NUREN - 'Hot'/'Cold' Engine Testing

OVERVIEW

▪ Adds intelligent noise/vibration signature analysis to engine testing (cold-crank and 'hot' [fired])
▪ Designed specifically for measuring noise/vibration (“NVH”) signatures of engines to assess whether those engines contain manufacturing faults
▪ Uses high update rate 1/3-octave spectrum analysis to provide joint time-frequency analysis applicable to the engine work cycle
▪ Provides an automated data capture and processing environment in addition to in-depth interactive graphing / reporting
▪ Installs on top of a standard PLATO NVH test system platform

WHAT DOES NUREN MEASURE?

▪ Engine noise and/or engine vibration
▪ Engine work-cycle marker signal (typically obtained from camshaft sensor, cylinder pressure or ignition)

Data capture typically lasts for 32 complete engine work-cycles. Any variation in engine speed is accommodated by the NUREN cycle-locking process. The result is a fixed number of spectra per engine cycle that allows cycle-averaging of the data to take place.

THE BASIC NOISE/VIBRATION WORK-CYCLE ‘MAP’

This example engine work-cycle map (for cylinder head vibration) shows a typically distinctive pattern for a 4-cylinder, 4-stroke, diesel engine. The plot is in terms of absolute vibration level. When faulty engines are tested, changes occur in these maps. For example, in the event of a missing exhaust valve rocker on cylinder 2, changes occur in the noise/vibration spectra corresponding to the difference in exhaust gas flow at that cylinder. When NUREN detects such differences, it can automatically fail the engine.
SPECTRAL PROCESSING

1/3rd-octave band frequency analysis based on continuous digital filtering to IEC615 Class 1 is used. The continuous nature of the analysis allows high spectrum updates rates to be used, providing the required resolution in the time (angle) domain.

SENSORS

- Noise/Vibration
- Contacting / non-contacting
- You supply / we supply
- Your choice (with our guidance)

Specially designed probe microphones can be deployed, which allow noise measurements to be made close to hot engine surfaces or, if manifolds are not fitted at the time of testing, close to the intake/exhaust openings.

ACCEPTANCE LEVEL MAPS

In keeping with core PLATO methodology, a peak-envelope noise/vibration 'map' (Acceptance Level) is typically constructed from the results of normal [fault-free] engines. This process is automated during the system commissioning period for each engine type. Once the acceptance level has been learnt the system operates in difference mode forming 'difference maps' for analysis. If noise/vibration energy is seen on the difference map that rises above user-set threshold and tolerance levels, NUREN will automatically fail the engine.
The example difference map shown here is from a 4-cylinder, 4-stroke, gasoline engine with a **timing-belt fault**. The left-hand graphic is derived from an accelerometer attached to a hydraulic clamp (used to hold the engine to the test stand during testing), whereas the right-hand graphic shows engine block surface vibration. The black zones on difference maps represent areas where the result data does not protrude above the acceptance level plus pre-set tolerance. The repetitive, impulsive nature of the fault can easily be seen.

By contrast, the further example shown here (from the same type of 4-cylinder, 4-stroke, gasoline engine, using the same sensors) is from an engine with a **balancer-shaft timing fault**. This fault shows relatively constant levels of excessive vibration energy throughout the complete engine cycle – as would be expected from the out-of-balance forces being generated.

**PRODUCTION LINE INTEGRATION**

**PLATO-NUREN** systems are designed to integrate easily and effectively with your cold and hot engine test machines (new project or retro-fit). A fully-automatic test regime can be set-up which receives engine details and selects the relevant test protocol and acceptance levels etc. using either OPC-server (software based), hardware (e.g. 24V logic circuits) or CAN-bus (serial) communications. Once trained, the **NUREN** system operates rapidly to distinguish acceptable engines from unacceptable.
FAULTS DETECTABLE
Experience to-date indicates that PLATO-NUREN systems can detect the following faults:

- Valve lifter noises
- Valve backlash errors
- Balancer-shaft timing errors
- Hydraulic tappets that fail to pump-up or which are slow to pump-up
- Missing valve rockers on multi-valve engines
- Missing bearing shells
- Timing errors / timing-belt errors
- Piston "slap"
- Noisy ancillary equipment

ADDING AUTOMATIC FAULT CLASSIFICATION
A further PLATO sub-product called FOCUS can also be deployed to carry out intelligent fault signature pattern-matching. In brief, the pattern of difference map protrusions, which effectively define characterising frequencies and positions within the engine cycle, is examined and matched to a library of previously seen patterns. If a reasonable degree of “match” is determined the fault is classified and reported e.g. missing valve rocker - cylinder 2 for example. See separate FOCUS brochure for more details, including details on how the fault definitions evolve, what happens when lower levels of match are detected and what happens when the fault pattern is a result of more than one discrete fault.