Machinery Fault Simulator Lite

MFS-LT

A ValuableTool for Learning Machinery Diagnosis

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Machinery Fault Simulator Lite (MFS-LT)

Features:

- Simple methods for introducing controlled and calibrated faults.
- Study the vibration spectra of common faults, learn fault signatures and validate rules provided in training courses.
- Bench top machine for hands-on training and skill sharpening.
- Learn machine condition monitoring and predictive maintenance.
- Manual with exercises for individually paced study.
- Learn resonance and variable speed diagnostics.
- Learn to determine vibration transmission path and perform root-cause analysis.
- Validate balancing procedures above and below the first critical resonance.

Applications:

- Balance training
- Shaft alignment training
- Alignment system assessment
- Coupling studies
- Bearing faults and load effects
- “Cocked” rotor
- Eccentric rotor
- Resonance studies
- Sleeve bearing studies
- Mechanical rub
- Foundation studies
- Signal processing techniques
- Bent shaft
- Variable speed/load effects
- Rotor dynamics
- Operating deflection shape and modal analysis
- Vibration training
- Analyst certification

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A Versatile Tool for Protecting Your Machinery Investment

Condition-based predictive maintenance (PdM) is a reliable, cost-effective technique for monitoring and diagnosing machinery faults before they irreversibly damage your machinery and cause breakdowns that threaten to undermine product quality, delivery and overall customer service. The success of any PdM program ultimately depends on how accurately and easily the vibration spectra, waveforms and phase relationships can be analyzed and understood. Spectra Quest's Machinery Fault Simulator - Lite (MFS-LT) is an innovative tool to study the signatures of common machinery faults without compromising production schedule or profits. The bench-top system has a spacious modular design featuring versatility, operational simplicity, and robustness. Each component is machined to high tolerances so it can be operated without conflicting vibration. Then, various faults can be introduced either individually or jointly in a totally controlled environment, making the MFS-LT a good tool for learning machinery diagnosis.

A Valuable Tool for Learning Machinery Diagnosis

To gain an in-depth understanding of different vibration signatures, controlled experiments on a device that emulates real world machinery are needed. While analysis of a single machinery fault may be beneficial, there are many occasions when the analysis of the interaction between dynamic stiffness, resonance, and speed is essential in order to gain an understanding of real world vibration spectra. With the MFS, the expertise required to diagnose industrial machinery problems in well controlled experiments can be developed and enhanced. With a plant running at full production, it is virtually impractical to gain an understanding of the kinetics and dynamics of machinery without adversely affecting production and profits: The MFS-LT enables offline training and experimentation which in turn will minimize production downtime.

Versatility Improves Plant Efficiency

The MFS-LT meets the needs of a broad range of vibration analysts, from novice to experienced. It is an effective tool for introducing the concepts and methodologies of predictive maintenance and design considerations to engineering students. Companies can train their maintenance professionals on the MFS-LT, offering experienced technicians a way to upgrade their job skills and improve performance. Having trained vibration analysts on staff offers companies a high degree of confidence in their operating efficiency because someone on the plant floor is immediately available to ensure that machinery continues to run productively. It enables not only to predict machinery condition to maximize yields and efficiencies, but also to support planned, efficient shut downs with just-in-time parts delivery.

Smart Design Makes the Simulator Robust and Easy to Use

The MFS-LT is designed to be both versatile and easy to operate. The simulator is constructed with a split bracket bearing housing, a sliding shaft, rotors with split collar ends and couplings; all of which are designed to be easily removed and replaced between various experiments.

The MFS is both versatile and easy to operate

Basic MFS-LT Configuration and Option Kits

The MFS-LT provides a basic setup for performing experiments and learning vibration signatures of different machine malfunctions. However, a detailed investigation of particular and more advance vibration phenomena or machinery fault will require additional attachments and fixtures which are available through optional kits.

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Basic MFS-LT Configuration (LT2010)

- 1/2 HP variable frequency AC drive with multi-featured front panel programmable controller
- 3 Phase, 1/2 HP motor, pre-wired self-aligning mounting system for easy installation/removal
- Built-in tachometer with LCD display and one pulse per revolution analog TTL output for DAQ purposes
- Split bracket bearing housings with features for span reconfiguration
- Two rolling element ball bearings with squeeze lock type
- Vibration isolators mounts and base stiffener
- Two balance rotors with two rows of holes
- Alignment system with calibrated reference dials and jack bolts
- One 5/8" TGP straight steel shaft
- Impact resistant clear safety cover with safety interlock
- Balance weight kit
- Allen wrench set
- 24V Power supply
- Cover support
- Comprehensive operations manual

Training Curriculum Manual (SQI-TRCM)

- The training curriculum manual begins with textbook and basic classroom training in the fundamentals of classic machinery vibration, transducers, monitoring, signal processing, analysis, etc; from beginner to upper intermediate levels. It is both hands-on and mathematically oriented, being appropriate for both technicians and engineers.
- A wide array of laboratory exercises to be conducted on the MFS to provide a truly experiential learning environment.
- Use as a basis for accelerated course preparation and the development of vibration training program.

Eccentric Rotor (M-ER-5/8)

- Learn the effects of rotor eccentricity on vibration spectra.
- Determine relationships between eccentricity and unbalance.
- Develop techniques to locate and correct the effects of eccentricity.
- Learn the effect of varying the mass moment of inertia on vibration amplitude.
- **The kit consists of one aluminum rotor with an asymmetrically located center and one clamp collar.**

Cocked Rotor (M-CR-5/8)

- Learn the effects of a sheave that has not been fitted to the shaft properly.
- Learn vibration signature of a cocked rotor.
- Develop methods to correct cocked rotor problems.
- Learn the effect of varying the mass moment of inertia on vibration amplitude.
- **The kit consists of a cocked aluminum rotor (0.5 degree off-axis) and one clamp collar**

Coupling Type Set (M-CK-5/8)

- Learn the effects of coupling stiffness on rotor dynamics and vibration signature.
- Clarify the complexities of machinery shaft misalignment problems (spectral pattern for shaft misalignment is a strong function of coupling stiffness).
- **The kit consists of one gear, one LoveJoy, one rubber, and one rigid steel coupling.**

Centrally Bent Rotor Shaft for Balance Studies (ML-BRS-5/8)

- Demonstrate the signature of a bent shaft.
- Observe the difficulty associated with attempting to balance a rotor mounted on a bent shaft.
- Learn to cope with the alignment issues due to a bent shaft.
- **The kit consists of one 5/8" shaft centrally bent ~0.020"**

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Coupling-End Bent Rotor Shaft For Alignment Studies (ML-CBRS-5/8)

- Investigate complicated vibration signature due to gyroscopic effects.
- Observe the difficulty associated with attempting to balance an overhung rotor on a bent shaft.
- Learn to cope with the alignment issues due to a bent shaft.
- **The kit consists of one 5/8" shaft coupling-end bent ~0.010"**

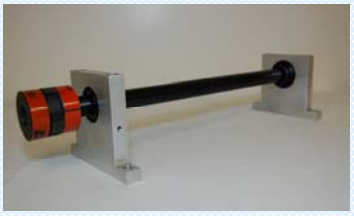
Rolling Bearing Resonance/Critical Study Kit (ML-RSK-1/2)

- Study resonance and critical speed phenomena, at speeds below 2000 RPM to simulate real world operating conditions while improving safety. The standard ¾" shaft has a high resonance frequency, 7000 RPM or more depending on rotor positions.
- Study damaging effects of resonance and develop control methods.
- Relocate rotors and supports to study the effects of mass and stiffness on resonance frequencies and mode shapes.
- Study beating due to closely spaced modes.
- Study non-linear dynamics for chaos modeling.
- **The kit consists of one ½" shaft, three rotors, two rolling element bearings, and one coupling.**

Sleeve Bearing Resonance Study Kit (M-SBK-1/2)

- Study resonance and critical speed phenomena in sleeve bearings.
- **The kit consists of two customized grease-lubricated, babbitt lined sleeve bearings, two bearing pedestals, and various thickness plastic shims.**
- Requires ML-RSK-1/2

1" Shaft Bearing Study Kit (ML-BSK-1)



- Study bearing fault frequencies away from multiples rotational speed. The standard 5/8" shaft exhibit fault frequencies close to multiples rotational speed, requiring ultra high resolution spectra to clearly identify bearing fault frequencies.
- Identify bearing fault frequencies in the presence of defects at multiples of shaft speed without using high-resolution spectra.
- Understand the signal processing issues such as averaging, spectral resolution, and leakage phenomena.
- **The kit consists of two split bearing housings, two 1" inside diameter bearings, two 6" aluminum rotors with 36 threaded holes, one 1" diameter shaft, and one coupling.**

5/8" and 1" Bearing Loader (M-BL-5/8 and M-BL-1)

- Investigate bearing radial loading effects.
- Enhance the spectral amplitude of system.
- **The kit consists of one 5/8" or 1" bore loader weighting 11lb (5kg) and two clamp collars.**

5/8" Shaft Sleeve Bearing Kit (M-SBK-5/8)

- Investigate waveform and spectral recognition of worn or loose fitting bearings.
- Modify the clearance of the split bearings with plastic shims.
- Perform shaft orbital analysis.
- **The kit consists of two customized grease-lubricated, babbitt lined sleeve bearings, two bearing pedestals, and various thickness plastic shims.**

Cocked Bearing Housing (M-CBM-5/8)

- Recognize the signature of a cocked bearing due to improper seating or due to inconsistent installation.
- **The kit consists of one cocked bearing housing**

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5/8" and 1" Bearing Fault Kit (M-BFK-5/8 and M-BFK-1)

- Learn waveform and spectra of classic bearing defects.
- Learn about signal processing issues such as averaging techniques, leakage, and spectral resolution on determining bearing faults.
- Perform experiments with increasing severity of defects.
- Determine why an ultra-high resolution spectrum is needed to diagnose a bearing fault when fault frequencies are located close to multiples rotational speed.
- Learn how a large signal can mask adjoining low amplitude signal due to spectra leakage.
- **The kit consists of one inner race defect, one outer race defect, one with ba of defects.**

Crack Shaft Study Kit (ML-CSRK-5/8)

- Study the effects of crack on the natural frequencies and vibration behavior.
- Develop diagnostic technique to detect crack at early stage.
- Study crack propagation and breathing.
- Apply advanced signal processing techniques, such as wavelet, joint time-frequency analysis, time series analysis, to study the vibration caused by crack.
- **The kit consists of one shaft with a 4 ½'' 4-bolt flange connection to simulate crack, one shaft with slit crack and filler, and one shaft with a deep V-notch crack.**

Fan Vibration Kit (M-FVK-5/8)

- Learn the sound and vibration signatures of fans.
- Study the effects of volumetric flow rate on pressure rise and fan vibration.
- Develop the noise and vibration control methods on fans.
- **The kit consists of one six-blade paddle fan, one ten-blade paddle fan, one 12-blade axial fan, and one axial fan obstruction**

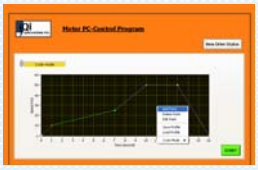
Mechanical Rub Kit (M-MRK)

- Evaluate typical rub phenomena associated with a variety of materials under different angle, loading, and lubricant conditions.
- Experiment rubs on shaft or rotor.
- **The kit consists of an adjustable spring-loader rub material holder and four different rub materials**

Damped Bearing Housing Kit (M-DBHK-1/2)

- Study bearing housing with a higher damping factor than the standard housing. Typical rolling element bearing systems are an all-metal structure with virtually no damping.
- Add damping to a standard rolling element bearing housing.
- Demonstrate the reduction in rotor resonance amplitude due to the installation of damping.
- **The kit consists of two bearing housings and two ½" bearings fitted with isolators.**
- Requires ML-RSK-1/2

PC Motor Control Kit (M-PCK)



- Operate MFS from remote location.
- Pre-program speed acceleration, deceleration, and length of run to meet exact requirements.
- **The kit consists of PC software, one interface module to motor drive and cables.**

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Shaft Alignment Kit (M-ATK)

- Align shafts precisely with convenient and simple Windows alignment software.
- Accommodates ½" to 1 ¼" diameter shafts.
- **The kit consists of two precision dial indicators, two mounting brackets/bars, one mirror, one set of feeler gauges and instructions packaged in a rugged plastic case.**

Vertical and Horizontal Bearing Force Transducer for 1/2" to 1" Shafts (M-FTVH)

- Measure forces exerted on bearings due to coupling misalignment, rotor unbalance, belt misalignment, and belt tension.
- Establish quantitative tensions for drive belt studies.
- Learn to relate the vibration signature to forces associated with common malfunctions such as resonance and bearing faults. Learn phase relationship between force and vibration spectrum.
- Learn nature of rotor dynamic forces due to common defects.
- Witness 180 degree phase shift between heavy and high spots when rotor goes through a critical speed. Demonstrate how mass unbalance force quadruples when the speed is doubled, but vibration amplitude does not follow the same trend.
- Verify and refine your rotor dynamic models and enhance modeling skills.
- **The kit consists of one transducer simultaneously measuring vertical and horizontal force and one matching signal conditioner.**

High Value Combination Packages

The MFS-LT is also available in four high value combination packages. Each package is designed to provide you with all the tools needed to study a variety of machinery fault topics:

MFS-LT Combination Packages	
Package No. 1	Basic MFS-LT +For in-depth studies of alignment, balancing and resonance issues
Package No. 2	Basic MFS-LT +For in-depth studies of alignment, balancing, resonance, and bearing defects issues
Package No. 3	Basic MFS-LT +For in-depth studies of alignment, balancing, resonance, bearing defect, crack shaft, fan vibrations, mechanical rub & damping issues
Package No. 4	Basic MFS-LT +For in-depth studies of alignment, balancing, resonance, bearing defect, crack shaft, fan vibrations, mechanical rub, damping issues; plus PC Operation, shaft alignment, and both bearing horizontal and vertical forced measurements

Turnkey Package

SpectraQuest simulators and software are conveniently sold as comprehensive training packages. The purchase of a training package provides you with all of the components necessary, such as sensors, data acquisition and analysis software, for a fully functional, turnkey training system.

- Turn your present engineers into vibration experts
- Accurate machinery problem assessment and identification as to root cause
- Improve process and machinery reliability and satisfy ISO and QS expectations
- Practice and experiment in laboratory environment to accelerate the learning process
- **Turnkey Training Package 2:** Vibration Study Complete system for in-depth studies of alignment, balancing, resonance, and bearing defects issues; including sensors, data acquisition and analysis software. Includes: MFS-Lite Package 2 (LT2010-PK2), four accelerometers (SQI604/4), 8 Channel 5kHz Portable USB (VQ-LC8)

Option kit		PKG 1	PKG 2	PKG 3	PKG 4
Training curriculum manual	SQI-TRCM	x	x	x	x
Eccentric rotor	M-ER-5/8	x	x	x	x
Cocked rotor	M-CR-5/8	x	x	x	x

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Coupling type set	M-BRS-5/8	x	x	x	x
Centrally bent rotor shaft for balance studies	M-CK-5/8	x	x	x	x
Coupling-end bent rotor shaft for alignment studies	M-CBRS-5/8	x	x	x	x
Rolling bearing resonance/critical study kit	M-RSK-1/2	x	x	x	x
Sleeve bearing resonance study kit (Requires ML-RSK-1/2)	M-SBK-1/2	x	x	x	x
5/8" shaft bearing fault kit	M-BFK-5/8		x	x	x
5/8" shaft bearing loader	M-BL-5/8		x	x	x
1" shaft bearing study kit	M-BSK-1		x	x	x
1" shaft bearing fault kit (Requires ML-BSK-1)	M-BFK-1		x	x	x
1" shaft bearing loader (Requires ML-BSK-1)	M-BL-1		x	x	x
Cocked bearing housing	M-CBM-5/8		x	x	x
5/8" shaft sleeve bearing (grease lubricated) kit	M-SBK-5/8		x	x	x
Mechanical rub kit	M-MRK			x	x
Damped bearing housing kit (Requires ML-RSK-1/2)	M-DBHK-1/2			x	x
Crack shaft study kit	M-CSRK-5/8			x	x
Fan vibration kit	M-FVK-5/8			x	x
PC motor control kit	M-PCK				x
Shaft alignment kit	M-ATK				x
Vertical and horizontal bearing force transducer for 1/2" to 1" shafts	M-FTVH				x(2)

Specifications

Electrical	
Motor	3 Phase, 1/2 HP motor, pre-wired self-aligning mounting system for easy installation/removal
Drive	1/2 HP variable frequency AC drive with multi-featured front panel programmable controller
RPM range	0 to 6000 rpm (short duration) variable speed
Tachometer	Built-in tachometer with LCD display and one pulse per revolution analog TTL output for DAQ purposes
Voltage	115/230 VAC, Single phase, 60/50 Hz
Mechanical	
Shaft Diameter	5/8” diameter; Turned, Ground, & Polished (TGP) steel
Bearing	Two sealed rolling element in aluminum horizontally split bracket housing for easy changes, tapped for transducer mount. Bearing mounts can be mounted in five different position for variable rotor span
Rotor Base	15” long, completely movable using jack bolts for easy horizontal misalignment and standard shims for vertical misalignment. Pinned for easy realignment.
Rotors	Two 6” aluminum with 36 threaded holes at 10 degree intervals for introducing unbalance
Safety Cover	Lockable clear, impact resistant hinged plastic cover with motor interlock switch to shut down motor when cover is raised
Foundation	1/2” (12.7 mm) die cast aluminum base, base stiffener and six rubber isolators
Physical	
Weight	Approximately 100lb (45kg)
Dimensions	L=32” (80cm), W=14” (36cm) , H=22” (55cm)

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