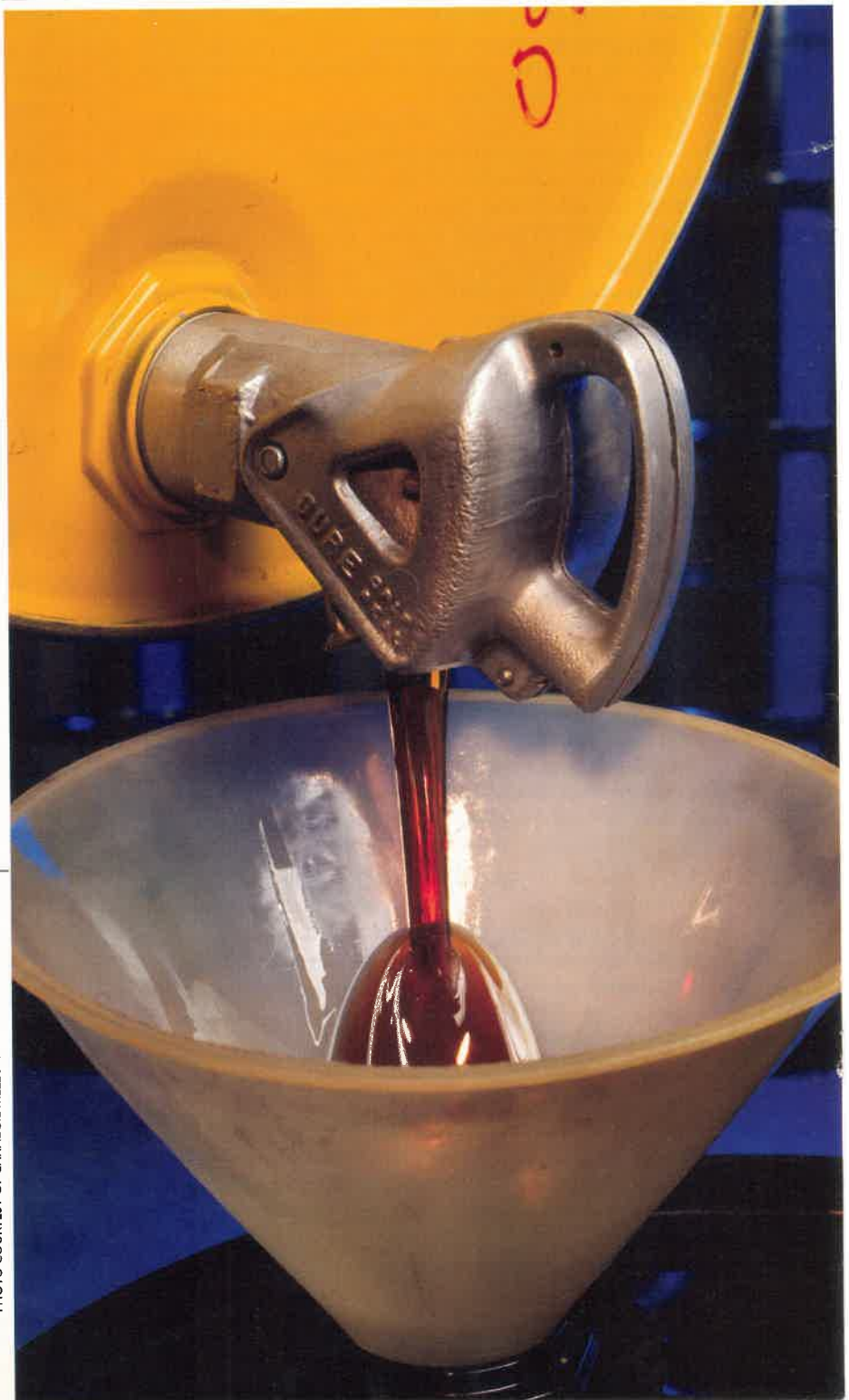


**BASED IN  
PITTSBURGH,  
PA., THE  
ASTM TEST  
MONITORING  
CENTER**

HAS PROVIDED BENCHMARK  
TESTING FOR THE AUTOMOTIVE  
LUBRICANT INDUSTRY FOR A  
QUARTER-CENTURY. TMC  
DIRECTOR JOHN L. ZALAR  
DETAILS HOW THIS RESEARCH  
AND TESTING EFFORT  
HAS ENSURED THE QUALITY OF  
THE LUBRICANTS USED IN  
YOUR CAR.



# The **ASTM** Test Monitoring Center

## 25 YEARS OF SERVICE TO THE AUTOMOTIVE LUBRICANT INDUSTRY

/BY DR. JOHN L. ZALAR/

**A** major anniversary is an appropriate time to pause, to celebrate achievements, to reflect on the past, and to ponder the future. The year 2001 marks the 25th anniversary of the ASTM Test Monitoring Center, a program of Committee D02 on Petroleum Products and Lubricants, dedicated to serving the automotive lubricant industry. The Test Monitoring Center's story is one of success, modest growth, expanding capabilities, and future challenges.

### HISTORY

Laboratory engine tests have been used to evaluate the performance of engine oils for over six decades. In 1938, the Caterpillar Tractor Company developed five engine tests for defining acceptable performance of oil used in Caterpillar engines. During the 1950s, as performance testing of lubricants became more prevalent, many more company-specific tests were developed by original equipment manufacturers. It was recognized in the mid-1950s that there was a need to develop a common language for lubricant performance and a clearly

defined testing protocol.

In 1956, General Motors, Ford, and Chrysler developed a series of gasoline powered sequence engine tests to evaluate lubricants for spark ignition engines. These test methods were documented in ASTM Special Technical Publications and were referenced in the American Petroleum Institute (API) Engine Service Classification System for engine oils. The OEMs took responsibility for their own tests by providing hardware supply, test fuel certification, field correlation data, test procedure updates, reference oils, laboratory calibration, and consultations with test laboratories. As engine design and technology advanced, performance testing of lubricants continued to evolve and increase in complexity. In 1972, the OEMs requested relief from their responsibility for maintenance of reference oils, laboratory calibration, and consultations with laboratories so that their personnel could concentrate on new test development.

ASTM was the logical choice to assume these responsibilities and, in 1973, the "Reference Oil Engine Sequence Test Monitoring System" was established within ASTM. An Engine Test Advisory (ETA) panel

was formed and given the responsibility of managing the system. The ETA was established under Committee D02 on Petroleum Products and Lubricants, Technical Division B (today known as Subcommittee D02.B). ETA panel membership was prescribed to include representatives of all interested groups including ASTM, the U.S. military, engine manufacturers, oil producers, test laboratories, and general interest. This system included a working arm known as the ASTM Test Monitoring Center (TMC), which was started in 1976. In 1978, the ETA panel was reorganized to provide a balance of producers and users and was renamed the ASTM Test Monitoring Board (TMB). The Test Monitoring Center, with governance by the TMB, operates according to a formal set of ASTM rules entitled *Regulations Governing the ASTM Test Monitoring System*.

### TMC CORE SERVICES

#### Reference Oils

TMC reference oils are the benchmarks used to calibrate engine test stands and laboratories. These fully formulated oils are supplied by major oil and additive companies and span a broad range of

performance and formulation technology. Frequently these oils are variations of commercial products, either past or present. The TMC targets a supply of reference oil that will last for five years of calibration testing. Volumes range from 50 to 10,000 gallons (metric) per oil, depending on the test method(s). Reference oils are received and stored at the TMC in 55-gallon (metric) drums. The number of reference oils handled by the TMC has steadily increased over the years; today, the center inventories over 100 different formulations having a total volume of nearly 75,000 gallons (metric). Reference oils are stored in heated warehouses and the inventory of each oil is split between two locations to ensure an uninterrupted supply of reference oil to the industry should disaster strike.

In order to ensure the quality and homogeneity of reference oils, the TMC follows a prescribed analytical/mixing protocol. When oils arrive at the TMC, samples are drawn from each drum. One drum is designated as the reference drum. The oil samples are analyzed by infrared and emissions spectroscopy and compared to the reference drum sample. If the analyses agree, the oil is ready for mixing. The TMC has three stainless steel tanks (350, 700, and 2,200-gallon (metric) capacities) that are used to mix reference oils.

The oil is poured from the 55-gallon drums into the appropriate sized tank and stirred for several hours to homogenize the blend. After mixing, the oil is pumped back into 55-gallon drums for storage. A representative sample from the mix is obtained and

analyzed by infrared and emissions spectroscopy. It is also analyzed for viscosity, sulfated ash, acid number, and base number and the results of these analyses are compared to the pre-mix results. The results are also compared to analyses performed on previous blends of the same oil, if any, and to analyses performed by the supplier of the oil. If all the analytical results show agreement, the oil is released for use in engine testing. Analytical results are retained in a TMC computer database for future reference.

Reference oils are poured from 55-gallon drums into the appropriate size sample containers for distribution to testing laboratories. The TMC prepares and distributes reference oil samples ranging in volume from one milliliter for bench analytical tests to 55 gallons for large multi-cylinder diesel engine tests. Reference oil samples in the range of two to five gallons are most common.

To ensure that reference oils are not degrading over time, the TMC performs quality control analyses on the active reference oils in its inventory. Once per year, top and bottom samples are drawn from the next undisturbed container of each reference oil. The samples are analyzed by infrared and emissions spectroscopy and determinations of viscosity, acid number, and base number are made. Comparisons are made between the top and bottom samples and each of these is compared to the representative sample from the original oil mix. In a small number of cases, problems identified through the QC process have resulted in reference oils being removed from use.

### *Reference Oil Test Data*

Every time a reference oil test is conducted, the results are reported to the TMC and stored in a computer database. Almost all reference oil tests are run blind, i.e., the identity of the oil is unknown to the laboratory until after a test is completed. This is accomplished via an oil coding system and a requirement that laboratories contact the TMC for a reference oil assignment prior to starting a calibration test. This system enables the TMC to provide full accountability for the use of its reference oils and maintain an exhaustive database of reference oil test results. Reference oil test reports are sent to the TMC electronically and include complete operational and performance data. First, operational data is reviewed to verify that the test was run under the proper conditions as specified in the test method. The TMC has been instrumental in the development of objective performance criteria for test operations using Quality Index, a mathematical measure of operational control. Once a test has been confirmed to be operationally valid, the performance data can be evaluated.

Reference oil performance data is used to determine test stand/laboratory calibration status. The TMC accomplishes this through the use of a statistical quality control chart process known as the Lubricant Test Monitoring System (LTMS). Reference oil test results are control charted against target values and the resulting plots must remain within pre-established control limits in order for a test stand/laboratory to demonstrate calibration, i.e., acceptable precision and minimal bias. The LTMS uses Shewhart charts that are sensitive to abrupt changes in stand/laboratory precision and bias and Exponentially Weighted Moving Average charts that track long-term consistent trends in precision and bias. The LTMS describes the actions necessary when control chart plots fall outside of their control limits. One or more reference oil tests may be needed to bring the charts back into control. The LTMS is designed to produce more data when problems exist and less data when testing is in control. The operational and statistical validity status of each reference oil test as well as stand/labo-

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## TMC MISSION

The mission of the TMC has remained basically unchanged over its 25-year history. The center calibrates engine test stands and/or laboratories, as prescribed in specific ASTM test methods, via reference oils. Although the TMC is directly concerned only with the evaluation of reference oil tests, TMC calibration enhances the reliability and cost-effectiveness of testing used to measure the performance of commercial engine lubricants. The American Chemistry Council (ACC) independently requires that commercial engine lubricant tests be conducted on TMC calibrated stands in order to comply with their Petroleum Additives Product Approval Code of Practice. Licensing of commercial engine oils by API requires compliance with this ACC code.

ratory calibration status is documented by the TMC.

The LTMS also provides control charting at the industry level, including reference oil test data from all stands and laboratories combined. These industry-wide control charts are a valuable tool for tracking the precision and bias of a test method and are used by ASTM test surveillance panels in support of their test maintenance and continuous improvement efforts. The TMC updates industry control charts on a real-time basis and posts the charts on its Internet Web site. Individual reference oil test data, coded to maintain confidentiality, is also available on the TMC Web site.

#### Laboratory Visits

As part of its laboratory consultation service, a TMC engineer visits each calibrated laboratory at least once per year per test type. The purpose of these visits is to help the laboratory verify that its testing is being conducted in accordance with the relevant ASTM test methods. TMC engineers, along with laboratory personnel, review test stand configurations, engine build procedures, instrument calibration, and test operations. Findings are reviewed with the laboratory test engineer and summarized in a written follow-up report. Laboratories use the information gained from TMC engineering visits to continuously improve the consistency with which they conduct tests, not only within their own facilities but also as compared to other testing laboratories.

#### STANDARDS DEVELOPMENT

The TMC plays a key role in standards development within ASTM Subcommittee D02.B on Automotive Lubricants. Due to the complexity of many lubricant test methods, parts and procedural changes are often needed immediately in order for commercial testing to continue without interruption. ASTM's Committee on Technical Committee Operations (COTCO) granted permission for the TMC to issue these urgent procedural changes as Information Letters, prior to their balloting within Subcommittee D02.B as test method revisions. Provided that there is no known tech-

nical objection to a proposed procedural change, a TMC Information Letter is issued that describes the change and defines the ASTM working group(s) that studied and approved the corrective action. All TMC Information Letters are balloted and brought to consensus within Subcommittee D02.B within six months of issuance. Annually, Information Letters become the content of Committee D02 ballots of revisions to ASTM test methods.

#### GROWTH AND FINANCES

The TMC has steadily expanded services and increased its technical capabilities over the years, growing from a staff of two in 1976 to its current size of 17 full-time employees. The expertise of the professional staff spans the areas of mechanical engineering, chemistry, statistics, and computer/information science. The TMC's involvement in lubricant testing has broadened beyond gasoline and diesel engine tests to include gear, two-stroke cycle, and bench analytical test methods. Recently, the TMC began providing services in support of several diesel fuel performance tests. The number of TMC monitored test methods has increased from three in 1976 to over 30 today. In addition to its core services, the TMC publishes technical reports and memoranda to ASTM surveillance panels, maintains test reporting formats and electronic data transfer protocols, supports industry matrix programs for new test development, provides statistical data analyses, conducts laboratory round-robin programs, and coordinates special oil blends.

The TMC is an industry-supported, non-profit operation. Revenues are generated from fees charged for reference oils and for the processing of reference oil test data. The fee structure is reviewed annually by the TMB and charges are periodically revised to meet annual budgetary com-

mitments. The TMC's annual budget has grown from approximately \$150,000 in 1976 to about \$2,100,000 for 2001.

#### CMRI – HOME OF THE TMC

The TMC is located in Pittsburgh, Pa., and is operated via a contract with Carnegie Mellon Research Institute (CMRI), a part of Carnegie Mellon University. CMRI provides innovative technology solutions to industry, government, and the community. CMRI invents, develops, and applies cutting-edge technologies in the areas of information systems, environmental processes, and engineering. CMRI has provided facilities and staffing for the TMC ever since the center was established in 1976.

#### FUTURE

Over the past 25 years, the TMC has evolved progressively in services, responsibilities, staff, and industry dependence. This evolution has been driven primarily by industry needs associated with advancements in engine lubricant technology and performance. Recent mergers and consolidations throughout the fuels and lubricants industry have posed new challenges for all stakeholders. Currently, there is strong interest in defining worldwide product specifications and testing protocols. There is also a perceived need for refinements to the process of training and calibrating laboratory raters of test parts.

In order to sustain its technical value and financial stability, the TMC must continue to react to the changing needs of the industry. The Test Monitoring Board stands ready to provide the necessary guidance. The TMB is receptive to requests for TMC services from the working groups of ASTM Committee D02 that can lead to improved definition of fuel and lubricant performance worldwide. //



**DR. JOHN L. ZALAR** is the administrator of the ASTM Test Monitoring Center. He is active within Subcommittee D02.B on Automotive Lubricants of Committee D02 on Petroleum Products and Lubricants.