

## VTB-Sensor, 2g/25g – Product Application Solution for a Six Throw, Separable Reciprocating Compressor



### Type of Reciprocating Compressors

Reciprocating compressors are positive displacement machines in which the compressing and displacing element is a piston having a reciprocating motion within a cylinder. There are single stage and multiple stage units. There are two types of reciprocating compressors- one type requires a combustion gas engine or an AC motor (high speed separable) which may be connected to a gear box to drive the coupled compressor. Operating speed is typically between 900 and 1,800 rpm. Separable units can be a single stage or have multiple stages. They can be skid mounted, easy to install, and are easily moved to different sites- both onshore and offshore.

The other type of reciprocating compressor has internal power cylinders (low speed integral) that drive the compressor. These units run at speeds of between 200 and 600 rpm. They are commonly used in gas plants and pipeline service where fuel efficiency and long life are critical. Integral compressors may be equipped with two to ten compressor cylinders with power ranging from 140 to 12,000 hp.

### VTB-Sensor / VTB-Impact / VTB- Com



The **VTB-Sensor** is smart, addressable three-axis vibration and temperature sensor that enables reliability engineers and maintenance professionals to have a one-size-fits-all vibration sensor. The VTB-Sensor is suitable for rotating machine applications such as motors, pumps, fans, compressors, engines, centrifuges, cooling towers as well as reciprocating compressors and pumps.

The sensor provides overall vibration level outputs for the X, Y and Z axes in acceleration and velocity, and also provides a temperature output.

The VTB-Sensor (2g/25g) is similar to the original VTB-Sensor, but this special device incorporates enhanced internal circuitry designed to detect, verify, and monitor impact severity profiles.

**VTB-COM** is a communications gateway which monitors the VTB-Sensors via the CAN bus network. This communications gateway system logs information from the VTB-Sensors and communicates the information to a control system (a PLC, DCS, or SCADA system), or a remote monitoring station (PC) using a variety of communications methods such as Ethernet, Modbus and USB. Additional connection options are available, including wireless, Wi-Fi, and cellular (GSM).

The VTB-COM acts as a CAN bus master on four independent CAN bus channels simultaneously. Each CAN bus is controlled by a dedicated controller chip. In non-hazardous locations, each CAN bus port can communicate with up to 24 different sensor devices attached at the same time. This makes it possible to run 96 different points to one VTB-COM communication gateway. **In hazardous locations, the entire CAN bus ports together are limited to 24 VTB-Sensors and the total cable distance is limited.**



### VTB-Sensor – Vibration Monitoring

#### Frame Vibration

For the machine crankshaft and frame, the VTB-Sensor should be mounted horizontally on the frame and centerline and opposite of each main bearing. **Reciprocating compressor malfunctions are associated with running speed (for example, crankshaft and crankshaft counterweight failure, connecting rod failure, frame/foundation looseness and change in piston rod, crosshead pin or connecting rod loading).**

Machine internal forces of concern:

- 1) changes in crankshaft condition or loss of crankshaft counter weight can produce unbalance force of the system at one times running speed (1X) component;
- 2) connecting rod failure that does not immediately stop the crankshaft will change the (1X) unbalance component;
- 3) in addition to rod load forces, moment unbalance forces (1X, 2X) also act on the frame;
- 4) soft frame to foundation connections reduces stiffness and increases the amplitudes caused by the rod load forces and moment forces (1X, 2X, 3X...);
- 5) for the horizontal reciprocating compressor, the lateral forces are more damaging than the axial forces.
- 6) crankshaft is the most expensive component inside the crankcase.

Since these forces and moments act directly the crankshaft and frame, the VTB-Sensor must be mounted at the frame center lined to the crankshaft and opposite to the main bearings (1X to 10X) and (10X to 100X).

For vibration monitoring, the recommendations provided by the equipment manufacturer should be followed. For reciprocating compressors, consider the following industry vibration monitoring standards- API 618, the Vibration Institute, ISO 13707, ISO 10816, and the European Forum for Reciprocating Compressors, "Guideline for Vibrations in Reciprocating Compressor Systems, specifically pages 11 – 13.

The following recommendations are offered as a starting point. Further inquiry into the condition of the compressor is required if:

- in comparison to past machine problems and other similar machines, any vibration frequency increases in amplitude
- the compressor frame vibration level at the crankshaft centerline exceeds 0.14 in/sec rms (3.50 mm/sec rms)
- the vibration amplitudes of the compressor cylinders exceed 0.21 in/sec rms (5.30 mm/sec rms)

### **VTB-Impact - Impact Severity**

Of all the vibration measurements that can be made on a reciprocating compressor, impact detection is the most cost effective. Even for small, spared, non-critical reciprocating compressors, a VTB-Sensor configured for impact monitoring on each compressor cylinder is easily justifiable

Our approach to capture and monitor for impact severity:

- 1) The VTB-Com Web interface menu allows machine impact configurations for running speeds between 200 and 1800 RPM.
- 2) It is essential that the impact signal can be detected and verified for impact monitoring accuracy, repeatability, and system reliability. Therefore, it is important that the VTB-Impact sensor is mounted vertically over the cross-head section of the compressor and connected to VTB-Com via the VTB-Impact sensor integral cable.
- 3) The special impact monitoring screen provides relevant impact information that allows reliability personnel to quickly assess the condition (alert and danger impact counts) of the reciprocating

compressor. The headings on the left side of the screen will allow the operator to configure the protection of the machine based on the percentages of the alert or danger count.



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### Impact Mode Sensors



| SN/RTU       | Alarm | CAN | Temperature | Type  | Axis | Impact Window | Alert Count | Danger Count | Avg. Alert (Peak) | Avg. Danger (Peak) |
|--------------|-------|-----|-------------|-------|------|---------------|-------------|--------------|-------------------|--------------------|
| 00003752 / 2 |       | 1   | 70 °F       | 25g2g | 2    | 1.00          | 3           | 8            | 4.8 g             | 6.4 g              |



To set up the VTB-Impact sensor, an operator can set up the window times (reset time) based on the calculation of 960/machine running speed (RPM). The impact threshold levels are user settable in 1 g increment from 2 g up to 20 g, pk. The window time will reset continuously and VTB-Net will accurately count how many impacts occurred within the user settable impact thresholds. The amount of impacts within the reset time indicates the repeatability of the impact and the severity of the mechanical looseness. The faster (slower) the machine RPM, the less (more) length of reset time is required for verifying impact severity.

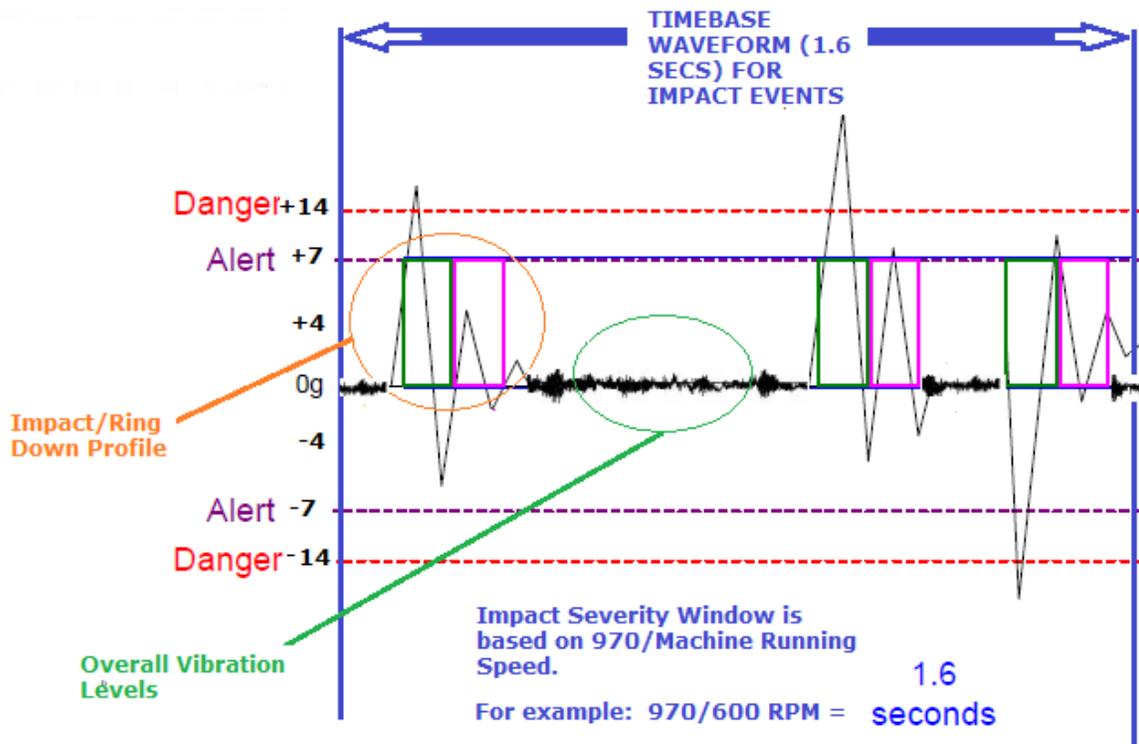
Window time example:

Machine Running Speed of 200 RPM,  $960/200 = 4.80$  seconds

Machine Running Speed of 600 RPM,  $960/600 = 1.60$  seconds

Machine Running Speed of 1200 RPM,  $960/1200 = 0.80$  seconds

Machine Running Speed of 1800 RM,  $960/1800 = 0.53$  seconds



The VTB-Impact sensor should be mounted on the frame extension of each compression cylinder to detect for impact related events associated with the axial motion of the cross-head and piston rod.

Due to the short duration and high frequency nature of the impact/ring down profile, the VTB-Impact will detect machine related impact problems much better than a velocity vibration sensor.

Impact acceleration related events:

- Mechanical looseness
- Loose piston or cross-head attachments
- Excessive cross-head clearance
- Loose or cracked compressor frame
- Excessive clearance in wrist pin bushings
- Excessive clearance in the main bearings
- Liquid carryover

The impacts will typically occur at Top Dead Center and Bottom Dead Center of the piston stroke as the forces reverse. During normal operation, impact acceleration levels slightly above 2 G Pk can be trended. Depending on the type of compressor, impact levels above 3 G Pk can be mechanical

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looseness and should be investigated. Impact levels above 6 or 7 G Pk should cause user configured alert or danger alarms to actuate in the remotely located control room.

For some reciprocating compressors, the normal operation of the acceleration amplitude can be at a constant 3.5 to 4.0 G Pk level. Therefore, a higher alert and danger impact threshold setting may be required to avoid false tripping. In order to properly set the alarm and danger impact settings, first contact the manufacturer of the machine and secondly, review the machine's maintenance records. You can then compare the machine's vibration and impact data to other similarly configured machines.

### **Conclusion**

This technical brief has practical suggestions to assist you in your application. We want to support you with a reliable vibration, impact severity, and temperature product that successfully and consistently detects, monitors, analyzes, and protects your equipment investment. Let us know about your application by consulting with the Machine Saver team at [service@machinesaver.net](mailto:service@machinesaver.net). Our team can provide vibration monitoring solutions and benefits for your present application and extend their vibration expertise and new technology to your entire balance of plant. Product and application information is available at [www.machinesaver.com](http://www.machinesaver.com)