Load Management System (LMS) Technical Training

January 2012

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Why do we need LMS?

- **Site safety regulations or customer requirements**
- **Reduction of risks associated with using a Telehandler**
- **Competition and Market Place Advantage**
- **Legal Risk – “Have you taken all reasonable steps to protect your workers?”**
- **Compliance with AS1418.19**

Compliance With AS1418.19

(Cranes, Hoists and Winches – Telehandlers)

- **Section 2.11 “Indicating and Limiting Devices”**
  - **Requirements (Indicators):**
    - Rated Capacity Indicator
    - Load Indicator
    - Boom Angle Indicator
    - Lateral Slope Indicator
    - Boom Length Indicator
  - **Requirements (Limiters):**
    - Maximum Capacity Limiter
    - Longitudinal Stability Limiter
    - Rated Capacity Limiter

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AS1418.19 – Requirements Table

TABLE 2.11.1

APPLICATION OF LIMITING AND INDICATING DEVICES (see Note 1)

Item	Telehandler with forks or fixed loads	Telehandler with fixed jib/hook attachment	Telehandler with wire rope hoist attachments
Longitudinal stability indicator	R	R (see Note 2)	R (see Note 2)
Rated capacity indicator	O	>3 t R	>3 t R
Load indicator	O	O	O
Boom angle indicator	R	R	R
Lateral slope indicator	R	R	R
Drum rotation indicator	N/A	N/A	O
Hoisting limit indicator	N/A	N/A	R (see Note 3)
Telescopic boom length indicator	R	R	R
Wind speed anemometer	O	O	O
Longitudinal stability limiter	R	≤3 t R (see Note 2)	≤3 t R (see Note 2)
Rated capacity limiter	O	>3 t R	>3 t R
Maximum capacity limiter	O	≤3 t R (see Note 2)	≤3 t R (see Note 2)
Hoisting limiter (see Note 2)	N/A	N/A	R (see Note 3)
Lowering limiter	N/A	N/A	O
Audible warning device	R	R	R

LEGEND:
R = Required
O = Optional
N/A = Not applicable

NOTES:

1 The above designations are the minimum requirements. Devices should be applied with due consideration for safe operation.

2 Mandatory where a rated capacity limiter is not fitted.

3 Not required where the design provides two-blocking damage protection.

AS1418.19 - Shortfalls

- **AS1418.19 – Table 2.11.1: Rated Capacity Limiter optional for machines with capacity of less than or equal to 3000kg (i.e. Merlo P25.6)**
- **AS1418.19 – Does not provide requirements for the safety integrity of limiting devices. (i.e. To what standards to limiting devices need to be designed IEC61508 SIL1)**
- **AS1418.19 – Lists "lack of stability" as a hazard but does not provide any numerical values as to the severity of this hazard.**

- **Irrespective of <= 3T or > 3T the same "lack of stability" hazards exist for every machine and should be mitigated against.**

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LMS Design – Risk Analysis

- **The LMS is designed to mitigate against two risks:**
  - **Longitudinal overturn due to excessive lifting load**
  - **Constant use of the bypass / override key (effectively disabling all interlocks)**
- **Risk Analysis based on**
  - **Severity of the harm (broken bones)**
  - **Frequency of exposure (constant)**
  - **Probability of the hazard (likely)**
  - **Possibility of avoidance (probable – if LMS designed correctly)**
- **Safety Integrity Level of the LMS**
  - **Determines the architecture and failure modes for the LMS**
  - **Based on the risk assessment**
  - **Required safety level of 1 out of a possible value of 3.**

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LMS Design – Lateral Stability

- **LMS2 does not implement or purport to implement any lateral (sideways) stability warnings or systems.**
  - **Lateral Stability is a SIL2 risk, beyond the scope of LMS2**
  - **Lateral stability is hard (i.e pipe handling on sand, buckets with mud buildup)**
  - **Requires additional sensors and forward look ahead.**
- **Dynamic Stability Triangle**
  - **Designed for forklifts on solid surface, not rough terrain telehandlers**
  - **Requires SIL2 compliant hardware due to lower avoidance probability.**

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LMS – Safety Integrity

- **Designed against the worlds leading functional safety standard used for the Process, Nuclear and Automotive Industries.**
  - **A Telehandler is a machine, a LMS is a safeguard for that machine.**
  - **Provides a very structured and very thorough approach to designing systems that if they fail, they fail in a predictable way.**
  - **Provides a numerical method to ensure the architecture of the LMS meets the requirements to mitigate against the risks.**
- **The Functional Safety Standard puts in place requirements for:**
  - **Installation Personnel**
  - **Service and Maintenance Personnel**
  - **Testing Intervals and Life Spans**

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LMS – Installation Safety

- **Installation Personnel can reduce the safety of the LMS:**
  - **Not following installation procedures**
  - **Using additional components or non standard materials**
  - **Taking short cuts**
  - **Damaging components during installation (using the wrong tools)**
  - **Failing to test systems correctly**
- **Installation Personnel can reduce the safety of the Telehandler:**
  - **Modifying structures (i.e. drilling into booms)**
  - **Using incorrect hydraulic systems safety procedures (lock valves)**
- **Installation Personnel can be injured:**
  - **Boom Supports when during and after installation of pressure sensors**
  - **Loss of hydraulic oil under pressure from cylinders and accumulators**

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Pressure Sensor Safety

- **Modification of any load holding valve on the Telehandler poses a potential safety hazard. Typical working pressure is 270bar.**
- **Lock valves are fitted with a gauge port. The port has a G1/4 plug using a DIN seal suited to mobile hydraulic applications.**
- **Pressure sensor is fitted into the gauge port, using DIN sealing methods. Sensor is burst tested to 1600bar.**

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Boom Tube

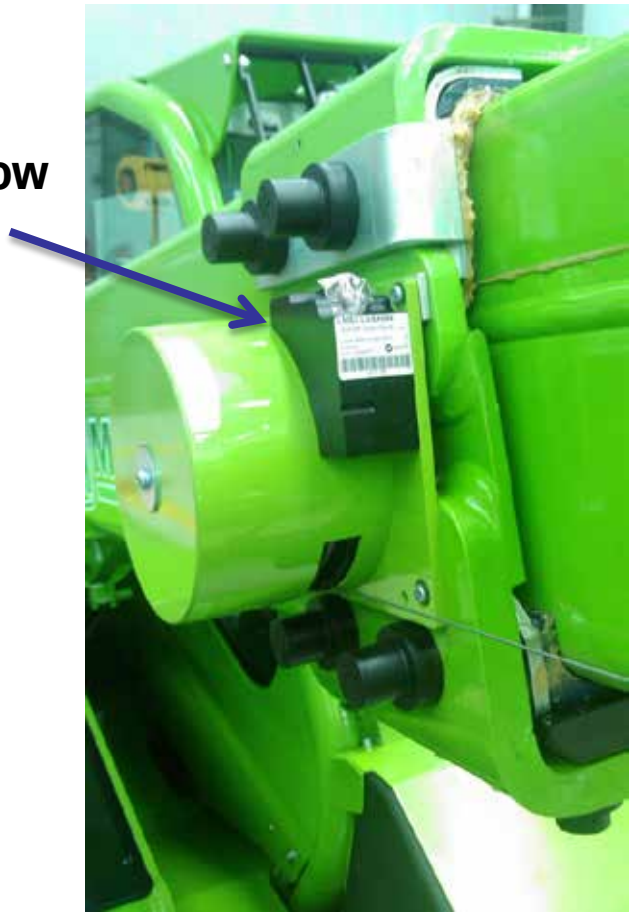
- **Lightweight Aluminium tube is fitted to the side of the boom to hold the data cable connecting the cable reel to the LMS system.**
- **Boom tube is held in place using purpose made plastic clips and silicon adhesive. Recommended to use masking tape or magnets to hold clips in place while silicon dries.**

Boom Components - Router

- **Radio network router provides communication between the display module, the end of the boom and any attachment fitted with a radio transmitter.**
- **Router is powered from end of boom wiring.**
- **Router is attached using two M5 x 25 SHCS.**

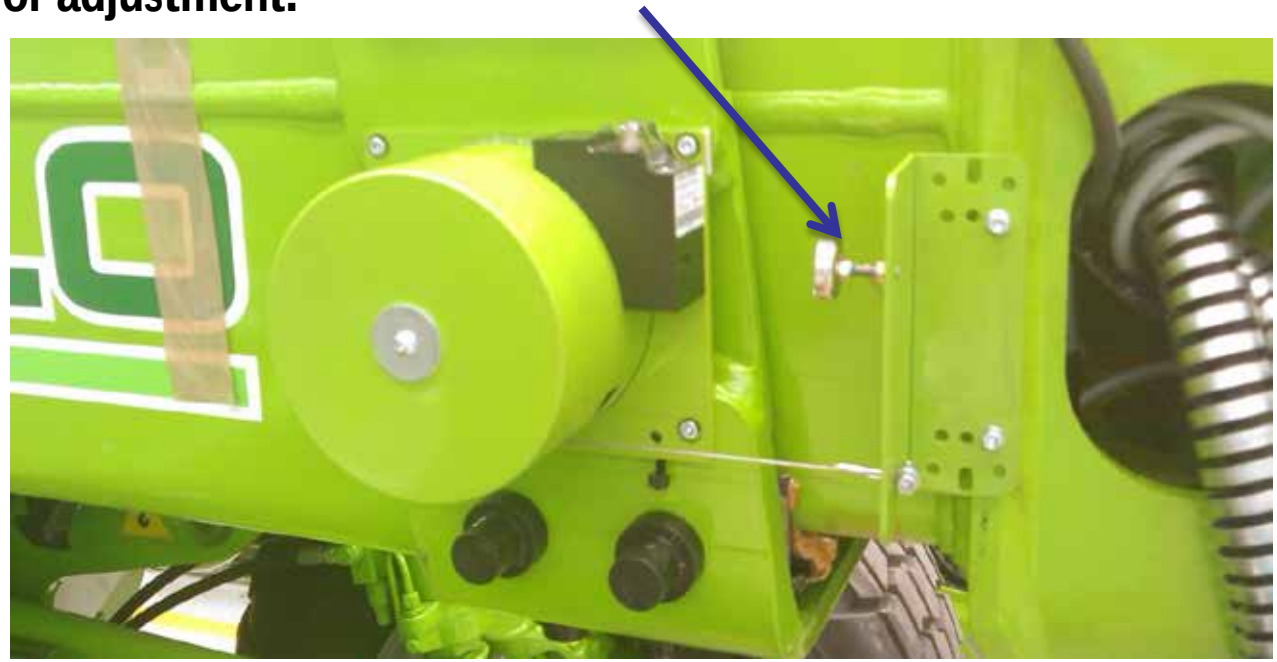
Boom Components – Cable Reel

- **Cable reel provides boom length measurement as well as an indication to the LMS when the boom is fully retracted (via magnetic sensor).**
- **Cable reel is fully digital and automatically re-calibrates each time the boom is returned to its stow position.**
- **Attached to boom using four M5 x 12 SHCS.**



Boom Components – Bracket

- **The boom bracket attaches to only the first boom section (in multi boom machines). The bracket is used to attach the cable reel cable (using M5x 12 SHCS) and also the stow position magnet.**
- **Attached to boom using two M5 x 12 SHCS. The magnet is attached using a M5 x 25 SHCS with lock nuts for adjustment.**



Carriage Magnet

- **A large magnet is fitted to the front of the carriage to interact with the attachment transmitter (if fitted)**
- **In some instances on P60.10, P72.10 and P25.6 an additional bracket is supplied which must be welded in place.**

IO Module

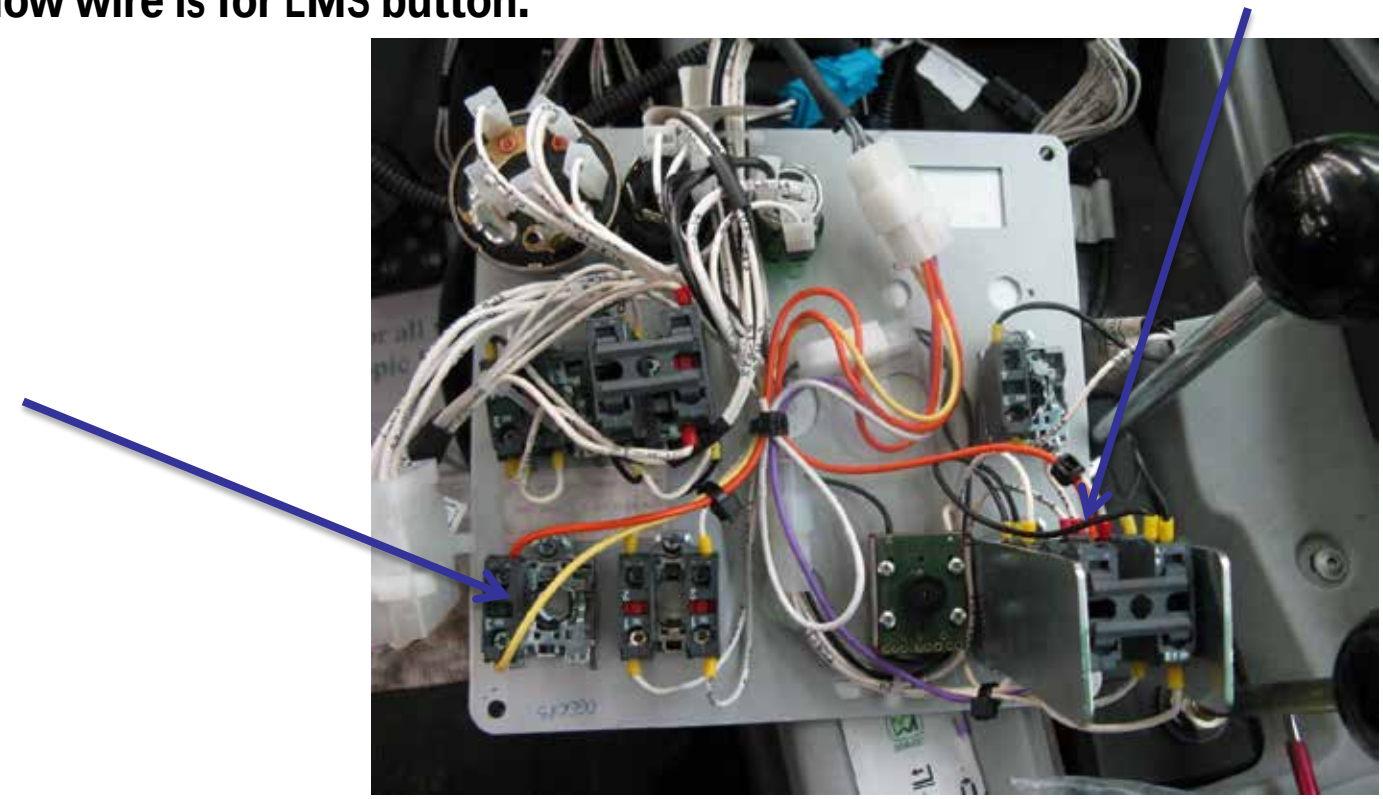
- **IO Module is fitted to the vertical wall of the engine bay (either inside the engine pay (P38.13, P25.6, P60.10, etc.) or in the boom tunnel (P34.7, P40.7, etc.)**
- **IO module interfaces the LMS to the trucks power supply, all electrical signals as well as providing pitch measurements of the truck chassis.**

Data Cable and System Harness

- **The system harness connects the LMS2 IO Module to all electrical connections around the truck.**
- **Specific connections are Forward and Reverse, ACC bus power, Bypass Key, Battery, Light Tower, Hydraulic Solenoid, Reverse camera power and LMS button.**
- **An additional cable is provided for the reverse camera**
- **A grey network data cable is provided to connect all LMS sensor to the LMS network.**

System Harness – Control Panel

- **Control panel is wired using the control panel harness.**
- **Orange wires are for ACC Bus and LMS button power, Purple wire is for bypass key detection, yellow wire is for LMS button.**

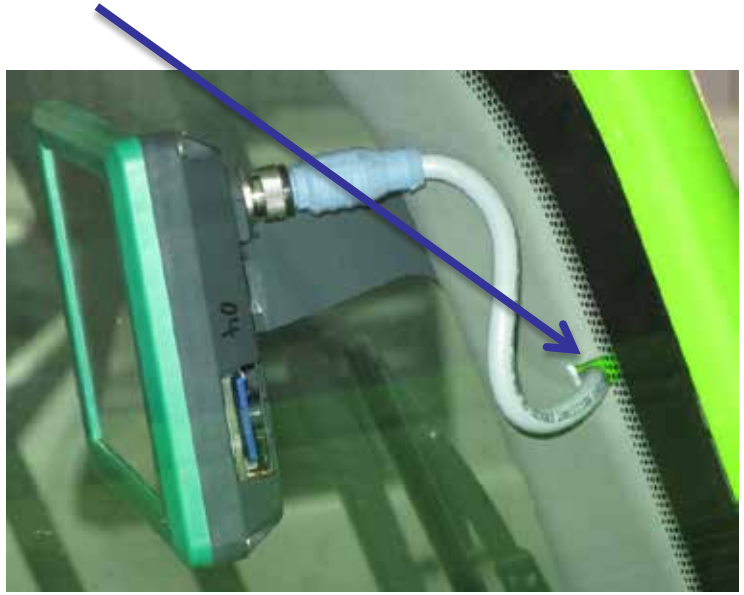


Reverse Camera - Mechanical

- **Reverse camera is mounted at the rear of the machine. In some instances the rear cover plate must be cut and painted.**
- **Camera is attached using two M5 x 12 Hex Bolts and washers.**

Display Module

- **Display is mounted on side pillar of cab.**
- **Pillar cover must be modified using a die grinder or similar. Its important that some cable relief is provided.**

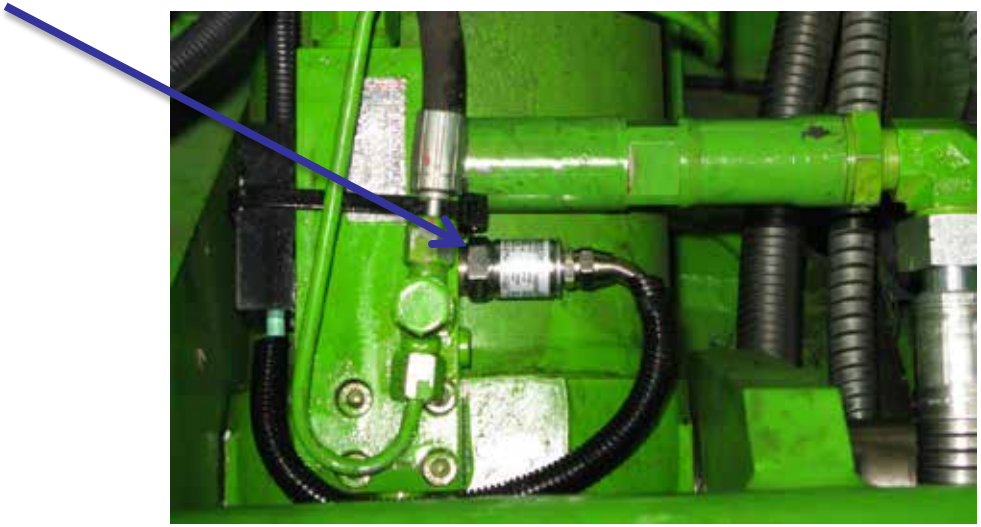


Pressure Sensor - Yellow

- **Yellow hydraulic pressure sensor measures rod end pressure in the main lift cylinder.**
- **Yellow sensor is typically fitted along side the valve bank using a tee fitting and 15L to G1/4 adapter. Adapter to Pressure s**

Pressure Sensor - Green

- **Green hydraulic sensors measure the pressure in the C1 port of a lift cylinder. This is the load holding side of the lock valve. Extreme care must be taken to ensure the sensors are fitted correctly, sealed with thread sealant, leak free and pressure tested.**
- **Green sensors must be clear of any obstacles that could cause damage to the sensor during lifting operations.**
- **NEVER work under an unsupported boom until the sensor has been pressure tested.**



Green Sensor - CAUTIONS

- **Always ensure the lock valve port and the sensor are clean. One grain of dirt can damage the seal. Use brake parts cleaner on the lock valve if necessary.**
- **Always use hydraulic thread sealer. It provides an extra layer of protection.**
- **Always use a pipe spanner to tighten the sensor. Avoid using an open ended spanner as this can damage the body of the sensor.**
- **NEVER twist the cable or bend the cable around sharp corners.**
- **NEVER use any other hydraulic fitting between the lock valve and the sensor. Such fittings are subject to fracture, leaks and burst failure. They will dramatically reduce the safety integrity of the lock valve.**
- **IF IN DOUBT, ASK!**

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Pressure Sensor - Blue

- **On dual lift cylinder machines (P60.10, P70.10) a second lift cylinder sensor is required.**
- **Blue pressure sensor compensates for any differences in the cylinder pressures to ensure accuracy of LMS.**

Attachment Transmitters

- **Attachments which are suspended load attachments (A1000, A1110, etc.) require an attachment transmitter. The transmitter relays information about the attachment to the LMS display. The display ensures the correct rating chart is loaded.**
- **Transmitters are held in place with M5 x 12 SHCS. All transmitters will need to be programmed to the correct type of attachment using the LMS display.**

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