950

Technical Manual

INTRODUCTION

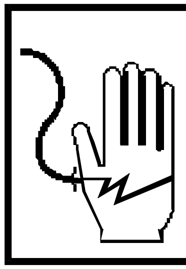
This publication is provided solely as a guide for individuals who have received METTLER TOLEDO Technical Training in servicing the METTLER TOLEDO product.

Information regarding METTLER TOLEDO Technical Training may be obtained by writing to:

METTLER TOLEDO
Training Center
P.O. Box 1705
Columbus, Ohio 43216
(614) 438-4400

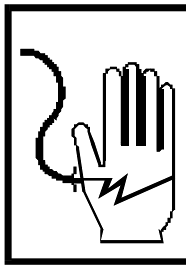
PRECAUTIONS

- **READ** this manual before operating or servicing this equipment.
- **ALWAYS REMOVE POWER** and wait at least 30 seconds **BEFORE** connecting or disconnecting any internal harnesses. Failure to observe these precautions may result in damage to, or destruction of the equipment.
- **ALWAYS** take proper precautions when handling static sensitive devices.
- **DO NOT** connect or disconnect a load cell scale base to the equipment with power connected or damage will result.
- **SAVE** this manual for future reference.
- **DO NOT** allow untrained personnel to operate, clean, inspect, maintain, service, or tamper with this equipment.
- **ALWAYS DISCONNECT** this equipment from the power source before servicing.
- **CALL** METTLER TOLEDO for parts, information, and service.



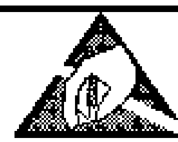
WARNING

DISCONNECT ALL POWER TO THIS UNIT BEFORE REMOVING THE FUSE OR SERVICING.



WARNING

ONLY PERMIT QUALIFIED PERSONNEL TO SERVICE THIS EQUIPMENT. EXERCISE CARE WHEN MAKING CHECKS, TESTS, AND ADJUSTMENTS THAT MUST BE MADE WITH POWER ON.



CAUTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

CONTENTS

1.0 INTRODUCTION

The information provided in this manual is to be used as a guide in the design and installation of Mettler Toledo CHECKMASTER™ and CAP-CHECK™ weighing systems. The content of the manual is limited to design considerations. Actual installation should be performed only by qualified personnel.

Should you have any questions regarding the technical feasibility or limitations of CHECKMASTER and CAP-CHECK load cells, please contact you local Mettler Toledo Scale representative.

All sales of goods described herein shall be subject to the standard warranty and the standard terms and conditions of sale published by Mettler Toledo Scale. The specifications and product description contained herein are believed to be accurate at the time of publication but are subject to change at any time without notice.

Weighing applications vary widely by industry. In conjunction with this guide, Mettler Toledo CHECKMASTER and CAP-CHECK load cells provided an extremely versatile, cost effective approach to solving a variety of these applications.

Mettler Toledo CHECKMASTER and CAP-Check load cells are inherently resistant to moderate side-load effects, therefore, horizontal checking is often not required. Their simple mounting designed are supplied in a variety of capacities and configurations.

While the “checkless” design permits ease of application, there are several technical considerations which must be understood and incorporated into the system. These considerations are discussed in the manual and should be understood prior to installation. Knowledge of these principles will result in a more accurate CHECKMASTER or CAP-CHECK system.

2.0 DESIGN CRITERIA

2.1 NUMBER OF SUPPORT POINTS

The number of support points required for an installation depends on the tank, hopper, or scale geometry for each particular application. In general, vertical tanks with circular horizontal cross sections are most suited to three cell installations. Four cell installations are most appropriate for horizontal tanks and floor scale applications. In the case of three point suspension, it is essential that the center of gravity remain within the triangle formed by the three load cell receivers. This design criteria must include consideration for shifted of uneven loads.

In the case of more than three support points, the structure must be sufficiently flexible to remain in firm contact with all load cells throughout the weighing range including zero load.

In some applications tipping forces are present or possible. These include wind loading or forces from material transfer devices. For these applications the vertical location of the support points with respect to the structure (three or four) should be give special consideration to insure stability. Refer to Figures 1 though 3 for typical support point placement.

Figure 1

Figure 2

Figure 3

2.2 SYSTEM CAPACITY

The gross load supported by the load cells is a combination of the following three factors:

INTIAL WEIGHT + WEIGHING CAPACITY + SHOCK LOADING EFFECT = GROSS LOAD

The initial weight is the empty weight of the tank, hopper, or scale deck. Weighing capacity refers to the maximum weight to be displaced at the indicator.* The third factor, shock (impact) loading, pertains only to certain installations. The effects of shock may range from negligible when considering the steady flow of liquid into a hopper, through significant when considering impact due to fork lift traffic, to critical, when drop or crane loading of heavy items is anticipated.

To determine the minimum cell capacity for tank and hopper applications, divide the gross load (as calculated above) by the number of cells used in the system. This method assumes that the load is always equally applied to each cell in the system. This is typically the case in most tank and hopper applications.

Always select the next higher available cell capacity. For example, if the gross load including shock factors is calculated to be 18,000 lb and a three load cell configuration is chosen then the gross load on each cell is 6,000 lb and a 10,000 lb load cell must be selected.

*This value will exceed the maximum weight of material to be weighed.

To determine the minimum cell capacity for platform scales one must consider the unequal load applied to the four cells during the loading/unloading cycles. Refer to Figure 3. In a typical example of two unequally loaded axles separated by a distance S. The distance C from the centroid (center of mass) of the axles to the center of the heaviest axle can be found by the following equation:

$$C = (\text{Axle 2} \times S) \,/\,)\text{Axle 1} + \text{Axle 2})$$

NOTE: If only one axle is present, C=0. The terms axle 1 and 2 refer to the loads carried by these axles, with axle 1 assigned to the heavier axle.

The maximum live force to a cell can be calculates by the following equations. Utilize the formula which produces the greatest value for R.

$$R1 = \frac{(\text{Axle 1} + \text{Axle 2}) \times (CL + OH-C) \times (CW + EH-D/2)}{CL \times CW}$$

$$R2 = [(\text{Axle 1} + \text{Axle 2}) \times (C-OH)] \,/\, CL$$

$$R3 = [(\text{Axle 1} + \text{Axle 2}) \times (D-EH)] \,/\, CW$$

$$R4 = (\text{Axle 1} + \text{Axle 2}) \times$$

The correct proportion of the platform weight must be added to the maximum value of either R1, R2, R3 or R4 since the platform's weight must be supported by the load cells too. This value will be 1.4 of the platform weight if the center of gravity coincides with the center of the load cell group. Select the higher load cell capacity.

To avoid platform tipping while an axle rolls on to or off of the platform, the maximum allowable axle load permitted will be:

$$\text{Axle Max} = \text{Platform Weight} \times \frac{PL}{4} \,/\, OH$$ (see Figure 3)

Note in Figure 3 that the CHECKMASTER load cells are arranges at a 45º angle. This will provide optimum checking when traffic flow is in all four directions. If the traffic is confined to one direction and its reverse and virtually no lateral forces at right angles, it might be desirable to arrange the cells with numbers aligned with the traffic as shown in Figure 4. If CAP-CHECK load cells are used the base plate can be arranges at any angle desired. The checking is between the circular cap and the top of the cell and is equal in all directions.

Figure 4

2.3 SELECTION OF AN INDICATOR

To select an indicator, the allowable number of increments and increment size must be determined. First, calculate the percent of the total load cell capacity that is used as weighing capacity. This can be accomplished with the following formula:

$$100 \times \frac{\text{Weighing Capacity*}}{\text{Load Cell Capacity x Number of Cells Used}}$$

Once the percentage of total load cell capacity has been calculated, refer to the Increment Selection graphs, Figure 5. The graph for controlled environments allows a higher number of displayed increments. This includes conditions with no wind and when temperature remain within 20ºF year round. Typically, this will be in a temperature controlled indoor environment. For outdoor installations where less stability can be expected and where temperatures vary widely, the graph for uncontrolled environments must be used. This results in a display less sensitive to environmental fluctuations. Move along the horizontal axis to the appropriate percent of capacity. Any number of increments found by moving vertically at this point (within the allowable zone) will provide satisfactory performance.

Tables 1 and 2 list the number and size of increments for available indicators. Indicator selections is based upon the requirements of your application including conformance with the above calculations. When selecting an indicator, remember the following formula:

Number of Increments x Increment Size = Weighing Capacity

*The maximum weight displayed by the indicator.

Table 1 - Number of Increments

Table 2 - Increment Size

NOTE: Check instrument specifications to insure adequate sensitivity (microvolts per increment) as described in the technical manual.

Figure 5 - Increment Selection Graph

2.4 STRUCTURAL INTEGRITY

The maximum allowable change in deflection of the load receiving plate from zero to full load is 0.5º (one-half degree). Refer to Figure 6. By adhering to the structural design stresses of the steel you can endure that the maximum deflection will not exceed one half a degree. However, deflection at the load cell should always be confirmed by measurement or calculation.

As with all installations of this type, the Mettler Toledo CHECKMASTER or CAP-CHECK load cells must be supported by a structure with sufficient rigidity to maintain a safe and stable weighing system. The structural requirements for load cell supports will be covered in the section on Site Preparation.

Figure 6 - Deflection of Vessel or Platform Under Load

2.5 ENVIRONMENTAL CONDITIONS

The CHECKMASTER and CAP-CHECK load cells are normally calibrates for temperatures between -10º and +40ºC. Outside this range, the system will continue to operate; however, calibration accuracy will not be maintained.

For those installations where unusual temperatures exist, special temperature compensated CHECKMASTER and CAP-CHECK cells are available. For details, contact Mettler Toledo Scale Industrial Marketing.

A specially designed slide plate mechanism for the CHECKMASTER load cell provides .03 inches of thermal expansion capability. Check rods are normally not required with these load cells, even when hot or cold materials are poured into the tank or hopper. For extreme cases the expected expansion should be pre-calculated. If thermal expansion greater than .03 inches is predicted, check rods must be considered to prevent scale lock-up./ This will not normally be a problem where the distance between load cells is less than fifteen feet.

The Mettler Toledo CAP-CHECK load cell assembly provides doe thermal expansion up to 0.16 inches and should be adequate for all but the most extreme conditions. The linear expansion per unit of length per degree Fahrenheit for carbon steel is about .000 006 5 or 6.5PPM/ºF. For example, a carbon steel tank ten feet long or ten feet in diameter would expand about .078 inches with a temperature increase of 100ºF on the tank. Of course the structure of the building supporting the tank could expand from the heat in time but this would depends on a number of factors. The expansion of aluminum with hear is about two times that of carbon steel.

Although CHECKMASTER and CAP-CHECK load cells are temperature compensated, best results are archived when they are kept at a stable temperature and out of drafts and direct sunlight.

Stability considerations are important in the design of any structure. When side loading is a possibility due wind or traffic impact, provision must be made to prevent topping. When mixers are to be installed anti-tip bolts should be designed into the load cell assembly to prevent vibration. Anti-tip bolts can be installed and adjusted using double nuts to lock them in place. Clearance between live members and the anti-tip nut and bolt assembly must be maintained for an accurate weighment (Figure 7). Check stays may also be used. For assistance with the use of check stays and anti-tip bolts, contact Mettler Toledo Scale Industrial Marketing.

Figure 7 - Anti-Tip Bolts for High Side Forces

The installed CHECKMASTER and CAP-CHECK load cell will withstand sideload forces as indicated in Table 3. Side forces due to impact must be kept below these values.

Table 3 - Side Load Capacity

Checkmaster

Load Cell Capacity (pounds)	Permissible Side Load (pounds)
1,000	1,700
2,000	1,700
5,000	1,700
10,000	1,700
20,000	2,000

CAP-CHECK

Load Cell Capacity (pounds)	Permissible Side Load (pounds)
50,000	15,000
100,000	30,000

The permissible side load given for the CHECKMASTER load cell is only to be applied in one direction and directly to the bumper bolt on the assembly, the permissible side loads for the other directions will be lower.

The permissible side load for the CAP-CHECK load cells can be applied in any direction and it is the same for all directions.

Mettler Toledo CHECKMASTER and CAP-CHECK load cells are provided with redundant waterproofing seals for protection against rain, sleet and snow. However, it is important to ensure that no standing water accumulates; therefore, adequate drainage should be improved.

To ensure accurate weight indication, keep snow and ice clear at all times.

Mettler Toledo CHECKMASTER and CAP-CHECK load cells are inherently insensitive to normal barometric pressure changes.

2.6 ELECTRICAL AND MECHANICAL CONNECTIONS

Tank or hopper installations often require filling or electrical connections. Precautions must be taken to ensure that the effects from connections are minimum. Figures 8a through 8c depict some of the typical methods for handling “live-to-dead” connections. The objective is to minimize the force that the dead portion (fill pipe) applies to the live portion (weighing element).

Figure 8 - Pipe Connections

The ideal weighing system would not include connections to the live portion of the scale. However, this is highly unlikely since the filling apparatus is a crucial element to many systems. When a continuous connection is necessary, it should be made as flexible as possible by means of a bellows type construction or a rubber inter-connector. If a homogenous metal pipe is required, wall thickness and tube diameter should be minimized, while pipe length is maximized as to ensure a reduction in spring force.

Figures 9a through 9d depict some of the more typical electrical connections. Rigid conduit is the least desirable. Notice the 90º bend depicted in Figure 9a. If at all possible, the horizontal lengths of the conduit should be maximized as to minimize the effects of thermal expansion on system accuracy.

Figure 9 - Electrical Connections

The graph, (Figure 10), may be used for reference when designing a system with rigid conduit or piping. For various capacities, based on given pipe diameter and Schedule 40 wall thickness, a minimum length may be determined.

It should be recognized that any connection to a live portion of a scale device can adversely affect performance. The total spring rate of all the pipes (in lb/inch) should not be more than the total capacity of the load cells (in lb) used to support the tank.

Figure 10

Figure 11

To understand how to use the graph in Figure 10, please refer to the example above. Assume we have a tank that will be supported with three 5000 lb capacity load cells; it will be filled with a pipe ten feet long and four inches in diameter. From the chart in Figure 10, one can determine that a pipe ten feet long and dour inches in diameter and has a spring rate of about 1500 lbs. This is less than the total load cell capacity so it is acceptable for our proposed scale. If, however, the pipe was two feet long, the spring rate for a 4" pipe would be 100,000 pounds and would not be satisfactory. 100,000 pounds is much greater than the 15,000 pound load cell capacity.

Selectable electronic filtering is available in most me Scale indicators. Electronic filtering can be used to minimize vibration effects caused by motor driven equipment connected to the weighing system.

As indicated above, it is never possible to reach the full potential accuracy's of a scale with electrical and mechanical connections running from ground to "live" portions of the scale. Another serious source of error is the presence of a mechanical vibration.

Mechanical vibration may be considered as arising from two locations:

1. SCALE OR HOPPER VIBRATION
   This would include conveyor, mixer, ultra-sonic shaker devices which are located on the live portion of the scale.

2. GROUND VIBRATION
   This source includes all vibrations which caused the ground or the support structure surrounding the scale to oscillate.

It is equally important to isolate and minimize sources of both kinds of vibration. Means to prevent and/or isolate sources of vibration must be included in the design. Sources and solutions to vibration problems are too numerous to cover within the scope of this guide. The following are intended as examples of problems only.

An example of the first type of vibration would be the use of a conveyor installed on the scale. Motors, rollers and shafts must be accurately balances to avoid unstable readings. Another example would be the use of a mixing device installed on the scale, accurate weighments cannot be accepted while a mixer is actually running.

In the case of external vibration, precautions must be made to assure that the scale is located on a sound foundation and that the sire is located as far as possible from any machinery.

The effects of vibration are most serious at frequencies below 20Hz. As a rule of thumb ground vibrations should be kept below an amplitude of 0.010 inches for frequencies from 0 to 20 Hertz. For further information concerning the problems of vibration, contact Mettler Toledo Scale.

2.7 SITE PREPARATION

The load bearing plate, whether structural steel or concrete, must be capable of receiving a load at least equal to the individual CHECKMASTER or CAP-CHECK load cell capacities. In addition, structural design safety factors must be considered. To prevent cell shifting cause from side-loading forces, secure the Mettler Toledo CHECKMASTER or CAP-CHECK load cell according to the bolt size shown in Section 4. Each cell should be installed level to within .5º ; all cells should be installed on the same horizontal plane. This requirement is especially critical in installations with more than three support points. This will ensure equal loads are conveyed to each cell. The tolerance required will be determined by the separation of cells and flexibility of the structure.

2.8 INSTALLATION GUIDELINES

The CHECKMASTER and CAP-CHECK load cell assemblies are designed to be installed as complete pre-set units.

The CEHCKMASTER load cell assembly uses a bumper bolt, which should be set to have .03 inch clearance between the end of the bolt and the end of the load cell. The parts of the assembly are held in their correct locations with three straps and six bolts. The straps are not removed until the assembly is securely bolted into the structure where it is to be used.

The CAP-CHECK load cell assembly has a fixed clearance around the cap. The assembly is held together and centered with four shipping straps and eight bolts. The clearance should be 5/32 inches on all sides (see Section 4.2). it may be necessary to loosen the top bolts to center the cap. Tighten the bolts once the cap is set correctly. Do not remove the shipping straps until the load cell assembly is securely bolted in place. During normal operation the cap will be centered on top of the load cell. The cap can be allowed to contact the cell during loading but this must be a temporary condition with no contact while weighing.

2.9 CALIBRATION

After the load cells and the instrument are installed, and before the scale can be used, some method of calibration must be employed. If the scale is used for commercial weighing, it must be calibrated with approved test weights.

Calibration of platform scales should not be difficult. Provisions for calibration should be planned in advance. There are several methods that can be used: simulators, preweighted materials, et cetera, but again the final check must be done with approved test weights for maximum accuracy and for Weights and Measures approval. Sometimes test weights and material in the tank or hopper can be built up to the necessary weight. However, it is much better to use test weights to the full scale capacity. Many times the hopper or tank is located high off the floor. If this is the case, it is not difficult to suspend test weights below the hopper. IT may be advisable to provide some type of eye bolts or loops to attach a hoist for lifting test weights. And, of course, there should be some way of transporting the test weights to the area below the hopper. If the tank or hopper is close to the floor, the test weights must be places somewhere on the structure itself. It may be necessary to provide brackets or shelves for this purpose. Another possibility is to lay a beam across the top of the structure and hang the weights from it.

In all cases, ensure that the hopper design is capable of withstanding the high, concentrates loads of the test weights.

2.10 LOW ACCURACY SYSTEMS

For those hopper and tank systems where accuracies less than 1% are acceptable, two of the load cells may be replaced with two flexures to provide a more cost effective installation. A typical vertical tank installation is shown in Figure 12. A typical horizontal tank installation is shown in Figure 13. This method can only be used where the horizontal location of the combined center of gravity of the tank contents remain constant. In other words, the tank or hopper must be symmetrical and the material being weighted must either be:

a. A liquid, or
b. A solid which is filled and emptied in the center of the hopper and has a consistency that produces "repeatable" weight distribution from one weighing cycle to the next.

The accuracy of this arrangement will also be adversely affected by unequal deflections of the foundation supporting the cells. It should be noted that this method cannot be used for any legal for trade application or where a specified accuracy performance is included as a condition of sale.

To properly apply low accuracy systems, one should remember that the weight indicated by the scale is not only effected by changes in weight, but also by changes in the location of weight.

In Figure 12, the load cell and the flexures each support 1/3 of the weight of the tank. The flexures set at an angle that will allow for maximum deflection. If CAPCHECK load cells are used the base plate can be oriented at any angle desired. The checking is between the circular cap at the top of the cell and is equal in all directions.

Figure 12 - Vertical Tank with Flexures for Low Accuracy Systems

In the example of Figure 13 the load cell will support one-half the weight, the flexures will each support one-fourth of the tank weight. Added stability can be achieved by using two cells and two flexures (similar to Figure 2), each of which will support one-fourth of the tank weight.

A CHECKMASTER load cell is shown in this example. CAP-CHECK load cell(s) would work equally well. The total capacity required should be the deciding factor.

Figure 13

If test weights are used for calibration, they must be placed exactly half way between the load cells and the flexures on the tank; this is usually not practical as the weights must be located very accurately. Premeasured volumes of liquids can be used for tank calibration. By this methods the tank is filled with water measured with a meter of known accuracy, or the water is weighed before it is put into the tank.

Flexures can be made from sections of “I” beams or “H” beams. A section of 6 inch beam makes a good flexure for smaller tanks, the 6 inch height is about the same as the height of the CHECKMASTER load cells. The larger 10 or 12 inch wide flange I beams are the approximate height of the CAP-CHECK load cell assemblies.

To calculate the maximum load forma flexure, use a calculation similar to the following one shown for a 12 inch section of 10” wide flange, 10WF x 12. X .19 gives 2.28 square inches. The maximum load should always be less than 10,000 lbs. Per square inch. 10,000 x 2.28 = 22,800 lbs. The maximum load for the flexure is 22,800 lbs., so this flexure could be used in place of a 20,000 lb/load cell. Another example: a 6 inch x 4.4 pounds girder has a flange 0.11 inches thick.

6 inches x .11 inches = .66 square inches
.66 square inches x 10,000 lb per sq. Inch = 6600 lbs. Maximum

3.0 SPECIFICATIONS

Model 934 and 950 load cells are rated NEMA 6P and are intended for indoor and outdoor use. They are not intended for applications where repeated water submersion is anticipated. Normal precautions for the protection of electrical device against the environment will extend the life of the load cells. The cells exploye several different metals and plastics, for applicability in environments where the devices may be exposed to chemicals consult Mettler Toledo Scale.

3.1 CHECKMASTER

Rated Output:	2.0± .005 Millivolts per volt.
Bridge Resistance:	input 380 ± 20ohms
	output 350 ± 2ohms
Excitation Voltage:	Recommended 15 volts AC/DC
	Maximum 20 Volts AC/DC

Compensated Temperature Range:	-10º to +40º
Repeatability:	0.01% full scale
Safe Overload:	150% of full scale
Ultimate Overload:	300% of full scale
Safe Side Load:	100% of full scale
Non-Linearity:	±0.2% of full scale
Combined Non-Linearity and Hysteresis:	±0.04% of full scale
Insulation Resistance:	2000 megohms at 100V DC
Finish:	Electroless Nickel (Including mounting hardware)
Cable Color Code:	plus excitation (white) minus excitation (blue) plus signal (green) minus signal (black) plus sense (yellow) minus sense (red) sheild (orange) floating.
Cable Length:	10 feet

Note: These specifications refer to load cells measured separately. Installation specifications will vary. By following the guidelines herein, operation within the requirements of NBS H-44 may be expected.

3.2 CAP-CHECK

Rated Output:	2.0± .002 Millivolts per volt.
Bridge Resistance:	input 825 ± 35ohms output 775 ± 5ohms
Excitation Voltage:	Recommended 15 volts AC/DC Maximum 25 Volts AC/DC
Compensated Temperature Range:	-10º to +40º
Repeatability:	±0.01% full scale
Safe Overload:	150% of full scale
Ultimate Overload:	500% of full scale
Safe Side Load:	30% of full scale
Non-Linearity:	±0.03% of full scale
Combined Non-Linearity and Hysteresis:	±0.03% of full scale
Insulation Resistance:	2000 megohms at 100V DC
Finish:	Rust inhibitive cycle
Cable Color Code:	plus excitation (white) minus excitation (blue) plus signal (green) minus signal (black) plus sense (yellow) minus sense (red) shield (orange) floating.
Cable Length:	40 feet

4.0 LOAD CELL DIMENSIONAL DATA

4.1 CHECKMASTER DIMENSIONS

Capacity (lbs)	A	B	C	D	E	F
1,2 & 5,000	4-1/2	10-1/2	12	3/4	5/8	2
10 & 15,000	5-11/16	11-1/2	13	1	3/4	2-1/2
20,000	6-7/8	11-1/2	13	1-1/2	3/4	3

Note: Dimensions in inches.

4.2 CAP-CHECK DIMENSIONS