Safety Systems - stability

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Safety Systems - stability

HMF cranes are equipped with an RCL Safety System and its primary function is to prevent the max. permissible load moment being exceeded (load moment limitation - LMB).

Provided that the vehicle is correctly supported and that it is stable at the max. load moment of the crane, the vehicle is thus protected against instability.

However if these conditions are not fulfilled, the RCL Safety System must also prevent the crane from stressing the vehicle beyond the stability limit.

Depending on the installation and the combination of crane and vehicle - for example:
- size of the vehicle
- number of axles
- crane size in relation to the vehicle
- positioning of the crane on the vehicle
- distance between the stabilizer legs of the crane
- installation of separate traverse etc.

the crane may be equipped with different types of safety systems for securing of stability that are to ensure vehicle stability during crane operation.
The safety systems for securing of stability are divided into two groups:

Passive safety systems - stability
The passive safety systems such as PAS, CYL, CYBEL, 2 CYL, 2CYBEL, MSL, 2LMB monitor that the vehicle is correctly supported and stable at the max. load moment of the crane before it is possible to work with the crane.
The safety system does not monitor the support of the vehicle during crane operation.

Active safety systems - stability
The active safety systems such as EVS-H, EVS-D monitor that the vehicle is correctly supported and stable at the max. load moment of the crane before starting to work with the crane.
Furthermore these safety systems are monitoring the stability of the vehicle during crane operation and stop the crane at the max. permissible heel of the vehicle.

Safety Systems - stability

In the following there is a description of the different safety systems for securing of stability.

Pictograms have been affixed at the control position on the crane, indicating which type of monitoring system is fitted on the crane in question.

PAS, Preparation for Alternative Stability

The vehicle body builder/crane installer fits his own monitoring system which gives an input signal for an input in the RCL 5300, when the vehicle is correctly supported and stable at the max. load moment of the crane.
In case of a high input signal, the RCL Safety System is being activated, and it will then be possible to work with the crane.
In case of a low input signal, the RCL Safety System is deactivated (the dump valve is open), and it is not possible to work with the crane.

CYL, Cylinder Limitation

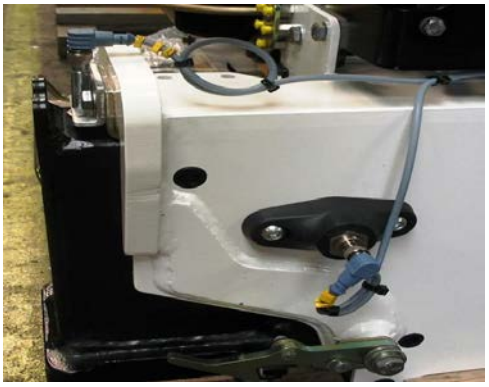
A proximity switch is included in the CYL monitoring system, which may for instance be fitted at the extreme end of each stabilizer beam. See the picture.
The proximity switches give an input signal to the RCL 5300 when the stabilizer legs have been lowered to the surface.
When the stabilizer beams are retracted and the stabilizer legs are down, the vehicle must be stable at the maximum load moment of the crane.

When changing from stabilizer mode to crane mode it is verified via signals from the proximity switches, whether the vehicle is correctly supported.

In case of a high input signal, the RCL Safety System is being activated, and it will then be possible to work with the crane.
In case of a low input signal, the RCL Safety System is deactivated (the dump valve is open), and it is not possible to work with the crane.
The RCL 5300 indicates which sensor does not give a signal.

CYBEL, Cylinder Beam Limitation

A proximity switch is included in the CYBEL monitoring system, which may for instance be fitted at the extreme end of each stabilizer beam (like CYL) and on each side of each stabilizer beam. See the picture.
The proximity switches give an input signal to the RCL 5300, when the stabilizer beams are fully extended and the stabilizer legs are lowered to the surface.
When the stabilizer beams are fully extended and the stabilizer legs are down, the vehicle must be stable at the maximum load moment of the crane.



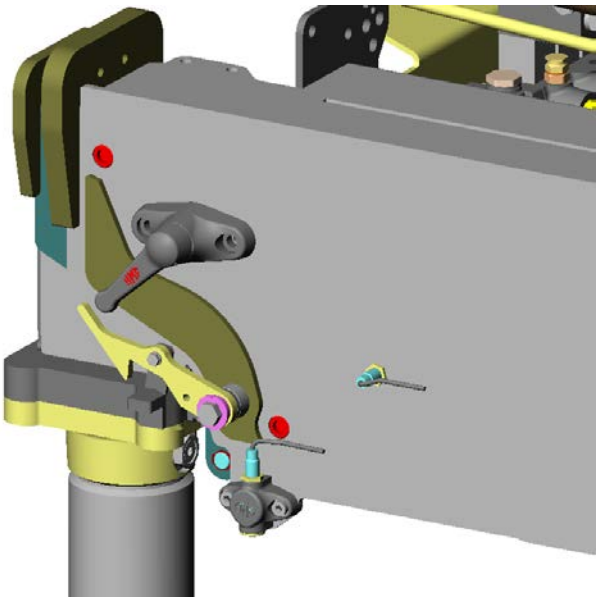
When changing from stabilizer mode to crane mode it is verified via signals from the proximity switches, whether the vehicle is correctly supported.

In case of a high input signal, the RCL Safety System is being activated, and it will then be possible to work with the crane.
In case of a low input signal, the RCL Safety System is deactivated (the dump valve is open), and it is not possible to work with the crane.
The RCL 5300 indicates which sensor does not give a signal.

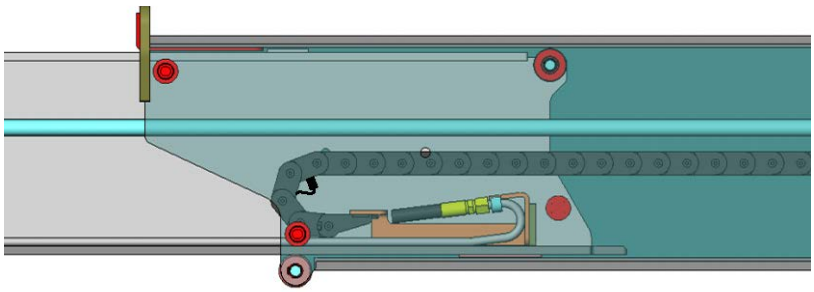
Alternative mounting of sensors

A proximity switch is fitted next to the pin for the suspended guide roller, which is spring-loaded.

A magnet proximity switch is fitted on the side of the stabilizer beam.
A magnet is inserted in the extensible stabilizer beam.



In case of a double beam, the side mounted proximity switch may be replaced by a tilt sensor fitted on the nylon drag chain internally in the stabilizer beam.



CYBEL versions

There are two versions of CYBEL with regards to functionality.

CYBEL-ver. 1
In case of CYBEL - up to and including RCL 5300 software version 31_22 - the stabilizer beams must be extended and the stabilizer cylinders lowered to the ground, before starting to work with the crane.

In case of missing signal from a stabilizer function (damaged cable or sensor, etc.), so that it is not possible to change to crane mode when pushing the yellow press button twice, it is possible to use an override function, in order to start crane operation again.
See description later in this chapter.

CYBEL-ver. 2
In case of CYBEL - as from RCL 5300 software version 32_23 - the stabilizer beams must be extended and the stabilizer cylinders lowered to the ground, before starting to work with the maximum lifting capacity of the crane.

In case of one or both stabilizer beams not being extended, and the stabilizer legs just being lowered to the ground, the lifting capacity of the crane is reduced.
In this CYBEL-ver. 2 it is not possible to use the override function.
See description later in this chapter.

CYBEL-ver. 2 / 2CYL

The same sensors as in the CYBEL safety system are included in the CYBEL-ver.2 safety system.
The difference is the software as described above.

In case of one or both stabilizer beams not being extended, and the stabilizer legs just being lowered to the ground, the lifting capacity of the crane is reduced.

The reduced lifting capacity is set by the crane fitter, so that the vehicle stability is ensured when both stabilizer beams are retracted and both stabilizer legs are lowered.
The factor of the reduced lifting capacity is called "Max Stable Load" in the CGW 5355.

The circles in the figures symbolize the lifting capacity of the crane:

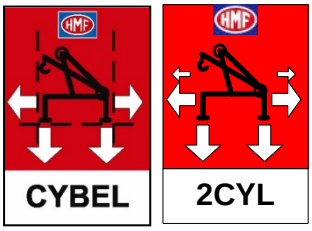


Fig. 1: Both stabilizer beams extended - maximum lifting capacity
Fig. 2: Right stabilizer beam retracted - reduced lifting capacity
Fig. 3: Left stabilizer beam retracted - reduced lifting capacity
Fig. 4: Right and left stabilizer beam retracted - reduced lifting capacity

In all examples both stabilizer legs are lowered to the ground.

The functionality of reduced lifting capacity is called **2CYL**.

Fig.1

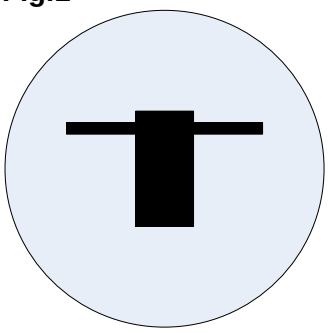


Fig.2

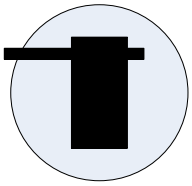


Fig.3

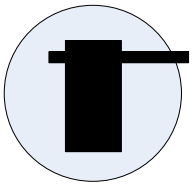
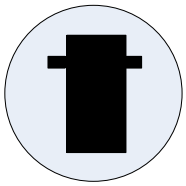


Fig.4



2CYBEL

The same sensors as in the CYBEL safety system are included in the 2CYBEL safety system.
Furthermore 2 proximity switches are included by a cam disc on the column.
The two proximity switches on the cam disc and the sensors on the stabilizer beams are coupled via a relay to an input terminal in the RCL 5300.
The input signal is high when the stabilizer beam is extended in the side where the boom system is.

In case of high signal the crane has maximum lifting capacity.
In case of low signal the crane has reduced lifting capacity.

In the side where the stabilizer beam is extended, it is possible to work with the maximum lifting capacity of the crane, while the lifting capacity of the crane is reduced to the side where the stabilizer beam is not extended.

The reduced lifting capacity is set by the crane fitter, so that the vehicle stability is ensured when both stabilizer beams are retracted and both stabilizer legs are lowered.
The factor of the reduced lifting capacity is called "Max Stable Load" in the CGW 5355.

The circles in the figures symbolize the lifting capacity of the crane:

Fig. 1: Both stabilizer beams extended - maximum lifting capacity to both sides of the vehicle.
Fig. 2: Right stabilizer beam retracted - the lifting capacity is reduced to the right side and there is maximum lifting capacity to the left side of the vehicle.
Fig. 3: Left stabilizer beam retracted - the lifting capacity is reduced to the left side and there is maximum lifting capacity to the right side of the vehicle.
Fig. 4: Right and left stabilizer beams retracted - reduced lifting capacity to both sides of the vehicle.

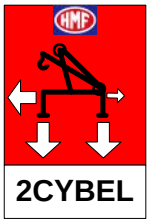


Fig.1

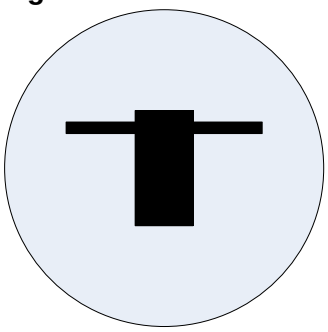


Fig.2

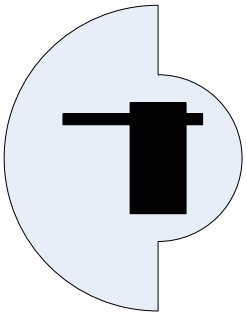


Fig.3

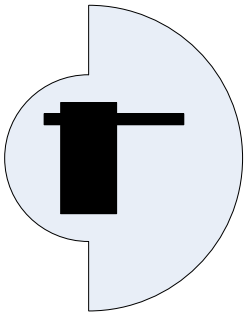
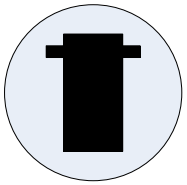


Fig.4



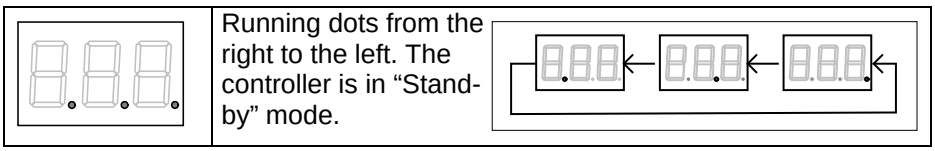
Starting up and end of crane operation

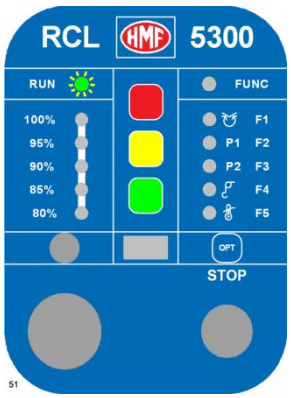
Before crane operation, start up the safety and operating system, and support the vehicle securely in order to make it stable.

As described above, there are two types of indication depending on the safety system for securing of stability:
- PAS, CYL, EVS and CYBEL-ver. 1 indications
- 2CYBEL and CYBEL-ver. 2 indications

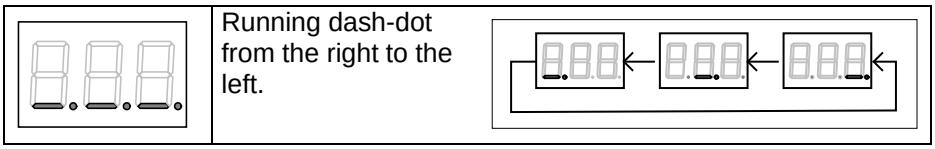
Starting up the RCL 5300 Safety System - PAS, CYL, EVS and CYBEL-ver. 1

1. Connect the pump (PTO); the controller is thus powered. The display shows:



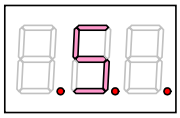


2. Then the display shows:



3. The green RUN diode is constantly lit, indicating that the safety system is ready for operation.

4. Push the yellow press button twice to select the stabilizer functions (stabilizer mode).
   The display shows a flashing **S** if the crane is fitted with a stabilizer deployment monitoring system. Otherwise the display continues to indicate as in item 2.



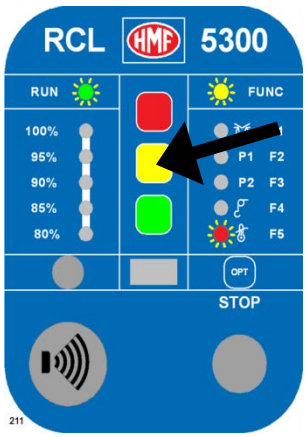
5. Operate the stabilizer legs so that the vehicle is correctly supported. Follow the instructions according to the Instruction Manual, Cranes as well as the following chapters concerning safety systems for securing of stability.
   The display shows a luminous **S** and a luminous symbol on each side indicating which stabilizer legs/stabilizer beams are down/extended (please see example to the right and the following chapter).

6. Push the yellow press button twice to select the crane functions (crane mode). The display indicates as in item 3.

If the crane is radio remote controlled, start up the radio remote control system according to the Instruction Manual for this system. Then crane operation can start.

End of crane operation

After crane operation the crane is prepared for transportation:
- Fold the crane in stowing position
- Change to stabilizer mode by pushing the yellow press button twice
- Raise all stabilizer legs and retract all stabilizer beams.



Carry out all operation and take all necessary precautionary measures concerning preparation for transportation according to the directions for use in the Instruction Manual, Cranes

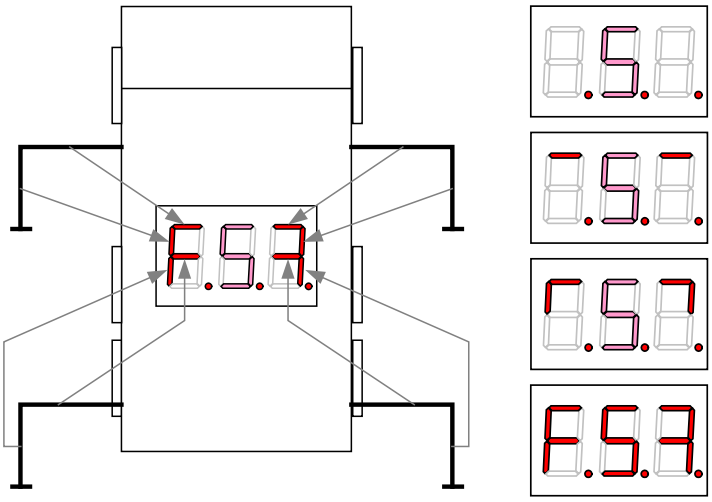
Then push the stop button on the RCL 5300 indicator panel as well as on the remote control box (if the crane is radio-controlled), and stop the hydraulic pump (PTO), the power for the controller is thus interrupted.

Monitoring of the PAS, CYL, EVS and CYBEL-ver. 1 safety systems

The RCL 5300 Safety System monitors a number of sensors on the stabilizer legs and stabilizer beams, and it is only possible to change from stabilizer mode to crane mode when the RCL 5300 has received a signal from all sensors.
In case of interruption of the power supply, restart of the RCL Safety System or if the system goes into stand by mode - the original mode of the system will be remembered.

Display indications in stabilizer mode, in general

When the monitoring system is in stabilizer mode (2 x yellow), a flashing **S** appears in the display. As the stabilizer beams are extended and the stabilizer legs are lowered to the surface, segments are lit on both sides of the **S** indicating the status of the stabilizer legs and stabilizer beams being monitored.



No stabilizer beams are extended and no stabilizer legs are lowered.

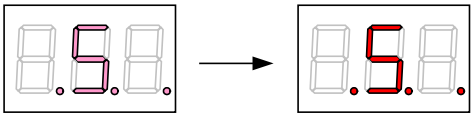
The stabilizer beams of the crane are extended in both sides.

The stabilizer beams of the crane are extended and the stabilizer legs are lowered in both sides.

All stabilizer beams (also those of the separate traverse) are extended and all stabilizer legs are lowered in both sides.

Display indication, PAS

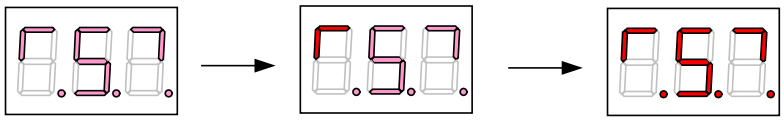
It is only permitted to change from stabilizer mode to crane mode, when a signal is coming from the PAS monitoring system.
The display indicates by means of a flashing **S** (figure to the left) that a PAS signal is missing or by a luminous **S** (figure to the right) that there is a PAS signal.



Display indication, CYL and EVS

It is only permitted to change from stabilizer mode to crane mode, when a signal is coming from the two sensors that register that the stabilizer legs are lowered to the surface.

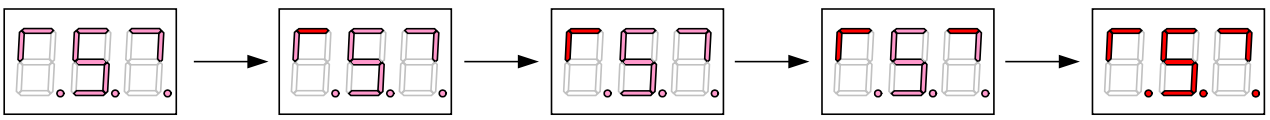
The display indicates:
Fig. 1:
A flashing **S** and two segments on both sides = no stabilizer legs have been lowered.
Fig. 2:
A flashing **S,** two segments on the right side flashing and two segments on the left side are lit = the left stabilizer leg has been lowered.
Fig. 3:
A luminous **S** and two luminous segments on both sides = both stabilizer legs have been lowered.



Display indication, CYBEL-ver. 1

It is only permitted to change from stabilizer mode to crane mode, when a signal is coming from the four sensors that register that the stabilizer beams are extended and the stabilizer legs are lowered to the surface.

The display indicates:
Fig. 1:
A flashing **S,** two flashing segments on both sides = no beams/legs have been extended/lowered.
Fig. 2:
A flashing **S**, a horizontal segment on the left side is lit = the left stabilizer beam has been extended.
Fig. 3:
A flashing **S**, a horizontal and a vertical segment on the left side are lit = the left beam has been extended/the left leg has been lowered.
Fig. 4:
A flashing **S**, a horizontal segment on the right side is lit = the right stabilizer beam has been extended.
Fig. 5:
A luminous **S** and two luminous segments on both sides = beams have been extended/ legs have been lowered in both sides.



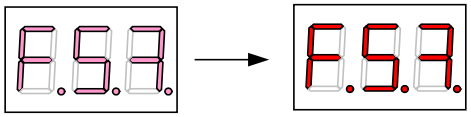
Display indication, separate traverse

In case of a separate traverse fitted on the vehicle (CYL/CYBEL), the display indicates correspondingly when the stabilizer beams are extended and the stabilizer legs are lowered. The functions of the separate traverse are indicated in the lower segments of the display.

Display indication, fig.1:
A flashing **S** and flashing segments = no beams/legs have been extended/lowered.

Display indication, fig.2:
A luminous **S** and luminous segments = beams have been extended/ legs have been lowered in both sides.

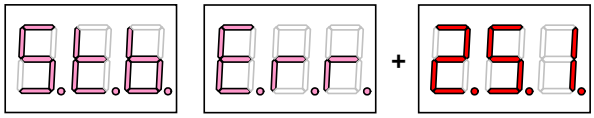
Fig. 1 Fig. 2



Error codes

In case of missing signal from a sensor, when all stabilizer beams are extended and all stabilizer legs are down, the **S** will continue to flash.
If pushing the yellow press button twice to activate crane mode, the display indicates an error by flashing:
S.t.b. E.r.r. - **S.t.b. E.r.r.** - **S.t.b. E.r.r.** and then an **error code**.

Example of error indication:

3x + 

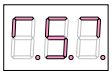
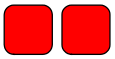
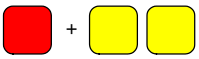
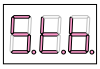
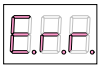
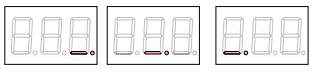
Error code	Type of error
251	Missing signal for left stabilizer leg down.
252	Missing signal for left stabilizer beam extended.
253	Missing signal for right stabilizer leg down.
254	Missing signal for right stabilizer beam extended.
255	Missing signal for left stabilizer leg down, separate traverse.
256	Missing signal for left stabilizer beam extended, separate traverse.
257	Missing signal for right stabilizer leg down, separate traverse.
258	Missing signal for right stabilizer beam extended, separate traverse.
261-268	Redundant signals are missing for the above-mentioned functions (option).
271	Missing signal for the PAS monitoring system.
272	Redundant signal is missing for the PAS system (option).

The error code remains until the missing signal from a stabilizer function has been re-established, or when pushing the red press button twice. Please see the chapter "Override in case of system errors".

Override in case of system errors

In case of missing signal from a stabilizer function (damaged cable or sensor, etc.), so that it is not possible to change to crane mode when pushing the yellow press button twice, it is possible to use an override function, in order to start crane operation again.

Example of handling the override function:

1. After operation of the stabilizer functions, the **S** is still flashing in the display..... 
2. Push the yellow press button twice to change into crane mode... 
3. An error is indicated in the display for example:.....3x   + 
4. **Make sure that the vehicle is correctly supported.**
5. Push the red press button twice…….. 
6. The error indication disappears and the **S** starts flashing again…….. 
7. Change into crane mode by means of the override function: Keep down the red press button and push the yellow press button twice…….. 
8. The display indicates warning in case of override…..…… 3x  
9. The display indicates ready for operation..…… 

If a signal is missing from several stabilizer functions, the error indication continues and you have to repeat item 5 until a luminous **S** in the display indicates ready for operation.

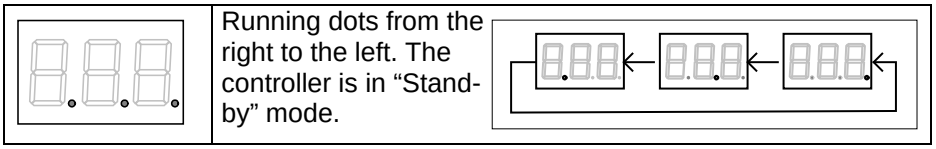
Please note: Abusing the override function is prohibited. Contact an HMF service point as soon as possible to have the error remedied.
Every time the override function is used, it is registered with date and time in a memory register in the RCL 5300.

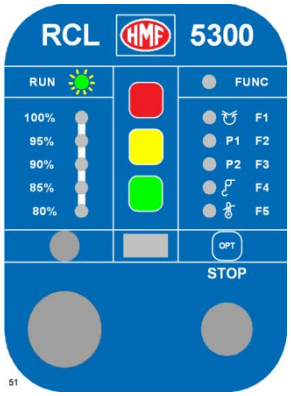
Monitoring of the 2CYBEL and CYBEL-ver.2 safety systems

As described above, there are two types of indication depending on the safety system for securing of stability. In the following there is a description of the 2CYBEL and CYBEL-ver.2 systems and the corresponding indications on the display.

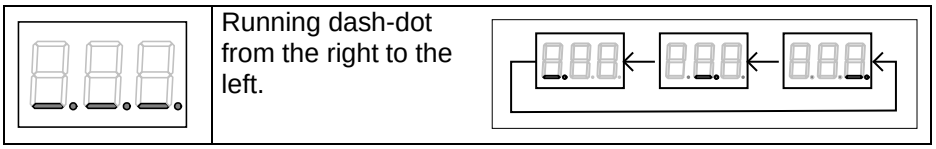
Starting up the RCL 5300 Safety System - 2CYBEL and CYBEL-ver. 2

1. Connect the pump (PTO); the controller is thus powered. The display shows:



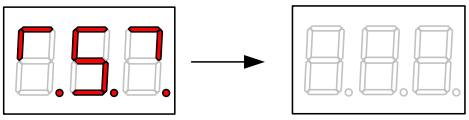


2. Then the display shows:

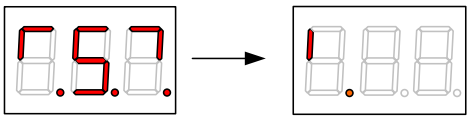


3. The green RUN diode is constantly lit, indicating that the safety system is ready for operation.

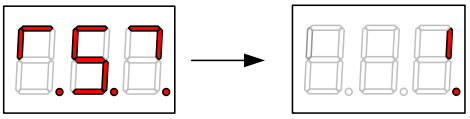
4. Push the yellow press button twice to select the stabilizer functions (stabilizer mode).
The display shows a flashing **S** if the crane is fitted with a stabilizer deployment monitoring system. Otherwise the display continues to indicate as in item 2.



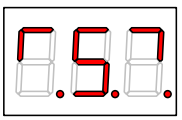
5. According to the instructions in the Instruction Manual, operate the stabilzer legs so that the vehicle is correctly supported.
When the left stabilizer leg has been lowered, the display shows alternately a flashing **S** and a flashing symbol as indicated, and the buzzer gives a short signal.



6. When the right stabilizer leg has been lowered, the display shows alternately a flashing **S** and a flashing symbol as indicated, and the buzzer gives a short signal.



7. When both stabilizer legs are lowered, the display shows a luminous **S** and a luminous symbol as indicated.



8. Push the yellow press button twice to select the crane functions (crane mode). The display indicates as in item 2.

If the crane is radio remote controlled, start up the radio remote control system according to the Instruction Manual for this system. Then crane operation can start.

Reduced lifting capacity in case of system errors or lacking stability

In case of missing signal from a sensor on the stabilizer (damaged cable or sensor, etc.), or in case of one or both stabilizer beams not being extended, and the stabilizer legs just being lowered to the ground, it is not possible to change into crane mode by pushing the yellow press button twice.
Instead the lifting capacity of the crane is reduced to a level where the vehicle remains stable when both stabilizer beams are retracted and both stabilizer legs are lowered.

Reduced lifting capacity is indicated in the display by a luminous **der** (derate) as indicated.

The factor of the reduced lifting capacity is called "Max Stable Load" in the CGW 5355.

The override function, SSO (Stabilizer Safe Override)

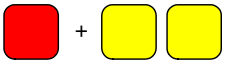
This override function can be used in situations, where it is necessary to work with the crane without stabilization. For example if the boom system is to be lifted from the truck body to make it possible to use the tipping function and in case of service overhauls etc.
When using the override function, the lifting capacity of the crane is reduced to a level where the vehicle remains stable, when none of the stabilizer legs are lowered.

The reduced lifting capacity is set by the crane fitter.
The factor of the reduced lifting capacity is called "SSO derate f." in the CGW 5355.

Example of handling the override function:

1. Activate the RCL Safety System, and start up in stabilizer mode. The display indicates a flashing **S**……

2. Change into crane mode by means of the override function:
   Keep the red press button down, and
   push the yellow press button twice.....

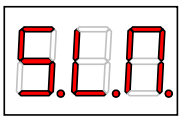


3. The display indicates by **SSo** that the system is ready for operation.
   The lifting capacity of the crane is reduced……

Stabilizer mode, manually controlled cranes

Some crane types have series connection of the control valves for crane functions and stabilizer functions.

The stabilizer deployment monitoring system functions as described above, but in stabilizer mode none of the functions with a spool sensor (except from the "extension - in" function) can be operated.
In case of activation of other crane functions in case of erroneous operation, the lifting capacity of the crane is furthermore reduced to a low level. In the display is indicated **SLm**:



The factor of the reduced lifting capacity is called "Max Load inc." in the CGW 5355.

Mechanical slewing limitation, MSL

A craned vehicle is very often not stable, even though the stabilizer beams are extended and the stabilizer legs are lowered to the surface. I.e. the max. load moment of the crane cannot be utilised in its entire working area.
If the vehicle is stable to the sides but unstable in front of the driver's cab, the slewing area of the crane is limited mechanically, so that it is not possible to work with the crane in the unstable area of the vehicle.
This mechanical limitation of the slewing area may be combined with one of the above-mentioned safety systems for securing of stability.

2LMB, 2-stage LMB

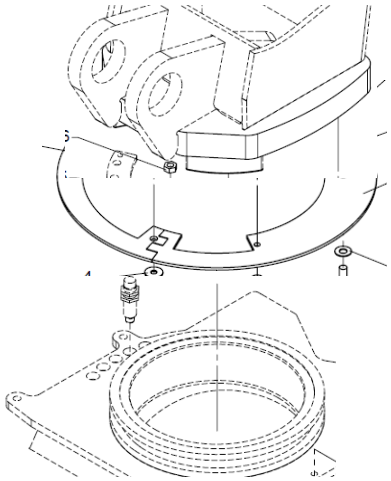
If the vehicle is stable to the sides but unstable in front of the driver's cab, the RCL 5300 Safety System can be extended by a 2-stage load moment limitation system (2LMB).

With 2-stage LMB, the lifting capacity of the crane is reduced in front of the driver's cab while the maximum lifting capacity is utilised backwards over the truck body.
The 2-stage LMB system is combined with one of the PAS, CYL, CYBEL or 2CYBEL monitoring systems, as the vehicle must be stable in the entire slewing area of the crane.

A proximity switch fitted on the base detects on a cam disc fitted on the column, at which point in the slewing area the boom system is positioned.

With the boom system in the direction backwards over the truck body, the proximity switch detects on the cam disc. Whereas when the boom system is in front of the driver's cab, the proximity switch is free of the cam disc.

Together with a signal from a spool sensor indicating the slewing direction, the proximity switch gives information to the RCL 5300. Based on the position of the boom system in the slewing area, the maximum or reduced lifting capacity is thus activated.



EVS-Electronic Vehichle Stability

EVS is a safety system, which is monitoring the stability of the vehicle during crane operation in the critical working areas. All crane functions that might increase the heel are stopped at the max. permissible heel.

If the crane is equipped with an EVS system, its lifting capacity can constantly be utilised to its max. limit in relation to the stability of the vehicle.
The stability limit is not being exceeded even though the stabilizer beams are not fully extended before the stabilizer legs are lowered. But the lifting capacity of the crane can only be utilised corresponding to the reduced stability.
Together with the EVS system, the CYL monitoring system is also included to ensure that the stabilizer legs are lowered to the surface before starting to work with the crane.

System configuration, EVS-H

If the crane is manually operated, the EVS system is of the EVS-H type. The configuration is:

- RCL 5300 Safety System
- Spool sensors on crane functions which may influence the stability of the vehicle.
- Adjustable restrictor valves - in the hydraulic circuit for the slewing movement - for reduction of the slewing speed.
- AIC 5062/1, **A**dvanced **I**nclination **C**ontroller
  (until week 19 - 2012)
- DPS controller, single
  (as from week 19 - 2012)

System configuration, EVS-D

If the crane has a radio remote controlled control valve, the EVS system is of the EVS-D type. The configuration is:

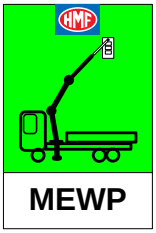
- RCL 5300 Safety System
- Radio remote control system
- AIC 5062/1, **A**dvanced **I**nclination **C**ontroller
  (until week 19 - 2012)
- DPS controller, single (as from week 19 - 2012)
  Two M12 plugs. a CAN-In plug (male) to the left and a CAN-Out socket (female) to the right.

DPS controller, single

AIC 5062/1 controller

System configuration, crane with personnel basket, MEWP

- RCL 5300 Safety System
- Radio remote control system
- AIC 5062/1, **A**dvanced **I**nclination **C**ontroller
- AIC 5062/2, **A**dvanced **I**nclination **C**ontroller
- Key switch for change between ordinary crane operation and crane operation with personnel basket.



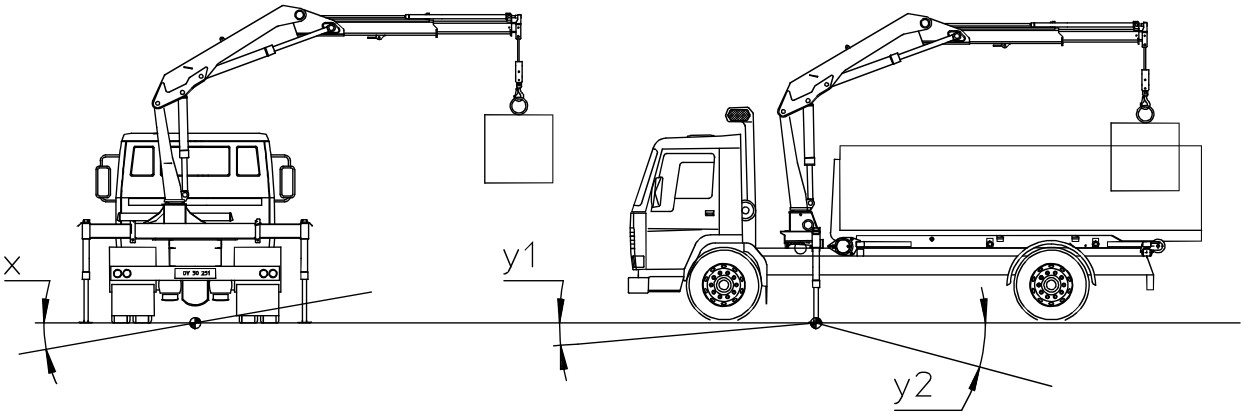
The AIC 5062/1 and AIC 5062/2 controllers have the same hardware but different software.

The RCL 5300 monitors and compares the signals from both AIC controllers and the safety system reacts based on the highest signal.

With the key switch in the position for crane operation with personnel basket, the permissible heel is reduced via the EVS stability safety system to increase vehicle stability. Furthermore the lifting capacities of the crane and the Fly-Jib are derated and
the speed of several crane functions is reduced.

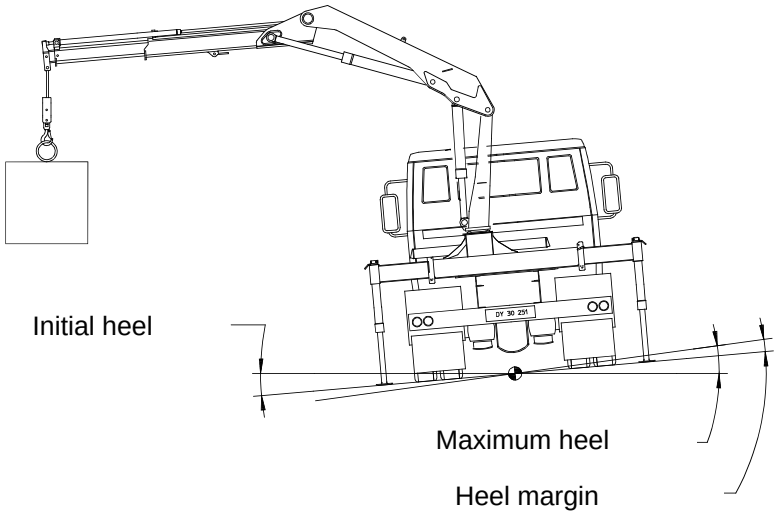
The function of the EVS system

The DPS controller fitted on the base of the crane and connected to the RCL 5300 controller has two built-in heel sensors. One of them measures the heel of the vehicle in the X-direction (to the sides) and the other measures the heel in the Y1-direction (in front of the driver's cab and in the Y2-direction (over the truck body).



The DPS has been pre-programmed from the factory so that absolute horizontal position has been defined. I.e. as a starting point, the DPS has information about what horizontal position is, when the vehicle is in a terrain with uneven surface.
Furthermore the DPS registers information about the following heel of the vehicle:

- If the surface where crane operation is to take place is not level, the vehicle has a so-called initial heel.
- After mounting of the crane onto a vehicle, the EVS system has been pre-set so that the vehicle is allowed to heel up to a max. marginal value called the heel margin.
- The total heel, i.e. the initial heel plus the heel margin must not exceed a marginal value called the maximum heel.



During crane operation the DPS is constantly monitoring the heel of the vehicle. When the heel reaches a marginal value, i.e. when the vehicle starts being unstable, a signal from the DPS is sent to the RCL 5300 Safety System.

In the same way as the crane's load moment increasing movements are stopped because of overloading (Load Moment Limitation – LMB), the RCL Safety System reacts in case of too much heel and stops the stability reducing crane movements (Stability monitoring – EVS).

Also a slewing movement registered as a stability reducing movement will be stopped.
All stability increasing crane movements can still be operated.

Calibration of the EVS system before starting up

Before starting up crane operation, the EVS system must be calibrated because of two factors that influence the functionality of the system, i.e. the initial heel as well as the dead load heel.

Initial heel
After starting up and correctly supporting the vehicle, it will as a rule be a little inclined. The DPS registers this initial heel and compares it with the absolute horizontal position.

Dead load heel
Depending on the position of the boom system and its position in the slewing area, the stress of the crane on the vehicle will entail a dead load heel.

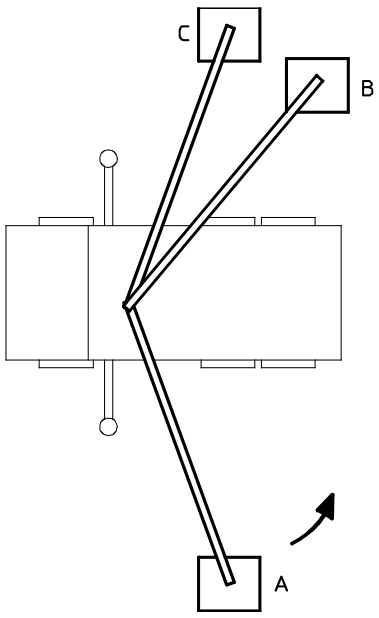
At each start-up of the crane operation where stabilizer functions have been operated, a calibration must be carried out in order to zero the initial heel and the dead load heel which the AIC has registered.

After calibration, which takes place automatically, the current heel is set at 0 degrees and during crane operation the vehicle is allowed to heel up to the pre-set marginal value.

The EVS system should be calibrated at as low a load moment as possible. The best possible calibration is obtained when the crane is folded in stowing position during start-up. In this position the tare weight of the crane has only little influence on the heel of the vehicle.

If the working tasks require the crane slewing a load from one side of the vehicle to the other, asymmetric stability might occur.
I.e. if a load is to be swung from point A to point C in the opposite side, it may occur that the EVS system is being activated and that the slewing movement is stopped already at point B.

In such a working situation it is necessary to optimise the calibration, i.e. the EVS system is calibrated at as low a load moment as possible.



Indication when calibrating

To ensure an optimal calibration, the dead load heel and the load moment of the crane must be as small as possible. The 80, 85, 90, 95, and 100 % diodes on the RCL 5300 indicator panel indicate, right before the calibration is carried out, the size of the current load moment on the crane:

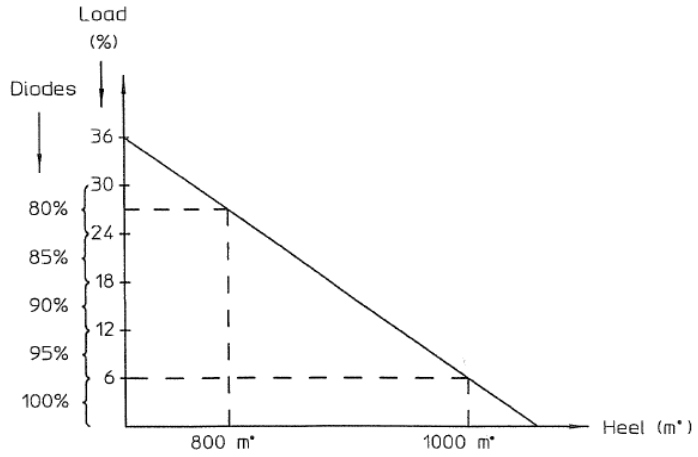
- The 80 % diode indicates the worst calibration (at the highest dead load)
- The 100 % diode indicates the best calibration (at the lowest load moment of the crane)

Example:

Heel margin = 1000 m°
Dead load heel = 200 m°

With a load moment below 6 % where the 100 % diode is lit before calibration, the heel of the vehicle must be utilised up to the pre-set heel margin of 1000 m°.

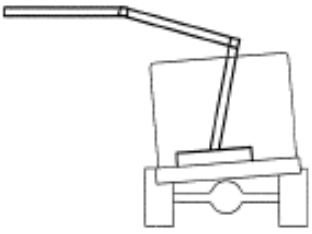
If the load moment of the crane is between 24 and 30 %, where the 80 % diode is lit before calibration, only 800 m° of the max. permissible heel of 1000 m° can be utilised.



The functionality of the EVS system in case of a non-optimal calibration (80 %)

The boom system is in a position to the left side of the vehicle while an 80 % calibration is carried out. The dead load heel is 200 m°.

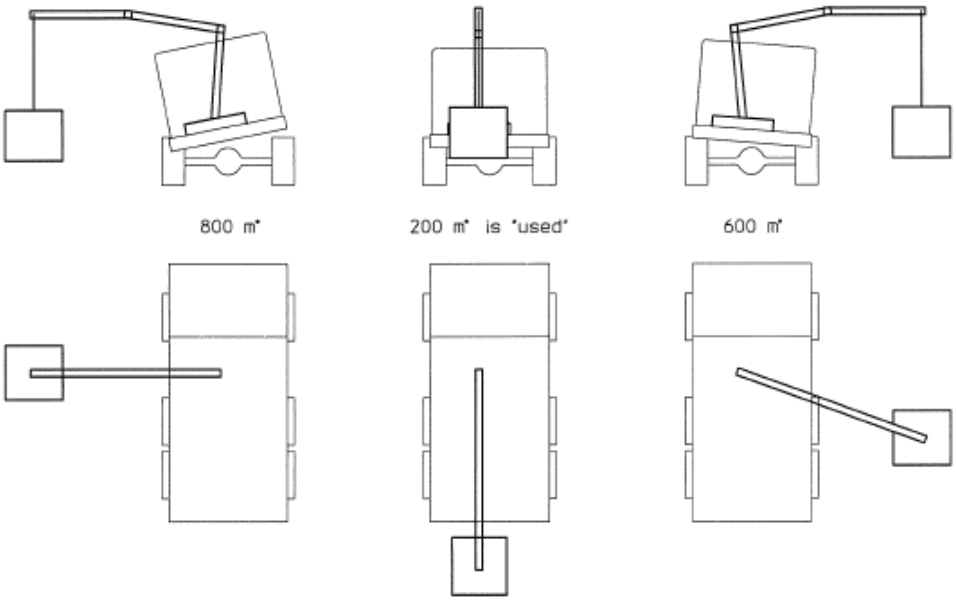
After calibration, the dead load heel of 200 m° is zeroed. Because of an 80 % calibration it is only possible to lift a load corresponding to the vehicle heeling maximum 800 m°.



Move the load to the left. In a position with the boom system over the truck body, 200 m° have been "used".

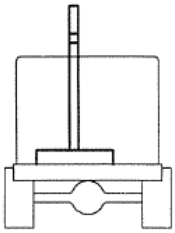
Move the load to the right, and the slewing movement stops when the heel reaches 600 m°.

It is not possible to move the load completely to a position where the stability of the vehicle is fully utilized.



The functionality of the EVS system in case of an optimal calibration (100 %)

The boom system is in a position backwards over the truck body. The boom system is unloaded, and a 100 % calibration is carried out.
The dead load heel is zero, as the boom system is over the truck body.
After the 100 % calibration the dead load heel is still zero.

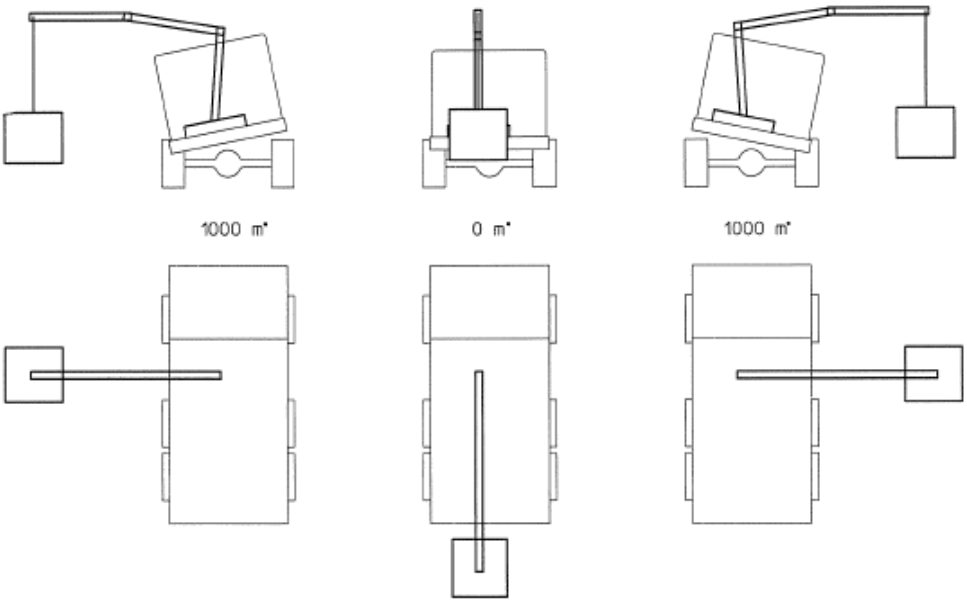


Slew the boom system to the right and out to the left side.
Because of a 100 % calibration it is possible to lift a load corresponding to the heel of the vehicle being utilized up to the pre-set heel margin of 1000 m°.

Move the load to the left. In a position with the boom system over the truck body, the heel is zero.

Move the load to the right, and the slewing movement stops when the heel reaches 1000 m°.

In case of a 100 % calibration with the boom system over the truck body, the load can be moved completely around to a position where the stability of the vehicle is fully utilized.



If the EVS system has not been calibrated after operating the stabilizer functions, the lifting capacity of the crane is reduced to a level, where the vehicle is stable with the stabilizer beams retracted and the stabilizer legs down.

Intervention from the EVS system in case of critical heel

When, during crane operation, a critical heel of the vehicle occurs, the EVS system interferes. When interfering, the crane is stopped by several types of safety checks and routines:

The TTL (Traditional Tilt Limitation) Routine

When the heel of the vehicle reaches the marginal value, i.e. the pre-set heel margin, the EVS system carries out a TTL routine

The TTL routine means that all stability reducing crane movements are stopped for 4 seconds to get the load stable. Also a slewing movement registered as a stability reducing movement will be stopped (the dump valve opens so that oil from the pump flows to tank).

All stability increasing crane movements can still be operated.

The crane stop is indicated both visually and acoustically on the RCL 5300 indicator panel.

The Derate routine

Concurrently with the TTL stop, the lifting capacity of the crane is reduced (derate) corresponding to the load which the crane was exposed to at the moment where it was stopped.

The load diodes (80 through 100 %) now indicate in relation to the reduced lifting capacity.

When operating stability increasing functions until the heel of the vehicle has come below the permissible heel margin, the EVS system automatically sets itself at a normal level, and the full lifting capacity of the crane functions can be utilised again.

The SIM (Superior Inclination Monitoring) Routine

The TTL routine stops the crane movements selectively by means of signals from the spool sensors or from the radio remote control. I.e. it is possible to operate stability increasing but not stability reducing movements with the crane.

In case of missing signals from a spool sensor, there is the risk after a crane stop that a stability reducing crane movement can be operated.

Such a crane movement means an increased heel, activating an SIM routine. The SIM routine means that crane movements are stopped again for 4 seconds.

The SIM routine is thus a superstructure of the TTL routine as regards safety.

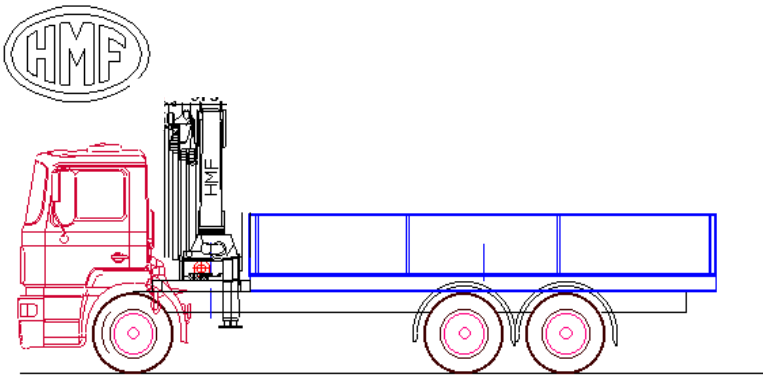
Comparison of safety systems monitoring stability

The following four examples illustrate the possibilities offered by the different types of stability safety systems with regards to:

- Utilisation of the slewing area of the crane in relation to the stability of the vehicle.
- Utilisation of the lifting capacity of the crane in its entire slewing area in relation to the stability of the vehicle.
- Improvement of the vehicle stability when placing the first load on the vehicle in an optimum position.

When comparing stability in the examples, the stability calculations are based on the same truck, platform body and crane etc.

The crane is front-mounted and the truck is not sufficiently stable for utilising the max. lifting capacity of the crane in front of the driver's cab.



The stability calculation with *stability limitation* and *stability curves* has been made in the CraneWin computer program.

The *stability limit* encircling the hatched area, indicates a load of 125 % (the 1.25 circle) on the crane, which is used when carrying out the stability test in practice. Nominal load on the crane (100 %) is the part lying within the 1.0-circle in the hatched area.

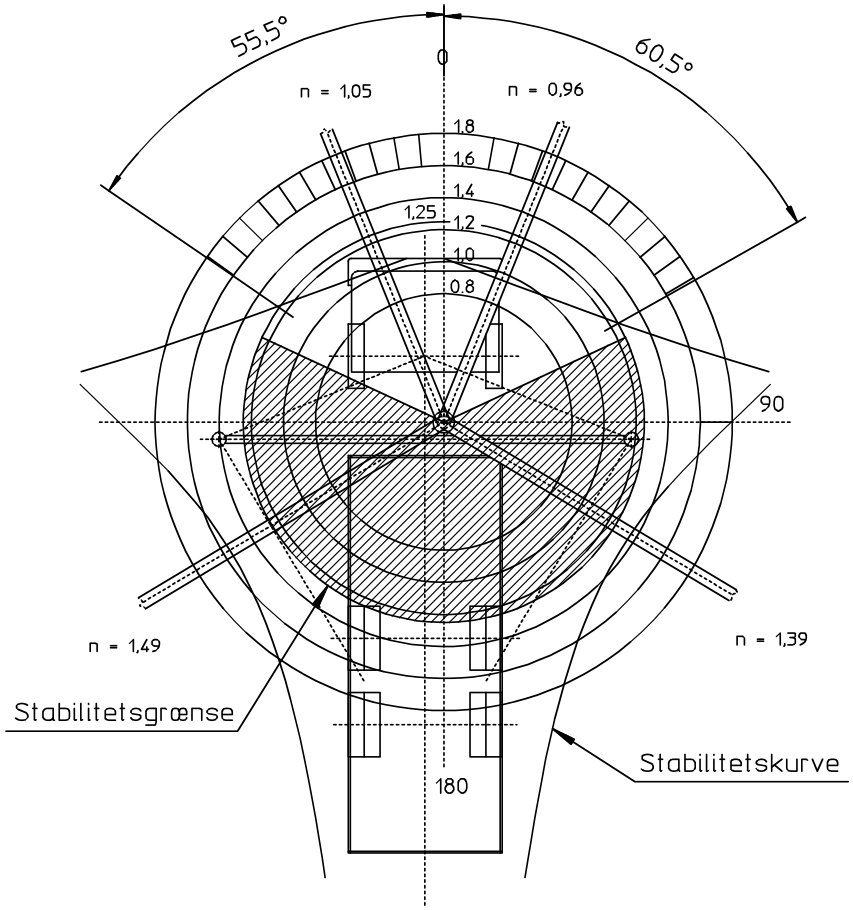
The crane has reduced slewing area

Conditions in relation to stability:

- The slewing area of the crane has been reduced to 230 degrees by means of bushings in the slewing cylinders.
- There is no stabilizing load on the truck body.
- The stabilizer beams are extended and the stabilizer legs are lowered.

Influence on crane operation:

- The working area of the crane is reduced to 230 degrees.
- It is not possible to work with the crane in front of the driver's cab.
- The precondition for sufficient stability is unconditionally that the stabilizer beams are extended and the stabilizer legs are lowered.



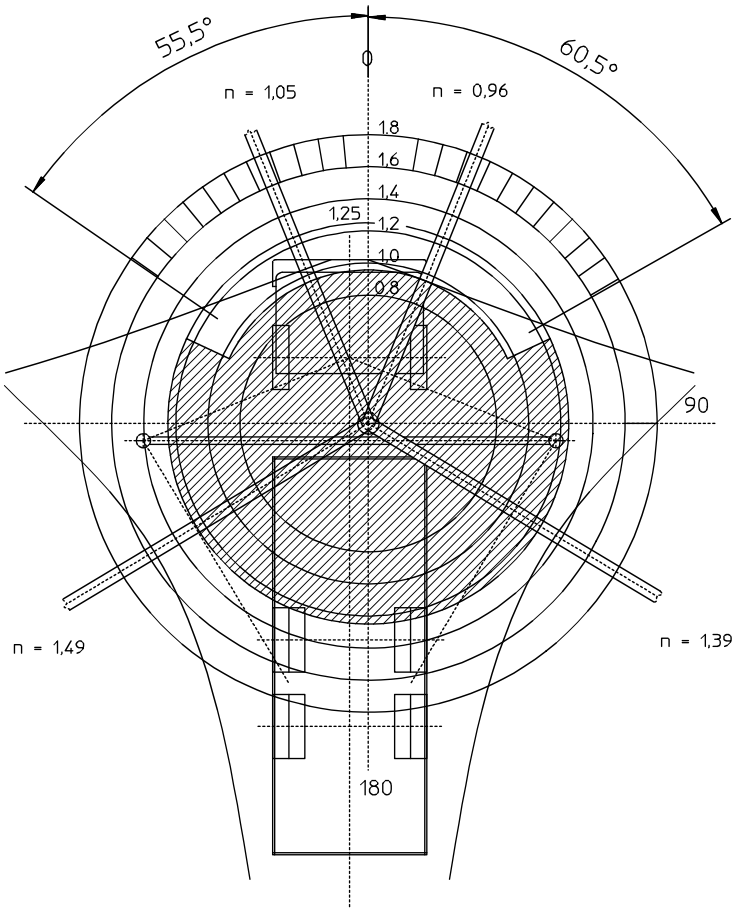
The crane is fitted with 2-stage LMB

Conditions in relation to stability:

- The lifting capacity of the crane is 100 % in the area 230 degrees backwards over the truck body.
- The lifting capacity of the crane is reduced to 90 % in the area 130 degrees to the front over the driver's cab.
- There is no stabilizing load on the truck body.
- The stabilizer beams are extended and the stabilizer legs are lowered.

Influence on crane operation:

- It is possible to work with the crane in front of the driver’s cab.
- The 2-stage LMB system offers a rough division of the lifting capacity of the crane. In certain areas in front of the driver’s cab the lifting capacity is reduced too much as the position of the boom system, where the truck is least stable, has to be taken into account.
- The precondition for sufficient stability is that the stabilizer beams are extended and the stabilizer legs are lowered.
- The lifting capacity of the crane in front of the driver’s cab cannot be increased, even if a stabilizing load is placed on the truck body.



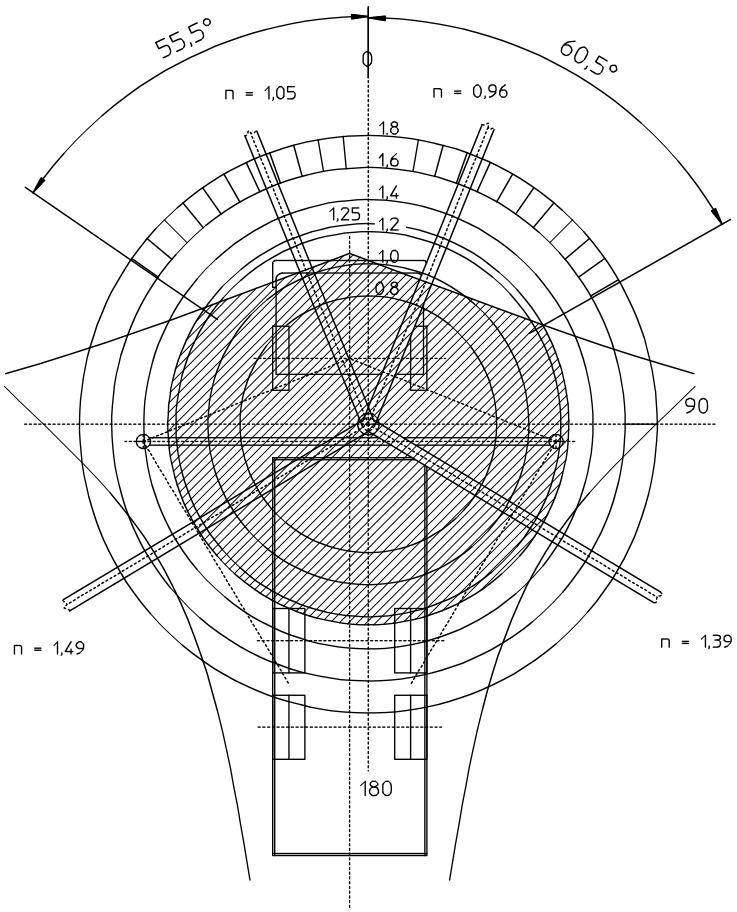
The crane is fitted with an EVS System

Conditions in relation to stability:

- When setting the EVS system, the lifting capacity of the crane is adapted to the stability of the truck in the entire slewing area.
- There is no stabilizing load on the truck body.
- The stabilizer beams are extended and the stabilizer legs lowered to obtain maximum stability.

Influence on crane operation:

- It is possible to operate the crane throughout its entire slewing area.
- The stability of the vehicle is utilised “right to the limit” in the entire slewing area of the crane.
- The stability does not depend on the operator having fully extended the stabilizer beams before lowering the stabilizer legs. But the lifting capacity of the crane can only be utilised corresponding to the reduced stability - the stability curve is displaced in the direction towards the crane column.
- If it is sufficient for the crane operator to work with reduced lifting capacity, he can leave the stabilizer beam stowed in travelling position prior to lowering the stabilizer leg. This is a help if it is not possible to extend the stabilizer beam because of a wall, a busy road or another obstruction.



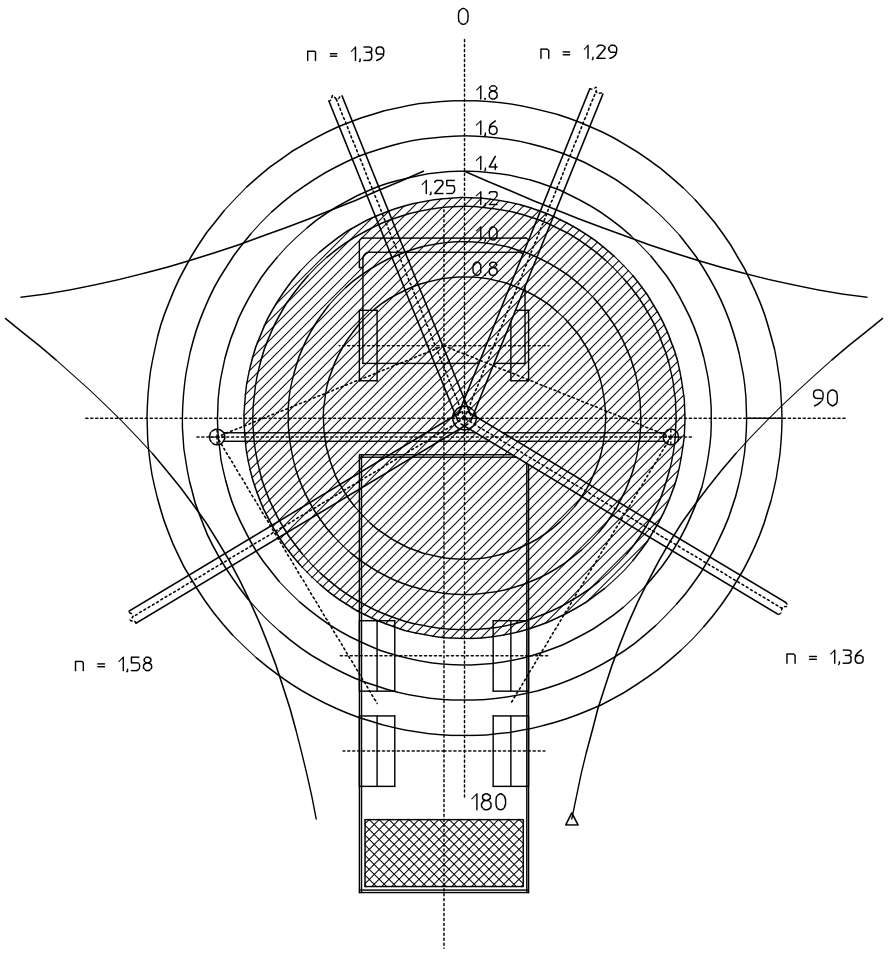
The crane is fitted with an EVS System and there is a stabilizing load on the truck body

Conditions in relation to stability:

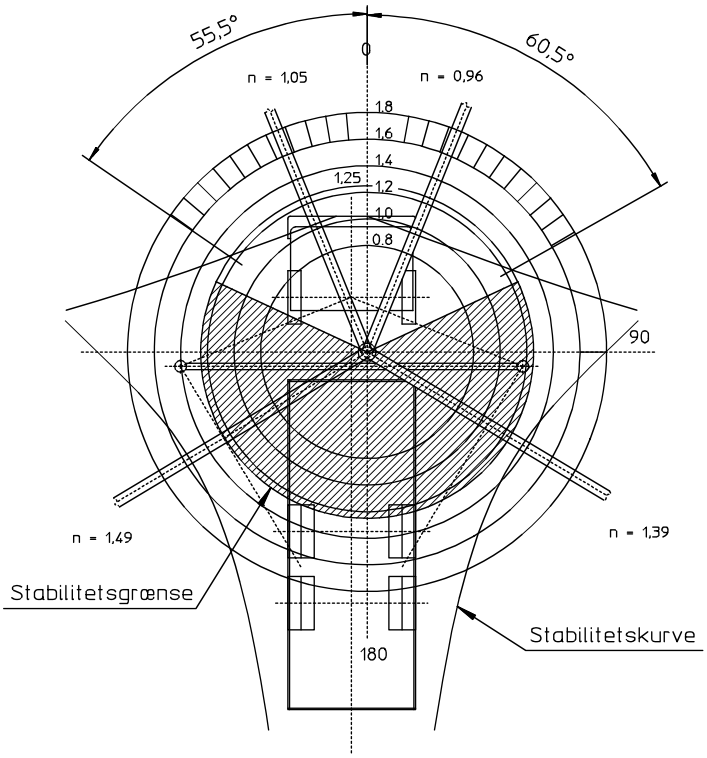
- When setting the EVS system, the lifting capacity of the crane is adapted to the stability of the truck in the entire slewing area.
- The first load is placed at the rear of the truck body. In this case the selected load has exactly the weight necessary for the truck being stable in the entire slewing area of the crane.
- The stabilizer beams are extended and the stabilizer legs lowered to obtain maximum stability.

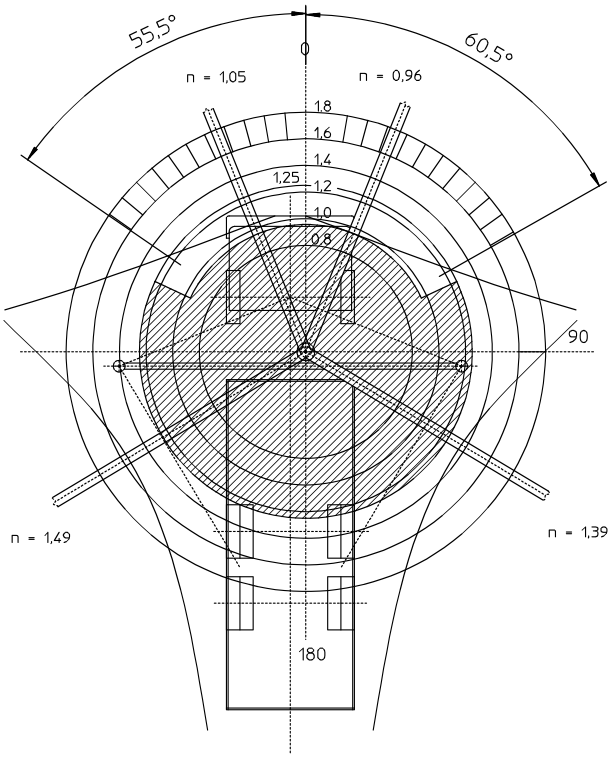
Influence on crane operation:

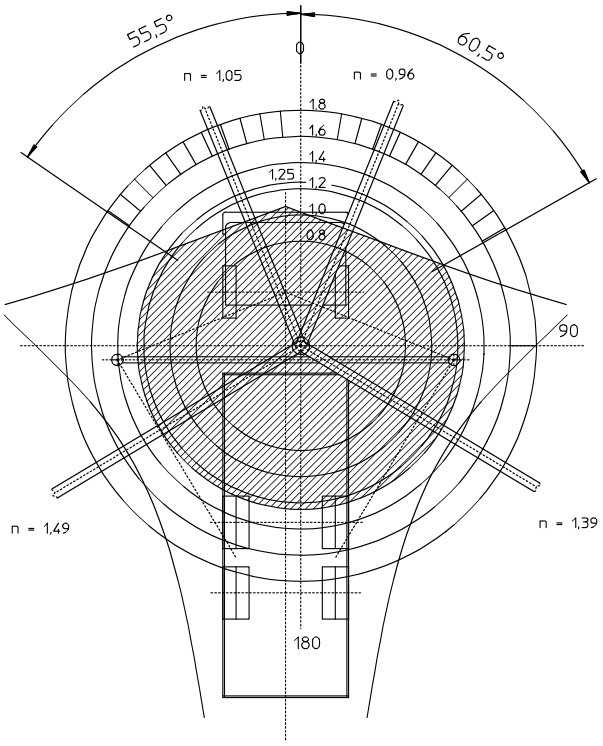
- It is possible to increase the lifting capacity of the crane in front of the driver's cab by means of a stabilizing load on the truck body.
- The positioning of the first load at the rear of the truck body increases the stability of the truck to such an extent that the crane's max. lifting capacity can be utilised in the entire slewing area.
- The precondition is that the stabilizer beams are extended and the stabilizer legs down. If not, the lifting capacity of the crane is reduced corresponding to the stability of the truck.

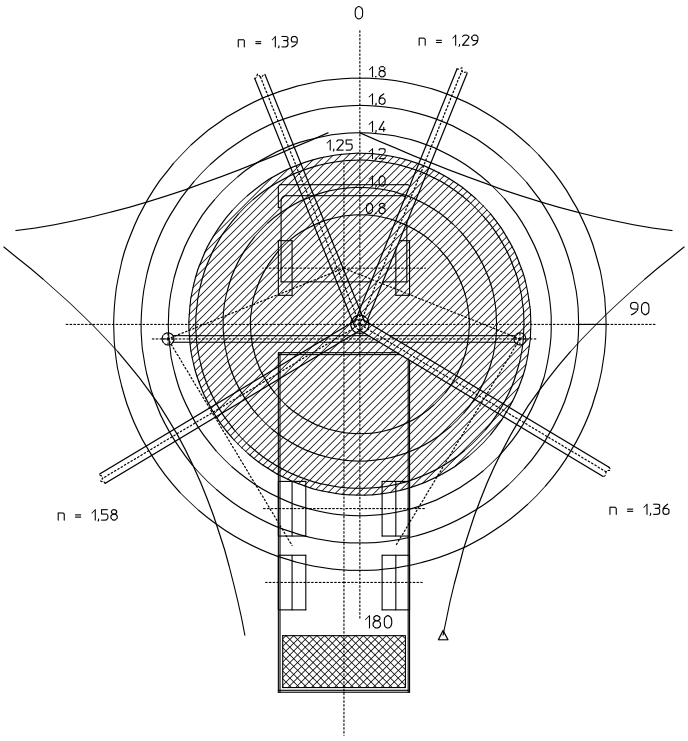


Comparison of stability in the four examples









Advantages of the EVS system

- The EVS system is superior to all other known types of vehicle stability systems.
- The vehicle stability is being monitored and utilised “right to the limit” in the entire slewing area of the crane.
- The crane operator can work to the maximum capacity of the crane right from the start, making the vehicle stable by positioning the first load on the body so that stability is optimised.
- In the area in front of the driver’s cab – on a vehicle with a front-mounted crane – the lifting capacity of the crane is increased by up to 60 %, if compensating with a load at the rear of the vehicle.
- The system is very user-friendly and the crane operator quickly learns how to utilise the lifting capacity of the crane in relation to the stability of the vehicle.
- The system offers security for the operator when he is working with remote control at a distance from the vehicle where he might lose touch with stability.
- The EVS system makes it possible for the operator to work with the crane if the stabilizer beams cannot be fully extended because of a wall, a busy road or another obstruction.
- The EVS system is monitoring the stability of the vehicle and stops the crane, should a stabilizer leg suddenly sink into the surface. The system does not distinguish between a stabilizer leg sinking into the surface and the vehicle actually heeling due to an increased load on the crane. Both situations mean instability.
- The system can often make a separate traverse redundant - thereby giving the vehicle a higher loading capacity while reducing the tare weight - as well as reducing the installation costs.

Please note

- It is not possible to manipulate the EVS system, as the DPS controller is connected to the RCL 5300 in an integrated CAN bus system.
- The EVS system will not be able to function appropriately, if the crane is fitted on a vehicle without spring suspension. The distinction between starting to heel and overturning is very narrow.
- An unstable vehicle does not become stable by fitting an EVS system. A vehicle fitted with a relatively big crane and without stabilizing load on the truck body, is and will always be unstable in a part of the slewing area of the crane at the maximum load moment. Only with a stabilizing load on the vehicle, the EVS system ensures that the lifting capacity of the crane can be utilised.