1 About TOA4

Transformer Oil Analyst 4.0 (TOA4) is a software product developed and marketed by Delta-X Research Inc. TOA4 provides state-of-the-art computerized interpretation of dissolved-gas analysis (DGA) and insulating fluid test results for power transformers and other liquid-filled high-voltage equipment. Its main purpose is to help you process test data and identify abnormal results quickly so that investigation or corrective action can be initiated promptly to prevent unscheduled outages, avoidable equipment failure, and safety hazards.

Whether TOA4 is installed on a single computer or on a network, its user interface is a web browser. If installed on a network, TOA4 is accessible by users on that network in the same way that a web site would be. TOA4 Online is a subscription-based service providing TOA4's data management, analysis, and reporting via the public Internet.

2 TOA4 Disclaimer

There are many unusual circumstances that can affect dissolved-gas analysis (DGA) and other oil test results, and no computer software can possibly handle all of them reliably and economically. For this reason, competent human involvement in data interpretation is essential. TOA4's automatic data intepretation is intended to assist, not replace, the equipment expert.

TOA4 results must always be reviewed by a person qualified to interpret the data, who can judge the correctness and applicability of the results in each case and decide upon follow-up action if required. The criteria upon which TOA4 results are based must also be subjected to review and control by a qualified person.

Although we do our best to ensure that TOA4 employs up-to-date and proven analysis methods, Delta-X Research Inc does not claim or guarantee that TOA4's automatically generated data interpretation is complete or correct. It is only offered as an aid to a qualified person, who would in most cases want to perform a similar type of analysis before deciding whether further investigation or alternative interpretations are required. Delta-X Research is pleased to reveal and discuss the details of TOA4's diagnostic calculations with any qualified TOA4 user.

It is also important to be aware that, although DGA is an extremely important tool for early detection of equipment faults, it is far from perfect. According to insurance company statistics, generally only about one-third of all transformer failures are avoidable by means of annual screening DGA, and only about two-thirds of all transformer failures are avoidable by means of continuous online monitoring.

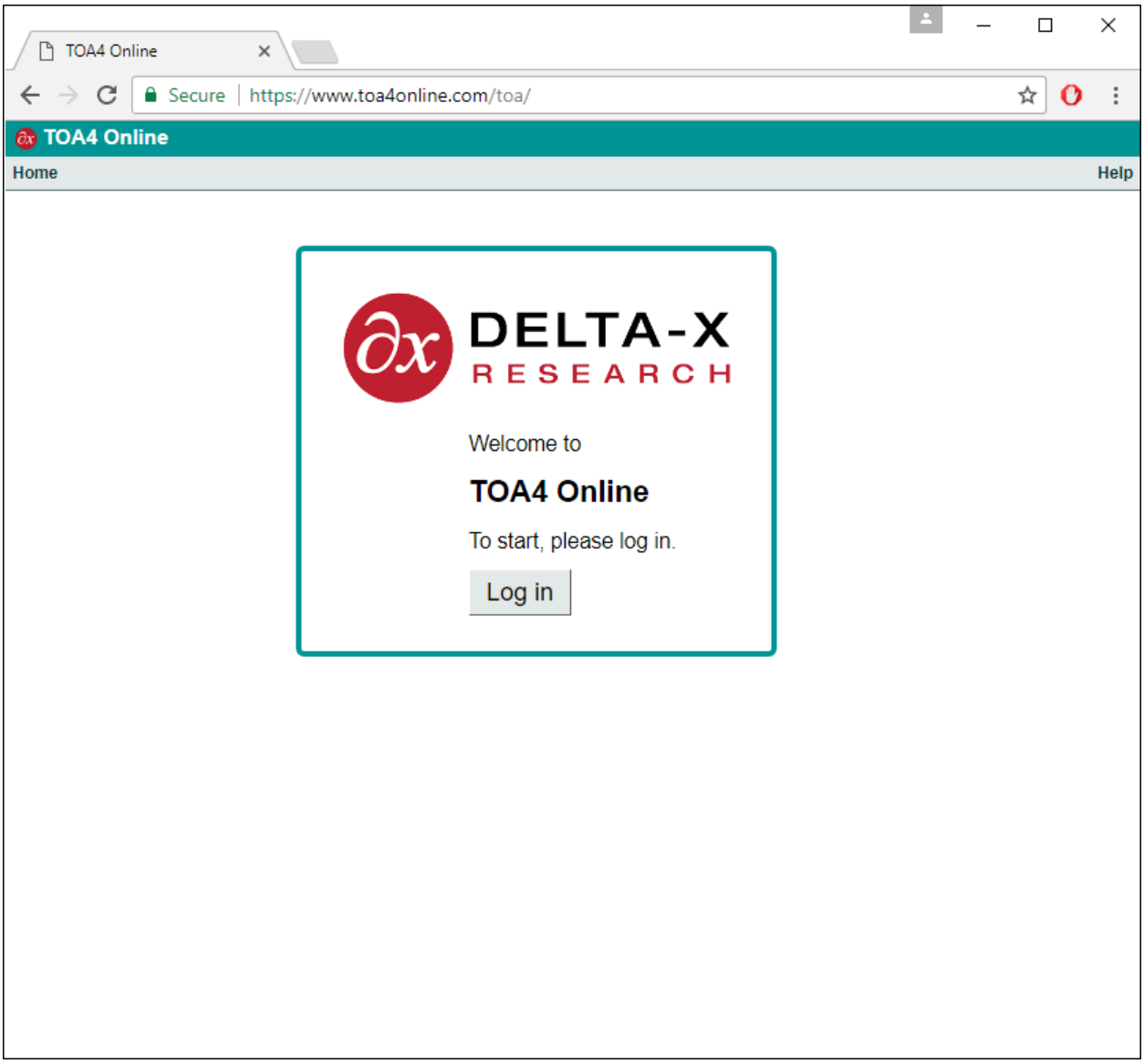
3 Find TOA4 Online

TOA4 Online is TOA4 software acting as a web site on the public Internet. To find it, point your web browser to this home address: https://www.toa4online.com/toa/
There are two special things to note about this address.

- First, it starts with "https" instead of the more usual "http". This signifies that a special high-security protocol is used which encrypts all information exchanged between your browser and the TOA4 Online server.

- Second, it ends with "/toa". This is a security feature. If you forget the "toa/" part and try to use the basic dot-com address, your browser will tell you that the requested web page does not exist.

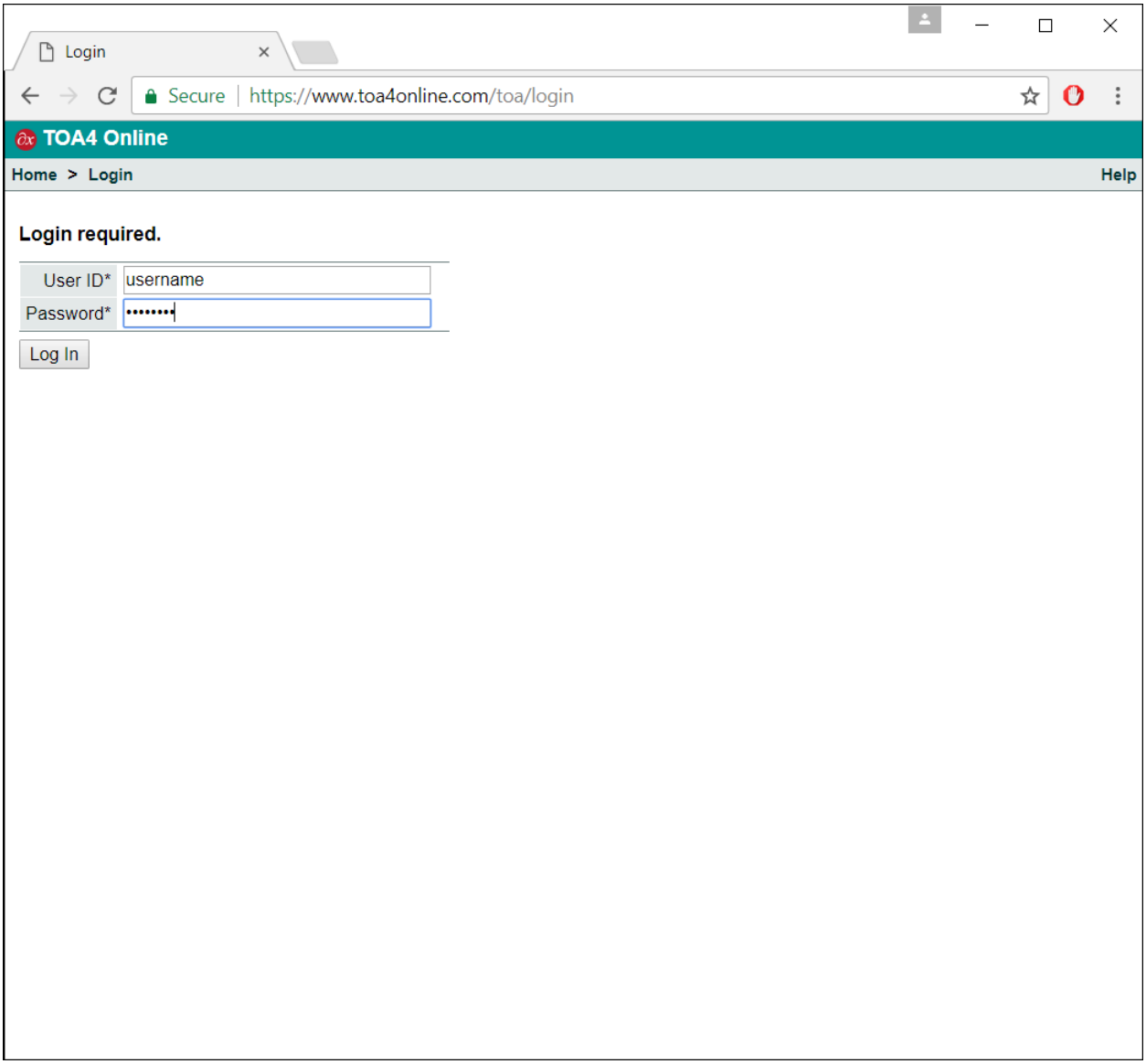
We suggest that you create a "bookmark" for the TOA4 home address. In Internet Explorer, this is the same as adding the TOA4 Online home address to your "favorites". Below is what you see when your browser first connects with TOA4 Online.



4 Log In and Out

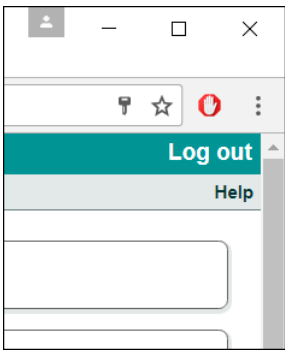
Each user must log in to TOA4 before using it. The user login ID's and initial passwords are assigned by your TOA4 Administrator.

To **log in**, click "Log in" in the TOA4 home page or try to access any of TOA's features other than the home page or Help. A login dialog box is presented.



Your login ID and password are case-sensitive.

When you are finished using TOA4, it is a good idea to **log out**. Click the "Log out" link at the right end of the title bar at the top of any TOA4 web page.



5 TOA4 User Security Roles

Every TOA4 login ID is associated with a security role which defines what data and operations are available to a user with that ID. There are two classes of login ID's - FULL and RESTRICTED. "Restricted" login ID's are issued with a particular security role which is permanent. The security role of a "Full" login ID can be changed (within a certain range) by a TOA4 administrator. Details are shown below.

FULL user security roles

unauthorized	View the home page and use Help.
authorized	Read-only access to equipment, test data, norms, lists.
operator	Import/edit equipment, unreviewed test data, lists.
supervisor	Import/edit/delete equipment, data, and norms. Review test data.
administrator	Like supervisor. Also edit user profiles and set passwords.

RESTRICTED user security roles

authorized	Read-only access to equipment, test data, norms, lists.
data-provider	Upload and view data files, download equpment.
rpc-user	Execute RPC commands (automation interface to TOA4).

6 Access Control Groups

In some cases it may be necessary or desirable to allow certain users access to only a subset of the equipment in a TOA4 database. For example, there may be several different departments or power plants, each with its own equipment, where the employees at each location should be able to see and work with information about only their equipment. In the same situation, there may also be equipment experts who need to be able to review and edit equipment information from multiple locations, and administrative users usually need to have access to everything in the database.

TOA4's access control groups feature provides a way to handle this kind of requirement.

Example
Power Short Corp. has two subsidiaries, Nuke Power Co. and Big Smoke Co., each of which has several TOA4 login ID's. At corporate headquarters, there is a lab, a group of equipment experts, and an I.T. person who takes care of TOA4 administration and database maintenance.

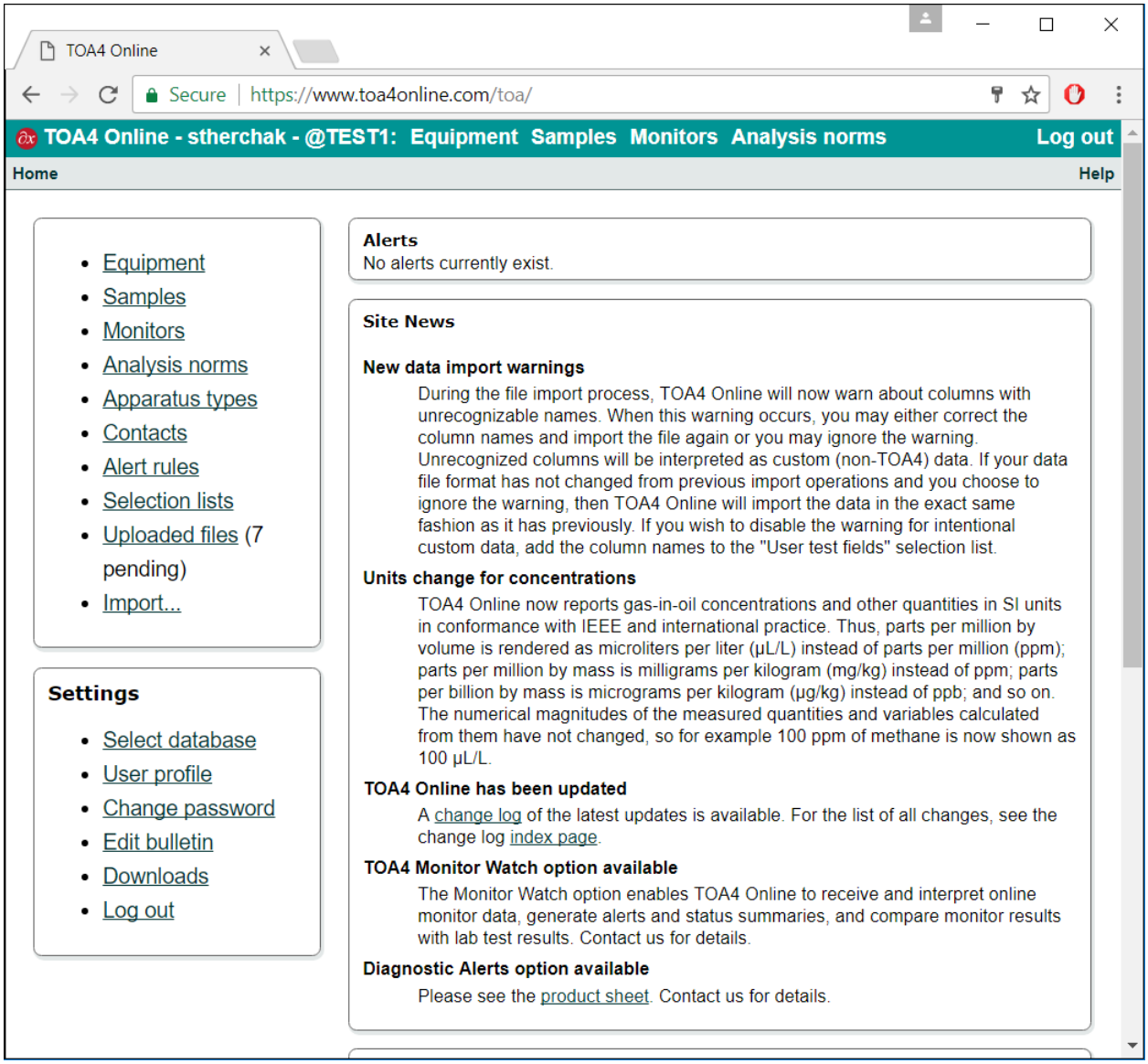
The administrator creates two access control groups, respectively called "NUKE POWER" and "BIG SMOKE". The users at those sites are put into the group for their site. The lab user and the equipment experts are put into both groups. It does not matter whether the administrator is included in the groups or not, because an admin user always has access to the entire database.

The administrator edits the equipment or does an equipment update import to set the group_name of each equipment item to NUKE POWER or BIG SMOKE.

For details, see "Access Control Groups" under "Reference Information" in TOA4 Help.

7 The TOA4 Home Page

After you log in, the TOA4 home page contains links to important features, What's New notices, and very basic pointers for new users. What exactly is visible to you on the home page (and other pages) depends on the "security role" assigned to your TOA4 Online login ID. If you are a supervisor-level user, for example, some extra links are provided for uploading, editing, and deleting data and analysis norms.



The "user profile" link under Settings allows you to **record your contact information** so that your TOA4 administrator can contact you when necessary.

The "change password" link allows you to set your own password. Please remember that since TOA4 Online is on the public Internet insecure (easily-guessed) passwords must not be used. A good way to invent a secure password is to think of an easily-remembered sentence or phrase, with at least six words, and use the first letter of each word to make a password. For example, if the sentence is "My dog Gonzo likes hot peppers," the password would be "MdGlhp". If you forget your password, **your TOA4 administrator can set a new one for you.**

8 Use Bookmarks

Since TOA4 Online is a web site, you can bookmark any page or report that you would like to return to in the future. For example, you might bookmark the Equipment page of a transformer which requires special attention. You could bookmark a Help page which contains information that you refer to often. It is handy to bookmark major pages such as Equipment and Analysis Norms to avoid using menus to find them.

9 Copy and Save

When viewing text or images in TOA4, you can use the copying and saving features of your web browser to transfer information to a separate file or to a word processing document or a spreadsheet.

Copying text

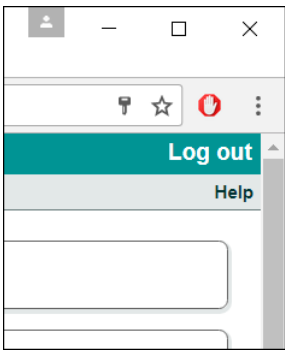
Highlight some text on a TOA4 page. Click on it with the right mouse button. In the context menu that appears, choose “Copy.” The text can now be “pasted” into a word processing document, spreadsheet, or notepad file in a different window. If you highlight and copy a table, such as the test history shown in an analysis report, in most cases it can be pasted into a spreadsheet or word processing document as a similar table. If pasted into a notepad file or pasted as “plain text,” it will appear as tab-separated text. To copy a large table, if not all rows are displayed in the current page, change “Rows to show” (near the top of the page) so that it is the same as “Records” and click the Go button. Even if the table contains hundreds of records, the page - with a table containing all those rows - should be redisplayed very quickly. Now you can highlight the entire table, copy it, and paste it into a document or file.

Copying or saving images

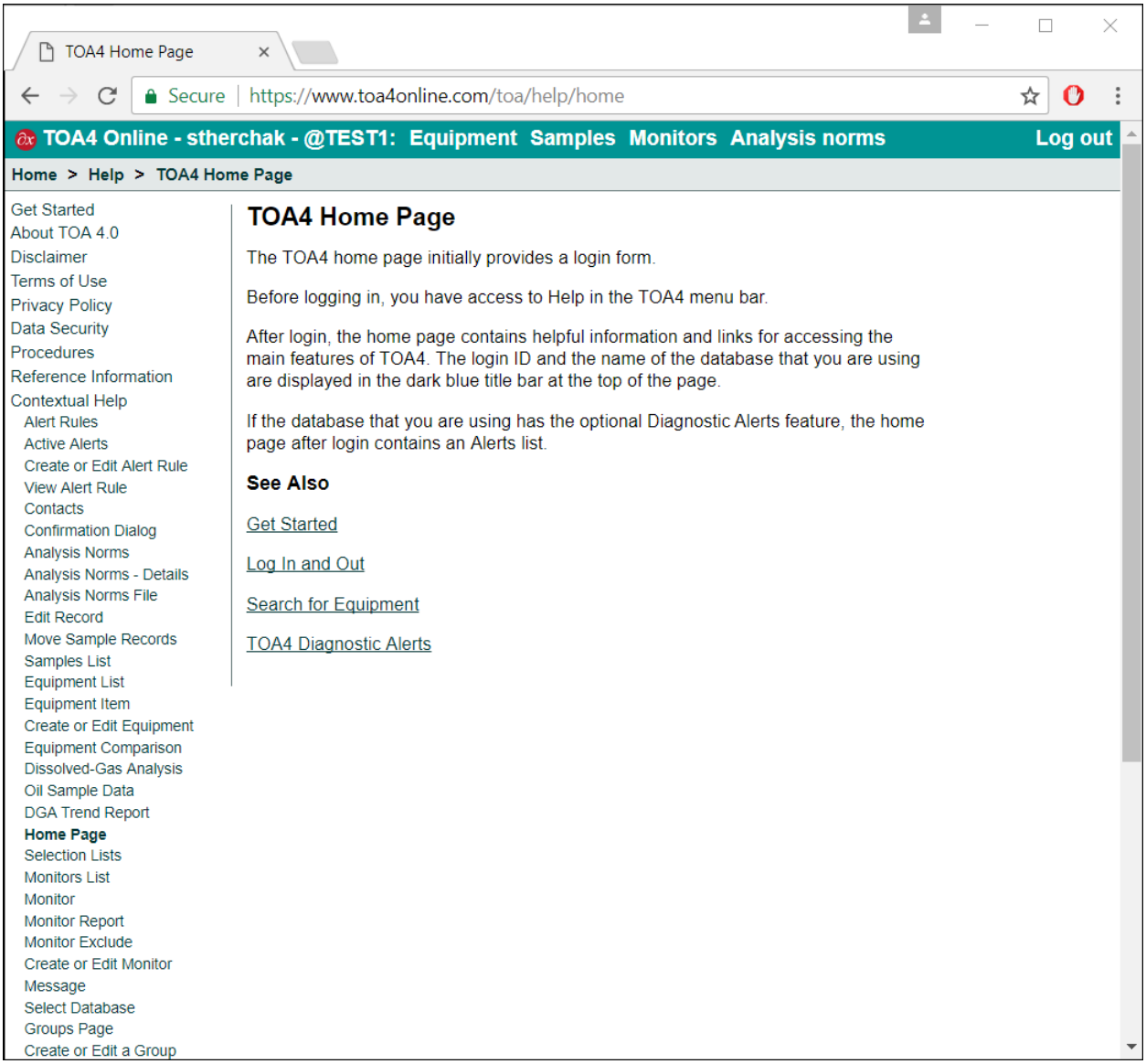
Every graph, triangle chart, or other image displayed in a TOA4 page can be saved to a file or copied and then pasted into a document. Simply click on the image with the right mouse button and choose “Save As” or “Copy” (depending on what you wish to do) in the context menu that appears.

10 Get Help

Most TOA4 web pages have a "Help" link in the upper right for displaying help information relating to the page you are currently viewing.



Each help page has a navigation menu on the left side that allows you to look up other information.



11 Equipment List

The equipment list displays basic information about equipment items and serves as a starting place for finding more detailed information about each equipment item. Above the equipment list is a set of controls which can be used to filter and sort the list in various ways and to scroll back and forth in the list, if it contains more items than those displayed.

11.1 Special List Columns

New

The number of new, un-analyzed samples for each equipment item is shown in the New column.

Total

The total number of oil sample records for each equipment item is shown in the Total column.

Last Sampled, Last DGA/FQ/moisture Sample

The date when the latest DGA or fluid quality (FQ) or moisture-in-oil sample was drawn is shown in a column named Last Sampled or Last DGA Sample, etc.

Next DGA, Next FQ
The suggested date when the next DGA or fluid quality (FQ) sample should be drawn is shown in the Next DGA or Next FQ column.

DGA, FQ, Moisture
The latest result codes for dissolved-gas analysis, fluid quality, and moisture content are shown in the DGA, FQ, and Moisture columns, respectively. The result code is a number:
0: Un-analyzed, or no data
1: No abnormality detected
2: May require retesting or extra attention
3: May require urgent attention
4: May require extremely urgent attention or action

Diagnosis
If the DGA, FQ, or Moisture result code is greater than 1, indicating the detection of an abnormal or faulty condition, a diagnostic code of the relevant type can be displayed indicating the most likely type of fault corresponding to the evidence found. For brevity, the DGA diagnosis is identified by a short code.

Status
When new test data are imported for an equipment item, its status is shown as UNREVIEWED until a supervisor or administrator designates each new test record belonging to that equipment as REVIEWED.

11.2 Batch Processing Buttons

The batch processing buttons (located below the equipment list) initiate operations which affect only the equipment items selected by the current filter settings. For example, if you filter on a specific substation, an analysis operation will process only data belonging to equipment at that substation.

Analyze new data
When some equipment items have recent un-analyzed data, the “Analyze new data” button is displayed. If the analysis is activated, the equipment with un-analyzed data is processed, typically at a rate exceeding 200 data records per second. Test data records marked as REVIEWED are not modified by the analysis. A message is displayed when the analysis is complete.

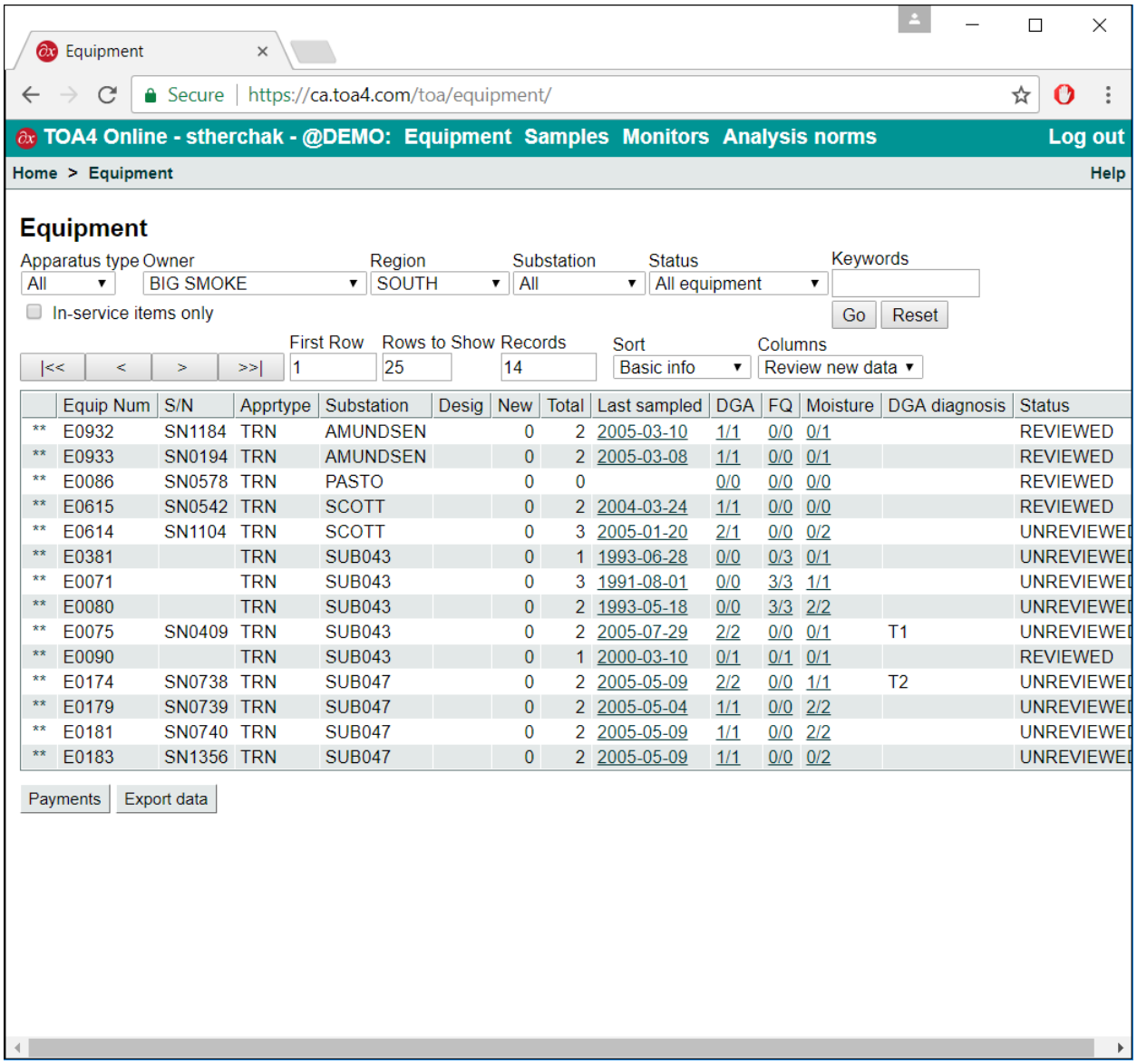
Analyze unreviewed
The “Analyze unreviewed” button is provided so that an analysis can be run even if there are no un-analyzed records. This will analyze all new data and also all UNREVIEWED data. Note that any reviewer edits and comments which may have been made on the UNREVIEWED items will be overwritten by this analysis. Test data records marked as REVIEWED are not modified, though. A message is displayed when the analysis is complete.

Delete
Deletes all equipment that is selected by the current filter, along with all the associated test data.

Review
The “Review” button is displayed when some test data records have been analyzed but are still UNREVIEWED. When Review is clicked, a confirmation dialog is presented explaining that UNREVIEWED test data with no evidence of abnormality (i.e., with all result codes < 2) will be marked as REVIEWED. After “Review” has been used, that button is hidden. Equipment with abnormal results which are still UNREVIEWED may be found by filtering the equipment list for Abnormal or Unreviewed status.

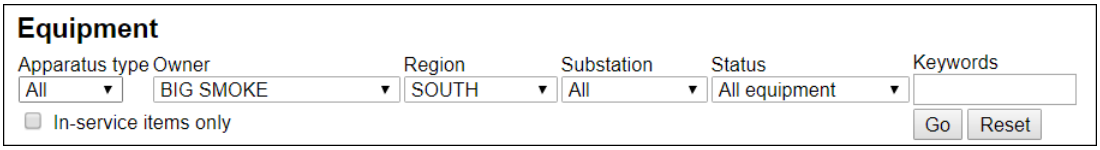
Import

The “Import” button displays the Upload File page.



12 Equipment List Filters

Just under the title of the Equipment page there is a row of selection lists for filtering the equipment list. To the right of the filter selection lists is a textbox for entering search text. At the extreme right of that row are a Go button and a Reset button. The filters, including the keyword search, act jointly. To remove all filters, click the Reset button.



12.1 Apparatus Type

Apparatus type designates a generic type of equipment, such as transformers, oil circuit breakers, and so on. The available apparatus types are generally subscriber-defined.

12.2 Owner

Owner is intended to designate the company, organization, or department to which an equipment item belongs. For an electric utility, owner might be TRANSMISSION, DISTRIBUTION, or GENERATION, or it might identify a subsidiary. For a lab or electrical service company, owner would usually identify the customer who owns the equipment.

12.3 Region

Region is intended to designate a geographical territory, but in some situations it might be used to identify a large facility, such as a refinery, containing several substations.

12.4 Substation

Substation normally identifies an electrical substation or similar group of equipment at one physical location.

12.5 Status

The status selections are as described here:

All equipment	Show all the equipment items.
Abnormal	Show all equipment with a DGA, FQ, or moisture code greater than one.
Unanalyzed	Show all equipment with unanalyzed test data.
Unreviewed	Show all equipment whose most recent test data is UNREVIEWED.
Reviewed	Show all equipment whose most recent test data is REVIEWED.

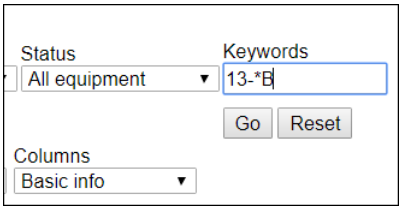
12.6 Keywords

The Keyword Search feature for finding equipment is located on the Equipment List page. Just under the page title there is a row of selection lists for filtering the equipment list by apparatus type, owner, and so on. At the right end of that row is a text box for entering search text. The equipment search feature operates in combination with the filter selection lists to restrict the contents of the equipment list according to criteria that you choose.

To filter the equipment list according to the search text that you have typed (and also the other filter selections you have made), press Enter or click the “Go” button after typing the search text.

A text or numeric expression typed in the Keyword Search box must be matched exactly unless a “wildcard” character (asterisk “*”), representing any number of anonymous characters, is found in the expression. The search looks at all the text attributes of all equipment for matches; these attributes include the equipment number, serial number, substation name, designation, owner name, manufacturer, model, description, apparatus type, year manufactured, kV rating, MVA ratings, current rating, fluid type, and cooling type.

For example, enter the name of a set of analysis norms to produce a list of all the equipment using those norms. A search for “03-001234” might display a single equipment item with that particular equipment number or serial number. Searching for “03-*” would display all the equipment having an attribute (probably equipment number or serial number, in this case) starting with “03-”. Searching for “03-*B” would display all equipment having an attribute starting with “03-” and ending with “B”.



13 Equipment List Display Controls

Between the row of filter controls and the top of the equipment list, there is a row of widgets for scrolling the list, controlling the number of rows displayed, and choosing different combinations of columns to show.

13.1 VCR Buttons

The "VCR buttons" at the left side are for showing different parts of the list:

|< < Beginning of list.
< One page back.
> One page forwards.
> >| End of list.

13.2 First Row

The First Row textbox shows which row of the equipment list (as currently filtered) is at the top of those displayed. To jump directly to a particular row, enter its number in the box. If the page size or number of rows in the list do not allow the designated row to be shown at the top, the number in the First Row textbox may change to a different value than the one you entered.

13.3 Rows to Show

The Rows to Show textbox controls the page size, i.e., the maximum number of rows displayed at one time. For some purposes you may wish to expand or shrink the page size to display exactly a particular set of rows. It is also possible to enter a large number and cause all the equipment in the list (as filtered) to be displayed at once, even if there are several thousand rows.

13.4 Records

The Records text box shows the number of rows present in the equipment list as filtered. This number is not editable.

13.5 Sort

The Sort selection list provides several different ways to sort the equipment list as currently filtered. Some sort options are available only with certain selections of columns.

Assessment	Combination of DGA, FQ, moisture condition codes. Worst at the top.
Equipment	Equipment No. / Serial No., in alphabetical order
Last sampled	Date of latest sample, with most recent dates at the top.
Next DGA/FQ	Recommended next DGA (or FQ) sample date, earliest at the top.
Oil test status	Reviewed/Unreviewed status. Reviewed at the top.
Substation	Substation, in alphabetical order.

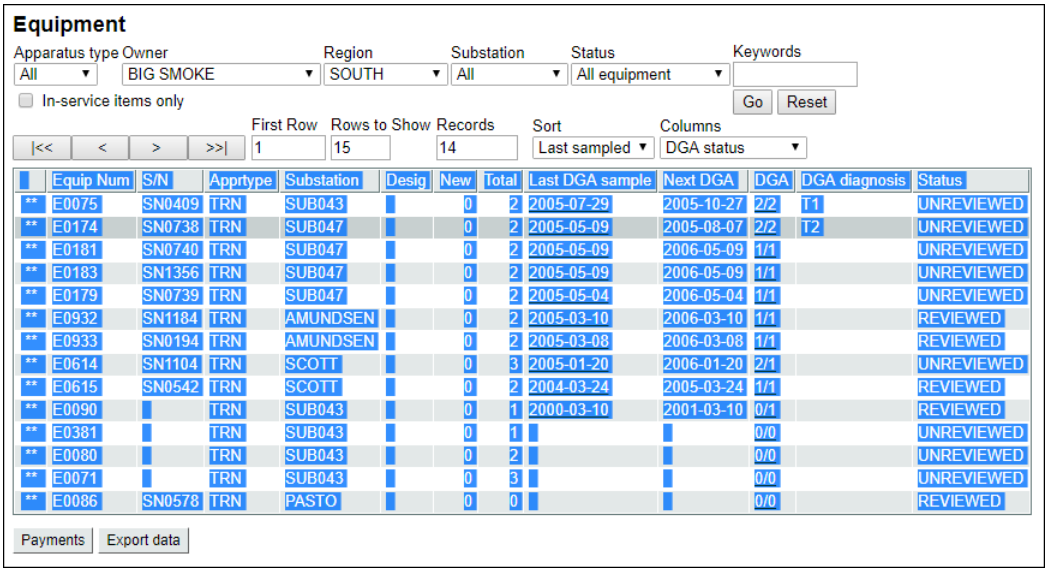
13.6 Columns

The Columns selection list provides several different combinations of columns to show. All views include the equipment identification (Equipment No., Serial No., Apparatus Type) and location (Owner, Region, Substation, Designation). Additional columns shown in each case are:

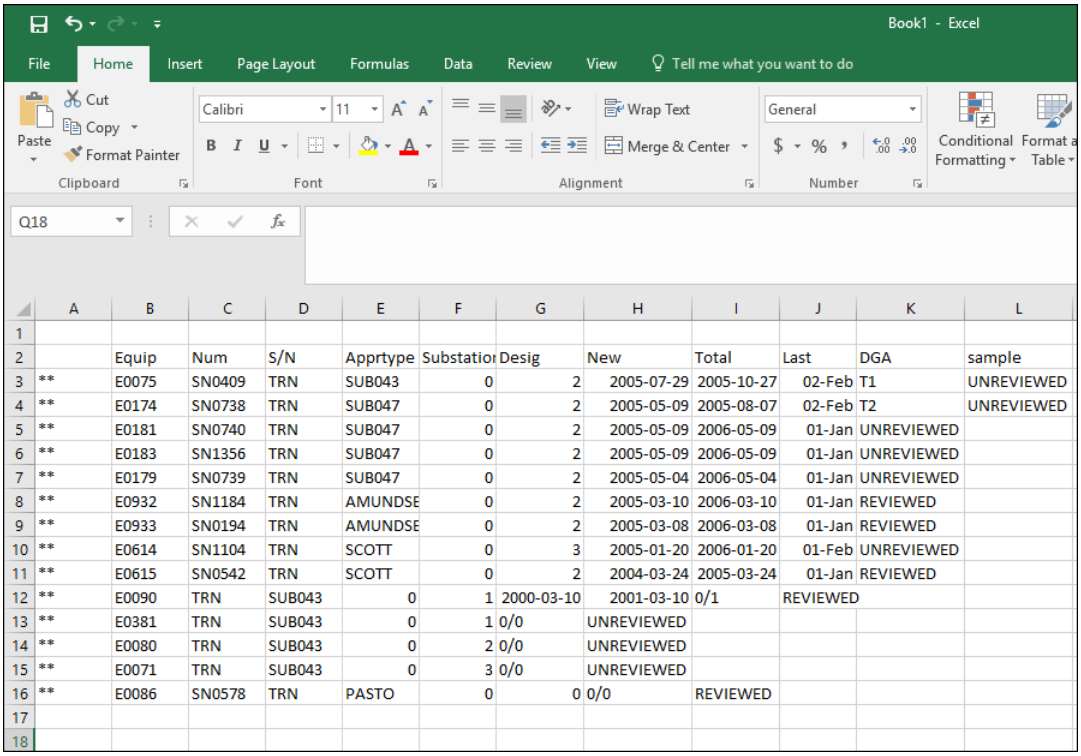
Analysis Norms	Manufacturer, kV rating, Norms.
Basic info	Manufacturer, kV rating, Amps rating, Cooling, Fluid type.
DGA status	New samples, Total samples, Last DGA, Next DGA, DGA result, DGA diagnosis, Oil test status.
FQ status	New samples, Total samples, Last FQ, Next FQ, FQ result, FQ diagnosis, Oil test status.
Moisture status	New samples, Total samples, Last moisture sample, moisture result, moisture diagnosis, Oil test status.
Review new data	New samples, Total samples, Last sample, DGA result, FQ result, moisture result, Oil test status.

14 Copy a Table and Paste to a Spreadsheet

To copy a large table, if not all rows are displayed in the current page, change “Rows to show” (near the top of the page) so that it is the same as “Records” and click the Go button. Even if the table contains hundreds of records, the page - with a table containing all those rows - should be redisplayed very quickly. Now you can highlight the entire table, copy it, and paste it into a document or file. Use “Paste Special” and select “Plain Text”.



	Equip Num	S/N	Apprtype	Substation	Desig	New	Total	Last DGA sample	Next DGA	DGA	DGA diagnosis	Status
**	E0075	SN0409	TRN	SUB043		0	2	2005-07-29	2005-10-27	2/2	T1	UNREVIEWED
**	E0174	SN0738	TRN	SUB047		0	2	2005-05-09	2005-08-07	2/2	T2	UNREVIEWED
**	E0181	SN0740	TRN	SUB047		0	2	2005-05-09	2006-05-09	1/1		UNREVIEWED
**	E0183	SN1356	TRN	SUB047		0	2	2005-05-09	2006-05-09	1/1		UNREVIEWED
**	E0179	SN0739	TRN	SUB047		0	2	2005-05-04	2006-05-04	1/1		UNREVIEWED
**	E0932	SN1184	TRN	AMUNDSEN		0	2	2005-03-10	2006-03-10	1/1		REVIEWED
**	E0933	SN0194	TRN	AMUNDSEN		0	2	2005-03-08	2006-03-08	1/1		REVIEWED
**	E0614	SN1104	TRN	SCOTT		0	3	2005-01-20	2006-01-20	2/1		UNREVIEWED
**	E0615	SN0542	TRN	SCOTT		0	2	2004-03-24	2005-03-24	1/1		REVIEWED
**	E0090		TRN	SUB043		0	1	2000-03-10	2001-03-10	0/1		REVIEWED
**	E0381		TRN	SUB043		0	1			0/0		UNREVIEWED
**	E0080		TRN	SUB043		0	2			0/0		UNREVIEWED
**	E0071		TRN	SUB043		0	3			0/0		UNREVIEWED
**	E0086	SN0578	TRN	PASTO		0	0			0/0		REVIEWED

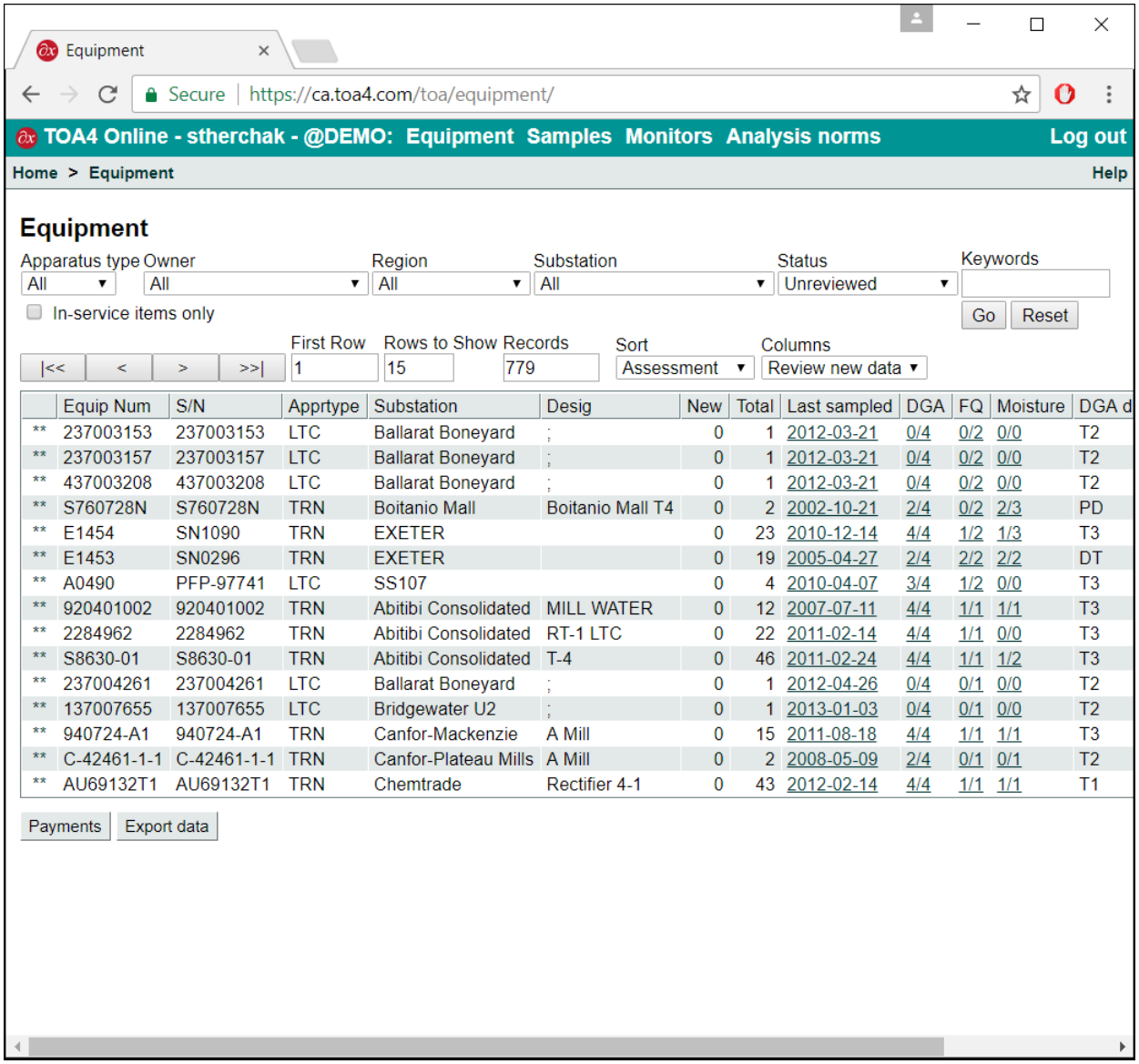


	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		Equip	Num	S/N	Apprtype	Substatio	Desig	New	Total	Last	DGA	sample
3	**	E0075	SN0409	TRN	SUB043	0	2	2005-07-29	2005-10-27	02-Feb	T1	UNREVIEWED
4	**	E0174	SN0738	TRN	SUB047	0	2	2005-05-09	2005-08-07	02-Feb	T2	UNREVIEWED
5	**	E0181	SN0740	TRN	SUB047	0	2	2005-05-09	2006-05-09	01-Jan	UNREVIEWED	
6	**	E0183	SN1356	TRN	SUB047	0	2	2005-05-09	2006-05-09	01-Jan	UNREVIEWED	
7	**	E0179	SN0739	TRN	SUB047	0	2	2005-05-04	2006-05-04	01-Jan	UNREVIEWED	
8	**	E0932	SN1184	TRN	AMUNDSE	0	2	2005-03-10	2006-03-10	01-Jan	REVIEWED	
9	**	E0933	SN0194	TRN	AMUNDSE	0	2	2005-03-08	2006-03-08	01-Jan	REVIEWED	
10	**	E0614	SN1104	TRN	SCOTT	0	3	2005-01-20	2006-01-20	01-Feb	UNREVIEWED	
11	**	E0615	SN0542	TRN	SCOTT	0	2	2004-03-24	2005-03-24	01-Jan	REVIEWED	
12	**	E0090	TRN	SUB043	0	1	2000-03-10	2001-03-10	0/1	REVIEWED		
13	**	E0381	TRN	SUB043	0	1	0/0	UNREVIEWED				
14	**	E0080	TRN	SUB043	0	2	0/0	UNREVIEWED				
15	**	E0071	TRN	SUB043	0	3	0/0	UNREVIEWED				
16	**	E0086	SN0578	TRN	PASTO	0	0	0/0	REVIEWED			
17												
18												

15 Prioritized List for Reviewing New Results

To get a list of equipment prioritized according to test results, with the worst cases at the top, choose “Review new data” in the Columns selection list and “Assessment” in the Sort selection list. Also choose “UNREVIEWED” in the Status selection list to restrict the list to equipment whose latest tests have not yet been reviewed. On the other hand, choose “REVIEWED” in the Status selection list to restrict the list to equipment whose latest tests have been reviewed.

Please note that the latest test results don’t get calculated until someone clicks the “Analyze new” button.

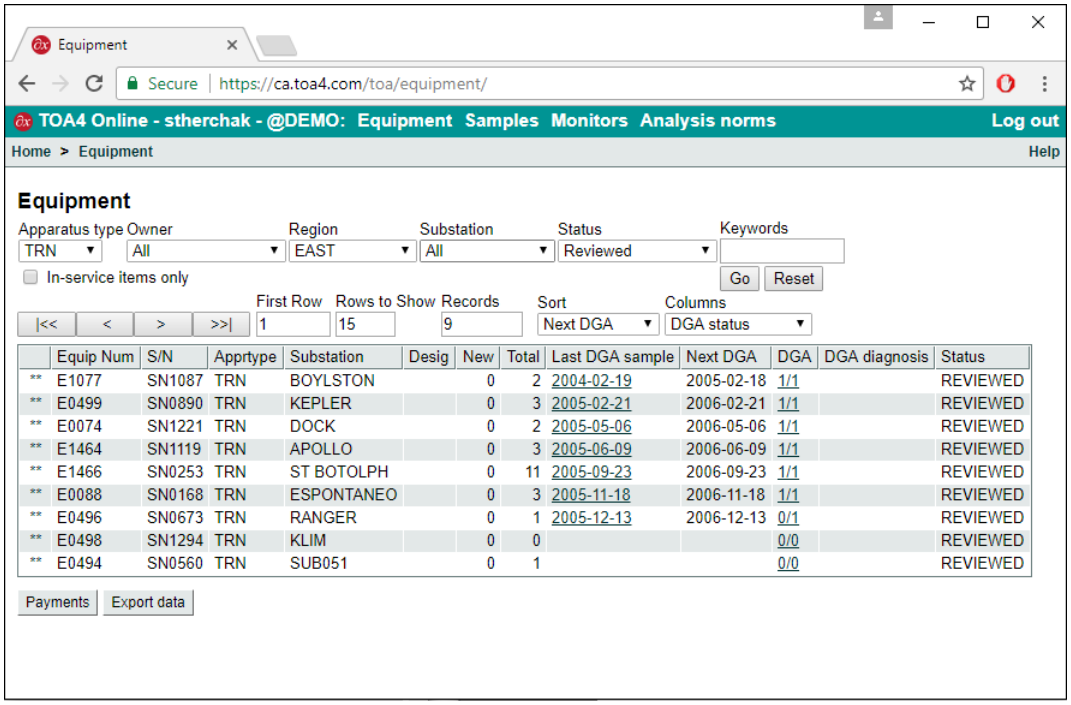


	Equip Num	S/N	Apprtype	Substation	Desig	New	Total	Last sampled	DGA	FQ	Moisture	DGA d
**	237003153	237003153	LTC	Ballarat Boneyard	;	0	1	2012-03-21	0/4	0/2	0/0	T2
**	237003157	237003157	LTC	Ballarat Boneyard	;	0	1	2012-03-21	0/4	0/2	0/0	T2
**	437003208	437003208	LTC	Ballarat Boneyard	;	0	1	2012-03-21	0/4	0/2	0/0	T2
**	S760728N	S760728N	TRN	Boitanio Mall	Boitanio Mall T4	0	2	2002-10-21	2/4	0/2	2/3	PD
**	E1454	SN1090	TRN	EXETER		0	23	2010-12-14	4/4	1/2	1/3	T3
**	E1453	SN0296	TRN	EXETER		0	19	2005-04-27	2/4	2/2	2/2	DT
**	A0490	PFP-97741	LTC	SS107		0	4	2010-04-07	3/4	1/2	0/0	T3
**	920401002	920401002	TRN	Abitibi Consolidated	MILL WATER	0	12	2007-07-11	4/4	1/1	1/1	T3
**	2284962	2284962	TRN	Abitibi Consolidated	RT-1 LTC	0	22	2011-02-14	4/4	1/1	0/0	T3
**	S8630-01	S8630-01	TRN	Abitibi Consolidated	T-4	0	46	2011-02-24	4/4	1/1	1/2	T3
**	237004261	237004261	LTC	Ballarat Boneyard	;	0	1	2012-04-26	0/4	0/1	0/0	T2
**	137007655	137007655	LTC	Bridgewater U2	;	0	1	2013-01-03	0/4	0/1	0/0	T2
**	940724-A1	940724-A1	TRN	Canfor-Mackenzie	A Mill	0	15	2011-08-18	4/4	1/1	1/1	T3
**	C-42461-1-1	C-42461-1-1	TRN	Canfor-Plateau Mills	A Mill	0	2	2008-05-09	2/4	0/1	0/1	T2
**	AU69132T1	AU69132T1	TRN	Chemtrade	Rectifier 4-1	0	43	2012-02-14	4/4	1/1	1/1	T1

If you are one of the expert reviewers, see the Analyze and Review help page for a suggested procedure. Look in the navigation menu of any Help page under the top-level heading Procedures.

16 Prioritized List for Sampling

To get a list of equipment arranged according to DGA sampling priority, with the most urgent items at the top, choose “DGA status” in the Columns selection list and “Next DGA” in the Sort selection list. Normally you would also choose "UNREVIEWED" in the Status selection list to restrict the list to equipment whose latest tests have been reviewed. To create a working list for DGA sampling, change “Rows to show” to a number large enough to display all the items that you want to include in the list. Then use the Copy a Table and Paste to Spreadsheet procedure described above to transfer those items to a spreadsheet.

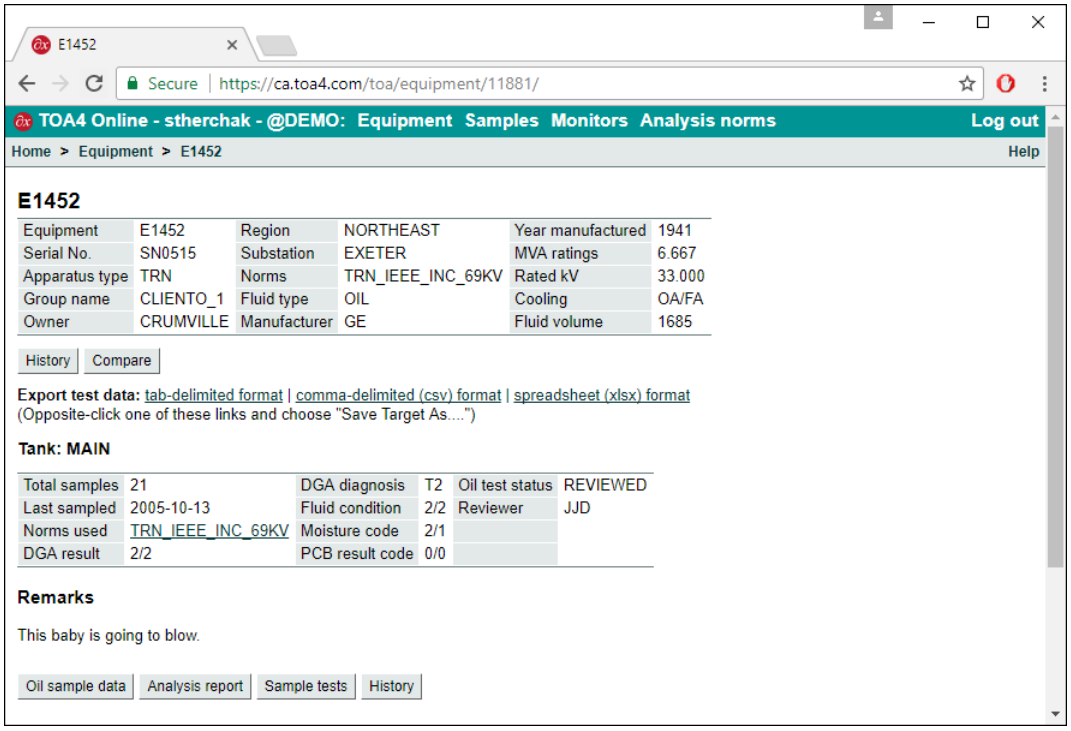


17 Equipment Detail

Click any equipment item in the Equipment List to view a page containing detailed information about that equipment, plus a summary of test results for each “tank” that is defined for it.

If you have a sufficiently high security role in TOA4, there are buttons below the equipment information for editing or deleting the equipment and for reanalyzing the equipment’s test data.

The Compare button generates a report (see separate writeup below) comparing this equipment’s latest test results to the corresponding test results of similar equipment. Under the summary information for each “tank,” there are buttons for viewing the oil test data (as a list of records), the latest analysis report, and the latest trend report. If your security role is high enough, and if the latest results are still unreviewed, there may also be a Review button which opens an edit form for entering reviewer remarks for the latest test results.



18 Equipment Comparison Report

Click the Compare button in the detail page of any equipment item to display an Equipment Comparison Report, showing the available information about the selected equipment and a side-by-side comparison of that equipment's latest test data with corresponding statistics from all the equipment in your database which uses the same analysis norms.

18.1 Equipment Information

The top section of the report identifies the equipment and shows all the nameplate and other static information provided for it. The standard buttons are provided for editing the equipment information, re-analyzing the equipment's test data, or deleting this equipment item from the database. Hyperlinks below the buttons enable you to download this equipment's test data in text files.

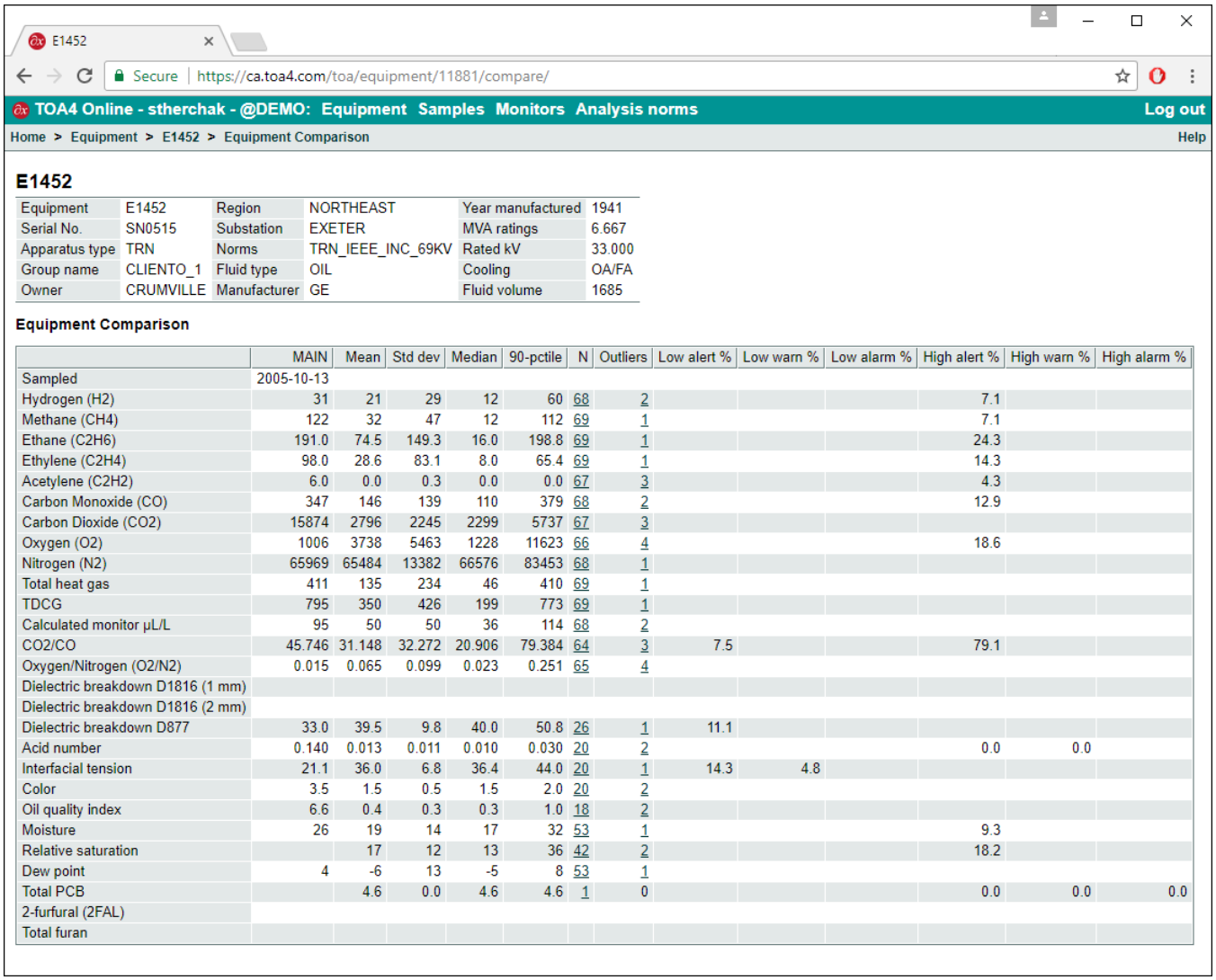
18.2 Equipment Comparison

The Equipment Comparison table shows the equipment's latest test results in the leftmost column(s), followed by several columns of statistical information derived from the latest test data for all equipment sharing the same analysis norms as the selected equipment. If no analysis norms are specified for the selected equipment, then the comparison is with all equipment of the same apparatus type.

Each row of the table represents one test variable which was either measured or calculated as of the sample date shown. The value is given, followed by statistics such as the mean, standard deviation, median, and 90-th percentile. The N statistic is the number of equipment items involved in calculating the statistics for each variable. The number of outliers (values so extreme that they are omitted from the calculations as invalid) is also shown; outliers are identified by a standard statistical rule known as Chauvenet's Criterion.

If analysis norms are specified for the selected equipment, there are additional columns summarizing how those norms classified the data for all the relevant equipment. For example, if the "High alert %" column contains 4.5 for hydrogen, it

means that, of all the hydrogen values reported for the latest samples for all the equipment included in the comparison, 4.5% exceeded the High alert norm for hydrogen.



E1452

Equipment	E1452	Region	NORTHEAST	Year manufactured	1941
Serial No.	SN0515	Substation	EXETER	MVA ratings	6.667
Apparatus type	TRN	Norms	TRN_IEEE_INC_69KV	Rated kV	33.000
Group name	CLIENTO_1	Fluid type	OIL	Cooling	OA/FA
Owner	CRUMVILLE	Manufacturer	GE	Fluid volume	1685

Equipment Comparison

	MAIN	Mean	Std dev	Median	90-pctile	N	Outliers	Low alert %	Low warn %	Low alarm %	High alert %	High warn %	High alarm %
Sampled	2005-10-13												
Hydrogen (H2)	31	21	29	12	60	68	2				7.1		
Methane (CH4)	122	32	47	12	112	69	1				7.1		
Ethane (C2H6)	191.0	74.5	149.3	16.0	198.8	69	1				24.3		
Ethylene (C2H4)	98.0	28.6	83.1	8.0	65.4	69	1				14.3		
Acetylene (C2H2)	6.0	0.0	0.3	0.0	0.0	67	3				4.3		
Carbon Monoxide (CO)	347	146	139	110	379	68	2				12.9		
Carbon Dioxide (CO2)	15874	2796	2245	2299	5737	67	3						
Oxygen (O2)	1006	3738	5463	1228	11623	66	4				18.6		
Nitrogen (N2)	65969	65484	13382	66576	83453	68	1						
Total heat gas	411	135	234	46	410	69	1						
TDCG	795	350	426	199	773	69	1						
Calculated monitor µL/L	95	50	50	36	114	68	2						
CO2/CO	45.746	31.148	32.272	20.906	79.384	64	3	7.5			79.1		
Oxygen/Nitrogen (O2/N2)	0.015	0.065	0.099	0.023	0.251	65	4						
Dielectric breakdown D1816 (1 mm)													
Dielectric breakdown D1816 (2 mm)													
Dielectric breakdown D877	33.0	39.5	9.8	40.0	50.8	26	1	11.1					
Acid number	0.140	0.013	0.011	0.010	0.030	20	2				0.0	0.0	
Interfacial tension	21.1	36.0	6.8	36.4	44.0	20	1	14.3	4.8				
Color	3.5	1.5	0.5	1.5	2.0	20	2						
Oil quality index	6.6	0.4	0.3	0.3	1.0	18	2						
Moisture	26	19	14	17	32	53	1				9.3		
Relative saturation		17	12	13	36	42	2				18.2		
Dew point	4	-6	13	-5	8	53	1						
Total PCB		4.6	0.0	4.6	4.6	1	0				0.0	0.0	0.0
2-furfural (2FAL)													
Total furan													

19 Analysis Report

Click the Analysis button under a tank in the detail page of any equipment item to display an analysis report for that tank's oil samples. At the top of the report is equipment detail and tank summary information, possibly with edit buttons for a reviewer to use for editing the report and changing the report's status to REVIEWED.

For each test type for which data is provided - DGA, fluid quality, moisture, furans, particles, PCB - there is a table showing the latest several samples in right-to-left order by sample date, with some interpretive text underneath.

If there is more than one sample for this equipment, the bottom of the report contains a large assortment of history graphs.

If you print the report from your web browser, using the Print command in the browser's File menu, the report is reformatted for printing without all the web page widgets.

Fluid Analysis Report

Secure | https://ca.toa4.com/toa/equipment/11881/tank/0/fluid_report?charts=y#c

TOA4 Online - stherchak - @DEMO: Equipment Samples Monitors Analysis norms Log out

Home > Equipment > E1452 > MAIN > Fluid Analysis Report Help

Oil sample data | Analysis report | Trend report

Fluid Analysis Report

Equipment	E1452	Rated kV	33.000
Serial No.	SN0515	Cooling	OA/FA
Apparatus type	TRN	Fluid volume	1685
Group name	CLIENTO_1	Tank	MAIN
Owner	CRUMVILLE	Norms used	TRN_IEEE_INC_69KV
Region	NORTHEAST	DGA result	2/2
Substation	EXETER	Fluid condition	2/2
Norms	TRN_IEEE_INC_69KV	Moisture code	2/1
Fluid type	OIL	PCB result code	0/0
Manufacturer	GE	Oil test status	REVIEWED
Year manufactured	1941	Reviewer	JJD
MVA ratings	6.667		

Remarks

This baby is going to blow.

Compare | Sample tests | History

Gas Analysis

Sample date	2005-10-13	2005-06-14	2005-04-27	2004-10-19	2004-06-02
Fluid temp			40		50
Hydrogen (H2)	31	16	16	41	51
Methane (CH4)	122	90	82	147	133
Ethane (C2H6)	191.0	132.0	119.0	161.0	165.0
Ethylene (C2H4)	98.0	73.0	75.0	94.0	114.0
Acetylene (C2H2)	6.0	0.0	12.0	14.0	13.0
Carbon Monoxide (CO)	347	214	217	341	322
Carbon Dioxide (CO2)	15874	11429	11622	9943	9518
Oxygen (O2)	1006	492	60	203	648
Nitrogen (N2)	65969	72594	67585	85939	61480
Total heat gas	411	295	276	402	412
TDCG	795	525	521	798	798
Equivalent TCG			0.320		0.603
Total partial press			72.7		64.2
Est. safe handling limit			7.9		7.1
Calculated monitor µL/L	95	56	57	105	112
CO2/CO	45.746	53.407	53.558	29.158	29.559
Oxygen/Nitrogen (O2/N2)	0.015	0.007	0.001	0.002	0.011
DGA retest days	90	90	90	90	30
DGA retest date	2005-11-12	2005-09-12	2005-07-26	2005-01-17	2004-07-02
DGA reference days	121.0	48.0	190.0	139.0	1227.0
DGA result	2	2	2	2	3
DGA diagnosis	T2	T2	DT	DT	DT

Gas Analysis Remarks

Significant increase (^). High level (*). Thermal fault (300 to 700 C). Consider investigative sampling. Acetylene did not actually increase. Prev sample had erroneous 0 value.

Fluid Analysis Report

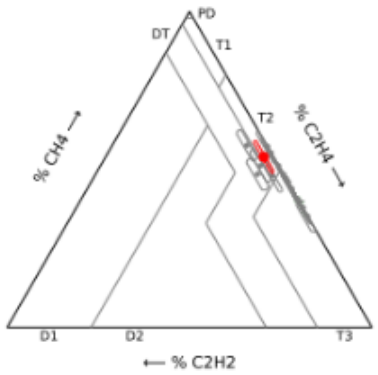
Secure | https://ca.toa4.com/toa/equipment/11881/tank/0/fluid_report?charts=y#c

Gas Analysis Summary

Variable name	Value	Units	Description
Ethane (C2H6)	191.0	µL/L	Level alert (high 66.0).
Ethylene (C2H4)	98.0	µL/L	Level alert (high 51.0).
Acetylene (C2H2)	6.0	µL/L	Level alert (high 3.0). Increment alert (3.0, 15.0, 30.0).

```
c2h6* c2h4* c2h2*^
```

Diagnosis



Triangle Diagnosis: T2

Rogers Diagnosis: T1

Fluid Quality

Sample date	2005-10-13	2005-06-14	2004-10-19	2004-06-02	2000-02-03
Fluid temp				50	0
Dielectric breakdown D877	33.0	24.0	40.0	31.0	52.0
Acid number	0.140	0.130		0.130	0.070
Interfacial tension	21.1	19.3		22.1	22.5
Color	3.5	3.5	3.5	4.0	3.5
Oil quality index	6.6	6.7		5.9	3.1
Fluid quality retest days			365		
Fluid quality retest date			2005-10-19		
Fluid condition	2	2	1	2	2
Fluid diagnosis	CONTAMINATED	CONTAMINATED		CONTAMINATED	CONTAMINATED

Fluid Quality Analysis Remarks

There may be polar contaminants or excessive moisture. Consider reclaiming the oil.

Fluid Quality Summary

Variable name	Value	Units	Description
Interfacial tension	21.1	mN/m	Level alert (low 24.0, 16.0).

```
ift*
```

Moisture Analysis

Sample date	2005-10-13	2005-06-14	2005-04-27	2004-10-19	2004-06-02
Fluid temp			40		50
Moisture	26	35	28	21	18
Relative saturation			23		10
Dew point	4	10	5	-0	-3

Fluid Analysis Report

Secure | https://ca.toa4.com/toa/equipment/11881/tank/0/fluid_report?charts=y#c

Moisture Analysis

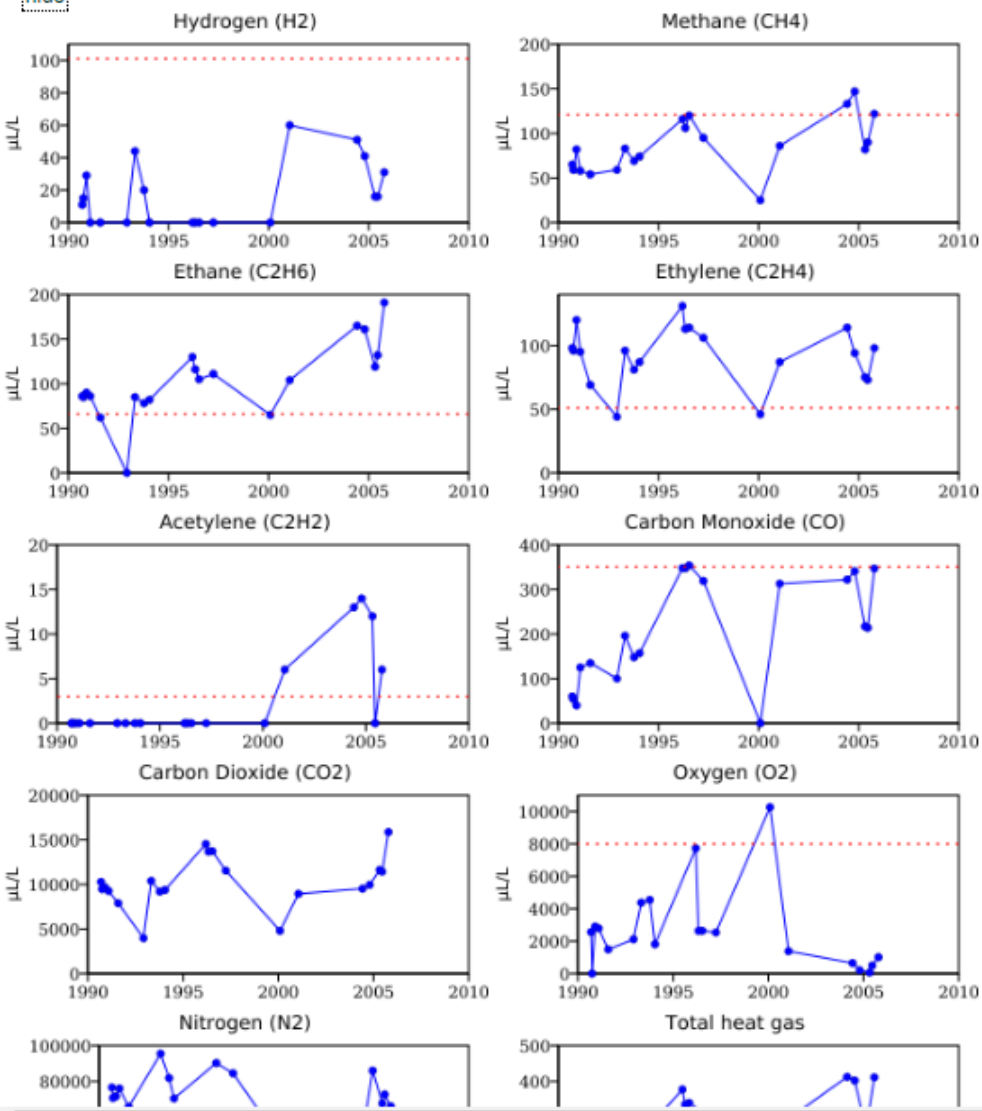
Sample date	2005-10-13	2005-06-14	2005-04-27	2004-10-19	2004-06-02
Fluid temp			40		50
Moisture	26	35	28	21	18
Relative saturation			23		10
Dew point	4	10	5	-0	-3
Moisture code	1	2	1	1	1
Moisture diagnosis		WET-OIL			

Moisture Remarks

The water content of the oil seems acceptable.

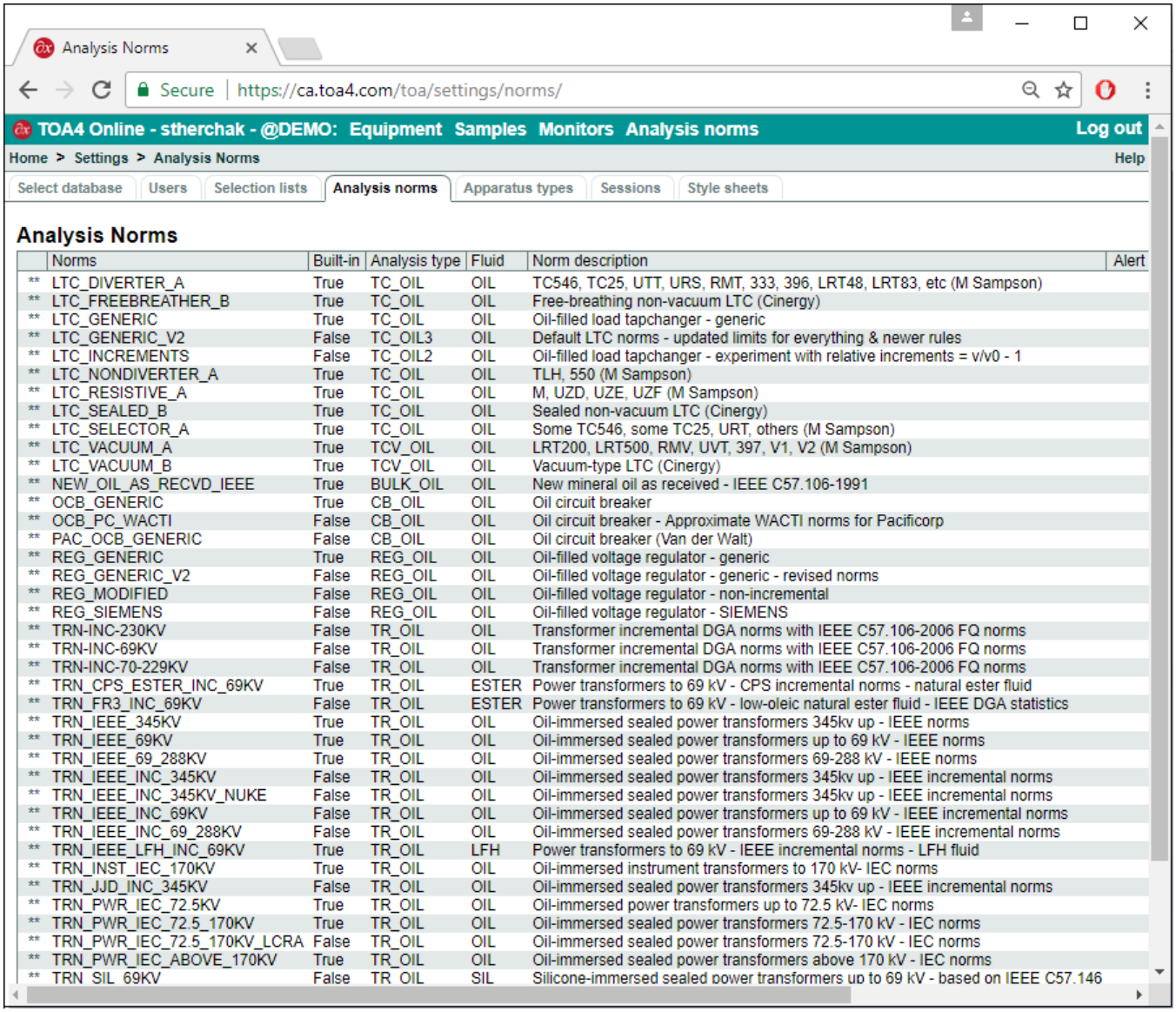
History Graphs and Diagnostic Charts

hide



20 Analysis Norms

There is a list of analysis norms (limits and resampling intervals) used by the automatic data analysis which can be viewed by clicking the “Analysis norms” link under Settings in the TOA4 Home Page. Some of these norms are supplied by Delta-X Research as examples, and some may be norms developed for use at your site.



Analysis Norms

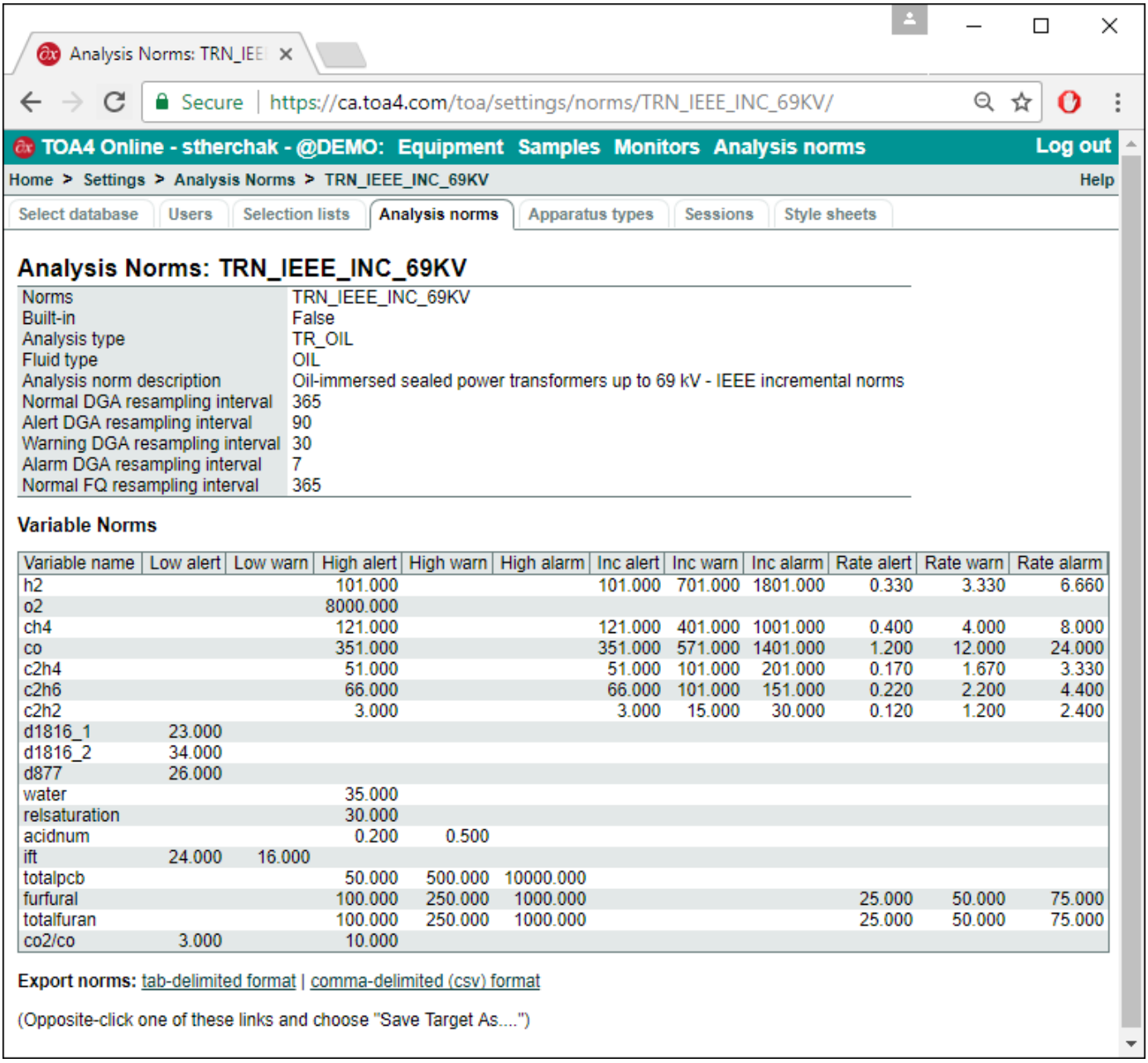
	Norms	Built-in	Analysis type	Fluid	Norm description	Alert
**	LTC_DIVERTER_A	True	TC_OIL	OIL	TC546, TC25, UTT, URS, RMT, 333, 396, LRT48, LRT83, etc (M Sampson)	
**	LTC_FREEBREATHER_B	True	TC_OIL	OIL	Free-breathing non-vacuum LTC (Cinergy)	
**	LTC_GENERIC	True	TC_OIL	OIL	Oil-filled load tapchanger - generic	
**	LTC_GENERIC_V2	False	TC_OIL3	OIL	Default LTC norms - updated limits for everything & newer rules	
**	LTC_INCREMENTS	False	TC_OIL2	OIL	Oil-filled load tapchanger - experiment with relative increments = v/v0 - 1	
**	LTC_NONDIVERTER_A	True	TC_OIL	OIL	TLH, 550 (M Sampson)	
**	LTC_RESISTIVE_A	True	TC_OIL	OIL	M, UZD, UZE, UZF (M Sampson)	
**	LTC_SEALED_B	True	TC_OIL	OIL	Sealed non-vacuum LTC (Cinergy)	
**	LTC_SELECTOR_A	True	TC_OIL	OIL	Some TC546, some TC25, URT, others (M Sampson)	
**	LTC_VACUUM_A	True	TCV_OIL	OIL	LRT200, LRT500, RMV, UVT, 397, V1, V2 (M Sampson)	
**	LTC_VACUUM_B	True	TCV_OIL	OIL	Vacuum-type LTC (Cinergy)	
**	NEW_OIL_AS_RECVD_IEEE	True	BULK_OIL	OIL	New mineral oil as received - IEEE C57.106-1991	
**	OCB_GENERIC	True	CB_OIL	OIL	Oil circuit breaker	
**	OCB_PC_WACTI	False	CB_OIL	OIL	Oil circuit breaker - Approximate WACTI norms for Pacificorp	
**	PAC_OCB_GENERIC	False	CB_OIL	OIL	Oil circuit breaker (Van der Walt)	
**	REG_GENERIC	True	REG_OIL	OIL	Oil-filled voltage regulator - generic	
**	REG_GENERIC_V2	False	REG_OIL	OIL	Oil-filled voltage regulator - generic - revised norms	
**	REG_MODIFIED	False	REG_OIL	OIL	Oil-filled voltage regulator - non-incremental	
**	REG_SIEMENS	False	REG_OIL	OIL	Oil-filled voltage regulator - SIEMENS	
**	TRN-INC-230KV	False	TR_OIL	OIL	Transformer incremental DGA norms with IEEE C57.106-2006 FQ norms	
**	TRN-INC-69KV	False	TR_OIL	OIL	Transformer incremental DGA norms with IEEE C57.106-2006 FQ norms	
**	TRN-INC-70-229KV	False	TR_OIL	OIL	Transformer incremental DGA norms with IEEE C57.106-2006 FQ norms	
**	TRN_CPS_ESTER_INC_69KV	True	TR_OIL	ESTER	Power transformers to 69 kV - CPS incremental norms - natural ester fluid	
**	TRN_FR3_INC_69KV	False	TR_OIL	ESTER	Power transformers to 69 kV - low-oleic natural ester fluid - IEEE DGA statistics	
**	TRN_IEEE_345KV	True	TR_OIL	OIL	Oil-immersed sealed power transformers 345kv up - IEEE norms	
**	TRN_IEEE_69KV	True	TR_OIL	OIL	Oil-immersed sealed power transformers up to 69 kV - IEEE norms	
**	TRN_IEEE_69_288KV	True	TR_OIL	OIL	Oil-immersed sealed power transformers 69-288 kV - IEEE norms	
**	TRN_IEEE_INC_345KV	False	TR_OIL	OIL	Oil-immersed sealed power transformers 345kv up - IEEE incremental norms	
**	TRN_IEEE_INC_345KV_NUKE	False	TR_OIL	OIL	Oil-immersed sealed power transformers 345kv up - IEEE incremental norms	
**	TRN_IEEE_INC_69KV	False	TR_OIL	OIL	Oil-immersed sealed power transformers up to 69 kV - IEEE incremental norms	
**	TRN_IEEE_INC_69_288KV	False	TR_OIL	OIL	Oil-immersed sealed power transformers 69-288 kV - IEEE incremental norms	
**	TRN_IEEE_LFH_INC_69KV	True	TR_OIL	LFH	Power transformers to 69 kV - IEEE incremental norms - LFH fluid	
**	TRN_INST_IEC_170KV	True	TR_OIL	OIL	Oil-immersed instrument transformers to 170 kV- IEC norms	
**	TRN_JJD_INC_345KV	False	TR_OIL	OIL	Oil-immersed sealed power transformers 345kv up - IEEE incremental norms	
**	TRN_PWR_IEC_72.5KV	True	TR_OIL	OIL	Oil-immersed power transformers up to 72.5 kV- IEC norms	
**	TRN_PWR_IEC_72.5_170KV	True	TR_OIL	OIL	Oil-immersed sealed power transformers 72.5-170 kV - IEC norms	
**	TRN_PWR_IEC_72.5_170KV_LCRA	False	TR_OIL	OIL	Oil-immersed sealed power transformers 72.5-170 kV - IEC norms	
**	TRN_PWR_IEC_ABOVE_170KV	True	TR_OIL	OIL	Oil-immersed sealed power transformers above 170 kV - IEC norms	
**	TRN_SIL_69KV	False	TR_OIL	SIL	Silicone-immersed sealed power transformers up to 69 kV - based on IEEE C57.146	

The links below the analysis norms list allow you to download the whole list in spreadsheetfriendly format. The Upload norms button (visible only if you have a high enough security level in TOA4) allows you to upload new or modified norms from the same kind of file.

See the Help information in the Analysis Norms help page for detailed information.

21 Analysis Norms Detail

Click any analysis norm in the analysis norms list to view its contents. The top section contains a name and description, plus a set of standard resampling intervals. The bottom section contains a table, each row of which defines various kinds of limits for the variable listed at the far left.



Analysis Norms: TRN_IEEE_INC_69KV

Norms	TRN_IEEE_INC_69KV
Built-in	False
Analysis type	TR_OIL
Fluid type	OIL
Analysis norm description	Oil-immersed sealed power transformers up to 69 kV - IEEE incremental norms
Normal DGA resampling interval	365
Alert DGA resampling interval	90
Warning DGA resampling interval	30
Alarm DGA resampling interval	7
Normal FQ resampling interval	365

Variable Norms

Variable name	Low alert	Low warn	High alert	High warn	High alarm	Inc alert	Inc warn	Inc alarm	Rate alert	Rate warn	Rate alarm
h2			101.000			101.000	701.000	1801.000	0.330	3.330	6.660
o2			8000.000								
ch4			121.000			121.000	401.000	1001.000	0.400	4.000	8.000
co			351.000			351.000	571.000	1401.000	1.200	12.000	24.000
c2h4			51.000			51.000	101.000	201.000	0.170	1.670	3.330
c2h6			66.000			66.000	101.000	151.000	0.220	2.200	4.400
c2h2			3.000			3.000	15.000	30.000	0.120	1.200	2.400
d1816_1	23.000										
d1816_2	34.000										
d877	26.000										
water			35.000								
relsaturation			30.000								
acidnum			0.200	0.500							
ift	24.000	16.000									
totalpcb			50.000	500.000	10000.000						
furfural			100.000	250.000	1000.000				25.000	50.000	75.000
totalfuran			100.000	250.000	1000.000				25.000	50.000	75.000
co2/co	3.000		10.000								

Export norms: tab-delimited format | comma-delimited (csv) format

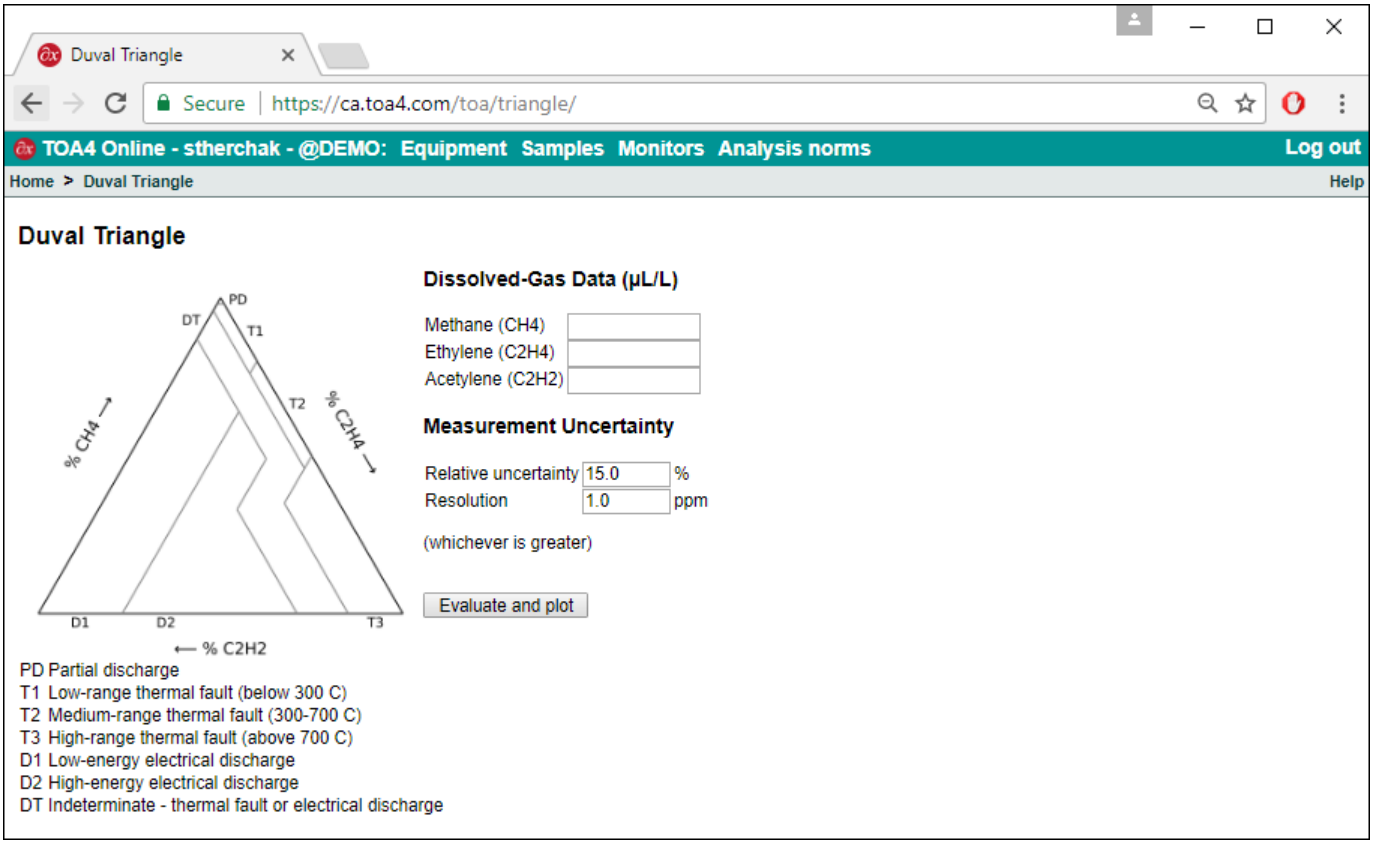
(Opposite-click one of these links and choose "Save Target As....")

The links at the bottom of the page allow you to download this one norm in spreadsheetfriendly format.

See the Analysis Norms - Details help page for detailed information.

22 Duval Triangle

The Duval Triangle is the main DGA diagnostic method applied in TOA4, although by popular request the Rogers Ratio method is also shown alongside it for transformer DGA. TOA4 contains an interactive form for experimenting with the Duval Triangle, and there is also a Help page explaining how it works.



The DGA fault diagnostic codes used in TOA4 are adapted from IEC 60599 and the Duval Triangle:

PD	Partial discharge.
T1	Low-range thermal fault (below 300 C).
T2	Medium-range thermal fault (300-700 C).
T3	T3 High-range thermal fault (above 700 C).
D1	Low-energy electrical discharge.
D2	High-energy electrical discharge.
DT	Indeterminate - thermal fault or electrical discharge.

23 Find More Information

Go to any TOA4 help page and explore the navigation menu for information about many features not covered in this document.

The Delta-X Research web site at http://www.deltaxresearch.com/ contains information and external references about topics related to equipment diagnostics.

The TOA4 Tech Notes technical support "blog" is available at http://toa4tech.blogspot.com/.

Document Revision Notes

Date	Version	Changes	Author
2007-02-15	1.2	Initial Draft	Jim Dukarm
2017-07-25	2.0	Updated format and screenshots	Steven Herchak