

The LICCON computer system for telescopic and lattice boom cranes.

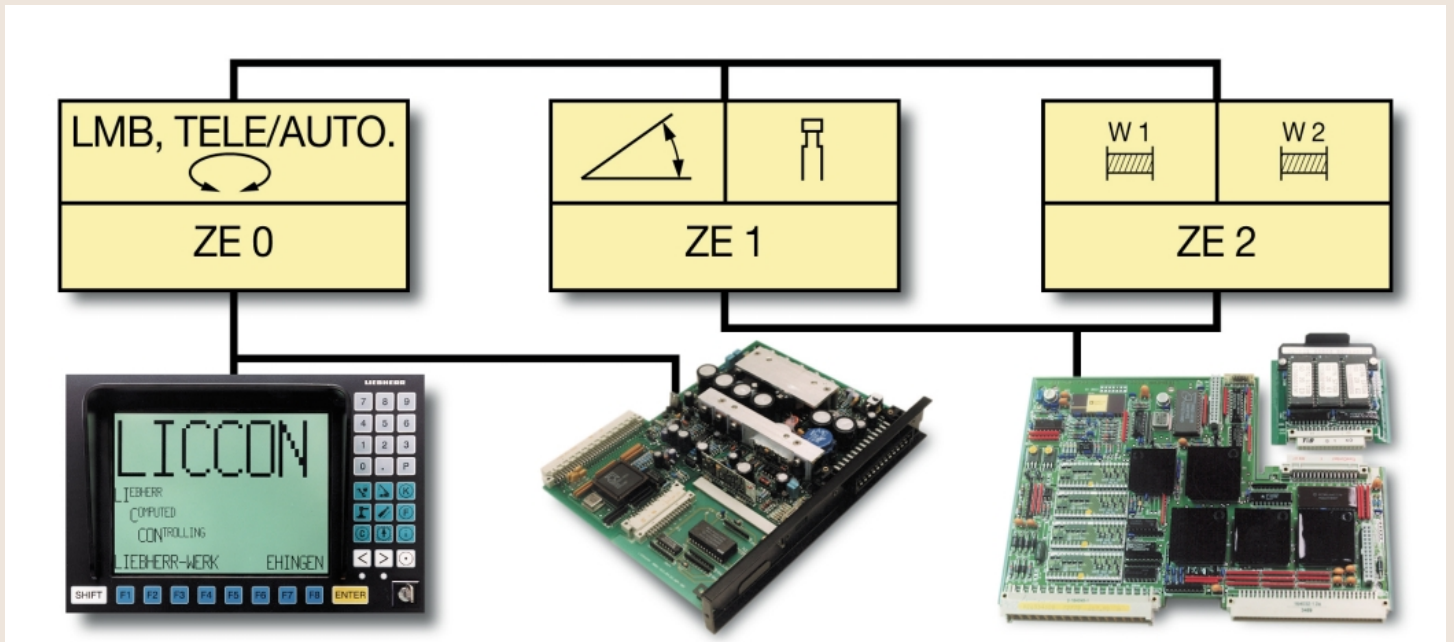
A system with comprehensive informative, monitoring and control functions.



LIEBHERR

The better crane.

The LICCON computer system.



In 1989 Liebherr already developed a modular, programmable control system for hydraulic functional units in Liebherr mobile cranes and briefly called it LICCON (Liebherr Computed Controlling). In essence, the LICCON computer system consists of the following components:

- the hardware system components with power pack, up to 6 central units, the monitor with operator keyboard, the insertion rack and the wiring and adaptor board
- the multi-tasking real-time operating system
- the application software
- the load charts, the geometry files and some other files with stored constants
- the software of the data base management system
- and the development programs for the software development

The LICCON computer system accomplishes all essential requirements in respect to crane operation, such as:

- insensitivity against environmental influence, e.g. differences in temperature from minus 40°C up to plus 85°C, vibrations, humidity and aggressive air, dust and dirt, electromagnetic and electrostatic exposure
- a limited number of plug-in cards (max. 2 modules), thus a constant high quality standard due to the production of large series, guaranteed spare parts supply, intensive and coordinated development possibilities
- highest safety standard in conformance to the relevant regulations

- cost-optimized coordination of the control system with the crane and its hydraulic system; crane control and safe load indicator (SLI) are combined into a unit; comfortable setting and diagnostic facilities, large flexibility due to free programmability, minor assembling and cabling expenditure
- the entire know how of the soft- and hardware is developed by Liebherr exclusively

The crane control is subject to additional requirements which are entirely taken into account by the LICCON computer system, such as maximum availability, reliability and quality, sensitive response of the crane motions, safe and simple operation as well as an individually adjustable control behaviour of the crane to the requirements of the crane operator.

At present, the LICCON computer system comprises the following application programs:

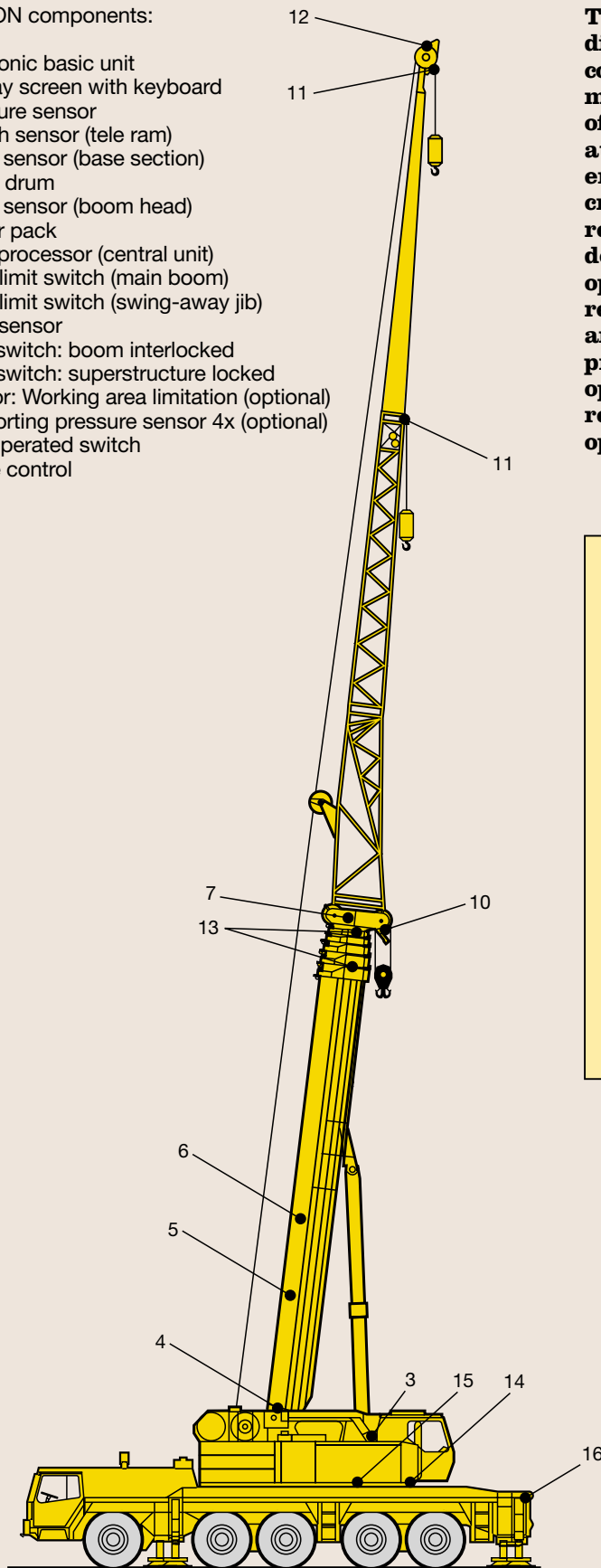
- Safe load indicator (SLI)
- Configuration program with configuration picture
- Operating program with operating picture and with additional displays
- Telescoping program with telescoping picture
- Supporting forces control program (optional)
- Working area limitation program (optional)
- Control parameter program
- Test system
- Work planning (optional)

The LICCON computers system features top-class engineering for functional and safe crane operation.

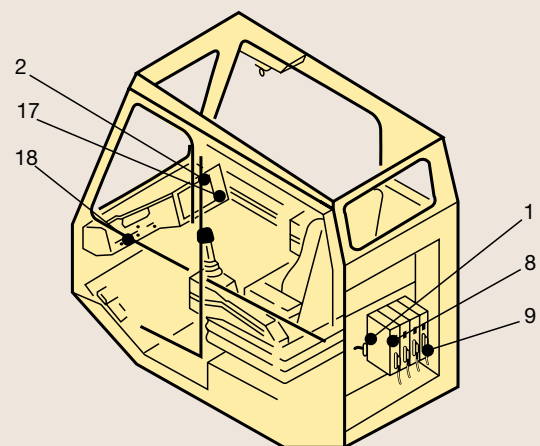
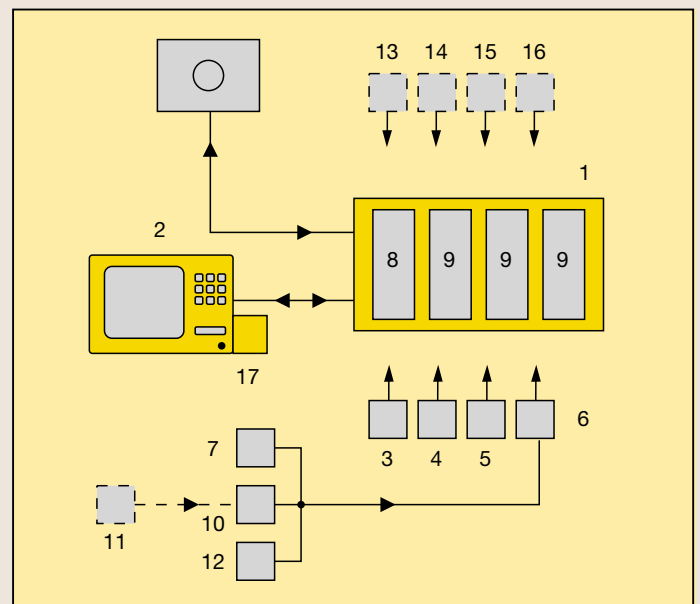
The LICCON safe load indicator (SLI).

The LICCON components:

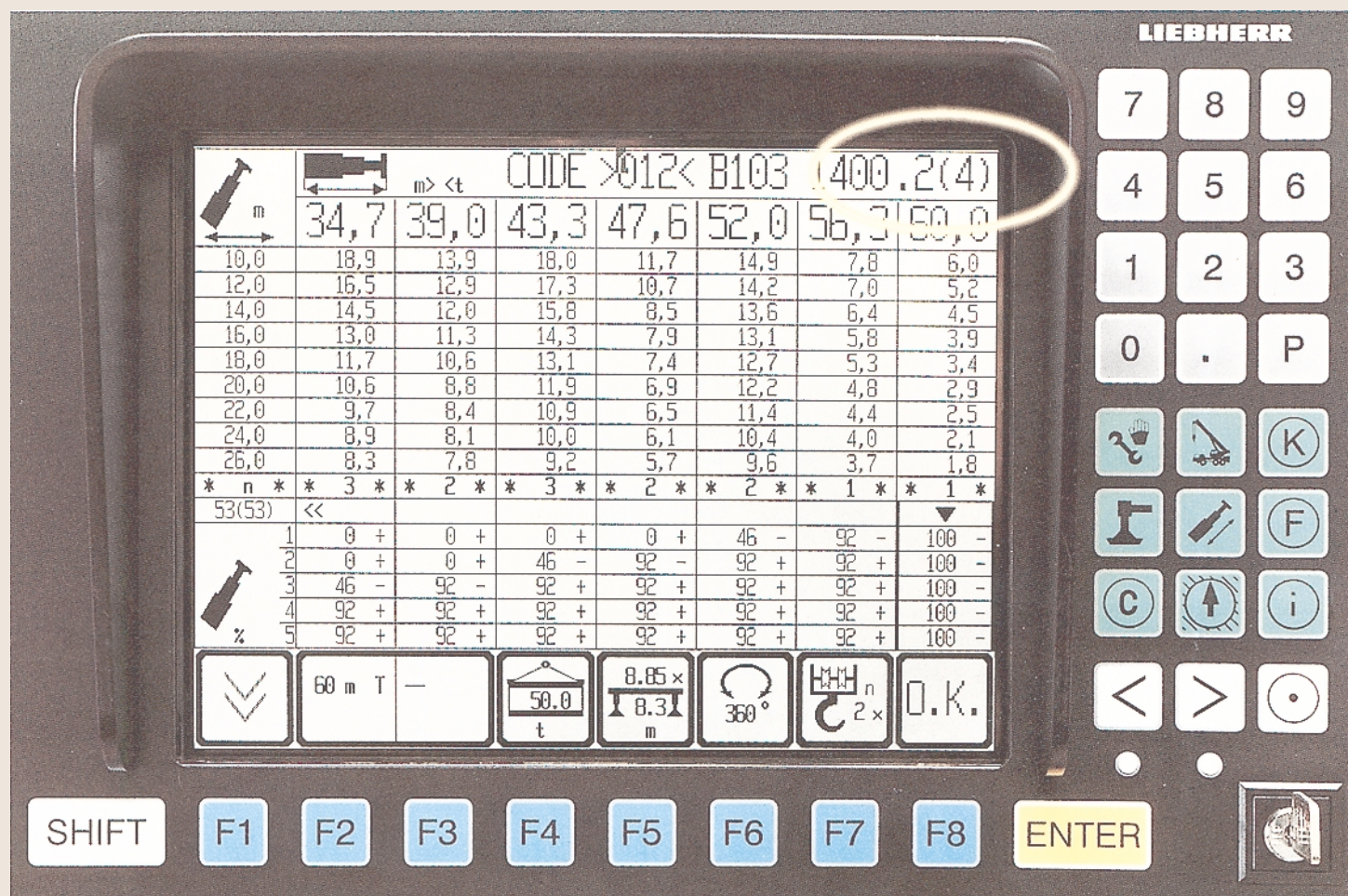
- 1 Electronic basic unit
- 2 Display screen with keyboard
- 3 Pressure sensor
- 4 Length sensor (tele ram)
- 5 Angle sensor (base section)
- 6 Cable drum
- 7 Angle sensor (boom head)
- 8 Power pack
- 9 Microprocessor (central unit)
- 10 Hoist limit switch (main boom)
- 11 Hoist limit switch (swing-away jib)
- 12 Wind sensor
- 13 Limit switch: boom interlocked
- 14 Limit switch: superstructure locked
- 15 Sensor: Working area limitation (optional)
- 16 Supporting pressure sensor 4x (optional)
- 17 Key-operated switch
- 18 Crane control



The LICCON safe load indicator (SLI) essentially differs from other SLIs on the market by the internal computing process. Liebherr developed a calculating method not only taking into account the deflection of given telescoping boom lengths but any deflection at any extended boom length. This method offers entirely new possibilities. Formerly, a telescopic crane could only handle the loads stipulated in the respective load charts. The safe load indicator developed by Liebherr allows the handling of the optimal load at any boom length. The system receives the measured data from the sensor inputs and its operating parameters by the "configuration program". The computer system informs the crane operator by means of the "operating picture" in respect to all parameters required for crane operation.



The LICCON configuration picture.



By means of the LICCON configuration picture on the monitor, the crane operator transmits to the safe load indicator the desired configuration and thus receives the respective load charts.

Comfortable interactive functions enable the setting of the desired crane configuration. The operating mode is preselected by means of function keys "F4" for the main boom and "F3" for the auxiliary jib. Function keys "F4" to "F6" set the configuration within the operating mode in respect to counterweight, supporting basis and operating area desired. An assigned code to each load chart selected according to this setting procedure also enables quick selection of a load chart. A load chart available according to the preselected operating mode and configuration is displayed on the monitor upon

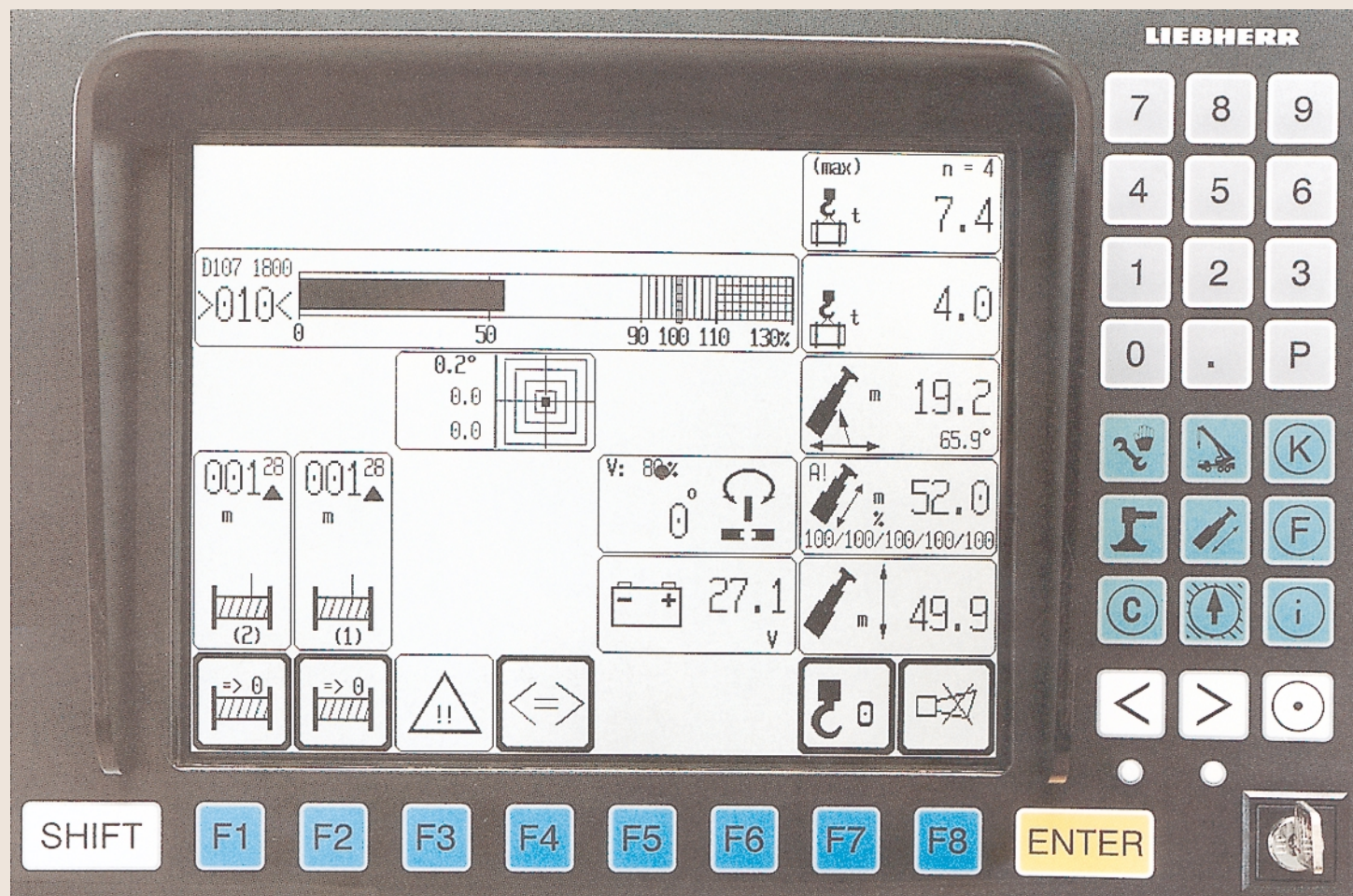
pressing the key "ENTER". The "F7"-key allows to set the hoist rope reeving. A load chart comprising more than 9 columns is displayed on several pages. The safe load indicator adopts the new set values upon pressing the key "O.K" which results in the automatic display of the operating picture.

The image shows the LICCON configuration interface on a Liebherr crane control panel, displaying a different load chart configuration. The 'ENTER' key is highlighted with a yellow circle.

m	m>lt	CODE	B103	1400.3(4)
52,0	52,0	56,3	60,0	17,5
21,8	26,1			
28,0	9,5	8,9	8,9	7,7
30,0	8,7	8,3	8,3	7,1
32,0	8,1	7,7	7,6	6,6
34,0	7,5	7,2	7,1	6,1
36,0	6,9	6,8	6,6	5,7
38,0	6,4	6,3	6,1	5,3
40,0	5,9	6,0	5,7	4,9
42,0	5,5	5,6	5,3	4,5
44,0	5,0	5,2	4,9	4,2

The development of the entire soft- and hardware of the LICCON computer system is the result of Liebherr's know-how.

The LICCON operating picture.



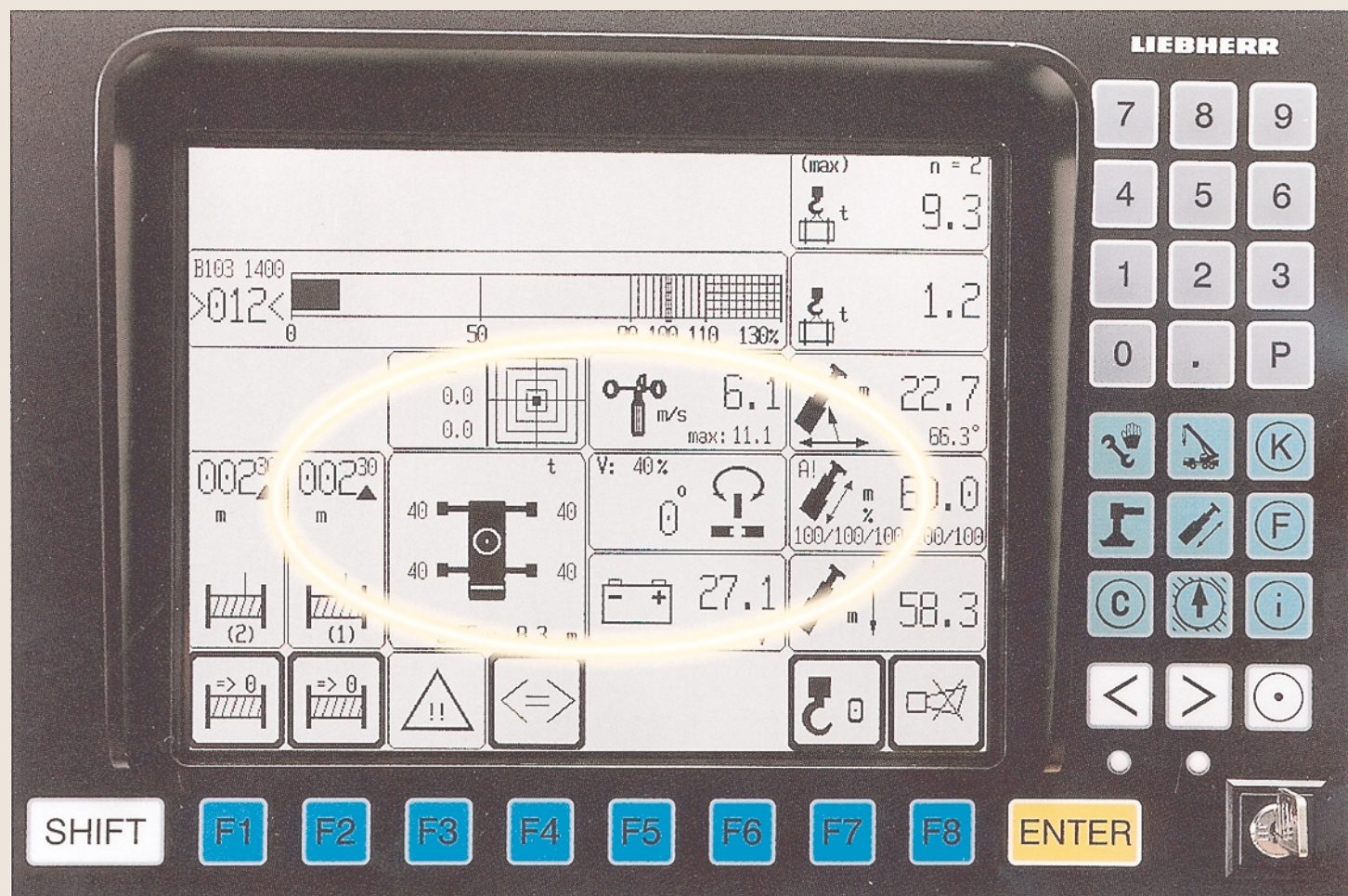
Graphic symbols in the LICCON operating picture display continuous information in respect to all essential data of the crane's geometry. Displayed are for instance:

- the maximum lifting capacity
- the actual load suspended on the hook including weight of the load hook and the taring possibility
- the radius and the angle of the main boom
- the total length of the telescopic boom in [m] and the extended lengths of the individual telescopes in [%]
- the height of the pulley head and, in case of a mounted luffing lattice jib, the angle of the lattice jib
- the rate of utilization by means of a baton display with a prewarning at 90 % of the crane's rate of utilization and with a STOP symbol when exceeding 100 % of the rate of utilization

- depending on the crane's equipment, the motion of winch 1 and, if existing, of winch 2 is displayed by flashing arrows; the actual hook path is continuously displayed with the correct sign according to the zero point adjustable according to requirement
- the contact of the hoist limit switch results in the display of a flashing symbol

All displays for critical conditions are accompanied by an audible signal. Due to safety reasons, another program may only be selected upon the operator's acknowledgement of the warning signal by switching off the horn. Any subsequent critical condition will again be audible.

The additional displays.



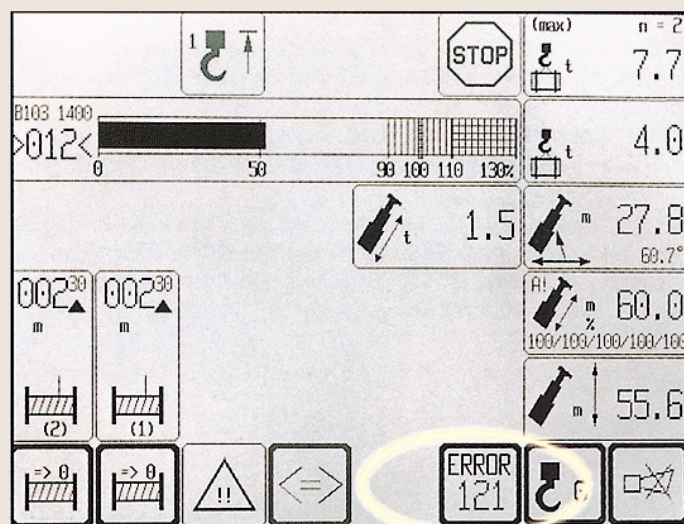
Depending on crane type and equipment, a series of other symbols can be displayed, either according to the requirement of the crane operator or automatically in case of a failure. The advantage of this feature is that the operating picture is not overcharged with information but that the operator always gets a warning signal in case of a failure. The following symbols are assigned to the monitoring function:

- indication of inclination
- wind sensor
- monitoring of supporting pressure
- interlocking of superstructure with horizontal slewing angle display and set slewing speed reduction
- tension of batteries

The overlay of these symbols is accompanied by an audible warning signal. The following symbols, of an informative character only and which do not signalize a failure, are displayed in another area of the operating picture:

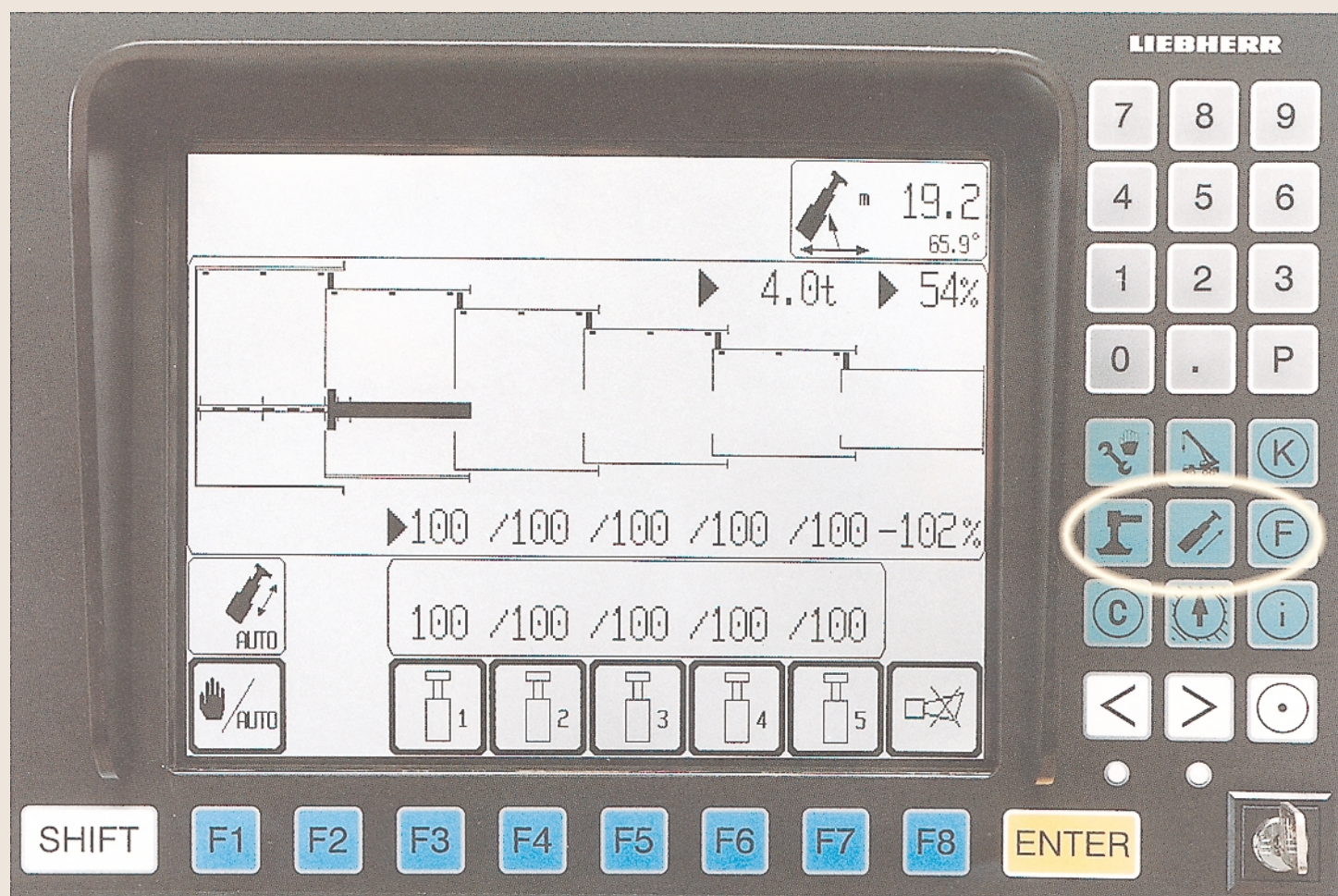
- high-speed switched off
- LICCON safe load indicator bridged by means of the setting switch
- lower/upper limit angle of the load utilization attained
- fuel indication

The LICCON computer system displays system errors and application errors on the monitor. Application errors caused by operation or external influence, e.g. on the sensors, are displayed in the operating picture by **ERROR** with an error number.



The LICCON computers system is the most modern computer system world-wide with comprehensive informative, monitoring and control functions.

The LICCON telescoping picture.

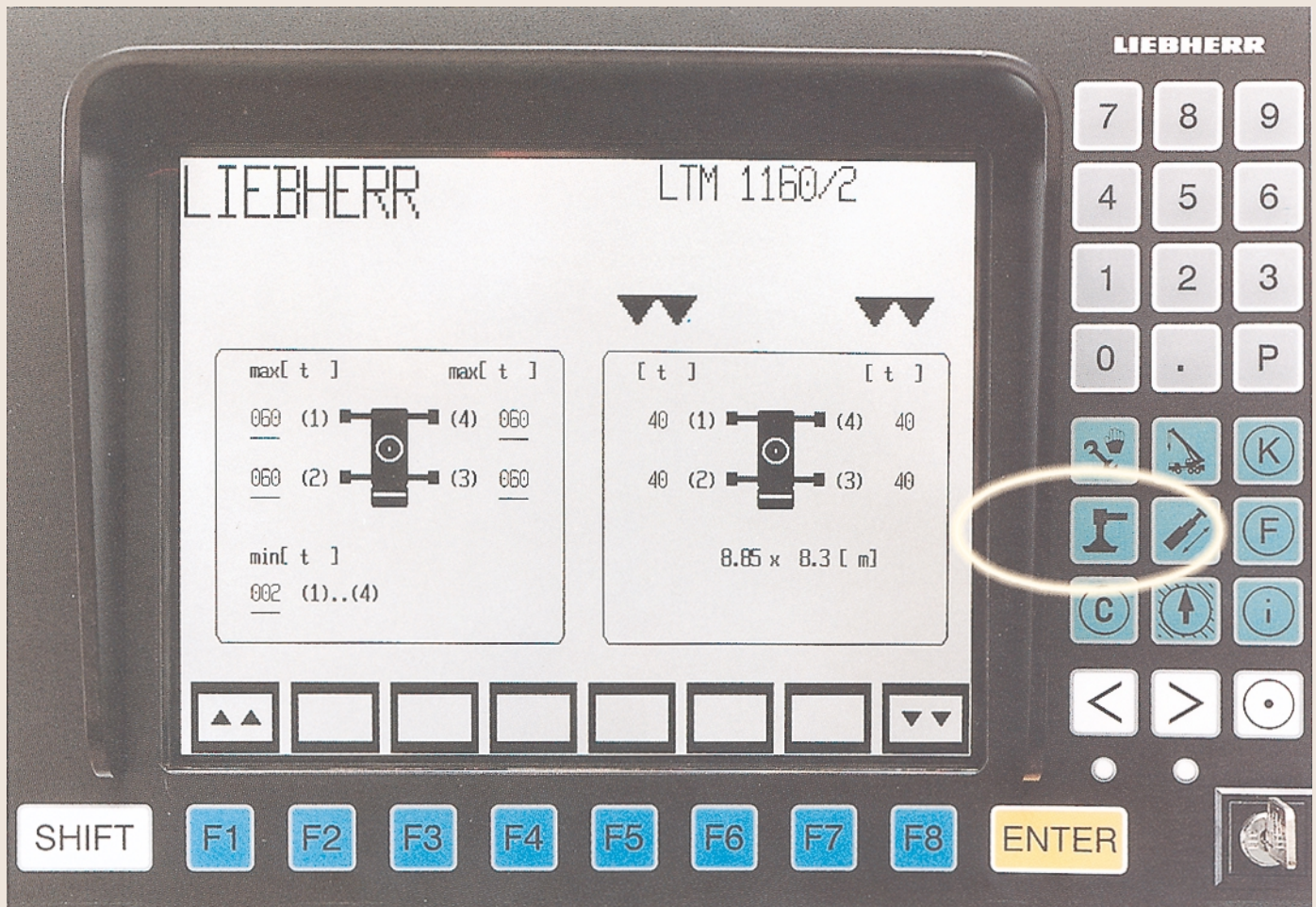


The LICCON telescoping picture is only available on mobile cranes with interlockable telescopic boom. It demonstrates the crane operator the interlocking condition of the telescopic boom by means of a dynamic full graphics display, the position of the individual telescopes to one another and the extended condition of the telescoping ram. Due to the automated telescoping procedure, it is very easy for the crane operator to perform telescoping since he does not need any more to take care of the interlocking/unlocking of the telescopic ram or of the telescopes. The computer system selects the operating sequence of the individual telescopes in attaining the final position desired. Upon preselection of the boom position required, all telescoping motions as well as the interlocking/unlocking functions are performed fully automatically. The telescoping control "Telematik"

enables manual as well as automatic telescoping. In the telescoping picture of the LTM 1160/2 for instance, the following display elements are represented:

- the stylised telescopic boom with base section and piston rod, the ram with interlocking device, and telescopes 1-5 with their interlocking points
- the function keys F3-F7 for selecting the position of telescopes 1-5
- the selected telescoping position of telescopes 1-5
- the actual telescoped condition of telescopes 1-5 and, divided by a hyphen, the condition of the telescoping ram
- the display symbols for the automatic and manual telescoping procedure
- the telescopable load

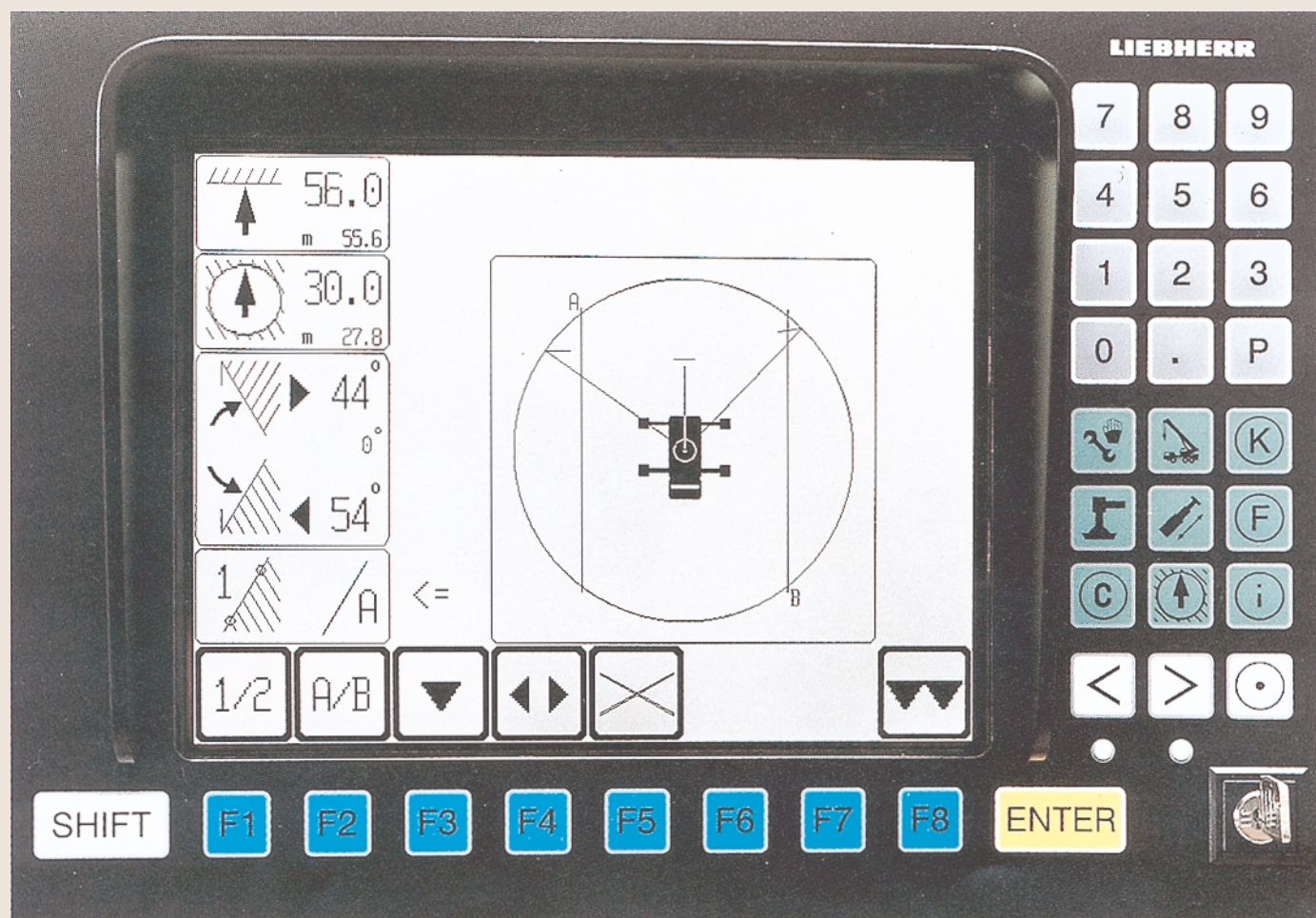
The system of supporting forces.



During operation, the monitoring system of supporting forces continuously determines, by means of pressure sensors, the actual pressure on the 4 supporting rams and displays it as supporting force (t) for each ram. The supporting forces can be displayed on the request of the crane operator by operating function key "F3", or will be displayed automatically in the operating picture if a critical situation arises. The crane symbol in conjunction with the audible warning signal is issued if the maximum force has been attained or exceeded by one ram at least, or if the minimum force has been attained or dropped below the set limits. The exceeded or insufficient supporting force value is displayed by flashing figures in those cases. However, the crane motions will not be switched off when the minimum or maximum supporting forces have been attained. Due to the variable programmability of the limiting values, the

monitoring system of the supporting forces can also be employed for prewarning by means of the program "modification of supporting force limiting values". Upon pressing program key "supporting force", at the right-hand side of the screen appears the DISPLAY window with the actual, really acting supporting forces, and at the left-hand side, the EDIT window with the maximum and minimum values programmed at the factory. Two double arrows point on the DISPLAY field, i.e. the program now operates in the "DISPLAY MODE". Upon pressing function key F1, both double arrows point on the EDIT window and the CURSOR appears on the maximum value of ram (1). The value indicated by the CURSOR can be modified by means of the numeric input panel. Any new value entered is checked in respect to its validity and, subsequently, either signalized as faulty or accepted directly by the LICCON system.

The working area limitation.



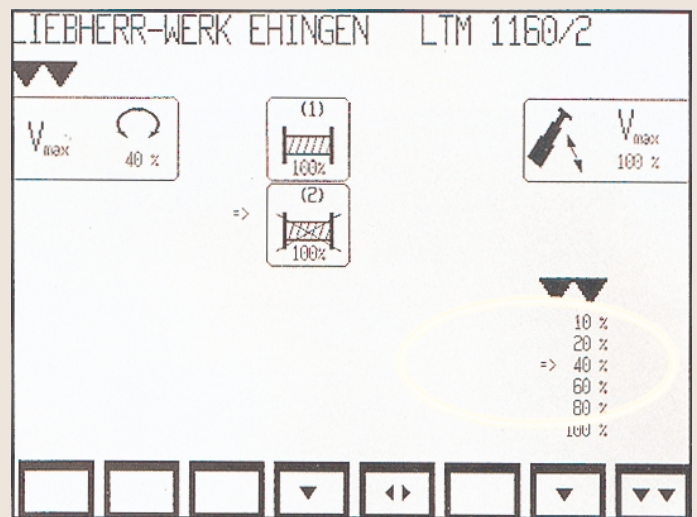
The LICCON working area limitation system for Liebherr mobile and crawler cranes contributes to the unburdening of the crane operator by controlling the working area limits, especially in situations where the handling of loads requires his full attention. Working areas may be restricted by buildings, bridges, roofs, high-voltage overhead lines, pipe lines or adjacent cranes. The automatic area limitation system can be programmed conveniently and its functions are easily understandable. Four different limitation functions are provided:

- The pulley head height limitation restricts the boom head pulley to a predetermined measure. The boom luffing and telescoping motions are cut off when the forbidden working areas are attained.
- The radius limitation prevents the load hook from exceeding a predetermined "maximum" radius. The boom lowering and telescoping motions are cut off when the forbidden working areas are attained.

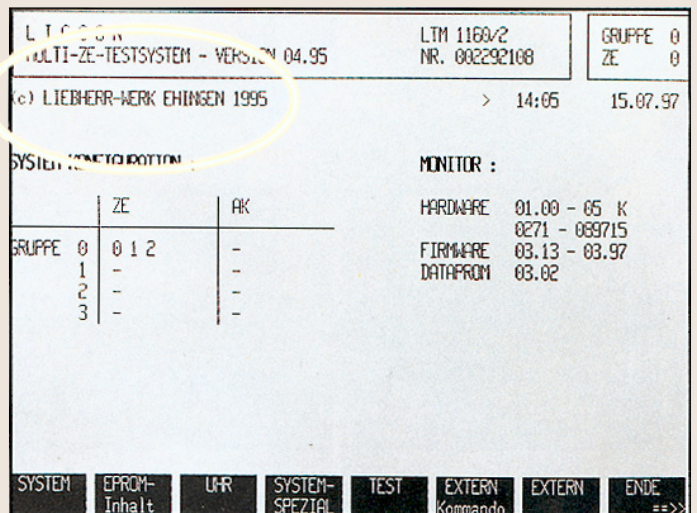
- The slewing area limitation consists of a right side and left side angle limit which cannot be overrun during activated limitation.
- The edge limitation allows a working area limitation between two edges - A and B - which, however, should not intersect the slewing rim centre. The edge limitation enables slewing at 360° but it may be necessary to reduce the radius in certain cases.

By means of a simple but convenient editor program, the crane operator can enter the various area limits into the LICCON system and activate or inactivate them. Every limitation function can be activated individually but also in conjunction with others so that even a complex of working area limitations are programmable.

The control parameter program allows preselection of the maximum slewing speed in steps of 10 % to 100 %. Thus, the operation of the control lever for the slewing motion results in an effect of different sensitivity. Moreover, the control parameter program enables the locking of a hoist winch with unreeved rope in order to prevent the formation of slack rope in case of unintentional operation of the respective control lever.



The test system enables the servicing personnel of quickly locating any failure at the servicing system. Convenient interactive functions permit the inspection of any input and output of the entire system by different displays on the screen, even during crane operation. The display on the screen includes the assignment of the individual sensors to the system, their function as well as the respective terminals in the control cabinet. Thus servicing already starts at the display screen, trouble shooting becomes a matter of seconds. The state of development of the program modules and load charts can be represented on the display screen with the aid of the table of contents. Thus a continuous service of the crane is guaranteed by the manufacturer.



For more efficient planning of crane jobs, Liebherr offers its customers the LICCON work planner, i.e. a software program on diskettes for planning, simulation and documentation of crane applications on the display screen. The 2-D planner program allows the drawing of buildings, the writing of texts and implication of a scale model crane with all its working motions into a fictitious construction site. Moreover, the work planner provides for more transparency in the submission of offers, facilitates the briefing of crane operators and can be run on a Laptop calculator for field service.

