

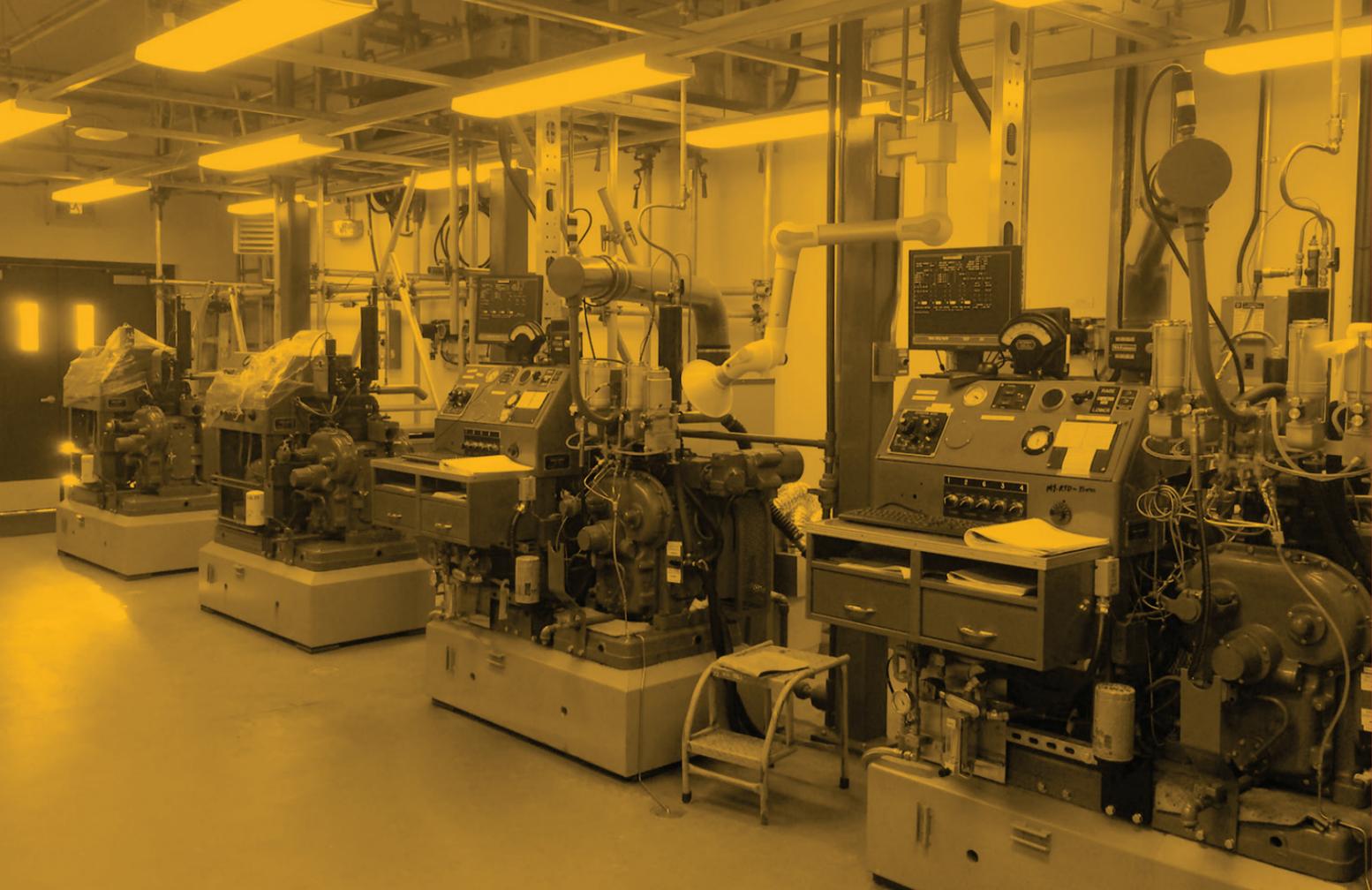
Our System Helps  
**Reduce Octane Giveaway**

Translating To Significant  
**Savings For Our Clients**



**ESD**  
A PROTECTOSEAL COMPANY

**HIGH ACCURACY**  
OCTANE ANALYZERS



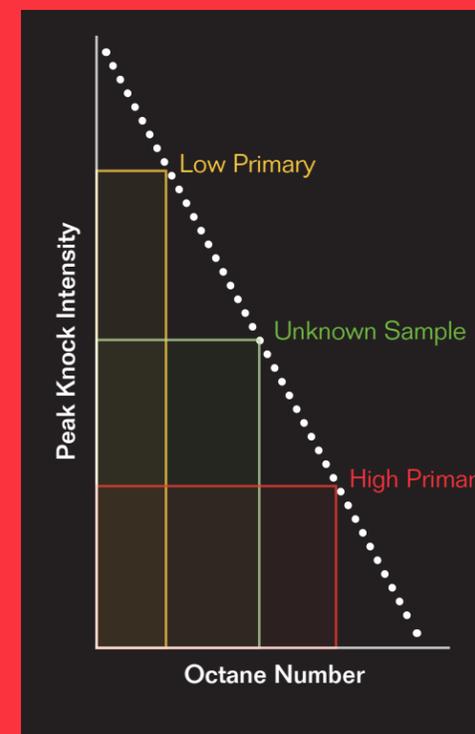
**The Protectoseal | ESD System meets stringent industry standards and delivers it with industry's highest level of customer service. Adopted as "best practice" by major Oil and Gas companies, the ESD Octane Analyzer System is utilized in refineries and test laboratories around the world to achieve maximum measurement accuracy and minimum octane giveaway.**

## The Falling Level Method

The ESD Analyzer Systems employ the well-known and proven Falling Level Method (Dynamic Fuel Level) for determining the octane number of a fuel sample. This method is documented in ASTM D2699 – Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel (Procedure B), ASTM D2700 – Standard Test Method for Motor Octane Number of Spark-Ignition Engine Fuel (Procedure B) and by reference, in ASTM D2885 – Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique.

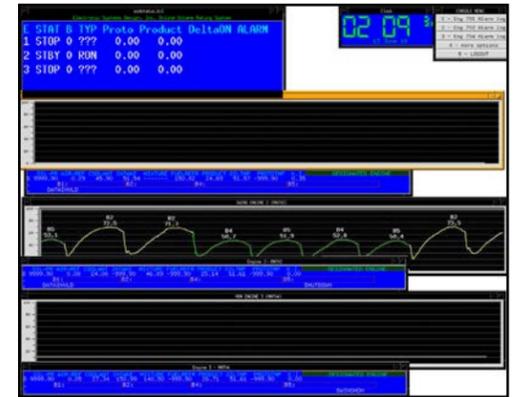
The Falling Level Method employs a specifically designed and calibrated fuel supply bowl which is filled and allowed to empty as the CFR test engine runs. The bowl design is such that a test cycle on any fuel sample can be completed in a reasonable amount of time while ensuring that a consistent and repeatable range of fuel mixtures are delivered to the engine without the need for operator intervention.

As the level in the supply bowl falls, the rate of fuel supplied to the engine decreases thereby changing the fuel / air ratio. The fuel /air ratio changes produce a change in knock intensity of the engine, passing from a light knock condition through a peak level and back to a light knock. The peak knock intensity levels of fuels with known octane numbers higher and lower than the sample fuel are plotted in a straight-line graph. The sample's octane number can then be determined by the position of its measured peak knock intensity along this plotted curve. By recording the level of the peak knock intensity and comparing this level to that of the known reference fuels, a simple straight line interpolation will yield the octane number of the unknown fuel. This Falling Level Method has been statistically proven and accepted by ASTM as a valid octane number determination procedure.



**Our system can improve site precision by increasing method repeatability, leading to reduced giveaway and increased profitability.**

*Remote monitoring terminal displaying knock curve characteristics, octane calculations and equipment status for a three engine online system.*



## System Overview

The ESD Analyzer System utilizes the dynamic ASTM Falling Level Method (Procedure B) to achieve the most effective method of determining your octane numbers. Unlike either the standard Bracketing Method (Procedure A) or the Compression Ratio Method (Procedure C), operator intervention is not required to manually change the fuel / air ratio to find the maximum knock. This function is accomplished automatically by the falling level of the fuel in the specially designed bowl. In addition, the test sequence, documentation as well as octane calculations are all software driven and not operator dependent. In operations with multiple operators responsible for conducting octane testing, the ESD Analyzer can improve site precision by increasing method repeatability, leading to reduced giveaway and increased profitability. Internal testing conducted by a major oil and gas company found that precision is better utilizing the Bracketing Methods by as much as 0.2 octane of the fuel being measured compared to the compression ratio method.

Two configurations of the ESD Analyzer systems are offered: an on-line as well as lab versions. The on-line system provides valuable, real-time feedback to allow the refinery's blending operations to make appropriate adjustments.

The lab systems allow users to conduct testing of discrete samples in an accurate and efficient manner.

Each system uses a server with RAID hard drives running a UNIX/ LINUX-based operating system for maximum reliability. A scanner program continuously reads all input signals and maintains an accurate moving average of all variables, resulting in precise, noise-free data acquisition. The database generated by the ESD analyzer can be customized by our expert software engineers for each installation and based on the customer's specific requirements.

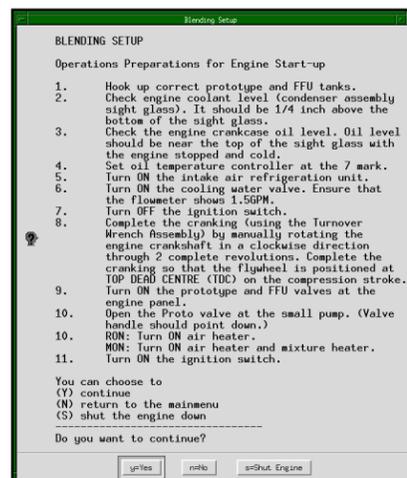
### Key Features and Benefits

- Falling level procedure ensures maximum precision resulting in reduced octane giveaway
- Software driven test sequencing, data capture and reporting, minimizing operator errors and variability
- Configurable to run tests on multiple engines simultaneously
- Built-in hardware redundancy for increased reliability
- Individual operator terminal with supervisory function capabilities
- Uninterruptible power supply for server(s) to avoid costly downtime
- Lockable instrument cabinet with easy viewing window
- Systems require minimal maintenance, most of which can be performed in-house

## On-Line System

The On-Line ESD Analyzer System is particularly appropriate for larger refineries where there is little or no time to stop production to make batch corrections to the blend. Sample fuel is drawn directly from the production stream and delivered to the engine. The octane number for each fuel is determined and the system reports in a continuous manner, the difference between the production fuel and the reference fuel (as prescribed by ASTM D2885 –Standard Test Method for Determination of Octane Number of Spark-Ignition Engine Fuels by On-Line Direct Comparison Technique). The analyzer continuously provides critical information to the blend computer so that necessary adjustments can be made real-time.

*Customized engine start up checklist. Used to ensure safe and consistent equipment operation.*



**Blending Setup**

BLENDING SETUP

Operations Preparations for Engine Start-up

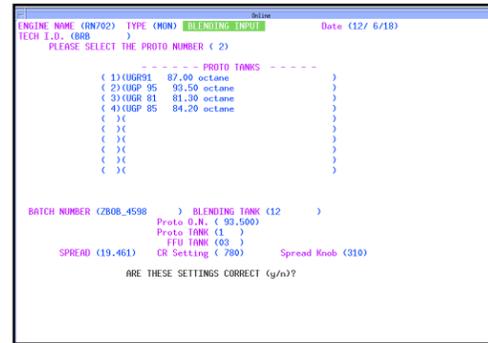
1. Hook up correct prototype and FFU tanks.
2. Check engine coolant level (condenser assembly sight glass). It should be 1/4 inch above the bottom of the sight glass.
3. Check the engine crankcase oil level. Oil level should be near the top of the sight glass with the engine stopped and cold.
4. Set oil temperature controller at the 7 mark.
5. Turn ON the intake air refrigeration unit.
6. Turn ON the cooling water valve. Ensure that the flowmeter shows 1.5GPM.
7. Turn OFF the ignition switch.
8. Complete the cranking (using the Turnover Wrench Assembly) by manually rotating the engine crankshaft in a clockwise direction through 2 complete revolutions. Complete the cranking so that the flywheel is positioned at TOP DEAD CENTRE (TDC) on the compression stroke.
9. Turn ON the prototype and FFU valves at the engine panel.
10. Open the Proto valve at the small pump. (Valve handle should point down.)  
ROM: Turn ON air heater.  
MON: Turn ON air heater and mixture heater.
11. Turn ON the ignition switch.

You can choose to  
(Y) continue  
(N) return to the main menu  
(S) shut the engine down

Do you want to continue?

Yes No Shut Engine

*Blending setup screen for an on-line system. The operator uses this screen to set the parameters for the blend process.*



ENGINE NAME (ON702) TYPE (MON) BLENDING TANK Date (12/ 6/18)  
TECH L.D. (BRB)

PLEASE SELECT THE PROTO NUMBER ( 2 )

----- PROTO TANKS -----

( 1 ) (UGP91	87.00 octane	)
( 2 ) (UGP 95	92.50 octane	)
( 3 ) (UGP 81	81.30 octane	)
( 4 ) (UGP 85	84.20 octane	)
( 5 )		)
( 6 )		)
( 7 )		)
( 8 )		)
( 9 )		)
( 10 )		)

BATCH NUMBER (ZB08\_4598) BLENDING TANK (12)

Proto O.N. ( 93.500 )  
Proto TANK ( 1 )  
FFU TANK ( 03 )  
SPREAD (19.461) CR Setting ( 780 ) Spread Knob (310)

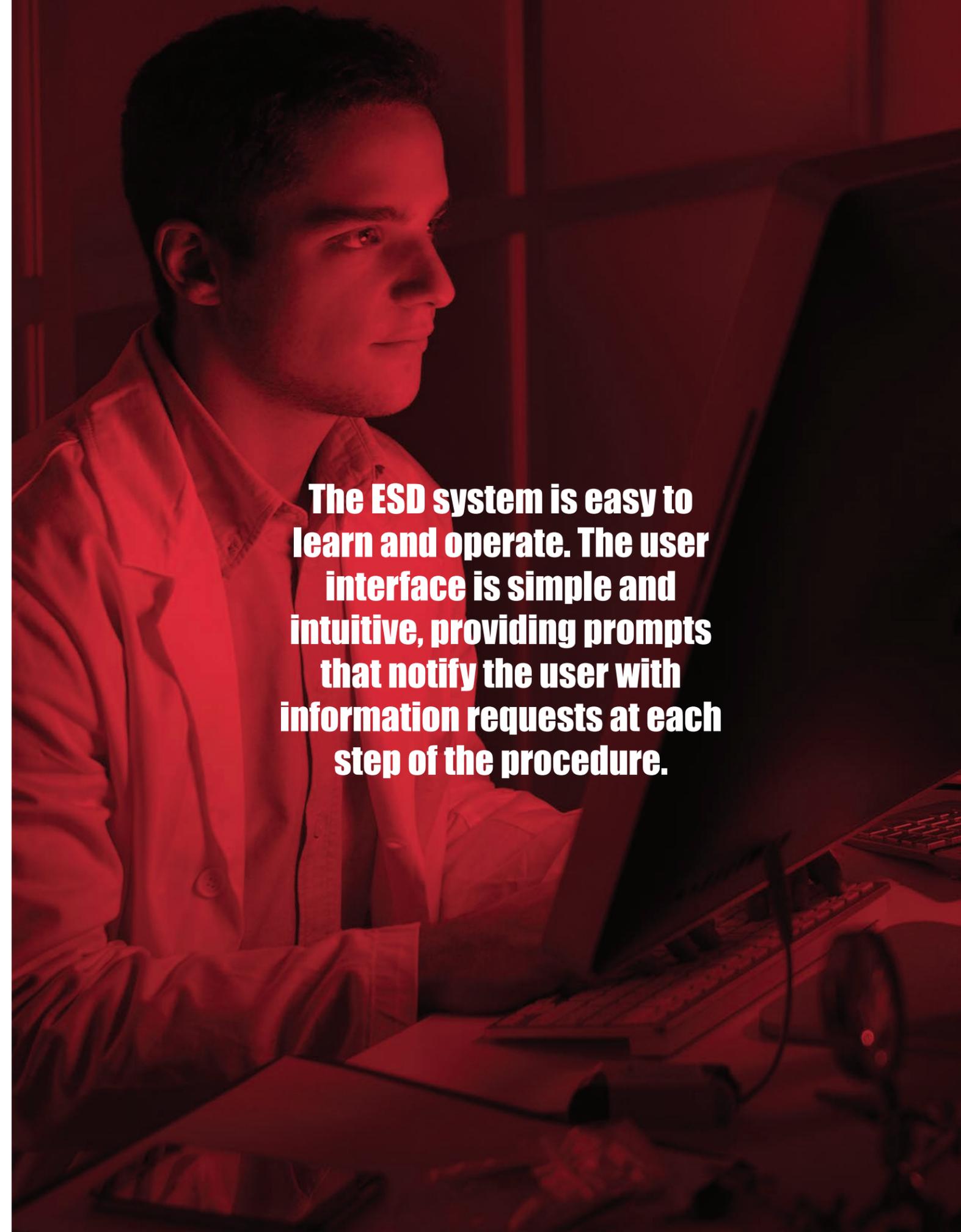
ARE THESE SETTINGS CORRECT (y/n)?

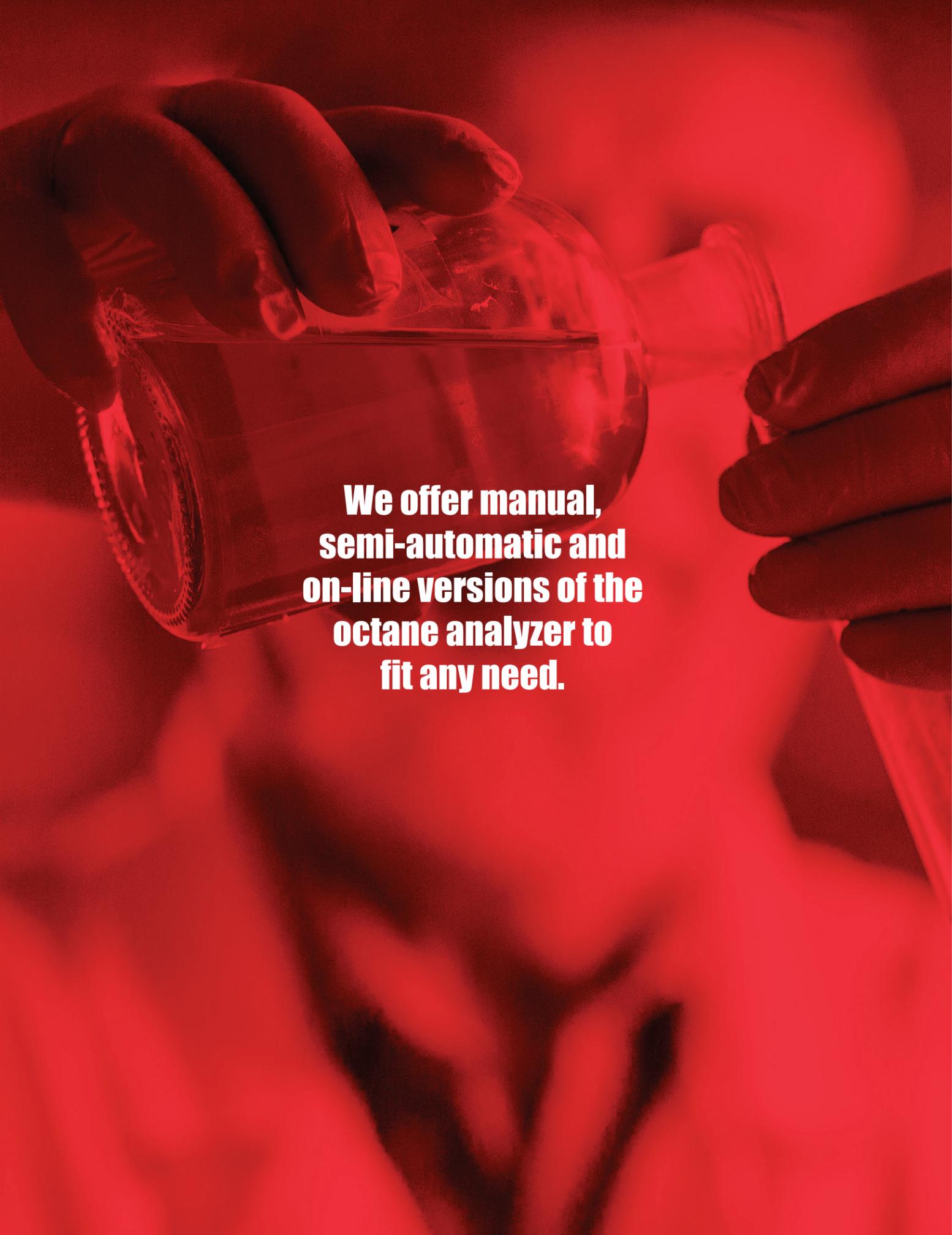
The on-line analyzer includes six fuel supply bowls. These are filled, analyzed, emptied and refilled automatically by the system, in the appropriate sequence, to provide the desired information. This information can be communicated to the refinery's blend computer via Modbus. Users can achieve economies of scale by using a central server, configured to handle testing on multiple engines.

### Key Features and Benefits

- The on-line analyzer provides real time feedback of blend quality.
- Customer specified process control signals are sent directly to the DCS.
- Controlled data entry with a complete historical record for maximum traceability.
- Proto fuel certification, ASTM system checkout, NEG checkout and quality control analysis operations are available at each terminal.
- Stainless steel ultrasonic level sensors assure repeatable fill levels.
- Flow through fuel bowls is controlled by software driven solenoids for optimal response time.
- Automatic scheduled backups on the active/primary server.
- Backup server can be made operational in under 10 minutes
- Detailed customized reports can be viewed, printed or exported to removable media for analysis

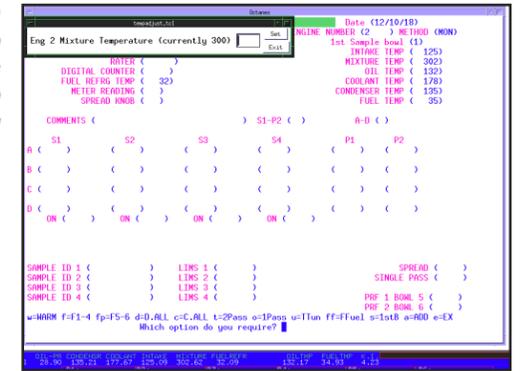
**The ESD system is easy to learn and operate. The user interface is simple and intuitive, providing prompts that notify the user with information requests at each step of the procedure.**





**We offer manual, semi-automatic and on-line versions of the octane analyzer to fit any need.**

*Sample rating screen with temperature control pop-up window shown. This screen is used by operator to set up a sample rating using a lab system.*



## Lab Systems

For batch testing, a laboratory ESD Analyzer is offered in either a manual or a semi-automatic version. The Manual Laboratory ESD Analyzer System is appropriate for use when smaller numbers of fuel samples are to be analyzed and determining the octane accuracy is the main requirement. The Semi-Automatic version is well suited to refineries that are blending directly into holding tanks and taking samples from these tanks for analysis and achieving maximum throughput. Semi-automatic lab systems are also found in state, research and development and independent testing laboratories.

### Manual Testing Sequence.

The standard manual lab system comes equipped with four fuel supply bowls. The operator fills two of the bowls with primary reference fuels (PRF). One of the bowls is used to warm up the engine. The remaining bowl is manually filled with the sample fuel. The operator then starts the system and the fuels are manually fed into the test engine, in sequence, until the maximum knock intensity for each is determined.

At this point, the octane number of the sample fuel is calculated and displayed. If a two pass analysis is required, as per ASTM D2699 and ASTM D2700, the bowls must be manually emptied and refilled. The operator has the option to repeat, delete or add additional runs on any of the bowls as necessary.

### Semi-Automatic Testing Sequence.

The Semi-Automatic lab system is equipped with six fuel bowls. The operator fills two of the bowls with primary reference fuels (PRF) that are at most two octane numbers apart. The remaining bowls are filled with up to four samples, all within the range of the two PRF fuels. The operator then starts the system and the fuels are automatically fed to the test engine, in sequence, until the maximum knock intensity for each is determined. The octane number the each sample fuel is calculated and displayed accordingly.

### Key Features and Benefits

- Lab Systems retain all of the measurement performance of the on-line system
- Can automatically send test results electronically to user's LIMS
- With the ESD Combo Bowls, the Manual Laboratory System can be configured so that operators can perform all three ASTM testing procedures
- Detailed customized reports can be viewed, printed and/or exported to removable media for analysis

# Alarms and Report Generation

## Engine Parameters and Associated Alarms & Warning

The ESD Analyzer Systems monitor a whole host of standard and optional engine parameters to ensure that the operating conditions are optimal to perform the most accurate and consistent octane measurements. The systems are delivered with alarms and warnings set to limits consistent with the relevant ASTM specifications.

Changes to these default limits can easily be made by the customer, as required. Alarms are considered more serious than warnings; their occurrence requires corrective action before measurements can continue. Some alarms act as backup to the safety system provided by the engine manufacturer. Alarms and warnings are both displayed and must be cleared by the operator.

Engine Parameters:	On-line System	Lab System Semi-Automatic	Lab System Manual
Engine coolant temperature	S	S	S
Intake air temperature	S	S	S
Mixture temperature (MON)	S	S	S
Fuel refrigerant temperature	S	S	
Oil temperature	S	S	S
Fuel temperature	S	S	
Knock intensity (K.I.)	S	S	S
Oil pressure	S	S	O
Humidity	O	O	O
Barometric pressure	O	O	O
Oil pressure (switch)	O	O	O
Water pressure (switch)	O	O	O
Water level (switch)	O	O	O
Condenser temperature	S	S	O
Product pressure (switch)	O		

Alarms:	On-line System	Lab System Semi-Automatic	Lab System Manual
Coolant temperature over 220° F*	S	S	S
Oil pressure under 20 PSI	S	S	O
Low oil pressure switch	O	O	O
Low water pressure switch	O	O	O
Low water level switch	O	O	O
Condenser temperature over 165° F*	S	S	O
QC bowl became full during blending (indicates level sensor failure)	S		
Oil pressure out of operating range	S	S	O
Product O.N. out of range	S		
No peak K.I. found after two attempts	S		
Proto K.I. over 80 or under 20*	S		
Product K.I. over 99 or under 10*	S		
Any abnormal exit from blending screen	S		
K.I. over 99 or under 10*	S		

\* User configurable limits

Warning limits	On-line System	Lab System Semi-Automatic	Lab System Manual
Excessive proto drift from previous proto measurement	S		
Any temperature out of operating limits	S	S	S
Rate of change of delta O.N. too large	S		
Out of fuel warning	S		
Delta octane out of user-specified range	S		
Product pressure low	O		

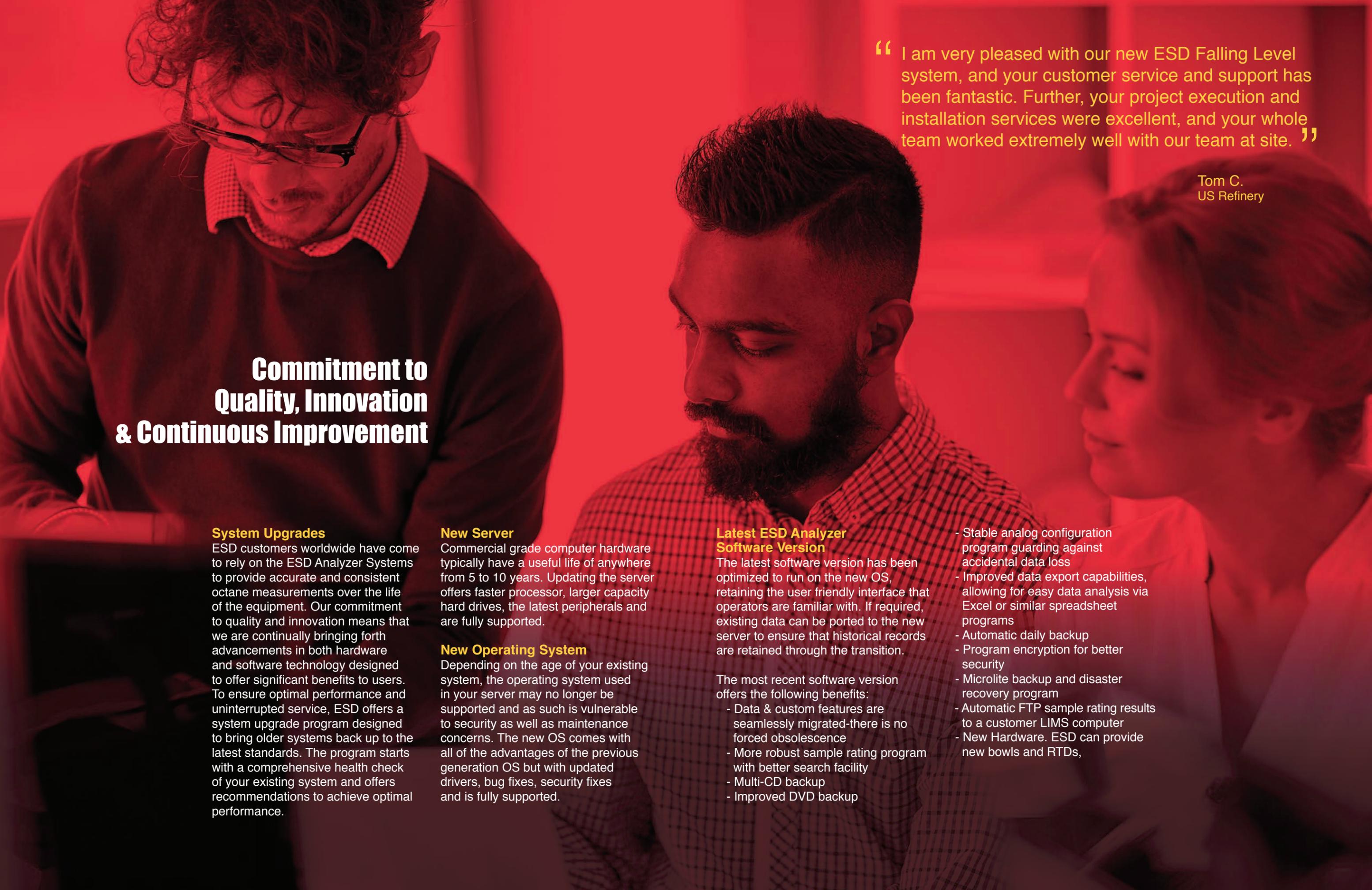
S : standard , O : optional



## Report Generation

A key feature of the ESD Analyzer systems is its comprehensive report generation capabilities. An extensive list of reports come standard with the delivered system. These standard reports are customizable and if necessary, optional reports can be created to meet the specific needs of the individual user. Reports may optionally be exported to readable media (CD, DVD-ROM, USB memory stick).

Comprehensive Report Generation:	On-line System	Lab Systems
<b>Blend History Report</b> • Detailed record of each blend • Graphs of blend results: delta O.N., Proto K.I.	X	
<b>System Configuration Reports</b> • Customer-changeable parameters, their current values and ranges • Sensor calibration and alarm / warning limits	X	
<b>Proto Tank Definitions Report</b> • O.N., ID, tank #, correlation to reference fuel used to rate, etc.	X	
<b>Pre-Blend Checkout Report</b> • Pre-blend (SQC) runs, with details	X	
<b>ASTM Checkout Report</b>	X	
<b>Proto Certification Report</b>	X	
<b>Historical Pre-Blend Checkout Report</b> • Archived SQC reports associated with proto fuels no longer used	X	
<b>Current Spread Table</b>	X	
<b>Spread Run Report</b>	X	
<b>Historical ASTM Checkout, Proto Rating and Spread Run Reports</b>	X	
<b>NEG Exchange Fuel Rating Report</b>	X	
<b>Graphs of Blend Results</b>	X	
<b>Alarm Log Report per Engine</b>	X	
<b>Detailed Log of Internal System Operations</b>	X	X
<b>Measurement Results Report</b> • Report may be optionally printed (user-selectable) at the conclusion of each test • Historical reports of all ratings made by system are available for the life of the system		X
<b>Summary Results Report, sorted by date or ID</b> • Provides summary of all tests performed over a given date range, including re-tests		X
<b>Detailed Summary Results Report, sorted by date or ID</b> • Same as above but with additional details and measurement parameters		X
<b>Sensor Calibration and Alarm / Warning Limits Report</b>		X



## Commitment to Quality, Innovation & Continuous Improvement

### System Upgrades

ESD customers worldwide have come to rely on the ESD Analyzer Systems to provide accurate and consistent octane measurements over the life of the equipment. Our commitment to quality and innovation means that we are continually bringing forth advancements in both hardware and software technology designed to offer significant benefits to users. To ensure optimal performance and uninterrupted service, ESD offers a system upgrade program designed to bring older systems back up to the latest standards. The program starts with a comprehensive health check of your existing system and offers recommendations to achieve optimal performance.

### New Server

Commercial grade computer hardware typically have a useful life of anywhere from 5 to 10 years. Updating the server offers faster processor, larger capacity hard drives, the latest peripherals and are fully supported.

### New Operating System

Depending on the age of your existing system, the operating system used in your server may no longer be supported and as such is vulnerable to security as well as maintenance concerns. The new OS comes with all of the advantages of the previous generation OS but with updated drivers, bug fixes, security fixes and is fully supported.

### Latest ESD Analyzer Software Version

The latest software version has been optimized to run on the new OS, retaining the user friendly interface that operators are familiar with. If required, existing data can be ported to the new server to ensure that historical records are retained through the transition.

The most recent software version offers the following benefits:

- Data & custom features are seamlessly migrated-there is no forced obsolescence
- More robust sample rating program with better search facility
- Multi-CD backup
- Improved DVD backup

- Stable analog configuration program guarding against accidental data loss
- Improved data export capabilities, allowing for easy data analysis via Excel or similar spreadsheet programs
- Automatic daily backup
- Program encryption for better security
- Microlite backup and disaster recovery program
- Automatic FTP sample rating results to a customer LIMS computer
- New Hardware. ESD can provide new bowls and RTDs,

“ I am very pleased with our new ESD Falling Level system, and your customer service and support has been fantastic. Further, your project execution and installation services were excellent, and your whole team worked extremely well with our team at site. ”

Tom C.  
US Refinery



## “Concierge” Customer Service Experience

A key strength of ESD is our organization’s commitment to quality and the delivery of the best customer experience possible. With over 25 years of industry experience and through the development of close partnerships with our customers worldwide, ESD offers solutions and services tailored to your specific needs.

**Customization:** Customizable user interface allows the system to be integrated into a site’s work process with minimal impact. In addition to the large selection of standard reports, customizable reports are also available.

**Installation and Commissioning Service:** On-site installation and commissioning services by our expert engineers and technicians will ensure a high degree of operational reliability.

**Operator Training:** Classroom and hands-on training at the engine are designed to ultimately achieve the objective of operator / user confidence. The training program is structured around ESD’s falling level system and tying it back to ASTM D2699 and D2700 Procedure B.

**Industry leading Technical Support:** Our Customer Commitment Team are technical experts in the field, responsive and ready to provide personalized solutions.

**Warranty:** The Protectoseal ESD Analyzer System comes with a 1 year parts warranty. Extended parts and service warranties are available on request.



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