When failure is not an option

AES' early failure detection service…

The UK Ministry of Defence (MoD) has awarded Advanced Expert Systems (AES) Ltd a major contract for the continued provision of their Machine Care Plus® equipment early failure detection service. Sophisticated analysis of oil samples taken from equipment at regular intervals provides detailed information about their condition and enables early prediction of failures.

From the initial introduction of the service in 1995, which was centred on the Challenger Driver Training Tank transmission, AES has developed their service to cover the main Armoured Fighting Vehicle Fleets (Challenger, Titan, Trojan, Warrior, AS90, BRV), as well as various Light 'A' (Bulldog, CVRT, Panther) and 'B' vehicles.

Early failure detection service

The system is designed to integrate data collected from many sources, automatically interpret this data and make firm recommendations/remedial actions. It is able to handle multiple equipment types, including critical items such as diesel engines, power transmissions and hydraulic systems. Data may be obtained from fluid samples, sensors (ie. HUMS), usage meters, physical inspection, maintenance histories, etc. In addition, oil sampling also provides the opportunity to gather accurate asset tracking information down to sub-assembly level. Fig. 1 shows the flow of data from initial collection, through interpretation to the production of diagnosis and remedial actions.

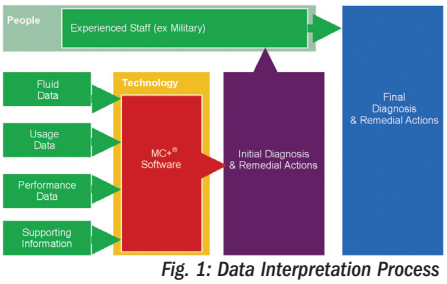

Fig. 1: Data Interpretation Process

The AES service is well proven in land systems providing assurance for Armoured Fighting Vehicles (AFV), whether they are in use during training or deployed in operational theatres. By introducing a condition monitoring system and a proactive approach to maintenance and servicing, catastrophic failures, repair costs and equipment downtime are reduced and availability increased, thereby achieving significant operational and financial benefits. Other current uses include supporting condition-based maintenance and the introduction of synthetic oils, which reduce the requirement for oil changes. It is also used during equipment trials and allows the equipment supplier to develop solutions to problems identified at an early stage in the procurement cycle, therefore enabling design changes to be implemented to improve reliability.

Photo courtesy of BAE Systems

The AES expert decision support software (see Fig. 2) produces initial recommendations/remedial actions that are reviewed by ex-military Early Failure Detection Centre (EFDC) staff who place them in an operational context prior to being confirmed and authorised for release. Users then connect to a server on 'The Land Environment Portal' (TLEP) via DII, or an MoD approved secure communications network, in order to access and/or download their reports, remedial actions and supporting information. Diagnostic feedback, management reports, asset tracking information, photographic evidence, etc. are also available as required.

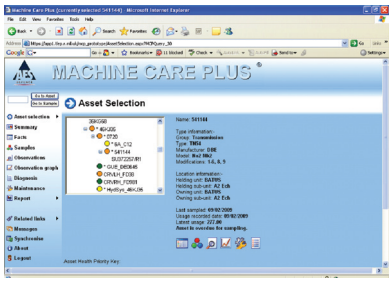

Fig. 2: Machine Care Plus® Software (Asset List view)

AES has supplied specially designed oil sampling kits/equipment to enable oil samples to be extracted by the equipment operators, at their convenience, and to send samples via the Forces Post Office or courier for analysis. In Canada at the British Army Training Unit Suffield, diagnosis and remedial actions, and management reports are available within three days of taking an oil sample, which provides Commanders with valuable equipment and planning information.

The following case study, an automotive diesel engine, illustrates some of the issues and benefits of an early failure detection programme in support of military equipment.

Case study

AES were tasked to provide technical support to Challenger 2 Main Battle Tanks and derivatives deployed to the Sultanate of Oman on a Joint Forces Exercise. The local environment and ground conditions in the Sultanate of Oman were the major factors in the performance of the equipment, but operational tasks and servicing requirements were also an important influence. The sand had a crust that once broken, resulted in a very fine abrasive dust, similar to talcum powder, which was carried easily in the air.

Most engines showed signs of sand/dust ingress but the amount varied according to a number of factors:

- The position of the vehicle in troop/squadron/convoy formation, ie. whether it was following in the dust cloud of another vehicle;
- The design and serviceability of the air filtration system;
- The maintenance and servicing procedures adopted when air filters became blocked.

The combined effect of blocked or damaged engine air filters, sand/dust ingestion and low oil levels led to very high wear rates of the internal engine components.

Potential failure analysis

Fig. 3 provides the spectrographic oil trends for a Perkins CV12 6A diesel engine, which suffered sand/dust ingress, ie. silicon (Si), cylinder liner, piston and piston ring wear, ie. aluminium (Al), iron (Fe) and chromium (Cr), and finally bearing wear, lead (Pb). Minor wear elements are not shown. The beneficial effect of an oil change can be seen where the sand and wear material contamination has been removed, and therefore the quality of the oil greatly improved.

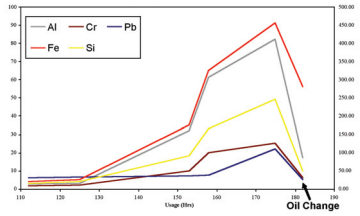

Fig. 3: Perkins CV12 6A Oil Trend Analysis

The following sequence of events has been established from analysing the data, strip and examination reports and failure information:

- Sand/dust is drawn into the engine, through seals, bellows/joints or damaged air filters;
- Cylinder liners and piston rings wear excessively and engine oil consumption increases; the engine lacks power and crankcase pressurisation occurs;
- The rate of wear increases, as does oil consumption and crankcase compression;
- The engine catastrophically seizes, and connecting rods shear, causing damage to the engine casing, heat exchanger, oil pump and reservoir, as well as other components.

Conclusion

The conditions encountered in the Sultanate of Oman were severe and very damaging to equipment operating there, especially main diesel engines, which suffered from the ingestion of very fine abrasive sand. However, numerous catastrophic failures were averted through the ability to take oil samples and analyse the data, and then take relevant and timely maintenance actions.

The lessons learnt from this case study and many other examples of equipment failures, coupled with information provided by AES, has led to design changes and modifications on a number of the British Army AFV fleets.

Benefits

The following benefits can be realised by implementing a proactive maintenance approach to equipment care through the use of the AES Machine Care Plus® service:

- Reduced secondary damage and repair costs;
- Condition-based servicing/oil changes;
- Life extension of assembly/system;
- Identification of potential failures caused by:
  - Contamination (solid debris/fluids);
  - Defective fuel injection equipment/systems and/or cooling systems;
  - Excessive component wear rates;
  - Incorrect operating/servicing procedures.

The benefits of the service have been recognised by the UK MoD, a major defence equipment supplier and the Royal Army of Oman (RAO). The RAO have extended their contract with AES to include Challenger, M60, G6 Howitzer and Piranha.

Summary

AES has used the experience gained from monitoring military equipment and systems deployed in many and varied operational theatres, which places high demands on equipment support, to very good effect. The AES expert decision support software is continually optimised to meet the latest requirements and new equipment types, and is fully compliant with UK MoD Defence Standard 25-24/1 (Health and Usage Monitoring Capability for Land Platforms).

The UK MoD contract for the Machine Care Plus® service is in place with prices, terms and conditions specified for the next five years; it is also very easy to add to or amend. In addition, AES supplies various other support services and is listed on the UK MoD Framework Agreement for Technical Support (FATS), which enables equipment managers to readily access approved suppliers.

The way ahead

To the armed forces, failure is not an option. This means a continuous quest for improved equipment support, such as that provided by the AES Machine Care Plus® equipment early failure detection service. The service is suitable for all types of engines, transmissions and fluid power systems (hydraulics). In addition, a detailed cost model has been produced that enables potential users to tailor and fully cost their requirements. For more information, contact Russ Kirkham (AES Ltd) on +44 (0)1962 711830 (email: efdc@aesdefence.com).

AES DEFENCE

Steve Docker
BSc (Hons) CEng MRAeS
Chief Executive

AES Ltd
Woburn House
Vernon Gate
Derby DE1 1UL

Tel: +44 (0)1332 206550
Fax: +44 (0)1332 383532

info@aesdefence.com
www.aesgrp.com