Perception™ Fleet

Transformer Fleet Risk Management Software System

Easy to install and configure, Perception Fleet delivers instantaneous results upon installation. Continuing its legacy in providing innovative solutions, Perception Fleet is GE's Online Transformer Fleet Management Software System that provides a revolutionary and holistic approach for transformer fleet assessments for utilities and industrial customers around the globe.

GE's Perception Fleet is a smart, simplified and standards-based software system that moves customers from a manual, one-on-one transformer assessment process to an automated and online fleet management assessment. By evaluating the condition of assets and establishing their risk of failure, Perception Fleet is able to prioritize and rank assets within a fleet.

The Perception Fleet software provides customers comprehensive transformer fleet condition rankings, transformer risk information, and expert analysis on-demand, removing time-consuming and costly manual processes as well as unnecessary maintenance, helping focus capital and reduce operational expenses.

Key Benefits

Transformer Fleet Replacement Strategy

- Provides a clear strategic view for asset replacement across the entire fleet
- Tracks the fleet risk index over time to show the fluctuations in the fleets condition as well as the trend of individual transformers
- Allows for flexible and scalable transformer fleet risk management

Condition-Based Maintenance Program

- Provides the insight required to shift from costly time-based maintenance to cost effective and focused condition-based maintenance
- Reduces ambiguity and the need to speculate regarding budget requirements
- Reduces OPEX usage on assets to only as required

Automated Data Analysis

- Reduces time required to gather, amalgamate, analyze and interpret transformer diagnostic data
- Provides intelligent algorithms to determine each transformer's condition, and ranks the transformers in the fleet based on their risks
- Reduces reliance on transformer expertise that is rapidly being lost

Smart Management System

- Automated, continuously calculated and always available, fleet transformer condition risk rankings and reporting
- Automatic, scheduled, real-time condition assessments and alarms (DGA, moisture, bushing monitoring and partial discharge data)
- Integrated Workflow Designer application for customizing algorithms to support unique transformer insight

Simple Diagnostics

- Built in dashboards with prioritized reporting on critical fleet and transformers "at-a-glance" enabling action plans for rapid response
- Simple setup, simple data acquisition and instant results
- Broad range and comprehensive suite of DGA diagnostics tools
- Fully interoperable data exchange facility with no predefined formats required

Standards-Based

- Risk calculations built on globally recognized IEC® and IEEE® standards (IEEE C57.104, IEC 60599, IEC 60422) as well as CIGRÉ® best practices
- Increased accuracy with 24/7/365 gas rate-of-change analysis utilizing Piecewise Linear Approximation versus period of time analysis

A Smart Transformer Fleet Management System

Perception Fleet is a smart software solution designed to provide a comprehensive condition evaluation of a transformer fleet. Perception Fleet can analyze and interpret data in order to determine the risk of a transformer without the need for expert data analysis. Full technical analysis is also instantly available for transformer technical expert use.

This is accomplished by gathering, amalgamating, analyzing and interpreting the data held on transformers utilizing GE's online monitoring devices and offline data. The data is analyzed using intelligent algorithms for condition anomalies and characteristics to determine the transformers risk. Each transformer is then assigned a risk score, and they are ranked based on their criticality and risk of failure.

Automated Fleet Transformer Condition Risk Rankings and Reporting

The built-in data download schedule ensures that Perception Fleet is always up to date with the latest data collected from the online monitoring devices. The data is then passed through an automated algorithm engine which analyzes the data for specific condition triggers and interprets the transformers condition and risk of failure based on the trigger points.

Once the condition of each transformer has been evaluated, the Perception Fleet software compares the transformers within the fleet and ranks them accordingly. Providing a ranked view of transformers that are at risk of failure provides an accurate picture of maintenance priority. This delivers valuable time savings as a majority of organizations currently perform such evaluations manually which can take weeks of data analysis.
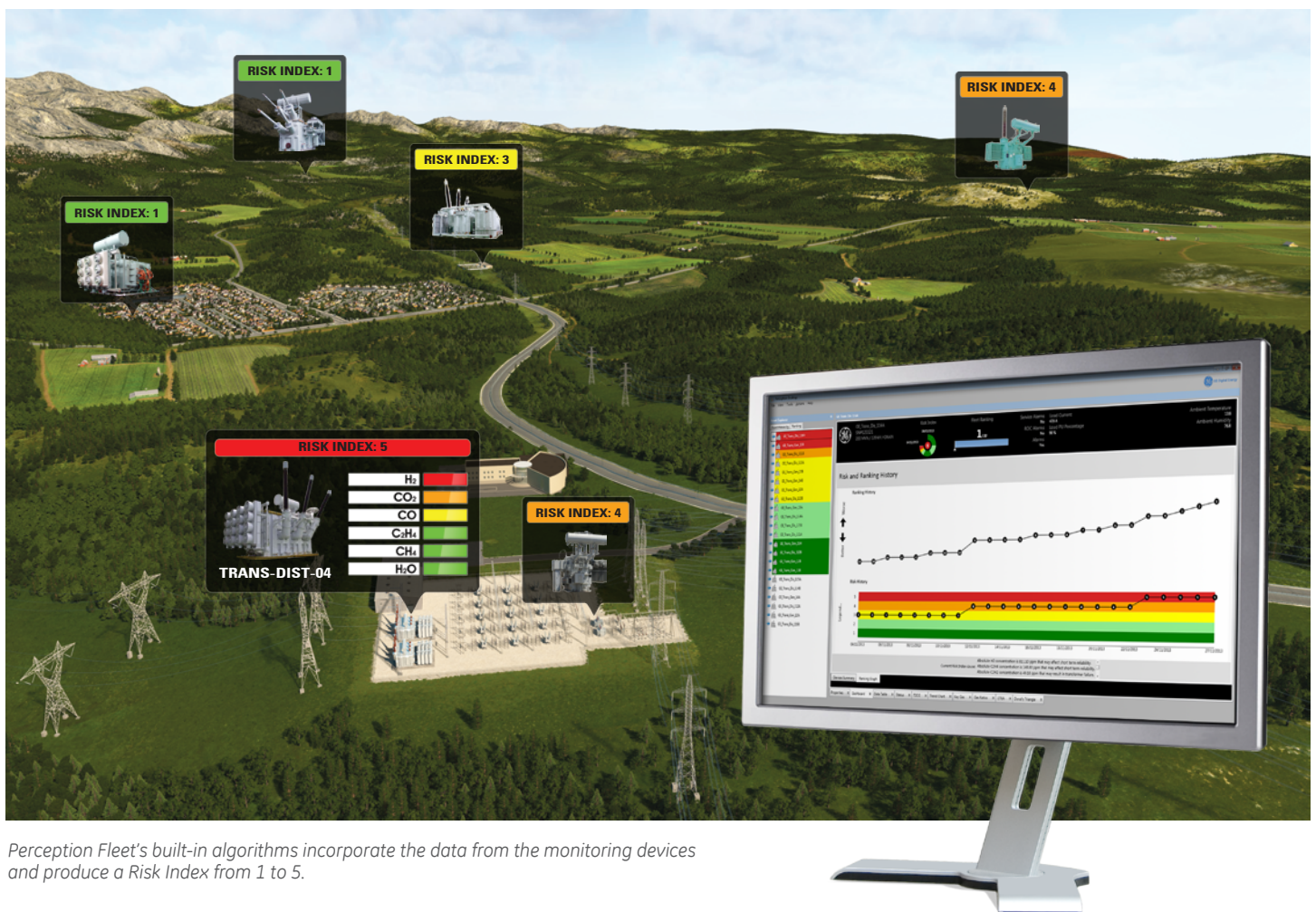

Perception Fleet's built-in algorithms incorporate the data from the monitoring devices and produce a Risk Index from 1 to 5.
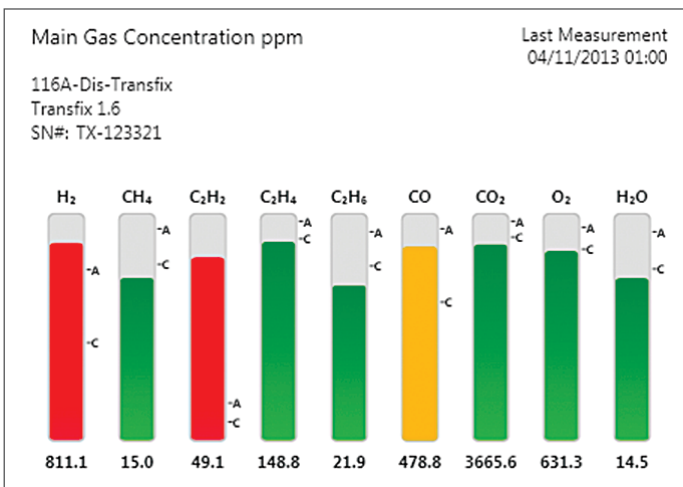
Critical Characteristics

The intelligence within the algorithms look at four critical characteristics within the transformer, it then generates a risk index based on the results of the evaluation.
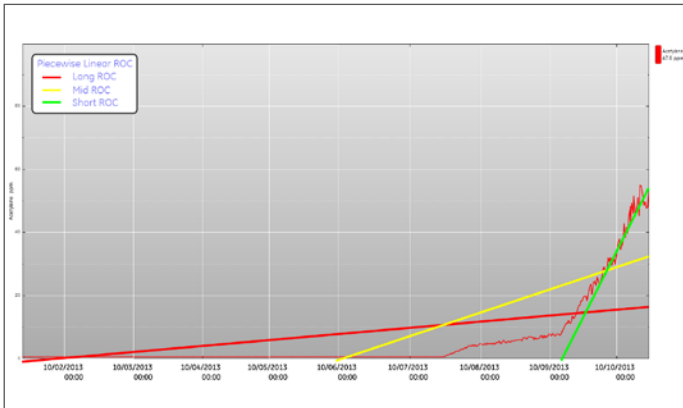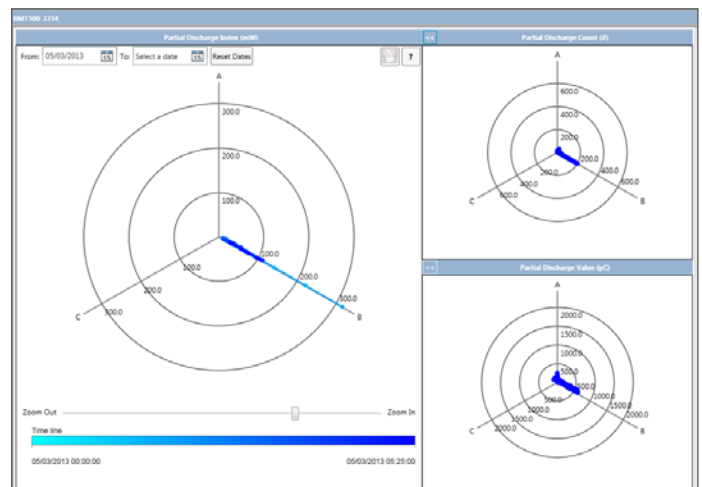

Piecewise linear rate of change of gas concentrations
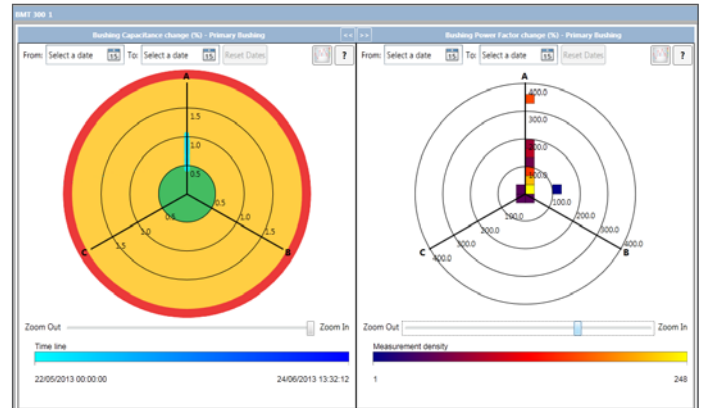
Bushing power factor and capacitance

Absolute gas level concentrations and moisture

Partial discharge

Current Transformer Risk Ratings

Once the risk index for each transformer has been established using the intelligent algorithms, Perception Fleet then analyzes the entire fleet, compares the risk index of each transformer within the fleet, and then ranks them according to their risk index. The risk index feature provides focus on critical assets and helps build a condition based maintenance program focusing valuable expenditure. Based on the information provided in the ranking table it is possible to evaluate which transformers are in potential need of replacing and which require maintenance.

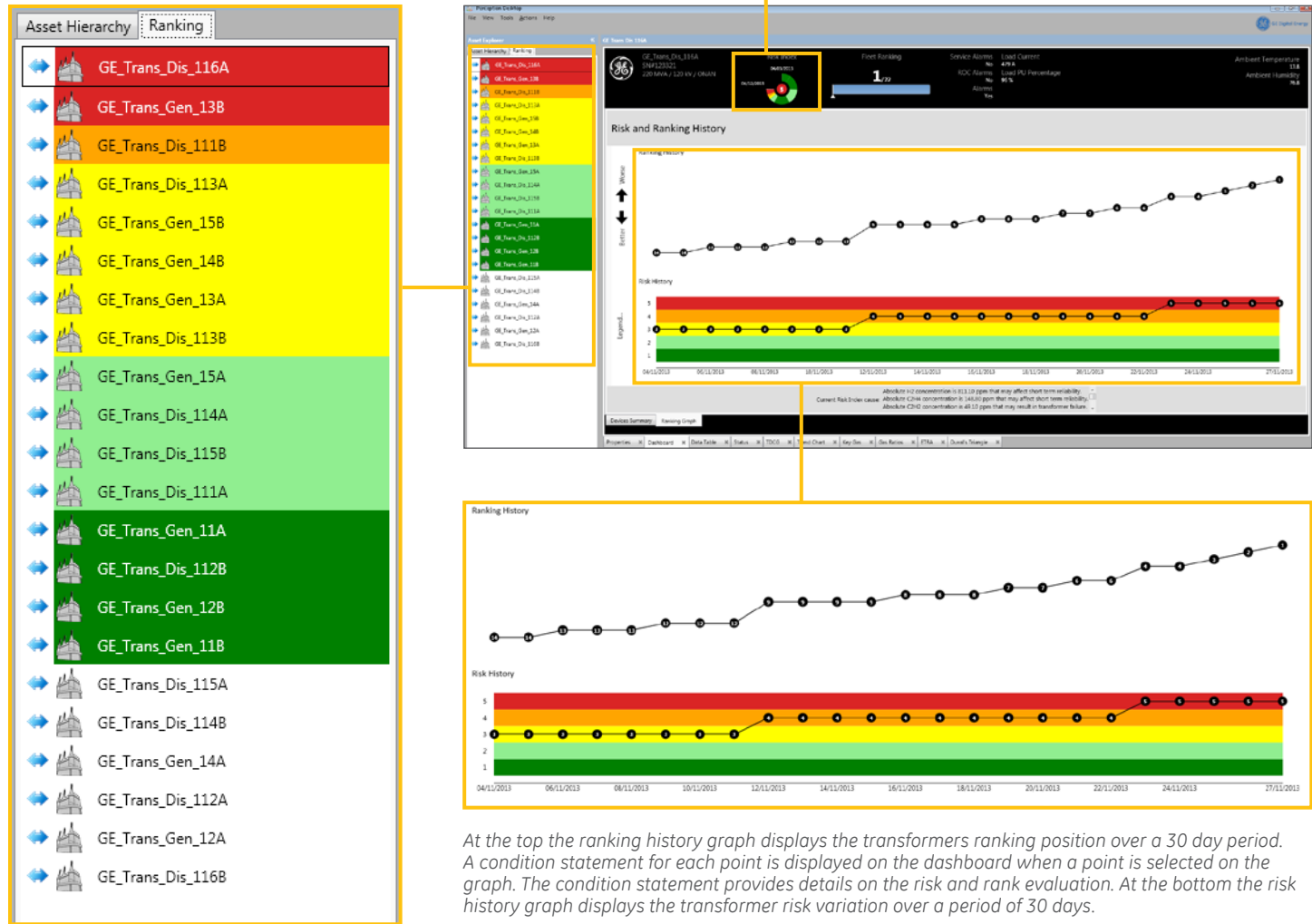## The Risk Score and Ranking Graph Dashboard

It is expected that several transformers will have the same risk index. In order to segregate the transformers even further, Perception Fleet then calculates the transformers risk score.

The risk score is based on an amalgamated value generated by the algorithms inside Perception Fleet. The risk score allows Perception Fleet to display which transformers within the same condition grouping are at the greatest risk of failing or developing further faults.

The ranking graph dashboard simplifies the process of tracking a transformer's risk and rank within the fleet over time to determine if the transformer health is degrading or improving and if maintenance actions were effective.
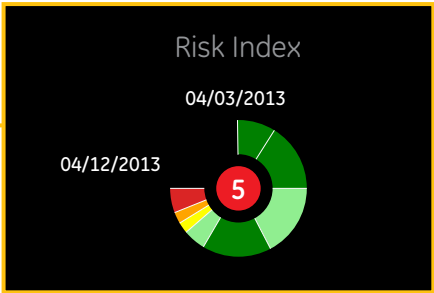
The transformers are color coded based on the risk index, making it simple to identify a transformers condition at-a-glance.

At the top the ranking history graph displays the transformers ranking position over a 30 day period. A condition statement for each point is displayed on the dashboard when a point is selected on the graph. The condition statement provides details on the risk and rank evaluation. At the bottom the risk history graph displays the transformer risk variation over a period of 30 days.

The ranking table to the shows all the transformers within the fleet ranked by risk index – from the transformer considered at greatest risk at the top, to the safest at the bottom. Transformers not highlighted with a color in the ranking table have not been risk evaluated.
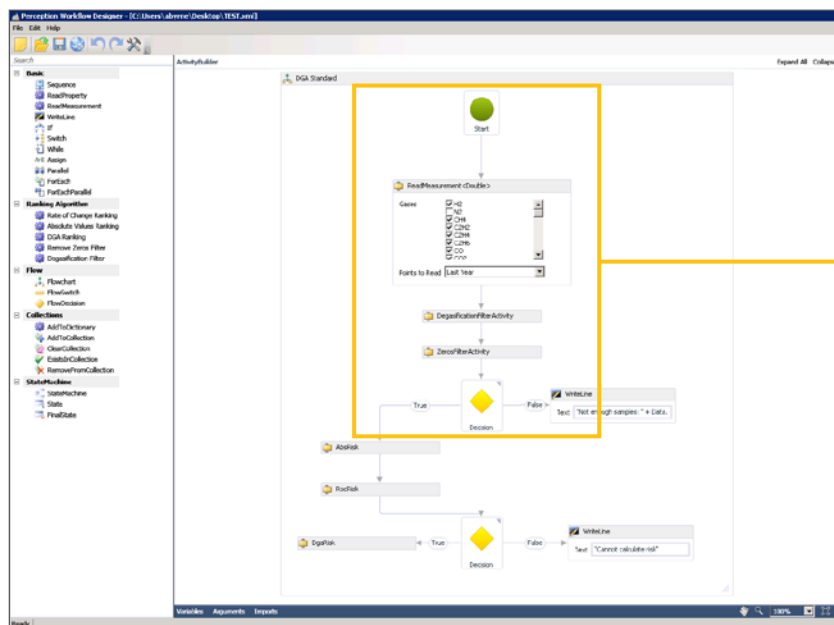
Integrated Workflow Designer

As transformers may vary greatly from one another due to design or vintage, and/or the organizations best practices may differ from the IEEE/IEC guidelines, Perception Fleet has the built in capability of allowing users to define their own risk evaluation algorithms. The customized algorithms can be as complex or simple as required by your fleets unique characteristics.

The Workflow Designer application allows users to alter and create new intelligent algorithms to be used within Perception Fleet. Customers have the ability to add custom algorithms to support additional and/or unique transformers insight into each transformers unique characteristics. This provides a tailored evaluation on a transformer-by-transformer or transformer family basis if desired or needed. Creation or modification of workflows require special permission levels due to its critical role for fleet management.

The Perception Workflow designer is a decision based flow chart. The user selects which elements of the transformer they want to evaluate within the algorithm and then provide the decision statements and results.

The result of the decision statement can then produce a condition value based on analyzed data or it can flow into additional decision statements adding another layer of validation into the algorithm, producing a more accurate risk index evaluation.

GE offers training programs on how to create custom algorithms, and can also analyze your fleet and create custom algorithms for you. For more information please contact your GE sales representative.

Perception Workflow Designer Application
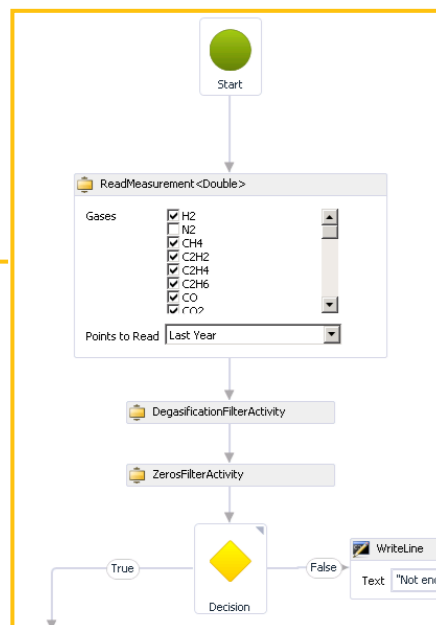
*Algorithm workflow evaluation statements and decisions*

Simple Management with Dashboards and Diagnostics

In a world of intelligent and powerful monitoring devices, customers face the problem of data overload making it hard for operators and other users to recognize changes, identify abnormal conditions and react quickly. Perception has used cognitive techniques to build its dashboards for rapid recognition of any change and with extensive use of the traffic light approach that empower users to at-a-glance recognize key indicators in alarm or important condition changes and act accordingly, optimizing reaction time.

Perception Fleet's built-in dashboards provide simplified, concise and critical information gathered on individual transformers, as well as a "big picture" overview of the entire transformer fleet in a clean intuitive design. The Dashboards are automatically updated every time new data is available, an event occurs or a risk assessment is performed on the fleet. Crews can then be assigned to the most critical transformers in the fleet – thus ensuring the time and material is utilized where it is most needed.

Fleet Dashboard

The fleet dashboard provides a comprehensive overview of the transformer fleet, highlighting which transformers are being monitored and risk assessed, how many monitoring devices are experiencing alarms, the overall fleet risk index history and the critical events that are captured.
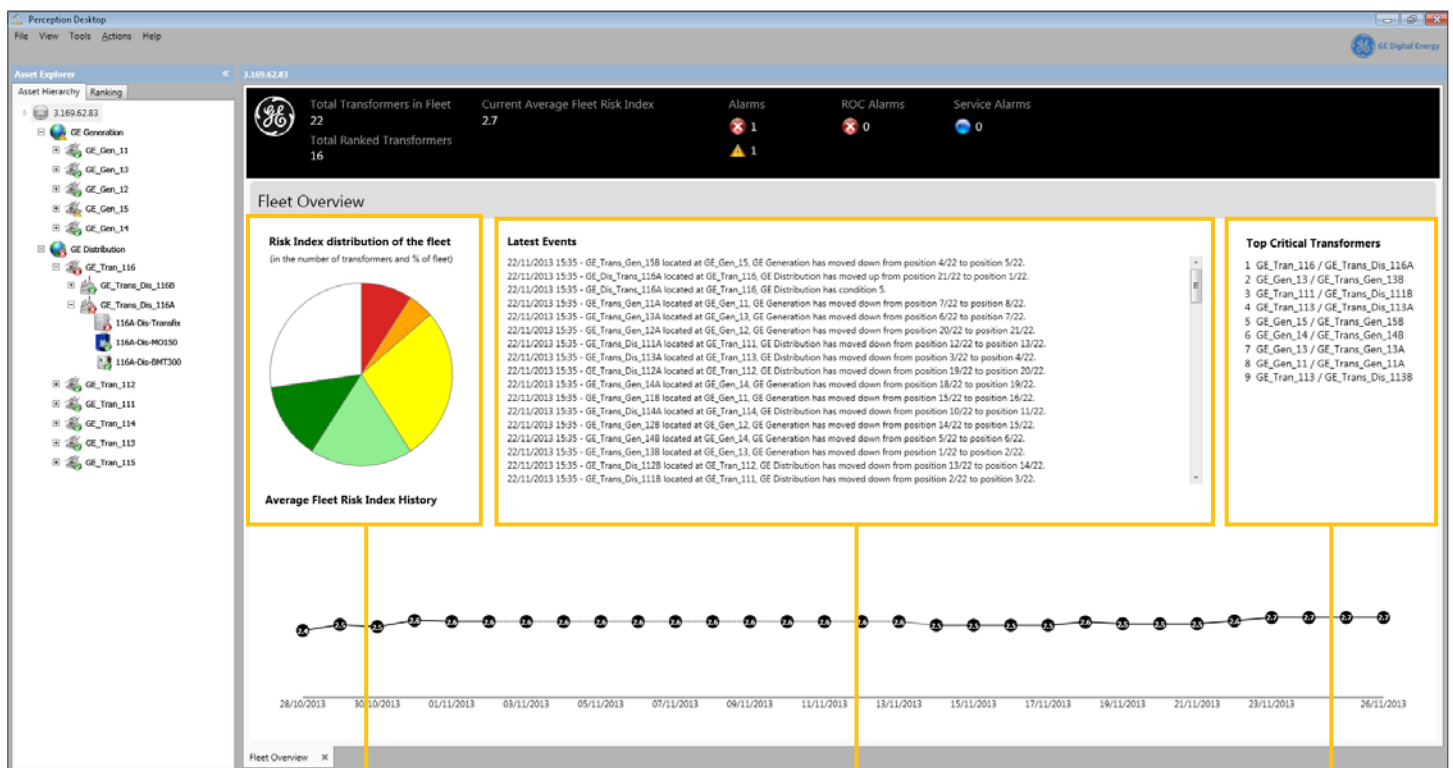
The pie chart shows a visual breakdown of the transformer conditions within the fleet.

A "Latest Events" section reports crucial events as they occur within the fleet, highlighting the specific transformers affected along with the time, event and location details.

The "Top Critical Transformers" list displays the transformers at highest risk of developing a serious fault or failing, helping focus maintenance action.

Device Summary Dashboard

The device summary dashboard automatically self-configures to show, the most important data from all available monitoring devices in a simple and concise design.

The title bar on the dashboard provides critical risk and rank detail, alarm information, transformer load and environment information.


The center section of the dashboard provides a snapshot of the latest critical data including DGA information, bushing power factor and capacitance, partial discharge, winding hot spot details, oil temperature and OLTC temperature and tap position. The gages change color if the value trespasses the limits set for caution or alarm and depicts how close the measured value is to the defined alarm limits. A miniature chart of TDCG is also available for quick graphical visualization of gas trends.

Comprehensive DGA Diagnostics Tools

Perception Fleet provides a broad range and comprehensive suite of DGA diagnostics tools. The diagnostics intelligence built into Perception Fleet provides internationally recognized industry standard transformer fault diagnostics based on dissolved gas analysis. Transformer experts throughout the world have published papers on data interpretation and transformer fault diagnosis methods supported within Perception Fleet. Perception Fleet simplifies the process of applying those widely trusted diagnostics methods to your transformer, expediting the process and liberating precious resources in the task of fault identification, intervention and prevention.

Duval's Triangle
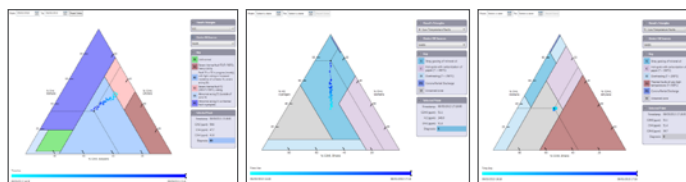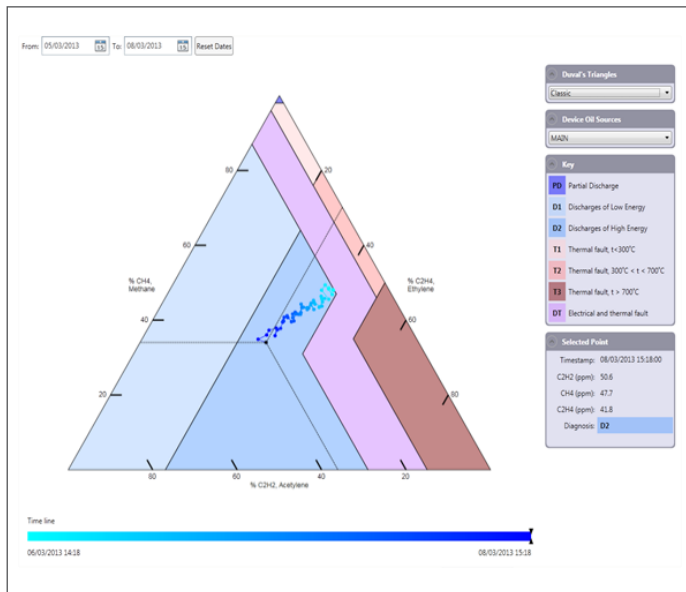
Developed by Michel Duval, this diagnostics method compares concentrations of key gases in transformer oil and presents a probable condition fault.
**Classic, LTC, 4 & 5 – Low Temp Faults*

Gas Ratio
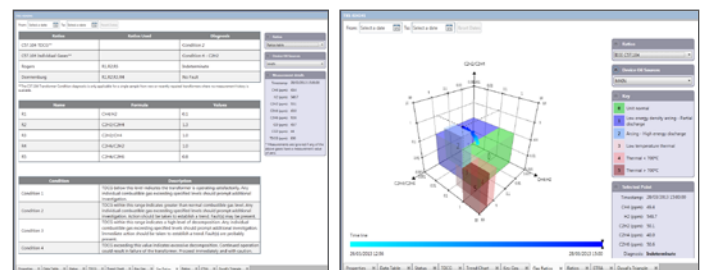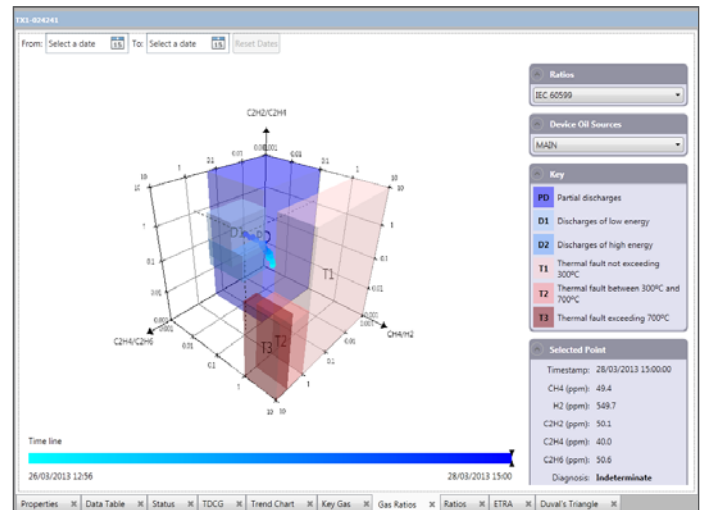
Encompasses the IEC 60599 & IEEE C57.104 standards in a 3D rotatable graph. Rogers and Doernenburg ratio diagnostics are also included in a separate concise and detailed table.

Japanese ETRA
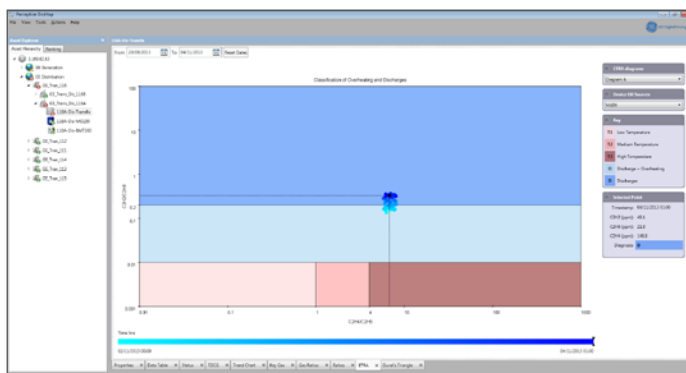
Diagrams A and B compare concentrations of C_2H_2/C_2H_4 against C_2H_4/C_2H_6, as well as C_2H_2/C_2H_6 against C_2H_4/C_2H_6 in order to determine fault conditions.

Transformer Models
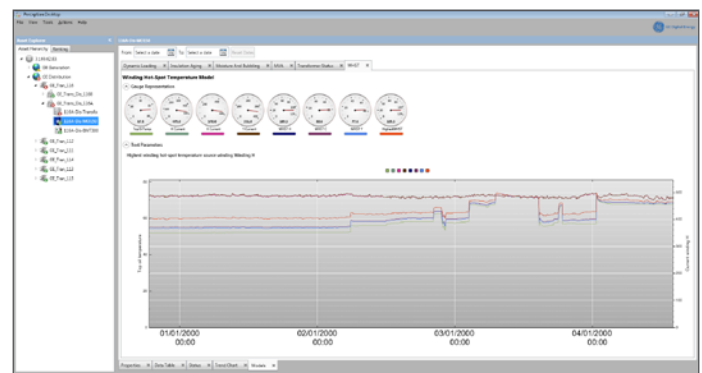
Measurements taken by units with modelling capabilities are converted into meaningful information and displayed in the models worksheets. This provides the user with information which ordinary cannot be directly measured through sensors.

Fully Interoperable Data Exchange Facility

Perception Fleet provides interoperability with other systems through its fully customizable automatic CSV import/export functionality. It allows data exchange and integration with other customer's systems such as SCADA, EMS, DMS, Historian, AM, SAS, planning, ERP, etc. Applications which support CSV file exchange can easily interface with Perception Fleet, enabling data to be exchanged between applications.

Seamless automatic data import is achieved by utilizing Perception Fleet's filewatcher facility. The software constantly monitors a folder for the arrival of a new CSV file and automatically imports the contents into its database. Conversely Perception Fleet allows automatic export of data to CSV files.

When a scheduled download from an online monitor occurs, Perception Fleet automatically exports any new data downloaded to a CSV file. The CSV file exchange capability also allows offline DGA data and lab DGA results to be loaded into Perception Fleet.

Perception Fleet utilizes the OPC UA interface and object model ensuring a secure 128 bit RSA encrypted channel between Perception Fleet and the remote clients. In addition to providing a secure communication channel, OPC UA also provides a secure interface allowing OPC UA compatible applications to interface directly with Perception Fleet.

Data Retrieval from Online Monitors

Perception Fleet has the ability to connect and download data from the entire range of GE's Monitoring and Diagnostic devices. The download schedule feature in Perception Fleet facilitates the automatic retrieval of data from GE online monitoring devices, ensuring data is up to date without the need for user interaction.
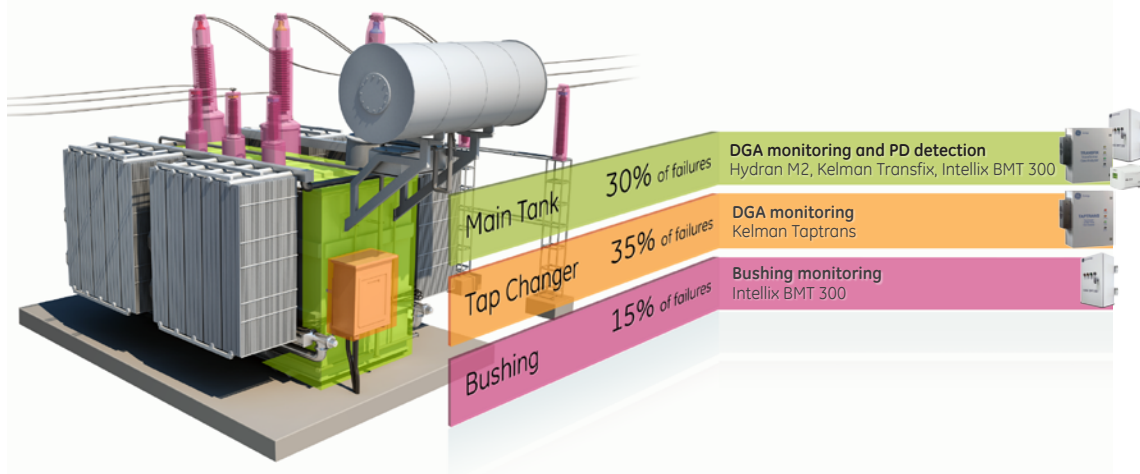
Standards-Based Management

Perception Fleet incorporates several internationally recognized standards for dissolved gas analysis. These standards are widely considered as the best in class and are attired to by transformer technical experts throughout the world.

The algorithms used in Perception Fleet automatically apply these standards against the dissolved gas data received by the GE online monitoring device. By combining these standards within the algorithms, the software is able to calculate the transformers risk index and score. The algorithm assigned to a transformer can also be weighted in terms of importance - the weighing has a direct impact on the algorithm and affects the final risk index and risk score applied to each transformer.

Perception Fleet's standards-based algorithms include:

CIGRÉ TB 227

CIGRÉ TB 227 provides five (5) transformer conditions in terms of its reliable operation. Using this information we are able to tailor the standards used within the Perception Fleet algorithms to determine 5 transformer risk index conditions.

IEEE C57.104

Describes four (4) condition levels for absolute dissolved gas concentration. To increase accuracy and provide a broader scope, GE rebuilt the condition limits and set five (5) condition levels using information from CIGRÉ TB 227. By individually assigning each gas, its condition level limits and triggers, we factor in the potential risk associated with the concentrations of certain gases over others.

IEC 60599 (1999)

Provides the dissolved gas rate of change expectance for normally operating transformers.

IEC 60422 (2005)

Used to analyze moisture in oil providing three (3) levels of H2O concentration. To increase accuracy and provide a broader scope, GE rebuilt the condition limits and set four (4) condition levels based on information from CIGRÉ TB 227.

Piecewise Linear Rate of Change

Dissolved gas rate of change is another key aspect of the algorithms used in the Perception Fleet ranking. In order to increase the accuracy of the rate of change calculations, GE adopted a piecewise linear approximation approach for the rate of change calculation.

This methodology for determining dissolved gas rate of change allows for a 24/7/365 gas rate of change analysis above and beyond the conventional single set period-of-time analysis used in online monitoring equipment. This method of calculating dissolved gas rate of change is considered to be more comprehensive as it can be used to distinguish fault conditions.

Piecewise linear rate of change works by using three (3) separate spans of time, providing the following:

- **Long rate of change** – Observation of defects developing and accumulating through transformer life (e.g. overheating defects, ageing, some types of discharge activity and general condition deterioration).
- **Mid rate of change** – Observation of seasonal dependent trends, related to changes in electrical systems (load etc.) or ambient condition.
- **Short rate of change** – Observation of defects which have spurious rise and need to be tracked from a short term perspective (e.g. discharge of high energy, high temperature overheating which will require urgent action and investigation).

A rate of change value is then calculated for each individual time span. The algorithm in Perception Fleet combines these three individual values and determines the criticality of a gas rate of change pattern.

Additional Features

Perception Fleet's additional features provide visualization of the data captured from the monitoring units in a number of ways depending on the users' requirements. The intuitive data display options offer a variety of data views enabling users to view raw or interpreted data as needed.

## Expert Analysis and Alarm Notification Emails
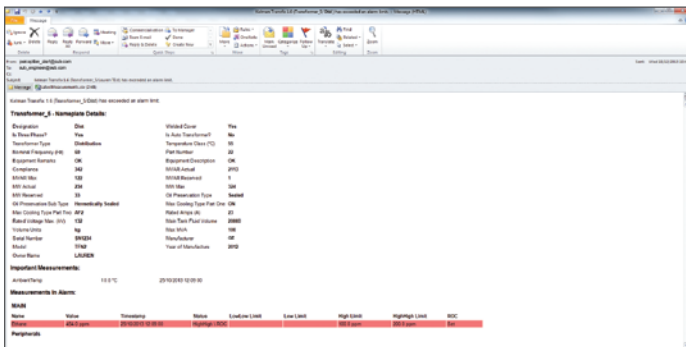
Ensuring prompt action is taken when a fault is reported can prevent further damage and potential catastrophic failures of transformers. The Expert Analysis Notification email feature in Perception Fleet facilitates such intervention. By providing a detailed snapshot of the transformers condition when a fault is reported, both the technical advisor and operator are alerted of the alarm at the same time and can remotely analyze the transformer data. The snapshot contains the critical information required for the advisor to diagnose the fault, react and intervene if necessary.

By availing of the Kelman Transformer Technical Services (KTTS) contract, transformer experts within GE will be notified and utilized should a trigger event occur. The expert analysis notification email will be sent to a transformer expert within GE, within an agreed time scale, enabling them to advise on the transformers' condition and recommend action to prevent further faults or a catastrophic failure.

Standard notification emails can also be configured on a per device basis. Designated recipients will receive emails should a monitoring device trigger a concentration alarm, rate-of-change alarm, require a service, or if Perception Fleet is unable to communicate with the monitoring device.

Transformer Reports
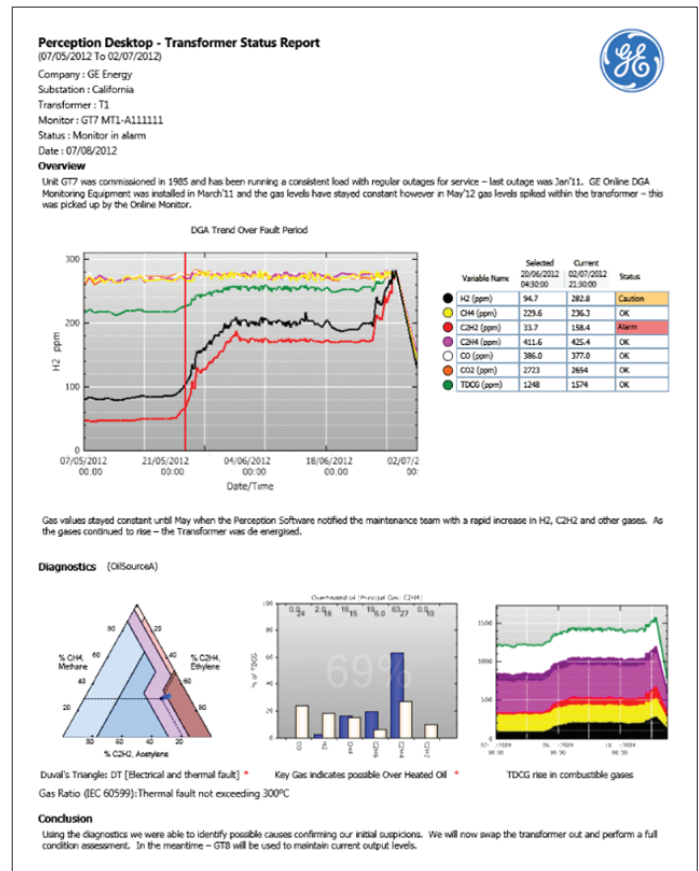
Perception Fleet enables users to automatically generate a customized transformer overview report. Upon selection, the report creation wizard will guide the user through the report generation process and automatically populate information regarding the transformer status, measurements and diagnostics. Space for editable text enables the user to comment on the assets, graphs and diagnostics. The report can be further customized by adding a company logo for presentation.

Visual Fleet Overview
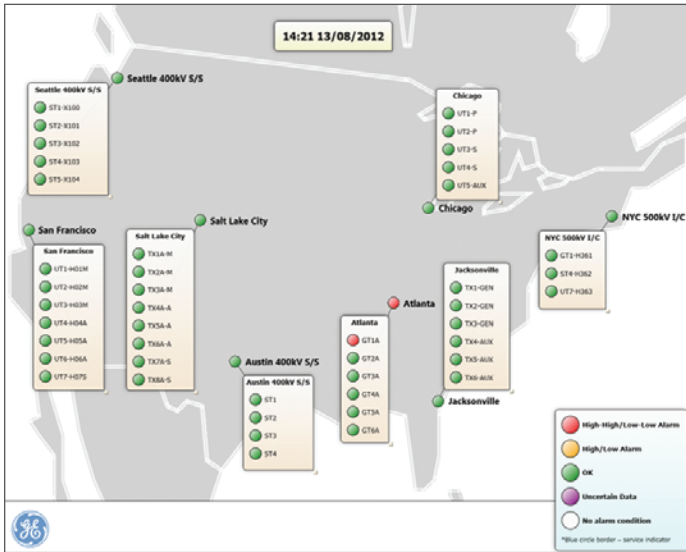
An asset network is built by adding monitoring units using Perception Fleet's intuitive graphical user interface. The wallboard screen displays the units in a geographical virtual fleet overview, automatically refreshing the status as measurements are collected. The network health can be quickly analyzed to identify problematic units or sites. Wallboard screens can be configured for sites and assets. Perception Fleet's asset explorer section can then be used to investigate the unit/site where the alert was raised. The user can select an asset, view the status of the unit, including the current gas levels, and check alarm limits set.

Transformer Bushing Data
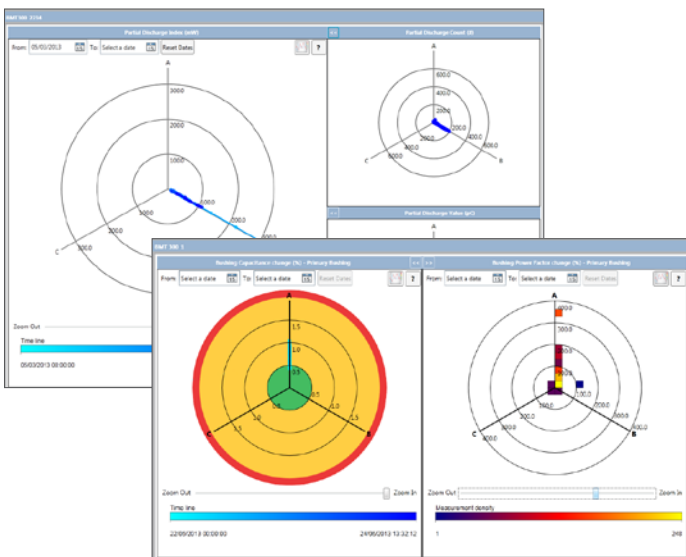
Transformer bushing data derived from the Intellix BMT 300 is displayed using a 3 point vector delta polar plot chart. The Intellix BMT 300 captures bushing Power Factor & Capacitance Change as well as Partial Discharge data namely PD count, PD value and PD index. The charts can be viewed as polar plot depicting the exact measurement point locations relative to the polar plot or as a histogram displaying the measurement point grouping and density relative to the polar plot.

Total Dissolved Combustible Gases (TDCG)
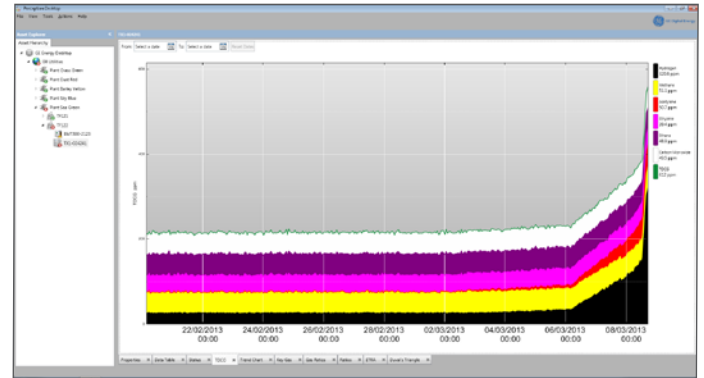
Displays the total dissolved combustible gas as relative concentrations within a trend chart. This view allows the user to quickly gauge the relative ratio concentrations of the individual gases.

Trend Chart
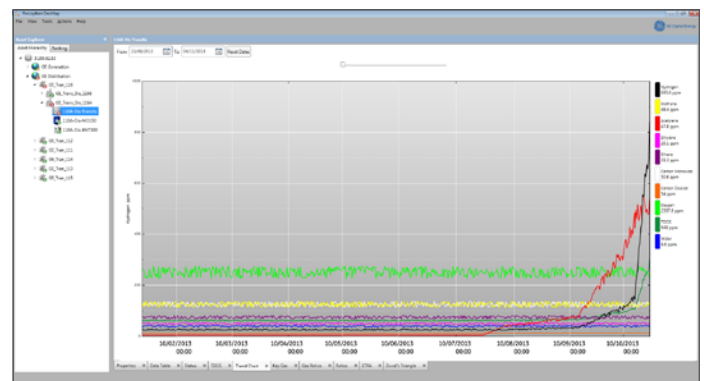
Numerous customizable features give the user control over how the chart and data are displayed. The charts can be filtered or zoomed, measurements can be added or removed, line colors can be changed, data smoothing and many more options are available.

Data Table

Displays all the raw data gathered on the transformer. Users can add and remove measurement points from the data table as well as export the data to a CSV file. Measurements that breach alarm limits are highlighted in amber or red.

Ordering

The flexible and scalable nature of Perception Fleet necessitates a dynamic pricing scale based on the number of online monitors feeding Perception Fleet data. For a quotation and details on how to order Perception Fleet please contact your local sales representative, or contact our global sales team at sales.digitalenergyMD@ge.com or +1-514-515-0445.

Technical Specifications

FEATURE\PRODUCT	DESKTOP	SERVER
Users	Single	Multiple
Install/Database	Local	Server
Number of units in database	Unlimited	Unlimited
Additional Languages	•	•
Trending	•	•
CSV Import/Export	•	•
Alarm Visualisation	•	•
Advanced Diagnostics	•	•
Transformer Overview Report	•	•
Trend Chart Annotations	•	•
Gas Ratio Alarms and Trending	•	•
Transformer Fleet Ranking		•
Transformer & Fleet Dashboards		•
Costomized Import/Export		•
Expert Analysis EMail		•
Wallboard Screen		•
Email Alarm Notification		•
User access control		•
Automatic Data Download		•
OPC UA Server		•
TOA4 Export		•
Support Contract		•

RECOMMENDED SYSTEM REQUIREMENTS

PERCEPTION DESKTOP
- 2 GHz 32-bit (x86) or 64-bit (x64) processor
- 2 GB RAM
- At least 100 GB of available hard disk space
- Microsoft® .NET Framework 3.5 SP1, 4.0 & 4.5
- Windows 7

PERCEPTION SERVER
- 3 GHz 32-bit (x86) or 64-bit (x64) Processor
- 4 GB RAM
- At least 500 GB of available hard disk space
- Microsoft .NET Framework 3.5 SP1, 4.0 & 4.5
- Windows Server 2003 or 2008
- Microsoft SQL Server 2005 or 2008

SUPPORTED LANGUAGES

- English
- German
- Russian
- Chinese (simplified)
- Japanese
- Spanish
- French
- Portuguese

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GE Digital Energy

Lissue Industrial Estate East
Lissue Road
Lisburn BT28 2RE
United Kingdom
Tel: +44 2892 622 915
Email: gedigitalenergy@ge.com

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