RAM5 Acoustic Mixer

Installation and Operation Manual

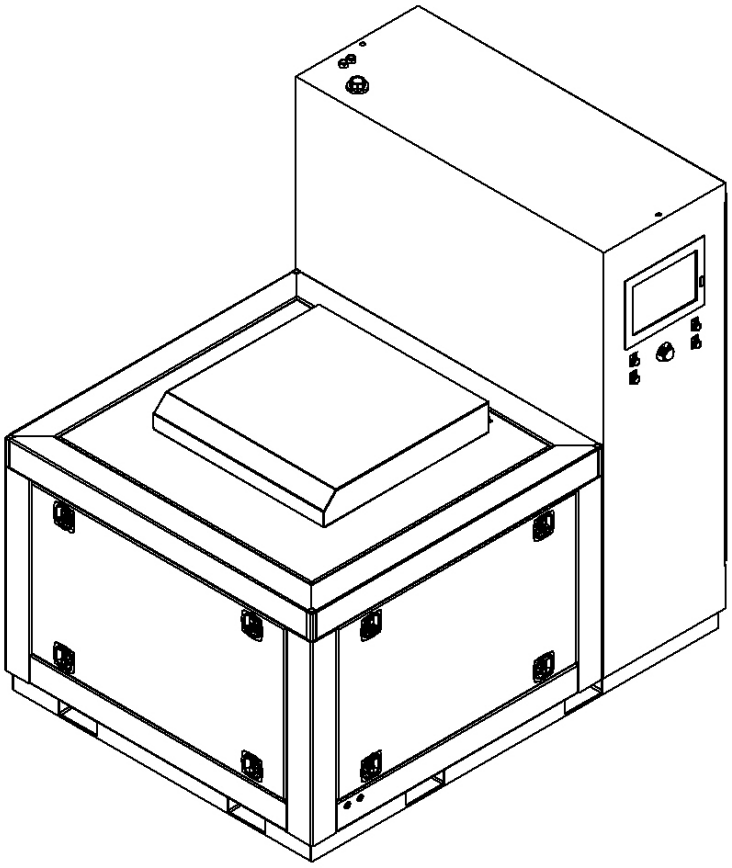


Table of Contents

Safety, Support and Warranty Information

Every effort has been made to assure that the RAM5 is easy to use, reliable and safe. This section will outline general safety considerations and define caution and warning symbols used in this document.

General Safety Considerations

For safe operation, the RAM5 should be operated only within the limits outlined in the system specifications. Specifically the following classification defines acceptable use for the RAM5:

- Indoor Use Only.
- Main supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- This equipment is suitable for continuous operation.

Warnings and Cautions

Throughout the manual, the following symbols are used to identify warnings and cautions:

The caution symbol indicates a potential hazardous situation which could result minor injury or damage to the product

The high voltage symbol indicates the possibility of electrical shock.

Electrostatic Discharge (ESD) sensitive components

Manual Format and Applicability

The RAM5 mixer is a highly customized industrial machine. This manual is supplied as a "generic" RAM5 document that covers base features of the every machine (except where noted). Training documentation and a Supplementary Information is provided with every RAM5 that covers features beyond that of the standard RAM5 and specific to each machine.

Important Safety Notes

Only trained and qualified personnel should open access panels or electrical enclosure door.

This equipment must only be operated by trained and qualified personnel.

Mixing operations can generate heat and internal pressure depending on material and mixer accelerations. Do not mix material longer than what has been characterized as safe.

Do not attempt to run the machine without a mix container holder, equipment damage may result.

Do not use sharp objects on the touch screen.

Do not disable or tamper with any safety items on the RAM5.

Do not load mix container with more than 80 lbs. of material.

Be cautious of pinch points on mixer lid.

Trouble Shooting and Service

The RAM5 systems should only be operated when it is in good working condition. If the system shows any signs of visible damage or fails to operate as outlined in this manual, the system should not be operated.

For operational errors and troubleshooting, refer to the Troubleshooting section.

If necessary, contact your Resodyn Acoustic Mixers customer service representative for additional technical support.

Resodyn Acoustic Mixers Customer Service:

Phone: (406) 497-5333 Fax: (406) 497-5206 e-mail: service@resodynmixers.com	Resodyn Acoustic Mixers 130 North Main, Suite 630 Butte, Montana 59701

Warranty

1. **LIMITED WARRANTY:**
   Seller warrants that for a period of one (1) year from the date of Seller's shipment of Product to Purchaser or 2000 hours of machine time, whichever occurs first, its Product is free from defects in material and workmanship. Some newly manufactured Seller Products may contain, and Seller Service may use, remanufactured parts which are equivalent to new in performance. The warranty period for the Product is a specified, fixed period commencing on its date of shipment, or the date of installation if installed by Seller. Seller does not warrant that the operation of Products will be uninterrupted or error free.

   If Seller receives written notice of defects from Purchaser during the warranty period, Seller will, at its option, repair or replace the affected Products.

   The warranties provided herein will apply only to those Products and integral components thereof that are identified by a unique Resodyn part number and for any Service provided by Resodyn employees or their authorized agents. Seller does not warrant any third party Products or Service even if included with other Resodyn Branded Products or Service. Furthermore, Seller provides all such third party Products and Service AS IS. However, the original manufacturers or suppliers may provide their own warranties as specified in the documentation accompanying such third party Products and Service.

   The above warranties do not apply to defects resulting from:
   a.) Improper or inadequate maintenance by Purchaser.
   b.) Unauthorized modification.
   c.) Improper use or operation outside of the Specifications for the Product.
   d.) Abuse, negligence, accident, loss, or damage in transit.
   e.) Improper site preparation.
   f.) Unauthorized maintenance or repair.

   THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. TO THE EXTENT PERMITTED BY LAW, SELLER SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NONINFRINGEMENT.

   In no event shall Seller be liable for any consequential damages or damages of any kind or nature alleged to have resulted from any breach of warranty.

Introduction

This user's guide describes the RAM5 ResonantAcoustic® mixer and explains its operation. This chapter provides an overview of the RAM5 and contains general information important to correct use.

ResonantAcoustic® Mixing (RAM) Overview

The RAM technology approach for acoustic mixing works on the principle of creating micro-mixing zones throughout the entire mixing vessel as well as macro (bulk) material flow fields. This approach differs from conventional mixing technology where mixing is localized at the tips of the impeller blades, at discrete locations along the baffles, or by co-mingling products induced by tumbling materials. This new technology provides faster, more uniform mixing throughout a vessel than can be created by conventional, state-of-the-art mixing systems. RAM technology has an added advantage that it does not use impellers or other intrusive devices to mix, and does not require unique vessel designs for a broad range of mixing applications.

RAM technology is compatible with many types of materials, which include liquid-liquid, liquid-solid, gas-liquid, and solid-solid systems. The technology can be utilized to mix low viscosity, highly viscous and non-Newtonian systems, as well as solid-solid systems in the same types of vessels, without changes to impeller design, baffles, or other complicated, intrusive components, such as injectors and nozzles.

RAM technology is designed to operate at mechanical resonance. At this operating condition the RAM technology results in a near lossless transfer of the mixer systems' mechanical energy into the materials being mixed. This is created by the propagation of a pressure wave in the mixing vessel. This condition is achieved by matching the mechanical operation of the mixer with the properties and characteristics of the range of materials to be mixed. The operating characteristics of the mixer are automatically sensed and controlled to keep the system at the mixing acceleration established to provide the best mixing performance.

Achievement of these mixing conditions requires a methodology that is patented and unique to RAM and RAM control technology; unachievable by any other mixing technology in the industry. For example, in conventional mixers the mechanical systems are typically designed to specifically avoid operating at resonance. This condition can quickly cause violent motions, which leads to catastrophic failure of the system. However, when designed correctly a mechanical system operating at resonance enables even small periodic driving forces to produce large amplitudes of vibration that can be harnessed to produce useful work. For RAM, this operating methodology is enabled through a system designed to conserve energy by balancing kinetic and potential energy in a controlled resonant operating condition.

In the RAM systems, the potential energy is stored in the springs and the kinetic energy is kept in the plates, or masses, that are coupled to the springs. The masses oscillate in a vertical

motion, Figure 1. The resonant frequency is defined as the frequency at which the mechanical energy in the system can be conserved between potential energy stored in the springs and as kinetic energy in the moving masses.

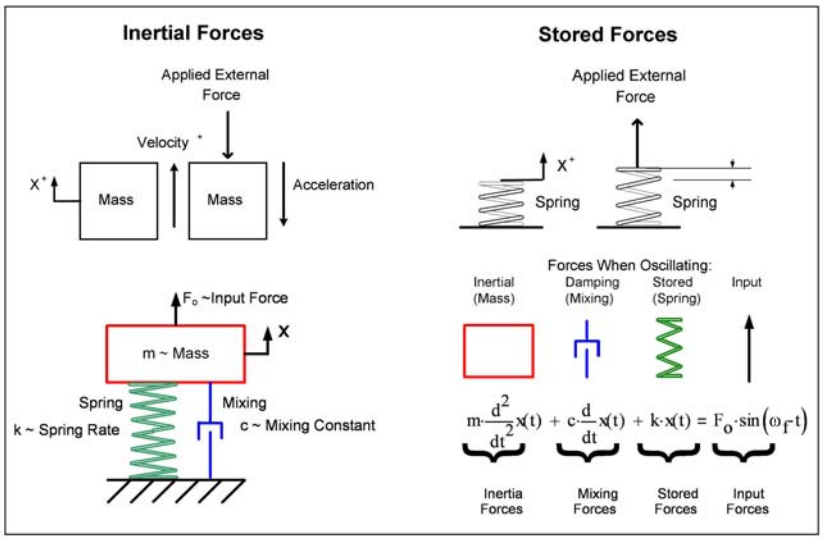


Figure 1: Simplified representation of the mass, spring and damper (mixing media) system that is in resonance.

For the RAM technology, it is the mixing system as a whole that is operated at mechanical resonance, which is nominally at 60 Hz. The exact frequency of mechanical resonance during mixing is only affected by the payload vessel (plus contents). The mix vessel contents are termed the “Mixture”.

The resonant mechanical system is the “Mixer”. The mixer operates on mechanical resonance. The mixture affects the mixers mechanical resonance frequency, by 1) the amount of material in the mixing vessel, 2) how well the material couples to the vessel, and 3) how much energy the mixture absorbs during mixing.

The amount of mixture mass affects the operating frequency because, as the payload mass increases, the operating frequency decreases. Conversely, a lighter mass will produce a higher operating frequency. The vessel weight, volume of contents, and specific gravity, are all components of the “static” payload mass. If the mixture mass is fully coupled, i.e., riding along with the vessel and not mixing, the resonant frequency will drop to the same frequency as if a mass of equivalent weight as the mixture was added to the mixer. Conversely, if the material is fully decoupled, i.e., not mixing, then the resonant frequency will become very close to that of an empty vessel. However, for all conditions of coupling between the two extremes, the resonant frequency will change depending on the amount of coupling.

Payload damping affects the amount of input force (intensity) required to accelerate the payload. Damping is a difficult number to predict for materials. However, a general understanding of what influences the amount of damping, and how damping affects the system has been compiled, which will serve as talking points in this discussion. The primary factors that affect damping are: 1) viscosity; 2) head space (amount of air or void in the mixing container above the mixture), 3) internal mix vessel pressure (vacuum, partial vacuum, ambient pressure, or pressurized); 4) temperature, and 5) vessel acceleration. Higher damping imposed by the materials being mixed requires higher input forces (intensity) to achieve a specific acceleration on the payload vessel. Damping is defined as the energy going into the mixture during mixing.

Payload acceleration is a measure of the amount of acceleration imparted onto the mixture vessel. It is measured in units of *g*. One *g* = 9.81 m/s^2. Through mixing trials and experience, the amount of acceleration required for a specific process will be determined. Higher damped mixed materials, i.e., higher viscosity materials, will typically absorb more energy during mixing than lower damped materials, i.e., low viscosity materials. As such, higher damping materials typically require higher intensities to achieve the same payload acceleration compared to the lower damped materials. The RAM5 mixer is controlled by setting the desired acceleration and the mixer automatically controls the frequency and intensity.

The principle of Resonance in ResonantAcoustic® Mixing is illustrated in both Figure 1 (above) and Figure 2. ResonantAcoustic® mixers are comprised of multiple masses and multiple springs, known as a three-mass system, that are simultaneously moving during mixing. The basic behavior of the mixer is best understood by considering the simplified case shown in Figure 1, above.

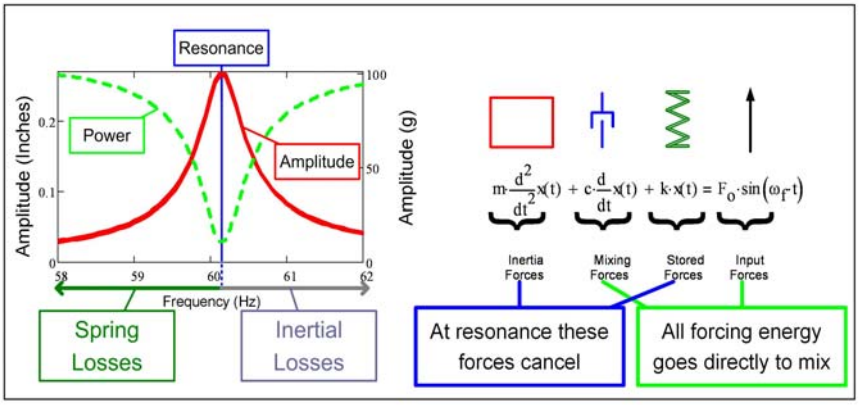


Figure 2: Differential equation and plots of oscillation amplitude and power vs. frequency showing the benefit of resonance.

The diagram in Figure 1, above, shows a mass moving with some velocity. In order to slow down the mass (decelerate) there needs to be an applied external force. When the mass decelerates, the lower velocity results in the mass having lower kinetic energy. Figure 1 shows that a spring can store potential energy when an applied external force compresses, or stretches the spring. The energy stored in the spring is greater when the deflection is large, and reduces to zero when the spring is not distorted. The lower left diagram in Figure 1 provides a representation of a spring-mass system. In this case, the “mixing” function is modeled as a damper, which absorbs energy when the system is in motion. A second order non-homogenous differential equation that describes the forces present during oscillation is shown in Figure 1, lower right. This equation shows the relationship between the forces due to the moving masses, the deflected springs, and the mixing process. The expression shows that these forces are equal to the mechanical force driving the system.

The differential equation is repeated in Figure 2, and is coupled with the diagram to the left, as a means to illustrate when resonance occurs. At a particular oscillation frequency, the resonant frequency, the stored forces in the springs are directly offset by the inertia forces of the masses, and cancel over one period of oscillation. Thus, the system can oscillate without the need for charging the spring, or providing energy to the mass during the cycles. The plot on the left side of Figure 2 graphically illustrates that for frequencies below resonance, energy is lost in charging the springs, and above resonance energy has to be added to maintain the inertial

energy. The result of operating at resonance, as shown by the red and green curves, is that the amplitude of the oscillations reaches a maximum, while the power required is at a minimum. The power consumed by the system is transferred directly into the mixing media.

With the system oscillating at resonance, the acceleration of the load-plate imparts a boundary condition on the vessel contents that is transmitted through the vessel contents as a pressure wave. Energy used in creating the mixing movement will add to the damping of the overall system, and the material contents will add to the mass. However, the amount of energy that must be transferred into the materials in order to satisfy the boundary condition will be dependent on a combination of many material and vessel geometry constraints. Some of these constraints are: the height of column of material to be moved (vessel fill height), the compressibility of the material, and its stickiness, or coupling of the material to the vessel walls, material density, vessel geometry, internal vessel pressure, vessel percent fill, and mixing regime.

Figure 3 displays the resonant response of the RAM mixer to variations in a payload. The solid black line represents a payload that has been accelerated to 100 *g*. Its response is slightly over 61 Hz. Next, assume that the payload mass is constant but the payload damping has increased. The dashed gray line shows how the same input force (intensity) will accelerate the payload to lower accelerations (40 *g*). The frequency drops slightly from 61 Hz because the mixture is absorbing more acoustic energy. If the same configuration is operated without any mix material, the dotted black line shows a resonant shift to a higher frequency, slightly lower than 64 Hz. The shift is due to a lower payload mass.

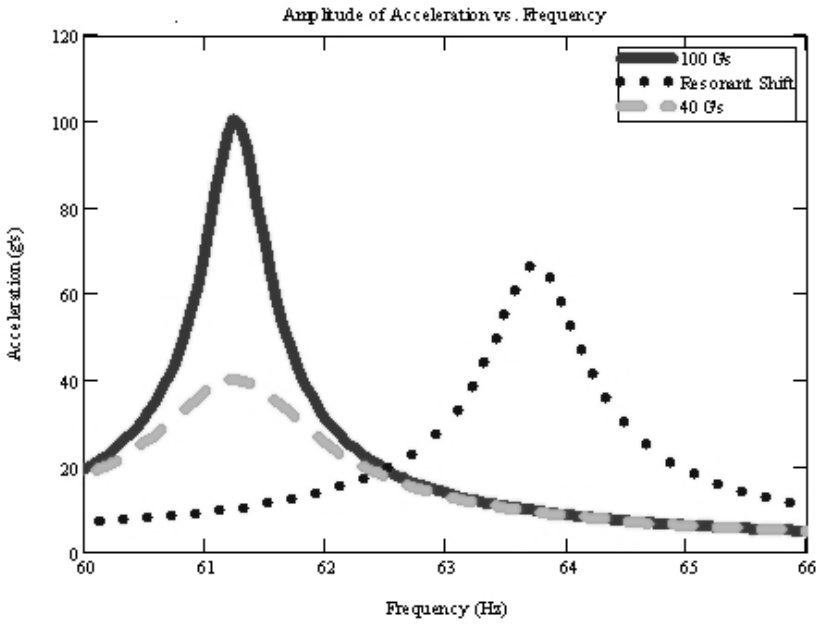


Figure 3: Resonant response of the mix media

During the mixing operation, the mix media may transition through different regimes. A regime is defined as mixing with a defined flow pattern. A regime change typically causes the materials coupling with the payload vessel to change. Because a change in the coupling causes a shift in the resonant frequency, a resonant tracking feature termed “Smart Mixing Technology” (SMT) is included. SMT controls the mixer frequency and acceleration, which keeps the mixer operating on the resonant peak at the desired preset acceleration.

System Overview

The RAM5 is a ResonantAcoustic® mixer for industrial applications. Figure 4 illustrates the main external features of the RAM5. The machine is composed of three main components, which include the Electrical Enclosure, Acoustic Enclosure, and Resonator (mixer).

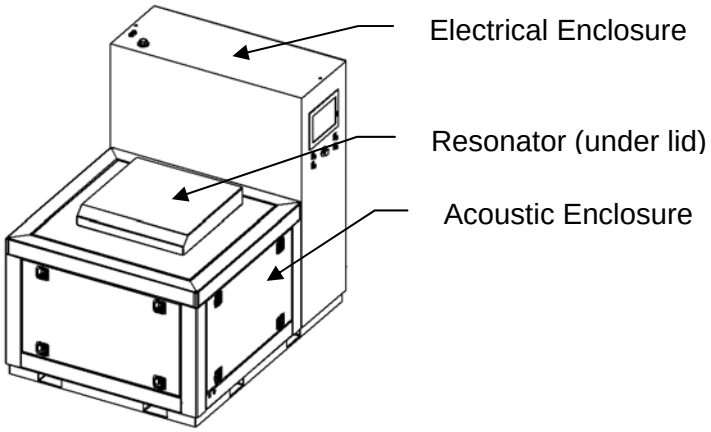


Figure 4: RAM5 Mixer External Features

Electrical Enclosure

The Electrical Enclosure, shown in Figure 5, houses all of the main electrical power and control components. External features of the electrical enclosure includes the main power disconnect switch, human-machine-interface (HMI) computer, emergency stop button, and lid open/close pushbuttons.

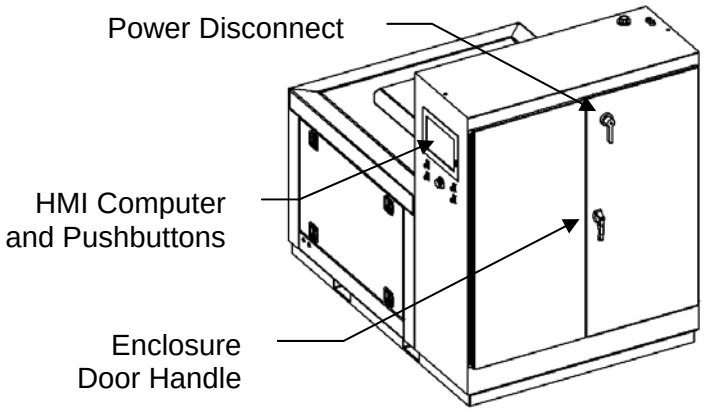


Figure 5: RAM5 Electrical Enclosure

The disconnect switch shuts power off to the entire machine and is defeatable and lockable. The HMI computer and pushbuttons located on the side of the Electrical Enclosure serve as the primary operator station. The two-hand control pushbuttons are used to open and close the mixer lid. The HMI is a touch screen computer (Hazardous Location RAM5's do not have a touch screen) that allows the operator to enter desired mix parameters and monitor machine operation and status.

The handle on the Electrical Enclosure allows access to the electrical components inside of the enclosure for maintenance and inspection purposes. Note: This handle requires a key to operate and gain access to the enclosure.

Only trained and qualified personnel should open Electrical Enclosure doors.

Observe recommended Electro-Static Discharge mitigation best practices.

Acoustic Enclosure

The Acoustic Enclosure encloses the resonator system. See Figure 6. The enclosure reduces acoustic emissions of the RAM5, and covers moving parts that could pose a risk to operators. A hydraulically powered lid provides access to the mixer to load and unload mixing containers. The hydraulic lid is controlled from the pushbuttons on the side of the Electrical Enclosure.

Three access panels provide for inspection and maintenance. These panels are removable via four quick release compression clamps.

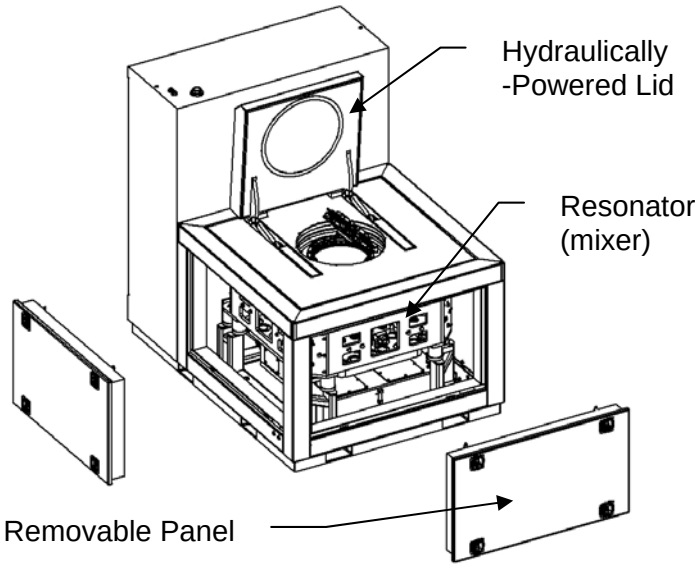


Figure 6: RAM5 Acoustic Enclosure and Resonator

Resonator

The Resonator is the mixer itself. It consists of the metal plate masses, springs, eccentrics, and drive system. The majority of the Resonator is enclosed by the Acoustic Enclosure. The only visible part of the resonator is the point at which the mixing container is secured to the Resonator. Several customer specific designs exist for mix containers and mix container holders. Refer to the Supplemental Information package for mix container and mix container holder specifics.

Although the panels are interlocked, their removal poses a risk of injury. Only trained and qualified personnel should remove side panels of acoustic enclosure. Electrical power should be removed from machine before accessing panels.

Installation

The RAM5 is designed to be a stationary, permanently mounted, indoor machine. Final equipment installation will be executed or supervised by Resodyn personnel. This section covers considerations for locating the machine and providing utilities for operation:

- RAM5's are shipped as one unit where the Resonator, Acoustic Enclosure, and Electrical Enclosure are all rigidly mounted to a skid base. The skid base is provided with fork-lift pockets.
- Footprint: 61.5"W X 85.5"D X 78"H +/- 1.5" (dimensions may vary depending on optional features). Also note that some units are provided with a hoist system that will require additional floor space and height clearance.
- Minimum Doorway Size: 67"W x 81"H (dimensions may vary depending on optional features). Refer to the Supplemental Information for exact machine dimensions.
- The RAM5 mixing system weight: 8,500lbs.
- Electrical configuration.
    - Installation Power Requirements: 3Φ, 400-480V~, 75-90A, 50/60 Hz (additional 1Φ, 120-230V~, 50/60 Hz circuit required for Hazardous Location RAM5s.
    - 400/480V~ Conduit: top entry, pre-punched hole for 1-1/2" conduit hub (1/2" conduit for 1Φ, 120/230V~ circuit)
- Cooling configuration.
    - Entry/fitting: Top entry, electrical enclosure, ¾" Swagelok style tube compression fittings.
    - RAM5 Mixers can be configured to be cooled via dedicated chillers that supply a 60/40 water glycol mixture, or facility cooling water with an internal water/glycol system. The graph in Figure 7 provides the flow and temperature requirements to provide adequate cooling to the mixer.

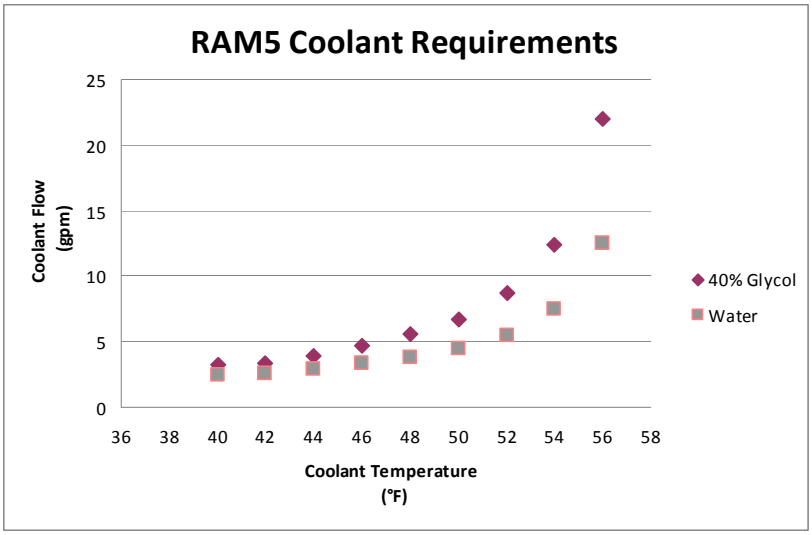


Figure 7: Cooling Flow and Temperature Requirements for Water and Glycol/Water

- Compressed air may be required, the pressure and flow of which are machine dependent. Refer to the Supplemental Information for pressure, flow, and pipe fitting requirements for compressed air.
- Ensure oil reservoir is filled with oil recommended in Maintenance Section.

Specifications

RAM5 Mixer machines are highly customizable. The following specifications are given below for the RAM5.

General Items

- The RAM5 is made out of steel with either a powder coated finish or zinc plating. The mix container holder is fabricated from steel.
- A control panel mounted to the Electrical Enclosure allows for process control and real time monitoring of pertinent machine parameters. These parameters can be observed on the human/machine interface (HMI) display.
- Acoustic Enclosure that has less than 80 dB sound at 3 ft from machine from any side.
- 3/4hp positive displacement oil pump.
- An internal cooling loop is part of the Mixer for all Mixer electronics and drives. Customer to supply chilled water for internal cooling loop.
- Hydraulically operated lid.
- Electrical Power Supply : 3Φ, 400-480V~, 75-90A, 50/60 Hz.
  Estimated Power Consumption: 35kW (under maximum operating conditions).
- Most surfaces have a powder coated finish.

Performance

- Maximum Acceleration: 100 g.
- Digital Controls.
- Maximum Mix Capacity: 36 kg (80 lbs.).
  Minimum Mix Capacity: No minimum.
- Data logging capabilities.
  - 2 Samples per second.
  - Data Recorded: Acceleration, Intensity, Frequency, Phase Angle, and Time (vessel vacuum and vessel temperature if equipped).

Vessel, Vessel Holder, Adapter

Due to the fact that mix container holders and often mix containers can be custom items, information regarding these items is located in the Supplemental Information.

Electrical

- Electrical Enclosure.
  - NEMA 12.
  - Powder coated steel.
  - Outward opening, vertically hinged doors located at the rear of the RAM5.
- Main power disconnect handle located on Electrical Enclosure door.
- Fused incoming power, Type J, 80A.
- 3Φ, 400-480V~, 75-90A, 50/60 Hz (1Φ, 120/230V~, 60 Hz for Hazardous Location RAMs)

- Internal 1Φ, 120VAC control transformer (on non Hazardous Location RAM5s).
- Sealed, liquid cooled Electrical Enclosure.
- Power-saving regenerative servo drives powering 10hp motors.
- Control circuit breakers for protection and isolation of the control circuits.

Controls

- Acceleration Control.
- PC running Windows XP as Human-Machine-Interface. Software runs in "Kiosk" mode where no other Microsoft Windows applications can be launched by operators.
- Configurable data logging.
- Mix log data collection for logging custom information entry like lot number, batch, etc.
- Alarm display and logging.
    - Active/recovered/acknowledged color coded
    - Log file records triggered time, recovered time, and acknowledged time
- User management.
    - One supervisor level user.
    - Multiple operator users.
    - Prevent machine operation without login.
    - Log file tracks login attempts.
- Machine parameter display and control.
- Recipe definition and control.
- Manual mix timer.
- Setup and Configuration screens for supervisors.
- Interlocked Acoustic Enclosure panels.
- Oil and cooling system control and monitoring.

Operation – Quick Start

This section defines the minimum steps required to operate the machine. This assumes proper installation of mix container holder fixture.

Setup

The following describes the necessary steps for preparing the machine for a mixing operation.

- If configured for a dedicated chiller, ensure that the chiller unit's main power switch is in the "On" position. The Chiller requires a warm up period for the crankcase heater.

Read the Chiller (if equipped) manual before proceeding.

- After the chiller warm-up period (if applicable) turn the System switch to the "Local" position, which will turn the chiller and pump on.
- The temperature setpoint for the chiller is 50 degrees Fahrenheit.
- Turn the main disconnect switch (located on the Electrical Enclosure doors) to the "On" position.

The Chiller cools the Electrical Enclosure. Always ensure the Chiller is running if the Electrical Enclosure's disconnect switch is in the "On" position.

If your RAM5 is equipped with a Hazardous Location Option, please consult the Training Manual and Supplemental Information for a description of the purge cycle that occurs at startup.

- During initial startup the HMI computer will take a few minutes to boot-up.
- To open the mixer lid, push both of the "Open" pushbuttons. Hold the pushbuttons down until the lid stops opening.
- Install the mix container. Ensure the container is properly clamped before proceeding.

Do not overload mix vessel, adherence to the maximum weight is required for proper operation and machine life.

- Close the mixer lid by pressing both "Close" pushbuttons. The HMI Computer will provide indication when the lid is completely closed, at which point the "Close" pushbuttons can be released.

HMI Operation

The HMI Computer is the primary user interface item on the RAM5. The RAM5 is completely digitally controlled and most control (besides lid and optional hoist operation) is provided by the HMI Computer. All data entry and operations are provided through software keypads and buttons on the screen. The machine is controlled through the use of two operating modes, which are referred to as Auto Mode and Recipe Mode. Recipe Mode should be the primary mode used by operators, and will be covered in this section. Auto Mode is generally used by

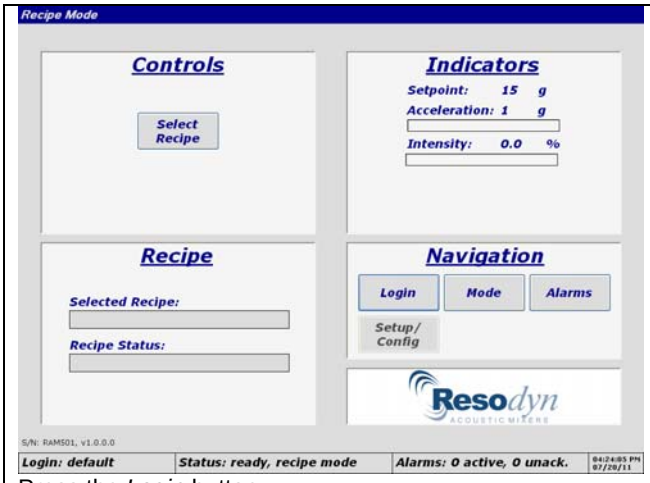
supervisors or technicians to characterize a mixing process, which will then be programmed as a recipe for the operators. The Auto Mode will be covered in subsequent sections.

Do not use sharp objects on the touch screen. Sharp objects can damage the touch screen.

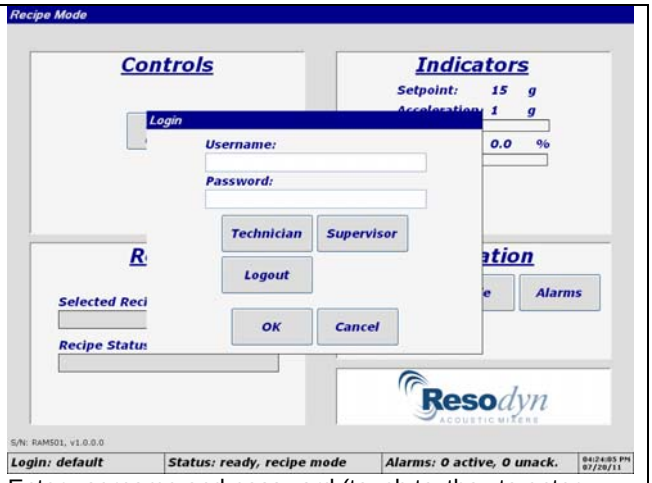
Login

The first step for HMI operation is to login to the machine.

- Login by pressing the *Login* button in the *Navigation* pane.
- The "Login" dialog box will appear. To enter username, touch the username box. This action will launch an alphanumeric keypad where username can be entered by touching on-screen buttons, similar to the operation of standard PC keyboard.
- Repeat this process for password entry and press the OK button when complete.
- A login successful (or failure) dialog will appear after touching the OK button. Touch the OK button on this dialog to complete the login process.



Press the *Login* button



Enter username and password (touch textbox to enter values through on-screen keypad)

On-screen alpha numeric keypad

Press OK when finished

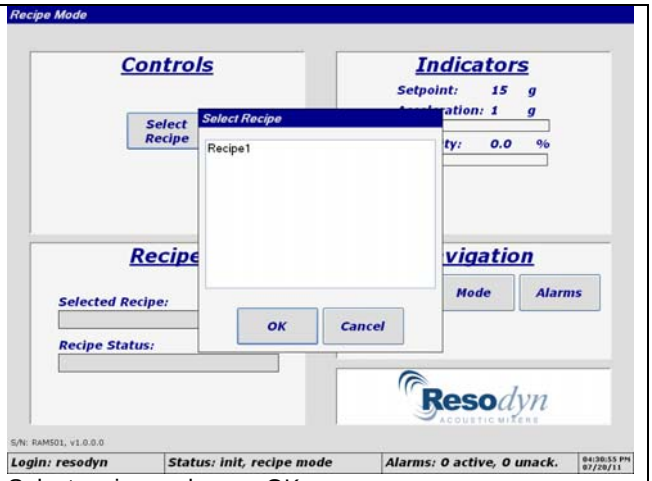
Figure 8: Logging in

Recipe Mode

Recipe Mode provides a means of pre-programming a mix profile without operator intervention. The Supervisor login level can generate a recipe's definition by defining segments that specify time duration at a specific g level.

- A pre-defined recipe can be selected by pressing the *Select Recipe* button in the *Controls Pane* and selecting a recipe from the list and pressing OK.
- The *Start* button will appear in the *Controls Pane*. Touching the *Start* button will begin the mixing process.
- The status of the mix process will be updated in the *Recipe Pane*. The selected recipe's name, along with g-setpoint and timer status will be visible in the *Recipe Pane*. Acceleration setpoints will be automatically passed to the control system at each segment timer's expiration.
- Upon completion of the final segment timer, the machine will stop.

Press the *Select Recipe* button



Select recipe and press OK.

Recipe name populates.

Press start. Mixer starts and recipe status is updated

Figure 9: Recipe mixing

Completion

Opening the lid and removing the mix container completes the mixing cycle.

- When the middle section of the status bar contains the word “ready”, the mixer lid can be opened by pressing both of the “Open” pushbuttons located below the HMI Computer.
- When the lid stops moving open, the “Open” pushbuttons need to be released.
- Remove the mix container.

To power the system down, turn the Electrical Enclosure disconnect to the “Off” position and the System selector switch on the Chiller to the “Off” position. Leave the Chiller’s disconnect in the “On” position.

Only turn the Chiller’s disconnect to the “Off” position for maintenance purposes.

HMI Overview and Configuration

This section covers the operation and features in more detail than the previous section. The audience for this section is technicians, engineers, supervisors, and maintenance personnel that will have configuration and maintenance activities to perform on the RAM5 Mixer. This more in-depth coverage of machine features includes the following:

- Detailed screen explanations.
- Alarming descriptions.
- Log file descriptions.

Main Screen

There are two primary sets of screens associated with the RAM5 machine. These are referred to as the *Main* Screen and *the Setup, Configuration and Troubleshooting* screen. The Main Screen is the primary control screen where the *Setup, Configuration and Troubleshooting* screen is used for maintenance, troubleshooting, and calibration. This section will discuss the contents and operation of the Main Screen.

Certain features of the *Main* Screen will update depending on the operational mode selected, current status, and the configured options for the RAM5 Mixer. While in recipe mode, the title bar of the *Main* Screen will read “Recipe Mode”, and will read “Auto Mode” while in auto mode.

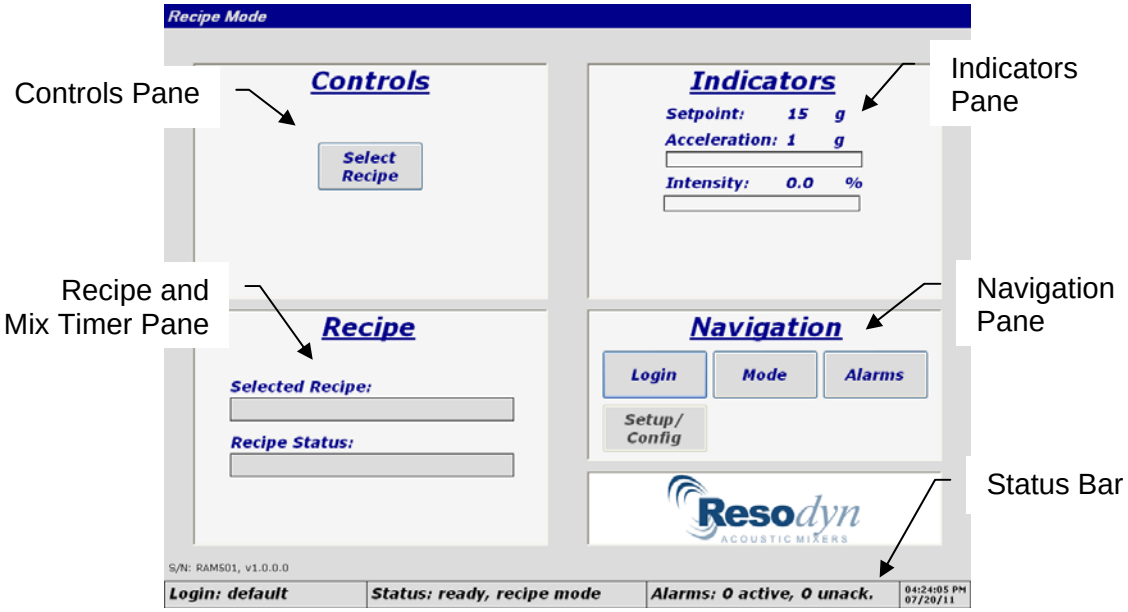


Figure 10: Main Screen layout

The Main Screen is divided into 5 operation panes or sections. These sections are as follows:

- Controls Pane.
- Indicators Pane.
- Recipe and Mix Timer Pane.
- Navigation Pane.
- Status Bar.

Controls Pane

The *Controls Pane* will change appearance and content based on the mode of operation. This pane is where the machine *Start* and *Stop* buttons are located. *Start* and *Stop* buttons will only appear when the machine is ready for a start or stop operation. Refer to the troubleshooting section if either button is not visible when it should be.

While in Recipe Mode, the *Select Recipe* button is the only visible control (besides *Start* and *Stop* buttons). By pressing *Select Recipe*, a recipe can be selected from the pre-defined list of recipes.

While in Auto Mode, the *Setpoint* numeric entry control will be the only visible control (besides *Start* and *Stop* buttons). The *Setpoint* entry allows the operator to simply enter a desired setpoint for payload acceleration in g.

Indicators Pane

Similarly, the Indicators Pane will update its appearance depending on mode of operation, configured options, and current status. This pane provides operational feedback to the operator on critical process parameters.

While in Recipe Mode, the visible parameters include:

- Acceleration setpoint (in g).
- Measured acceleration (in g).
- Current intensity (in %).

While in Auto Mode, the visible parameters include:

- Current mixer frequency (in Hz).
- Measured acceleration (in g).
- Current intensity (in %).

Recipe and Mix Timer Pane

This pane provides status for current recipe operation or the controls and indications for the Auto Mode mix timer. While in Recipe mode, two textboxes are visible. The topmost textbox indicates the name of the currently selected recipe. The bottom textbox provides the status of the current operational segment of the recipe, including duration, elapsed time, and current segment g-setpoint.

In Auto Mode, this pane displays two textboxes and two buttons. The topmost textbox with the white background allows for mix timer duration entry and the bottom textbox with the gray background indicates the remaining time on the timer. Start and Reset buttons allow manual control of timer for the mix.

Navigation Pane

The Navigation Pane provides screen, login, and operational mode navigation. This pane's appearance will update according to current login level and configured options. Controls that are grayed out are disabled due to inadequate login level.

The *Login* button launches the *Login* dialog where username and password are entered via the on-screen alpha numeric entry keypad. Pressing the *Technician* or *Supervisor* button on the *Login* dialog automatically enters the username and launches the password entry keypad. Supervisor and Technician are automatically logged out after 15 minutes (if the Mixer is not running), but the preferred method for logging out is to return to the Login dialog and press the *Logout* button to ensure that no unauthorized operations can be performed.

Pressing the *Mode* button launches the *Mode Select* dialog, where the operator can choose between Auto and Recipe Mode. Manual Mode is currently reserved for Resodyn personnel only. Also note that switching between Recipe and Auto modes is not possible when the machine is running because both buttons are disabled.

The *Alarms* button will display the *Alarms* dialog box. The Alarms dialog box provides alarm information and is organized in a table format to provide alarm message, identifier, and date/time of recovery and acknowledgement. This dialog is described in more detail in subsequent sections.

The *Setup/Config* button is used to access the *Setup, Configuration and Troubleshooting* screen for Technician and Supervisor login levels. This button will be grayed out if logged in as an operator.

Depending on options or customizations, the Navigation Pane may have additional buttons.

Status Bar

The status bar is meant to provide a discrete location for status feedback to the operator. The status bar is located at the bottom of the screen for all screens. The leftmost section of the status bar indicates the current login level. The middle section of the status bar provides messages of the current most pertinent information. And finally the right portion of the status bar provides date and time.

Setup, Configuration and Troubleshooting Screen

The *Setup, Configuration and Troubleshooting* screen provides Supervisors and Technicians a window to the inner workings of the machine. To contain as much information as possible, this screen uses a tab control format. The included tabs and required login level to view are as follows:

- Status (Technician and Supervisor).
- Recipe Edit (Technician and Supervisor).
- Data (Technician and Supervisor).
- Supervisor (Supervisor).

Items that are not contained within the tab control are:

- The *Main Screen* button which closes the *Setup, Configuration and Troubleshooting* and shows the *Main* screen.
- *Acceleration*, *Phase Angle*, *Intensity*, and *Frequency* indicators.
- *Stop* button to stop the mixer from this screen (no *Start* button is provided on this screen.

Status Tab

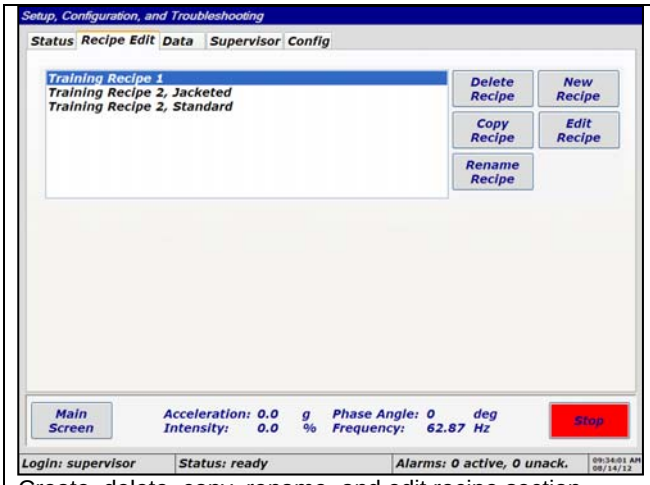
The Status tab is divided into separate regions which are labeled “Inputs” and “Outputs”. Values located in the “Inputs” region display the state (on/off) of sensor inputs. Additionally, analog temperature and vacuum (optional) values are displayed in this region.

The “Outputs” region provides indication of digital output (on/off) status of controls for motors, valves, etc. Motor drive status codes are also displayed. The codes for normal operation are as follows:

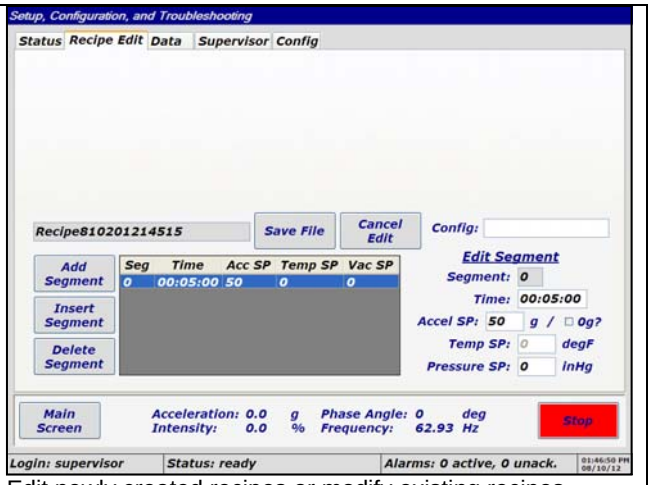
- Drive 1: A4002.
- Drives 2, 3, and 4: A0163.

Recipe Edit Tab

The Recipe Edit Tab allows the Supervisor login to create or edit recipe definitions. Recipes are pre-programmed mix profiles that are organized by segments. Segments represent time durations were the machine will operate at the recipe-specified acceleration (g) level. The Recipe Edit Tab has a top section that allows recipe selection and lower section that allows editing of the selected or newly created recipe. The top section will appear when first entering the Recipe Edit Tab. After touching the *New Recipe* button or the *Edit Recipe* button, the top section will disappear and the bottom section will appear. After completing recipe definition by entering time durations, and acceleration setpoints (and temperature and vacuum if configured), the Save File button is pressed and after confirming the save, the bottom section disappears and the top section re-appears. Refer to the Training Manual for detailed Recipe operations.



Create, delete, copy, rename, and edit recipe section



Edit newly created recipes or modify existing recipes

Figure 11: Recipe Creation and Editing

Data Tab

The Data Tab allows for log file management by listing data log files, alarm log files, and mix log files. From this tab files can be copied, or deleted one-by-one, or the entire grouping can be deleted or copied.

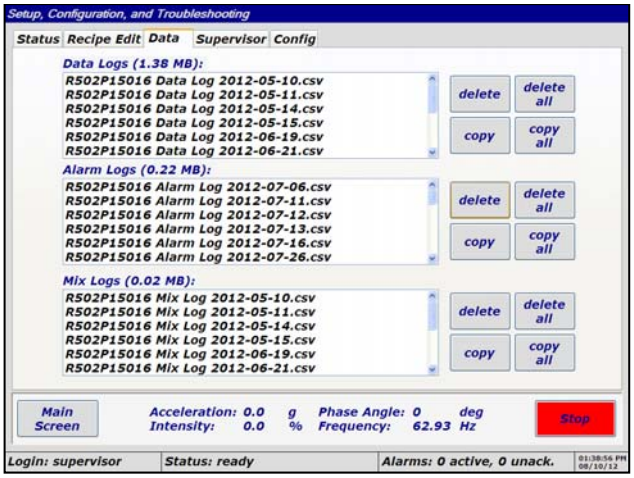


Figure 12: Data Tab

Supervisor Tab

The Supervisor Tab provides high level data inputs and functionality:

- System date and time adjustment.
- Alarm level setpoints.
- Calibration settings.
- Datalogging configuration.
- Add/edit operator logins.
- Install HMI software updates.

Config Tab

The Config Tab provides a method of enabling/disabling certain features of the machine. This may include temperature measurement, vessel interlock switches, etc. This may be necessary to avoid alarm conditions that are not applicable to a mix setup, i.e., if a temperature sensor is not being used, its alarming functions needs to be shut. Additionally, this tab allows selection of configured fixtures (mix container and mix container holders) that provide necessary operating parameters and limitations of different fixtures. Refer to the training manual for detailed use of the Config Tab.

Alarming

Alarming for the HMI program is accessed from the Alarms button on the *Main* Screen. After touching the Alarms button, the Alarms dialog appears. This dialog uses a table format to display currently active and/or unacknowledged alarms. The alarms are color coded to indicate their current state as follows:

- Red – active and unacknowledged.
- Light Blue – active and acknowledged.
- Green – inactive and unacknowledged.
- Dark Blue – currently selected alarm for acknowledging only one item.

If an alarm recovers (goes inactive) and is acknowledged, it is removed from the list.

Alarms are acknowledged using the *Acknowledge* and *Acknowledge All* buttons. Individual alarms can be acknowledged by touching their row in the table and pressing the *Acknowledge* button. The entire list of alarms can be acknowledged by pressing the *Acknowledge All* button.

Oil and cooling temperatures have high, high-high, low, and low-low alarms. High and low alarms simply trigger an alarm, but the high-high and low-low alarms will stop the mixer motors. The following table provides these alarm trip points in degrees Fahrenheit:

Oil Temperature Alarm Trip Points (in deg F)		Cooling Temperature Alarm Trip Points (in deg F)	
High-High	150	High-High	70
High	120	High	65
Low	50	Low	40
Low-Low	45	Low-Low	35

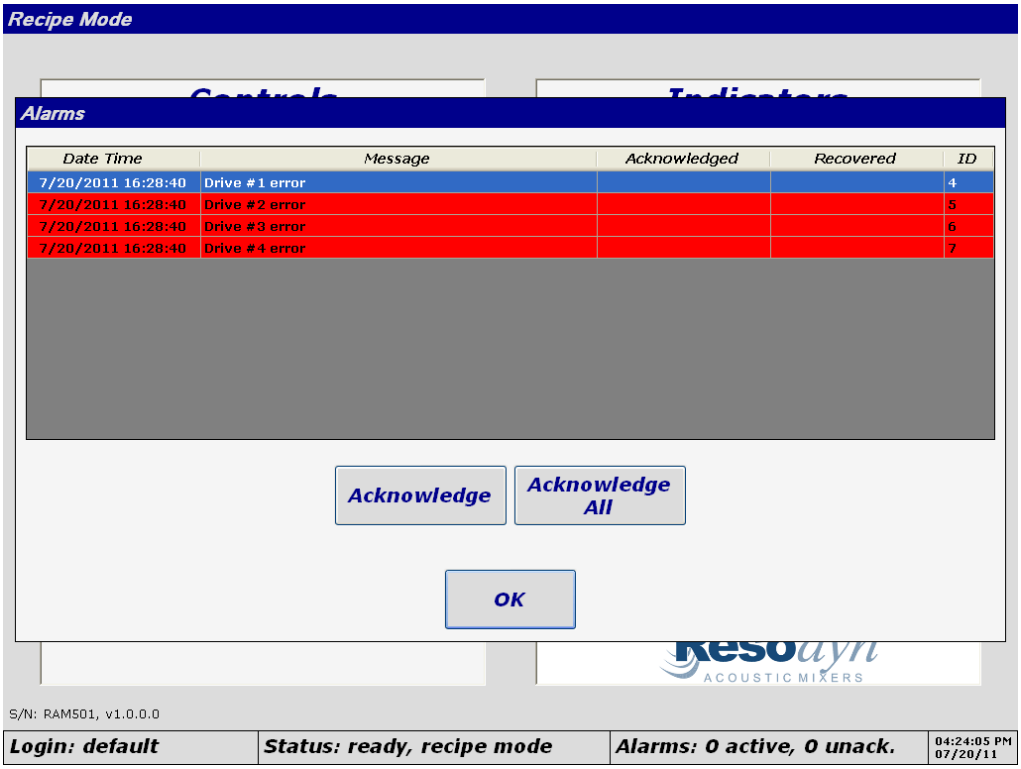


Figure 13: Alarms Dialog

Log Files

Several different types of log files are automatically generated by the HMI program. All log files are stored on the hard drive as comma-separated-variable files for easy viewing in Microsoft Excel. A new log file is created for each day. The following lists the available log files that are created:

- Data log files – store a time history of mix parameters including time and date stamp, acceleration (in g), intensity (in %), acceleration setpoint (in g), frequency (in Hz), and phase angle (in degrees). Also, optional features can be stored, like temperatures and pressures.
- Alarm log files – store the date and time at which alarms are triggered, cleared, and acknowledged. Also stores alarm message and identifier.
- Mix log files – store time stamped comments that are entered before each mix. This can include operator comments, lot number, batch number, mix container information, etc. Additionally, these files log which recipe was used when machine was started and the time at which the machine stopped.

Log file directories are limited to 100 mega bytes. Alarms will be posted to the alarming system when file size exceeds 100 mega bytes, and the oldest files will be deleted one per day when the log file directory exceeds 110 mega bytes.

Troubleshooting

Here are some simple solutions to check before contacting your Resodyn Acoustic Mixers service representative. Use the following chart to resolve operational problems. If the problem persists contact your customer service representative.

Only trained maintenance and service personnel should open Electrical Enclosure doors or remove Acoustic Enclosure panels

Description of Problem	Potential Problem	Solution
Mixer will not power up	Main disconnect off	Turn main disconnect to "On" position
	Main fuses blown	Contact your on-site support staff to have fuses replaced
No start button visible	Alarm active	Correct source of alarm and acknowledge alarms
	Auxiliary system not ready	Wait for auxiliary system to become active and acknowledge any alarms
	Mixer lid switch not engaged	Close mixer lid
X, Y, or Z axis Over g	Unstable mix regime	Contact Resodyn Acoustic Mixers customer service
	Overloaded mix container	Verify weight of mix container and adjust weight to within specification
	Mix media decoupling from mix container wall	Verify vacuum system (if equipped), or contact Resodyn Acoustic Mixers customer service
E-stop interlock open	Emergency stop button pressed	Pull emergency stop button out
	Acoustic Enclosure panel removed	Ensure Acoustic Enclosure panel is latched in place
	Drive error	Try to acknowledge drive error from Alarms dialog, if error is not cleared, contact Resodyn Acoustic Mixers customer service with drive status code from Status Tab of Setup, Configuration and Troubleshooting Screen
Oil high temperature alarm, or flow/pressure alarm	Chiller is off	Turn chiller system to "On" position
	Chiller fluid is too warm	Adjust chiller temperature setpoint down and watch oil temperature from Status Tab of Setup, Configuration and Troubleshooting Screen
	No cooling flow	Verify cooling system pump is active

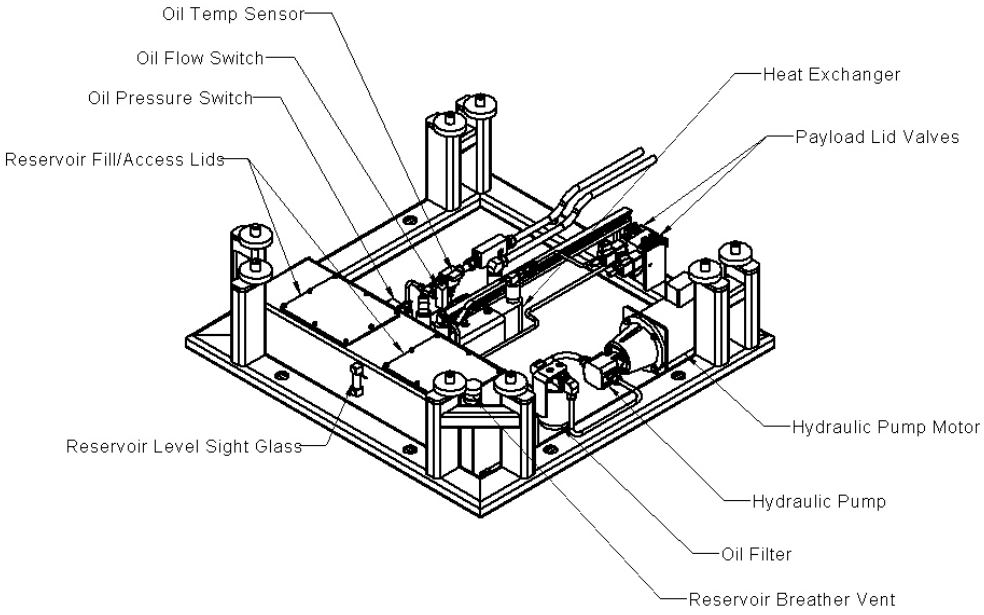
		and valve line-up is correct
	Pump is not running	Check alarm log for an oil pump error and contact customer service if alarm cannot be cleared
	Broken hydraulic line	Turn machine off and contact customer support for replacement parts
Oil low temperature alarm	Chiller fluid is too cold	Adjust chiller temperature setpoint up and watch oil temperature from Status Tab of Setup, Configuration and Troubleshooting Screen
Cooling high temperature alarm or flow alarm	Chiller is off	Turn chiller system to “On” position
	Chiller fluid is too warm	Adjust chiller temperature setpoint down and watch oil temperature from Status Tab of Setup, Configuration and Troubleshooting Screen
	No cooling flow	Verify cooling system pump is active and valve line-up is correct
	Broken cooling line	Turn machine off and contact customer service for replacement parts
Acoustic enclosure interlock open	Compression latch not engaged completely	Verify all enclosure panel compression latches are completely closed
Ethernet communications with drives lost alarm	Unplugged/broken Ethernet cable	Contact your on-site support staff to plug Ethernet cable into switch
Lost comms with RAM_EC alarm	Unplugged USB/Serial cable	Contact your on-site support staff to plug USB/Serial cable back into RAM Embedded Controller

Care and Maintenance

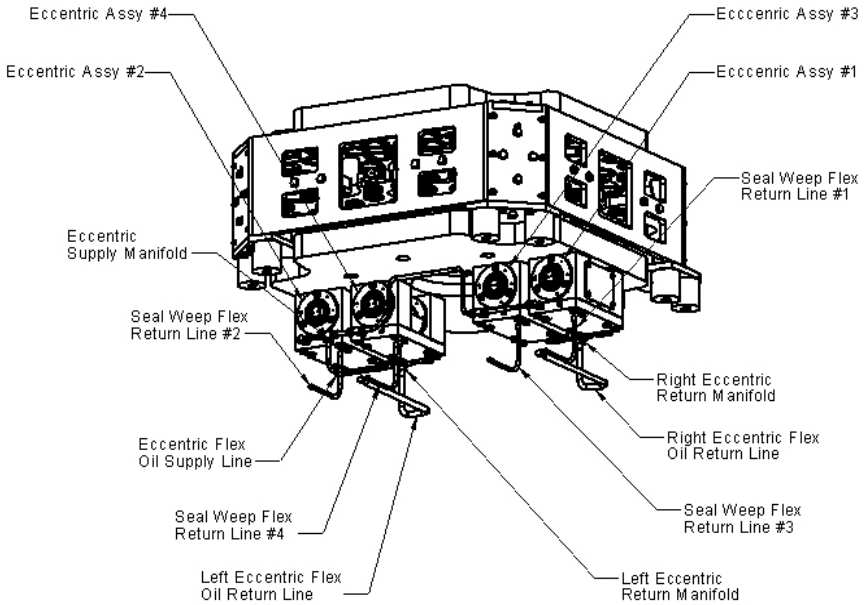
RAM5 Base Machine Preventative Maintenance Schedule														
	Interval	Whichever Comes First												Notes
	Hours	150	300	450	600	750	900	1050	1200	1350	1500	1650	1800	
	Months	1	2	3	4	5	6	7	8	9	10	11	12	
Hydraulic System														
	Reservoir Breather Vent	•	•	•	•	•	•	•	•	•	•	•	•	Replace If Necessary
	Oil Level	•	•	•	•	•	•	•	•	•	•	•	•	Add/Remove If Necessary
	Hydraulic Oil and Filter Replacement												•	
	Suction Screen Inspection						•						•	Clean/Replace If Necessary
	Suction Screen Clean or Replacement												•	
	Flexible Oil Line Inspection			•			•			•			•	Replace If Necessary
	Flexible Oil Line Replacement												•	
	Eccentric Oil Seals Inspection						•						•	
Mechanical Systems														
	Eccentric Assmbly Inspection						•						•	
	Drive Shaft Inspection						•						•	
	Resonator Assembly Inspection						•						•	
	Isolator Spring Inspection						•						•	
	Resonator Spring Inspection						•						•	
Cooling System														
	Cooling Loop Inspection						•						•	
Electrical/Controls System														
	Cabinet Wiring - Inspection												•	
	Resonator Wiring - Inspection			•			•			•			•	
	Accelerometer Cables - Inspection	•	•	•	•	•	•	•	•	•	•	•	•	Replace If Necessary
	Interlock Sensors Inspection						•						•	Replace If Necessary
	Oil Flow Switch						•						•	Replace If Necessary
	Oil Temp Sensor						•						•	Replace If Necessary
	Oil Pressure Switch						•						•	Replace If Necessary
	Coolant Flow Switch						•						•	Replace If Necessary
	Coolant Temperature Sensor						•						•	Replace If Necessary
RAM5 General Procedures														
	General Inspection	Whenever Resonator Compartment Is Accessed												
	Acoustic Panel Removal-Installation	As Required												
	Oil Reservoir Lid Removal-Installation	As Required												
	Hydraulic System Air Removal	As Required												When Hydralic System Opened

Hydraulic System

Frame View



Eccentric View



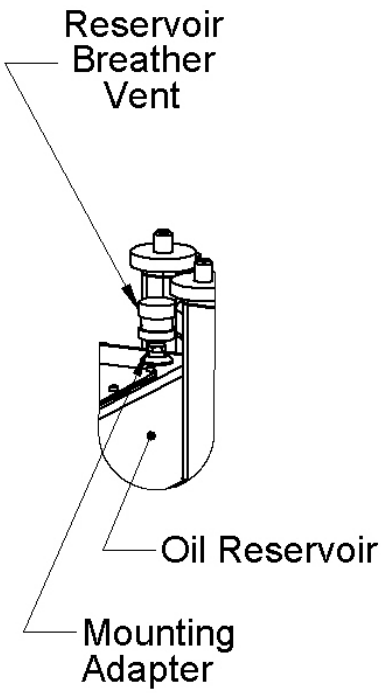
Reservoir Breather Vent

Access

1. Remove either the front or right side acoustic panel, (See Section - Acoustic Panel Removal-Installation) the reservoir breather vent is located on the front right upper surface of the oil reservoir.

Inspection

1. A gradient scale is printed on the side of the breather vent showing a color key from yellow green. This scale indicates the approximate life of the desiccant cells contained within the breather. When the desiccant cells have transitioned from yellow to green the breather vent is ready for replacement. Useful life of the breather vent will vary depending on many factors, local relative humidity and machine usage being the most predominant.



Removal

1. The reservoir breather should only be installed hand tight, and as such be removable by hand, however, if necessary; a strap wrench may be used to loosen the assembly. In order to ensure that the mounting adapter is not loosened during the breather removal process, a 7/8” wrench can be used to keep this adapter from coming loose.
2. Dispose of expired desiccant breather properly.

Installation

1. Install a new desiccant breather in the reverse order of removal. (See Section – Spare Parts). Install only to hand tight.
2. Remove the sealing band from around the breather.
3. If the mounting adapter has loosened during the removal process, tighten until the adapter is snug.

Oil Level

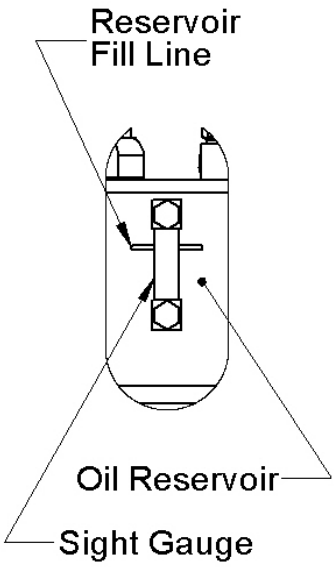
Access

1. Remove the front acoustic panel. (See Section - Acoustic Panel Removal-Installation).

Inspection

1. Find the oil level sight gauge is located on the front of the oil reservoir in the center of the machine.

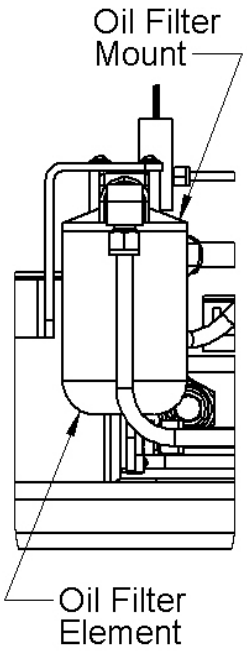
2. The oil level should sit at the line engraved in the oil tank center of the sight glass +0 inch / - 1/2 inch.
3. If the oil level is below acceptable limits, oil must be added, and to the contrary, if the oil level is above operable limits due to overfill, excess oil must be removed.



Additionally, the oil color should be inspected within the sight gauge. The oil should be translucent and a very light shade of yellow to orange, if the oil is losing its transparency and is darker in color the oil has become contaminated and will need to be replaced, additionally if the oil is a tan milky opaque color, excessive moisture has entered the system and an oil/filter/breather change will need to occur immediately. See appropriate sections.

Addition

1. Remove either reservoir fill/access lid. (See Section – Oil Reservoir Lid Removal-Installation).
2. Add required volume of hydraulic oil, so the level is centered in the sight gauge. (See Section – Recommended Fluids).
3. It is recommended that the oil level is added with the use of an oil transfer pump to minimize the possibility of oil spillage.



Removal

1. In the unlikely event that the oil reservoir is overfilled with oil, oil will need to be removed from the system. (See Section – Oil Reservoir Lid Removal-Installation).
2. Once the reservoir has been accessed, a transfer pump must be used to remove oil from the tanks and into a suitable container for disposal.
3. Observe local oil disposal regulations.
4. Replace oil reservoir lid.

Hydraulic Oil and Filter Replacement

Access

1. Remove the front and right side acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Hydraulic Oil Removal

1. Locate the oil filter on the right side of the hydraulic reservoir.

2. Ensure that the RAM5 is off and the hydraulic pump motor is not running prior to performing this procedure.
3. Due to the positioning and low profile nature of the hydraulic reservoir, it is impractical to provide a drain port for the hydraulic reservoir; as such expired oil must be removed by means of a transfer pump that is placed into the tank through one of the reservoir access panels. (See Section - Oil Reservoir Lid Removal-Installation).
4. Once the oil has been removed from the reservoir, it should be placed in a container and disposed of per local regulations, unless the oil is being removed for the purpose of replacing a flex oil line or other service where the oil can be reused. Note: To minimize the potential of contamination, only temporarily store oil in a clean storage container that has contained no other incompatible chemicals.
5. With the reservoir empty, it is highly recommended that the following additional maintenance procedures be performed
    a. The interior of the tank should be wiped down with lint free cloth to remove any traces of sediment that have accumulated over time. For this procedure, both access lids should be removed.
    b. Suction screen clean and inspection. (See Section – Suction Screen Clean or Replace).

Hydraulic Oil Fill

1. To add oil, if not removed already, remove either reservoir fill/access lid. (See Section – Oil Reservoir Lid Removal-Installation).
2. Add required volume of hydraulic oil, so the level is centered in the sight gauge. (See Section – Recommended Fluids)
3. It is recommended that the oil level is added with the use of an oil transfer pump to minimize the possibility of oil spillage.
4. Once the oil has been replaced, the hydraulic system may need to have the air removed. (See Section – Hydraulic System Air Removal). Replace reservoir lid(s).

Hydraulic Filter Change
Filter Removal

1. Ensure that the RAM5 is off and the hydraulic pump motor is not running prior to performing this procedure.
2. Remove the front and right side acoustic panel (See Section - Acoustic Panel Removal-Installation).
3. Place rags or other oil absorbent cloth under the filter to minimize the migration of oil due to potential oil spill.
4. Remove oil filter by hand or using an appropriately sized oil filter wrench.
5. Wipe oil filter mount.

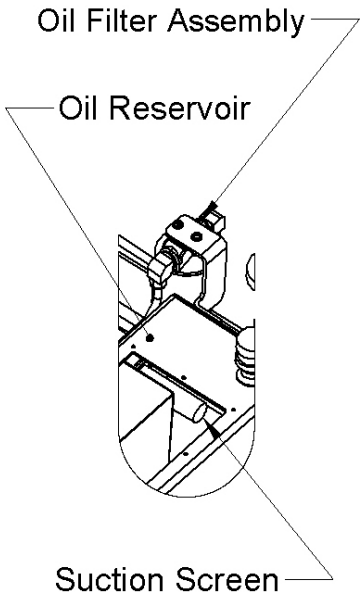
Oil Filter Replacement

1. Take new filter and smear a thin film of clean oil on the gasket. (See Section – Spare Parts).
2. To minimize the amount of air introduced into the hydraulic system, fill the oil filter element with new hydraulic oil. (See Section – Recommended Fluids).
3. Thread the oil filter onto the filter mount until the gasket makes contact.
4. Continue to tighten the filter an additional 1 to 1-1/2 turns.
5. Since air will have entered the hydraulic system, this air will need to be removed. (See Section – Hydraulic System Air Removal).

Suction Screen

Access

1. Remove the front acoustic panel. (See Section - Acoustic Panel Removal-Installation).
2. Remove right side reservoir lid. (See Section - Oil Reservoir Lid Removal-Installation).



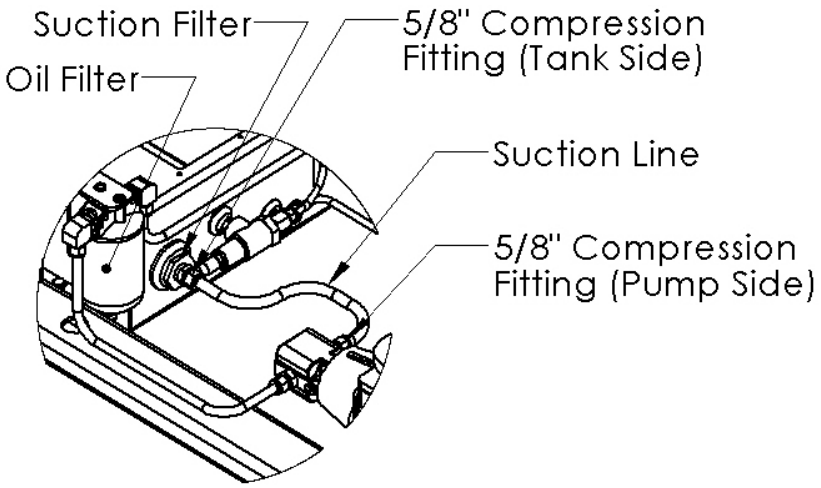
Inspection

1. Locate the suction screen inside the oil reservoir in the lower right corner mounted through the rear face.
2. If the reservoir is empty the screen should be easily visible, look for large particulate adhering to the screen or deterioration of the screen. If there is oil in the reservoir, the screen should be viewable with the air of a light through the oil.
3. If large particulate is identified, remove prior to re-filling the reservoir with clean oil.
4. If any damage or deterioration is noticed on the screen, the screen should be replaced.
5. If there are significant amounts of smaller particulate on the screen, it should be removed and cleaned or replaced.
6. If all oil other oil reservoir service has been completed, fill reservoir with oil and remove air from hydraulic system. (See Section – Hydraulic System Air Removal).
7. Replace oil reservoir lid. (See Section Oil Reservoir Lid Removal-Installation).

Cleaning or Replacement

1. If it is determined that the suction screen requires a more significant cleaning or replacement, then it must be removed.
2. To remove the suction screen, loosen both of the compression fittings on either end of the suction line.
3. The suction line can then be removed by first pulling the pump side out followed by the tank side.
4. With a large wrench unthread the suction filter from the oil reservoir

5. Remove the tank side compression fitting from the suction filter.
6. If the suction filter is to be cleaned and re-used, clean using a suitable solvent and brush. Allow the solvent to completely dry prior to re-installation.
7. If the suction filter is to be replaced, simply discard the old filter adhering to local disposal regulations.



8. With a replacement or cleaned suction screen, wrap the threads with Teflon tape or suitable oil compatible thread sealant.
9. Thread the suction filter into the oil reservoir.
10. Wrap the threads of the tank side compression fitting with Teflon tape or a suitable oil compatible thread sealant.
11. Thread the compression fitting into the suction filter and tighten with a wrench.
12. Replace the suction line into the compression fittings.
13. Hand tighten the compression nut to hand tight and then with a wrench tighten an additional 1-1/4 turn, no more, no less.
14. If all oil other oil reservoir service has been completed, fill reservoir with oil and remove air from hydraulic system. (See Section – Hydraulic System Air Removal).
15. Replace oil reservoir lid. (See Section Oil Reservoir Lid Removal-Installation).

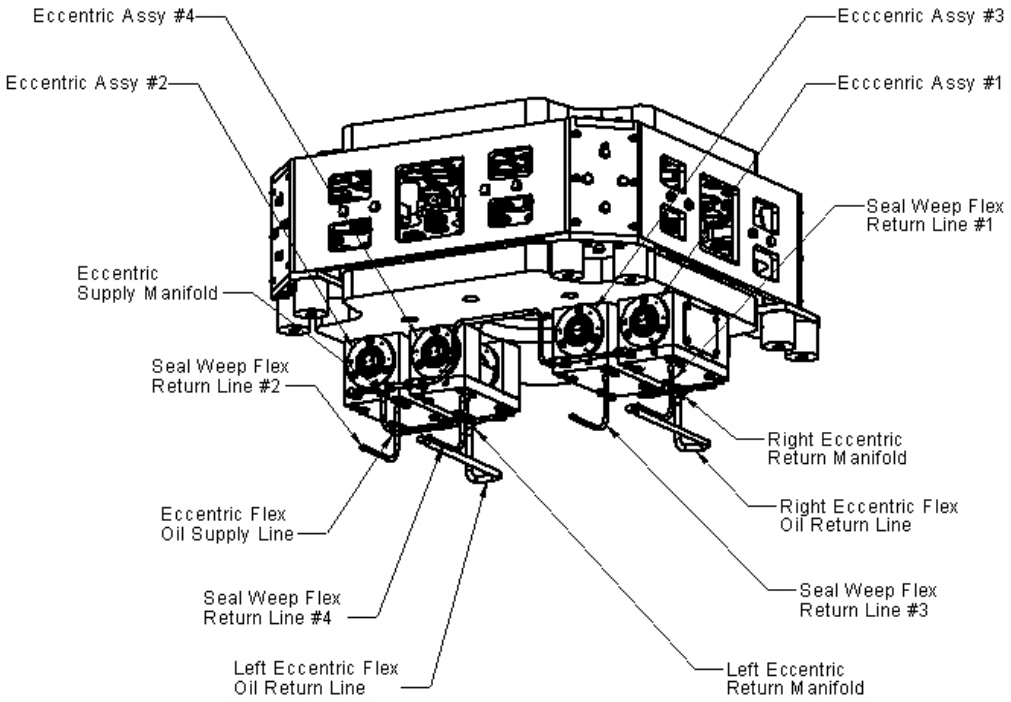
Flexible Oil Line

Access

1. Remove the left and right side acoustic panels; (See Section - Acoustic Panel Removal-Installation).

Inspection

1. Identify the 7 flexible hydraulic lines that run between the eccentric assemblies and the oil reservoir, identified as follows in the above illustration:
    a. Eccentric Flex Oil Supply Line
    b. Left and Right Eccentric Flex Oil Return Line
    c. Seal Weep Flex Return Lines (#1 to #4)
2. Look at each of these lines and check for wear, cracks, or other signs of deterioration.
3. If any of the above signs are identified, the respective line must be replaced.



Replacement

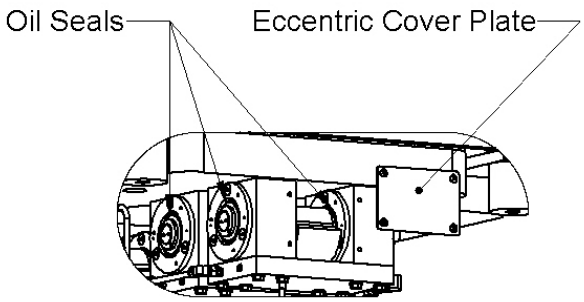
1. This procedure is the same for all flex lines identified in this section other than the Eccentric Flex Oil Supply Line.
2. If the Eccentric Flex Oil Supply Line is to be replaced, it is not necessary to remove the oil from the oil reservoir, otherwise, the oil reservoir muse be emptied below the level of the tank end of the line to be replaced. (See Section – Hydraulic Oil and Filter Replacement, Sub-Section Hydraulic Oil Removal).
3. Place rags or other oil absorbent cloth under each end of the flex line to be removed.
4. Remove the elevated end of the line (this will be connected to a component of the resonator assembly, eccentric assembly, manifold, block, etc. Not the tank).
   Note: this will be the non-swivel end of the line, and as such the line itself must be rotated as the fitting is loosened, however, following this procedure will allow the oil contained in the line to drain back into the oil reservoir as air enters the line.
5. Remove the tank end of the line and dispose of the used line(s) per local disposal regulations.
6. With a replacement part, wrap threaded ends with Teflon tape or a suitable oil compatible thread sealant. (See Section – Spare Parts).
7. Install swivel end into the tank and tighten.
8. Install non-swivel end into non-tank side and tighten.
9. Ensure that the line is not twisted after installation as this can significantly shorten the usable life of the line.

10. When all lines have been installed, refill the oil reservoir. (See Section – Hydraulic Oil and Filter Replacement, Sub-Section Hydraulic Oil Fill).
11. Remove air from the hydraulic system. (See Section – Hydraulic System Air Removal).

Eccentric Oil Seal Inspection

Access

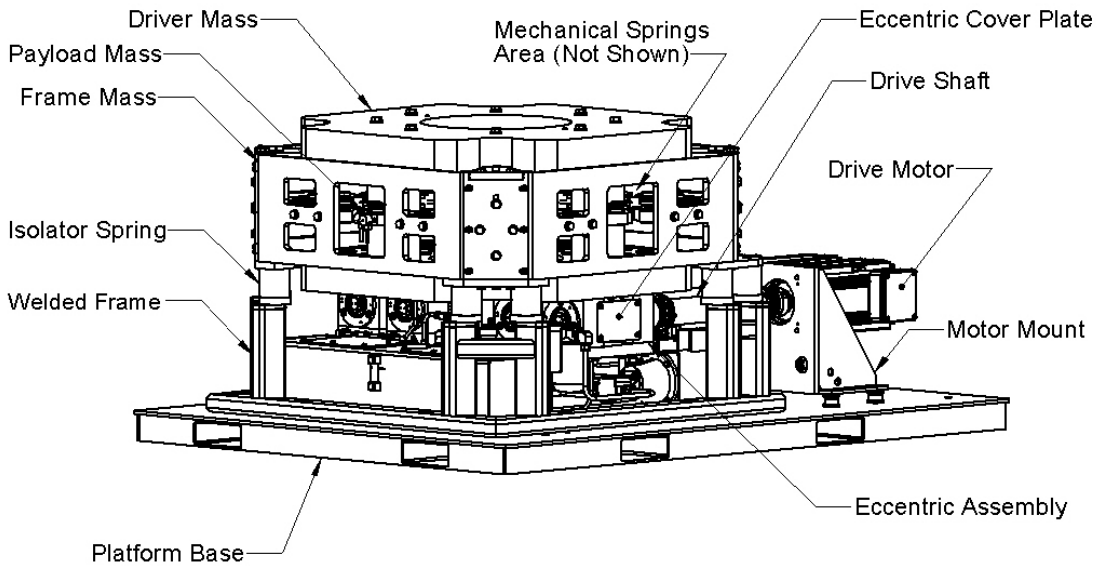
1. Remove all acoustic panels. (See Section - Acoustic Panel Removal-Installation).



Inspection

1. Ensure that the RAM5 is off and is not running prior to performing this procedure.
2. Remove the eccentric cover plates on eccentric assemblies 1 and 2 by removing the 4 button head cap screws.
3. Inspect the seal areas on each eccentric assembly; there are 4 seals per eccentric assembly, 16 total per machine.
4. Check for signs of oil leaking or dripping from these assemblies. Note: Some oil weeping is normal, as is oily black build up around the seal faces. However, pooling of oil under the machine or an oil stream running down the face of the eccentric is not normal.
5. If some oil leaking is found, monitor it over the course of normal operation. If the leaking becomes pronounced, then seal replacement may be necessary, however, seal replacement is beyond the scope of this manual. Contact customer service for troubleshooting and solution to this situation.
6. Wipe the seal faces clean with a rag and replace the eccentric cover plate, apply Blue Loctite and torque fasteners to 66 in-lbf.

Mechanical System



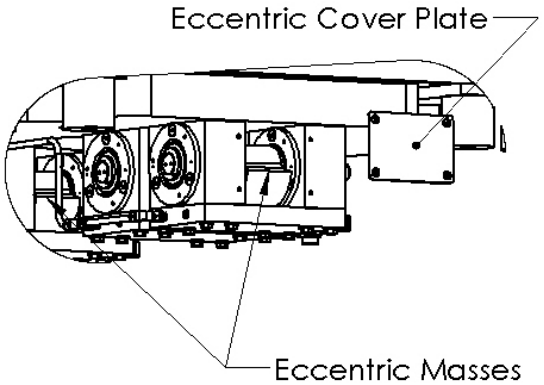
Eccentric Assembly Inspection

Access

1. Remove all acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection

1. Ensure that the RAM5 is off and locked/tagged out prior to performing this procedure.
2. Remove the eccentric cover plates on eccentric assemblies 1 and 2 by removing the 4 button head cap screws.
3. Rotate eccentric masses by hand and check for signs of any resistance to motion. The rotational motion should be smooth.
4. Inspect oil seals. (See Section – Eccentric Oil Seal Inspection).



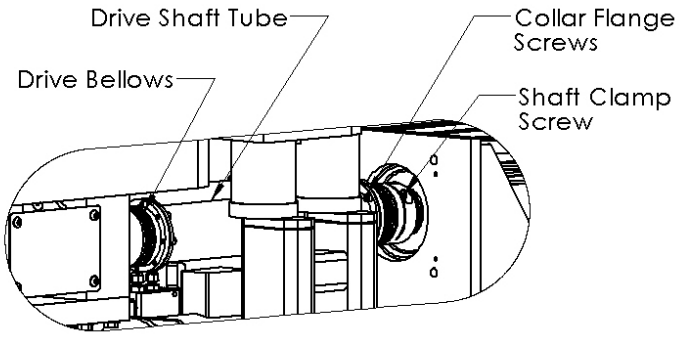
5. Check for signs of oil drips from the bottoms of the eccentric assemblies or pools of oil on the platform base.
6. Ensure all fasteners are in place and none look to be vibrating loose.
7. If necessary wipe down the assemblies to remove typical buildup of particulate

Drive Shaft Inspection

Access

1. Remove both side acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection



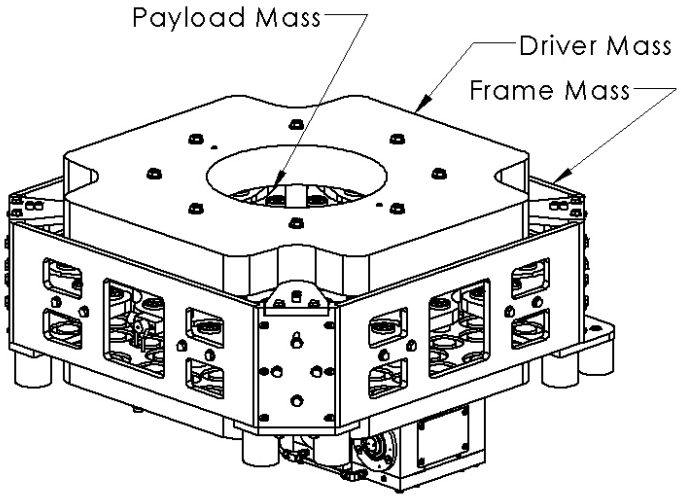
1. Ensure that the RAM5 is off and locked/tagged out prior to performing this procedure.
2. By hand grab drive shaft tube and rotate back and forth, check for any free play in the system and smooth motion.
3. Inspect collar flange screws and ensure that none are missing and all are tight. Replace/tighten if necessary
4. Inspect shaft clamp screws and ensure that none are missing and all are tight.
5. Replace/tighten if necessary
6. Inspect drive bellows and ensure that there are no signs of fatigue. If the drive bellows show signs of fatigue, wear or other breakdown, the shaft must be replaced. Contact customer service for assistance.

Resonator Assembly Inspection

Access

1. Remove all acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection



1. Look over the entire resonator assembly, search for signs of wear, missing/broken fasteners, wear around washers, and potential damage to the spring plates.

Isolator Spring Inspection

Access

1. Remove both side acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection

1. The isolator springs are cylindrical rubber blocks located on top of the welded frame post and connect with the lower side of the resonator frame mass. See the mechanical overview drawing to aid with the identification and location of the isolator springs.

Resonator Spring Inspection

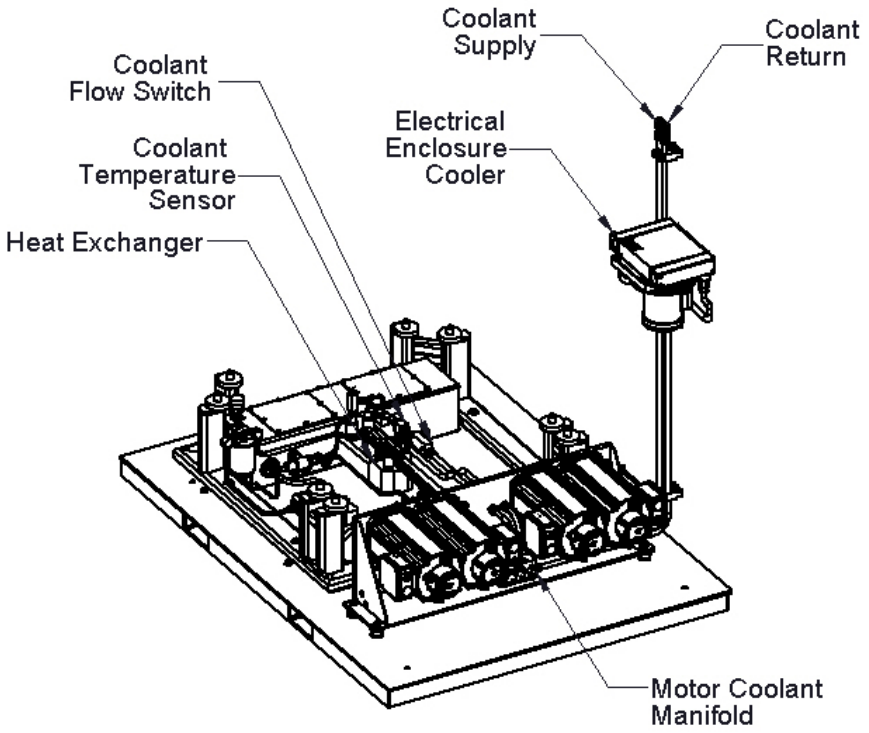
Access

1. Remove all acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection

2. Look through the material cutouts in the frame mass to observe the coil springs. With a flashlight look at the springs, look for signs of breakage or inconsistent/abnormal wear.

Cooling System Overview



Cooling Loop Inspection

Access

1. Remove Left side acoustic panel and open electrical cabinet. (See Section - Acoustic Panel Removal-Installation).

Inspection

1. Ensure that the RAM5 is off and locked/tagged out prior to performing this procedure.
2. The RAM5 cooling system requires little maintenance provided the cooling system is supplied with proper coolant. (See Section – Recommended Fluids).
3. Systematically check the system for leaks, the flow path is as follows:
    a. In through the supply port on the top of the electrical cabinet.
    b. Through the coolant manifold.
    c. Distribution through the motors.
    d. Back into the distribution manifold.
    e. Through the motor mount and into the resonator compartment.
    f. Through the coolant flow switch.
    g. Through the coolant temperature sensor.
    h. Through the heat exchanger.
    i. Back into the electrical enclosure.

   j. Through the enclosure cooler.
   k. Exit the RAM5 through the Coolant return tube.
4. Inspect all fitting for leaks.
5. Inspect coolant lines for wear or corrosion.
6. Check the platform base for puddles, either dried or wet.
7. The color of the coolant is visible through the motor coolant lines, between the distribution manifold and motor cooling ports.

Electrical/Controls System

Cabinet Wiring Inspection

Access

1. Open electrical cabinet.

Inspection

1. Ensure that the RAM5 main power is off and locked/tagged out prior to performing this procedure.
2. Inspect wiring within the RAM5 electrical cabinet.
3. Check for loose connections.
4. Check for wires that look like they may have damaged insulation.
5. Wipe down the inside of the cabinet if there are any dust deposits.

Resonator Wiring Inspection

Access

1. Remove both side acoustic panels and open electrical cabinet. (See Section - Acoustic Panel Removal-Installation).

Inspection

1. Inspect wiring that goes from the electrical cabinet to the devices in the enclosure.
2. Inspect wiring/connectors on devices for fluids that may have leaked on them and wipe clean if necessary.
3. Check for wires that look like they may have damaged insulation.

Accelerometer Cable Inspection

Access

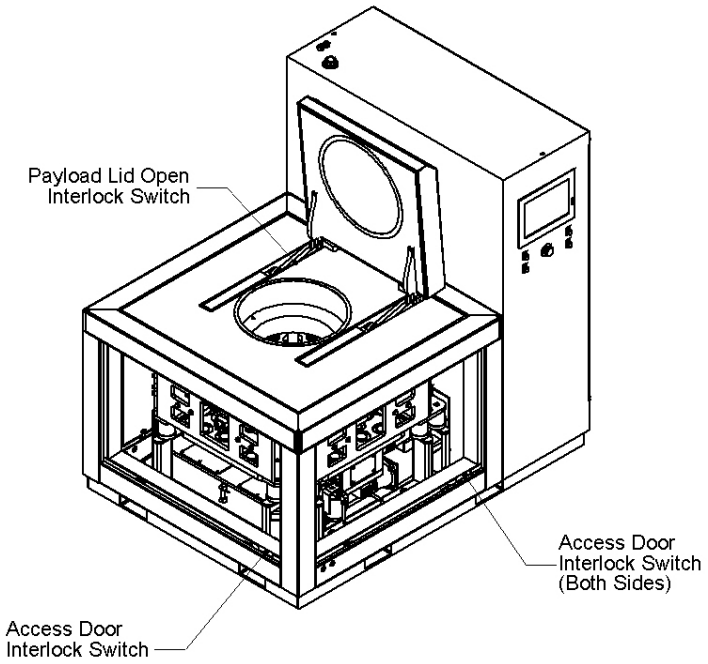
1. Remove front acoustic panel and open the payload lid. (See Section – Acoustic Panel Removal-Installation).

Inspection

1. Ensure that the RAM5 main power is off and locked/tagged out prior to performing this procedure.
2. Locate Accelerometers; X and Y Axis are located on the front edge of the payload plate. Location of the Z-Axis accelerometer will vary depending on the payload tool installed in the RAM5, most typically, this accelerometer is located on the tool mounting flange.
3. Inspect the wire as is moves from the vibratory components to stationary components, most particularly look at the wire as it leaves the accelerometer and where it attaches the stationary component.

Interlock Sensor Inspection

Acoustic Enclosure Interlock Layout Overview



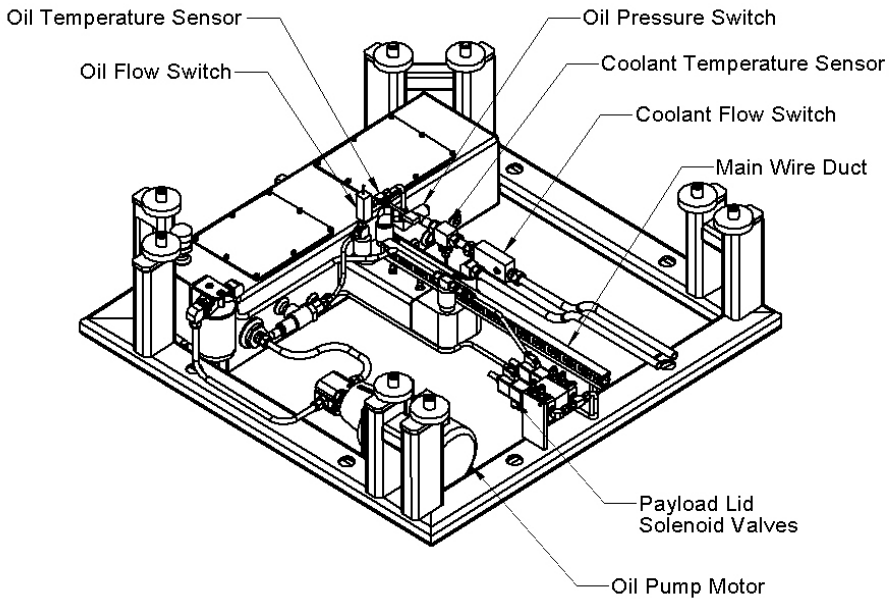
Inspection

1. Locate access interlock switches.
2. Inspect switches for wear or damage.
3. Open the Setup/Config Screen in the HMI, and identify the readout for the interlock sensors.
4. With the power applied to the RAM5 remove and re-install the acoustic panels, verify that this operation is viewed in the Setup/Config Screen in the HMI.
5. With the power applied to the RAM5 open and close the payload lid, verify that this operation is viewed in the Setup/Config Screen in the HMI.
6. Should any of these safety interlock switches fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

Operation Sensor/Device Inspection

- **Oil Flow Switch**
- **Oil Temp Sensor**
- **Oil Pressure Switch**
- **Coolant Flow Switch**
- **Coolant Temperature Sensor**

Operation Sensor/Device Layout Overview



Access

1. Remove both side acoustic panels. (See Section - Acoustic Panel Removal-Installation).

Inspection – Oil Flow Switch

1. Locate the oil flow switch.
2. Inspect switch for wear or damage, and check electrical connections for potential trouble.
3. Open the Setup/Config Screen in the HMI, and identify the readout for the oil flow switch.
4. Manually power the oil pump via the breaker in the electrical cabinet and ensure that the HMI indicator readout coincides with the operation of the oil pump. (See Electrical Drawings Section to locate this switch).
5. Should the Oil Flow Switch fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

Inspection – Oil Temp Sensor

1. Locate the Oil Temp Switch.
2. Inspect switch for wear or damage, and check electrical connections for potential trouble
3. Open the Setup/Config Screen in the HMI, and identify the readout for the oil flow switch.
4. Start the RAM5 and verify that the temperature readout on the HMI reads predictably with the operation of the machine.
5. Should the Oil Temp Sensor fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

Inspection – Oil Pressure Switch

1. Locate the Oil Pressure Switch.
2. Inspect switch for wear or damage, and check electrical connections for potential trouble
3. Open the Setup/Config Screen in the HMI, and identify the readout for the Oil Pressure Switch.
4. Start the RAM5 and verify that the pressure switch readout on the HMI reads predictably with the operation of the machine.
5. Should the Oil Pressure Switch fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

Inspection – Coolant Flow Switch

1. Locate the Coolant Flow Switch.
2. Inspect switch for wear or damage, and check electrical connections for potential trouble
3. Open the Setup/Config Screen in the HMI, and identify the readout for the Coolant Flow Switch.
4. Manually power the coolant pump via chiller or other coolant source and ensure that the HMI indicator readout coincides with the operation of the oil pump.
5. Should the Coolant Flow Switch fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

Inspection – Coolant Temp Sensor

1. Locate the Coolant Temp Switch.
2. Inspect switch for wear or damage, and check electrical connections for potential trouble
3. Open the Setup/Config Screen in the HMI, and identify the readout for the Coolant Temperature Sensor.
4. Start the RAM5 and verify that the temperature readout on the HMI reads predictably with the operation of the machine.
5. Should the Coolant Temp Sensor fail to transmit a signal to the HMI, replacement of the device may be required, contact customer service for assistance.

RAM5 General Maintenance Procedures

General Inspection

This is a general inspection is to be carried out whenever the RAM5 machine is accessed, and is more a point of practice than an actual procedure. Items to look for are pools of fluid on the machine platform, loose or damaged wiring, loose or damage fittings, broken fasteners, etc.

Acoustic Panel Removal and Installation

Removal

1. For virtually all resonator maintenance the acoustic panels will need to be removed.
2. The acoustic panels are held in place by 4 draw latches located in the corners of each respective panel.
3. In order to remove the panels, the handle of the draw latch is lifted out from the machine. This action releases the compression on the latch pin.
4. Once the load is off of the latch pin, it is then able to be turned 90° to allow the acoustic panel to be pulled away from the machine.
5. Pull acoustic panel away from machine. Note: The Acoustic panels will typically require two people.

Installation

1. Installation of the acoustic panels is reverse of the removal procedure.
2. Fit the acoustic panel into the frame opening.
3. Engage the latch pins by rotating the handles.
4. When the handles are oriented correctly, flip the handles down to draw the acoustic panel into place.

Oil Reservoir Lid Removal-Installation

Removal

1. To remove either of the oil reservoir lids, remove the M6 socket head cap screws holding the lid in place.
2. Remove the lid.
3. Ensure that the underside of the lid remains clean while removed from the reservoir.
4. Inspect the sealing gasket, replace if necessary.

Installation

1. Wipe bottom of lid to ensure no particulate is introduced to the hydraulic system.
2. Replace lid over gasket and line up holes.
3. Insert M6 screw and tighten hand tight.
4. Torque screws to 5 ft-lbf.

Hydraulic System Air Removal

After the hydraulic system has been opened up for service or maintenance, air must be removed from the system.

1. Once all connections are closed and the reservoir is filled to the appropriate level, the RAM5 and oil pump are started.
2. The system will most likely run louder than normal as an air and oil mixture is moved through the piping and the oil pump.
3. Once the bulk air has moved through the system, the system will quiet itself.
4. Next operate the hydraulic payload lid several times to remove any air that may have become entrained in those lines.
5. Run the resonator at the lowest g setting for about 20 minutes and this should remove all additional air from the system, if the lid is removed from the oil reservoir, there will be no air bubbles visible in the tank and the procedure will be verified complete.
6. If there is continued hydraulic noise generated, repeat the above procedure, if the system is unable to be quieted, contact customer service for assistance.

Required Fluids

Required Fluids	
Fluid	**Part Number**
Ethylene Glycol, 40%	Chevron DELO Extended Life Coolant/Antifreeze
Water, 60%	Distilled
Hydraulic Circulating Oil	Chevron Rando HDZ ISO 46 VG
	Mobile DTE 10 EXCEL ISO 46 VG