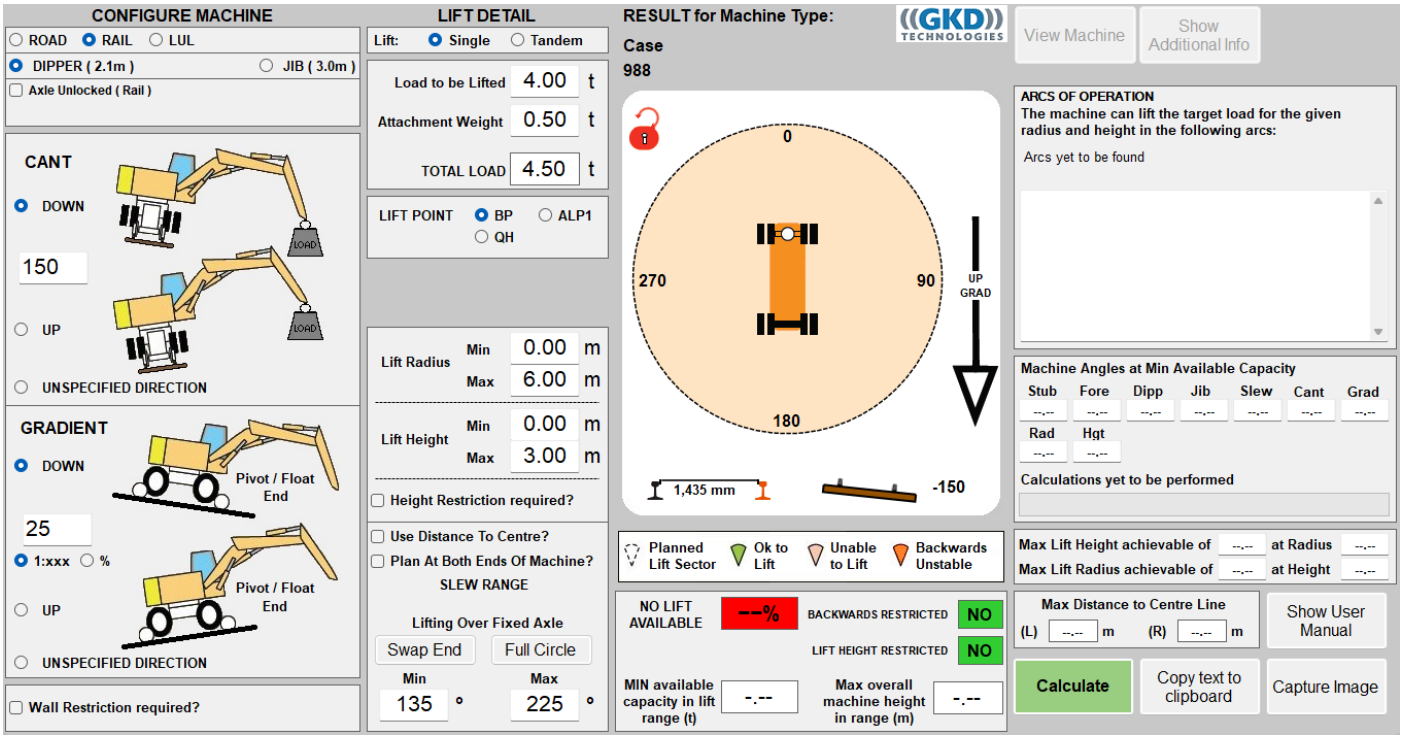
GKD Capacity Planner Software User Guide



Introduction

The purpose of the Capacity Planner software is to enable fast and accurate lift planning to be carried out for machines equipped with GKD Rail Rated Capacity Indicators.

The GKD Capacity Planner consists of a folder, which contains the Capacity Planner program, and a number of files containing data relevant to the dimensions and lift capacity of the RRV. This RRV data included is identical to the data files existing within the GKD 3RCI system fitted to the machine being planned for, the data is derived from extensive tip testing within a range of track conditions under controlled conditions when the First of Class machine is calibrated.
The capacity planner software will therefore reflect the true lift capacity of the machine under all track conditions.

A planner appropriate for the RRV being planned for must be used, a planner for a different machine will give inaccurate results.

Terminology and Abbreviations

The following terminology is used by the Planning tool:

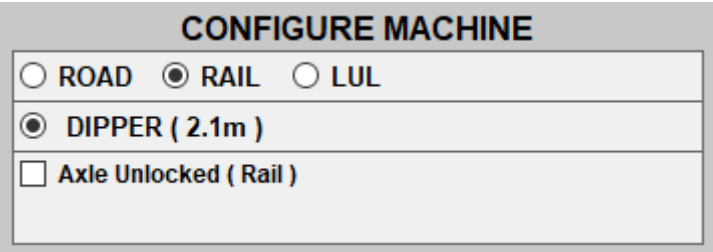
- SWL - Safe Working Load. This is the maximum load that the machine can lift safely.
- LOH - Load on Hook. The amount of load or weight that the machine is currently lifting.
- BP - This is short for the Bucket Pin. It is the default lifting point used by GKD Rail.
- ALP1 - Auxiliary Lifting Point. This is normally a lifting eye that is welded on the underside of the Dipper Arm.
- ALP2 - Second Auxiliary Lifting Point. See ALP1.
- QH - Quick Hitch. When a Quick Hitch is fitted with a lifting eye, this option can be made available. It is always assumed that the Quick Hitch is horizontal if this lifting point is selected.
- Alt Dipper - Secondary dipper that can be retro fitted to a machine. Can have the same selection of lifting points as shown above.
- Jib - An addon attachment that is fitted either to a Quick Hitch, or directly to the end of the dipper. This is typically referred to as a Rhino Horn. The Jib can have the following options:
  - ⇒ Fixed Length - Typically either a 3.1m or 5.1m. The safe working load of the machine is also capped when either of these is selected. The 3.1m is capped at 3400Kgs and the 5.1m is capped at 1500Kgs.
  - ⇒ TeleJib - means that the Jib can extend. Typically, it will have 2 different safe working loads, one for fully retracted (RET) and a reduced one for fully extended (EXT).
- CW OUT - Counterweight Out. Refers to the machines extending counterweight, if fitted. If this is NOT ticked, then the planning tool assumes that the counterweight is fully in. if this IS ticked, then the counterweight is fully extended and can allow the machine to lift more at a greater radius.
- LO RAIL - indicates that the machine can operate in either HI Rail Mode (road wheels are raised up of the rail head) or LO Rail Mode (the road wheels are in direct contact with the rail head).
- LUL - London Underground. Refers to a specific duty setting for when the machine is to be used on London underground network as opposed to Network Rail Infrastructure.

Using the Capacity Planner

The Capacity Planner has three sections that need to be filled in. These three sections are:

1) Configure Machine - whether in Rail or Road modes, whether axles are locked or unlocked.
2) Enter Track Conditions - Cant and Gradient values and direction.
3) Lift Detail - weights, lift heights, slew range.

Configure Machine



Simply select whether the machine, when performing the lift, will be on the rail or off the rail by selecting either "RAIL" or "ROAD".
If the lift is to take place on London Underground track, select "LUL".

Tick the "AXLE LOCK" box if the machine's axles will be locked for the lift operation being planned. Static lifts generally use the machine in a Locked state as it is a more stable lifting platform, however the Axles Locked state is not suitable for Lift and Carry operations as the axles should not be locked whilst the machine is driving.

You can now select from the following configurations:

- NORMAL DIPPER - 95% of Rail Machines that use a single, fixed or extending dipper. Also the Long Dipper option, when using a converted Doosan or an Atlas Giga-Railer.
- ALT DIPPER - common for converted Doosan or Atlas Giga-Railers when the Dipper is inter-changeable).
- JIB - if fitted. This typically refers to a fixed length jib that can be fitted onto the Bucket Linkage.
- Stabiliser - If the machine is fitted with stabiliser legs and the planned lift is to take place with the stabiliser legs deployed, Tick the Stabiliser box. An icon indicating Stabilisers Deployed will appear in the Results window.
- Extending Tracks - If the machine has got extending tracks, then this box will indicate Extending Tracks. Tick the box to extend the tracks. This option will only be available in Road Mode. An icon indicating Tracks Extended will appear in the Results window.
- Extending Counterweights - Where a machine is fitted with an extending counterweight, and the planned lift is to take place with the counterweight extended, tick the "Counterweight Extended" box. This will cause the planner to select the Counterweight Extended duty and also show an icon on the Results window.
- Lo Rail - If the machine is able to be used in a Lo-Rail Mode, and this mode has been set up in the software, this button can be ticked if required.

Some of the options above will now only be shown if the machine is configured for them.
The planning tool uses actual machine data so if the above options are not available on the planning tool, then they are not available on the Road-Rail Machine.

Cant and Gradient

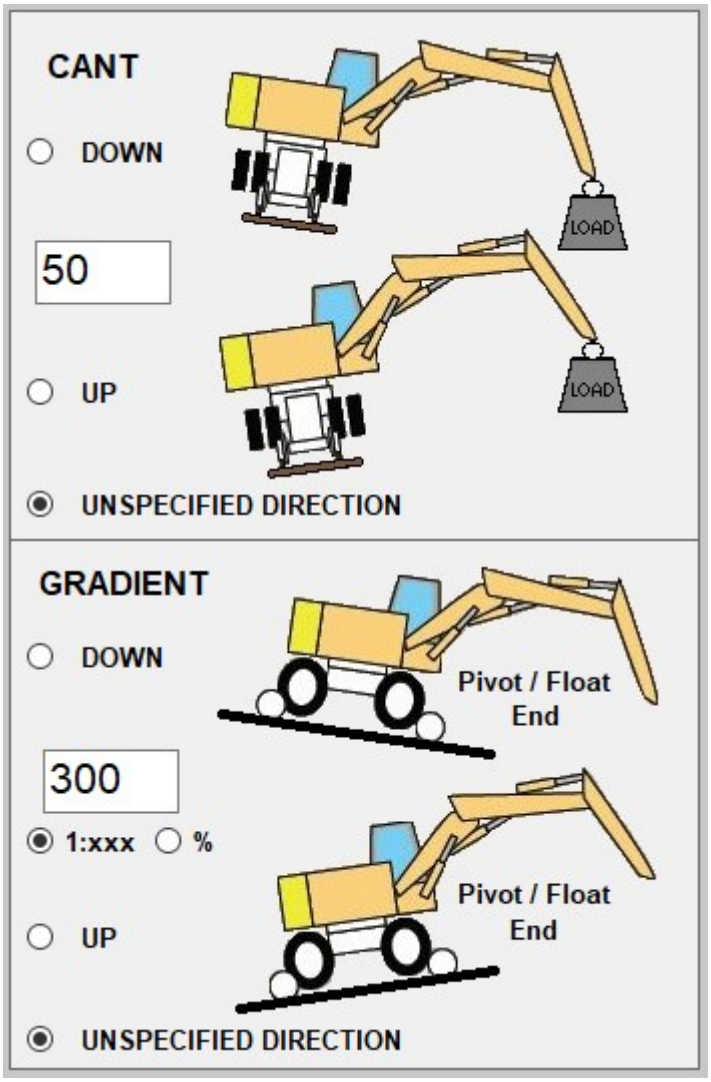
The direction of Cant and Gradient will have an effect on the lift capacity of the machine.

Cant - First, enter the Cant of the track at the point where the lift is to take place, or for Lift and Carry operations, the highest track Cant that will be
experienced. The value entered is mm of Cant, and should be between 0 and 150mm.

Select whether the lift is to take place with the machine up cant or down cant. To determine cant direction, with the machine at 0 degrees of slew (usually over the oscillating axle), if the rail to the machine right hand side is the high rail, select UP cant.

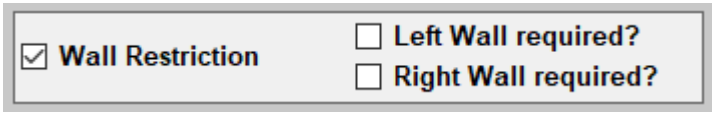
If the direction of Cant is not known, or if both Up and Down Cant will be experienced during a Lift and Carry operation, the "UNSPECIFIED DIRECTION" option should be selected.
The machine's lift capacity will then be rated at the worst case within the range entered.

Gradient - Select whether the pivot / float end of the machine will be facing uphill or downhill, or, if not known or if both states will be experienced during a Lift and Carry operation, select the "UNSPECIFIED DIRECTION" option. Enter the gradient value of the track, either as 1:xxx (the default option) or, if preferred, as a %.

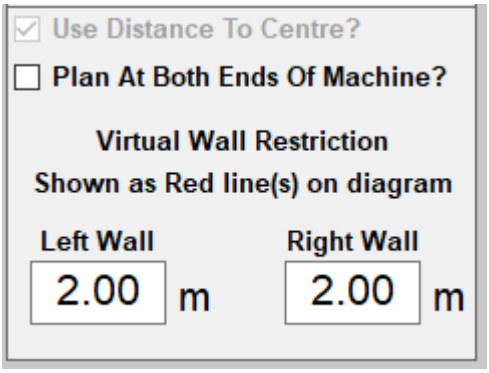


Note: Level Rail, expressed as a gradient, should be entered as 1:1000

Planning with Virtual Walls



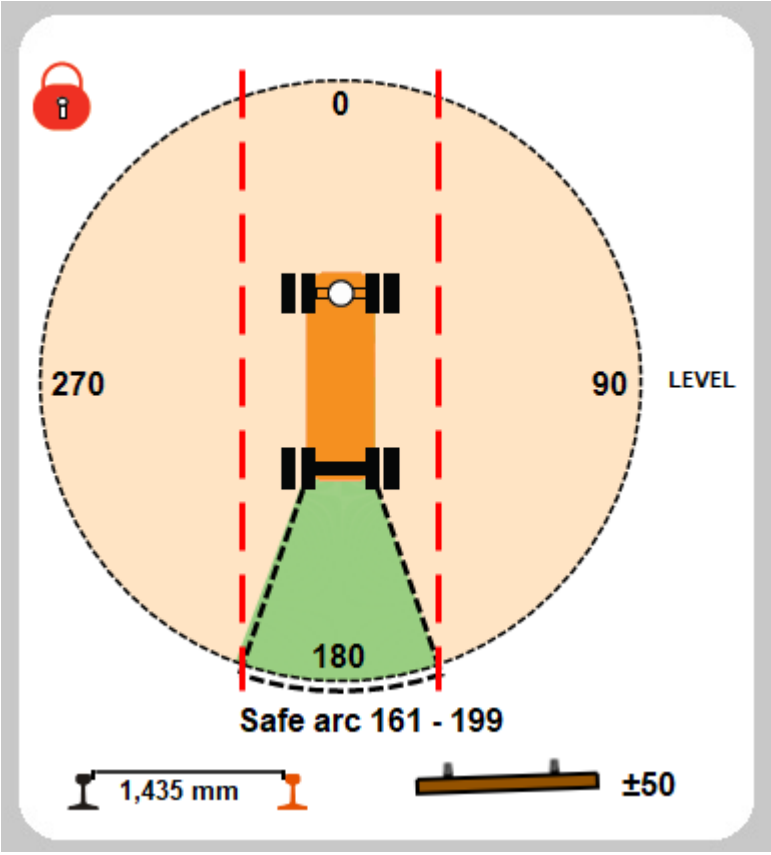
Where the plan calls for use of a virtual wall, the virtual wall can be represented on the results graphic.



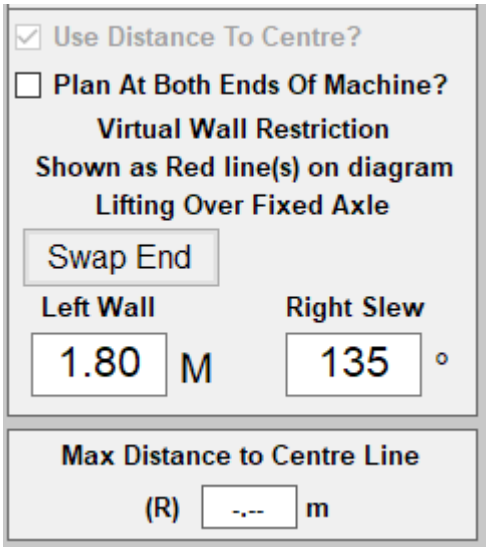
Select the **"Wall Restriction"** check box.
A popup will appear stating the following:
"When planning with Virtual Walls, Enter the Radius and the distance between the centre line of the Rail and Lift position/destination closest to wall (in metres)"

Then select whether a Left or Right wall is required.
Enter the distance in meters from the track centre to where the wall is required.

When the calculation is completed, the virtual wall will be represented on the graphic with a red dashed line, as per the picture to the right (the example shows both walls active).



When planning with either Left or Right walls, you can also enter the slew angle that is required opposite the wall.
In the example to the right, a Left wall is required up to a right slew angle of 135 degrees.



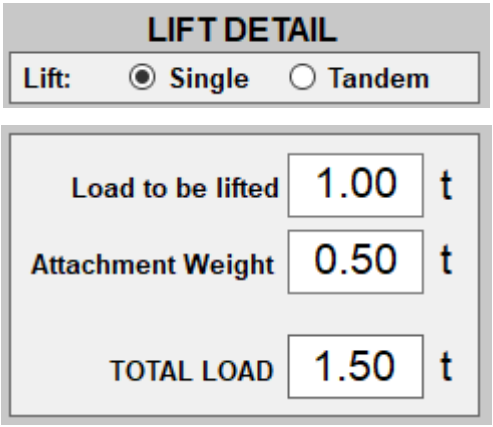
If you select a Right wall, then you can enter a left slew angle.

If you enter a distance that would be too close to the machine, then the following message will appear:
"Virtual Wall distance is too close to the Machine. Please check the Virtual Wall Dimension"

The planning tool will also show the 

message.

Lift Detail



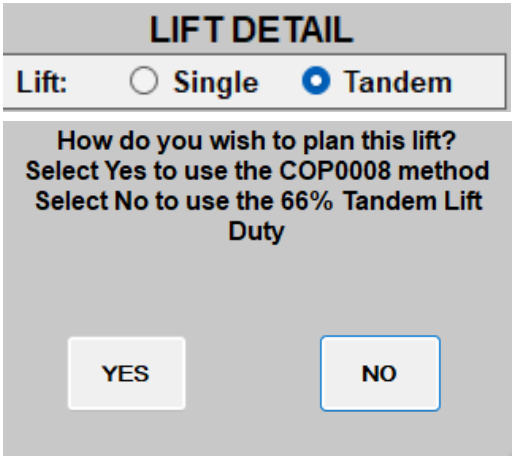
- Lift Type - Select from **Single** or **Tandem**.

Single Lift Mode

- **Load** - First, in the top box enter the weight of the load to be lifted, in tonnes.
- **Attachments** - Next, enter the weight of any attachments, in tonnes, into the second box down **"Attachment Weight"**. The attachments will include the quick hitch, any chains or slings, and the weight of any grabs or other attachments being used.

The Total Load will then automatically be calculated.

Tandem Lift Mode



Press on the Tandem Lift radio button.
In the window that opens, select

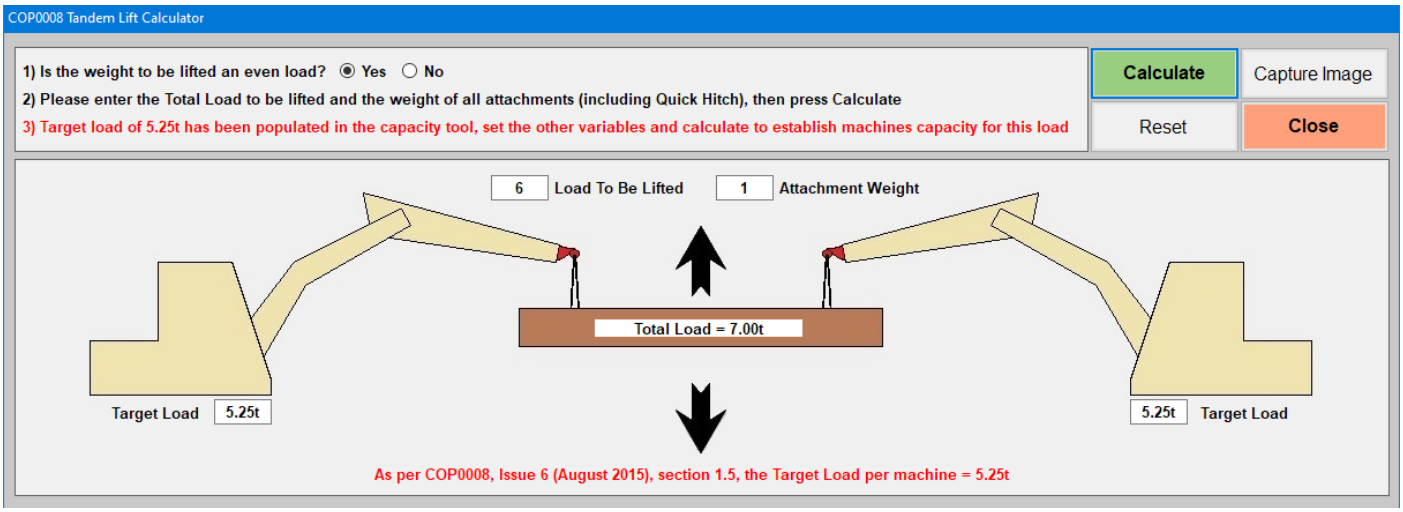
- **YES** to use enter the load according to the COP0008 method
- **NO** to use the 66% Tandem Lift Duty

If YES is pressed, in the COP0008 Tandem Lift Calculator, select whether the weight to be lifted is an Even load (option Yes).

Tandem Lift - Even Load - COP0008 method

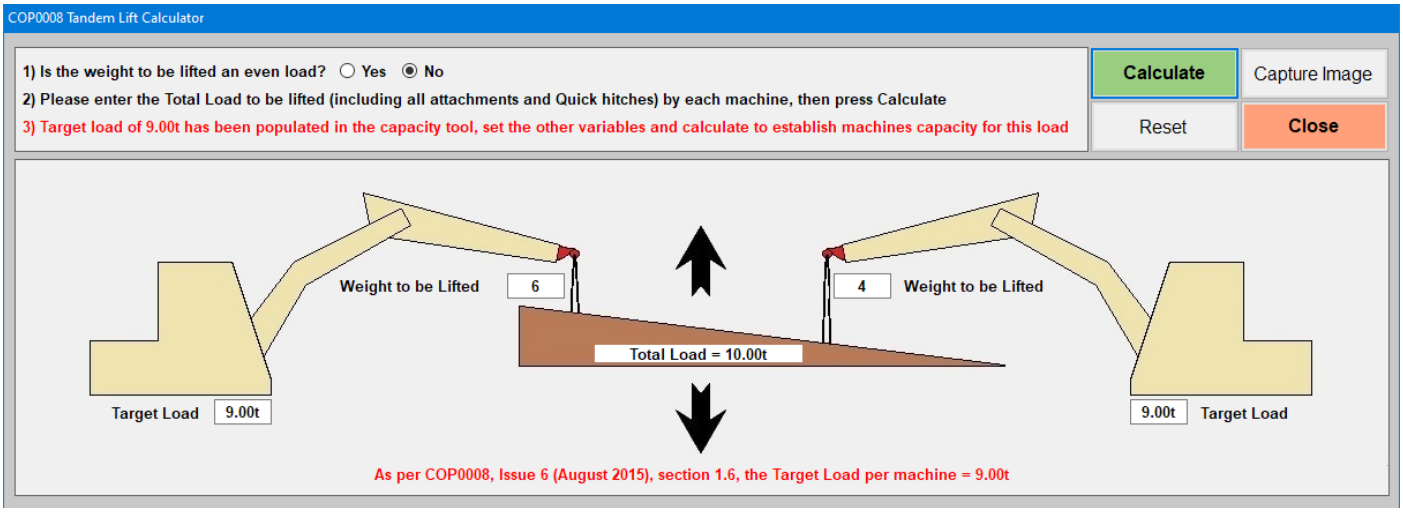
If Yes to Even is selected, then enter the Load to be lifted and the total attachment weight in the boxes and press Calculate.

Once it has calculated the Total Load, it will then show the Target Load per machine as well as automatically copy the Target Load to the Planning Tool.



Tandem Lift - Un-Even Load - COP0008 method

If No to Even is selected, then enter the Load to be lifted by each machine in the boxes and press Calculate. Once it has calculated the Total Load, it will then show the Target Load per machine as well as
automatically copy the Target Load to the Planning Tool.



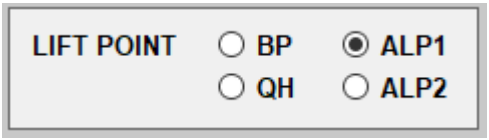
There are 3 buttons available on the right hand side of this window, in both Even and Un-Even modes. These are as follows:

- **Capture Image** - will capture the window so that you can paste it into the lift report.
- **Reset** - will clear all tandem lift settings to allow you to enter new figures.
- **Close** - will close the window and return to the Planning Tool.

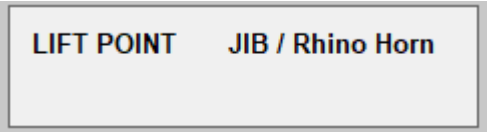
Tandem Lift Mode - Using the 66% Tandem Lift Duty

The 66% Tandem Lift Duty is built into the RCI in the machine. It automatically de-rates the lifting capacity to 66% of the current lifting duty. In this mode, the machines will need to be identical. The planning tool will calculate the lift capacity required for each machine.

Lift Points

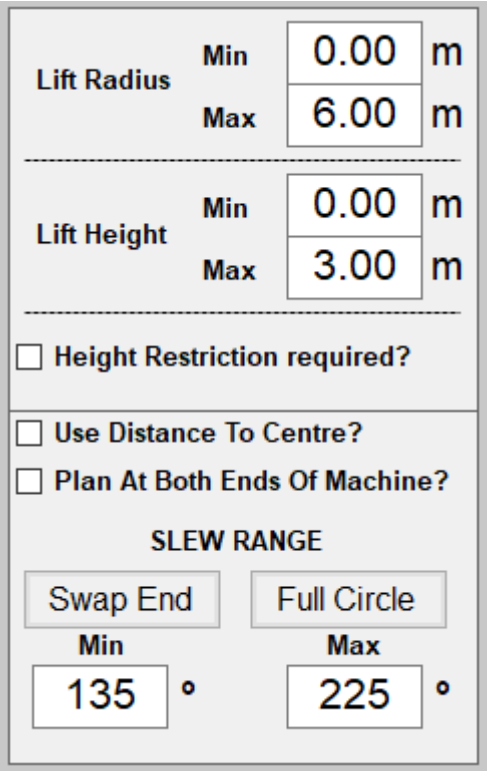


There are a maximum of 4 lifting points for the Normal or Alternate Dippers. These are selectable via the radio buttons shown here. If any of the buttons are not shown, then this lifting point is not setup / enabled for this machine.
If the Machine is configured for a Jib / Rhino Horn, and it is selected, then the Lift Point will be indicated as JIB / Rhino Horn.



If any of the lifting points have a Maximum Capacity set, then this will be taken into account by the Planning Tool. E.g. A 3m Rhino Horn will have a Max Capacity of 3.50t whereas a 5m Rhino Horn will have a Max Capacity of 1.70t.

Lift Options



Lift Radius - Enter the minimum and maximum Lift Radius in metres that will be achieved by the RRV during the planned lift (if 0.0m is left for the minimum radius then the lift will only be planned at maximum radius).

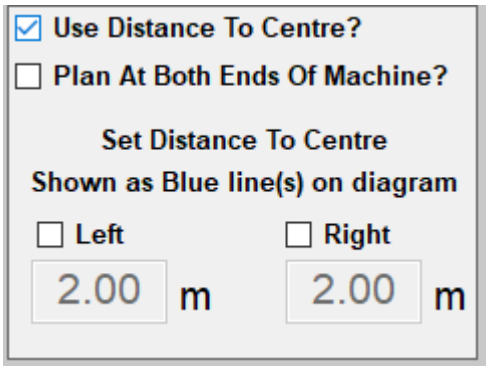
Lift Height - Enter the minimum and maximum lift point heights that will be achieved by the RRV during the planned lift.

Height Restriction

Where the lift is to take place with limited height clearance (such as under live overhead cables, for instance) the lift capacity will be restricted by the maximum angle the primary boom can be lifted to.

Tick the **"Height Restriction"** box, and enter the maximum height the machine is able to work to, in meters. When performing the capacity calculation, the program will reject all results where the boom exceeds the entered height limit.
Where no height restriction exists, leave the check box UNTICKED.

Use Distance to Centre



This option allows you to enter the distance from Rail centre line to lift position, instead of an angular range.
The planning tool will then use this distance, along with the max radius entered above, to plan the lift.
When this option is used, the left or right distance from centre line will be shown on the Results graphic by a Blue Line.

Ticking the **"Plan at both ends of machine?"** box will allow the planner to plan at the back and front of the machine at the same time. E.g. if a slew range of 135 to 225 is entered and the plan at both ends box is ticked, then 2 angle zones will appear. One from 135 to 225 and one from 315 to 45.

Slew Range - enter the minimum and maximum degrees of slew that will be achieved by the RRV during the planned lift, or you can now press the **"FULL CIRCLE"** button to allow a lift to be planned round the entire machine.

Press the **"Swap End"** button to swap the current slew range from the back to the front of the machine, or front to back if the slew range is over the front.

Note that 0 degrees of slew is usually over the end of the machine with a pivoting axle, the fixed axle end is usually at 180 degrees of slew.

Calculation

The Capacity Planner now has all the information it needs to plan the lift.

Click the green **"Calculate"** button.



The Capacity Planner will update any calculated figures on the screen, such as the total loads to be lifted, and will check the planned lift against the capacity of the machine under the track conditions entered.

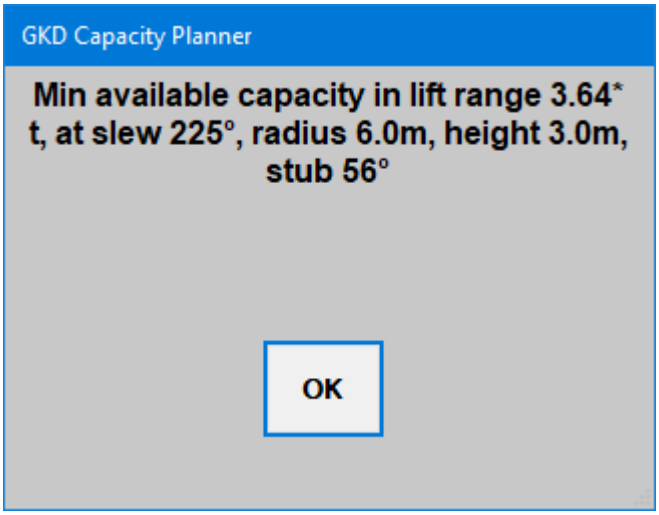
Please note that the calculation may take several seconds to complete. This is because the planner tests the capacity of the machine with the stub boom, fore boom and dipper in multiple positions, and performs several hundred thousand calculations before coming up with the best capacity for the machine, taking into account both machine stability and hydraulic limit, throughout the full lift and slew range entered.

As soon as the calculation has completed a pop-up box will appear in the centre of the screen.

This pop-up box contains information on the point of minimum lift capacity within the height and slew range selected.

The pop-up box will disappear when "OK" is clicked.

The information displayed within the pop- up box is:



Minimum available capacity in lift range - this is actually the minimum available, maximum capacity the machine has at the point within the lift range selected.

The point at which the lowest capacity within the lift range selected occurs is identified by slew angle and bucket pin height and radius, and the stub boom angle is also listed. In order to achieve the same capacity on the machine, it will be necessary for the machine operator to adjust the position of his stub boom to the same angle.

This information is also included in the text summary generated by the "Copy Text to Clipboard" function discussed on page 14, and can be easily transferred into the lift plan.

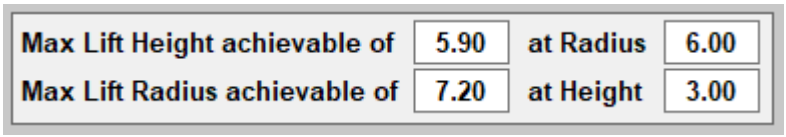
Max Distance to Centre Line



Once a lift has been planned using the angular ranges, the Planning Tool will also calculate the maximum distance to the centre line of the machine from furthest part of the lift range.
This is information that might be required or used by a lift plan.

When planning by using the distance to centre line option (shown on page 8) then this panel is hidden.

Max achievable Lift Height and Radius



Another new feature is showing the maximum achievable Lift Height and Radius once a lift has been planned. Once a lift has been planned, it will calculate the max Lift Height at the max radius that is entered as part of the lift detail. It will also calculate the max Lift Radius that is achievable at the max height entered as part of the lift detail. This panel will always be shown at the bottom of the window.

Additional Information

If you press on any of the dark grey area, then the planner window will be automatically resized to show some additional information.

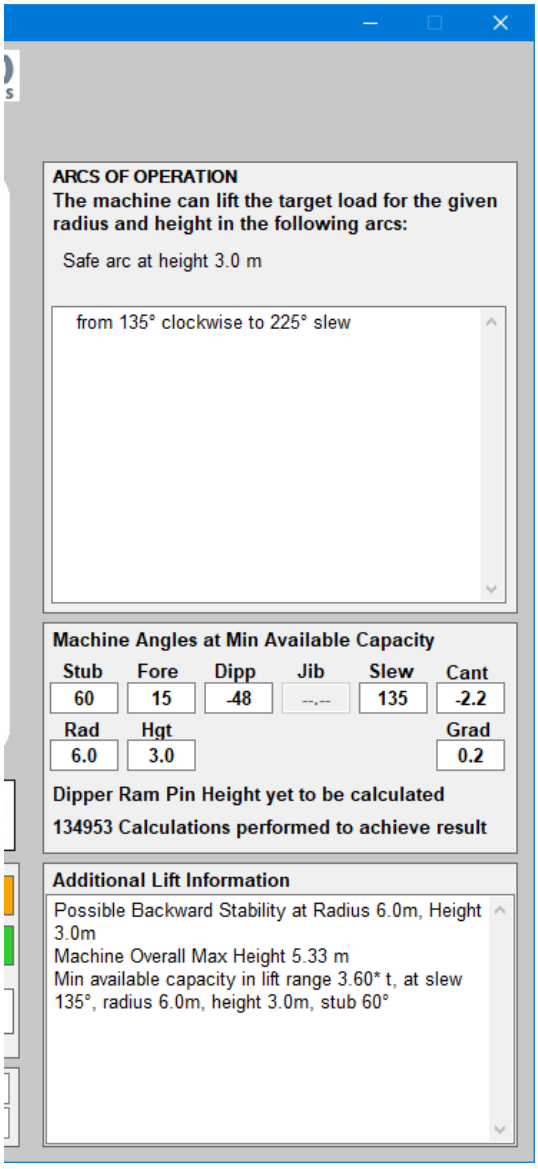
This information includes the Arcs of Operation.
This will show the angular range of all the safe arcs that have been found once the lift has been planned.

Machine Angles at Min Available Capacity

This panel will show the equipment angles for the machine to reach the minimum available maximum capacity that has been calculated by the planner. If the machine was positioned at these angles, then its Safe Working Load shown on the indicator will match the planner.

Additional Lift Information

This box will show the information from any popup messages, for the lift that was planned.



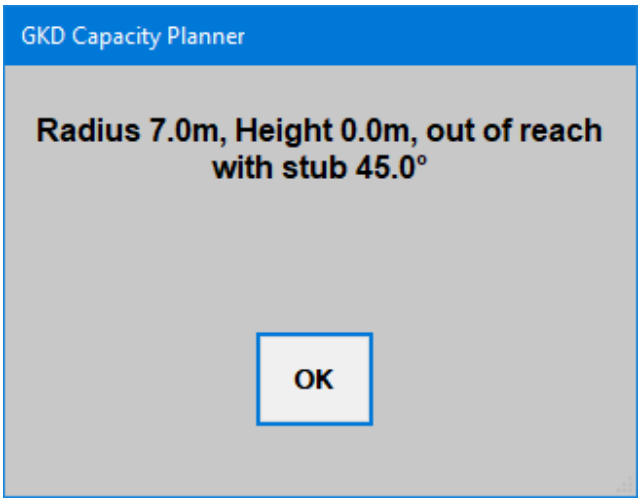
Out of Reach

In some circumstances, it is possible that a lift being planned cannot be performed by a machine due to the machine being unable to "reach" part of the height range at the top or bottom of the lift for a given radius.

This can occur when a lift is being planned at short lift radius very close to the machine at low height, and more commonly affects Monoboom type machines.

It can also occur when a lift is being planned at height, and where the machine is physically unable to reach the desired height and radius point.

Should the planner be unable to calculate a capacity at the top or bottom of the lift range due to the machine being unable to reach the height and radius, once the calculation has taken place a pop-up warning box will appear, similar to the one shown here.



In this example a lift has been planned for a -4m height range at 4m radius, and the machine is physically unable to achieve a 4m radius and -4m height.

The planning tool will also show "OUT OF REACH" in an orange box just above the "CALCULATE" button.



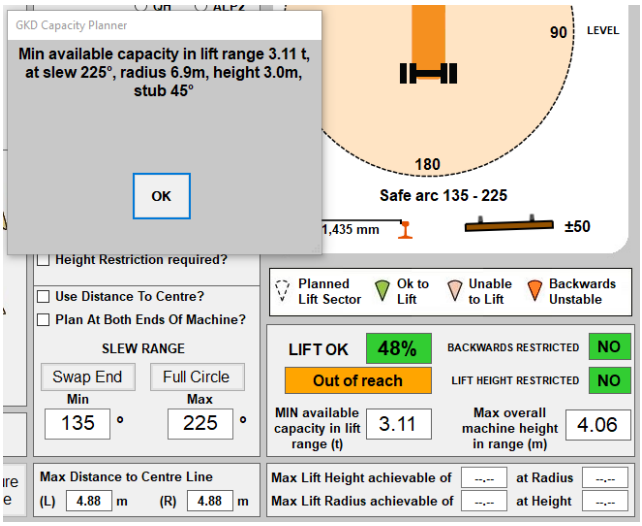
No result, apparently out of Reach

Should part of the desired lift range be out of reach of the machine, a pop up box will be shown stating that the planner is unable to calculate the desired lift due to part or all of the desired height range and radius being out of reach.

Out of reach of part of the desired height range

Should part of the desired lift be out of reach of the machine, a pop up box will appear.

In this example a lift of 3m height was asked for at 7m radius. This particular machine is unable to reach more than 6.9m radius at 3m height, and the pop up box will show details of the height that is out of reach.

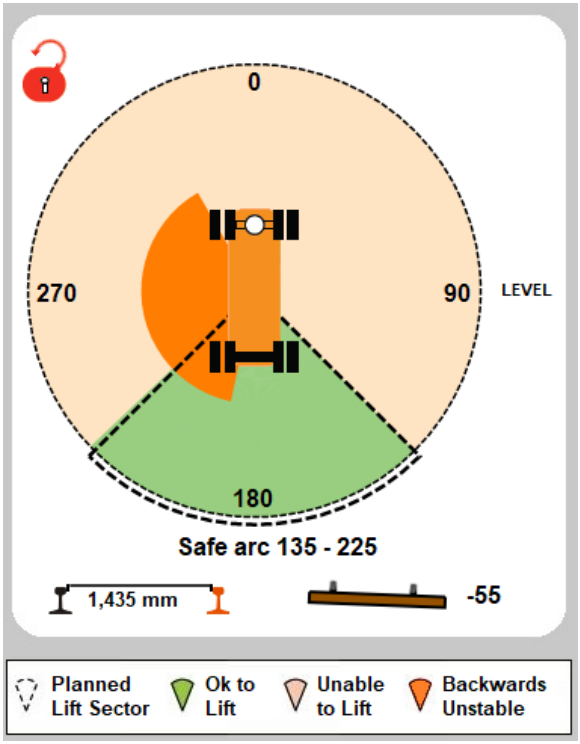


Note: with this new version of planning tool, you might need to adjust the radius distances by 200/300mm to achieve the same lift as planned in a previous version. This is due to the planning tool now applying the CANT and Gradient to the Stub Boom position, which in turn affects the achievable radius of the planning tool.

Interpreting the results

In the **"Result"** section of the page, a representation of the machine viewed from above is shown, with the planned lift slew range indicated. The diagram will be coloured green where the lift is safe, and pink where the lift capacity of the machine is exceeded. Provided the planned lift, represented on the diagram by the dotted section between minimum and maximum slew positions, falls entirely within the Green section of the diagram, the lift can be undertaken within the lift capacity of the machine.

If any part of the dotted section indicating the planned lift falls within the pink part of the diagram, the lift capacity of the machine is insufficient to perform the planned lift within that section.



Backward Stability

In some circumstances an orange triangle may be shown on the results diagram on the up cant side, roughly at right angles to the machine. This orange triangle represents an area where the machine may be backwardly unstable if a load is picked up or dropped off within the orange section. The RCI will allow the machine to carry a load through the orange section, but the lift point of an unloaded machine may not be permitted to enter the orange section, and the load should not be dropped off with the lift point positioned within the orange section.

Lift OK - This box indicates whether or not the machine has the capacity to perform the lift being planned. If the box is Red after the Calculate button has been clicked, the machine's lift capacity will be exceeded and the lift cannot be performed, if the box is Green the machine capacity is sufficient for the lift being planned.





The % figure within the "LIFT OK" Box represents the percentage of the machine's lift capacity used to complete the planned lift within the planned slew and height range and at the planned lift radius.

Backwards Restricted - Indicates whether backwards stability needs to be considered when picking up or dropping off the load. An orange box here does not mean that the machine cannot perform the lift, only that backward stability should be considered whilst performing the lift. Green indicates no backward stability issues.



Height Restricted - Indicates whether the machine is capable of lifting the load through the height range entered in the **"Lift Detail"** section. If Green, the machine is capable of operating at the height and radius entered, if Red, the machine is incapable of lifting to the entered height and radius. When the box is red, the maximum height the machine can lift to at the desired lift radius at is shown.



Out Of Capacity - This will be shown if the load entered in the Lift Detail box, exceeds the calculated load that the planning tool thinks the machine can lift (It cannot physically lift the load). i.e. if the load entered is 5t but the machine can only lift 3.5t, it will show OUT OF CAPACITY above the CALCULATE button.

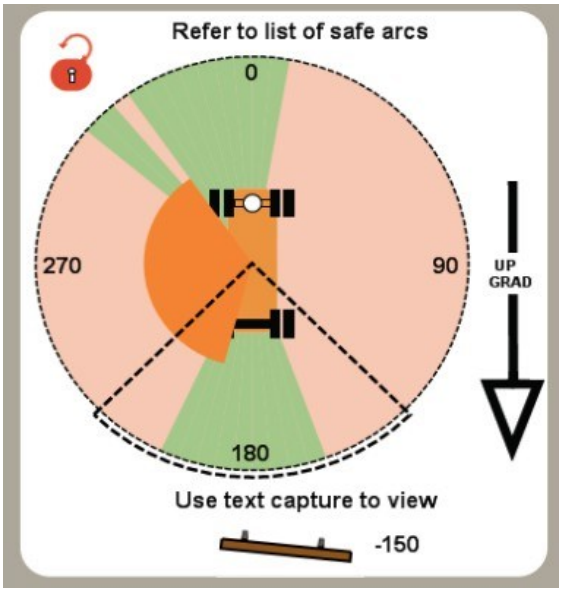


Hydraulics Lmtd - This will be shown if the machine is capable of lifting the load entered in the Lift Detail box, but the machine is limited by hydraulic capacity.
The hydraulic capacity will vary between machines, but our RCI system will deem a machine hydraulically limited if the capacity calculated is not derived by machine stability.
This is typical between 340—20 degrees over the front of the machine (towards the floating axle) and 160—200 degrees over the rear (fixed axle). Typically, Hydraulic Limits are higher than stability derived capacities.



Multiple Safe Arcs

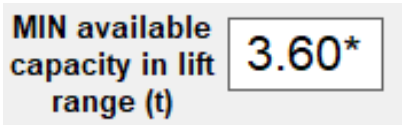
In some circumstances it is possible that more than two safe arcs will be available to the machine at the height range and radius entered. This may occur when small "dips" in
capacity occur, over wheels etc.! Should this condition occur, the "Results" window will show the circle around the machine with all the available safe sectors coloured in green, but the text indication of safe arcs against the circle around the machine will change to show "Refer to list of safe arcs" and "Use text capture to view".



To get a list of all the safe arcs available, please use the "Copy Text to Clipboard" button at the bottom right of the screen, and then open a text editor such as Notepad, and select "Edit - Paste" to paste the text analysis of the lift in a text form. Included within the text will be a list of all the safe arcs available to the machine at the radius and height range entered.

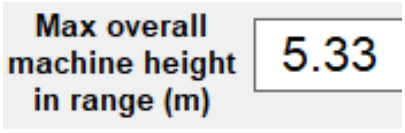
Min Available Capacity in Lift Range

Included in the Results section of the planner is a box marked "Min Available Capacity in Lift Range". The figure displayed in this box is the minimum lift capacity available to the machine within the height and slew range specified in the "Lift Detail" section.



Max Overall Machine Height

The figure displayed in this box indicates the height reached by the highest part of the machine whilst performing the planned lift. When working with height restrictions this figure can be used to check that the machine is able to perform the lift without fouling overhead obstructions.



Transferring the results to a Lift Plan

The GKD Capacity Planner supports two means of transferring information directly into the lift plan.



Capture Image - if the "Capture Image" button is clicked, a copy of the entire Capacity Planner page as shown on the computer screen will be captured as an image and copied to the computer's clipboard. This image can be pasted directly into the lift plan document by using the "Paste" function. The image will paste into an Excel document if required.

Copy Text to Clipboard - if this button is clicked, a block of text relating to the results of the Capacity Planner's planned lift will be copied to the clipboard, and can be pasted directly into the Lift Plan document using the "Paste" facility.

A sample of the text that will be copied is below:

<MACHINE DETAIL>	(identification of planner / machine type)
Rail Mode/Axle Unlocked	(Road or Rail mode, axle locked or unlocked)
Stub boom length 1963 mm	(length of primary boom in mm)
Fore boom length 3225 mm	(length of fore boom / artic boom in mm)
Dipper boom length 2100 mm	(length of dipper boom in mm)
Slew Angle 135° to 225°	(slew range entered for the planned lift)
Cant mm/Angle -150 mm/-6.0°	(maximum cant entered for the planned lift)
Grad/Angle -1:25/-2.3°	(maximum gradient entered for the planned lift)
Radius 4000 mm	(radius entered for the planned lift)
Height 0 mm to 700 mm	(height range entered for the planned lift)
Hook Point BP	(lift point selected for the planned lift)
Rated Min. Capacity 2.50 t	(capacity of machine at point of lowest capacity in lift)
(at slew 135°, height 0.2m, stub 79.0°)	(position of lowest capacity in planned lift)
Machine Overall Max Height 4.12 m	(height of highest point of machine during lift)
Load, wt panel s/c 2.1 t	(weight of load entered for planned lift)
Wt of attachments 0.4 t	(weight of attachments entered for planned lift)
Total Load 2.50 t	(total weight of load and attachments for planned lift)
Target load per m/c 2.50 t	(load per machine if undertaking a tandem lift)
Two safe arcs at 0.2 m	(arcs within which the machine is able to lift the load)
from 313° clockwise to 359° slew	
from 135° clockwise to 233° slew	
Backwards unstable	(backward stability needs to be considered in planned lift)

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