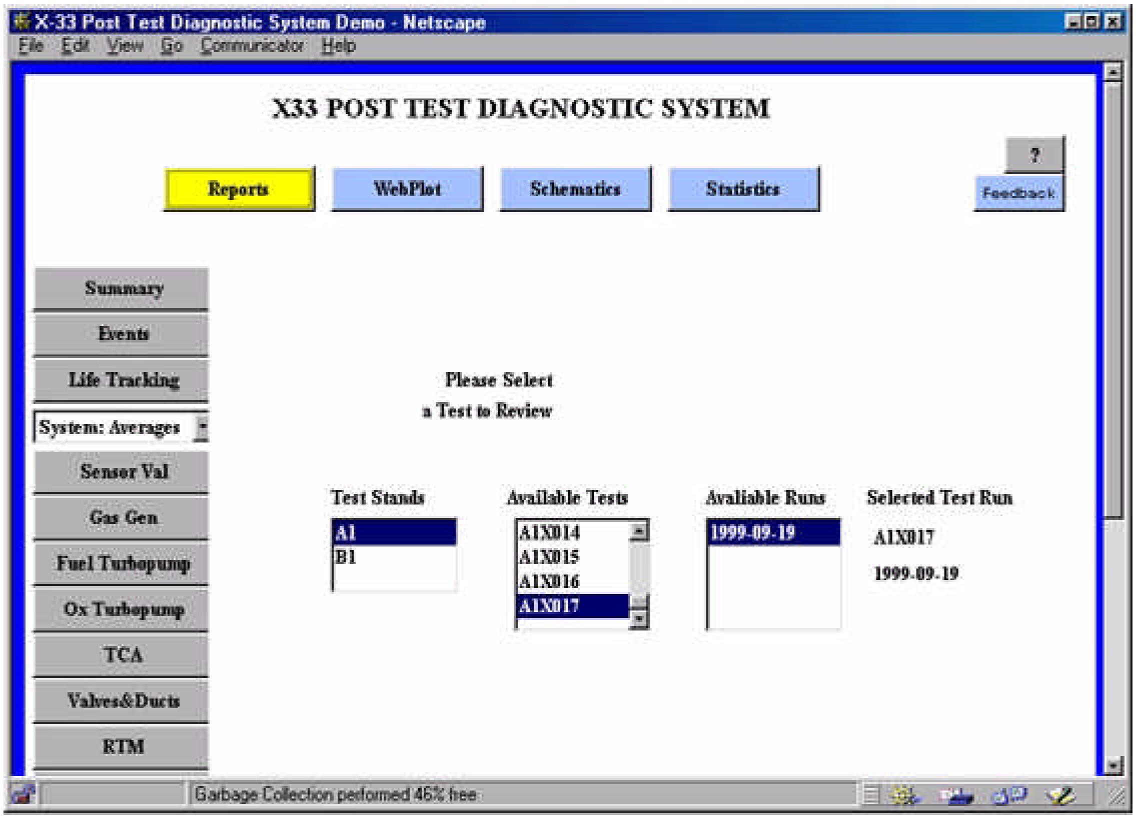
Aerospike Engine Post-Test Diagnostic System Delivered to Rocketdyne

The NASA Glenn Research Center at Lewis Field, in cooperation with Rocketdyne, has designed, developed, and implemented an automated Post-Test Diagnostic System (PTDS) for the X–33 linear aerospike engine. The PTDS was developed to reduce analysis time and to increase the accuracy and repeatability of rocket engine ground test fire and flight data analysis. This diagnostic system provides a fast, consistent, first-pass data analysis, thereby aiding engineers who are responsible for detecting and diagnosing engine anomalies from sensor data. It uses analytical methods modeled after the analysis strategies used by engineers. Glenn delivered the first version of PTDS in September of 1998 to support testing of the engine's power pack assembly. The system was used to analyze all 17 power pack tests and assisted Rocketdyne engineers in troubleshooting both data acquisition and test article anomalies. The engine version of PTDS, which was delivered in June of 1999, will support all single-engine, dual-engine, and flight firings of the aerospike engine.

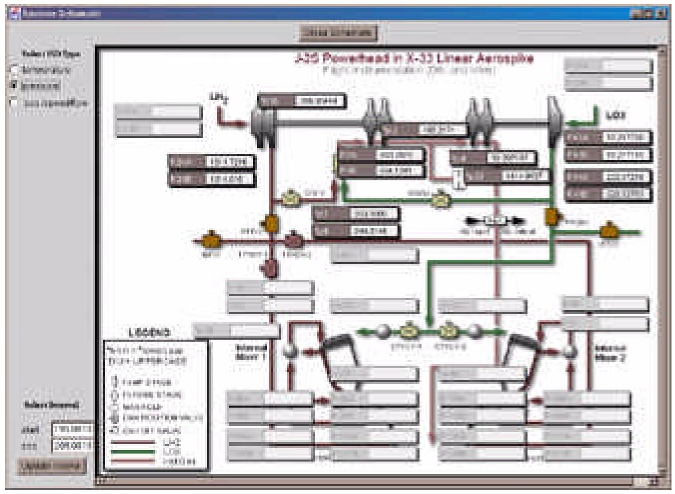
The aerospike engine PTDS has two primary components: the analysis system and the viewing system. The analysis system performs automated diagnosis and performance assessment of the sensors, valves, turbomachinery, gas generator, thrust chamber assembly, nozzle, and facility thrust measurement system. Open-loop and closed-loop system-level models of the aerospike engine are employed for model-based fault detection. Detailed performance predictions are generated for each component, and data are statistically characterized during startup and shutdown transients and at key steady-state conditions. Finally, life tracking is performed on a test article basis.

The viewing system, which provides the essential interface to the data and the analysis results, is Web-based to promote platform independence. Data and results can be accessed through reports, annotated schematics, a sophisticated plotting tool, or an interactive statistics tool. The plotting tool, called WebPlot, and the statistics tool were provided to promote experimentation with the data and with the PTDS-generated performance predictions; such experimentation continues to facilitate an understanding of both the nominal and off-nominal behavior of aerospike engine subsystems. Users can actually expand the routine analysis performed by the aerospike engine PTDS through statistics interface requests.



The Web-based viewing system allows users to access PTDS analysis results and data through reports, an interactive plotting tool called WebPlot, schematics, and an interactive statistics tool.

The analysis and viewing system architectures designed for the aerospike engine PTDS emphasize modularity, extensibility, and reusability. The modular architecture accommodates both procedural and nonprocedural knowledge-based components, thereby permitting the inclusion of conventional algorithms as well as heuristic, model-based, and case-based analyses. Extensibility has been essential, since the PTDS has evolved concurrently with the engine system design. Although domain knowledge and limits are specific to this engine, many aspects of the analysis system such as the event-detection routines, statistical characterization, and sensor validation methodology have been and are being applied to other aerospace systems as well. Likewise, the statistics tool and WebPlot are generic and, in addition to aerospike data, have successfully handled data from the Space Shuttle Main Engine and from the Fastrac engine developed by NASA Marshall Space Flight Center. Current efforts are focused on preparing for the engine test and increasing the depth of the automated data analysis.



The schematic portion of the viewing system provides users with access to values for key test parameters during a user-specified time interval. Sensor failure information also is given.

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