INTRODUCTION

This is an introduction to the TIGER knowledge based gas turbine condition monitoring system. Its purpose is to:

- Give an overview and explanation of TIGER
- What it is
- What it isn’t
- Its benefits
- Some of the frequently asked questions relating to TIGER

TIGER is designed to assess the condition of the gas turbine by continuous interpretation of its behaviour. This knowledge of the state of the gas turbine is the information needed to make decisions for condition-based maintenance. By having TIGER analyse continuously the state of the gas turbine we can then make decisions about: what needs to be maintained on the turbine; what doesn’t need to be maintained on the gas turbine; are problems developing; and do certain problems not exist.

A key aspect of TIGER is to check for anything going wrong at once per second so that the smallest deviations are picked up right away at the earliest possible stage. These are presented through the fault manager to give a day-to-day summary of all the problems which have occurred on the gas turbine.

TIGER also performs calculations of the performance of the gas turbine on a continuous basis so that performance deteriorations can be tracked and the information needed for making decisions on off-line washing is available. TIGER also provides diagnostics to assist any time there is a disturbance; a problem; a gas turbine trip, or a failure to start. TIGER rapidly analyses the data available to it to help the user understand why the gas turbine tripped or why it wouldn’t start.

TIGER OVERVIEW

TIGER is focused on helping people get the most out of their gas turbine. Generally in a single cycle or a combined cycle power generation facility, there are two main goals for companies; one is they do not want to stop unexpectedly or unnecessarily. If it is run on base load they need continuous power output, but they also want maximum efficiency and that reflects not only efficiency from the viewpoint of the compressor blades being cleaned, but also not having other problems that inhibit the performance of the gas turbine.

A key task is to know what needs to be maintained and when it needs to be maintained. If I am going to stop for an overhaul, I need to know what the faults and problems are that I need to take care of, and what parts of the system seem to be performing fine. If a problem is developing it will need unusual maintenance or actions. I need to know this as early as possible.

By continuously assessing the condition of the gas turbine, TIGER is able to record and describe the problems that need maintenance and need attention so that reports can be prepared to justify various maintenance actions.

This addresses a major need, which is, if you just look at a gas turbine you don’t actually know what is wrong with it; what the problems are; what needs attention; what state the gas turbine is in. With TIGER building up a complete history of all the problems that have been detected, you then have the information to make these decisions.

What we really want is a way to understand the condition of the gas turbine by having this assessment of all the niggles; the problems and the little things that have occurred, so that we have a complete view of where the gas turbines performance is.

We want to detect problems at the nearest possible stage so that the slightest hint of any developing faults are detected. It can then be monitored and its actions can be planned around it.

We also need to understand what happens when problems do arise so that if there is a trip, or some other incident occurring, we can understand not only what the cause is, but what the impact and the likely long-term influence will be.

Much of this is like having a doctor following you around continuously. If you look at a gas turbine at a 10,000-hour inspection, you don’t know what happened to the gas turbine; what problems have occurred; and what state it is in. This is the same as your doctor.

When you go for an annual check-up, he looks at you and sees what you look like now, but he
doesn’t really know the stress and strains that you have had over the past year; the problems or faults that you have developed. So imagine your doctor could follow you at once per second, continuously. He would then have a complete idea of your health history over the past year; all the colds and little problems you have had; and all the unusual situations that you recovered from. So this is the idea of building a continuous assessment of the gas turbine — to get a picture of its condition so that you have the information you need to make your condition based maintenance decisions.

Where does TIGER fit in the context of condition monitoring? There are many types of condition monitoring, and in many peoples minds, condition monitoring equals vibration based condition monitoring. That is they think that the type of vibration assessment that Bentley Nevada does is the only type of condition monitoring. But in fact, there are several techniques such as visual monitoring, behaviour monitoring, vibration monitoring and oil or debris analysis. TIGER fits into the category of behaviour monitoring — we monitor how the turbine behaves, how it operates; how it changes to load or other conditions, and based on that information, make an assessment of the condition.

The smart bit of TIGER, the intelligent bit, is the continuous assessment of the condition based on the way the gas turbine behaves. Every time the fuel valves are meant to move in response to a load set-point change, TIGER checks with the fuel valve to see that it is moving properly; that they reacted the way they should; did the exhaust temperatures increase?; and did the power increase all the way it should?

All this reflects the behaviour, which is a bit like the idea if you want to know how nimble or capable someone is - seeing them sitting there at a nightclub doesn’t help, but if you see them getting up and dancing a bit, then you know, that it is the dynamics and the movement that really shows whether the system is working properly.

So, TIGER fits very clearly in condition monitoring using the behaviour of the gas turbine as the influence, and not the vibration techniques. TIGER compliments vibration based condition monitoring techniques such as provided by Bentley Nevada. It actually provides a lot more ‘bang for the buck’. TIGER is relatively simple and does not require additional sensors, it is only software. TIGER can be installed in only half a day, with just an interface to the control system implemented with the right data communication so it is a very low cost rapid system to install.

Vibration based condition monitoring is very expensive and requires special sensors for the special hardware, or signal processing, and only looks at the mechanical aspect. TIGER is much more powerful because it looks at the supporting system such as the fuel system, any dry low NOx, or NOx reduction control system; the combustion system; the starter mechanisms; the generator if the data is available through the controller.

TIGER fits clearly in the context of condition monitoring by looking at the behaviour and the clever bit is the knowledge-based assessment of the condition continuously. So the approach of TIGER is continuous monitoring and diagnosis at once per second.

The unique aspect of TIGER is the fact that it does a diagnosis of the data at once per second. Other systems such as Scada systems will allow the user to display data and store data, but doesn’t provide any interpretation at all. They might provide simple limit checking and alerting capabilities, but nothing dynamic or sophisticated.

TIGER uniquely and continuously does an analysis and diagnosis of the data so that, not only does it see if something is unusual, but also it builds up a diagnostic explanation of what that is. All that is done at once per second, continuously 365 days a year, or whenever the gas turbine is running.

TIGER combines several layers of diagnostic analysis. The lowest level is continuous automated fault detection so it has many ways to detect that something is unusual or a fault is present. TIGER has multiple levels of diagnostics that combine what has been detected as faulty into a partial diagnosis, or a more complete diagnosis, to the best diagnosis conclusion we can reach for a given situation. It is important to recognise that TIGER cannot diagnose everything and cannot diagnose everything perfectly. It does the best it can to put together the conclusions of the data available. Some situations we have never seen before, no one else has seen before, we want to diagnose, or know what to reach as a conclusion. Sometimes the sensors that we have limit the amount of diagnostic conclusions in TIGER. For example, we might be missing a critical measurement to separate whether the problem is in the flow or the valve control itself.

All of the output of TIGER is presented through an easy to read fault manager, a summary of the conclusions and the diagnostics that have been developed, which is presented in a hypertext tree style, so you can read the high level summary first, and then click with the mouse to browse incrementally through to have the explanation.

The fault manager is the real key benefit of TIGER, all the diagnostics at once per second are summarised into a simple set of diagnostic
messages. They are very short and concise to read, that way if you want to check ‘Is my turbine okay? Was there a problem on the last day? Has anything unusual happened? You can just read through the diagnostics rather than having to browse lots of data. This enables the ability to actually check the turbine once per second realistically. Manually by hand, you could never do that. You can never go through all the graphs of all the data 24 hours a day. TIGER’s fault manager provides that unique summary to let you do that very easily.

All of the data is kept permanently, and TIGER has extensive data archives, displays and trending mechanisms so that you can view things rapidly; investigate incidents and problems, as well as look at trends from short term to very long term. All the data is kept permanently so that you can go back and look at any problems or key aspects at any point.

To summarise the steps of condition monitoring, you first need to frequently check the machine at some interval; detect problems at an early stage; then assess the condition of the machine and use that assessment to build up a picture of the overall condition of the machine. That is standard condition monitoring.

TIGER’s approach is to take data, 600 measurements every second, from the gas turbine controller. To detect problems we have thousands of fault detection checks that are automatically tuned to a particular gas turbine. TIGER looks at data on the gas turbine for a short period and adjusts all the limits to detect problems for each operating band for that gas turbine.

The analysis is done by using the knowledge capture from gas turbine experts, and over 40 years of operating hours that have run through TIGER. A picture of the condition of the gas turbine is presented through the high-level fault manager. TIGER has an extensive set of displays that provide quick views of the state of the gas turbine at a very high level, and are easy to look at including each sub-system and identify whether any problems have developed.

The diagnostics are also continuously available. The fault manager provides the diagnostic summary. In the diagnostic summary all identified events are presented three times, first, by the priorities, critical; indications of faults or just warnings. Second, by the sub-system of the gas turbine such as the gas fuel; the liquid fuel; the air inlet system; the combustion system; and the NOx reduction system. Thirdly, a complete time sequence.

The idea is that no matter which way you are trying to look at a problem there are a set of messages organised to be helpful. So if you want to investigate what is wrong with a particular sub-system, you can use the sub-system view. If you are trying to identify precisely a fault, you can look in the time sequence. When you are making a quick daily check of the overview of the turbine, you can look at the highest priority messages to see.

For every diagnostic message, by clicking on the mouse in the hypertext tree, you can get a diagnostic explanation of what the problems and symptoms were that lead to that particular conclusion. In that way, you can understand how it reaches certain conclusions and follow through the logic of the diagnosis yourself.

An important aspect of TIGER is that once it reaches a conclusion it has a set of messages that are now ‘accounted for’. So within the fault manager the ‘accounts for’ takes the big flood of messages that have to be resolved and organises them into those that are important, and those that you can effectively ignore. So instead of having to look at pages of printouts, the TIGER diagnostics are organised in a tree, saying these are the important messages and these are messages that are accounted for and you can ignore them.

For selected customers and gas turbines, TIGER also provides links to on-line manuals so that if you want further information on a particular diagnostic conclusion or sub-system, you can jump directly to the on-line manuals.

TIGER also has extensive graph facilities providing six windows with up to eight channels in each. The graph can hold virtually any time periods selected by the user, and data can be expanded out to x10 (times ten) for looking at concise detail. The graph has shown itself to be extremely useful and help people verify faults; troubleshoot the timing and sequencing of events, and investigate problems that otherwise would be very hard to troubleshoot.

Very often, the output of the fault manager and the diagnostic graph are put together to make reports to either document an incident or document work that must be done. So for example, if there has been a repetitive problem on a gas turbine the TIGER diagnostics can be used to show the fault manager conclusions and identify the faults that arise from when the incident occurs. Diagnostic graphs can be attached to the report to show in more detail the exact sequencing.

TIGER also includes a query mechanism so that you can query across the diagnostic conclusions and find out how often certain faults occur, or, get a list for example, of all the faults in the gas fuel system that were critical in the last month, and how many times each one occurred. This is part
of the management information to help you make decisions about the condition of the gas turbine. By having a summary of all the faults and problems that have occurred, it is now possible to identify the main faults that need attention so that you can now take the action to eliminate those.

TIGER continuously performs a performance analysis of the gas turbine. It does this several ways using ISO formulas. It calculates dry corrected power and dry corrected heat rate, assuming the appropriate instrumentation is available. TIGER watches the data on the turbine continuously and finds the most stable set of data each day to use in its calculations, so you get a much more accurate assessment of the daily performance compared to taking the measurement at 1400hrs for example. Every time there is a crank wash, the base expected power levels are reset so you can instantly compare on the graphs where your performance is relative to the output.

Also, these performance reports can be printed out from Adobe Acrobat reports so that they can be inserted into notebooks and files. TIGER calculates dry corrected power; dry corrected heat rate; compressor efficiency and also does daily, and 30-minute average of NOx levels, to provide a performance evaluation against the regulations.

The diagnostics and the knowledge in TIGER have been developed by over 50 fired years of gas turbine operation, and well over 750 incidents and faults. Every time TIGER detects an incident, this is logged and analysed by the TIGER developers to ensure that the diagnostics were adequate and appropriate, and they are constantly and continuously improved. With over 50 fired years of operation, we provide a very stable and reliable set of detected events and diagnostics.

A key aspect of installing TIGER is that it uses the existing sensors already in place on the turbine through the control system and does not require additional instrumentation. It might be that a plant decides to add extra instrumentation once TIGER is installed, for example, appropriate performance measurement instruments. But to install TIGER is a rapid software process that does not require extra sensors and instrumentation to be fitted, this greatly reduces the cost, as the user sees the benefit and capability of TIGER, they can then add additional sensors as required.

A key aspect of TIGER compared to other condition monitoring systems, is that it has a wide range of sub-systems, such as the gas fuel; the liquid fuel; the NOx control system; the combustion system, and the generator. By looking at a wide range of sub-systems, helps to isolate where the problems are originating and whether impacts work.

TIGER has extensive data displays; trending and archive facilities and very importantly, all of TIGER’s capabilities can be accessed remotely through a modem or other type of network link. So if a remote site is having a problem, the head office or engineering staff can use a TIGER to dial in, evaluate first the diagnostics by downloading diagnostics not data initially; analyse the diagnostics to see the problem and situation; then pull back the relevant data for that incident to very rapidly get an understanding.

TIGER has been used many times to help people remotely monitor gas turbines. For example, during a problem start-up, or after some maintenance work has been performed to ensure that everything is working okay. TIGER is set-up already so that if you have a fleet of gas turbines and you want to centrally monitor them, it provides the ability to collect diagnostics overnight from each site, so that in the morning you can quickly assess what happened yesterday on all the gas turbines by browsing through the diagnostics. The remote link can also be used by other members of the TIGER team to provide additional engineering backup and support.

TIGER has provided consistent and substantial benefits for customers. In every case shortly after TIGER is installed, we find that TIGER has identified many faults and problems that were already existing but nobody was aware of. Some of these then help sites to understand why they are having to do maintenance more frequently and earlier than expected.

TIGER has a $150,000 Club, which are sites for which TIGER has produced a saving, or benefit, of at least $150,000 within a year. In fact, virtually all the mature and established installations of TIGER are members of the $150,000 Club.

The faults cover a wide range of problems from:

- Hydraulic system problems affecting the generator;
- Steam injection problems affecting the performance of the gas turbine, which were then documented through TIGER, and that part of the justification of a major refurbishment;
- Liquid fuel being unstable at low-load levels, where the turbine would oscillate quite severally until it got to a higher load and this was traced to the liquid fuel;
- Various problems with other oscillations affecting first and second stage nozzles were tracked back using TIGER to help identify.
In one situation, they knew that they had a very short life on the blades but couldn’t understand why. As soon as TIGER was installed it identified that there were oscillations occurring and TIGER was rapidly used to track down the cause of these oscillations so that problems could be detected.

TIGER has found, not only the failed start-up problems, but also problems during shutdown that would prevent a start-up. In one case, an oil platform was down for two days until an engineer arrived and used TIGER to identify the cause of the faults. The problem was that they did not know how to identify the problems of the liquid fuel. TIGER had been installed on the oil platform only a few days before, and had not had the opportunity to train the staff on the oil platform on how to use TIGER. So as soon as a competent engineer on TIGER was flown out, he used TIGER to isolate the fault. After two days of shutdown, he had the system back up and running.

In another example, a site was able to delay its shutdown until the weekend when they had the appropriate repair equipment and staff on hand. Rather than shutting down mid-week which would have been inconvenient and also not prepared. That greatly reduced the cost and avoided an unplanned shutdown.

For one of the gas turbines, TIGER was used to catalog the wide range of problems that existed. This provided a good foundation on how good the turbine was, and from that case, they were able to make a warranty claim to have many problems fixed and repaired that the vendor had claimed were not existing and not a problem. So everybody benefited by identifying problems and then under warranty being able to claim against those.

TIGER is also ideal for cataloguing the state and problems of the gas turbine at the start of any type of contract, so that when you take over your maintenance contract you can verify how good the turbine is; whether any problems are there that can affect the maintenance commitments.

TIGER has also been used very successfully to underwriting and guarantee commitments of high availability. By identifying small problems at the earliest stage, by way of rapidly troubleshooting causes of trips or failed start, companies have achieved much higher availabilities through the information collected on TIGER. So it provides a good foundation of underwriting any fixed commitments that one has. In fact, once you see the information TIGER gives you about the state of the gas turbine, you would wonder how you were ever brave enough to run a gas turbine without it!

TIGER provides consistent benefits to the user. Generally the pricing model is on an annual lease, although this will depend on the situation. It is consistently providing a payback within a year for each customer and it is designed to help minimise the downtime, either by reducing the analysis required to understand why a fault failed; identifying problems that would prevent a restart; helping to plan effectively for the work that would be required when it does shut-down so that when you do go down for maintenance then you have all the right equipment and repair information available; it helps to maximise the service intervals because TIGER provides a good assessment and explanation of whether the turbine has performed well and smoothly, or had a lot of disruptions or problems. You have a good view of whether the turbine is likely to be in good enough condition to extend the service or whether there is a problem. We help sites to optimise cleaning cycles.

Finding the best data to use in the performance calculations and continuously making performance calculations, we provide the information needed so that the site can decide whether it is beneficial to perform an off-line wash at the current time or to wait a bit longer.

TIGER helps with the advanced prediction of faults through the detection of faults at the earliest possible stage. The concept is to detect faults as early as they appear and then track how they change and how severe they are so that you have the information you need to make your own prediction. TIGER does not actually directly predict the faults, but provides the data needed so that you can make an assessment.

TIGER provides a good mechanism to track the history of the faults and problems. The query mechanism can tell you all the times a certain diagnostic message appears, or how many times it’s appeared. So for example, you can rapidly get a report of all the times you had a sticking liquid fuel valve and see whether the frequency is increasing. The diagnostics within TIGER can be used to replay an incident at any time, so that you can go back and post investigate incidents time and time again, or from different viewpoints.

Very often the history of TIGER has been used to go back one or two years, to recheck certain incidents for a sign of other problems. All these give a very consistent payback to the sites where we have TIGER installed.

In summary, the benefit of TIGER is that we know everything that happens to the gas turbine. The once per second analysis is like your doctor following you – it keeps track of all the problems that you have had, so that now you have the information needed to make a good assessment of the condition.
TIGER helps to detect the first symptoms of a developing problem, so that you get the earliest indication of any fault or problem that comes, and then you can monitor it over time to see how rapidly, and how severe it is becoming. TIGER can capture transient or short events with its once per second sampling time and rather than having to spot check a turbine, you are able to focus very rapidly on the rare times that sort one transient events occur.

TIGER has all the tools starting with the diagnostic summary to troubleshoot or investigate major incidents; to analyse the cause or sequencing; what happened first, to make an assessment of the damage or the strain on the turbine that this has caused, and then to write reports and document it through the displays available in TIGER.

All that enables you to understand the condition of the gas turbine so that you can make appropriate decisions, and if we think of the problem of ‘What state is my gas turbine? Is it okay? Or not okay?’ for maintenance actions, through the data available from TIGER, you know it’s precisely state. All this enables condition-based maintenance which is the goal of minimising the costs on a site.

HISTORY OF TIGER

A short explanation of the development history of TIGER. Dr. Robert Milne, Managing Director of Intelligent Applications in Scotland, first had the idea of the concept of TIGER about 10 years ago. The company was working in the application of artificial intelligence to industrial problems, and had developed a very successful knowledge based diagnostic system for vibration based condition monitoring. The system was called Amethyst, and was sold by IRD Mechanalysis – at the time, the world’s largest supplier of hand-held vibration data collectors.

The Amethyst system was proving successful in the use of artificial intelligence diagnostic techniques for condition monitoring. Gas turbines were then identified as a major area where condition monitoring would be of great benefit. Rob Milne and Intelligent Applications had unique experience to combine the techniques of artificial intelligence; the knowledge of diagnostics and online continuous diagnostics; with the area of condition monitoring and the needs of condition monitoring.

After some background research and analysis, Exxon Chemical in Fife, just North of Edinburgh, at their Fife Ethylene Plant, agreed to be the initial customer for TIGER. A relatively simple system was developed to perform continuous knowledge based diagnostics of the data available on their General Electric Frame 5 two-shaft gas turbine. Roughly a year after that system was first developed, Intelligent Applications lead a consortium of six companies, with funding from the European Union, under what is known in Europe as the ESPRIT Program. This project had Intelligent Applications as the lead; Exxon Chemical as the prime user; John Brown Engineering as a manufacturer, who had installed the turbine at Exxon Chemical; Dassault Aviation in Paris, looking at smaller aero-turbines; as well as two research groups: CNRS-LAAS in Toulouse and the Polytechnic University of Catalonia in Barcelona.

These partners were picked because they had the relevant technical knowledge for the problems that need to be addressed. That three-year project, with a total budget of almost $5 million, developed the prototype TIGER system. TIGER was then able to develop it over the next year from a prototype to a ready commercial product and the first installations of TIGER began.

Over the next few years, the TIGER installations have steadily increased to well over 25 locations, and 50-fired years of operation. The product is now well developed and stable, and even the diagnostics are stable in the sense that very rarely do major new faults or problems occur, that are not covered by the diagnostics.

TIGER INSTALLATION

So what does a TIGER installation mean, or what does a user get with TIGER? The TIGER software runs on a Pentium computer and is interfaced to the gas turbine controller through a communications link. For example, for a General Electric Mark V controller, TIGER communicates through a modbus serial link with an Inode supplied by General Electric. The software also includes a backup tape drive; a printer, and a modem to enable the remote communications.

The software is installed and provided as part of the initial purchase of TIGER. Depending on the contract that is agreed, continuous support is provided for diagnostic backup and analysis of any problems that might occur. In addition, the TIGER diagnostics and the TIGER software, are being continuously upgraded based on the operational experience in the field so that a user gets new diagnostics several times per year, and new faults are analysed and improvements made to the system.

FREQUENTLY ASKED QUESTIONS

In this section, I want to address a number of questions that come up very often in presentations to give some background to the questions asked.
Are new sensors needed?
People often ask this question because they are worried about the cost of having to fit new sensors. The answer is no. TIGER works with the data available through the gas turbine controller, and hence, uses what is available. If the right sensors are not available certain diagnostics are not effective or cannot isolate the faults to certain levels. So we will work with whatever they have installed, but the quality of the diagnostics and their ability to isolate faults might be limited if they do not have as much as we normally like.

Also in the performance area, the performance module requires certain inputs. If those inputs are not available, it cannot perform the performance analysis.

How does TIGER compare with vibration based condition monitoring, such as supplied by Bentley Nevada?
The Bentley Nevada system requires additional sensors to be drilled into the casing of the gas turbine; it requires special cabling and some processing equipment that is generally extremely expensive to supply and fit. Well over $100,000 for installation itself. In addition, the gas turbine has to be stopped for a substantial period of time for all these installation activities. The vibration systems then look at the mechanical aspects of the shaft, such as, unbalanced, problems with the bearings themselves, or any kind of rub or bending of the shaft. TIGER looks at much more with a much simpler installation cost. So TIGER is much more bang for the buck because it doesn’t require additional sensors, it is easy and rapid to fit; it looks at a wide range of sub-systems and not just the mechanical aspects of the bearing.

What if I have a vibration-based condition monitoring system and I want to integrate that with TIGER?
Theoretically this is possible. Intelligent Applications have had discussions with people with Bentley Nevada on how we can incorporate the analysis done by the vibration based monitoring system with the TIGER system. Theoretically it is no problem, however, to date, none of our customers have had a full Bentley Nevada system installed. In fact, the people we help tend to find TIGER much higher value than buying a Bentley system anyway.

If I have several gas turbines on my site, can TIGER analyse all of those, and how many computers do I need?
The TIGERS are networked for any site, so that from one TIGER workstation, you can see any of the gas turbines on the network just by changing from a menu item. So if there are four gas turbines, from any one of the display stations for TIGER, you can see all the other gas turbines. You can even graph the data across any particular gas turbine.

What do I need if I have several gas turbines?
The pricing of TIGER is based on a software licence, per gas turbine. So the number of TIGERS you pay for is effectively the same as the number of gas turbines you have. The number of computers depends on two factors: the physical closeness and location of the gas turbines and their control rooms. Because we have the serial links, the limitation is generally how many serial links we can provide into a Pentium computer and how rapid that can go. In many cases, a Pentium could process data from several gas turbines, but the serial links could really only manage two of them just from the physical way PC’s are made.

Also, you can have display nodes connected on a network. So for four gas turbines, we might provide three computers: one computer analysing the data from two gas turbines; another computer analysing the data from the other two gas turbines; and the third one being a view node or display station in the engineers office or control room, with the ability of all three of them to display data on the systems. Users can have any number of display stations and remote stations (for a cost).

What if I have a Windows NT network. Can I view the results of TIGER?
Yes. We have software available so that the diagnostics and displays of TIGER can be displayed on a Windows NT network.

Does TIGER really keep all the data, or how much data does TIGER keep?
Yes, we keep all the data permanently. The local disk drive will typically hold 4-6 months worth of once per second data, all the diagnostics and all the 24-hour trends that are created. That data is available on-line. We then back-up the data through a tape-drive and write a CD-Rom containing all the diagnostics data and trends for each month. That CD-Rom provides a very rapid and easy access to any of the historical data and can be reloaded onto a hard disk at any point. Currently the backup system is through a DAT tape.

Can I access TIGER remotely?
Yes, everything you can do locally in TIGER can be done remotely. A remote view node or display system can be programmed to automatically connect across the network and collect data.
What turbines are available?
Currently, TIGER is installed on a General Electric Frame 5 and a General Electric two-shaft; a General Electric Frame 6; a General Electric Frame 9b. A General Electric Frame 7e has been installed in the US and work is being done to prepare General Electric Frame 9 as well.

We are also in the process of developing a Westinghouse 501 version and Pratt and Whitney version of TIGER.

Can I take data from several sources such as the distributed control system, or other existing systems?
Theoretically yes, the problem is the drivers from the distributed control system for communication with other computer systems. If it is a modern system with a good control system, then it is easy to interface TIGER, assuming the software information or drivers are available. Sometimes the DCS vendors don’t like to co-operate and hence, make it expensive or inhibit us getting data fed into TIGER.

What about covering the balance of plant, the heat recovery steam generators or the steam turbines?
TIGER is technically capable of this. We have not done it in the past because of the problems of getting data from other data sources and those problems are because the DCS provider made it more expensive to provide data to us. In the future, TIGER will be extended to cover the balance of plans and a steam turbine. Currently it just covers the gas turbine. We have TIGER installed on a steam turbine with a Mark V controller.

How does TIGER adjust to an individual gas turbine?
When TIGER is first installed it takes a week or two of data and analyses how the gas turbine varies, identifies a small operating range, and then sets the limits within TIGER to the variation of that gas turbine, rather than to control limits and machine protection limits. In that way, TIGER customises itself to how each gas turbine individually behaves.

Can TIGER help me make reports to document problems or incidents?
Yes. Particularly if TIGER is displayed off a Windows NT network. It is simple to cut and paste the fault manager displays and graphs into Microsoft Word documents to then prepare a report.

We have used TIGER output extensively to document faults and problems, either to justify what maintenance work has done or could provide an explanation of the incident to provide clear information to the user.

What about the fleet of gas turbines I have.
TIGER is designed to be accessed remotely from a variety of locations, so if you have a fleet of 6-8 power stations all with several gas turbines, all the software is in place within TIGER to provide a central monitoring facility or distributed monitoring facility to see each of these gas turbines from the new location.

Already there is an installation set-up that from one office they can monitor several remote gas turbines in a very simple way. If a company was interested in central monitoring of the remote fleet, it is ideal.

Can TIGER help me before I send a Field Engineer?
Yes. TIGER is able to provide an analysis of the problem through its diagnostics so that before a field engineer is sent to site, he has got a good understanding of what the probable cause and area is so that he doesn’t have to arrive and discover that he is missing a piece of equipment.

Can TIGER work with any control system?
No. TIGER needs a modern digital control system such as a General Electric Mark V or even Mark IV controller. For example, TIGER cannot be used with the old General Electric Mark II controllers.

How can I get a summary of my most common problems?
TIGER’s query mechanism searches through all the diagnostic messages and provides either a summary of all the times a particular fault or problem occurred with all the date and times. Or provides a summary of the number of times that fault occurs.

For more information, contact:
Turbine Services Limited
Venture Building, Kelvin Campus
West of Scotland Science Park
Glasgow, G20 0SP, UK
Tel: +44 (0) 141 945 7000
Email: info@turbineserviceslimited.com
http://www.turbineserviceslimited.com/proconditionmonitoring.html
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