

KRISTEN M. SCALISE CPA, CFE

FISCAL OFFICER, COUNTY OF SUMMIT

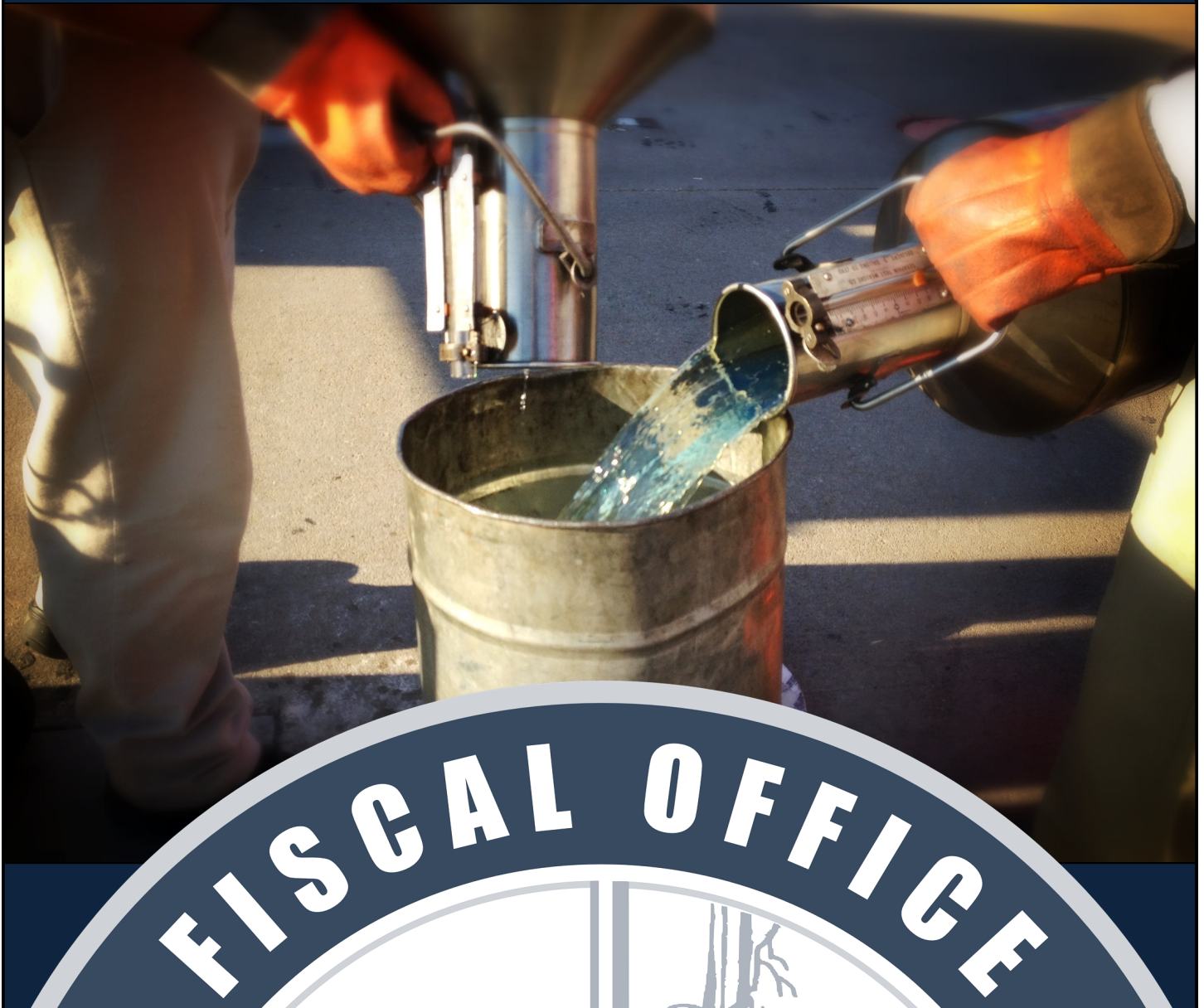
SERVICES DIVISION, DEPARTMENT OF WEIGHTS & MEASURES

1030 E. TALLMADGE AVE., AKRON, OH 44310

PHONE: 330-630-7226 WEBSITE: <http://FiscalOffice.summitoh.net>



FUEL QUALITY TESTING PROGRAM



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INTRODUCTION

As your Fiscal Officer, it is my priority to protect the consumers of Summit County. Our Services Division oversees weights and measures testing. Inspectors test the accuracy of measuring devices throughout the county, including fuel pumps. In 2004 we enhanced this program to incorporate fuel quality testing and became the first county in the state of Ohio to implement a program of its kind.

The Fuel Quality Testing Program evaluates the octane levels, water and sediment in gasoline and diesel to ensure there is no contamination. Testing takes place at more than 170 filling stations in Summit County. Inspectors use tools such as the *Scully Water Detection Device* to test for water, *Bacon Bomb* (used from 2004 to 2018) or *Nasco Fuel Sampler* (used from 2018 to present) to determine irregularities, and a *Zeltex Octane Analyzer* to measure octane levels.

This program has proven to be effective in providing valuable consumer protection. Upon implementation, inspectors determined that nearly 11% of filling stations had water in their gas or diesel storage tanks. Another 15% presented inaccurate octane ratings. Today, thanks to the success of our Fuel Quality Testing Program, we can ensure that all fuel sold in Summit County is safe for your vehicle and that fuel pumps deliver accurate amounts.

I am proud that our office provides outstanding accuracy and fairness in the marketplace. We continually meet and exceed the standards set by the National Conference on Weights and Measures (NCWM).

Sincerely,

Kristen M. Scalise CPA, CFE
Fiscal Officer, County of Summit



HISTORY

Currently, only three states in the country do not have laws regarding the testing of fuel quality. Ohio, Nebraska and Alaska are the three states without fuel testing.

There are existing laws for county Weights and Measures Departments across the state of Ohio to inspect every gas pump for accuracy at least once a year. However, there are no laws that allow for the testing of the quality of regular fuel, diesel fuel and kerosene or to test for water in storage tanks.

Protecting consumers and assuring fairness in the marketplace are among our top priorities for testing the quality and quantity of fuel.

RESEARCH

We began compiling information regarding fuel quality in July 2003. In January 2004, Fiscal Office Weights and Measures staff members talked with officials from several states regarding their fuel testing laws. Those officials told us their programs were run through that state's various respective departments, which are responsible for investigation, inspection and sampling to ensure the fuels that consumers buy contain the proper materials and abide by legal standards.

Dennis Harrison, from the State of West Virginia Division of Labor, Office of Weights and Measures, agreed to visit Summit County and bring various types of equipment that is used by West Virginia inspectors. Staff members learned about testing and results and then spent two days in the field conducting inspections and testing for fuel quality at eight random gas stations.



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SUMMIT COUNTY, OHIO LEGISLATION

In August 2004, legislation was presented to Summit County Council so the Fiscal Officer's Weights and Measures Department could begin testing for fuel quality in addition to testing for fuel pump accuracy as mandated by the State of Ohio.

The legislation that was adopted authorizes the County Fiscal Officer to perform fuel quality testing pursuant to the Uniform Engine Fuels, Petroleum Products and Automotive Lubricants Regulation, as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, *National Institute of Standards and Technology (NIST) Handbook 130* (2004), as amended. A majority of the states that have fuel testing laws have adopted some portion or all of *NIST Handbook 130** pertaining to fuel quality testing.

In addition, the County of Summit adopted by reference the latest standards established by the *American Society for Testing and Materials* (ASTM)*. If standards change, they are updated by ASTM and Summit County does not have to change our law to stay current with industry standards.

Retail dealers in the state of Ohio are not required to disclose the fact that gasoline contains *ethanol** and they are not required to disclose the percentage of ethanol in the gasoline by any law, rule, resolution or ordinance of any political subdivision of the state according to O.R.C. 1345.021, enacted in 2001. NIST Handbook 130 requires labeling.

A new ASTM standard was passed in June 2004 regarding diesel fuel, with an enforce date of January 2005. Members of the petroleum industry contacted us asking for a one year extension so they would be able to put the necessary procedures in place to meet the new standard. The extension was granted.

*See Glossary

ORDINANCE NO. 2004-454

SPONSOR (Mr. McCarthy), Mr. Teodosio, Mr. Crawford and Council of the Whole

DATE October 4, 2004

A Substitute Ordinance enacting new Section 745.04 of the Codified Ordinances of the County of Summit, entitled “Fuel Quality Testing,” to authorize the County Fiscal Officer to perform fuel quality testing pursuant to the “Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation,” as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), as amended, for the Fiscal Officer, and declaring an emergency.

WHEREAS, the State of Ohio is one of only four states that has not enacted the “Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation,” (“Uniform Fuel Regulation”) as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), attached hereto as Exhibit A and incorporated herein as if fully restated; and

WHEREAS, the County Fiscal Officer checks and verifies all weighing and measuring devices, including fuel pumps, scales and uniform product code price scanners used in commercial transactions; and

WHEREAS, enacting a new section of the Codified Ordinances of the County of Summit to authorize the Fiscal Officer to perform fuel quality testing pursuant to the Uniform Fuel Regulation will enable the Fiscal Officer to determine if fuel is contaminated and keep consumer vehicles from being damaged and to determine if the station has been given the correct octane of fuel and/or disbursing the proper octane cited on the dispenser; and

WHEREAS, this Council has determined by reviewing all pertinent information that it is necessary and in the best interest of the County of Summit to enact a new section of the Codified Ordinances to authorize the Fiscal Officer to perform fuel quality testing pursuant to the Uniform Fuel Regulation, as amended;

SECTION 1

Section 745.04 of the Codified Ordinances of the County of Summit, entitled “Fuel Quality Testing,” is hereby enacted as follows:

“SECTION 745.04 FUEL QUALITY TESTING.

(a) The County of Summit hereby adopts the “Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation,” (“Fuel Testing Regulation”) as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), as amended. In addition, the County of Summit hereby adopts by reference the latest standards established by the American Society for Testing and Materials (ASTM). The County Fiscal Officer shall be authorized to perform fuel quality testing pursuant to the Fuel Testing Regulation, as amended, in the County of Summit.

SECTION 1 (Cont.)

The County Fiscal Officer's designated agents shall issue separate stop sale and or written citation for the first violations detected at each pump, hose, and/or storage tanks located at the same fuel dispensing premises. Failure to correct said violation, within seven days after the first offense was issued, may constitute a subsequent offense. Notice of citations shall also be issued to the owner of the fuel dispensing premises or his/her statutory agent within a reasonable amount of time if they have filed a "Notice of Citation Registration Form" with the Summit County Fiscal Office.

(b) Civil Penalties.

Any person who individually, or through their servant or agent, or as the servant or agent of another person, commits any violation of the Fuel Testing Regulation *at the same fuel dispensing premises*, as amended, shall be issued a stop sale and or written citation for the first violation and assessed a civil penalty for all subsequent violations as follows:

1. Not less than \$ 100.00 nor more than \$500.00 for a second violation in a two (2) year period.
2. Not less than \$ 250.00 nor more than \$ 1,000.00 for a third violation in a two (2) year period.
3. Not less than \$500.00 nor more than \$1,500.00 for a fourth violation in a two (2) year period.

All penalties collected by the Fiscal Office pursuant to this Section shall be allocated for the exclusive operations of the Fiscal Officer's Fuel Quality Testing Program.

(c) Administrative Hearing.

Any person subject to a civil penalty shall have a right to request an administrative hearing before the Fiscal Officer's Chief of Staff within ten (10) days of receipt of the notice of a civil penalty. The Chief of Staff or their designee shall be authorized to conduct the hearing after giving appropriate notice to the respondent. The decision of the Chief of Staff shall be subject to review and all final decisions shall be made by Consumer Affairs Director. Said director shall confirm, modify and/or dismiss the citation and/or penalties based upon the demonstration of mitigating circumstances by said person. Citations and penalties may be appealed to the court of appropriate jurisdiction.

(d) Criminal Penalties.

Any person who commits a fifth violation of the Fuel Testing Regulation, as amended, at the same fuel dispensing premises within a two (2) year period, shall be guilty of a misdemeanor of the third degree, and for a misdemeanor of the second degree for a sixth or subsequent offense at the same fuel dispensing premises, within a two (2) year period after the first offense.

Registration and/or Inspection Fees

The County shall not charge any inspection or registration fees to perform fuel quality testing pursuant to the "Uniform Fuel Regulations".

SECTION 2

This Ordinance is hereby declared an emergency in the interest of the health, safety, and welfare of the citizens of the County of Summit, and for the further reason that it is necessary in order to authorize the County Fiscal Officer to perform fuel quality testing pursuant to the "Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation," as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), as amended.

SECTION 3

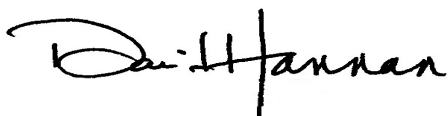
Provided this Ordinance receives the affirmative vote of eight members, it shall take effect immediately upon its adoption and approval by the Executive; otherwise, it shall take effect and be in force at the earliest time provided by law.

SECTION 4

It is found and determined that all formal actions of this Council concerning and relating to the adoption of this Ordinance were adopted in an open meeting of this Council, and that all deliberations of this Council and of any of its committees that resulted in such formal action, were in meetings open to the public, in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

INTRODUCED August 16, 2004

ADOPTED October 4, 2004



APPROVED October 5, 2004

PRE



CL

October 5, 2004

EX



ENACTED EFFECTIVE

VOICE VOTE: YES: Callahan, Congrove, Crawford, Crossland, Gallagher, Heydorn, King,
Schrader, Smith and Teodosio ABSTAIN: Dickinson

RESOLUTION NO. 2004-579

SPONSOR (Mr. McCarthy)

DATE October 25, 2004

A Resolution confirming an award by the Board of Control of a professional service contract with The University of Akron to provide a fuel testing program, for the period of one year, with one annual option to renew, in an amount not to exceed \$50,000.00, for the Fiscal Officer, and declaring an emergency.

WHEREAS, the Board of Control, at its meeting held October 13, 2004, has awarded a professional service contract to provide a fuel testing program, subject to confirmation by County Council; and,

WHEREAS, County Council has determined by reviewing all pertinent information that the contract is necessary;

NOW, THEREFORE, BE IT RESOLVED by the Council of the County of Summit, State of Ohio, that:

SECTION 1

The award by the Board of Control of a professional service contract with The University of Akron to provide a fuel testing program, for the period of one year, with one annual option to renew, in an amount not to exceed \$50,000.00, is hereby confirmed, and the County Executive is authorized to execute such contract.

SECTION 2

This Resolution is hereby declared an emergency in the interest of the health, safety, and welfare of the citizens of the County of Summit, and for the further reason of providing a fuel testing program.

SECTION 3

Provided this Resolution receives the affirmative vote of eight members, it shall take effect immediately upon its adoption and approval by the Executive; otherwise, it shall take effect and be in force at the earliest time provided by law.

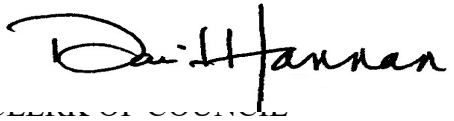
SECTION 4

It is found and determined that all formal actions of this Council concerning and relating to the adoption of this Resolution were adopted in an open meeting of this Council, and that all deliberations of this Council and of any of its committees that resulted in such formal action, were in meetings open to the public, in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

RESOLUTION NO. 2004-579
PAGE TWO

INTRODUCED October 25, 2004

ADOPTED October 25, 2004



CLERK OF COUNCIL



PRESIDENT OF COUNCIL

APPROVED October 26, 2004



EXI

October 26, 2004
ENACTED EFFECTIVE

VOICE VOTE: YES: Callahan, Congrove, Crawford, Crossland, Dickinson, Gallagher, Hey-
dorn, Schrader, Smith and Teodosio ABSENT: King

ORDINANCE NO. 2005-567

LATE FILING

SPONSOR Mr. McCarthy

DATE December 5, 2005

An Ordinance amending Section 745.04(b) of the Codified Ordinances of the County of Summit, entitled “Fuel Quality Testing,” to provide for assessment of actual costs of testing for all fuel sample failures and those costs of testing samples necessary to guarantee fuel quality following a station’s remedial measures post-failure, and declaring an emergency.

WHEREAS, pursuant to Ordinance No. 2004-454, County Council enacted Section 745.04 of the Codified Ordinances of the County of Summit, entitled “Fuel Quality Testing,” which authorizes the County Fiscal Officer to perform fuel quality testing within the County of Summit; and

WHEREAS, for the first six (6) month cycle of fuel testing, the Fiscal Office incurred approximately \$16,000.00 in testing costs for samples which failed established standards; and

WHEREAS, Section 745.04(a) requires fuel samples to be tested prior to resumption of sale where a stop sale citation is issued for a violation; and

WHEREAS, the Fiscal Officer seeks to have violators responsible for the payment of restitution to the County for the cost of testing failed samples and requests that Section 745.04(b) be amended to require payment of such restitution; and

WHEREAS, this Council has determined by reviewing all pertinent information that the amendment of Section 745.04 for the aforementioned reasons is necessary and in the best interest of the County of Summit;

NOW, THEREFORE, BE IT ORDAINED by the Council of the County of Summit, State of Ohio, that:

SECTION 1

Section 745.04 of the Codified Ordinances of the County of Summit, entitled “Fuel Quality Testing,” is hereby amended as follows:

“745.04 FUEL QUALITY TESTING.

(a) The County of Summit hereby adopts the “Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation,” (“Fuel Testing Regulation”) as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), as amended. In addition, the County of Summit hereby adopts by reference the latest standards established by the American Society for Testing and Materials (ASTM). The County Fiscal Officer shall be authorized to perform fuel quality testing pursuant to the Fuel Testing Regulation, as amended, in the County of Summit.

The County Fiscal Officer’s designated agents shall issue separate stop sale and or written citation for the first violations detected at each pump, hose, and/or storage tanks located at the same fuel dispensing premises. Failure to correct said violation, within seven days after the

SECTION 1 (Cont.)

first offense was issued, may constitute a subsequent offense. Notice of citations shall also be issued to the owner of the fuel dispensing premises or his/her statutory agent within a reasonable amount of time if they have filed a "Notice of Citation Registration Form" with the Summit County Fiscal Office.

(b) Civil Penalties and Costs. Any person who individually, or through their servant or agent, or as the servant or agent of another person, commits any violation of the Fuel Testing Regulation at the same fuel dispensing premises, as amended, shall be issued a stop sale and/or written citation for the first violation. All violations shall result in an order of restitution, payable to the County, for actual costs of testing both the failed sample(s) and testing necessary to resume sale. and assessed a A civil penalty for all subsequent violations at the same fuel dispensing premises, shall be assessed as follows:

- (1) Not less than \$ 100.00 nor more than \$500.00 for a second violation in a two (2) year period.
- (2) Not less than \$ 250.00 nor more than \$ 1,000.00 for a third violation in a two (2) year period.
- (3) Not less than \$500.00 nor more than \$1,500.00 for a fourth violation in a two (2) year period.

All penalties collected by the Fiscal Office pursuant to this Section shall be allocated for the exclusive operations of the Fiscal Officer's Fuel Quality Testing Program.

(c) Administrative Hearing. Any person subject to a civil penalty shall have a right to request an administrative hearing before the Fiscal Officer's Chief of Staff within ten (10) days of receipt of the notice of a civil penalty. The Chief of Staff or their designee shall be authorized to conduct the hearing after giving appropriate notice to the respondent. The decision of the Chief of Staff shall be subject to review and all final decisions shall be made by Consumer Affairs Director. Said director shall confirm, modify and/or dismiss the citation and/or penalties based upon the demonstration of mitigating circumstances by said person. Citations and penalties may be appealed to the court of appropriate jurisdiction.

(d) Criminal Penalties. Any person who commits a fifth violation of the Fuel Testing Regulation, as amended, at the same fuel dispensing premises within a two (2) year period, shall be guilty of a misdemeanor of the third degree, and for a misdemeanor of the second degree for a sixth or subsequent offense at the same fuel dispensing premises, within a two (2) year period after the first offense.

(e) Registration and/or Inspection Fees. The County shall not charge any inspection or registration fees to perform fuel quality testing pursuant to the "Uniform Fuel Regulations".

SECTION 2

This Ordinance is hereby declared an emergency in the interest of the health, safety, and welfare of the citizens of the County of Summit, and for the further reason that it is necessary in order to authorize the County Fiscal Officer to perform fuel quality testing pursuant to the "Uniform Engine Fuels, Petroleum Products, and Automotive Lubricants Regulation," as adopted by the 88th National Conference on Weights and Measures 2003, and restated in the United States Department of Commerce, National Institute of Standards and Technology Handbook 130 (2004), as amended.

ORDINANCE NO. 2005-567
PAGE THREE

SECTION 3

Provided this Ordinance receives the affirmative vote of eight members, it shall take effect immediately upon its adoption and approval by the Executive; otherwise, it shall take effect and be in force at the earliest time provided by law.

SECTION 4

It is found and determined that all formal actions of this Council concerning and relating to the adoption of this Ordinance were adopted in an open meeting of this Council, and that all deliberations of this Council and of any of its committees that resulted in such formal action, were in meetings open to the public, in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code.

INTRODUCED October 24, 2005

ADOPTED December 5, 2005


APPROVED December 6, 2005

P 


December 6, 2005
ENACTED EFFECTIVE

VOICE VOTE: **YES:** Callahan, Congrove, Crawford, Crossland, Dickinson, Gallagher, Heydorn, Kostandaras, Prentice, Smith & Teodosio



TESTING

DOCUMENTATION: Bill of Lading* for fuel delivery. When the documentation is reviewed, it will indicate whether the fuel is conventional or ethanol extended. This information is needed to test the water levels in the underground storage tanks. The Bill of Lading will also show the pipeline from where the fuel originated.

OCTANE LEVEL: A Zeltex octane analyzer* measures all grades of unleaded gasoline directly from the pump. Samples taken from the eight stations tested showed inconsistent results. Some examples for the inconsistent octane levels can include improper blending of octane levels, excessive water level in storage tanks and winter vs. summer fuel. NIST Handbook 130* refers to ASTM* standards that prescribe, that in certain areas of the country, dates as to when winter and summer fuel can be used.

UNDERGROUND STORAGE TANKS: Test samples from the underground storage tanks showed where most of the problems begin. There are several types of equipment used to test for fuel quality. First used was the Scully water detector*, which sounds an alarm if water is present. If the alarm sounded, the next step is to use the Sargel Stick and Paste* method to measure the level of water in the storage tank. Two inches of water is allowed for conventional fuel but only ¼ inch is allowed for ethanol extended fuel. The last instrument that was used in the storage tank was the Bacon Bomb*. It is attached to a chain and slowly lowered to the bottom of the tank and extracts a sample of fuel. Fiscal Office staff found water, cloudy and milky color, sediment and microbial contamination in the tanks. *Please note that we currently use a *Nasco Fuel Sampler* in place of the *Bacon Bomb*.

SPILL RIM: Designed to catch any spillage from the truck driver as he is dispensing fuel into the storage tanks. These rims should be kept free of dirt and debris otherwise all waste material could drop into the underground tanks.

TURBIDITY: A Hach Model 2100P Portable Turbidimeter is used to monitor contamination in fuel by testing for sediment and clarity. This instrument can measure turbidity from 0.01 to 1000 NTU.

*See Glossary



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EXAMPLES OF VIOLATIONS

Missing Octane Level Label:

If an Octane level label is missing from the pump, each button at each pump is a separate violation.

Documentation not available:

The station must have the proper documentation (Bill of Lading*) on-site for one year.

Improper Octane Sale:

Selling 87 Octane gasoline for 93 Octane price

Storage tanks:

Water in tanks exceeding $\frac{1}{4}$ inch for Ethanol and 2 inches for conventional fuel.
Incorrect octane level in the tanks.

NOTE: Citations and/or fines could be assessed against pumps, hoses and/or underground storage tanks. See legislation for full description of civil and criminal penalties, written citations and stop sale orders.



BASIC EQUIPMENT AND START-UP COSTS

Equipment	Cost
* Bacon Bomb (used from 2004-2018)	\$700
* Nasco Fuel Sampler (used from 2018-present)	\$108
* Water Detector	\$295
* Folding Measuring Dipstick	\$10
* Sargel Stick and Paste (12 tubes)	\$70
* Turbidimeter Instrument	\$1,000
* Zeltex Octane Analyzer	\$10,000

*See Glossary

The above includes basic start-up costs that could be incurred. Other potential costs include ASTM laboratory expenses, storage, shipping and disposal of hazardous materials. Summit County Weights and Measures staff has found the Scully Water Detector, Zeltex Octane Analyzer, the stick and paste method and the Bacon Bomb/ Nasco Fuel Sampler provides the most information on fuel quality during inspection and sampling.



SUMMARY

The intent of this law is for consumer protection regarding fuel quality. Since there are no fuel testing laws in Ohio, there is a need to educate the public regarding the choices of fuel that are available and what is best for their car. The station owners also need to be further educated regarding the dangers caused by the fuel problems discovered during our research.

With over 15 million cars registered in the State of Ohio we are looking at this as a partnership between local government and consumers.

Additives can be used and storage tanks can be pumped to expel any water that resides in them. These problems, if left untreated, can become very serious and expensive for everyone.

The damage it can do to an automobile, storage tanks and meters is significant. Fuel quality testing will help prevent costly repairs.

The spill rims around the underground storage tanks were found to be excessively dirty at the stations we visited. The rims are designed to be kept free of dirt and debris. Otherwise, the possibility exists that waste material could be dropped into the tank.

There is no federal, state or local law that addresses filters on fuel pumps, which is why testing laws should be necessary.



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Summit County inspectors will be required to check for winter fuel versus summer fuel in storage tanks. NIST Handbook 130 refers to ASTM standards that prescribe, in areas of the country such as Ohio, dates as to when each type of fuel can be used.

No jurisdiction in Ohio has the authority to check on the different types of fuel. There could possibly be winter fuel in the storage tanks during hot periods, which could cause vapor lock. Summer fuel, during cold periods, could cause engine-starting problems.

By testing, unnecessary car expenditures can be avoided.

The Fiscal Officer's Fuel Quality Testing Program will benefit everyone in Summit County. It is our hope that the State Legislature will follow Summit County's lead and address this issue statewide, allowing the other 86 county auditors to implement fuel quality testing standards in their respective counties.



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GLOSSARY

In Alphabetical Order

ASTM
(American Society for Testing and Materials)

Bacon Bomb

Nasco Fuel Sampler

Bill of Lading

Ethanol

Gasoline Related Definitions

NIST
(National Institute of Standards and Technology)

Scully Water Detector

Stick and Paste

Turbidimeter Instrument (2100P)

Zeltex Octane Analyzer



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ASTM

American Society for Testing Materials



ASTM (from www.astm.org)

ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. Today, some 12,000 ASTM standards are used around the world to improve product quality, enhance safety, facilitate market access and trade, and build consumer confidence.

- ASTM's leadership in international standards development is driven by the contributions of its members: more than 30,000 of the world's top technical experts and business professionals representing 150 countries. Working in an open and transparent process and using ASTM's advanced electronic infrastructure, ASTM members deliver the test methods, specifications, guides and practices that support industries and governments worldwide. Learn more about ASTM International.
- ASTM was formed in 1898 by chemists and engineers from the Pennsylvania Railroad. At the time of its establishment, the organization was known as the American Section of the International Association for Testing and Materials. Charles B. Dudley, Ph.D., a chemist with the Pennsylvania Railroad, was the driving force behind the formation of the Society. In 2001, the Society became known as ASTM International. Click here for more on ASTM's history.
- ASTM International standards are the tools of customer satisfaction and competitiveness for companies across a wide range of markets. Through 143 technical standards-writing committees, ASTM serves diverse industries ranging from metals to construction, petroleum to consumer products, and many more. When new industries look to advance the growth of cutting-edge technologies, such as nanotechnology and additive manufacturing, many of them come together under the ASTM International umbrella to achieve their standardization goals.
- In the arena of global commerce, ASTM International standards are the passports to a successful trading strategy. High quality, market-relevant ASTM standards, developed in accordance with the guiding principles of the World Trade Organization, fuel trade by opening new markets and creating new trading partners for enterprises everywhere. From Fortune 500 leaders to emerging startups, ASTM standards help level the playing field so that businesses of all sizes can better compete in the global economy.
- ASTM International standards are developed in accordance with the guiding principles of the World Trade Organization for the development of international standards: coherence, consensus, development dimension, effectiveness, impartiality, openness, relevance and transparency. Learn more about ASTM and Global Cooperation.
- ASTM International welcomes and encourages participation from around the world in the development of its standards. ASTM's open consensus process, using advanced Internet-based standards development tools, ensures worldwide access for all interested individuals. Join ASTM International.
- Beyond its leadership in the area of standards development, ASTM International offers technical training programs for industry and government, as well as proficiency testing, interlaboratory crosscheck programs and newly initiated certification programs, which support manufacturers, users, researchers and laboratories worldwide. Learn more about training.
- ASTM International world headquarters are located in West Conshohocken, Pa. The Society also has offices in Belgium, Canada, China, Mexico and Washington, D.C.



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BACON BOMB

(used from 2004 to 2018)



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◀ **K27700 Sample Thief (Bacon Bomb)**

Test Method

All samplers conform to ASTM D4057 (formerly ASTM D270), D6074 or ASTM D1265 specifications.

Features and Benefits

- Obtains bottom samples or samples from any level
- Four different capacities
- Plated brass, stainless steel or acrylic construction
- Standard Viton O-ring seal
- Optional metal-to-metal seal



Click on the image to view a larger photo of the instrument.

Sample Thief (Bacon Bomb)

Obtains samples from storage tanks, tank cars and drums. When the thief strikes the bottom of the tank, a plunger assembly opens to admit the sample. The plunger closes again when the bomb is withdrawn, forming a tight seal. Samples can be taken at any depth with the use of a secondary trip line, or extension rods may be added for obtaining samples at levels of up to 18 (46cm) off the bottom. Equipped with plunger locking cam for tight closure during transport (except for 4 oz 1 1/8" dia. model). Special models include a 4 oz (118mL) 'pencil' model for sampling through small diameter pipes and openings, and clear acrylic samplers with plated brass plunger and end pieces. Modified samplers can be supplied for special applications – we invite your inquiries.



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NASCO FUEL SAMPLER

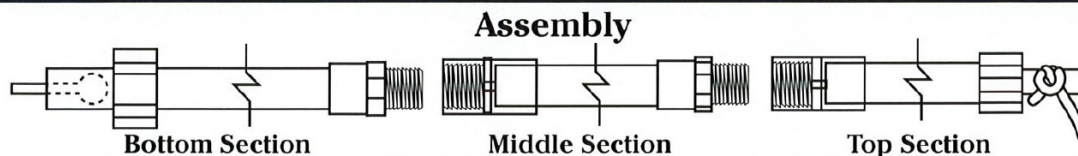
(used from 2018 to present)



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Nasco Fuel Sampler (B01477WA) Instructions



Outside dimension of tubing is 1" (2.5 cm) pipe size. Inside is $\frac{3}{4}$ " , (1.9 cm).

- A. The bottom pipe has the ball check valve on one end and male threads on the other.
- B. The middle pipe has female threads on one end and male threads on the other.
- C. The top pipe has female threads on one end and a rope on the other.

ASSEMBLY

Screw the three sections of pipe together until the connections are snug.

HOW TO USE

Lower the Sampler to the bottom of the fuel tank. It should be lowered slowly and *not* plunged to the bottom. Plunging the unit will result in an *inaccurate* reading and possible damage to the bottom valve. **PLEASE LOWER SLOWLY.**

SPECIAL NOTE: In order to get a consistent, accurate measurement of solids in the fuel, it is important that the top of the Sampler not be submersed below the fuel. Submersing the unit completely into the fuel affects the amount of sediment rising into the sampler from the bottom. The deeper the unit is submersed below the fuel, the more effect there is on the reading.

When the bottom of the tank has been reached or the pipe has filled to the desired level, tug slightly on the rope as you begin to raise the unit. This will seat the check valve, trapping the column of fuel in the Sampler.

CAUTION

When raising the unit up, keep it as vertical as possible. Do not allow the unit to bend or bounce while it is full. After looking at the sample, empty the tube before further use.

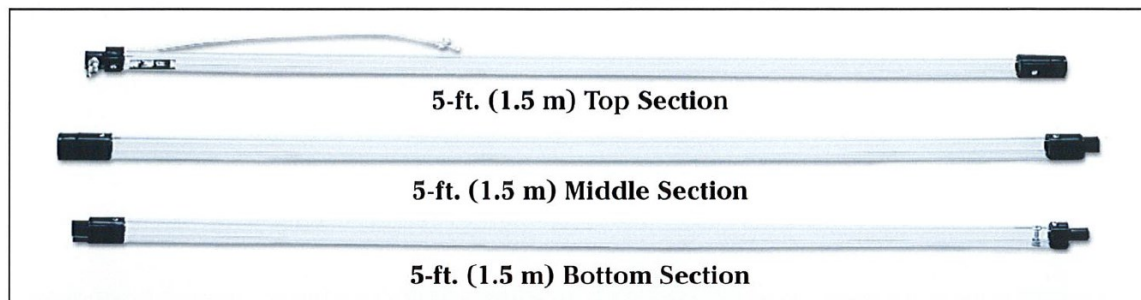
To release the material, touch the pin extending from the bottom section against a hard surface. This opens the check valve and the sample will flow out.

STORAGE

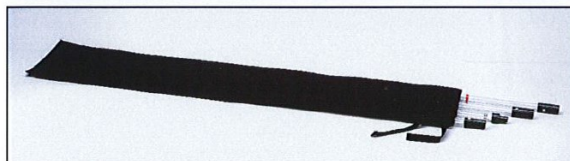
Please store this unit where it cannot be damaged, especially by foot traffic, doors, or machinery. *Do not leave it exposed to the sun.* Sampler is made of PVC.

CLEANING

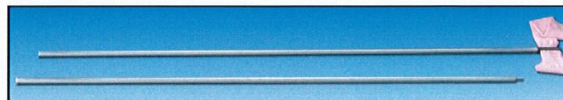
The unit may be cleaned with hot water and a mild soap or vinegar, and a 6-ft. (1.8 m) cleaning brush or rod and cloth strips (see below).



Accessories

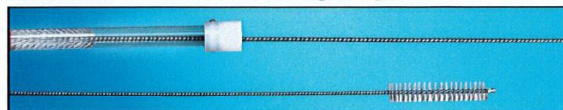


C09249WA Canvas carry bag. Holds four sections.



B01412WA Cleaning Rod

B01413WA Cotton Cleaning Strips



B01291WA 6-ft. (1.8 m) Cleaning Brush

Printed in U.S.A. NP 138-08

Nasco • Fort Atkinson
901 Janesville Avenue
Fort Atkinson, WI 53538-0901
1-800-558-9595
www.whirl-pak.com

Nasco • Modesto
4825 Stoddard Road
Modesto, CA 95352-3837
1-800-558-9595
www.whirl-pak.com

Spectrum Nasco • Canada
150 Pony Drive
Newmarket, ON L3Y 7B6
1-800-668-0600
www.spectrumed.com



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BILL OF LADING



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HM FN	PRODUCT	QUANTITY/UNIT
DANGEROUS GOODS DESCRIPTION		
UN1203 Gasoline, 3, PG II 1 Cargo Tank		
SEE REVERSE FOR EMERGENCY RESPONSE GUIDE AND OTHER INFORMATION		
FOR PRODUCT EMERGENCY - Spill, Leak, Fire, Exposure, or Accident Day or Night - Call: CHEMTREC 1800-424-9300 Account #:		
SHIPMENT ORIGIN:		
VEHICLE/UNIT NUMBER:		
FREIGHT:		
PO #:		
LOAD START DATE: 09/18/14 TIME: 04:33		
LOAD END DATE: 09/18/14 TIME: 04:51		
BILL OF LADING		
FOLIO NUMBER:		
CUSTOMER	ACCOUNT	TRANS ID:
CONSIGNEE DELIVER TO		
SUPPLIER:		
TERMS:		
FN	PRODUCT	QUANTITY/UNIT
PRODUCT	Octane Rating (R + M) / 2	Gross Volume
87 REG E10 9+	87.00	3799
RUL CBOB 9+	84.00	3412
ETHANOL (DENAT) ALCOHOL	.00	387
87 REG E10 9+	87.00	1199
RUL CBOB 9+	84.00	1077
ETHANOL (DENAT) ALCOHOL	.00	122
87 REG E10 9+	87.00	2000
RUL CBOB 9+	84.00	1796
ETHANOL (DENAT) ALCOHOL	.00	204
TOTAL		6998 GAL GROSS
		6985 GAL NET
FINISHED PRODUCT SUMMARY		
87 REG E10 9+	Gross 6998	Net 6985
National Detergent Additized Gasoline This product does not meet the requirements for reformulated gasoline and may not be used in any reformulated gasoline covered area. E10: Contains between 9 and 10 vol% etha nol EPA#456482357 90169093		
This is to certify that the above named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.		
Carrier certifies that the container supplied for this shipment is a proper container for the transportation of the Products as above described and driver acknowledges Emergency Response Guide information received on reverse side of this document.		
SHIPPER:		
DRIVER/AGENT		
DRIVER:		
CARRIER:		



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ETHANOL



1345.021 Ethanol blended or mixed into gasoline.

(A) As used in this section, "retail dealer" means a person who owns, operates, controls, or supervises an establishment at which gasoline is sold or offered for sale to the public.

(B) When ethanol is blended or mixed into gasoline that is sold or offered for sale to the public, it is not an unfair or deceptive act or practice in connection with a consumer transaction for a retail dealer to fail to disclose either of the following:

- (1) The fact that the gasoline contains ethanol;
- (2) The percentage of ethanol that is contained in the gasoline.

(C) If a retail dealer elects to disclose any of the information specified in division (B) of this section, the dealer may make that disclosure in any form, using any type of sign or label and any size or style of letters, at the retail dealer's discretion.

(D) A retail dealer shall not be required to disclose the fact that gasoline contains ethanol and shall not be required to disclose the percentage of ethanol in the gasoline by any law, rule, resolution, or ordinance of any agency or department of the state or any political subdivision of the state.

Cite as R.C. § 1345.021

History. Effective Date: 03-21-2002



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GASOLINE RELATED DEFINITIONS



Gasoline Related Definitions

Acceptance Limit	A numerical value that defines the point between acceptable and unacceptable quality.
Additive	A material added to another, usually in small amounts, to impart or enhance desirable properties or to suppress undesirable properties.
Anti Icers	Fuel additives used to control fuel line freeze up.
Anti Knock Index (AKI)	Measures of a gasoline's resistance to engine knock.
Anti Oxidants	Fuel additives used to minimize gum formation of stored gasoline.
Automotive	Description of equipment associated with self-propelled machinery, usually vehicles driven by internal combustion engines.
Base Gasoline	The gasoline used blending with blending agents such as alcohols or ethers.
Cetane Number	Measure of the ignition performance of a diesel fuel.
Combustion Enhancers	Fuel additives used to improve combustion.
Corrosion Inhibitors	Fuel additives used to minimize fuel system corrosion.
Crude Oil	Liquid petroleum as it comes out of the ground. No two crude oils are exactly alike. They range from very light (high in gasoline) to very heavy (high in residual oil).
Dehazer	An additive that controls water contamination or "water haze" that is normally used with oxygenated fuels.
Denatured Fuel Ethanol	Ethanol that has been denatured (rendered undrinkable) by the addition of no more than 5% hydrocarbons.
Deposit Control Additives	A mixture of powerful detergents, dispersants and other chemicals designed to keep the fuel system free of fuel and oil related deposits.
Detergents	Fuel additives used to control fuel system deposits.



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Diolefins	An ingredient of gasoline which contributes to gum and lacquer formation in the fuel system and engine.
Distillate	Petroleum fuels that are heavier than gasoline but also lighter than residual fuels. Diesel, kerosene, jet fuels and home heating oil are examples of distillate fuels.
Distillation Pressure	The pressure measured as close as possible to the point where the vapor temperature is taken, normally at the top of the condenser.
Distillation Temperature	In column distillation, the temperature of the saturated vapor measured just above the top of the fractionating column.
Distributor	(Also see P.A. 44 definition.) A gasoline wholesaler (often wholesales other petroleum products in conjunction with gasoline)
Downstream	Transportation, refining and marketing that takes place after the crude is produced.
E85	An engine fuel blend of denatured fuel ethanol and hydrocarbons where the ethanol portion is 85% by volume.
End Point	The maximum temperature reading obtained during distillation test.
Ethanol	(Also called ethyl alcohol or grain alcohol) An alcohol made from the fermentation of grain (usually corn), potatoes, sugar or timber, used as an octane enhancer/blending agent in gasoline.
Excise Tax	A tax levied on the production, sale or consumption of a commodity.
Fluidizer Oils	Fuel additive used with detergents to provide valve deposit protection.
Gasohol	Term used to refer to gasoline and alcohol mixes.
Hot Soak	Term used to refer to the period of time immediately after a vehicle engine is shut down and the engine is still warm.



Hydrocarbon	A class of compounds that contain hydrogen and carbon atoms. Crude oils and natural gas are sometimes referred to hydrocarbon fuels.
Initial Boiling Point	The liquid temperature that is observed at the instant that first drop of condensation falls from the lower end of the condenser tube.
Lead	(tetra-ethyl lead) A gasoline octane enhancer.
M85	M85 is a fuel blending 85% methanol and 15% petrol.
M100	An engine fuel consisting primarily of anhydrous methyl alcohol.
Metal Deactivators	Fuel additives used to minimize the effect of metal-based components present in gasoline.
Methane	A light, odorless, flammable gas that is the chief constituent of natural gas.
Methanol	(Also called methyl alcohol or wood alcohol). An alcohol made from natural gas, coal or biomass used as an octane enhancer/blending agent in gasoline.
Motor Fuel	Liquid used as fuel for internal combustion engines.
Motor Fuel Device	A device designed for the measurement and delivery of liquids used as fuel for internal-combustion engines.
MTBE	(Methyl Tertiary Butyl Ether) A gasoline octane enhancer.
National Ambient Air Quality Standards	Standards in the clean air act that set maximum concentration that should be allowed nationwide for air pollutants.
Natural Gas	A mixture of hydrocarbon compound and small amounts carbon dioxide, helium, hydrogen sulfide and nitrogen, existing in the gaseous phase. Some refineries also produce a substandard octane product in the liquid state that is suitable in some instances for blending with gasoline. This may also be called "natural gas."



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Non-attainment	Areas Regions of the country that do not meet the National Ambient Air Quality Standard of the Clean Air Act.
Octane Number	A rating used to grade the relative anti-knock properties of various gasolines.
Octane Span or Calibration	The octane number scaling or adjustment, in terms of compression ratio or the knock intensity, of the testing unit variable used to measure relative octane quality.
Offset Octane Number	The difference between the desired octane number and the actual octane number of a secondary reference fuel.
Olefins	A gasoline component resulting from several refining processes. Olefins often contribute to the formation of gum and engine deposits.
Percent Evaporated	The sum of the percent recovered and the percent loss.
Percent Residue	The percent total recovery minus the percent recovery, or the volume of residue in milliliters if measured directly.
Re-refining	The use of refining process ensuring recycling to produce base stock for lubricants or other petroleum products from used oil.
Reformulated Gasoline	A volatile mixture of liquid hydrocarbons and oxygenates meeting the reformulated gasoline requirement of the Clean Air Act Amendments of 1990.
Repeatability	A quantitative expression of the random error associated with a single operator in a given laboratory obtaining replicate results with the same apparatus under constant conditions on identical test material within a short period of time.
Reproducibility	Quantitative expression of the random error associated with operators working in different laboratories, each obtaining single results on identical test material when applying the same method.
Retail Device	A device designed for single delivery less than 100 gallons and in addition, any device designed or used for retail deliveries of motor fuels to individual highway vehicles.



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Sour Crude	Crude oil that is high in sulfur content.
Specific Gravity	The ratio of the density of a substance to that of a reference substance such as water (for solids and liquids) or hydrogen (for gases) under specified conditions.
Standard Fuel	In octane number determination, a gasoline or process unit material that is octane number calibrated for use in subsequent calibration of secondary reference fuels.
Sweet Crude	Crude oil that is low in sulfur content.
Toluene	A blending agent commonly used octane enhancer at refineries.
Vapor-Liquid Ratio	The ratio, at a specified temperature and pressure, of the volume of vapor in equilibrium with liquid to the volume of liquid sample charged at 32 F (0 C).
Vapor Pressure	The pressure exerted by the vapor of a liquid when in equilibrium with the liquid.
Viscosity	The internal resistance to flow of a fluid.
Volatility	A fuel's ability to vaporize or change from liquid to vapor.



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NIST

National Institute of Standards and Technology



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NIST (from www.nist.gov)

From the smart electric power grid and electronic health records to atomic clocks, advanced nanomaterials, and computer chips, innumerable products and services rely in some way on technology, measurement, and standards provided by the National Institute of Standards and Technology. Founded in 1901, NIST is a non-regulatory federal agency within the U.S. Department of Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

NIST carries out its mission through the following programs:

the NIST Laboratories, conducting world-class research, often in close collaboration with industry, that advances the nation's technology infrastructure and helps U.S. companies continually improve products and services;

the Hollings Manufacturing Extension Partnership, a nationwide network of local centers offering technical and business assistance to smaller manufacturers to help them create and retain jobs, increase profits, and save time and money; and

the Baldrige Performance Excellence Program, which promotes performance excellence among U.S. manufacturers, service companies, educational institutions, health care providers, and nonprofit organizations; conducts outreach programs; and manages the annual Malcolm Baldrige National Quality Award which recognizes performance excellence and quality achievement;

From 2007 to 2011, NIST provided cost-shared grants through the Technology Innovation Program, and between 1990 and 2007, it managed the Advanced Technology Program.

NIST's FY 2014 resources total \$850.0 million in direct appropriations, an estimated \$47.3 million in service fees, and \$107.0 million from other agencies.

The agency operates in two locations: Gaithersburg, Md., (headquarters—234-hectare/578-acre campus) and Boulder, Colo., (84-hectare/208-acre campus). NIST employs about 3,000 scientists, engineers, technicians, and support and administrative personnel. NIST also hosts about 2,700 associates from academia, industry, and other government agencies, who collaborate with NIST staff and access user facilities. In addition, NIST partners more than 1,300 manufacturing specialists and staff at more than 400 MEP service locations around the country.



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SCULLY WATER DETECTOR



Scully Water Detector

The Portable Paste Problem Solver



The Scully WB 100 water detector detects the depth of water lying under petroleum products and water presence in dry containment areas. The unit is hand held and covers a variety of applications. The Scully WB 100 offers all of these advantages:

- Can be used in gasoline, gasohol, diesel fuel, jet fuels and #1 through #4 fuel oil.
- Ideal for petroleum storage tanks, boat bilges and manholes.
- Available in a variety of sizes for virtually all tanks.
- No need for messy paste sticks.
- Rugged, lightweight construction.
- Inexpensive and easy to use.
- Audible alarm indicates the presence and level of water.
- Approval for use in hazardous areas.
- Battery operated.

Description

The Scully WB 100 water detector is a battery operated, hand held unit. The unit is comprised of a rugged metal housing with audible alarm and a water detection sensor permanently attached via a two-conductor petroleum resistant cable.

The weighted sensor is lowered into the fuel storage tank, boat bilge, truck compartment, etc. by simply unwinding the cable. The audible alarm will sound when the presence of water is detected. By lowering the weighted sensor to the bottom of the tank and raising it until the alarm shuts off, you can accurately measure the level of water within the tank. It's as easy as using a drop line and less awkward and more accurate than a messy paste covered stick.

The WB 100 water detector weighs less than four pounds. The unit is self-contained and easy to store. Consult Scully for special applications.

Setting New Standards In Safety



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STICK AND PASTE



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SAR-GEL[®]

BY ARKEMA

Water-Indicating Paste
a product of Sartomer Americas



Advantages

- Easy to apply – no messy jars, no need to mix
- No guessing – complete color change from white/pink to deep scarlet
- Faster reaction – immediate detection means less time wasted
- Easier to see water line – does not run
- Fast easy clean-up



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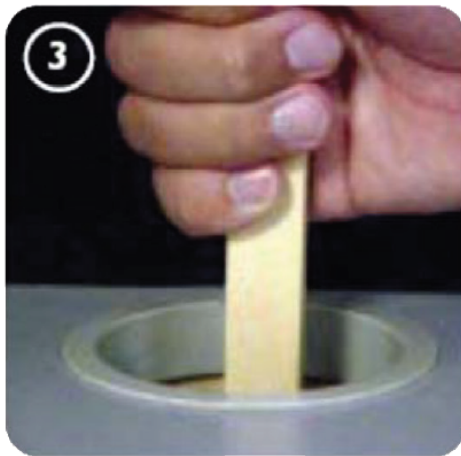
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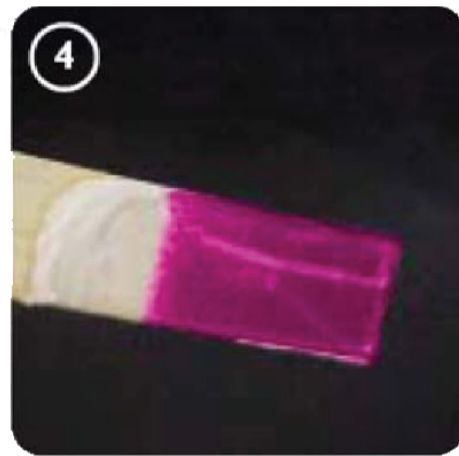
Apply a small amount of Sar-Gel® paste to the end of the dip stick.



Spread the paste over the surface of the stick.



Insert the dip stick into the tank for 30 seconds.



The presence of water is indicated when the Sar-Gel® paste turns deep scarlet.



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TURBIDIMETER INSTRUMENT



1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

Figure 1 **2100P Turbidimeter and Accessories**



Note: Avoid prolonged exposure to ultraviolet light and sunlight.

Note: Do not hold the instrument during measurements; place the instrument on a flat, steady surface.



SECTION 1, continued

1.2 Accessories

Accessories supplied with the turbidimeter include nine sample cells; three Gelex[®] Secondary Standards (included with 4650000 only); one sealed vial each of:

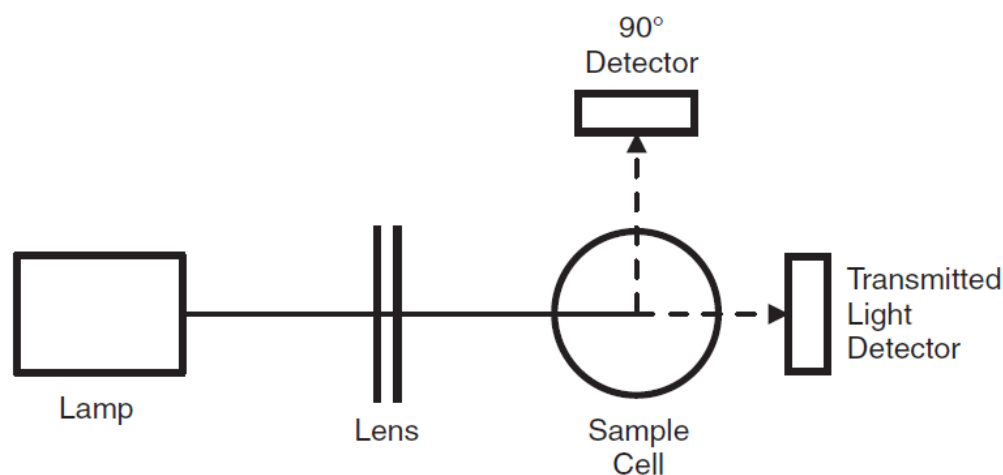
<0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal[®] Stabilized Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Figure 2 **Ratio Optical System**



* Patent number 4,198,161; other patents pending.



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ZELTEX OCTANE ANALYZER



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ZELTEX® ZX-101XL

Portable Near-Infrared Octane/Cetane Analyzer

**Featuring Automatic
Fuel Detection:**
Gasoline
Ethanol Blended Gasoline
Diesel (optional)



**For Analysis
...Where you need it most
...When you need it most™**

For Lab Accurate, On-Site Analysis of Octane and Cetane



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Specifications

Function

Quantitative constituent analysis for product research measurement and/or product monitoring

System Capabilities

Precalibrated for Octane number RON, MON, (R+M)/2
Optional Calibrations Diesel cetane index, cetane number
Outputs LCD display, built-in printer
Data Transfer Via RS-232 port for interface with PC
Data Analysis Includes full calibration software
Results Traceable to CFR Engine or other fuel lab standards
Calibrations Stores up to 10 calibration sets
Data Storage Stores data for up to 25 samples

Optical Capabilities

Measurement Mode Diffuse transmittance
Spectrum Range 14 filters covering wavelengths from 893 to 1045 nm
Scan Speed Up to 10 scans per second
Optical Range 0 to 6 AU
Resolution 0.00001 AU
Stability 0.05 Mili-AU
Measurement Time Variable (Typically under 20 seconds)

Sample Information

Sample Size 200mL with 75 mm path length
Sample Holder Reusable glass with chemical seal cover
Sample Preparation None required
Sample Destruction None

Physical Data

Dimensions 5"W X 14"L X 4"H (12 cm X 36 cm X 11 cm)
Weight 3 lbs. (less than 2 kg)

Installation Data

AC Power Requirements 120 or 240 VAC 50/60 Hz AC adapter (supplied)
DC Power Requirements 6 AA alkaline batteries (included)
..... optional 12V automobile adapter
Power Consumption 750 ma



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The Industry's Only Truly Portable, Battery Operated Octane/Cetane Analyzer

Superior Technology

The patented ZX-101XL utilizes highly accurate and reliable near-infrared spectroscopy for analysis of octane and cetane levels in gasoline, ethanol blended gasoline (e-gas), and diesel fuel.

In the Field or at the Lab

The ZX-101XL has been specially designed for rugged in-the-field use, but is equally well suited for laboratory applications.

With a warm up time of less than one minute and analysis time of less than 20 seconds, the ZX-101XL allows for nearly instantaneous *analysis when you need it most, where you need it most*. It is ideal for at the pump inspections, spot checks at the pipeline, and quality control at the refinery.

More Features for Improved Performance

The ZX-101XL's Delron sense head makes it easy to firmly seat and position the sample holder in the instrument making field tests faster and smoother.

The ZX-101XL's two piece sealed optical filter tray extends the life of the optical filter and increases wave length stability.

The ZX-101XL offers Automatic Fuel Selection, enabling it to detect the type of fuel being analyzed and reducing potential operator error.

The ZX-101XL offers an optional GPS locator allowing personnel to document and verify the time and location of each analysis.

Who Uses Zeltex Technology?

Government Inspection Agencies

- At the pump inspections
- Over 30 states already use Zeltex Analyzers for their field inspectors
- Used in over 40 countries worldwide

Service Stations/Gasoline Retailers

- Make sure you're not giving octane away
- Make sure you get what you're paying for

Blending Stations

- Ensure that your delivery vehicles are delivering the proper blends

Refineries & Terminal Docks

- Quality control spot checks on blended fuels
- Allows for immediate adjustments

Military

- Quick, efficient analysis of overseas or unverified fuel supplies to maximize vehicle performance

Research & Development

- Research labs can perform complex analysis for new product development projects



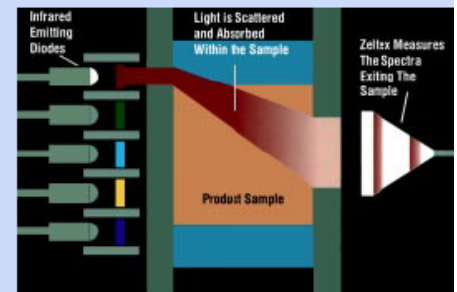
**Optional
GPS Locator**

**Less Than One Minute
Warm Up Time!**

**Results In
Less Than
20 Seconds**

How It Works: Applied Science In Measurement

Light energy that enters the sample is scattered and absorbed within the sample. The ZX-101XL measures the spectra exiting the sample, and directly displays the product's constituent concentrations.





Unique Design Features Add Versatility, Dependability and Convenience

- Automatic fuel detection (Gasoline/E-Gas/Diesel)
- Less than one minute warm up time
- Stores data for up to 25 samples
- Precalibrated for unleaded and Ethanol blended fuels
- Optional diesel cetane index and cetane number calibrations available
- Automatic temperature compensation
- Displays results in less than 20 seconds
- Self-standardizing to ensure accuracy
- Easy-loading sample holder
- Easy-to-read LCD display
- Built-in printer that includes time and date of analysis
- Optional GPS locator - GPS data is printed and stored
- RS-232 port for PC interface
- Optional USB capability
- [(R+M)/2], RON, MON
- Can store up to 10 separate gasoline formula calibrations
- Small, lightweight, and easy to use
- Operates on "AA" batteries or AC Power
- Sturdy aluminum carrying case

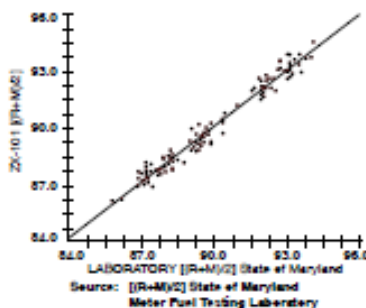
A Proven Track Record - Used Worldwide

Thousands of Zeltex Octane Analyzers prove themselves every day at major refineries, state laboratories, federal labs, military laboratories, government regulatory agencies, blending wholesalers and many other users worldwide.

Control Quality - Control Costs

Portable octane testing allows on-the-spot control and decisions that will save money and time - making octane control a reality.

The ZX-101XL provides accuracy and repeatability equivalent to ASTM-approved CFR engines.





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Evaluation of the ZX101™ Octane Analyzer

Glenn N. Merberg, Ph.D.



Introduction

This report contains an evaluation of the new ZX101™ Octane Analyzer from Zeltex, Inc. The data described herein were collected by independent laboratories, with the exception of the precision data, which were collected by the author. All statistics reported were calculated by the author using standard statistical functions in a commercial spreadsheet software package.

Background

Octane Testing

The octane number associated with a motor fuel is a measure of the performance of that fuel. The number does not correspond to the concentration of any one constituent in the fuel, but rather to the pre-ignition properties of the fuel as compared with *standard* fuel mixtures. The term "octane number" is derived from the fact that the standard fuels contain iso-octane.

The ASTM Standard Procedures for determination of octane numbers require the use of two Waukesha CFR engines®. The "Research Engine" runs at 600 rpm, with a controlled air mixture and temperature as defined in ASTM D 2699. The "Motor Engine" runs at 900 rpm, with a controlled air mixture and temperature, and controlled fuel temperature as defined in ASTM D 2700. Waukesha engines or "knock engines" necessarily consume the fuel sample and a series of standard fuels during the test procedure.

The octane number of a fuel is defined by the compression at which the knock intensity of that fuel is 50% of the maximum knock intensity for the engine. Pure iso-octane is defined as having an octane number of 100, while heptane is defined as having an octane number of 0. A series of standards containing heptane, iso-octane and toluene are used to define a scale between these two bounds. The Research Octane Number (RON) of a fuel is the octane number measured on the Research Engine. Similarly, the Motor Octane Number (MON) is that number determined by the Motor Engine. The octane number typically posted on the pump at a service station is the average of the RON and MON (called PON, or $(R+M)/2$).

In recent years, there has been a great deal of research aimed at the development of new, more sophisticated techniques for the determination of octane number in gasolines. The method receiving the most attention has been near-infrared spectroscopy. 1-3 Several commercial devices have been developed to date. 4,5 This paper focuses on the ZX101™ Octane Analyzer from Zeltex, Inc.

The ZX101™

The ZX101™ is a portable, battery powered octane analyzer for use with gasoline. It consists of three primary components: the analyzer, a sample container and a light shield. The entire package in its carrying case weighs less than 5 kg. The instrument performs an octane number determination in less than a minute, and does not require the use of standard samples. The measurement is completely non-destructive.

The ZX101™ measures octane number via near-infrared transmission spectroscopy. The instrument contains a patented solid-state optical system, comprising 14 near-infrared emitting diodes (IREDS) with narrow bandpass filters, a silicon detector system and a fully integrated microprocessor. Figure 1 shows a schematic representation of the ZX101™. The sample holder is a sealed, flat-sided, reusable glass container with an optical pathlength of 75 mm. The sample volume is approximately 225 ml.



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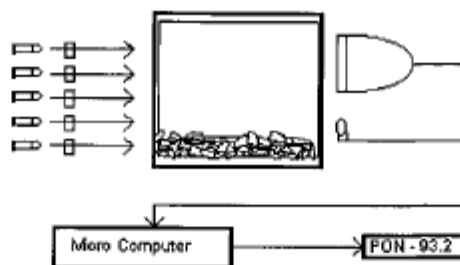


Figure 1
Schematic Diagram of ZX101C Optical System

To make an octane number determination, the user acquires a background signal from the empty sample chamber, measures the absorption spectrum of the sample twice, then acquires a second background signal. The entire process requires less than a minute, and can be performed by untrained, unskilled personnel.

Near-infrared spectroscopy

The near-infrared (NIR) spectral region is usually defined as that portion of the spectrum with wavelengths in the range 700 to 2500 nm. In this spectral region, overtone frequencies of molecular vibrations absorb light quite readily. Because the overtone absorption bands are typically wide and overlapping, spectroscopists cannot merely measure peak heights to perform quantitative analysis. Instead, multivariate regression analyses are utilized to correlate spectral features with concentrations or physical properties of interest.

The ZX101™ operates in the short-wavelength NIR, from 800 to 1100 nm wavelength. The instrument is factory calibrated to predict octane number (RON, MON and PON) from the absorption spectra of the fuels being tested. This prediction is accomplished through the use of a multivariate regression equations of the form:

$$\text{Octane number} = K_0 + K_1 (OD1) + K_2 (OD2) \dots + K_{14} (OD_{14}) + K_{15} (T_a)$$

where K_0 is a bias term, K_1 through K_{15} are slope coefficients, $OD1$ through OD_{14} are the absorbencies measured at each of the 14 wavelengths, and T_a is the ambient temperature at the time of the test.

The instrument can store up to 10 calibration equations, and is factory calibrated for RON, MON and PON of blended gasolines.

Features of the ZX101™

The ZX101™ has several features that safeguard against erroneous readings.

- *High Variance Warning* - triggered if repeat measures for a given sample exceed some preset value.
- *Temperature Warning* - triggered if the analyzer is used outside of the recommended temperature range (15° to 45° C).
- *Out of Range Warning* - triggered if the sample being tested is outside the range of the calibration range of the ZX101™.
- *Curve Checking* - triggered if the optical spectrum of the current sample is atypical of gasoline samples stored in the unit.



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Limitations imposed by CFR engine testing

Quantitative NIR spectroscopy is a secondary technique, in that results are generated through regression equations that model the output of some primary method of analysis. In the case of octane testing, the primary method of analysis is the CFR engine.

A secondary method can never show better accuracy than the precision of the primary method. This is true because accuracy cannot be determined beyond the bounds set by the primary method. In the case of CFR engine testing, the limitations are as summarized in Table I. In this context, reproducibility describes the ability of a an engine to generate the same result for a given fuel after being shut down then restarted and used by a new technician. Repeatability describes the ability of an engine to generate the same result for a fuel sample in successive tests. The 95 % confidence interval corresponds to roughly two times the standard deviation of measurement (2σ) for large numbers of re-tests.

Table I: ASTM Specifications for CFR Engine Testing

	As per procedure	Reproducibility (95% confidence)	Repeatability (95% confidence)	At Octane number
RON	2699	± 0.7	± 0.2	95
MON	2700	± 0.9	± 0.3	85

Validation Studies

State Sponsored Octane Screening

An increasing number of state governments are requiring filling stations to undergo octane testing. Stations caught selling fuels with octane numbers significantly different from the values posted on the pump are fined, and in some cases closed down.

In a traditional test, gasoline samples are collected from various filling stations and brought back to the laboratory for testing on CFR engines. The testing is necessarily time consuming and expensive. For this reason, many states have begun using the ZX101™ to perform on-site octane screening. The ZX101™ makes octane determinations in seconds, and eliminates the tremendous expense of CFR testing.

During one recent survey, the State of Maryland (Jessup, MD) collected 161 gasoline samples from various filling stations. The samples were each measured with the ZX101™, and then tested on both the Research and Motor CFR engines. Figures 2, 3 and 4 contain scatterplots of the RON, MON and PON of these samples as measured by the ZX101™ and CFR engines. A statistical summary of the data is presented in Table II.

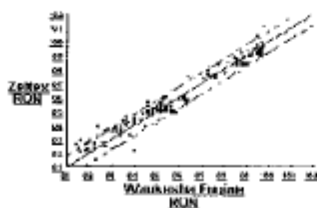


Figure 2
State of Maryland RON

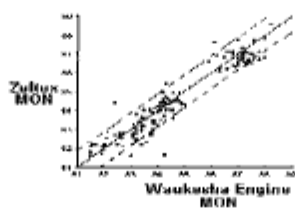


Figure 3
State of Maryland MON

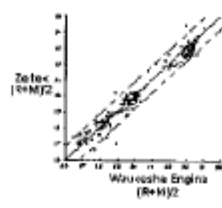


Figure 4
State of Maryland (RON)



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It is important to note that the properties of gasoline blends are engineered specifically for various climates through the use of additives. The gasoline samples tested by the State of Maryland represented a wide variety of fuels, with vastly different properties. For example, the sample set contained fuels with vapor pressures ranging from 10.6 (B-type mild-temperature gasoline) to 15.4 (higher than allowed in E-type cold-weather gasoline), and MTBE additive concentrations ranging from 0.2 to 16 volume %. While no statistical analyses were performed to correlate additive concentrations or vapor pressures with prediction errors, a cursory examination of the data does not indicate that any strong correlation existed.

In an independent survey, the Commonwealth of Virginia (Richmond, VA) collected 163 gasoline samples. As with the Maryland study, the samples were brought to the state laboratory and tested with the ZX101™ and CFR engines. Figure 5 shows the calculated PON as measured with the ZX101™ and the CFR engines. A statistical summary of the data is presented in Table II.

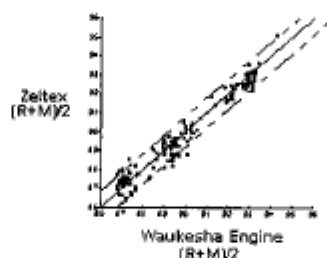


Figure 5
Commonwealth of Virginia (R+M)/2

The results of both of these validation studies show that the ZX101™ provides sufficient accuracy for the screening of gasoline samples from filling stations.

Octane Exchange Group

Laboratories that make use of CFR engines typically belong to one or more “Octane Exchange Groups” (OEG). These groups circulate gasoline samples to the member laboratories, and compile statistics about the octane numbers determined for similar samples by different laboratories. The purpose of the exchange groups is to allow laboratories to confirm that their engines are generating accurate data.

Zeltex™ recently participated in one OEG’s round-robin test. A set of 20 samples was provided to Zeltex™ with no laboratory data. The samples were measured on the ZX101™, and the results returned to the OEG.

Later, the compiled laboratory values for RON and MON as determined by the OEG were returned to Zeltex™. Scatterplots for RON, MON and PON, as determined by both the ZX101™ and the OEG are shown in Figures 6, 7 and 8, respectively. A statistical summary of the data is presented in Table II.



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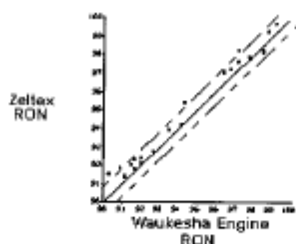


Figure 6
Octane Exchange Group RON

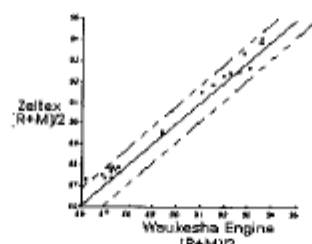


Figure 8
Octane Exchange Group (R+M)/2

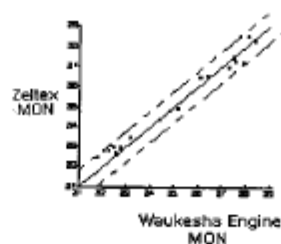


Figure 7
Octane Exchange Group MON

Because the initial calibration in the ZX101™ was performed with one set of CFR engines, it is possible that the instrument may produce results that have a relative bias to other sets of CFR engines. For this reason, the ZX101™ is generally slope and bias corrected upon installation to provide results that are compatible with the customer's CFR engines. The OEG round-robin test did not afford Zeltex™ the opportunity to perform slope and bias correction, as it was a blind test. However, after the test was complete, and the analytical values for all the samples were known, slope and bias correction were performed. The statistical analysis the corrected data is summarized in the last section of Table II. Note that the slope and bias corrected data provide only a best-fit model for the ZX101™ predicted data to the CFR engine data.

Table II.
Table II: Summary of Validation Studies

Test Site	Test Type	Standard Error of Estimate	Correlation
Maryland	RON	0.55	0.97
	MON	0.59	0.95
	PON	0.46	0.98
Virginia	PON	0.49	0.98
OEG	RON	0.66	0.98
	MON	0.47	0.98
	PON	0.47	0.98
OEG (Slope and Bias corrected)	RON	0.45	0.99
	MON	0.39	0.99
	PON	0.30	0.99

Precision Studies

In order to assess the precision of the ZX101™, the author obtained an instrument from the manufacturer and performed two experiments. In the first test, a single user tested a single sample 25 times in succession. The second experiment utilized 5 different technicians to test a single sample 5 times each.

For each experiment, the mean, standard deviation and range were calculated. Tables III and IV summarize the results of these tests. The 95% confidence intervals are calculated using a Student's t distribution with 24 degrees of freedom ($\alpha/2 = 2.064$).

Table III: Precision Study; 25 retests by a single user



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	RON	MON	(R+M)/2
Mean Value	98.4	87.9	93.2
95% Confidence	± 0.25	± 0.12	± 0.12
Maximum Reading	98.6	88.1	93.3
Minimum Reading	98.2	87.8	93.1

Table IV: Precision Study; 25 retests (5 by each of 5 users)

	RON	MON	(R+M)/2
Mean Value	98.5	87.9	93.2
95% Confidence	± 0.25	± 0.12	± 0.10
Maximum Reading	98.7	88.1	93.3
Minimum Reading	98.1	87.8	93.1

Summary

The ZX101™ was demonstrated to be an effective tool for the measurement of octane number in gasoline samples. Three independent studies provide validation of the instrument's utility.

The instrument is extremely easy to use, portable, fast and inexpensive. A typical analysis takes less than a minute and requires no standard fuels or experienced personnel.

In general, the users seemed extremely satisfied with the ZX101™, and had already integrated the instrument into their regular octane testing program. Many commented that the ZX101 provided tremendous cost savings by drastically reducing the number of CFR engine tests.

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