use case – Creating an Analysis specification

Role players – Labmanager

- i. the user navigates to the Analysis specification page and clicks [add new specification]
- ii. the user completes the specification's title and description fields
- iii. all sample types and analysis are listed
- iv. the user selects the sample type(s) to enter specifications for
- v. the user enters min/max values and error % per analysis as required
- vi. the user saves the spec

Clients may maintain their own set of specifications too

19 Quality Control

19.1 Standards

A Standard is a sample of which the chemical composition is known and kept in the system. As the standards can be supplied by more than 1 supplier, the specification is stored in the system set-up as a 'Standard Stock'. In the terminology here, a Standard is an instance of a Standard Stock

Sometimes the lab will make up it's own Standard in a container and repeatedly use some of it for analyses. Other times it will be ordered from a Standard Supplier and be delivered in a batch of say 24 ampoules, and 1 ampoule is used per analyses

Standards have expiry dates where after the system does not allow analyses on them

Standard Suppliers are maintained in the system per standard Bika 'organisation and contact' model with the addition of a tab listing all the Standards supplied to the lab. From this listing, links lead to the lab's performance stats and graphs on that Standard – these are updated every time an analysis of the standard is carried out

19.2 Duplicates

Worksheets often include part of the same sample twice and the system compares their results - the exact same result must be returned for the 2 analyses in the perfect lab. Should they differ more than a specified %, the Labmanager is alerted and a 'reject or retract' workflow entered

Duplicates don't have to be Standards. Most of the time labs use any arbitrary sample on the worksheet or instrument tray

19.3 Blanks

A Blank is defined as an empty sample container, or a sample that does not contain any of the analytes tested for. When a blank is put through the analysis process, its result must be 0. If the result is more than set-up specified % error, an alarm is raised and reject or retract workflow entered

19.4 Specifications

Out of range limits are maintained to measure QC results against and Labmanagers alerted when exceeded

Standards have these values stored on their individual records

Fault tolerances for Blanks and Duplicates are set per sample type and analyses in the LIMS set-up

19.5 QC Workflow

The laboratory includes a duplicates and control analyses on each worksheet. Should the results returned for it fall outside the allowable tolerance specified

- the result is displayed as out of range
- all analyses on the same worksheet are flagged for rejection or re testing and the worksheet cannot be promoted to verification

19.6 QC Graphs

When the user selects a Standard, he/she may select the [QC] tab and complete a form to view the lab's performance for a given analysis on that standard over any given time period

All data gathered in the period is tabled and if it is enough to make statistical sense, Standard Deviation is calculated and a distribution curve and trend graphed

Distribution - shows true or expected value for the analysis and standard, the lab's mean and normal distribution around it. If the user drilled down from a specific result, that is also indicated on the graph

Trend - shows the same data set over time: the true expected value, min & max measured, standard deviations and a trend plotted through the data

QC Duplicates. Relative % error – shows the % error on duplicates in the results range tested

20 Supply Orders

This functionality allows the lab to sell non analytical services and other items on-line – like sampling containers, distilled water, consulting hours and as in the case of co-operative labs, chemicals and glass ware to satellite labs

The functionality and workflow is similar to submitting Analysis Requests

Ordering in advance on-line, has the advantage that lab personnel can make up orders to be ready when the driver arrives at the lab. For this purpose, the system alarms the data clerk when new orders are placed.

Like for the AR use cases, Clients not using the Internet place there orders at reception with the Labclerk who then fills out the order form in LIMS

Use Case - Placing an Order

Role players: ClientContact, Labclerk and manager

- i. the ClientContact fills out an order form from the 'Orders' item on her main menu
- i. the same client status checks and workflows are carried out as specified for ARs
- ii. she provides quantities for items on order and maintained in the systems set-up

- iii. the form totals the cost for the order at the bottom of the form: total, VAT total, total incl. VAT
- iv. the ClientContact submits the form
- v. the LIMS generates unique serial order number and displays it to the client
- vi. like for ARs a notification of the pending order is posted to lab staff, clerks, and managers
- vii. she navigates to the order and prints it
- viii. the Labclerk gets the products ordered ready and packs it
- ix. she hands the products to the client's shipping agent / driver
- x. the driver signs the printed order form as 'delivered'
- xi. the Labclerk pushes [dispatch] on the order form in LIMS
- xii. LIMS sets the order's status to 'dispatched'

Manually - the data clerk captures the order

For any other orders not submitted by clients themselves, be it telephonically or 'over the counter', the data clerk captures and executes the order as per the above use case

21 Invoices

Purpose

- i) To print a date ranged batch of invoices during a month-end run and export the data to Pastel 7
- ii) To print ad-hoc invoices immediately for walk-in customers
- iii) Items can only be invoiced once – those on these ad hoc invoices are excluded from month-end runs
- iv) However tricky: when batches are exported or printed, ad hoc invoices dated in the same date range as the batch but not actually in the batch, are exported or printed with the batch

21.1 (Pro Forma) Invoice Tabs

The laboratory prefers prices kept from results views to keep it pure science. All ARs have 'invoice' tabs where associated costs can be viewed. Where, for instance, an AR will appear on an invoice as one line only, a more detailed financial break down is provided on the invoice tab, i.e. for ARs showing costs per analysis and all discounts applied

If the item has not been invoiced, this tab is titled 'Proforma' Invoice. If the item has been invoiced already, the Invoice ID is displayed and hyper linked to the invoice

Not in the scope of the invoices module

- i) Corrections to invoices are not allowed, these are carried out via credit and debit notes in the accounting system Pastel
- ii) Invoices cannot be deleted – but are corrected per credit and debit notes in Pastel
- iii) Emailing invoices

21.2 Compiling invoice batches

Use case – Creating and invoice batch

Role player: Labmanager

- i. the role player navigates to the Invoice batching page and clicks [add new batch]
- ii. she enters the 'Invoice date' to be shown on the invoice itself
- iii. she completes fields to enter the begin and end date/time for items to be included in the run
- iv. she enters the remarks to go into the comment field on all invoices
- v. the invoices are compiled from all the items published during the date range
- vi. invoices are sequentially and uniquely numbered, prefixes to be supplied in the prefix set-up page
- vii. once included in an invoice, the item is flagged as 'invoiced' and the ID of the invoice it appears on is displayed on the item itself
- viii. for items where a 3rd party invoicee is specified, her address and VAT details etc., are used off the invoicee's set-up pages
- ix. the invoices show:
 - “Tax Invoice” prominently
 - Individual serialized tax invoice number
 - Date of the tax invoice
 - Lab name address and VAT#
 - Client's postal or physical address
 - The Client VAT#
 - The Client's order#
 - A disclaimer at the bottom of the invoice – the lab Laboratories' conditions of business applies

21.3 Printing month-end Invoices

Use case - Printing month-end Invoices

Role player: Labmanager only

- i. the role player navigates to the Invoice batches page and opens the batch to be printed
- ii. she clicks [print] on that page

21.4 Export Invoices

Pastel 7 format

Use case – Invoice export

Role player - Labmanager only

- i. the role player navigates to the Invoice batches page and opens the batch to be exported
- ii. she clicks [export] on that page

- iii. she specifies the file name and network folder for the export file
- iv. the invoices are exported in comma delimited file formatted to be read by accounts software Pastel
- v. the accountant imports the invoice export file into Pastel

21.5 Ad-hoc Invoices

Use case - Ad-hoc Invoices

Role players: Labmanager only

- i. the role player navigates to the client's Ad hoc Invoices page and clicks [add new]
- ii. she enters the 'Invoice date' to be shown on the invoice itself
- iii. she selects the items to be included on the Invoice
- iv. she enters the remarks to go into the comment field on the invoice
- v. she clicks [create invoice]
- vi. items included on invoices are flagged as 'invoiced' and the ID of the invoice it appears on is displayed on the item's pages
- vii. the Invoice displays the information described earlier
- viii. the manager pushes the [print] button

21.6 Re-printing Invoices

Use case - Re-printing Invoices

Role players: Labmanager, Labclerk

- the role player navigates to the invoices screen and finds the invoices to be printed
- the manager pushes the [print] button
- the invoices are printed

22 Price Lists

Purpose

To compile price lists from the services and products listed in the system for distribution amongst lab prospects and clients

Notes

Price lists are not shown to clients or anonymous visitors but can be printed or emailed by the Labmanager

Since prices are kept separately for corporate and non-corporate clients, two separate price lists for these two groups can be created. This is not indicated on the eventual price list

Separate price lists are used for Analytical services and products

For pseudo-quoting and promotions etc., it is possible to apply a discount percentage on all of the price list

Use case - Creating price lists

Role players: Labmanager

Prices themselves are maintained in the LIMS set-up on the list of analytical services, surveys, culture reports etc.. all price updates are done there, see Analysis Services and Prices

- i. the role player navigates to the price lists page
- ii. she presses [create price list]
- iii. on the price list creation page she gives the price list a name, i.e. Chemical Analyses 2005 and
- iv. she enters a start and end date
- v. she completes a field to indicate whether it is a corporate or non-corporate price list
- vi. she select the groups of items to be included, i.e. surveys, inspections, culture reports etc..
- vii. for, i.e. a promotional price list, a discount percentage can be applied per price group or all items
- viii. remarks about the prices can be entered in a remarks field
- ix. as well as selected from the global insertion list
- x. she presses [save]
- i. the price list is compiled off the list of analytical services and their prices, discounts applied and kept in the LIMS set-up
 - for a corporate price list, the corporate prices are used
 - for a non-corporate price list, the non-corporate prices are used

22.1 Emailing and printing price lists

Use case - Emailing and printing price lists

Role players: Labmanager

- i. the role player navigates to the price lists page
- ii. she opens the price list to email/print
- iii. to print it, she presses print in the browser's menu system
- iv. she may also email the price list to any of the contacts on the system – their addresses are available to lab staff off a pick list, clients and other users type in email addresses
- v. once the email address field is completed, she presses [email]
- vi. the LIMS delivers the price list to the addressee

23 Queries

Query forms are available to query each of the following on any their attributes:

- Analyses - on Analysis Requests and Worksheets
- Supply Orders
- Invoices

In tabular layouts for query results, where results were not requested or are not available yet, this is indicated to prevent confusion

For example, Lab personnel might want to view invoices to field queries

Use case - Invoices query. Emailing Query results

Role players - Labmanager and Labclerk

- i. the role player navigates to the 'query invoices' screen
- ii. she completes fields to select invoices:
- iii. client or all clients and/or date range and/or AR ID and/or Analyses
- iv. she presses [submit query]
- v. all the invoices complying to the search terms are listed
- vi. 1 Invoice per line, showing the Invoice number and its main
- vii. the role player may drill down to any of these by clicking on it
- viii. she may also email the query result to any of the contacts on the system – their addresses are available to her off a pick list
- ix. alternatively she may type in an email address

24 Reports

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

General

Analyses totals

Analyses totals per client

Analyses requests per client

Analyses totals per sample type

Analyses totals per Analysis Service type

Analyses per sample source

Efficiency

Analyses repeated

Turn around times

Accreditation

Analyses out of range

Accounting

Analysis Requests not invoiced

Client statuses, balances & credit limits

ARS without Client Order Numbers

Analyses subcontracted

25 True Working hours calendar

For the calculation of late analyses alerts and turn around reports, Bika uses only true lab working hours. The maximum time allowed for analyses are configured in the analysis services' set-up

25.1 Calendar management

The Labmanager configures the lab's working days and hours for any future period

Use case - setting up the calendar

Role player: Labmanager

i. The role player navigates to the calendar in the LIMS set-up and is shown the current calendar. By default all future dates have no working hours assigned to them until edited

ii. she selects edit

Calendar period

iii. she keys in a start and end date for the period to be edited

iv. she is not allowed to modify working hours for past dates

Regular working weekdays

v. she selects the lab's working weekdays from a panel

- typically Monday, Tuesday, Wednesday, Thursday and Friday
- and not Saturday and not Sunday

vi. she then sets working hours for all these working days, allowing for breaks

- e.g. 9:00 to 12:30, 13:15 to 17:00

vii. the role player may edit each weekday individually, say to use shorter working hours for Fridays 9:00 to 12:30, 13:15 to 15:00

viii. she clicks [save]

ix. all regular working weekdays, in the selected calendar period, are populated with these data

x. the calendar is displayed

Holidays

xi. the role player now access individual days on the calendar to indicate then as holidays, public or otherwise

xii. a 'repeat holiday' function is used to enter holiday breaks of longer than one day, e.g. a 14 day end of year recess

xiii. holidays have title fields - the role player enters any text here, e.g. Youth day.

xiv. The holiday title text is displayed on the calendar in the standard weekly or monthly views

xv. she saves her edits

xvi. no working hours are allowed on holidays. If a day has working hours assigned to it and then gets marked as a holiday, its working hours are set to zero

Irregular days

xvii. individual days may be edited to reflect half days etc., e.g. Friday 13 March 9:00 to 12:00

xviii. she saves her edits

26 LIMS Set-up and configuration

All constants are maintained in the LIMS set-up for system wide use.

Only Analysis Services are described here. The use case is the same for all and may only be executed by the Labmanager. All saved changes take immediate effect

All set-up items: Analysis profiles, Analysis services, Analysis specs, Bika calendar, Bika settings, Calculation Types, Instruments, Lab contacts, Lab departments, Laboratory information, Mail Templates settings, Methods, Products, Sample Sources, Sample points, Sample Types, Standard Stocks, Users and Groups Administration, Worksheet Templates

26.1 Analysis Services

Use case – Configuring an Analysis Service

Role players: Labmanager

- i. the user navigates to the LIMS set-up and selects Analysis Services
- ii. the user clicks on an existing Analysis Service to edit it or [add new analysis service] to create a new one
- iii. the user completes the following fields:
 - iv. title
 - v. description – made available as pop-up to Clients
 - vi. instructions – made available as pop-up to Clients
 - vii. Report as dry matter Y/N - Select if result can be reported as dry matter
 - viii. Unit
 - ix. Precision as number of decimals - defines the number of decimals to be used for this result
 - x. Price excluding VAT
 - xi. Corporate price excluding VAT – a different price for bulk buyers. Clients can be toggled as 'corporate' to be charged this price
 - xii. VAT % - defaults to system's percentage
 - xiii. Instrument Import Keyword - this is the name of the service in the CSV file exported by the analytic instrument
 - xiv. Analysis Keyword - the analysis identifier for imports from instruments
 - xv. Dependant Analyses – if the service depends on other results they are selected here
 - xvi. Instruments
 - xvii. Methods
 - xviii. Maximum Hours Allowed - maximum time allowed for publication of results before raising a late analysis alert - 0 for undefined
 - xix. Calculation Type – select from weight and titration calculations

- xx. Titration Volume Unit
- xxi. Duplicate Variation - the percentage duplicate variation permitted before a QC alarm is raised
- xxii. Department – the lab department responsible for the analysis
- xxiii. Accredited – check if the lab is accredited for the analysis
- xxiv. Uncertainties – to define the measure of uncertainty in certain value ranges
- xxv. the user presses [save] to submit the changes, they take immediate effect

27 Addendum A. Full-tilt Order Batching

27.1 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

27.2 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 ClientContact 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

27.3 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

27.4 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

Role players: ClientContact, Labclerk and Labmanager

- 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 ClientContact
- vi. Sampled By - defaults to the ClientContact

Submitted By - defaults to the ClientContact. "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 ClientContacts, 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

27.5 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'

27.6 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
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Order views have tabs for

- |edit|
- |view|
- |manage results|
- |export|
- |import|

|QC|
|final report|
|pro forma invoice|

27.7 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

27.8 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

27.9 Order logs

Same as for ARs

27.10 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 ClientContact 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 Labmanager

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 ClientContact 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 Labmanager

27.10.1 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

27.10.2 Worksheet per order

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

28 Addendum B. 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.)

28.1 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

28.2 Causes and reasons look-up

28.2.1 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

28.2.2 Combustible 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

28.2.3 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

28.2.4 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**

28.2.5 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, C_2H_2/C_2H_4

if C_2H_2 and C_2H_4 both > 10 and $C_2H_4 > 0$, then C_2H_2/C_2H_4 else 0

Methane/Hydrogen, CH_4/H_2

if CH_4 and H_2 both > 10 and $H_2 > 0$, then CH_4/H_2 else 0

Ethylene/Ethane, C_2H_4/C_2H_6

if C_2H_4 and C_2H_6 both > 10 and $C_2H_6 > 0$, then C_2H_4/C_2H_6 else 0

Ethane/Methane, C_2H_6/CH_4

if C_2H_6 and CH_4 both > 10 and $CH_4 > 0$, then C_2H_6/CH_4 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

28.2.6 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 >=0.1 and <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

28.2.7 % 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

28.2.8 % 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

28.2.9 Diagnosis – Water, Acid, Dielectric

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"

28.2.10 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-through 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.

28.2.11 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		Distribution	Furnaces	Power ppm	Distribution ppm	Furnaces ppm
	Min	Max					
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

28.2.12 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

28.2.13 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 with Tracking	<=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

28.2.14 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

28.2.15 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

28.2.16 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

28.2.17 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

28.2.18 Recommended re-sampling date

Look up from the above table using Total Combustible Gas

28.2.19 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-through 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.

29 Addendum C. 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

29.1 Export

Use case: Export data to instruments

Role players Labtechnician, Labmanager

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

29.1.1 Export Templates

To be provided

29.2 Import

Use case. Import data to instruments

Role players Labtechnician, Labmanager

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 ClientContact, these get imported to but kept out of view for the purpose of the ClientContact 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

29.2.1 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

29.2.2 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	Chromato gram 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

29.2.3 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	Chromato gram 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

29.2.4 TCD and FID combined

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

Summary : Samancor_Summary_DGA_FID_TCD.SUMR

Date : 21/04/2008 03:51:53 PM

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

30 Addendum D. Import CSV

The CSV import format illustrated here is available as an OpenOffice (or MS Word) file that include some look-up automation. It can be requested from lemoene@bikalabs.com

CSV:

```
"Header";"Import / Export";"File name";"Client name";"Client ID";"Contact ID";"CC recipient ID";"CC Email";"Order ID";"Quote ID";"Sample point";,,,,,;
```

```
"Header Data";"Import";"<File name>";"<Client name>";"<Client ID>";"<Contact ID>";"<CC recipient ID>";"<CC Email>";"<Order ID>";"<Quote ID>";,,,,,;
```

```
"Samples";"Client Sample ID";"Sampling date";"Sample type";"Sample Source";"Sample point";"Total number of analyses";"Price excl VAT";"Analysis 01";"Analysis 02";"Analysis 03";"Analysis 04";"Analysis 05";"Analysis 06";"Analysis 07";"Analysis 08";"Analysis 09";"Analysis 10"
```

```
"Analysis price";,,,,,;"<Price 01>";"<Price 02>";"<Price 03>";"<Price 04>";"<Price 05>";"<Price 06>";"<Price 07>";"<Price 08>";"<Price 09>";"<Price 10>"
```

```
"Total analyses";,,,,,;"Analyses Grand Total";"Control 1";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>";"<Total analyses>"
```

```
"Total price excl VAT";,,,,,;"Price Grand total";"Control 2";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>";"<Analysis price total>"
```

```
"Sample 1";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 2";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 3";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 4";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 5";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 6";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 7";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 8";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```

```
"Sample 9";"<Client Sample ID>";"<Sampling date>";"<Sample type>";"<Sample Source>";"<Sample point>";"<Number of Analyses>";"<Sample price>";,,,,,;
```