

## S A F E T Y

The operating of engine tests can expose personnel and facilities to a number of safety hazards. It is recommended that only personnel who are thoroughly trained and experienced in engine testing should undertake the design, installation and operation of engine test stands.

Each laboratory conducting engine tests should have their test installation inspected and approved by their Safety Department. Personnel working on the engines should be provided with the proper tools, be alert to common sense safety practices, and avoid contact with moving and/or hot engine parts. Guards should be installed around all external moving or hot parts. When engines are operating at high speeds, heavy duty guards are required and personnel should be cautioned against working alongside the engine and coupling shaft. Barrier protection should be provided for personnel. All fuel, oil lines and electrical wiring should be properly routed, guarded, and kept in good order. Scraped knuckles, minor burns and cuts are common if proper safety precautions are not taken. Safety masks or glasses should always be worn by personnel working on the engines and no loose or flowing clothing should be worn near running engines.

The external parts of the engine and the floor area around the engines should be kept clean and free of oil and fuel spills. In addition, working area should be free of all tripping hazards. In case of injury, no matter how slight, first aid attention should be applied at once and the incident reported. Personnel should be alert for leaking fuel or exhaust gas. Leaking fuel represents a fire hazard and exhaust gas fumes are noxious. Containers of oil or fuel cannot be permitted to accumulate in the testing area.

The test installation should be equipped with a fuel shut-off valve which is designed to automatically cut off the fuel supply to the engine when the engine is not running. A remote station for cutting off fuel from the test stand is recommended. Suitable interlocks should be provided so that engine is automatically shut down when any of the following events occur: engine or dynamometer loses field current, engine overspeeds, exhaust system fails, room ventilation fails or the fire protection system is activated. Consider an excessive vibration pickup interlock if equipment operates unattended. Fixed fire protection equipment should be provided.

ASTM Sequence Tests use chemicals to flush engines between tests. Some of these chemicals, for example Oakite Rust Stripper, require that personnel wear face masks, dust breathers, and gloves as exothermic reactions are possible. Emergency showers and face rinse facilities should be provided when handling such materials.

The undiluted ethylene glycol type coolant used in the Sequence IIIC test presents a special fire hazard. Coolant hoses and clamps should be selected and installed with special care to prevent leaks and spills since ethylene glycol may ignite when it contacts hot exhaust system components. Dry chemical fire extinguishers should be available at the test stands to extinguish any coolant fires. Water is not recommended for use on these fires.

G L O S S A R Y

Blowby	That portion of the combustion reactants and unburned air-fuel mixture which leak into the engine crankcase during operation of the engine.
Clogging	Restriction of a flow path due to the accumulation of debris along the flow path boundaries.
Corrosion	Any observed chemical attack on the metal parts. Rust is a special case of the corrosion of iron.
Lifter, stuck	One that does not return to its original position by its own force upon removal from the engine.
Ring, free	One that falls of its own weight from side to side in its own groove.
Ring, stuck	One that is either partially or completely bound in its groove.
Ring, tight	One that offers resistance to movement in its groove, but which can be pressed into or out of the groove under finger pressure without springing back.
Rumble	An abnormal combustion phenomenon that is characterized by an audible throbbing sound resulting from crankshaft vibration.
Rust	The chemical combination of oxygen with ferrous engine parts, including other iron complexes not removable by organic solvents.
Scoring	A condition resulting from metal to metal contact or foreign matter causing surface roughness in the direction of relative motion characterized by dragging and smearing of the material of one or both surfaces.
Scuffing	Adhesive wear which is the result of progressive removal of material from a rubbing surface caused by localized welding and subsequent fracture.
Sludge	A deposit, principally composed of engine oil and fuel debris, which does not drain from engine parts but can be removed by wiping with a soft cloth.
Varnish	A hard, dry, generally lustrous oil insoluble deposit which cannot be removed by wiping with a soft cloth.
Wear	The loss or relocation of material from two or more surfaces in relative motion.

P R E C I S I O N   I N F O R M A T I O N  
I N  
T H I S   D O C U M E N T

Reproducibility data included in this STP were developed using different guidelines from those set forth in the current ASTM D-2 Precision Manual as necessitated by the required test durations and equipment differences.

The reported reproducibility data are generally valid within the scope of the standardized engine testing procedures. Conversely, repeatability as defined in the current ASTM D-2 Precision Manual is inapplicable to engine testing practice.

## GLOSSARY OF SYMBOLS AND TERMS\*

<u>Symbol</u>	<u>General Meaning</u>
n	The number of test runs (observations)
k	The number of paired test runs (repeat runs made using the same oil, same procedure, same laboratory, etc.)
$\bar{X}$	The arithmetic mean or average
$\Delta \bar{X}$	Two results must differ by more than this amount to be significantly different at the 90 percent CL
s	An estimate of the true standard deviation in a finite set; any finite set is considered to be a sub-set from the infinite set
$s^2$	An estimate of the true variance in a finite set; any finite set is considered to be a sub-set from the infinite set
df	Degrees of Freedom
V	Coefficient of Variation
d	The difference (delta) between duplicate measurements
r	Repeatability; the measure of precision within a single laboratory
R	Reproducibility; the measure of lab-to-lab precision
P	Probability
m	Multiplier of the estimate of the standard deviation for calculating the greatest difference between two results at the 95 percent confidence limit
CL	Confidence limits; 90 or 95 percent confidence limits are used in the STP and each are shown where applicable
F	The F distribution (ratio) describes the behavior of the ratio of two Chi squared variables; it is used for comparing two sample variances
"t"	"Student's t"; the ratio of the difference between the averages to the standard deviation of this difference; used for comparing sample means by assuming equality of variances

\*The symbols and terms shown are those generally used in the statistical analysis of results from standardized engine testing.