

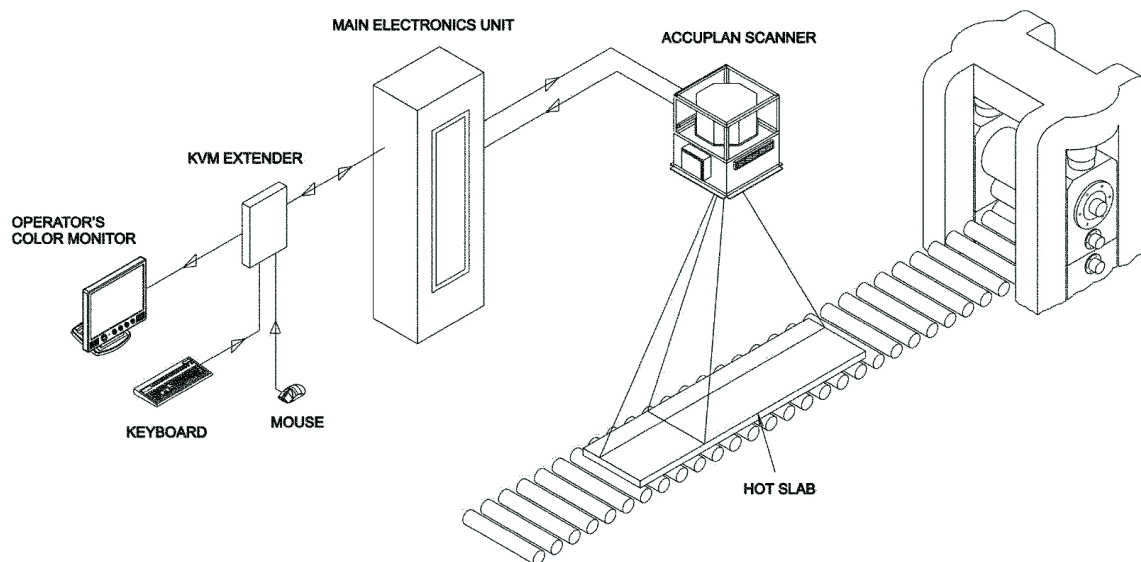


1 DESCRIPTION

The ACCUPLAN Plate Outline Gage is an optoelectronic instrument that surveys the complete plan view of hot slabs or plates from a strategic overhead location. It provides accurate measurements in two dimensions using only the metal's own radiant energy and in the presence of normal amounts of steam and scale. Because ACCUPLAN completely surveys the slab, it also defines accurately the outline shape of the material which is essential for efficient rolling.

ACCUPLAN is a necessary part of advanced plate pattern rolling schemes that produce near-perfect rectangular plate outlines as well as special shapes. Modern plate mills using ACCUPLAN to implement such techniques continue to set world yield records.

2 APPLICATIONS



APPLICATIONS continued

- In automated plate mills ACCUPLAN supplies the size and shape data needed by closed loop computer control systems.
- In manually operated plate mills ACCUPLAN increases productivity by eliminating the time needed for caliper or sideguard measurement.
- Operators using a monitor to display ACCUPLAN measurements can literally see camber as it develops, enabling them to make immediate corrective adjustments between passes. Total yield increases can range beyond five percent.
- Continuous casters with adjustable molds can be fine-tuned through feedback from ACCUPLAN to eliminate slab curvature, resulting in increased yield in downstream processing.
- In rolling mills and continuous casters, ACCUPLAN can be used to provide width measurements under environmental conditions that are too severe for silicon array or vidicon width gages.

2.1 ACCUPLAN MEASUREMENT MODES

Four models of the ACCUPLAN Plate Outline Gage are available:

MODEL	WIDTH ONLY	LENGTH / WIDTH	PLAN	LONG PLATE
C10600-A	x			
C10600-B	x	x		
C10600-C	x	x	x	
C10600-D	x	x	x	x

(x = measurement mode included)

2.1.1 Width Only Mode:

ACCUPLAN measures the width continuously while the plate crosses a predetermined scan position (normally the centerline of the field of view.) It provides the process control computer with 27 width readings per second, also maximum, minimum and average widths at the end of the measurement. The operator's display reports the cumulative maximum, minimum and average width during this measurement cycle and retains the final values until the next measurement.

2.1.2 Length / Width Mode:

ACCUPLAN scans the centerlines of the field of view continuously. When a hot slab is inside the limits of the field of view a command from the mill operator or computer causes ACCUPLAN to average a number of length and width measurement scans and to output the resulting "mean" length and width dimensions. The effects of slab motion are canceled by alternately scanning in two directions. Data are returned to the process control computer and displayed on the operator's display.

2.1.3 Plan Mode:

ACCUPLAN measures the slab's velocity as the slab enters the field of view, creates an imaginary grid locked to the moving slab and measures lengths and widths along those grid lines to precisely define the plate's outline. At the end of the measurement the data are re-mapped to compensate for plate skew and offset. The plate's outline is then displayed graphically for the operator on a color video monitor.

Summary information (minimum, maximum, and average length and width) is also displayed. Data are transmitted to the mill computer via an Ethernet link (10/100 BaseT Ethernet is standard) or an optional Fieldbus interface (various protocols - consult KELK.)

2.1.4 Long Plate Mode:

ACCUPLAN explores the head and the tail ends separately when each is in the field of view and reports the composite length when the whole plate has crossed the width centerline. When neither end of the plate is visible to ACCUPLAN at the same time, length measurement is done by integrating the output of a work roll tachometer which is calibrated by ACCUPLAN itself at each new plate entry into the field of view. Widths are output in real time and displayed to the operator as in the WIDTH ONLY mode.

3 FEATURES

- 3.1** Spectral response to more than 4 microns due to detector material, mirror optics and calcium fluoride windows. Usable signals are obtained from sources as cool as 300°C (570°F). This characteristic makes ACCUPLAN much more tolerant to steam, scale and temperature gradients than systems using silicon or germanium detectors.
- 3.2** Spatial resolution of 1/40,000 of field length is at least one order of magnitude higher than is presently achievable with CCD arrays or vidicons.
- 3.3** Large detector integrating diameter of more than 100 units of resolution provides a high tolerance to water droplets and edge roughness.
- 3.4** Uses survey method of measurement, which is intrinsically free of linearity errors. Imaging systems require a correction for lens non-linearity.
- 3.5** Velocities of moving slabs are measured by ACCUPLAN itself and data are compensated to freeze motion at speeds up to 6 m per second (19.7 feet per second).
- 3.6** Measurement data are acquired on a grid that is orthogonal to the table then remapped relative to the slab coordinates. This facilitates graphic display and eliminates errors due to slab skew.
- 3.7** Extensive test and diagnostic functions with a user-friendly interface. Built-in continuous self-tests monitor all critical gage signals.
- 3.8** Automatic calibration is recommended at intervals of 6 to 12 months and using the portable calibrator provided with ACCUPLAN takes only a few minutes. Routine maintenance consists of infrequent cleaning of windows.
- 3.9** ACCUPLAN's central processor uses a state-of-the-art 32 bit microprocessor.

4 SYSTEM CONFIGURATION

4.1 MILL-MOUNTED PARTS

4.1.1 Scanner:

A sealed, shock-mounted, temperature-controlled enclosure contains an optical system that facilitates detectors of infrared energy to scan the field of view alternately along two orthogonal axes. Viewing windows are kept free of dust and condensation by a system of baffles and a plenum chamber. The Scanner is mounted above the roll table, housed in a cubicle (supplied by the user) and suspended from the roof of the mill building.

4.2 OTHER EQUIPMENT

4.2.1 Main Electronics Unit:

The Electronics Unit is a vented (NEMA 1, comparable to IP 23) cabinet housing the main processor, operator's display PC, mill I/O interface, a color LCD video display and a keyboard drawer including a trackball. It functions as the central processor for ACCUPLAN and can be located in any reasonably protected environment (motor room or pulpit) up to 300m (1000 feet) from the Scanner.

4.2.2 Operator's Interface:

The Operator's Interface consists of a color video monitor for display of measurement data and a keyboard and mouse for operator entry. ACCUPLAN is also provided with Manual Override inputs which can be used in Computer Mode.

4.2.3 Laptop Computer:

A laptop computer is provided for test, diagnostic and calibration functions. The laptop computer is plugged into either the Electronics Unit or the Scanner but is not required for normal operation.

4.2.4 Calibrator:

The Calibrator is a portable unit consisting of infrared sources and a power supply. It is placed on the roll table while the mill is down in order to simulate two edges of a slab of accurately known dimensions.

4.3 DOCUMENTATION

Several user manuals including installation drawing(s) are provided. Electronic, bound and unbound copies are available. English language is standard.

4.4 SCOPE OF SUPPLY

4.4.1 Standard Equipment, Models C10600-A, -B, -C and -D:

- Qty. 1 Scanner
- Qty. 1 Electronics Unit
- Qty. 1 Operator's color video display with keyboard and mouse
- Qty. 1 Calibrator
- Qty. 1 Laptop computer

4.4.2 Optional Equipment, Models C10600-A, -B, -C and -D:

- Additional operator's color video display.
- **Standard kit of spares, which includes:**
 - 1 - set of drum bearings
 - 1 - of each printed circuit board
 - 1 - of each type of lamp and power supply
 - 1 - set of light sources for Calibrator
 - 1 - spare fuse kit
- Customized mill computer interface protocol (Consult KELK for standard protocols available).
- Temperature Compensation Option to provide "Cold" length and width data.
- Data Logging Option. An optional data logging PC and software provides a turnkey data logging system for storage and recall of measurement data and status information.

5 SPECIFICATIONS

5.1 PERFORMANCE

5.1.1 Accuracy₁:

- Plan Mode: ± 2 mm (0.08 inches) to 2 sigma
- Length/Width Mode: ± 2 mm (0.08 inches) to 2 sigma
- Width Only Mode: ± 2 mm (0.08 inches) to 2 sigma
- Long Plate Mode: Lengths in LONG PLATE mode are subject to some site dependent external errors (consult KELK).

5.1.2 Repeatability₁:

- ± 1 mm (0.04 inches) to 2 sigma

5.1.3 Resolution₁:

- ± 1 mm (0.04 inches) output
- ± 0.1 mm (0.004 inches) internal to ACCUPLAN

5.1.4 Sweep Pitch:

- 100 or 200 mm (4.0 or 8.0 inches) in both length and width axes
- Selected by Host Computer or Operator's Interface

5.1.5 Measurement (Sweep) Rate:

- Model C10600-A: 72 width measurements per second
- Model C10600-B, -C, -D: 72 length measurements plus 72 width measurements per second

5.2 RECOMMENDED OPERATING CONDITIONS:

5.2.1 Slab/Plate Temperature Range:

- 300°C to 1300°C (570°F to 2370°F)

5.2.2 Slab/Plate Velocity 2.3:

- Plan Mode: 6.0 m per second (19.7 feet per second) maximum, unless limited by available in field time.
- Length/Width Mode: 6 m per second (19.7 feet per second) maximum
- Width Only Mode: 8.0 m per second (26.2 feet per second) maximum
- Long Plate Mode: 6.0 m per second (19.7 feet per second) maximum, unless limited by available in-field time.

- 1) Scanner installed at 20 m (66 feet) above passline, parallel to roll table surface.
- 2) Acceleration in excess of 2 meters (6.6 feet) per second per second may degrade the accuracy.
- 3) The slab/plate velocity limits refer to the ability to measure in the length axis. The time required to survey the slab/plate fully may dictate a lower speed.

5.2.3 Field of View:

- Determined by the installed height from the roll table surface to the bottom of the scanner housing.
- Length/Scan Angle: 16 to 24° (24° is standard)
- Width/Scan Angle: 16 to 24° (16° is standard)
- Sum of Length & Width Angles: 40° maximum
- Typical Field Size: 8,500 x 5,500 mm (28 x 18 feet) when scanner is installed 20 m (66 feet) above the passline.

5.2.4 Tolerance to Scale:

- Edge must be free of cold scale for at least 25 mm (1 inch) inward for a good scan. ACCUPLAN will suppress data at those points of the slab outline where it fails to see a clean edge.

5.2.5 Tolerance to Temperature Gradiance & Seam:

- The combined effects of these conditions must be such that the radiation received by the Scanner, in the band of one micron to four microns wavelength, from the edges of the slab is at least 30% of that of the most intense radiation received across the slab.

5.2.6 Reflections:

- Reflections such as those arising from sideguards and rolls must give signals less than 60% of the radiation from the edges. If strong reflections from table rolls are detected, the operator may choose an alternative stopping position for the slab.

5.2.7 Skew:

- Maximum slab skew of 25°

5.3 COMMUNICATIONS:

5.3.1 Mill Computer Interface:

- The standard interface is 10/100 BaseT Ethernet using TCP/IP. Full duplex serial link to (9,600 bps) RS232, RS422, or 20 mA current loop interface using standard protocol is available.
- Optional custom protocol available (consult KELK).
- Optional analog input and output interfaces available for customer specified applications (consult KELK).
- Optional Fieldbus (various protocols - consult KELK)

5.3.2 Inputs from Computer:

- Slab thickness
- Measure commands according to mode and pitch required
- Target Length and Width
- Roll Speed
- Plate # and Pass # (optional)

5.3.3 Inputs from Operator's Interface (for Manual Control):

- Slab thickness
- Measurement mode
- Sweep pitch
- Start Measurement

5.3.4 Outputs to Computer:

- Measurement summary data
- Full outline data (for PLAN and LONG PLATE modes only)
- Gage, slab and measurement status signals

5.3.5 Process control outputs:

Outputs are SPDT relay contacts (30 V, 1 A maximum) and digital outputs (24 V, 0.5 A maximum)

- Gage healthy
- Slab in field
- Slab in view
- Slab stopped
- Scanner high temperature
- Measurement in progress

5.3.6 Outputs to Operator's Display Monitor:

- Graphical display of plate outline
- Length display - Minimum, Maximum, or Average
- Width display - Minimum, Maximum, or Average
- Gage and slab status signals

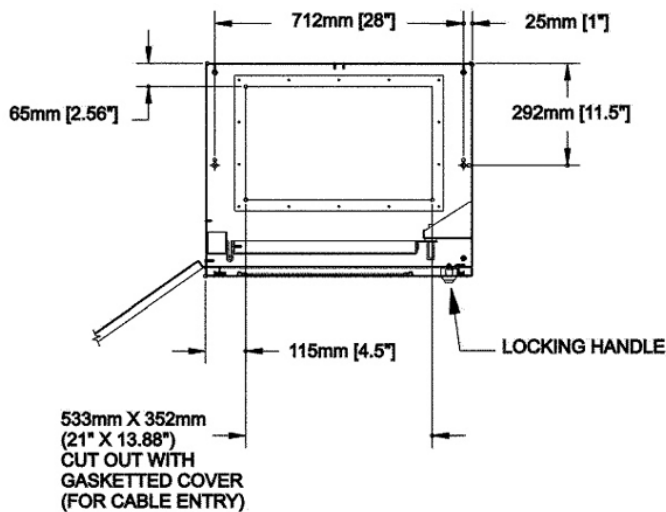
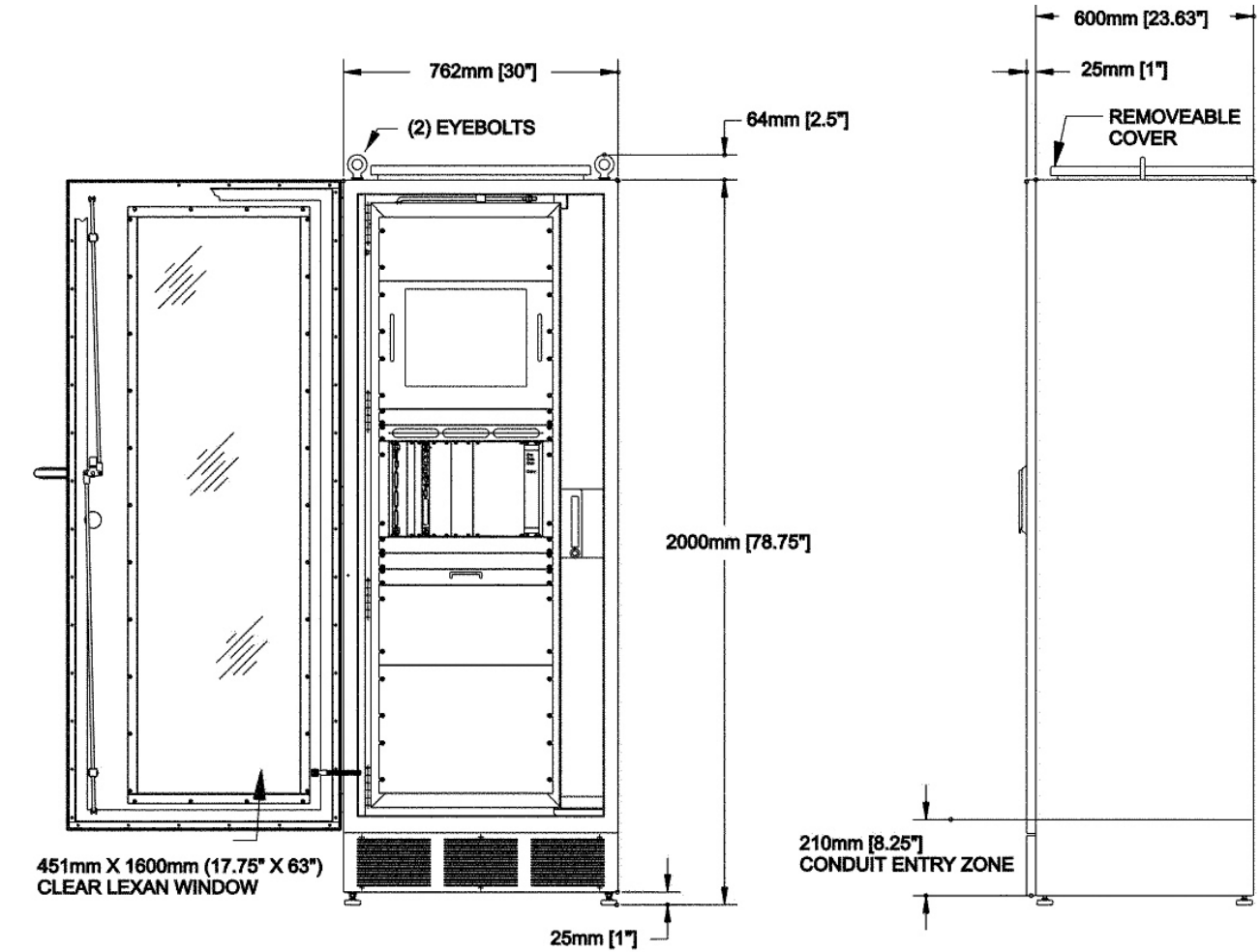
5.3.7 Gage Diagnostics:

- A laptop computer (supplied) can be used at the Scanner or Electronics Unit to operate ACCUPLAN and to access more than 30 special test functions. An optional connection can be made to the gage via Internet to allow remote access to the gage for diagnostics and software upgrades.

6 WHAT USERS MUST PROVIDE

6.1 ACCUPLAN Scanner Room:	3.2 m long x 2.9 m wide x 2.7 m high (10.3 feet long x 9.3 feet wide x 8.9 feet high) minimum inside dimensions.
6.2 ACCUPLAN Scanner typical floor opening:	950 mm x 850 mm (37.4 inches x 33.5 inches).
6.3 Ambient temperature:	
• Scanner:	-18°C to 40°C (0°F to 104°F).
• Electronics Unit:	40°C (122°F) maximum (vented cabinet). Sealed and air-conditioned cabinets also available.
	(Consult KELK for details.)
6.4 Air to Scanner Room:	1,700 liters (60 cubic feet) per minute minimum, at 5°C to 30°C (41°F to 86°F) and 80% maximum relative humidity.
6.5 Cabling between:	Scanner and Electronics Unit
6.6 Power to Input:	All inputs single phase, 60 Hz (50 Hz optional).
• Scanner Electronics:	120 (95-130) VAC, 1 kVA; or 208 (175-235) VAC, 1 kVA; or 240 (190-260) VAC, 1 kVA.
• Scanner Ambient Control:	240 (190-260) VAC, 1 kVA.
• Electronics Unit:	120 (95-130) VAC, 1 kVA; or 208 (175-235) VAC, 1 kVA; or 240 (190-260) VAC, 1 kVA.
• Calibrator:	240 (205-265) VAC, 5 kVA; or 480 (410-530) VAC, 5 kVA.

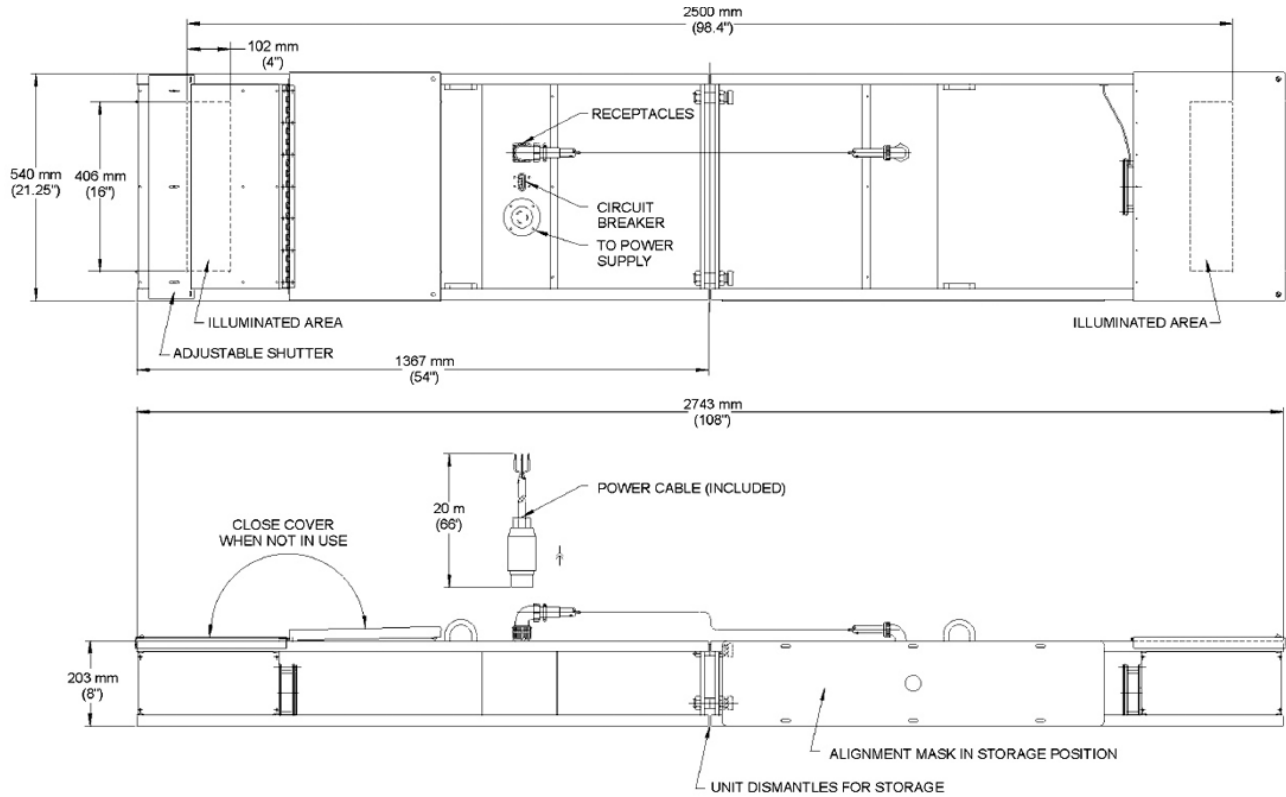
7.2 ELECTRONICS UNIT



NOTES:

1. CABINET MUST BE BOLTED TO FLOOR OR WALL USING M12 (½") BOLTS.
2. THIS CABINET CONFORMS TO NEMA 1 (APPROXIMATELY EQUIVALENT TO IP23) STANDARDS.
3. APPROXIMATE WEIGHT: 227 KILOGRAMS (500 POUNDS).
4. 95 MILLIMETERS (3.75 INCHES) CLEARANCE AT HINGED SIDE OF CABINET REQUIRED TO ALLOW DOOR TO FULLY OPEN WHEN INSTALLED NEXT TO OTHER SIMILAR SIZED CABINETS.
5. PROVIDE SUFFICIENT CLEARANCE FOR DOOR TO OPEN 145°. THIS IS REQUIRED TO ALLOW THE RACK TO BE FULLY OPENED FOR SERVICE.
6. CABINET MUST BE LOCATED IN A RELATIVELY CLEAN ENVIRONMENT (eg COMPUTER OR MOTOR ROOM).

7.3 CALIBRATOR



Notes: Weight: 64 Kilograms (141 Pounds)

7.4 OPERATOR INTERFACE SCREEN

KELK ACCUPLAN 2005-10-07 14:45

F1 MEASURE PROFILE	F2 LOGGER NONE	F3 DISPLAY TARGET	F4 OPTIONS THICK.: 111	F5 PLATE DATA 00000000 55
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ID: 00000000	PASS #: 55	TEMP# 0	LC# 0	WC# 5	
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LENGTH

TARG 4680

MIN 4674

AVG 4677

MAX 4682

WIDTH

TARG 2690

MIN 2691

AVG 2694

MAX 2699

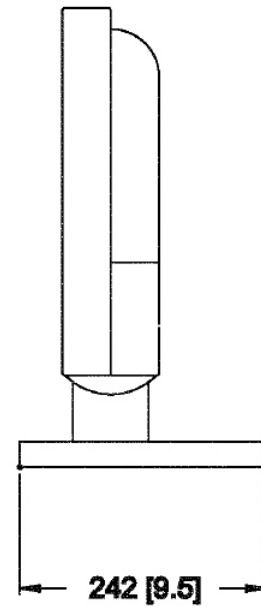
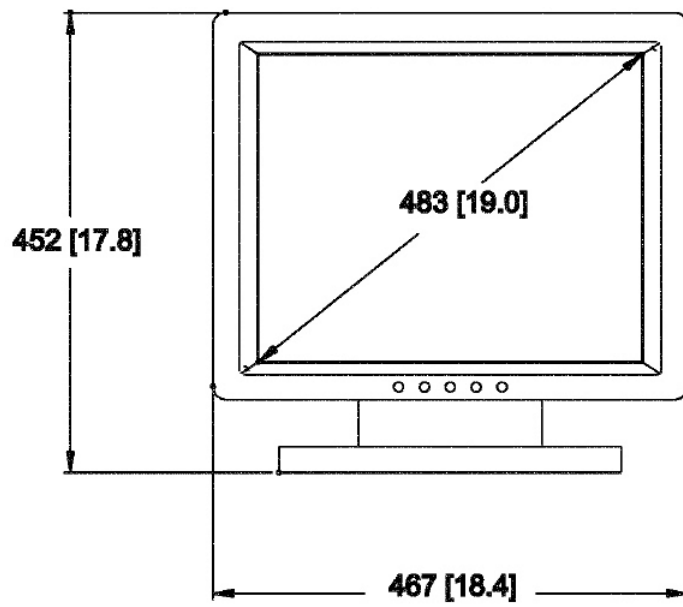
DEV 130

THICK 111

SK/CMB 0.0

STATUS [F10] DIAG [F11]
GAGE READY

7.5 ACCUPLAN 483 mm (19") XGA MONITOR



SIDE VIEW