SERIES 2|LHS+

RATED CAPACITY INDICATOR



USER MANUAL: SERIES 2LHS+ (STANDARD AND SPACEGUARD)

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1 INTRODUCTION

The Series 2LHS+ is an integrated road-rail rated capacity indicator system.

The system incorporates state of the art sensing and processing to provide audible and visual warning, plus machine control signals. This manual applies to GKD Series 2LHS+ systems only.

Information contained in this instruction guide may not apply to previous versions.

2 WARNING

During normal operation the Safe Working Load (Rated Capacity) of a crane should not be exceeded. Therefore the warning of overload should not be used as a normal operating facility. It should be noted that certain statutory requirements do not permit the safe working load to be exceeded except for the purpose of testing.

THIS RCI IS NOT SUITABLE FOR USE IN EXPLOSIVE ATMOSPHERES. ADJUSTMENT BY UNAUTHORISED PERSONS WILL INVALIDATE ANY WARRANTY OR CERTIFICATION SUPPLIED. IF A PROBLEM ARISES WHICH CANNOT BE RECTIFIED USING THESE INSTRUCTIONS, AUTHORISED SERVICE SHOULD BE SOUGHT.

THIS DEVICE IS CERTIFIED TO MEET CURRENT UK & EC SAFETY REGULATIONS FOR EXCAVATORS USED AS CRANES, AND IS COMPLIANT WITH RSSB STANDARD RIS-1530-PLT Issue 6.

Series 2LHS+ SPACEGUARD IS CERTIFIED TO MEET THE CONDITIONS OF NETWORK RAIL REMIT MLD-R003 FOR MOVEMENT LIMITING DEVICES WORKING ADJACENT LINE OPEN AND UNDER LIVE OVER-HEAD CABLES, PROVIDED IT HAS BEEN INSTALLED AND CONFIGURED IN ACCORDANCE WITH GKD INSTALLATION AND CALIBRATION INSTRUCTIONS, IS USED IN ACCORDANCE WITH THE GKD OPERATING INSTRUCTIONS, AND IS SUBJECT TO REGULAR TESTS TO ENSURE CORRECT OPERATION.

3 SERIES 2LHS+ SPACEGUARD

Series 2LHS+ SpaceGuard systems are certified to work under OLE and system 1, 2 and 3 ALO conditions. It is the responsibility of the operator to ensure that the system is fully operational and that the dimensions of any load or attachment is taken into account when setting limits. In operation, the slew speed of the machine should never exceed 2 meters per second measured at the bucket pin when a slew limit or virtual wall is set.

4 DEFINITIONS

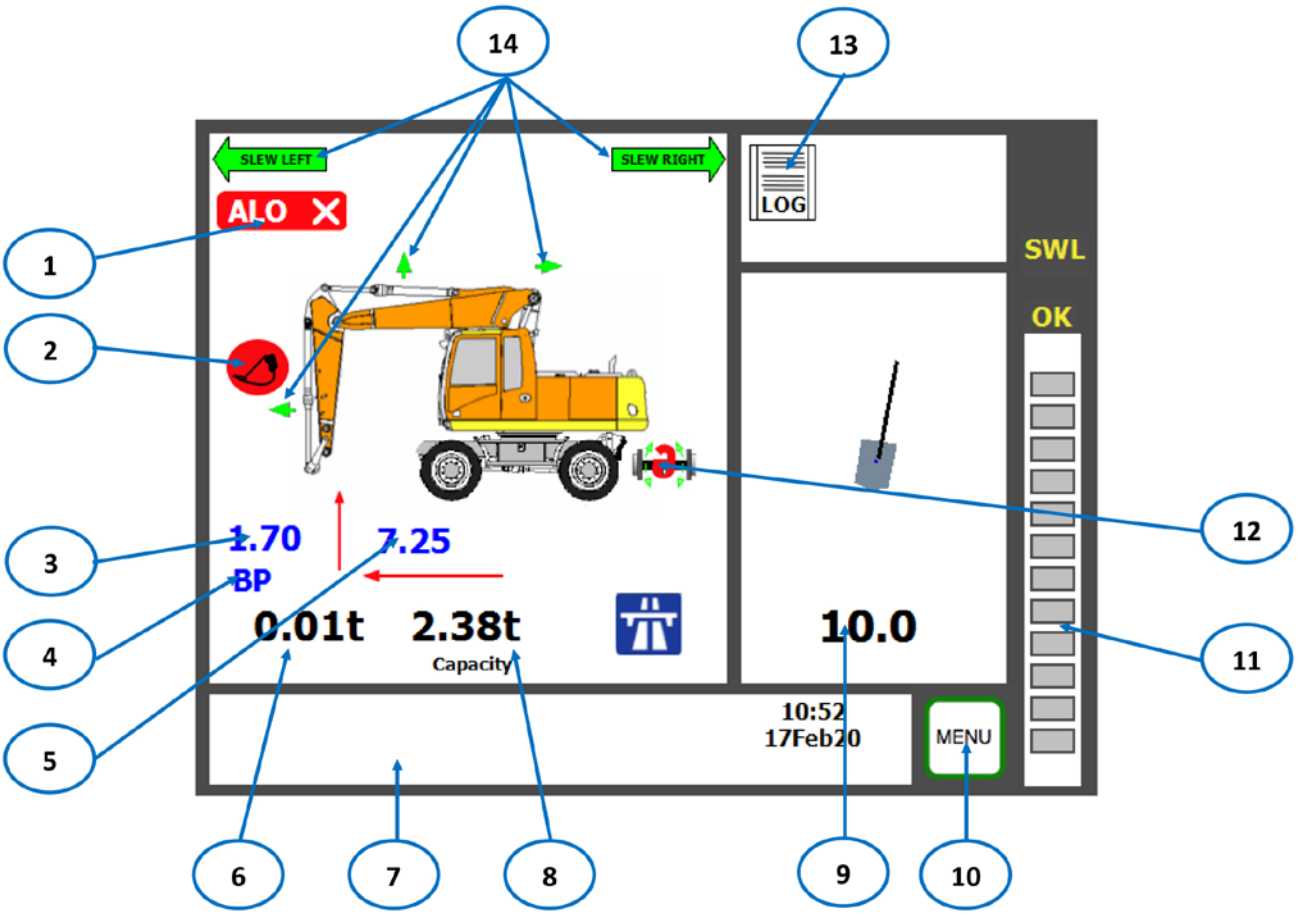
Radius	Radius is defined as the horizontal distance between the slew centre line and the bucket pin. This is the slew centre line measured at the joint between the upper and lower machine structure.
Height	Height of bucket pin measured from the virtual plane created by the supporting wheels. This height may not correspond to the measured height between the ground and the bucket pin when operating on canted and gradient rail.
Rated Capacity	The maximum load that may be lifted at the current radius and height. The weight is shown in tonnes. This is usually determined as a percentage of the load that will tip the machine.
Slew Angle	The angle measured in degrees that the turret is positioned referred to the zero slew point. Zero slew angle is when the turret (and operator) is facing the floating axle and direction of travel of the machine.
S.W.L.	Safe Working Load. Term which has been replaced by Rated Capacity.
Articulated Boom	An articulated boom is a boom comprised of two pieces with a hydraulically adjustable centre section.
Planning Chart	A planning chart comprises of a series of charts giving rated load capacity of the excavator at different radius and heights. This information is used to determine that the machine is capable of performing the lifting operation.
Module	External module providing inputs, outputs or additional processing. Typical installations may use four or five modules in total.
Unloaded Wheel	A wheel upon which the load is reduced from the normal balanced status of the machine.

5 SCREEN LAYOUT



Screen layout		
1	Foreman Key switch	Machine Controllers Switch (Foreman's key switch) allows or denies access to the user settings and service menus. Used when there are slew and height limits in use to avoid accidental changes by the operator.
2	Display	Touchscreen colour display which provides user information and control of the system.
3	Overload warning LED	**RED LED** illuminates to show when the machine is in an overload condition.
4	Rated Capacity warning LED	**AMBER LED** illuminates to show when the machine is approaching the rated capacity and overload condition.
5	System power Comms OK	**GREEN LED** flashes continuously to indicate power and system operation.
6	Light Sensor	Automatically dims or brightens the screen, depending on lighting conditions.

5 SCREEN LAYOUT continued...



Screen layout		
1	ALO Symbol	Series 2LHS+ SpaceGuard systems that are certified to work Adjacent Line Open will show the symbol **"ALO √"**. Series 2LHS+ systems that are not certified to work Adjacent Line Open, or approved systems without operational slew limits or virtual walls, will show **"ALO X"**.
2	Dig Mode	If the system is in dig mode this icon shows green. The motion cuts and alarms on overload are disabled and the blue beacon is not illuminated.
3	Height	Height of lift point from ground level (road mode) or rail head (rail mode).
4	Active Lift Point	The current active lift point is shown here. Possible options are **BP** (Bucket Pin), **ALP** (Auxiliary Lift Point), **QH** (Quick Hitch), or **TLJ** (demountable Tele-jib). If nothing's shown here then only one lifting point is enabled (Bucket Pin).
5	Radius	Radius of current lift point from the slew centre of the machine.
6	Load	Displays the current load on hook. This will include any attachments and the quick hitch.
7	Status Bar	This area shows machine information, error messages and current date and time.
8	Rated Capacity	Shows the maximum permitted load for the current height and radius. **Note:** when an * appears against this number, it will indicate that either the machine is in hydraulic limit or the rating displayed is the maximum based on the hydraulic limitations of the machine.

Screen layout continued...		
9	Slew	Shows the current slew angle in degrees. 0° is typically over the oscillating axle.
10	Menu button	Allows access to user and service functions. **Note:** if the machine controllers key switch is off then the system will not allow access to service menus or limit functions.
11	RCI Status Bar	This bar fills from bottom to top and provides a visual reference of the relationship between the applied load and the rated capacity. A warning will occur at **90%** of the rated capacity. This warning is an **AMBER LED** and an audible alarm on the cab. If the applied load should exceed **100%** of the rated capacity then the **RED LED** is lit and a continuous external siren is sounded. The machine will then be inhibited to prevent further unsafe movements.
12	Axle Lock Icon	Shows the current state of the axle lock. A locked padlock indicates that the axle is locked, an unlocked padlock indicates that the axles are unlocked, and an unlocked padlock with a cross through it indicates that the axles cannot be unlocked as it is unsafe to do so as it would put the machine into an overload condition.
13	Logging	This icon shows the status of the onboard data logging system. There are three states for the icon. 1. **Not shown - logging is disabled.** 2. **Logging icon - Logging is on and an event has been recorded.** 3. **Logging symbol with red cross - Log is inoperative or card full.**
14	Movement	These arrows indicate the safe direction each piece of equipment can be moved. **GREEN** indicates movement is safe. **RED** indicates movement is unsafe.

6 OPERATION

6.1 Auto-diagnostics

During the start up procedure, and during normal operation, the system performs constant checks on all inputs and systems to ensure that the data is within prescribed limits. If an input data is in error then the system will issue a warning. Depending on the severity of the error, the system may continue to operate at a de-rated performance or forbid further operation. The system may request the operator to slew through the zero reset (over the front of the machine). The operator will be required to acknowledge the message to remove the warning.

6.2 Daily Checks

Before operating this system, the operator should check the following on a daily basis:

- Visually inspect the angle sensors and pressure sensors for damage or misalignment.
- Visually inspect angle sensor and pressure sensor cables for damage and proper connection.
- Start the machine to allow RCI to complete start-up procedure. Note any errors and call service if required.
- Raise boom and then slew through 360 degrees to ensure the slew counts correctly and allow a reset of slew to be carried out (important if the machine has been idle for a long period of time). Ensure the slew counts in both directions.
- Operate the booms and verify that the height and radius displayed on the screen correspond with the actual height and radius to the selected lift point, and that the displayed height and radius change as appropriate when the booms are moved.
- Select the **MENU** screen and press the **TEST** tab, and then press the alarm test button. The external indicator lamps and alarms should be activated one by one in sequence as reported on the Series 2LHS+ screen. Verify that they all work as expected.

For SpaceGuard systems the following checks should be carried out, in addition to those listed above, prior to commencing works in a restricted area. These checks should form part of a pre-use work procedure which should be signed by the operator and witnessed by a competent person.

- Set a height limit. Operate the machine at full speed to attempt to exceed the height limit.
- Set slew limits. Operate the machine at full speed to attempt to exceed the slew limit.
- Set virtual wall limits. Operate the machine at full speed to attempt to exceed the wall limits.

6.3 Touchscreen

The Series 2LHS+ system uses a colour touchscreen for control of the indicator functions. The touchscreen is designed for use by finger or gloved hand or with an approved stylus.

DO NOT ATTEMPT TO USE ANY SHARP OR HEAVY ITEMS TO OPERATE THE INDICATOR. USE OF UNAUTHORIZED OBJECTS MAY SCRATCH THE OVERLAY OR DAMAGE THE SCREEN GLASS AND THIS DAMAGE WILL NOT BE COVERED UNDER WARRANTY.

6.4 Switching On

The RCI automatically engages when the machine is switched on and started.

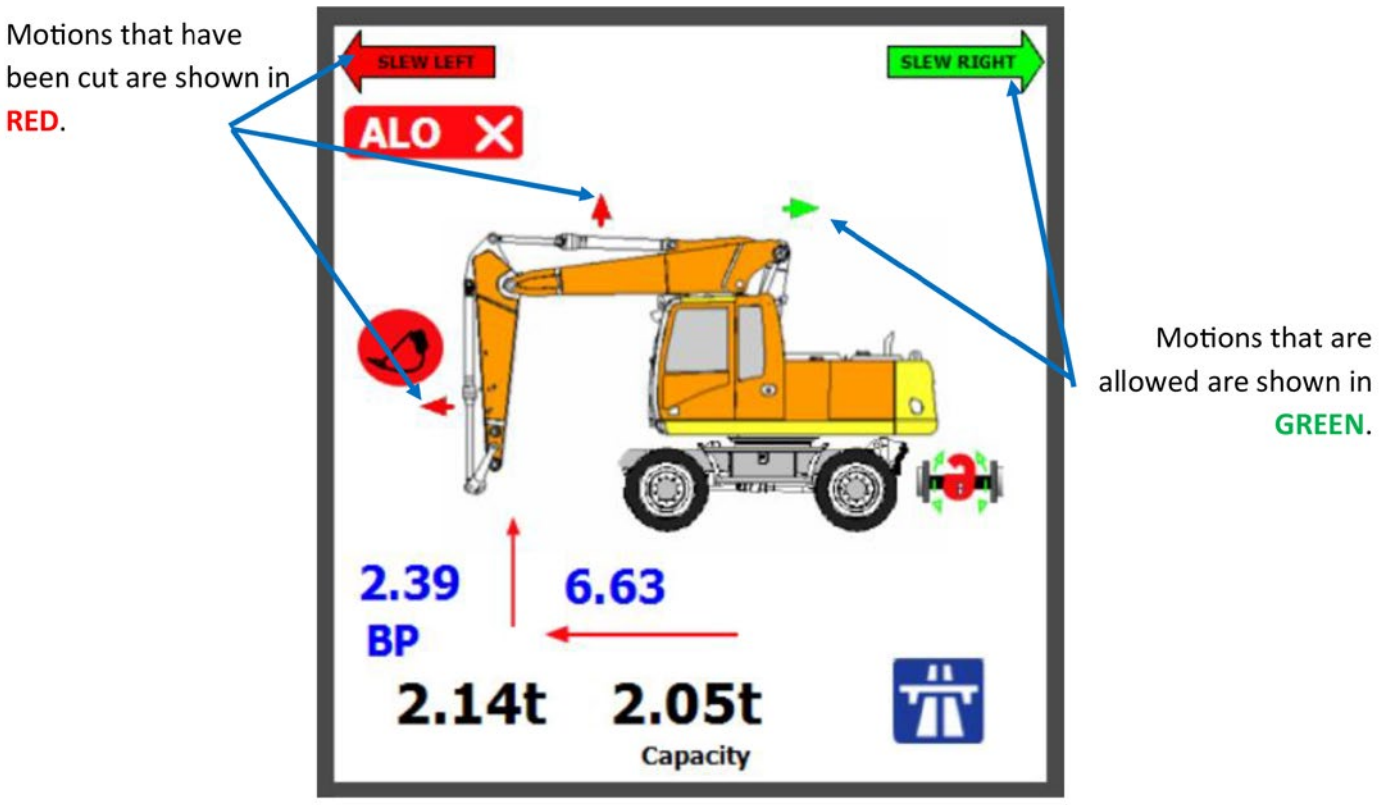
The system automatically detects the machine status.

6.5 External Indicator Beacons

- **RCI Beacon** - The system is fitted with at least one beacon on the outside of the cab. This may take the form of a lamp or LED strip. The beacon is illuminated when the machine is configured in a lifting duty. The beacon will be turned off when the machine is in DIG mode. The beacon is typically magenta in colour, but any colour can be used.
- **Limit Set Beacon** - Series 2LHS+ SpaceGuard systems will have a specific beacon installed on the roof of the cab. This beacon illuminates when a height limit, angular slew limit or a virtual wall has been set AND the foreman key switch on the display is in the locked position.

6.6 Motion Cuts

When a lifting duty is engaged, the RCI system will protect the machine from moving into unsafe conditions when unstable. The overload alarm will sound at this time. To aid the driver to recover to a safe position the system graphics provide a visual indicator of the allowable motions through use of coloured arrows associated with each hydraulic function.



The RCI uses intelligent algorithms to determine which motions are allowable and will only release valves to reduce the overturning moments. All motion valves are de-activated when the RRV engine is switched off. This is a battery saving feature and will show all the arrows as red accompanied by an **"engine off"** message on the front screen.

6.7 Axle Lock

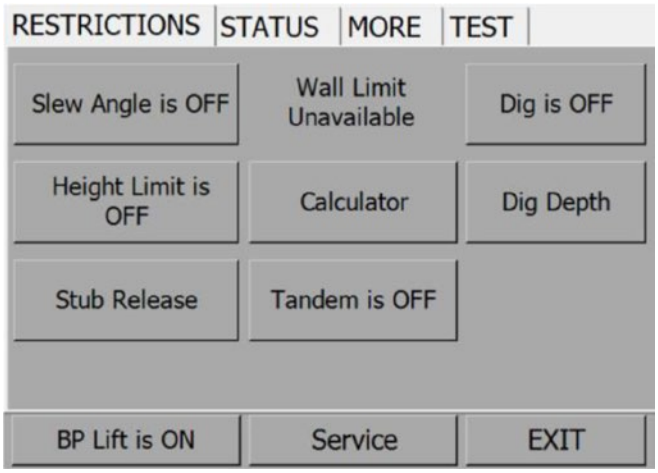
The axle unlock is controlled by the RCI system. When the machine is in an axle locked configuration the system will calculate if it is safe to unlock the axle on the operator command. If it is unsafe then the axle will remain locked until the load is reduced. The axle lock icon will be greyed out and a red cross is shown through it.

7 USER SETTINGS

User settings are reached by pressing the **MENU** button on the front screen. Some features are only available when the machine controller's key is in the unlocked position.

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The **RESTRICTIONS** screen is shown to the right. There are five tabs which switch between restrictions and status screens showing the current configuration of the machine.



To return to the main screen press the **EXIT** button.

- **Restrictions** - Operator options for setting limits, operating modes, lift point selection and recovery conditions.
- **Status** - Shows system status for diagnostics.
- **More** - Screen which shows all error conditions (the front screen only shows highest relevant error condition).
- **Test** - Accesses the test screens, including the alarm test button used as part of the daily system check.

The **TEST** button (inside the **TEST** tab) and **SERVICE** button are password protected and allow access to maintenance and diagnostic modes. System operation is not possible when inside the test screens, service mode access is data logged with time and date.

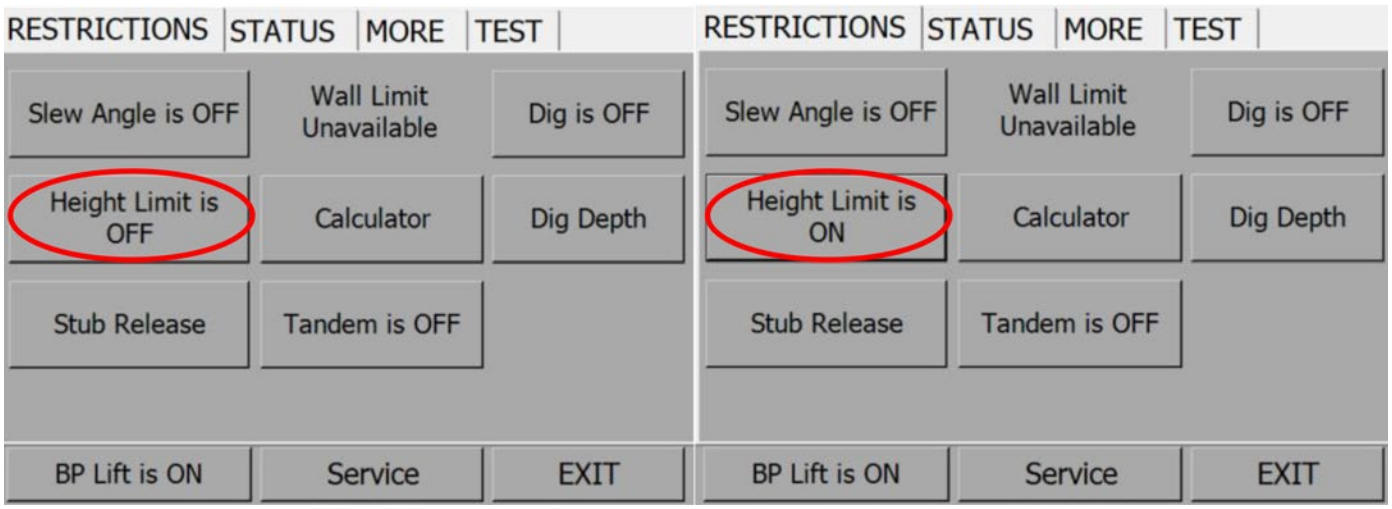
8 HEIGHT RESTRICTION

Height restriction is defined as the maximum height that the excavator can work at. This allows the machine to be used in restricted areas such as tunnels, stations and under overhead wires.

WARNING: THE HEIGHT RESTRICTION FUNCTION IS DESIGNED TO BE USED AT SLOW LIFT SPEEDS ONLY. USE AT SPEED MAY RESULT IN AN OVERSHOOT INTO A POTENTIALLY DANGEROUS POSITION.

The height restriction functions in the GKD Series 2LHS+ continually monitor the highest part of the machine. If the highest part of the machine should exceed the pre-programmed height restriction then the appropriate motion cut signals will be activated.

The buttons in the **RESTRICTIONS** menu indicate the current status of the restriction. The two screens below show the height limit switch legend when the restriction is off and on. When set, the height limit is shown on the front screen as a red line above the machine graphic. The text in blue shows the current height of the highest part of the machine, the red height figure under the red line indicates the current active height limit.



8 HEIGHT RESTRICTION continued...

8.1 Setting a height limit

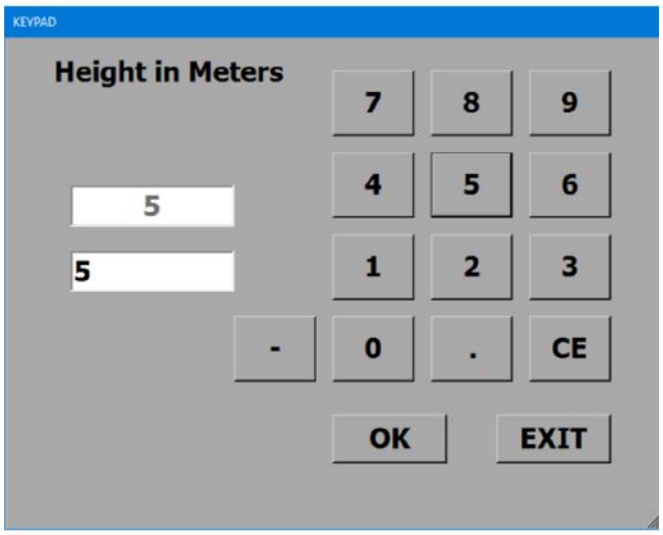
There are two methods of setting the restriction value, either by entering a height on the keyboard or by moving the machine to the required limit and capturing a position.

To enter a height press the **"Height Limit is OFF"** button to begin the height limit set procedure.

The system will now ask you to confirm that you wish to enter the height via the keyboard.



Select **"YES"** to enter the height in meters via the keyboard. Otherwise select "NO" to capture the machine position.



If **"NO"** is selected, the system will prompt you to move the machine to the maximum height. Move the machine booms to the maximum height that is allowed.

Select **"YES"** to set the restriction. The height limit will be set based on the highest point of the machine equipment.

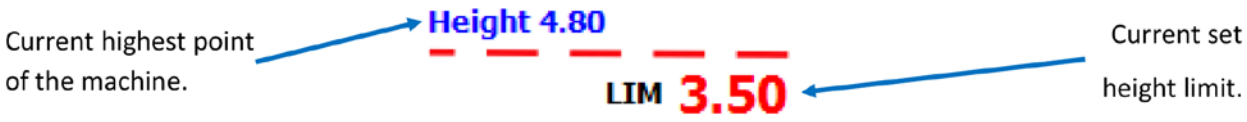
You may exit from this screen without setting a height restriction by selecting the **"NO"** button.



Once a height limit has been set, when the machine reaches the set limit the hydraulic lift circuits will automatically be restricted.

The main display will show the active height limit in red below the current machine height display, which is shown in blue . When the programmed maximum height is reached then machine movement will be restricted. Any motion cuts that are inhibited will be shown in red on the depiction of the machine on the screen.

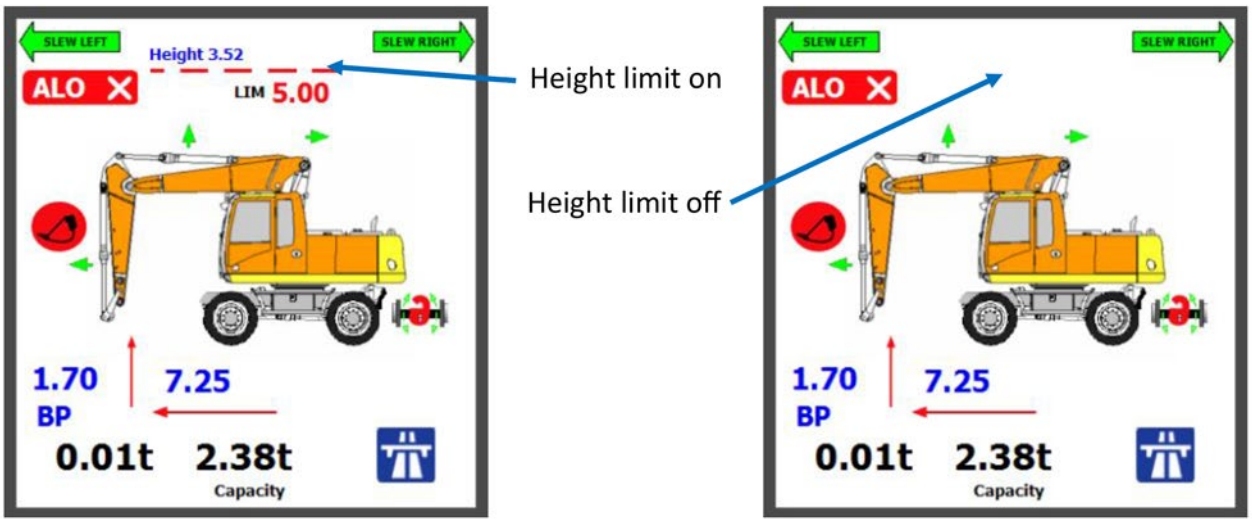
NOTE: THE HEIGHT RESTRICTION IS MEASURED FROM THE HIGHEST POINT OF THE MACHINE WHICH IN MANY CASES WILL BE HIGHER THAN THE BUCKET PIN HEIGHT. THE RCI MONITORS THE TOP OF THE FORE BOOM, THE TOP OF THE DIPPER BOOM, AND THE END OF THE DIPPER BOOM. ON MONO BOOM MACHINES, THE RCI WILL ALSO MONITOR THE TOP OF THE "BEND" ALONG THE MAIN BOOM.



8.2 Turning the height limit off

To remove the height restriction press the **MENU** button and select the **"Height Limit is ON"** button.

The limit will be reset and the button status will show **"Height Limit is OFF"**. The main operator screen will show no height limit set, as indicated by the examples below.



8.3 Logging of Height Limits

The enabling, disabling and exceedance (breach) of height limits is logged in the event logger within the display. This will also include the date and time of the event.

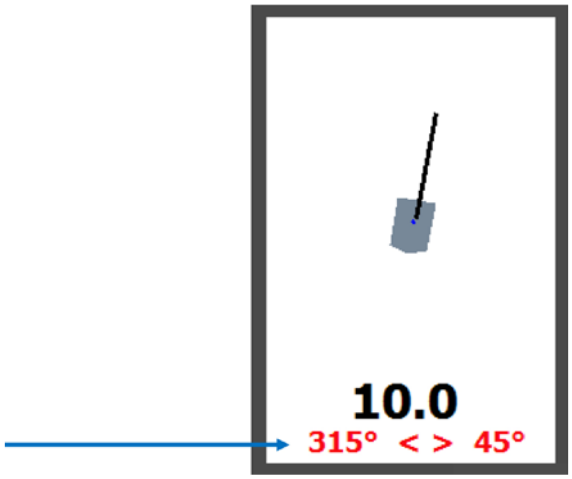
9 SLEW RESTRICTION

There are two modes of slew restriction:

- **Angular** restricts the slewing of the machine between two user determined angles.
- **Virtual wall** restriction allows the machine to operate to a limit determined by a virtual wall placed parallel to the rails.

WARNING: THE SLEW RESTRICTION FUNCTIONS ARE DESIGNED TO BE USED AT SLOW SLEW SPEEDS ONLY. USE AT SPEED MAY RESULT IN AN OVERSHOOT INTO A POTENTIALLY DANGEROUS POSITION.

The buttons in the user settings menu indicate the current function of the button. Therefore, when the system is active then the button will say **"Slew Angle is ON"** and requires a button press to switch it off. In addition the slew restriction status is shown on the front screen as part of the slew position graphic, as depicted in the graphic on the right.



Angular slew limits are shown next to the slew angle on the main operator screen.

9.1 Entering of slew limits

Press **MENU** and select **"Slew Angle is OFF"**.

When asked if you wish to enter slew Limits, select **"YES"**.

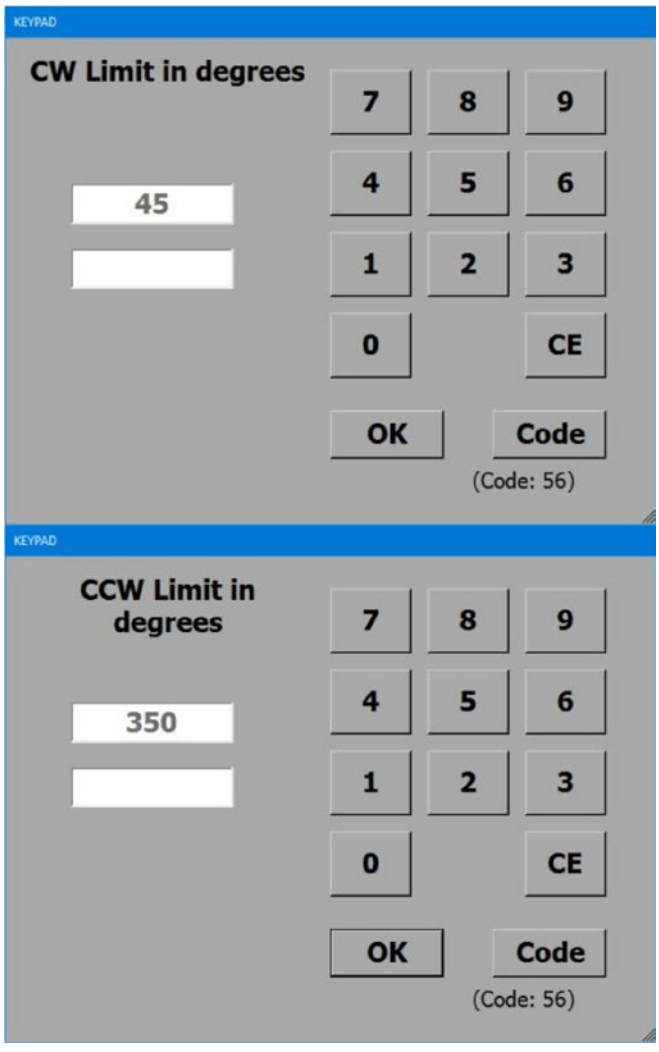
Using the keypad enter the clockwise maximum angle. Press the **"OK"** button.

Then enter the counter clockwise maximum angle. Press the **"OK"** button.

The button on the restrictions page will now show **"Slew Angle is ON"** and the main operator display will change to indicate angular slew limits.

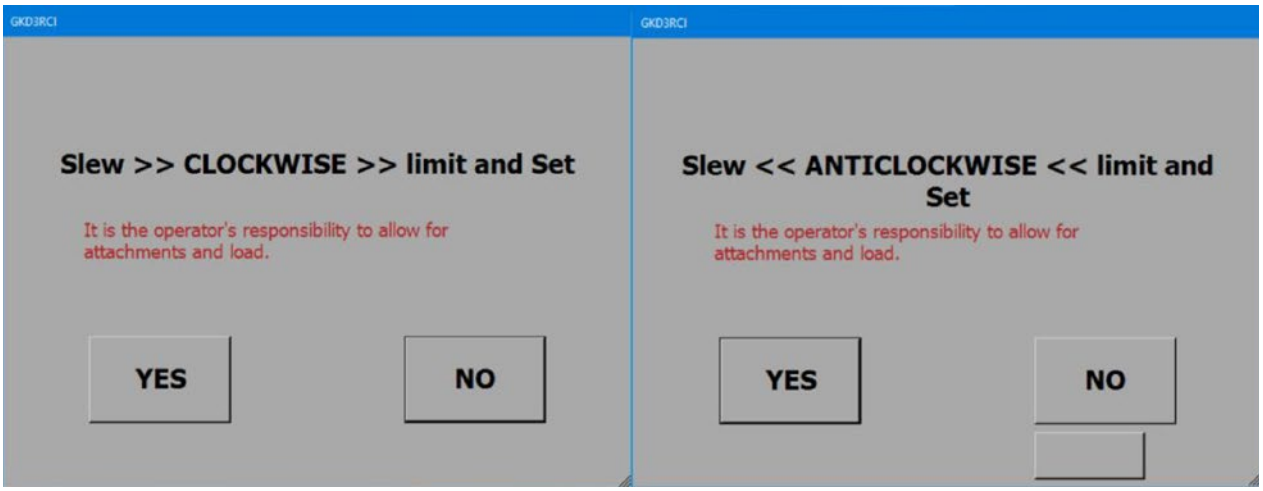
The limits are shown below the slew angle. (see graphic at top of this page).

If the preset angles are exceeded then the appropriate slew motion cut is applied, and the slew motion cut icons on the operator display change colour to RED to show the slew service is cut.



9.2 Capture of Slew Limits

When asked if you wish to enter slew limits, select **“NO”**. You will then be asked to slew to the desired clockwise slew limit. Slew the machine to required position and press **“YES”.** Then slew the machine to the desired counter clockwise slew limit and press **“YES”**.



9.3 Turning the slew restriction off

To turn off the slew restriction select **MENU** and press the **“Slew angle is ON”** button.

The system will ask for confirmation that slew limits are to be turned off, confirm by pressing **“YES”** and the slew limits will be turned off. The slew Limits button will now show **“Slew angle is OFF”** and no slew limits will be active.

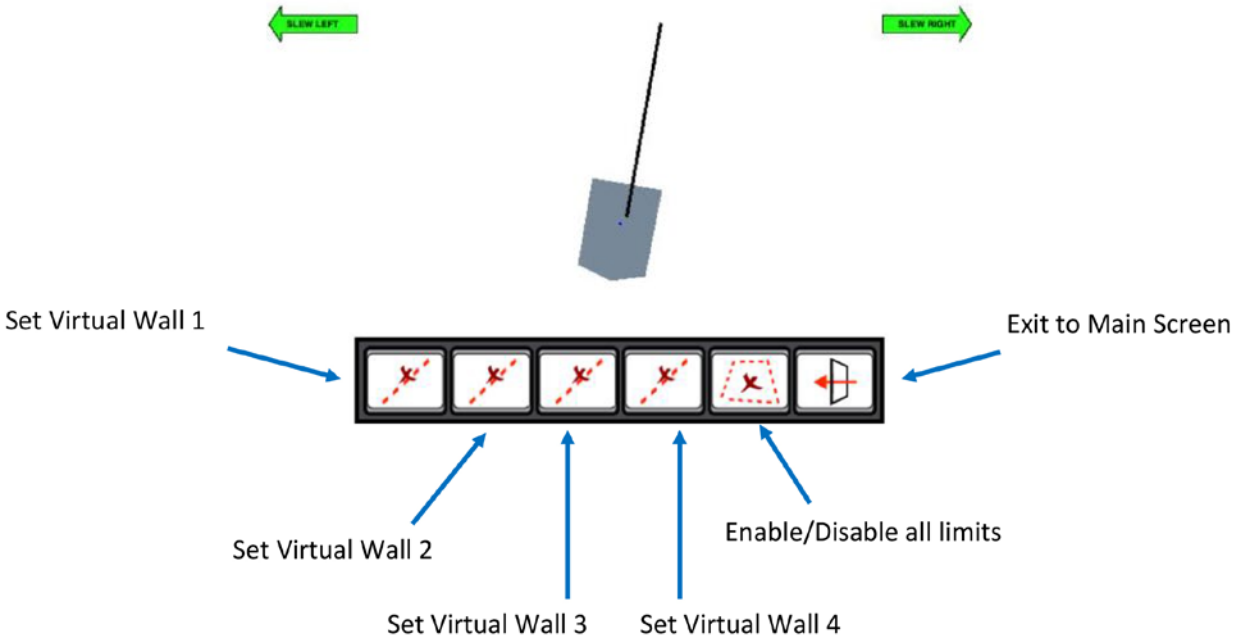
9.4 Logging of slew limits

The enabling, disabling and exceedance (breach) of slew limits is logged in the event logger within the display. This will also include the date and time of the event.

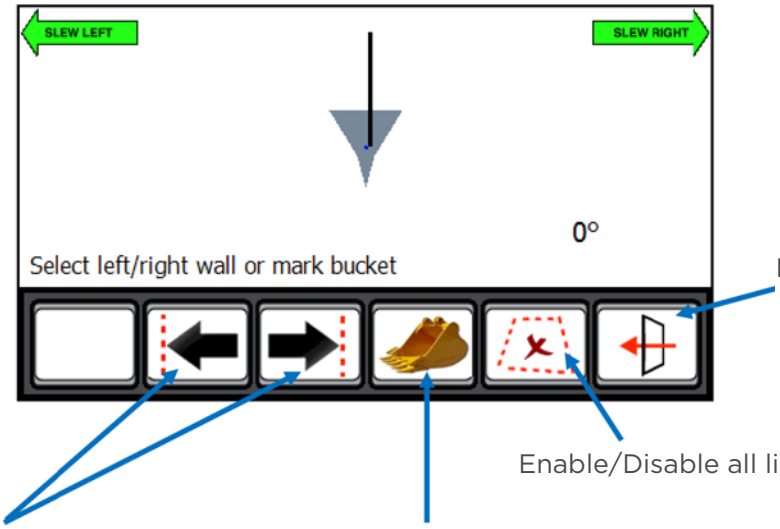
10 VIRTUAL WALLS

It is possible to set a left parallel wall, a right parallel wall or up to 4 multi-point walls.

Select **MENU** and press the **"Virtual Wall Off"** button. The screen shown below appears.



Pressing on any of the **"Set Virtual Wall"** buttons will display the following screen:



Set a left or right virtual wall which will be parallel with the tracks or wheels of the machine.

This is entered as a distance, in metres, from the set a left or right virtual wall which will be parallel with the tracks or wheels of the machine.

Set a virtual wall by moving the bucket or tool to 2 different points near the machine. The system will then connect these points with a 'virtual wall' which will then become the limit.

WARNING: IT IS THE RESPONSIBILITY OF THE DRIVER TO MAKE SURE THAT ANY LIMIT SET IS OUTSIDE ANY WHEELS, STABILISERS OR ATTACHMENT THAT MAY BE FITTED TO THE MACHINE WHICH COULD CAUSE IT TO BE IN A DANGEROUS POSITION. THE SIZE OF THE LOAD SUSPENDED FROM THE BUCKET PIN OR LIFTING POINT SHOULD ALSO BE CONSIDERED WHEN SETTING A WALL.

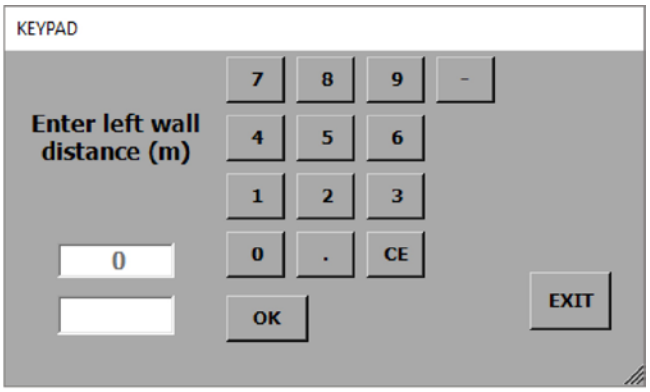
10.1 Setting a virtual wall by entering a distance

Press on the **“Set Virtual Wall 1”** button.

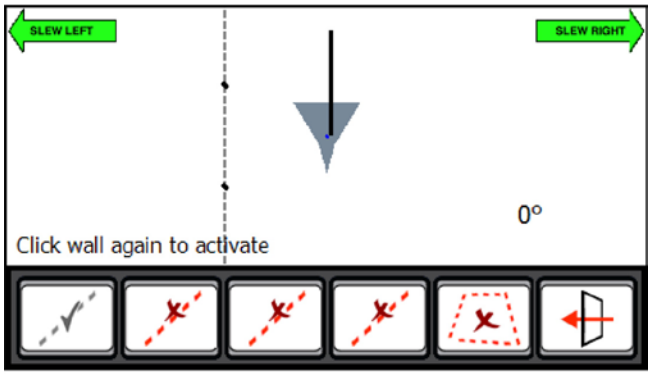
Then press on the **“Left Wall”** button.

A keypad will open for you to enter the distance to the left wall, in metres.

Enter the distance and press ok.

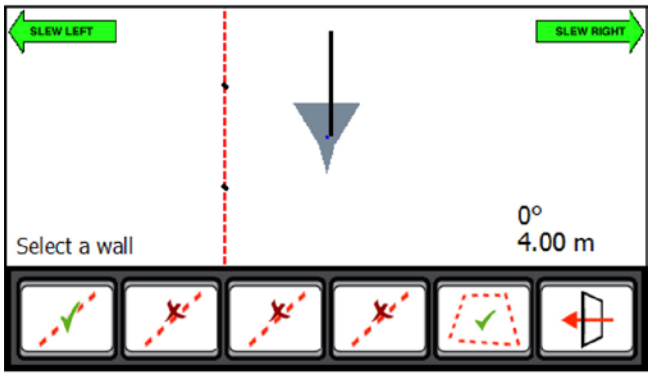


The screen should now change back to one similar to that pictured to the right.



The **“Set Virtual Wall 1”** button will now be greyed out. Pressing on this button will activate the virtual wall and the button will change to indicate that the virtual wall is not active.

The screen pictured to the right, shows a virtual wall set and active.

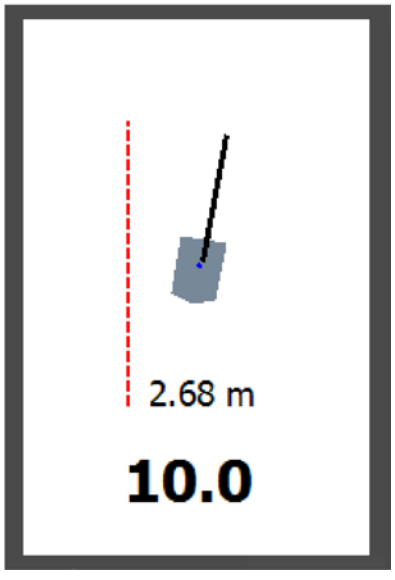


The screen pictured to the right, shows the main operator screen once the virtual wall has been set and activated.

The top right corner of the display will show where the virtual wall is in relation to the machine. It will also show the distance to the virtual wall from the machine.

As the machine slews, its position and distance to the wall will be updated automatically.

When the machine reaches the virtual wall, all relevant machine motions will be prevented from breaching the wall. This includes Boom and Dipper motions.

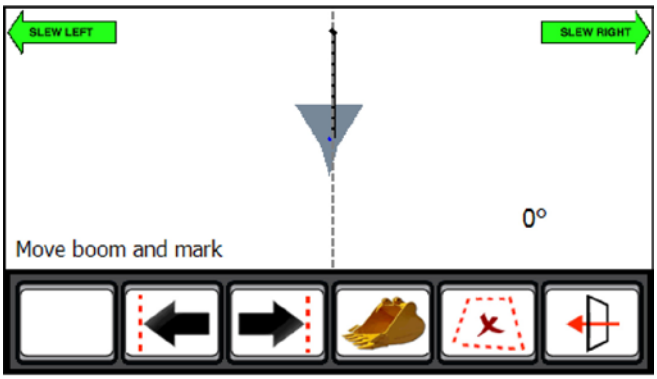


10.2 Setting a virtual wall using the bucket

Move the machine and position the bucket where the first point of the wall is required.

Press on the **"Bucket"** button.

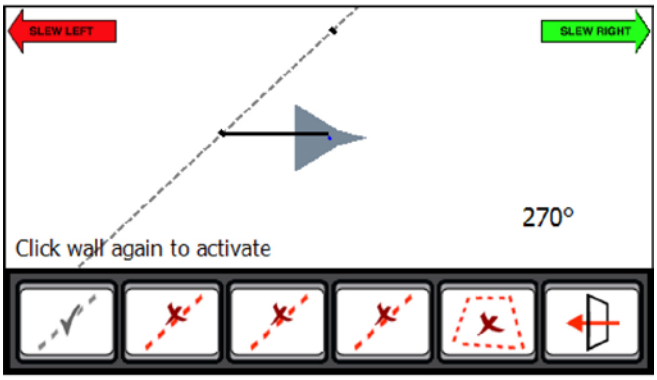
The system will log this point as the first point of the virtual wall.



Slew the machine to move the bucket to the second position. As the machine moves, you will see the screen update and create a virtual wall between the first point and where the bucket is.

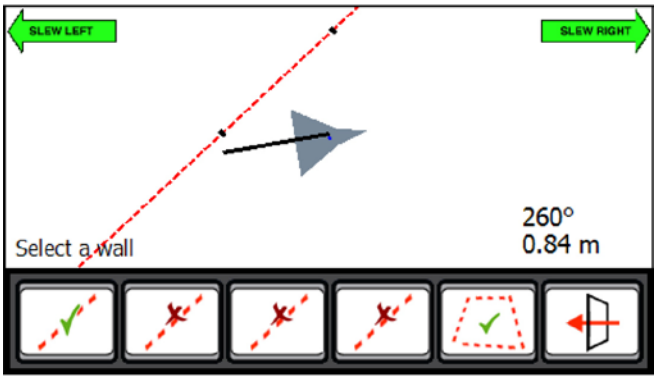
Once you have positioned the machine at the second point, press the **"Bucket"** button again.

This will log the second point of the virtual wall.



The **"Set Virtual Wall 1"** button will now be greyed out. Pressing on this button will activate the virtual wall and the button will change to indicate that the virtual wall is not active.

This method is the same for Virtual Walls 2, 3 & 4.

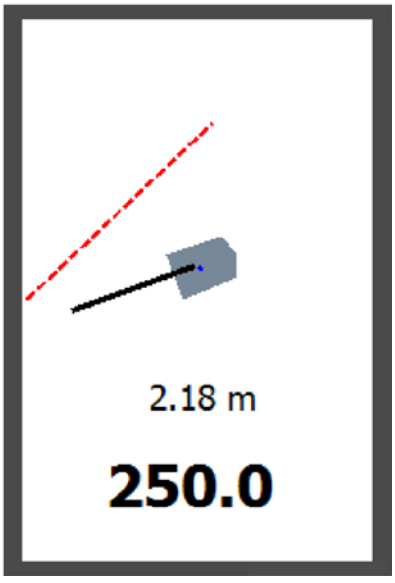


The screen pictured to the right, shows the main operator screen once the virtual wall has been set and activated.

The top right corner of the display will show where the virtual wall is in relation to the machine. It will also show the distance to the virtual wall from the machine.

As the machine slews, its position and distance to the wall will be updated automatically.

When the machine reaches the virtual wall, all relevant machine motions will be prevented from breaching the wall. This includes Boom and Dipper motions.



11 TRACK LOCK

The Track Lock feature is fitted to all 2LHS+ SpaceGuard systems, and is optional on Standard systems.

This function is used to control the drive motion of the machine and works as follows:

- On a Tracked Machine, when a limit is set and the Foreman Key Switch is in the locked position, you can only track the machine forwards and backwards. Also, only one control lever will function. This allows the machine to be used alongside Network Rail infrastructure.
- On a Wheeled Machine, The same function will prevent the steering from being turned. The machine will then only be allowed to travel forwards and backwards.

WARNING: On a Wheeled Machine, always ensure that the steering is straight before turning the Foreman Key Switch to the locked position.

Always ensure that the Foreman Key Switch is turned to the locked position as soon as a limit is set to allow the Track Lock function to be engaged. Failure to do this could have serious consequences.

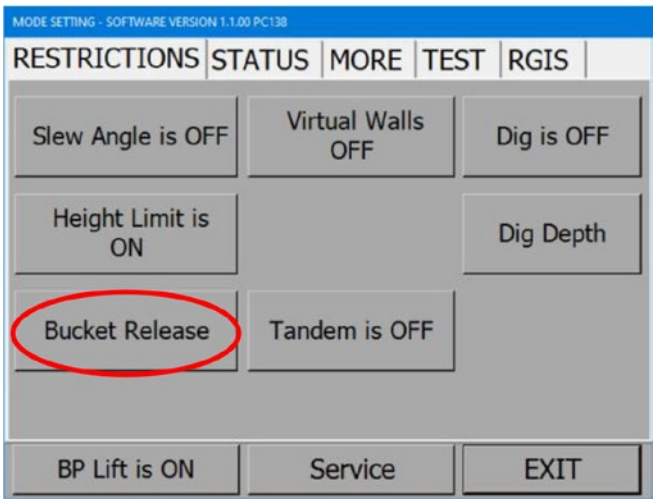
12 BUCKET RELEASE

With addition of multiple hydraulic services on RRVs, it has become necessary to include a feature that can 'release' the bucket motion cuts to allow the operator to relieve any pressure prior to changing attachments.

To do this, the engine of the machine needs to be off, but the ignition still needs to be on.

While this is the case, the Bucket Release button will be available.

Pressing on this button will turn on the bucket motion cuts for 5 seconds so that they can be de-pressurized.



Select **MENU** ➡ **Bucket Release**. Move the bucket lever from side to side to release the trapped pressure and then you should be able to disconnect the attachment.

13 OFFSET BOOM / SWING BOOM MACHINES

It should not be possible to perform lift operations with an offset boom or swing boom machine unless the boom is in the **"straight"** position. This position is detected generally by a proximity switch sensor, and when the boom is detected as **"straight"**, normal lift duties are allowed.

When the boom is not detected as **"straight"**, the Series 2LHS+ will impose a capacity restriction of typically 700kg, to prevent potential overturns caused by forces imposed when lifting with the boom in an offset position.

14 DIG MODE

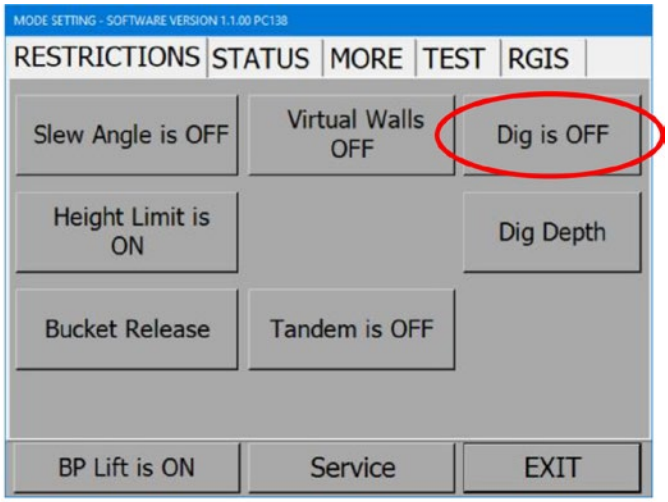
The system has a function to allow the machine to be used for digging. Whist the system is in Dig Mode, it is inoperative as an RCI and external alarms and beacons are disabled.

There is no protection against overloading or tipping.

Use of this mode is recorded in the Data Logger.

You cannot enter Dig Mode if there is more than 500kgs Load On Hook present.

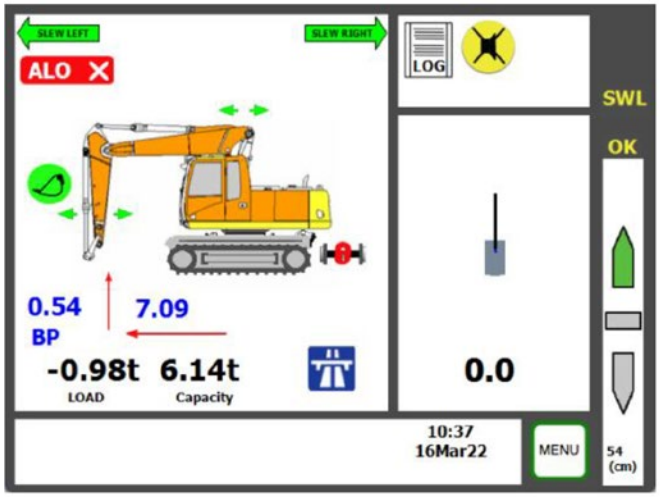
To access this mode, press on **Menu** then the **Dig is OFF** button (shown here).



Press on the **Dig Depth** button to set the required depth, with a negative number being under ground level.

When in Dig Mode, the operator screen will change to represent the image shown to the right.

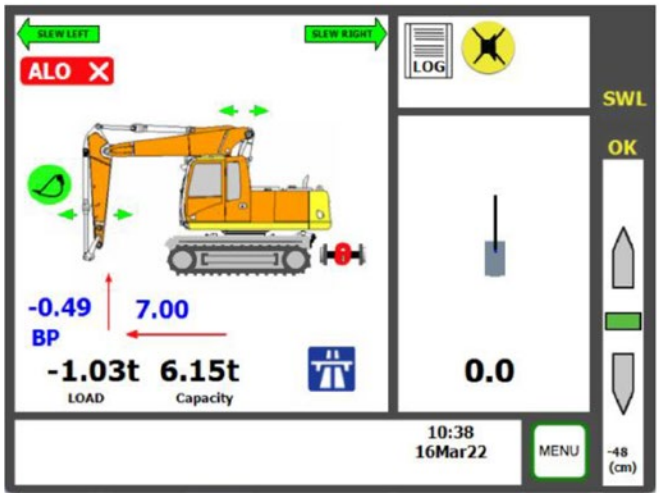
There is an icon to show that the Alarms have been disabled (in the yellow circle) and the Lifting Bar Graph has been replaced by the Dig Depth indicator.



Whilst in Dig Mode, the height of the Bucket Pin is used to see if the depth is on target.

If the Bucket Pin is above the target level then the Green upwards arrow will be lit (see middle picture).

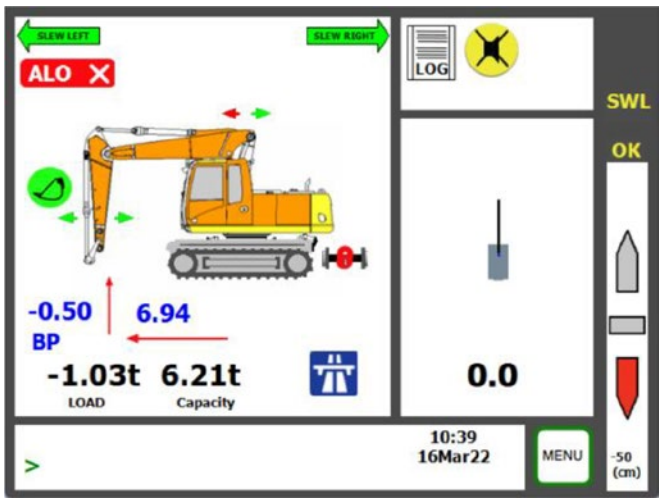
If the Bucket Pin is at the target level, then the horizontal symbol will be green (see bottom picture).



If the Bucket Pin goes below the target level, then the down arrow will be red (see adjacent picture) and the Boom Down motion will be cut to prevent digging down any further.

If the machine is fitted with a Hydraulically Adjustable Boom (sometimes referred to as a Luffer) then the down movement of this section will also be cut.

To exit Dig Mode, press on **Menu** then the **Dig Mode On** button.



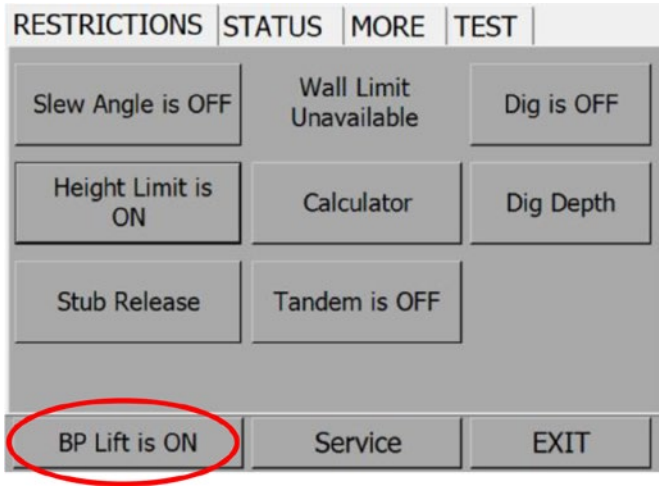
14.1 Lift Point Selection

Series 2LHS+ supports multiple lift points. If multiple lift points have been set up, from the “Restrictions” page, press the bottom left button to cycle through the available lift points.

Available options may include:

- **BP** (Bucket Pin)
- **ALP1** (Auxiliary Lift Point)
- **ALP2** (second Auxiliary Lift Point)
- **QH** (Quick hitch) assumes the Quick hitch is Horizontal for purpose of Height and Radius display
- **TLJB** (Tele jib)

The lift point in use is indicated on the RCI main screen (item 5 on page 8) just above the load on hook value.



15 REMOTE KILL SWITCH OPERATION

The Remote Kill Switch, once enabled, will cut all hydraulic movement of the machine when the button on the key fob is pressed. The hydraulics will remain cut until the button is pressed again.



When the system is operational and the button is pressed, the following splash screen appears on the Operator Screen:



Even if the Operator press the 'Accept' button, motion is still cut until the key fob button is pressed again.

16 ERRORS

If the Remote Kill Switch fails for any reason, or becomes disconnected, then it will show the **E159 Remote Kill Switch Fault** error message. While this message is shown, the capacity of the machine is reduced to 0.7t and all motions will be cut until the fault is resolved.

17 SPACEGUARD SYSTEMS

17.1 Introduction

The Series 2LHS+ SpaceGuard system adds dual sensing and processing of machine component position to the standard system. This allows the system to provide improved electronic stops for the height and slew limits and for virtual walls.

There are two independent angle sensors fitted to each of the stub boom, fore boom and dipper.

In addition, a second means of measuring the machine slew position is fitted. These angle and slew sensors are compared continuously against each other and if a calculated error between the safety and standard computers occurs a “Safety Mismatch” message is shown on the screen and the machine will stop motion.

The SpaceGuard also incorporates slow zones to allow the system to stop the machine movement within the set limits even if it is being operated at speed. SpaceGuard evaluates the speed of operation and uses pre-emptive stopping to stop motion before the limit is reached.

17.2 Operation

Please read the section in the main manual on the setting of virtual walls and slew/height limits. The manner of setting these limits has not changed in the SpaceGuard system. However, the operation of the machine is now affected when using limits.

17.3 Slow zones

In accordance with the Network Rail remits for working under overhead electrics and with an adjacent line open, whenever an angular slew limit or virtual wall is set and active, the slew speed of the machine will be reduced to a maximum of 2 meters per second measured at the bucket pin with the boom at full reach.

When the machine is in proximity to a slew limit or virtual wall the system will automatically select a further slow mode, where the slew speed of the machine will be further reduced to 1 meter per second.

When working with height limits, full machine boom speed will be available when working away from a set height limit, but as the boom approaches an active height limit boom speed will be reduced.

17.4 Pre-emptive stopping

The SpaceGuard system implements a pre-emptive stop software to allow the system to predict the stop position of the machine when running quickly. This means that the machine may stop early when approaching a limit quickly. It will then release the motion cuts and allow slow movement towards the limit. The use of pre-emptive stops take into account inefficiencies in braking and reaction times for stop valves.

17.5 Margins

The SpaceGuard system applies a dead band margin to the limits set by the user to ensure that should a pre-emptive stop occur very close to a limit the system will not allow an overshoot.

17.6 Safety System and mismatches

The SpaceGuard system continuously monitors the inputs from the angle and slew sensors to check that they agree. If there is a mismatch then **"Safety Mismatch"** will be displayed and all motions are disabled. Should this occur an override button appears on the screen to allow movement to a safe position.

Only use the override button for recovery purposes. If the mismatch is cured then the Override button will disappear and normal operation recommences. The external **"tipping"** alarm will sound constantly under a mismatch condition, and will continue to sound once the override button is pressed. The alarm will stop only once the mismatch is cured.

Should a safety mismatch warning occur, use the override button provided to re-enable motion, and slew the machine over 0° of slew to reset the slew sensor. Should this fail to correct the mismatch, further investigation will be required by a service engineer to determine the cause of the mismatch and to correct the fault.

WARNING: WHEN THE "OVERRIDE" BUTTON IS USED TO RE-ENABLE MOTION, NO PROTECTION IS IN PLACE WITH REGARD TO SLEW OR HEIGHT LIMITS OR VIRTUAL WALLS. IT WILL BE POSSIBLE TO EXCEED ANY SET LIMITS.

17.7 Safety Mismatch at start up

There may be occasions when the safety mismatch occurs at start up due to slew angle differences accumulated during shut down. Use the override button to slew round past the reset sensor on the floating end (0°) of the machine. Once the slew is synchronized the machine may be operated normally.

17.8 Offset Boom or Swing Boom machines

Where a GKD Series 2LHS+ SpaceGuard system is installed onto a machine with a swing boom or swivel boom, additional protection is provided to ensure that the boom is in the **"straight ahead"** position when working with positional limits. Sensors automatically detect when the offset or swing boom is in the **"straight ahead"** position.

When the boom is NOT detected as being straight, access to setting of positional limits (height, slew and virtual wall limits) is disabled. The machine lift capacity is also reduced, typically to 700kg.

It will only be possible to set a limit when the boom is in the straight ahead position. Once a limit is set, the hydraulic controls to the boom swing or offset will be motion cut, and it will not be possible to swing or offset the boom whilst a limit is active.

18 TROUBLESHOOTING

18.1 Error codes and error diagnosis guide

The system diagnostics continually monitor all of the system components for correct operation. If there is a problem, the system will show an error message on the display and if appropriate sound the alarm. Below is a link to the GKD Knowledge Base where you can find definitions of all the error codes for the Series 2LHS+ system including SpaceGuard.

https://hello.gkdtechnologies.com/knowledge

19 DISCLAIMER

Incorrect installation of any part and or incomplete calibration will affect the correct operation of the Series 2LHS+.

If in doubt contact GKD Technologies on:

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www.gkdtechnologies.com

GKD Technologies reserve the right to change these instructions in line with the policy of continuous improvement.

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