IMPACT REGISTER, INC.
PRECISION BUILT RECORDERS SINCE 1914

RM-3WE (THREE WAY) ACCELEROMETER

GENERAL

The RM-3WE accelerometer measures and permanently records, for periods of 30, 60, and 90 days, the magnitude, time of shock (impact) and vibration on three axis: vertical, lateral, longitudinal. The RM-3WE may be used interchangeably to monitor all modes of transportation and record handling errors. It is an excellent accelerometer for laboratory testing.

The RM-3WE records directly in G forces and will indicate not only from which axis the force occurred but also from which direction on that axis: left side or right side, front or back, and top or bottom (acceleration and deceleration).

The electric chart drive mechanism allows the accelerometer to record the time, within an accuracy of 0.5 sec. per day.

Damping, other than friction (coulomb damping) must be used in mechanical accelerometers where accurate acceleration measurement is required and where input frequencies cannot be controlled. One example of this is monitoring rail car movement while the accelerometer is mounted directly to the car itself.

Basically, pneumatic damping controls the performance of the accelerometer on a definite 65% of critical damping curve. An accelerometer which performs in accordance with the 65% of critical damping curve will not experience resonant build-up. A friction damped unit performs on a 0.1% of critical damping and a resonant build-up resulting in an infinite error, is possible.

APPLICATIONS

RAIL & TRUCK

Records magnitude, time of occurrence of all in-transit impacts and vibration as well as the total running and down time of each trip.

Lateral (X) Axis records the amount of rough motion from side to side.

Longitudinal (Y) Axis records the forces involved during coupling (switching), sudden starts and stops, "slack action", and the condition of the draft gears.

Vertical (Z) Axis records the amount of up and down oscillation and shock that the vehicle or lading experiences. This is an important aspect of interpreting potential damage.

Lading can theoretically leave the floor of a vehicle at any reading in excess of -1G.

X-Y-Z: the records of the three axis will indicate a combination of good or bad data, the condition of the vehicle suspension system, excessive speeds, excessive deflection in structural systems, and the total overall quality of vehicle handling.

PRODUCT HANDLING

Records the quality of, or lack of product handling, either manual or mechanical. When the accelerometer, set at a comparatively low G level, is placed within a package, it will indicate which side or end the package was dropped and when it was dropped in this position. This is helpful in determining whether or not instructions such as "this end up" are being followed.

All records may be vectored in order to determine exact magnitude and direction of shocks to packages. Approximate drop heights may be determined by duplicating accelerometer records in the laboratory.

LABORATORY

To correlate actual damage occurring in-transit with similar lading damage as it is reproduced on the conbur tester, the vibration (shake table) tester and by drop tests. The instrument records the degree of severity of package testing and thereby allows repeated test to be run on an equally severe and controlled basis.

GENERAL SPECIFICATIONS

Each accelerometer is manufactured to customer specifications. This is done by offering standard units with a selection of G ranges from plus or minus 2G to plus or minus 50G for each axis, chart speeds of 3/8" per hour (90 day), 3/4" per hour (60 day), 1-1/2" per hour (30 day), 3" per hour (14 day), and 6" per hour (7 day), faster chart speeds are available upon request.

The RM-3WE is 10"X 7"X 6" and weighs 16 pounds. The accelerometer mechanism is completely mechanical, using pivoted mass elements (pendulum fashion) suspended by coil springs. The damping is pneumatic provided by a piston and cylinder with a variable orifice in the piston head so that the percentage of damping may be adjusted**.**

The chart is 4" wide, wax coated, and if properly handled provides a completely permanent record.

All steel and brass parts are heavily chrome plated (some for protection and some for use as bearing surfaces) and the instrument case is machined from 1/4" aluminum for exceptional strength in an instrument of this weight. Stainless steel is used for those parts which make plating difficult or undesirable. The RM-3WE is very durable and if properly maintained will last many years.

NOTE: The RM-3WE is not weatherproof; weatherproof boxes are available upon request.

G-RANGE, NATURAL FREQUENCY & SENSITIVITY

The available G ranges of this instrument are plus or minus 2G to plus or minus 50G. The proper G ranges to monitor packaged products is listed in the "How to Order a RM-3WE" section. The most popular G ranges to monitor rail cars and truck trailers are:

AXIS	RAIL	TRUCK
Lateral (X) side to side	5G	5G
Longitudinal (Y) fore. & aft.	5G	5G
Vertical (Z) up & down	10G	10G

The longitudinal, lateral, and vertical records are each made on a 1" section of the chart. Lading, or an object which receives a 2G longitudinal or lateral impact will exert a force of two times its weight (neglecting friction between floor and object). Thus an object weighing 200 lbs. which receives an impact of 2G will exert 400 lbs. on the end or side of lading. This same information applies to the vertical record with the exception that there is an initial reading corresponding to a 1G acceleration in the downward direction; therefore, in the above example a force of 600 lbs. would result.

The undamped natural frequency is determined completely by the G range. The higher the natural frequency the higher the G range. The table below gives a few representative values, these are not the theoretical natural frequencies of the spring and mass system, but the true undamped natural frequencies as determined on a sinusoidal shake table, and are less than the theoretical frequencies.

G-Range	Undamped Natural Frequency	Maximum Operating Frequency
1G	10	5
5G	25	12
10G	40	18
15G	50	21
25G	60	30
50G	75	35

Additional engineering data such as Natural Frequency, Operating Frequency, Critical Pulse, and Rise Time Response can be obtained upon request.

CHART DRIVE

The RM-3WE chart is driven by a (quartz) electric D.C. stepping motor. The ON-OFF switch was installed inside and to the right to prevent any unauthorized person from turning the unit off.

Power is supplied to the RM-3WE by one C-cell extra heavy duty battery, (Part No. 1235, 1.5 Volt Extra Heavy Duty C Eveready) located on the right, front, top cover. On the right, front, top remove the battery cover by taking the two screws and lift the cover off. Remove the screws on the ground bar, notice how the bar was correctly in place, the battery will raise 1/4" so that it can be easily removed.

When installing a new battery put the PLUS END OF THE BATTERY DOWN INTO THE BATTERY TUBE. We recommend the battery be replaced every four to six months, although the estimated life is one year.

The RM-3WE's chart is 4" wide and is 90' long. The standard chart speeds are as follows: 3/8" per hour (90 day), 3/4" per hour (60 day), 11/2" per hour (30 day), 3" per hour (14 day), and 6" per hour (7 day). Faster chart speeds are available, also remote control devices can be installed.

During controlled tests faster chart speeds produce very useful information. For example, on truck tests, a chart speed of 1" or 3" per second will record the levels of a vehicle or lading moves up, down, and from side to side. From this it is possible to calculate how far the vehicle moves, in inches, during such oscillation.

The longitudinal axis records the acceleration and deceleration rate along with its corresponding time function during accelerating and breaking procedures.

ACCELERATION SENSING UNIT

The sensing unit consists of three masses (representing lateral, longitudinal, and vertical axis) suspended as pendulums from precision machined stainless steel screws with coil springs attached through a multiplication system. The air damping is the most critical part of the instrument since this is a major factor in the accurate dynamic performance of the instrument. These parts of the damping apparatus have to be manufactured to tolerances as close as .0002", thus a large portion of the effort of construction is devoted to this phase. This type of damping does not give a truly linear damping force; however the instruments can be calibrated to within 4% of full scale deflection of linear performance up to frequencies of about 0.5 of the undamped natural frequency of the instrument. This is essentially the same performance that can be expected from an ideally damped instrument.

A special multiplication system is used to multiply the basic motion of the mass element (which is the motion of the center of percussion of the mass relative to its pivotal axis). The multiplication is approximately 15 to 1 from the center percussion to the stylus tip. Even at this multiplication ratio, the slack in the system is held to less than .0005" as measured at the stylus tip.

In instruments with low maximum G, the pressure of the stylus on the recording chart is of utmost importance since the tip must remove wax from the chart in order to make a mark. The stylus points are hardened stainless steel and the stylus pressure is adjusted so as to be as light as possible while still making a clean record on the chart. Correct pressure adjustment is imperative for precise readings.

ACCURACY

The instrument is calibrated to within plus or minus 4% of full scale deflection. The most important part of the calibration process is the dynamic basis. Calibration on a centrifuge is really a static calibration.

The dynamic calibration used at Impact Register Inc. is done on what is commonly called a "shake table". This table gives a motion similar of a piston in a car engine (although the displacement of the table is much smaller than any common engine stroke), the actual displacement of the "shake table" is .762. This is technically referred to as a sinusoidal motion.

The frequency range of the acceleration to be measured is normally not more than 0.5 of the undamped natural frequency of the instrument. The calibration consists of adjusting the damping so that a true record (within a given tolerance) is obtained at various accelerations and frequencies throughout the operating frequency range of the instrument. Making an accurate calibration over the desired frequency and G range is quite an involved procedure as we do it.

For use in recording individual impacts, this instrument will give peak acceleration readings within approximately 4% of the full scale deflection as long as the impact is within the range of the instrument. A full discussion of the problems involved in the measurement of impact can be found in a publication of the Impact Register Inc. entitled "A Discussion of the Problems and the Requirements for Measuring Dynamic Acceleration with Mechanical Instruments" by David D. Redhed. This thirty-six page booklet is available for $15.00 upon request.

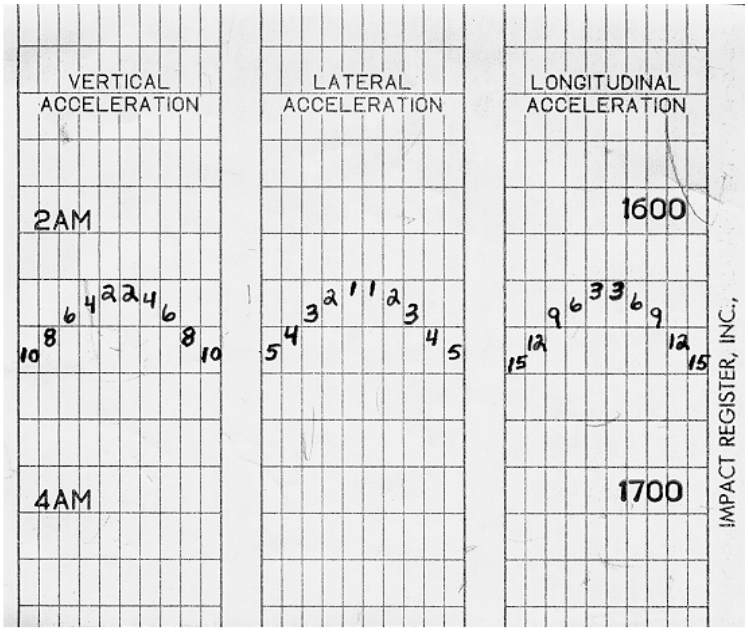

CHART INTERPRETATION

The above is a sample piece of chart. It assumes a chart speed of ¾" per hour and a G range of plus or minus 10G vertical, plus or minus 5G lateral, plus or minus 15G longitudinal.

The above graph indicates how to read the resultant impacts which occurred. Please note that each axis block is divided into ten equal sections, five on each side of the center line. These five spaces are very important. Assuming the vertical axis is set for a maximum of plus or minus 10G, each space on the vertical axis equals 2G. If the lateral axis is set for plus or minus 5G, each space equals 1G. The longitudinal axis set at plus or minus 15G will result in each space equaling 3G.

Do not read the full swing of the stylus for each shock incurred, only read the maximum deflection from the CENTER LINE on the shocks that are recorded.

HOW TO ORDER A RM-3WE ACCELEROMETER

WHEN ORDERING A RM-3WE BE SURE TO INCLUDE THE FOLLOWING INFORMATION:

1. Specify model numbers and thereby indicate the chart speed.
   See **NOTE A** -- Chart Drives.

2. Specify desired G-range for each axis.
   See **NOTE B--** Sensitivity Settings

   X (lateral) @ +/- ___ G.
   Y (longitudinal) @ +/- ___ G.
   Z (vertical) @ +/- ___ G.

3. Specify quantity of charts
   See **NOTE C** -- Chart Types.

4. Each instrument has the name of the purchaser as well as his "return to" address stamped on the nameplate of the RM-3WE. Include the desired nameplate information in the purchase order.

5. List all the optional supplies and parts separately.

ACCESSORIES

Weatherproof container available upon request.

PLEASE NOTE: The RM-3WE is not weatherproof and should be sent to Impact Register annually for recalibration and overhaul.

NOTE A -- CHART DRIVES:

MODEL NO.	DESCRIPTION
RM-3WE-30	30 DAY ELECTRIC DRIVE
RM-3WE-60	60 DAY ELECTRIC DRIVE
RM-3WE-90	90 DAY ELECTRIC DRIVE
RM-3WE-120	120 DAY ELECTRIC DRIVE
RM-3WE SPECIAL	12" AN HOUR; 1", 3" 6" AND 12" A MINUTE; 1", 2" PER SECOND AND OTHER SPEEDS AVAILABLE.

-- Battery operated (D.C.) or Electrically operated (A.C.) Chart Drives are required when faster chart speeds are needed. This option allows for chart speeds of 1" or 2" per SECOND. These speeds produce a record which can be examined for the magnitude of the shock received as well as the time the shock lasts, displacement, and rise time.

NOTE B -- SENSITIVITY SETTINGS:

-- The recommended maximum sensitivity settings to monitor vehicle movement are:

	G-RANGE FOR EACH AXIS		
VEHICLE	(X) LATERAL	(Y) LONGITUDINAL	(Z) VERTICAL
TRUCK TRAILER	+/- 5G	+/- 5G	+/- 10G
RAIL CAR - STANDARD DRAFT GEAR	+/- 5G	+/- 15G	+/- 10G
RAIL CAR - LONG TRAVEL DRAFT GEAR/CUSHIONED UNDERFRAME	+/- 5G	+/- 5G	+/- 10G

-- It is often desirable to have different sensitivity settings for each axis of the RM-3WE. A large package, such as a refrigerator, will most always be shipped according to this end up instructions. Accordingly, the recommended settings would be +/- 10G Z (vertical) and +/- 5G X and Y (lateral and longitudinal).

-- All small and lightweight packages which are susceptible to being dropped and thrown should have identical and high sensitivity settings on all three axis.

-- The standard maximum sensitivity settings are 2, 5, 10, 15, 20, 25, 35, 50 G's.

NOTE C -- CHART TYPES:

MODEL NO.	STANDARD CHART SPEED	CHART TYPE
RM-3WE-30	1 ½" Per Hour	RM-90 ¾" – 1 ½"
RM-3WE-60	¾" Per Hour	RM-90 ¾" – 1 ½"
RM-3WE-90	3/8" Per Hour	RM-90 3/8"

-- The thirty day RM-3WE has a chart speed of 1-1/2" per hour and uses chart type RM-90 ¾" – 1 ½". The sixty day RM-3WE has a chart speed of ¾" per hour and uses chart type RM-90 ¾" - 1 ½".

-- The ninety day RM-3WE has a chart speed of 3/8" per hour and uses chart type RM-90 3/8" per hour. The one-hundred twenty day RM-3WE has a chart speed of 3/8" per hour and, also, uses chart type RM-90 3/8" per hour. This chart has a blank side for use in the faster chart speed RM-3WE's. (i.e. 1" and 2" a second.)

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