06-02-2008

System Bill of Materials for: 100387

QUANTITY	COMPONENT	COMP_DESC
1	100295	AC100 CENTRAL PROCESSING UNIT
1	140275	JW CARRYING CASE
4	140078	JW-ICQ30 QDINTCNCT CABLE-CPU 30FT
4	100276	JW25 LOADCELL ASSEMBLY. 25K LBS 3IN
4	800510	PLATING AC RING ADAPTER
4	800536	PLATING DLC GUIDE_PIN
4	800526	PLATING JACK WEIGH CUP ADAPTER

AC100
ACJW
JW_1BC
JW_2BC
JW25
JW_RA
JW_SA
JW_TA
JW_ICQ30

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Aircraft Weighing Guide

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this scale. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the scale. Intercomp assumes no liability for the customer's failure to comply with these requirements.

DO NOT SUBSTITUTE PARTS OR MODIFY SCALE

Because of the danger of introducing hazards, do not substitute parts or perform any unauthorized modifications of the scale.

WARRANTY

INTERCOMP CORPORATION (hereafter called "the company") warrants the equipment that this document accompanies to be free of defects in materials and workmanship, and to operate according to design specifications for a period of one (1) year after receipt by the original purchaser. After authorized return to the company at the purchaser's expense, the company shall evaluate any returned equipment under warranty claim, and shall make such repairs or replacements as may be judged necessary, in as expeditious a manner as possible.

IN THE EVENT that the company determines the claim to be made as a result of improper use, abuse, modification, shipping damage, or other factors beyond the reasonable control of the company, the company will advise the purchaser of the estimated repair costs. The company makes no warranty other than that contained in this statement. No agent other than an executive officer of Intercomp Corporation is empowered to modify in any manner this statement of warranty.

COMPLIANCE WITH FCC RULES

Please note that this equipment generates, uses, and can radiate radio frequency energy. If this equipment is not installed and used in accordance with the support manual, you are warned that it may cause interference to radio communications. This unit has been tested and has been found to comply with the limits for a Class A computing device pursuant to subpart J of part 15 of FCC Rules. These rules are designed to provide reasonable protection against interference when equipment is operated in a commercial environment. However, if this unit is operated in a residential area, it is likely to cause interference and under these circumstances the user will be required to take whatever measures are necessary to eliminate the interference at their own expense.

Introduction to Weighing Concepts

This section is intended to provide a basic familiarity with the weighing process and Intercomp weighing systems. Later sections of this manual provide detailed descriptions of how to operate each component and more details on weight and balance control.

NOTE: We will mention some details of the aircraft as it appears throughout the text, but this is for demonstration only. It is important to remember that you **MUST** seek and follow the specific requirements of the aircraft manufacturer.

In order to understand the operation of a scale, it is necessary to have a basic knowledge of the elements of any aircraft weighing system. There are three basic elements you should know in weight and balance control.

1) The relationship between mass and weight

What is weight?

Weight is related to mass. The earth's mass attracts any object's mass, producing a downward force we call weight. This force varies depending on your location and altitude. This downward force can be measured and related to the weight. Remember, a scale is a force measurement instrument; it does not measure mass directly.

2) Gross, net and tare values.

What are you weighing?

The next element of weighing is the definition of just what is being weighed. A scale detects anything on its surface. You may need to use a fixture to hold what you are weighing on the scale. The scale weighs this fixture just as if it is part of the object you wish to weigh. An example: you wish to weigh some liquid. You might use a container to hold this liquid. A scale would show the combined weight of the liquid and container. This relationship is so common that special words describe each part of the weight.

Gross: The combined weight of an object being weighed and any container holding it.
Net: The weight of an object only. This is the weight used in all calculations.
Tare: Any container or fixture weighed with the object to be weighed.

3) Arms, moments, center of gravity

Where is the weight located?

The purpose of weighing an aircraft is to determine the amount and location of the aircraft's mass. The location of the scales and weight read from the scales are combined with simple mathematical formulas to determine where the aircraft would balance if suspended at a single point. This point is known as the **CENTER of GRAVITY or CG**. The manufacturer designates the correct CG for the aircraft, referenced to the datum (See below). Changes to the aircraft structure, equipment, fuel supply, and loading affect the CG.

It is necessary to have a standard reference point for all measurements concerning the aircraft. Each aircraft manufacturer therefore designates some point on or near a specific type of aircraft as the standard reference point, which is called the **DATUM**. The datum is often a point some distance in front of the aircraft, although it may also be located on the aircraft. It is used for the zero reference point for all longitudinal (front to rear) arm measurements on the aircraft. Specifications for locating the datum must be permanently with the aircraft, and are often found in the cockpit on a datum plate or included in the aircraft records. Manufacturers usually use the longitudinal centerline of the aircraft as the datum for lateral (side to side) arm measurements. If a different lateral datum is specified, its location is included in the datum record.

The distance from the datum point to the scale is called an **ARM**, measured in inches or centimeters.

The weight from the scale is multiplied by the arm to give us a **MOMENT ARM**. The preferred unit of measure for moment is in*lb (or cm*kg).

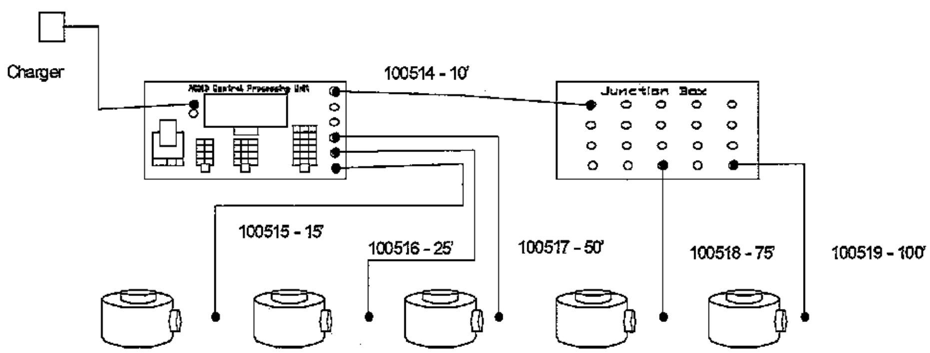
The moments are combined and divided by the total weight to determine the center of gravity.

Each aircraft has an aircraft record book that contains a listing of the CG location. This weight record listing must be updated for any permanent changes made to the aircraft.

Scale System Components

This drawing shows the basic components that complete the weighing system. The JWD, AC30-60, and AC1-25LP may be used in the standalone mode. All of these devices may be connected to the AC100 CPU or AC2000 Computer for central control and enhanced feature set. If more than 5 devices are to be connected to a central controller, the AC100 Junction box will allow more sensing devices to be connected. Up to 42 weighing elements of any type may be connected to the AC100 CPU or AC2000 computer in any combination.

Setup: AC100 to Load Cells



System Connection Diagram

Some items not shown: carrying cases, transport carts, and calibration equipment.

Introduction to Aircraft Weighing

Before You Weigh

Aircraft must be weighed before we can determine the center of gravity. The only way to find the weight is to use accurate and calibrated scales. Also, the weighing site should be prepared and the aircraft must be brought to a standard configuration.

Before weighing certain factors must be prepared. These fall in the categories of aircraft and site preparation.

The floors should be leveled to 1/4 inch per foot (1.2°). It is possible to compensate for greater slopes mathematically but a level floor is best.

The hangar must be free of drafts or stray wind currents. Any air currents across the wings or tail will be sensed as changes in weight. Close hangar doors (if you have any). Turn off all blowers and air conditioning while weighing.

The aircraft must be prepared for weighing. We assume that a standardized checklist is used for this task. This list is available from the aircraft manufacturer. Some items on this list would be: The aircraft should be washed and dried, tires inflated, struts serviced, engines serviced, de-fueled, all interior stations cleaned and brought to standard conditions. All the aircraft contents must be inventoried. A weight without an accurate inventory is of no value. In addition, flap position, horizontal stabilizer, seat position, etc. are all set according to manufacturers' recommendations.

It is convenient to charge the scales the day before the weight job. At this time check that the scales are within the specified calibration interval. Allow the scales to acclimate to the temperature in the hangar before use.

Arrange the scales in the required configuration. The detailed operation section of this manual gives specific details for configuration and use.

Connect any cables as required. Turn the scales on. Intercomp scales are stable within 3 minutes after turning on.

Zero each scale, and verify a displayed zero weight. Load the scales. This varies according to the type of scales used. Please check manufacturers' recommendations for any special weighing or leveling fixtures.

Weighing

Load with Platforms:

Release the aircraft brakes. Push or tow the aircraft onto the scales. Use chocks or towbar to control the aircraft. Read and record all weights. Tow the aircraft off the scales. Verify and record that all scales return to zero. Where possible, exchange scales between positions. Push or tow the aircraft onto the scales again. Record the weights. Remove the aircraft from the scales. Verify and record that the scales return to zero.

Load with Top of Jack Load Cells:

Attach the load cells to the top of jacks. Position the jacks under the jacking points. Raise the aircraft and level it per the manufacturer's recommendations. Read and record all weights. Lower the aircraft. Verify that all load cells return to zero. Where possible, exchange load cells between positions. Jack and level the aircraft again. Record the weights. Lower the aircraft. Verify that the load cells return to zero.

Compare the weights obtained from the first and second weighings. The weights should agree within a specified tolerance. This tolerance varies with the application but a common figure is 0.25%. Repeat the weighing with scale rotation if there is not agreement. Check to see if a particular scale is weighing too much or too little. (A high or low reading moves with the cell). When you have agreement, average the two closest readings.

NOTE:

While it is not strictly necessary to do two or more weighings with scale rotations between positions during a weigh job, the benefit of catching potential human or machine error outweighs the cost in time. Intercomp recommends this as the best practice, regardless of the brand or type of scale used.

After Weighing

This is where you would normally calculate any scale factor corrections such as latitude or altitude corrections. Intercomp equipment calculates this automatically.

Calculate MAC if your CG is specified this way.

Compare your readings with your calculated values. They should agree closely. Some possible reasons for discrepancy: weighing error (residual fuel, residual water, equipment, etc.); operator error in recording values; calculation errors; charting errors; scales past due calibration.

AC100 Aircraft Weighing System

Operations Manual

Covering software versions 3.08 to 3.12

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Manual #: 700042-U

System Description

The AC100 Aircraft Weighing System consists of a main control box, power supply, internal printer, and 1 to 42 JW digital load cells or AC platforms, with interconnect cables and junction box, as required. The AC100 control box (CPU) serves to control each JW digital cell or AC platform as well as display the weight applied to it. The CPU also controls output in the form of both an internal printer and an external RS-232 output. In addition it handles the storage of arm lengths and the calculation of moments and center of gravity. The JW digital cells or AC platforms consist of a load transducer and circuitry used to convert the load to a digital weight signal for the CPU.

Note: The JW digital load cells and AC platforms will hereby be referred to as 'cells'.

Features:

Display of up to 42 independent Intercomp aircraft indicators.
These may include:

- JW digital cell.
- JWD Jack Weigh Digital scale with remote indicator.
- AC1-25LP Low profile platform scale.
- AC30-60 High capacity platform scale.

Memory for 10 complete sets of cell arm lengths.
Automatic calculation and display of moments and center of gravity.
Up to 8 subtotal groups (comprising any of the cells in system)
Automatic calculation and display of subtotal groups total gross, net, tare, moment, and center of gravity.
Automatic handling of spare cell.
Altitude and latitude correction.
Provisions for mixing of cell capacities and graduations.
Internal printer.
External RS232 output up to 9600 baud.
Default complete printer ticket.
Custom printer and external output.
Time and date.

AC 100 Specifications

Controls

Keys	35 control keys: ON, OFF, ZERO, KGS/LBS, PRINT, CLEAR, ENTER, ADJUST SCREEN, LIGHT, SET TIME/DATE, TARE, NET, GROSS, SET TARE, SET LAT/ALT, SET GROUP, SET ARM, SHOW MOMT, SHOW CG, ACFT ID, four arrow keys, and a numeric keypad.
Display	4 X 20 Alphanumeric display, 0.5 inch characters, back light.

Electrical

Power source / Charger	universal transformer: 18 VDC, 21W, 110 - 240 VAC input International adapter plugs: USA, UK, Europe, Australia
Back-up Battery	1 '2/3A' size lithium cell; 5 year life.
Batteries	10 'D' cell ni-cads or Alkaline cells*
Charge voltage	18 VDC.
Charge current	up to 230 mA.
Charge time	16 hours.
Battery life	8 to 20 hours: dependent on the number of cells, printer, and back light use.
Auto shut off	Under low battery condition.
Back-up Battery	1 '2/3A' size lithium cell; 5 year life.

Performance

Cell update	Approximately 8 cells per second.
Screen update	8 per second.

Environmental

Humidity	10 to 95% non-condensing.
Temperature	***Operating:*** 14 F to 122 F / -10 C to 50 C. ***Storage:*** -40 F to 170 F / -40 C to 75 C.

****WARNING!***
Do not use provided charger when using alkaline cells!
Serious damage may occur to both AC-100 and cells!

JW 25K Load Cell Specifications

Controls

RS485 multi-drop communications bus.

Accuracy

± 0.1% of applied load or ± 2.5 lb, whichever is greater.

Electrical

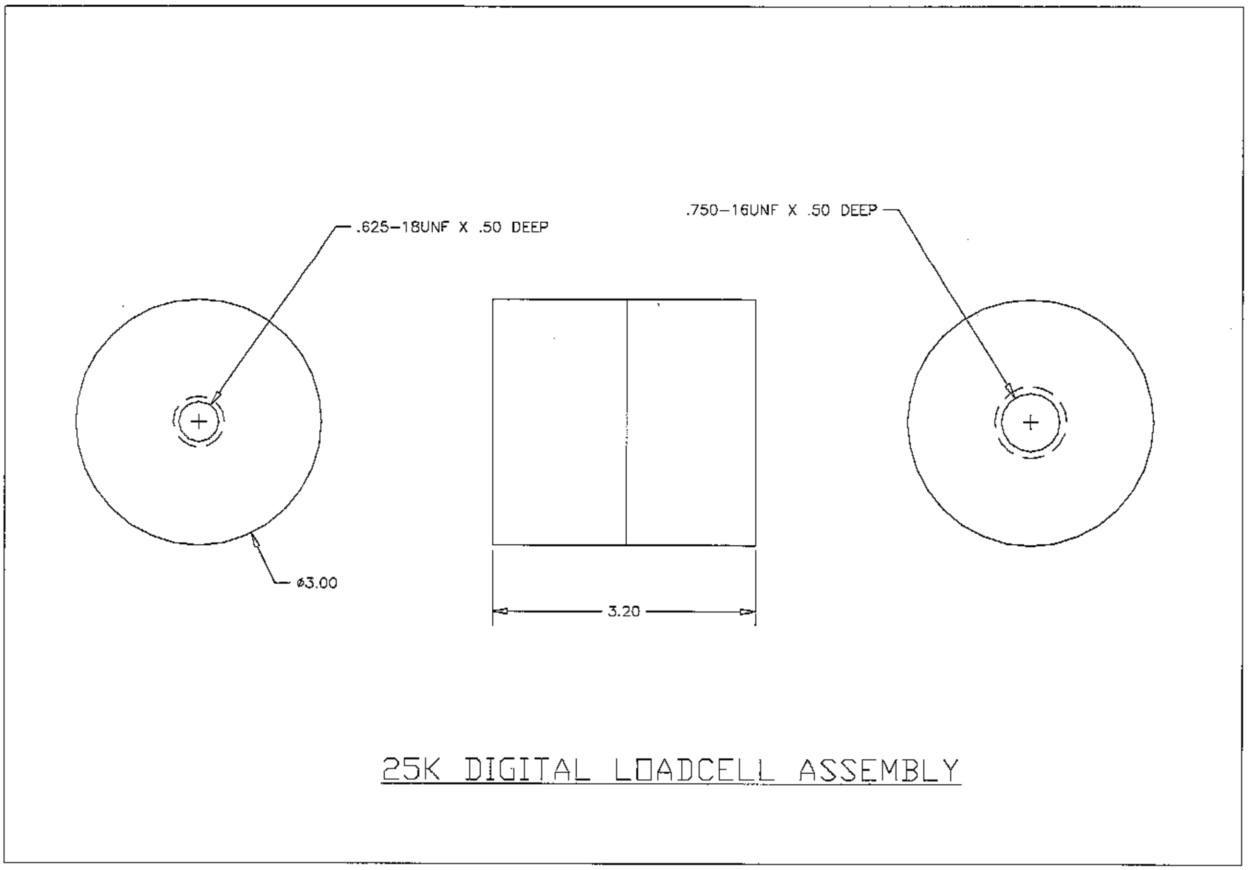
Input: 7 to 20 VDC @ 60 mA typical.
Output: RS485 signal.

Environmental

Humidity: 10 to 95% non-condensing.
Temperature: ***Operating:*** 14 F to 122 F / 10 C to 50 C..
Storage: 40 F to 170 F / -40 C to 75 C.

Physical

Capacity: 25,000 Pounds / 12,500 kg
Dimensional Data:



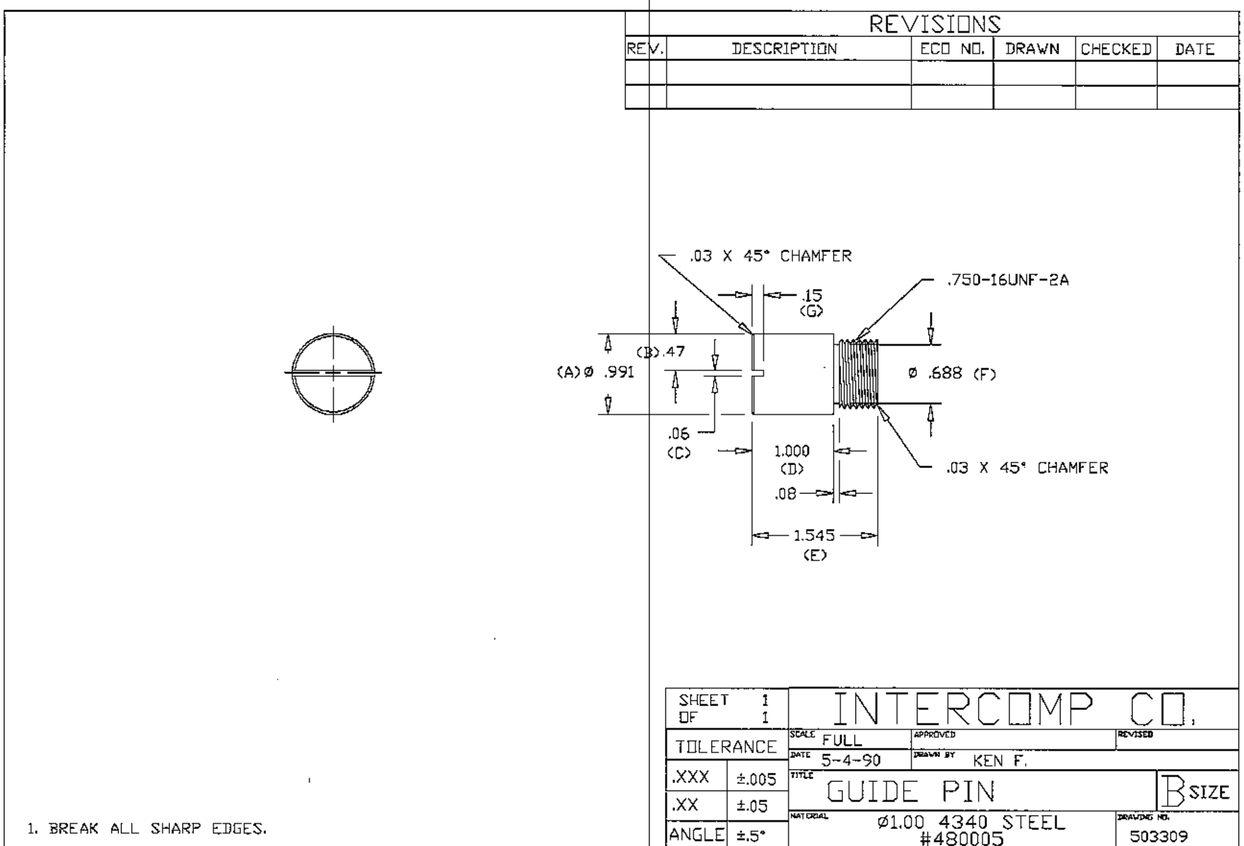
Stud Adapter, 1.0" Specifications

Environmental

Humidity: 10 to 95% non-condensing.
Temperature: ***Operating:*** 14 F to 122 F / 10 C to 50 C..
Storage: 40 F to 170 F / -40 C to 75 C.

Physical

Dimensional Data:



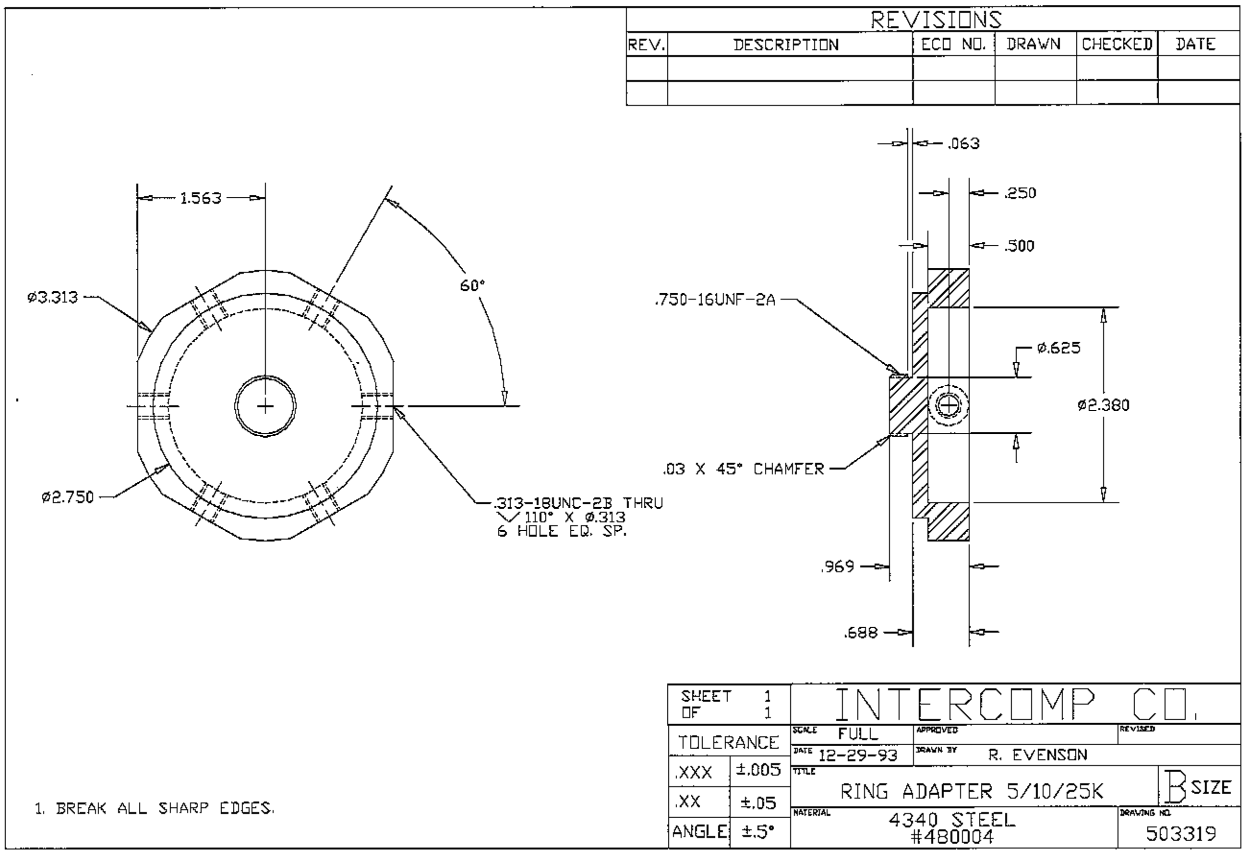
Ring Adapter Specifications

Environmental

Humidity: 10 to 95% non-condensing.
Temperature: ***Operating:*** 14 F to 122 F / 10 C to 50 C..
Storage: 40 F to 170 F / -40 C to 75 C.

Physical

Dimensional Data:



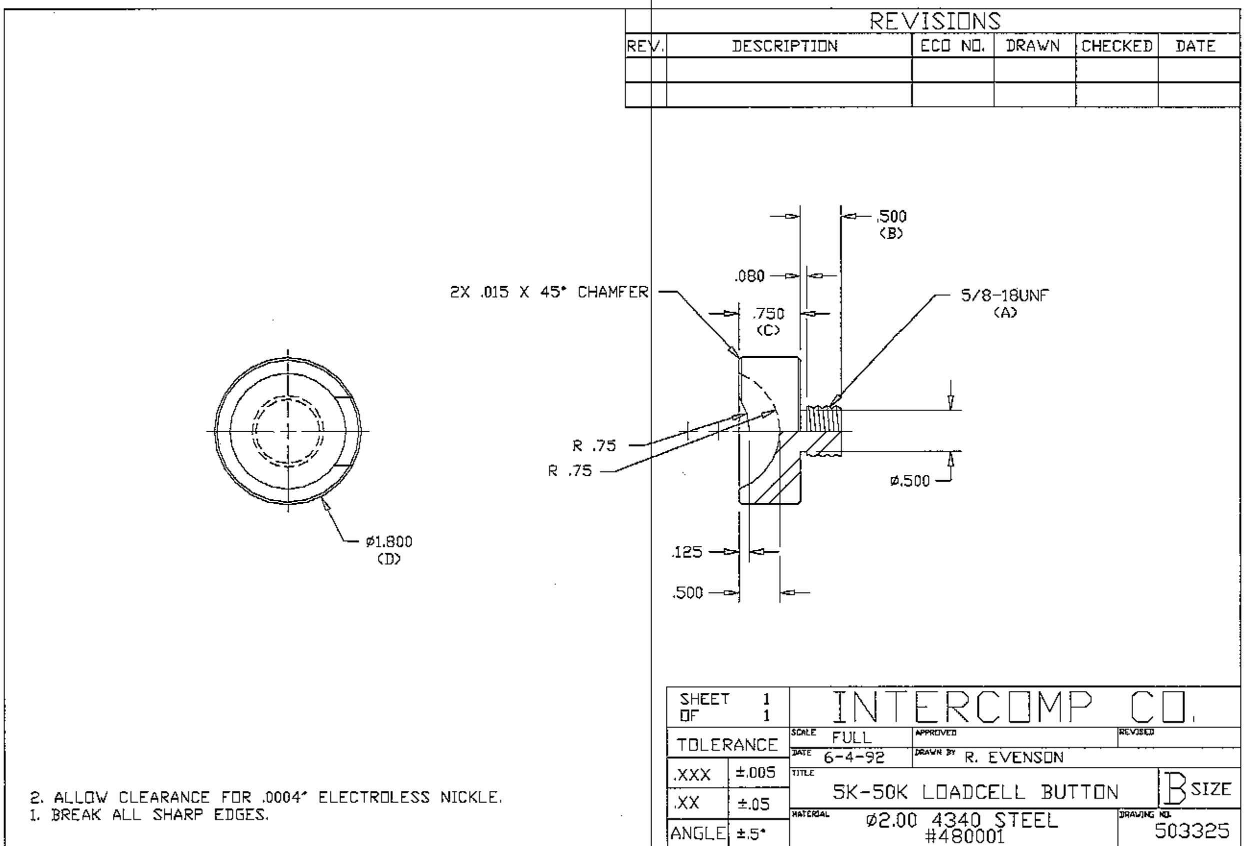
Top Load Adapter Specifications

Environmental

Humidity: 10 to 95% non-condensing.
Temperature: ***Operating:*** 14 F to 122 F / 10 C to 50 C..
Storage: 40 F to 170 F / -40 C to 75 C.

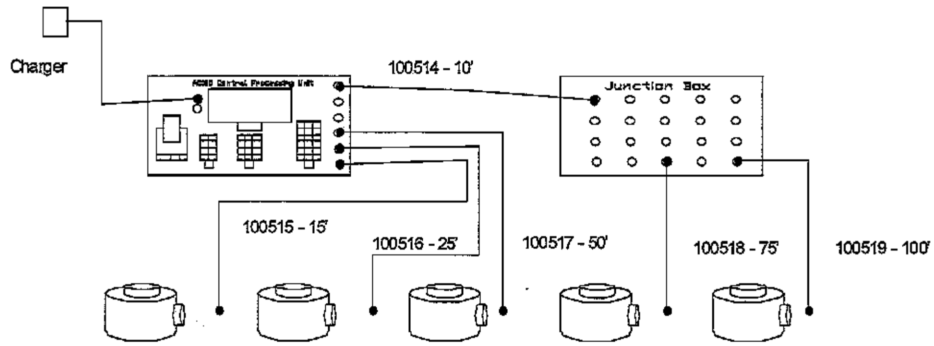
Physical

Dimensional Data:



Detailed Operation

Setup: AC100 to Load Cells



System Connection Diagram
Warning: The load cells contain digital circuits, therefore they should only be plugged and unplugged from the AC100 CPU box while the unit is turned off.

1: Make sure power is off on AC100 CPU box.
2: Position all cells in their appropriate weighing stations. Please note that at this time there should be no load that you wish to measure placed on the cells.

> **Note:** For systems with more than 6 cells, connect the AC100 CPU box to the connector junction box using the 10 foot interconnect cable. Any one of the six connectors on the AC100 (CH1-CH6), and any one of the connectors on the connector junction box may be used.

3: Use the interconnect cables provided to connect one end of each cable to each of the cell connectors.

4: Connect the other end of each of the interconnect cables to one of the six connectors on the AC100 CPU (CH1-CH6) box, or one of the connectors on the junction box if one is being used.

Note: Each cell can be connected to any connector on the AC100 CPU box or connector junction box. The weight from each cell will appear in its appropriate location on the screen no matter which connector it is plugged into.

5: To conserve on battery life, you can plug the charger into the power input jack on the AC100 CPU.

If you use the charger, plug the power transformer (cube end) into a 120 VAC 60 Hz power source; or 220 VAC 50 Hz power source depending on the charger provided.

6: Turn the unit on by pressing the [ON] button on the AC100 CPU box.

The AC100 CPU unit will display a sign on message that informs you how many channels the AC100 CPU is capable of reading. This is followed by a screen showing the status of various items stored in memory. The display screen will then switch to the operational mode displaying the first four cells (or all cells and total; on systems of less than 4 cells), numbered one to four. The display will start with "off" for each cell. Once a weight reading has been transmitted from the cell to the AC100 CPU, the display screen will then shift from displaying "off" to displaying the corresponding cell weight.

7: Preload each cell and zero if necessary.

8: You should check and set the Latitude and Altitude each time you use the system. See the "Setting the latitude and altitude" section later in this manual. The system can be configured to retain the values permanently; see the "recall alt/lat" item in the option list section to find out how.

Weighing

Set up and turn on the system as described in the previous "Setup" section of this manual. Wait 3 minutes for the cells to warm up.

Press the [ZERO] key in the upper left corner of the control panel. Press [ZERO] a second time to zero all cells. Once the cells have been zeroed, a load can now be applied to the cells. As the load is applied, the display screen will display the corresponding weight of each numbered load cell.

Systems may be configured such that each cell retains its zero condition even when power is removed; see the recall "power on zero" item in the option list section to find out how.

Note: In the event that zero shift occurs during weighing, the displayed zero shift should be subtracted from the observed weight. As an example, zero shift = 100 lb; weight = 10000 implies the actual weight is 9900; or zero shift = -100 lb would imply the actual weight is 10100.

Display Control

The display is set up to show four out of a possible 51 line of information. Up to 42 of the lines of information are the individual cells, then the total line followed by up to 8 groups. Initially the display shows the weight present on cells 1, 2, 3, and 4. If your system has less than 4 cells the total and some of the groups (if any) may be on the screen. You can use the blue arrow keys (in the upper right hand corner of the keyboard) to control what is displayed. The keys operate as follows:

Down arrow:	Moves forward one item in the list.
Up arrow:	Moves backward one item in the list.
Right arrow:	Moves forward four items in the list.
Left arrow:	Moves backward four items in the list.

As an example, if the display were showing cells 1, 2, 3, and 4; by pressing the [DOWN ARROW] you would move one item forward; and the display would show cells 2, 3, 4, and 5. If you had instead pressed the [RIGHT ARROW], the display would have advanced four cells, and would now show cells 5, 6, 7, and 8.

What is Displayed

There are five possible items that can be displayed on the screen: gross weight, tare weight, net weight, arm length, and moment. The type of the current information being displayed is labeled vertically along the right side of the display

Gross weight:

(Press [GROSS] key to view) This is the weight present on each cell.

Tare weight:

Press [TARE] key to view) The tare weight is set equal to the gross weight when the SET TARE key is pressed. To clear the tare weights to zero press [CLEAR] and [SET TARE] keys together and release.

Net weight:

(Press [NET] key to view) The net weight equals the gross minus the tare.

Arm length:

(Press [SHOW CG] key to view) This is a value that you enter. It is the distance from your reference (datum) point to the cell. The number entered represents 1 or 1/10 inches if in the pound unit, or 1 or 1/10 centimeters if in the kilogram unit. Note that there is no total arm length, instead the total line of information is the center of gravity (cg = total moment / total net weight) as calculated by the unit.

Moment:

(Press [SHOW MOMT] key to view) This is the entered arm length times net weight.

Setting arm lengths and registers

To enter the arm length for a cell, use the arrow keys to position the cell on the top line of the display. At this point press [SET ARM], and enter the arm length for that cell. The entry will be in tenths if that option is selected (see ahead in the options section). Repeat this procedure for all cells.

The system has 10 registers, which hold 10 complete sets of arm lengths. When the system is turned on it defaults to register number 0. Any arm lengths that you enter are saved into whichever register is currently selected. When you select a new register the arm values for that register are loaded. You can select a new register by pressing [ACFT ID]. The 10 registers are numbered 0 to 9. After the register is selected you can enter aircraft identification (AC ID) followed by an aircraft type (AC type). These two ID's will then be included on printouts. To enter the ID's use the left and right arrow keys to move from one letter to the next and the up and down arrow keys to change the letter. You may type in numbers directly from the numeric keypad. When complete pressing the [ENTER] key continues. Pressing the [CLEAR] key will reset the entry to blanks. Each ID is limited to 16 characters.

Zeroing of load cells

When the [ZERO] key is pressed the AC100 will ask you to press [ZERO] a second time to zero all channels, press [ENTER] to zero a single channel, or press any other key to cancel. If [ENTER] is pressed the scale will then ask you to enter the number of the cell you want to zero. Enter the required cell number and press [ENTER].

Back Light

Press the [LIGHT] key to toggle the backlight on and off.

Screen Contrast

Press [ADJUST SCREEN] to adjust the display screen contrast. Use the up arrow to darken the display, and the down arrow to lighten it. When you have finished press [ENTER] to return to normal weighing.

Setting altitude and latitude

The affects of gravity on an object vary depending on where the object is located on the earth. This variation can be as much as 0.35% of applied load. The AC100 CPU has provisions for correcting this error with entry of your current altitude and latitude. The weights displayed will then represent what the object would weigh at sea level, 45 degrees latitude.

The current altitude and latitude can be entered by pressing the [SET LAT/ALT] key. If the latitude and/or altitude are changed to compensate for your location, the unit will adjust the weight readings to reference them to 0 feet altitude and 45 degrees latitude. The unit will round your entries to match the scaling factors found on the table in Appendix A.

The AC100 will default to the previously saved altitude and latitude settings whenever the unit is turned on. As an option you can set the AC100 to default to 0 feet/45 degrees whenever the unit is turned on (see the "Options List" section).

Time/Date

When [SET TIME/DATE] is pressed, the current time and date will be displayed. At this point you can press [SET TIME/DATE] again to change the time and date, or press any key to return to normal operations.

If [SET TIME/DATE] is pressed a second time, you begin by entering the date; month first, day, and then year. The months are numbered from 1 to 12 where 1 is January, 2 is February, and so on. The date is a number form 1 to 31 representing which day of the month it is. The year is from 92 to 99 representing the 20th century of 0 to 91 representing the 21st century. Next the time is entered, enter a future time because you will be allowed the chance to wait to start the time going. The hour is entered as a number from 1 to 12. Next the minutes are entered as a number from 0 to 59. Then the second are entered as a number from 0 to 59. Finally you are asked to enter whether it is AM or PM. The AC100 will then wait for you to press [ENTER] to start the clock running.

Turning the system off

[OFF] Turns the system off. If platform scales are being used and the remote turn off option is turned on, the platform scales will also turn off.

Printer

The AC100 comes standard with a 24-character roll printer installed. The rocker switch on the printer unit turns power on to the printer. Left side down is off and right side down is on. If while turning the printer on you hold the rocker switch down all the way to the right the printer will print a test pattern. To stop the test patterns turn the printer off. The printer will only turn on while the control unit itself is on.

After the printer is turned on, pressing the rocker switch to the right will advance the paper. The paper is loaded by placing one end in the metal groove at the back and advancing the printer. The ribbon can be replaced by pressing down on the two pressure points on the top lid to remove it. Then press down on the right side of the ribbon to pop it out.

The printout details and other print features can be changed. See the "Default Comm Formats", and "Customize your printout/RS-232 output" sections in this manual.

RS-232 Output

An RS-232 output is available on the external connector labeled CH6-I/O. Pin E is the signal wire and pin F is ground.

The connection to an Intercomp S400 display is:

CH6-I/O	S400
E	2
F	7

The connection to an Intercomp SA2000 display is:

CH6-I/O	SA2000
E	3
F	7

The connection to a 9-pin PC communication port is:

CH6-I/O	PC 9-pin
E	2
F	5

Note: For some setups it may be necessary to jump pins [6, 1, and 4] together, and pins [7 and 8] together on the PC port connector.

The connection to a 25-pin PC communication port is:

CH6-I/O (AC100)	PC 25-pin
E	3
F	7

Note: For some setups it may be necessary to jump pins [6, 8, and 20] together, and pins [4 and 5] together on the PC port connector.

Spare Cell

The AC100 system can be configured to have one automatic spare cell. To achieve this one cell is numbered one higher than the number of cells in the system. As an example, in a three-cell system the spare cell would be numbered four. If the spare is plugged into the system, it will be substituted in for the first cell that is missing. The cell will remain at that number until it is changed using the renumber command.

Configuring the system

Command List

To view a list of available commands, first press [-] and [ENTER] together to unlock keypad features. Then press the [0] key located on the numeric keypad. This will access a list of all available special commands. To move through this list press [ENTER] until you return to normal weighing.

NOTE: To access any of the keypad single digit commands (0-9), you must first unlock keypad features by pressing the [-] and [ENTER] keys together.

Comm setup (communications)

The following will allow you to modify the printer format and the RS-232 output format.
To enable this setup feature switch three must be turned on, located on s1 of the main circuit board. After you have finished return switch three to off to guard against change. This safeguard to becomes effective the next time the system power is turned on.

Basic

The basic setup includes **baud rate**, **data bits**, **parity**, and **stop bits**. To enter the basic settings press the [-] and [1] keys together. The above information will be entered for the "Printer:" and then for the "RS-232 output:". For the printer, the settings should be 1200 baud (enter 3), 8 data bits (enter 0), no parity (enter 0), and 1 stop bit (enter 0). These values should be preset and should not need to be changed (just press [ENTER] four times). "RS-232 output" appears on the display. Enter numbers to the following four prompts that will set the RS-232 communication format:

Baud rate: The baud rate is entered from 0 to 7 (see table below).
Data bits: For 8 data bits enter 0, for 7 enter 1.
Parity: For no parity enter 0, for odd parity enter 1, and for even enter 2.
Stop bits: For 1 stop bit enter 0 and for 2 stop bits enter 1.

Number	Baud Rate
0	9600
1	4800
2	2400
3	1200
4	600
5	300
6	150
7	75

Advanced

The advanced setup includes for the "Printer": handshake, continuous delay, and print button; For the "RS-232 output": continuous delay and print button. To enter the advanced settings press the [-] and [2] keys together. As with the Basic setup, you should not have to change the printer settings. Press the [ENTER] key three times until the display shows "RS-232 output:"

Cont delay: When the print button is off (continuous transmitting mode), this value determines how much time passes between each transmit. Each count here is approximately 1/15 of a second. For example, to send the message every 4 seconds enter 60. (60 = 4 seconds * 15)

Print button: If you enter (1), the AC100 will send the information only when [PRINT] is pressed. If you enter (0), the AC100 will send the information continuously out the RS-232 port. When set to continuous (0), how often the message is sent is determined by **Cont delay** (above).

Default Comm Formats - Printer and RS-232 output

To set the printer or RS-232 output to one of (3) formats, press the [-] and [5] keys together. You will be prompted whether you wish to default the printer or the RS-232 output. Enter your choice. You will be asked which type to default to: 0=Standard, 1=Large, or 2=Computer. Enter your choice (examples are on the following pages). The printer (or RS-232 output) will now be defaulted to that type. NOTE: The number of cells contained in this printout depends on how many cells you have your system set up for (see the "Number of Cells" section).

The printer and RS-232 output can be set to a choice of 3 standard defaults:

Standard print: This shows the Gross, Tare, Net, Moment, and the Arm length for each cell and for the total. NOTE: This print format gets too large and will not fit in memory for systems with 10 cells or more. Use the 'Large print' format instead.

Large print: This shows each cell's Net weight, and the totals for Gross, Tare, Net, Moment, and center of balance.

Computer print: This just shows each cell's Gross weight in a compact format suggested for an RS-232 output to a computer. NOTE: This format will only work for the RS-232 output - don't set the printer default to this.

Standard print

```
 2:02:00pm
JUN  1, 1999

REG#  0
AC ID
AC TYPE

          0lb      G CH  1
          0lb      G CH  2
          0lb      G CH  3
          0lb      G TOT

          0lb      T CH  1
          0lb      T CH  2
          0lb      T CH  3
          0lb      T TOT

          0lb      N CH  1
          0lb      N CH  2
          0lb      N CH  3
          0lb      N TOT

        0.0in*lb M CH  1
        0.0in*lb M CH  2
        0.0in*lb M CH  3
        0.0in*lb M TOT

        0.0in    A CH  1
        0.0in    A CH  2
        0.0in    A CH  3
        0.0in    A CG
```

Large print

```
 2:02:00pm
JUN  1, 1999

          0lb      N CH  1
          0lb      N CH  2
          0lb      N CH  3
          0lb      N CH  4
          0lb      N CH  5
          0lb      N CH  6
          0lb      N CH  7
          0lb      N CH  8

          0lb      N TOT
          0lb      G TOT
          0lb      T TOT
        0.0in*lb M TOT
        0.0in    A CG
```

Computer print

```
 2:02:00pm
JUN  1, 1999

     0lb    G CH  1        0lb    G CH  2        0lb    G CH  3
     0lb    G CH  4        0lb    G CH  5        0lb    G CH  6
     0lb    G CH  7        0lb    G CH  8
```

Customize your printout/RS-232 output

This feature will allow you to tailor the printouts to your needs. This can be helpful to cut down on wasted lines of information that you never use, or to add some specific weights of interest. You are allowed to enter up to 100 different lines to be printed. Each item that is printed is in a fixed 24 character field. You have the option of having up to 63 spaces printed before the item and a carriage return and/or a linefeed after.

To use this feature, press the [-] and [3] keys together. For this to work, switch three must be turned on, located on S1 of the main circuit board inside the AC100 (MPC board). After you have finished return switch three to off to guard against change. This safeguard to becomes effective the next time the system power is turned on.

Begin by using the up and down arrow keys to move between lines, and the left and right arrow keys to move between items within a line. When you are moving around in the list an 'M' (movement) will appear in the upper right corner of the screen. The items from left to right are: the number of spaces to print first (xx), the information to print (a list of possible entries is shown on the next page), whether to print a carriage return (C), and whether to print a linefeed (L).

To modify one of these items position the cursor on the item by using the arrow keys, and press the [-] key. Once you press the [-] key an 'E' (edit) will appear in the upper right corner of the screen; signifying that you are in the edit mode. Then use the up and down arrow keys to change the item. To save time, you can skip ahead or backward 10 items by pressing the left and right arrow keys. When finished changing an item from a line, press the [-] key to exit edit mode. ('M' appears; which shows you are back in movement mode.)

The carriage return (C) and linefeed (L) items are toggled when you press the [-] key.
A line can be inserted into the list by pressing the blue key above the left arrow key.
A line can be deleted from the list by blue key above the right arrow key.
The information on a line can be cleared by pressing the [CLEAR] key.

When you are finished editing your print list, press [ENTER] once to enter RS-232 editing and press [ENTER] again to exit.

<u>**NOTE**: Be careful that you do not accidentally erase your custom list. Changing the number of cells [2] or setting the print defaults [-5] will reset the print format and your custom list will be erased.</u>

On the following page is an ordered list of all the different types of information that can be printed on a particular line:

<u>When in edit 'E' mode use the up/down arrow keys to move through this list one item at a time, or the left/right arrow keys to skip ahead or backwards 10 items.</u>

Print Formatting Commands:

nothing: A blank line.
TIME: The current time.
DATE: The current date.
REG#: The register number [0-9] currently selected.
AC ID: For the register currently selected.
AC TYPE: For the register currently selected.
CLS: ANSI escape sequence to clear the screen.
HOME: ANSI escape sequence to place the cursor at the upper left of the screen.
FF: ANSI form feed.
TOTAL GROS: The total gross weight.
TOTAL MOMT: The total moment.
CG: The center of gravity.
TOTAL TARE: The total tare.
TOTAL NET: The total net weight.
RESERVED: Not used at this time, just skip through these entries.
G*x* GRP GROS: Gross weight for groups 1 to 8.
G*x* GRP MOMT: Moments for groups 1 to 8.
G*x* GRP ARM: Center of gravity for groups 1 to 8.
G*x* GRP TARE: Tare weight for groups 1 to 8.
G*x* GRP NET: Net weight for groups 1 to 8.
CH *xx* GROS: Individual cell gross weights, cell 1 to 42.
CH *xx* MOMT: Individual cell moments, cell 1 to 42.
CH *xx* ARM: Individual cell arm lengths, cell 1 to 42.
CH *xx* TARE: Individual cell tare weights, cell 1 to 42.
CH *xx* NET: Individual cell net weights, cell 1 to 42.

NOTE: Only active cells and groups will be displayed.

NOTE: If you are not sure, every line should have a carriage return and a line feed ("C" and "L" visible at the end of a line).

Labeling Cells

To enable this setup feature switch two must be turned on, located on s1 of the main circuit board. After you have finished return switch 2 to off to guard against change. This safeguard becomes effective the next time the system power is turned on.

This menu allows you to setup what is printed in place of "CH *x*" on the display. To change the label for a given cell; position that cell at the top of the screen using the arrow keys and then press the [-] and [4] keys together. Use the up and down arrow keys to adjust the individual characters and left and right arrow keys to move between characters. To speed things up, you can press either of the two unmarked keys above and below the left arrow key, which change the letter by five characters rather than by one. You can also use the keypad to enter digits. When finished, press the [ENTER] key. If you wish to remove the labels press [CLEAR] then [ENTER], and the system will again use "CH *x*".

Groups

To enable this setup feature switch 4 must be turned on, located on s1 of the main circuit board. After you have finished return switch 4 to off to guard against change. If switch four is off you can still view which cells are included in a group, you just can't change them.

There are eight groups available, numbered from one to eight. Each group allows you to group any number of the cells in a system together for display. The cells grouped together are displayed and printed as subtotals.

To set which cells are placed in a group, do the following steps:

1. Press the key labeled [SET GROUP], located in the lower right corner of the keypad.
2. Enter in which group you wish to modify and press [ENTER].
3. The CPU will then display which cells are currently included in the group. Press [ENTER] twice to view this list and continue.
4. Enter in which cell you wish to add to (or remove from) this group. Press [ENTER].
5. Repeat steps 3 and 4 to add or remove any cells in the group.
6. When you wish to make no further changes to a group, enter a cell number of '0'.

If any cell is included in a group, that group will be included after the total line on the display list, labeled "Gx:"; where x=1 to 8.

Version Number

First press [-] and [ENTER] together to unlock keypad features. Then pressing the [1] key located on the numeric keypad will cause the CPU to display the version number of the software present in the box.

Options List

There are currently twelve options that can be set. These will be followed by four reserved options that should be set to (0). To change the options press the [-] and numeric [0] keys together.

To enable the following setup features switch five must be turned on, located on s1 of the main circuit board. After you have finished return switch five to off to guard against change. This safeguard to becomes effective the next time the system power is turned on.

Confirm zero

If yes, you will be asked to enter the number 123 to confirm that you really do want to zero the cells. Default No.

Total always

If yes, the total line will display the total for all cells; even if an error exists on one (including 'off'). Default Yes.

Power on zero

If yes, the AC100 CPU will zero all cells on power up. Default Yes.

Power on alt/lat

If yes, the AC100 CPU will prompt you to enter the current altitude and latitude when it is turned on. Default No.

Lb/Kg switch

If yes, the kgs/lbs key is enabled; allowing the toggling of units. Default Yes.

Kg on wake up

If yes, the AC100 and cells will turn on in kilograms. Default No.

Sw pak disabled

If yes, all safe guards are removed and all functions are available regardless of how the switches on switch pack S1 are set. Default No. **Warning: It is important to leave this option off (enter '0') to prevent accidental loss of calibration. This safeguard to becomes effective the next time the system power is turned on.**

Turn off remotes

If yes, the AC100 when it is turned off will turn off all platform scales that are connected to it. Default No.

By 1 Arm Graduation

If yes, the AC100 will operate with the arm length graduation set to by 1 inch or centimeter; If No, the graduation will be by 0.1 inch or centimeter. By 1 inch or centimeter is required when large numbers of cells at high capacity are used. This results in an overflow error on the total moment, which is limited to just over +/- 2 billion ignoring any decimal point. Default value is No.

Recall old alt/lat

If yes, the AC100 will recall the altitude and latitude settings from the last time the system was used; if no, the altitude will default to 0 and the latitude to 45 degrees whenever the system is turned on. Default value is Yes.

Max contrast on PU

If yes, the AC100 will set the display contrast to maximum when the power is turned on. If no, the unit will return to the display contrast used previously. Default value is No.

High range C.G. calc

If yes, the AC100 does some rounding to fit larger moments in memory. This is suggested when the cell divisions are by 10 or greater. Default value is No.

Number of Cells

First press the [-] and [ENTER] keys together. By then pressing the [2] key on the numeric key pad you can enter the number of cells in the system. The cells will be numbered '1' to the number entered.

Renumbering a Cell

First press the [-] and [ENTER] keys together. Then press the [3] key. The CPU will ask you to enter the old cell number, then the new cell number. After entering these numbers, the CPU will now list the cell's weight under the new number.

Warning: All of the following parameters configure the way the attached cell(s) handles its weighing operation, therefore, they should only be accessed if it is your intent to change the calibration of the cells. All cells currently plugged in will have their operation changed to the new value.

To enable the following setup features switch five must be turned on, located on s1 of the main circuit board. After you have finished return switch five to off to guard against change. This safeguard becomes effective the next time the system power is turned on.

Setting Graduation

First press the [-] and [ENTER] keys together. To change the graduation size of a cell, press the [5] key. The CPU will then ask you to enter a graduation size, (0-11). The corresponding graduations will be assigned according to the following table. All cells will have their graduation changed to the new value.

Number	lb	kg
0	100	50
1	50	20
2	20	10
3	10	5
4	5	2
5	2	1
6	1	0.5
7	0.5	0.2
8	0.2	0.1
9	0.1	0.05
10	0.05	0.02
11	0.02	0.01

Graduation Break Points

To change the graduation break points first press the [-] and [ENTER] keys together and then press the [6] key. You can set three weight values (in lb) at which the graduation size increases one level. As an example: Say a cell has a capacity 100K pounds with a graduation of 6 (by 1 lb). If the graduation break points were set at 10000, 20000, and 50000 lb; the cell would display the following ranges: 0 to 10000 by 1 lb, 10000 to 20000 by 2 lb, 20000 to 50000 by 5 lb, and 50000 to 100000 by 10 lb. All cells will have their graduation break points changed to the new value. Default 110% of capacity.

Azt (Auto zero tracking) Size

To change the Azt size first press the [-] and [ENTER] keys together. Then press the [7] key. There are four options for the Azt size. Default 3.

Number	Grad Size
0	None(Off)
1	0.6
2	1
3	3

All cells will have their Azt sizes changed to the new value. The Grad size is the maximum amount of weight the Azt can zero off. If a weight under the Azt size is present on the scale for a short period of time it will be zeroed off.

Number of Samples

To change the number of samples first press the [-] and [ENTER] keys together. Then press the [8] key. You can set the number of samples from 1 to 31; which represents how many internal readings the cell averages. This can be useful in getting stable weight readings off an unstable load. All cells will have their number of samples changed to the new value. Default 4.

Update time

To change the update time first press the [-] and [ENTER] keys together, then press the [9] key. You can set the update time from 1 to 255; which represents how many internal time intervals in the cell must pass before is updates what is sent to the AC100 CPU. All cells will have their update time changed to the new value. Default 1.

Raw Counts

The cell can be toggled back and forth from displaying raw counts versus weight. The raw counts are the number coming from the A/D chip. This is for diagnostic purposes only. Press the [-] and [7] keys together to toggle.

Zero Range

The zero range is the maximum percentage of full capacity that can be zeroed off using the [ZERO] key. Additionally, the unit can display an error message if a zero operation is attempted with a sensed load on the cells. These selections are used to allow the detection of concealed load cell failures.

To change the zero range press the [MINUS] key and [8] on the numeric pad. Enter the zero range from the table below. For choices 1, 2, and 3 the scale displays OL if the zero button is pressed with the specified percentage load (or larger) on the platform. For choices 4, 5, and 6 the zero range is the percentage of capacity where the zero button is allowed to work. This setting is used to prevent accidental zeroing of the scale while a load is applied. Choice 0 defeats the detection of zero range when the zero button is pressed.

Default is 0, [ZERO] can function with 100% of capacity applied.

Number	Amount
0	100% (Off)
1	1% with OL error
2	2% with OL error
3	5% with OL error
4	1%
5	2%
6	5%

All cells currently plugged in will have their zero range changed to the new value.

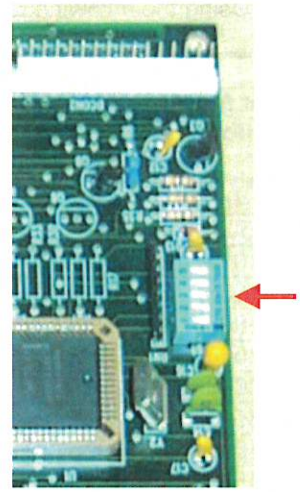
Calibration adjustment procedure

Warning: The following will destroy the current calibration of a cell and replace it with a new calibration. Do not continue unless you are sure you want to do this. If you are unsure, turn the AC100 off to exit calibration mode or call Intercomp Service at (763) 476-2531.

The cells have a three-point calibration feature that reduces the effects on non-linearity in the cells. This requires that you place three weights on the cell during calibration. The first weight must be greater than zero, the second greater than the first, and the final weight somewhere between the second and the capacity.

Enabling calibration

There is a switch pack located on the circuit board inside the AC100. The switch is labeled as “S1”. To enable calibration move switch location 5 to “ON”. To protect the AC100 from being calibrated, move switch location 5 to the “OFF” position. Note: The AC100 must be powered up after the switch position is changed before the change will take effect.



Notice: Systems shipped from the factory are already calibrated.

Notice: If a cell is calibrated using dead weights the correct altitude and latitude must be set. If it is calibrated using a force calibration press the altitude should be set to 0 feet and the latitude set to 45 degrees.

Notice: For aircraft platform scales the calibration load must be applied to the platform through a metal block, separated from the platform by a 0.5" thick piece of firm rubber; this setup best simulates the load applied by a tire and prevents damage to the platform.

Notice: The electronics contained within the AC100 are mathematically capable of performing 50,000 divisions for graduations under by 0.5; and 500,000 divisions for graduations above by 0.5. This limitation applies to the capacity and graduation break points. Where the number of divisions is equal to the capacity (or graduation break point) divided by the graduation. As an example, the scale could not be set for 10,000 lb by 0.1 lb. If the limit is exceeded an error message could occur.

Calibration Verification

Tools required:

- Calibration force generator; press or deadweights. This calibration source must cover the range of 10% to 100% of nominal capacity with an accuracy of 0.025% of reading or better.

1. Bring the AC100 to the calibration site. If there is more than 5°F difference in temperature between the load cells or platform scales temperature and the calibration site allow the cells to reach room temperature.
2. Place cell on calibration fixture. Turn system on. Wait 3 minutes for warm-up.
3. Using the following table, apply the specified test forces.

5K Capacity			10K Capacity			25K Capacity		
Test force (lb)	Lower limit (lb)	Upper Limit (lb)	Test force (lb)	Lower limit (lb)	Upper Limit (lb)	Test force (lb)	Lower limit (lb)	Upper Limit (lb)
0	0	0	0	0	0	0	0	0
500	499	501	1000	998	1002	2500	2495	2505
1000	999	1001	2000	1998	2002	5000	4995	5005
1500	1499	1502	3000	2998	3004	7500	7495	7510
2000	1998	2002	4000	3996	4004	10000	9990	10010
2500	2498	2503	5000	4996	5006	12500	12490	12515
3000	2997	3003	6000	5994	6006	15000	14985	15015
3500	3497	3504	7000	6994	7008	17500	17485	17520
4000	3996	4004	8000	7992	8008	20000	19980	20020
4500	4496	4505	9000	8992	9010	22500	22480	22525
5000	4995	5005	10000	9990	10010	25000	24975	25025
0	-5	5	0	-10	10	0	-25	25
30K Capacity			**50K Capacity**			**100K Capacity**		
0	0	0	0	0	0	0	0	0
3000	2990	3010	5000	4990	5010	10000	9990	10010
6000	5990	6010	10000	9990	10010	20000	19980	20020
9000	8990	9010	15000	14990	15020	30000	29970	30030
12000	11990	12010	20000	19980	20020	40000	39960	40040
15000	14990	15020	25000	24980	25030	50000	49950	50050
18000	17980	18020	30000	29970	30030	60000	59940	60060
21000	20980	21020	35000	34970	35040	70000	69930	70070
24000	23980	24020	40000	39960	40040	80000	79920	80080
27000	26970	27030	45000	44960	45050	90000	89910	90090
30000	29970	30030	50000	49950	50050	100000	99900	100100
0	-30	30	0	-50	50	0	-100	100

4. Verify that each display value is within the limits shown.
5. If using load cells, rotate the cell 120 degrees and 240 degrees from the starting position and repeat the applicable table at each position.
6. If any value is out of acceptable limits proceed to the adjust calibration procedure.

This concludes the verify calibration procedure.

The Actual "Adjust Calibration" procedure begins here:

Tools required:

- Calibration force generator; press or deadweights. This calibration source must cover the range of 10% to 100% of nominal capacity with an accuracy of 0.025% of reading or better.
- If calibrating aircraft platform scales
  Appropriate loading plate (see platform scale's manual for details)
  Appropriate loading pad (see platform scale's manual for details)

Note: Only one cell can be connected to the AC100 at one time during "Adjust Calibration". If multiple cells are connected, all calibration actions will affect all units connected at that time.

Note: Bring the AC100 to the calibration site. If there is more than 5°F difference in temperature between the cells temperature and the calibration site allow the cells to reach room temperature.

1: Turn the unit off.
2: Plug in the one cell to be calibrated, and only that one. Any operations done at this time will affect all cells plugged in.
3: Turn the unit on.
4: After the CPU has reached the weight window, press the [-] and [ENTER] keys together, and then press the [4] key on the numeric keypad.
5: Enter the capacity of the cell.
6: The display will show 'no load, press enter'. At this point, with no load applied to the cell, press [ENTER].
7: Enter the amount of load number one.
8: The display will show 'load 1, press enter'. At this point, with load number one applied to the cell press [ENTER].
9: Enter the amount of load number two.
10: The display will show 'load 2, press enter'. At this point, with load number two applied to the cell press [ENTER].
11: Enter the amount of load number three.
12: The display will show 'load 3, press enter'. At this point, with load number three applied to the cell press [ENTER].
13: The system returns to normal weighing.
14: Repeat this process for all cells as required.
15: Return to Calibration Verification and ensure all cells that have been adusted will pass the procedure.

Appendix A: Altitude and latitude correction table

deg\ft	0.000	1000	2000	3000	4000	5000	6000	7000
0	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	1.0034
5	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033
10	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032
15	1.0023	1.0024	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030
20	1.0021	1.0022	1.0023	1.0024	1.0025	1.0025	1.0026	1.0027
25	1.0017	1.0018	1.0019	1.0020	1.0021	1.0022	1.0023	1.0024
30	1.0014	1.0015	1.0016	1.0017	1.0017	1.0018	1.0019	1.0020
35	1.0009	1.0010	1.0011	1.0012	1.0013	1.0014	1.0015	1.0016
40	1.0005	1.0006	1.0007	1.0008	1.0009	1.0010	1.0011	1.0012
45	1.0000	1.0001	1.0002	1.0003	1.0004	1.0005	1.0006	1.0007
50	0.9996	0.9997	0.9998	0.9999	1.0000	1.0001	1.0002	1.0003
55	0.9991	0.9992	0.9993	0.9994	0.9995	0.9996	0.9997	0.9998
60	0.9987	0.9988	0.9989	0.9990	0.9991	0.9992	0.9993	0.9994
65	0.9983	0.9984	0.9985	0.9986	0.9987	0.9988	0.9989	0.9990
70	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985	0.9986	0.9987
75	0.9978	0.9979	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984
80	0.9976	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0.9982
85	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981
90	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981

Appendix B: Error Messages.

AC100 CPU error messages

EEPROM error: Information saved within the system has been lost or corrupted, the AC100 needs to be configured.

Low Battery: The voltage the batteries are providing is to low, they need charging.

Switch x is off: You have attempted to use a feature that has been safety locked out by a switch pack inside the CPU. To disable the switch pack's safety features do the following:

1. Enter the 'options' menu by pressing the [-] and [0] keys together.
2. Keep pressing [ENTER] until the display shows 'Sw pak disabled',
3. Enter [1] (yes).
4. Keep pressing [ENTER] again until the AC100 returns to normal weighing.

You should now be able to access the feature that you were locked out of before.
IMPORTANT: When you are done, make sure to go back to the 'options' menu and return 'Sw pak disabled' to '0' (no). The calibration for the load cells could accidentally be lost if you do not do this. This safeguard to becomes effective the next time the system power is turned on.

Key disabled or has no function: Just a reminder that the key you just pressed serves no function at the moment.

Keypad features unlocked: Reminder that you have just pressed the [-] and [ENTER] keys together and you can now access the single digit (0-9) keypad functions.

[Blank display]: If when you turn on the AC100 nothing shows on the display but you can still hear a beep when you press a key, try the following:

1. Press the [OFF] key.
2. Press the [ON] key.
3. Wait 30 seconds.
4. Press the [ENTER] key twice.
5. Press the [ADJUST SCREEN] key.
6. Press and hold the [up arrow] key for approximately 40 seconds.
   The display should become visible at this point.
7. Press [ENTER] to return to normal weighing.

[Blank display]: No beeps.
Press the [TEST] and [ON] keys together.

Cell error messages

(Displayed for a specific cell number)

Off: No cell has been detected.

Lost: A cell has been detected, but is no longer responding.

Disabled: The cell has been disabled using command '**-9**'. It will remain disabled until the AC100 is turned off.

Wait: The cell has not responded since being issued a command.

Alt/lat: The altitude and latitude settings in the cell do not match the settings in the AC100, Use [SET LAT/ALT].

Units: The units the cell is set to do not match the units the AC100 is set to, Toggle using [KGS/LBS].

Over: The cell is over 103% of the calibrated capacity.

Bad power: The cell is not getting sufficient power.

Zero: The cell is zeroed outside the limit set by zero range.

EEPROM: The cell calibration has been lost or corrupted. Call Intercomp Service.

Overflow: A mathematical limit has been exceeded.

Intercomp
3839 County Road 116
Medina, MN 55340
763-476-2531
800-328-3336
Fax 763-476-2613

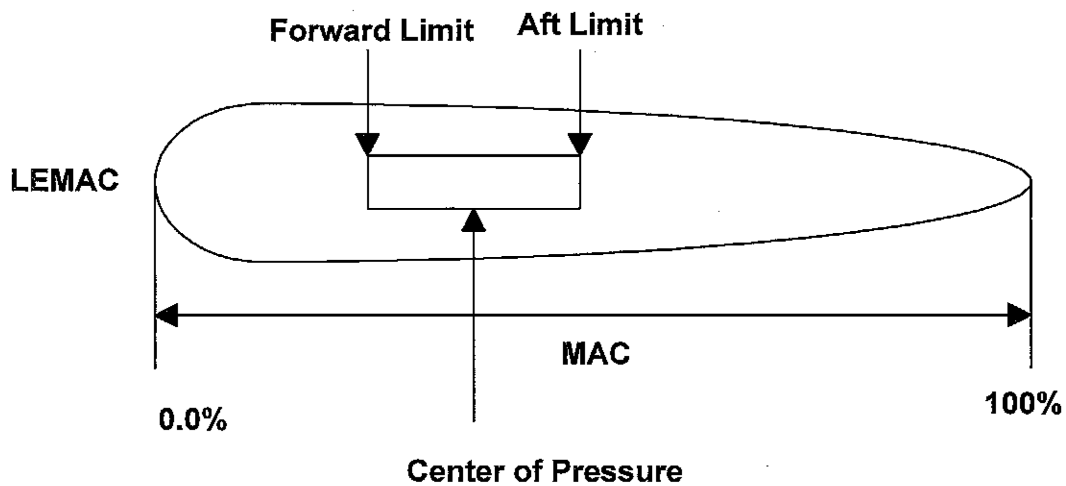
Weight and Balance Considerations

Basic Weight and Balance Theory

Weight and balance control consists of accounting for all the forces acting on an aircraft, and verifying that these forces stay within fixed limits. In a maintenance setting, we insure that all weight and balance changes are accounted for and that Service Weight Pickup is within acceptable limits.

Forces acting on an airframe

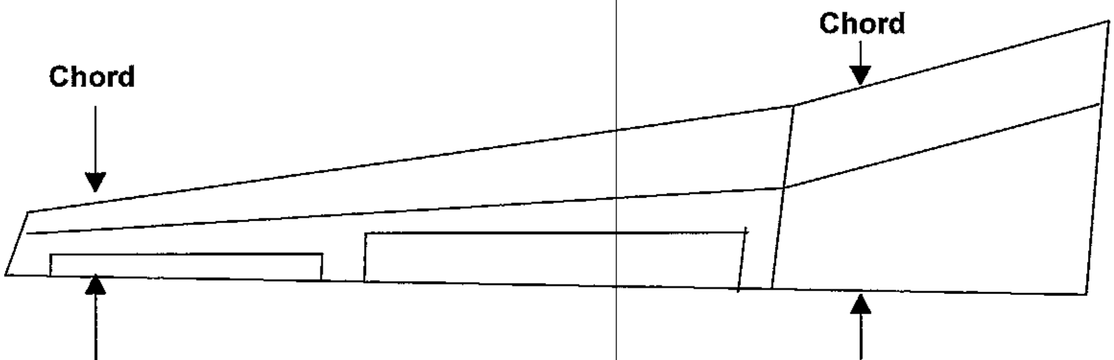
Air moving around the wing generates lift. The lift is generated over the entire wing, but you may consider the net effect as centered on the "Center Of Pressure". The horizontal stabilizer may modify this lift over a certain range. This establishes some limits on where the airplane may be loaded, called the Aft Center of Gravity Limit, and the Forward Center of Gravity Limit.



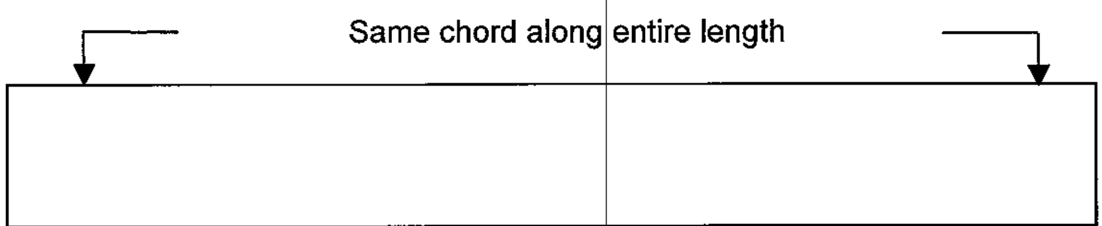
*** Note: MAC and LEMAC are only used on aircraft ***

Chord and Mean Aerodynamic Chord

The wing is the center of lift in an airplane. As such, many important parameters of an airplane are specified in terms of the wing. A unit of measure used frequently is the "Mean Aerodynamic Chord". A chord is an imaginary line from the leading edge to the trailing edge. In many aircraft this varies from one end of the wing to the other.



Where is the center of lift in a wing like this? The mean aerodynamic chord is the average chord of the entire wing. For weight and balance purposes the wing may be replaced with a wing like this:

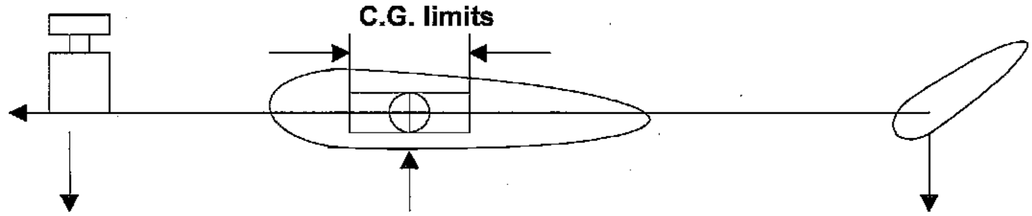


The airframe has a certain weight that may be idealized as a single replacement weight at a point known as the Center of Gravity. This equivalent weight must fall in the range set by the center of gravity limits given above.

It is the task of weight and balance control to insure that this is so

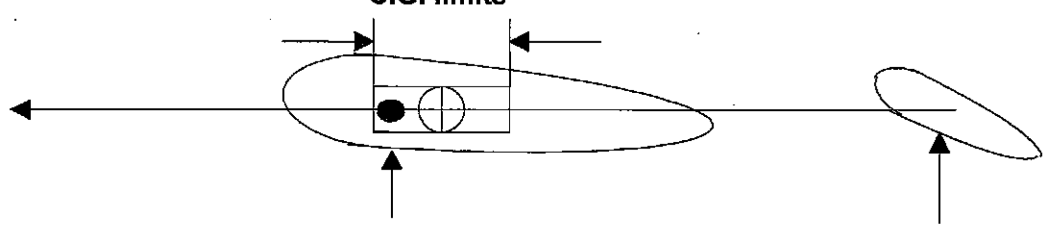
Longitudinal dynamics

The wing is combined with the mass of the airframe and the horizontal stabilizer to form a stable flying machine. There are three configurations in use, lets examine each in turn.



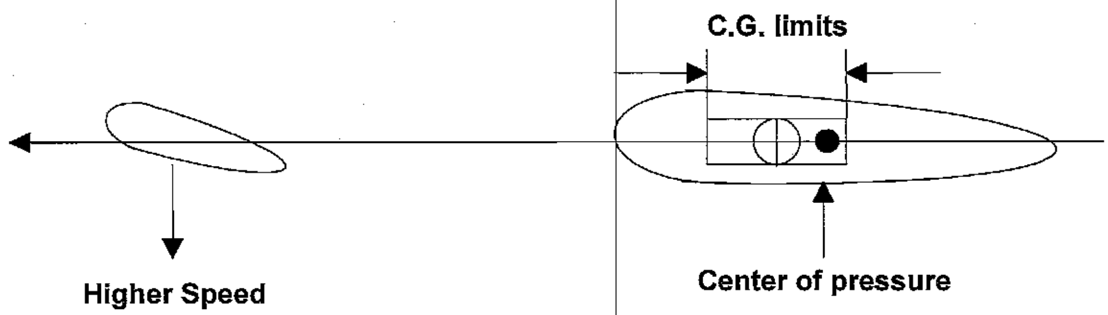
Classic Configuration

In the classic system the aircraft is weighted lightly forward of the center of pressure, and the tail is inclined slightly downward. As the aircraft moves forward the tail reacts to the airstream flowing over it. At some point, there is as much pressure pushing the tail downward as there is weight in the nose, and the system is stable. If the airplane slows down, the tail does not exert as much pressure and the nose drops. The plane picks up speed until the tail counterbalances the weight in the nose. If the plane has too much speed, the tail presses down, picking up the nose and slowing the plane. The angle of the stabilizer may be changed which changes the angle of attack of the wing, and the subsequent lift generated.



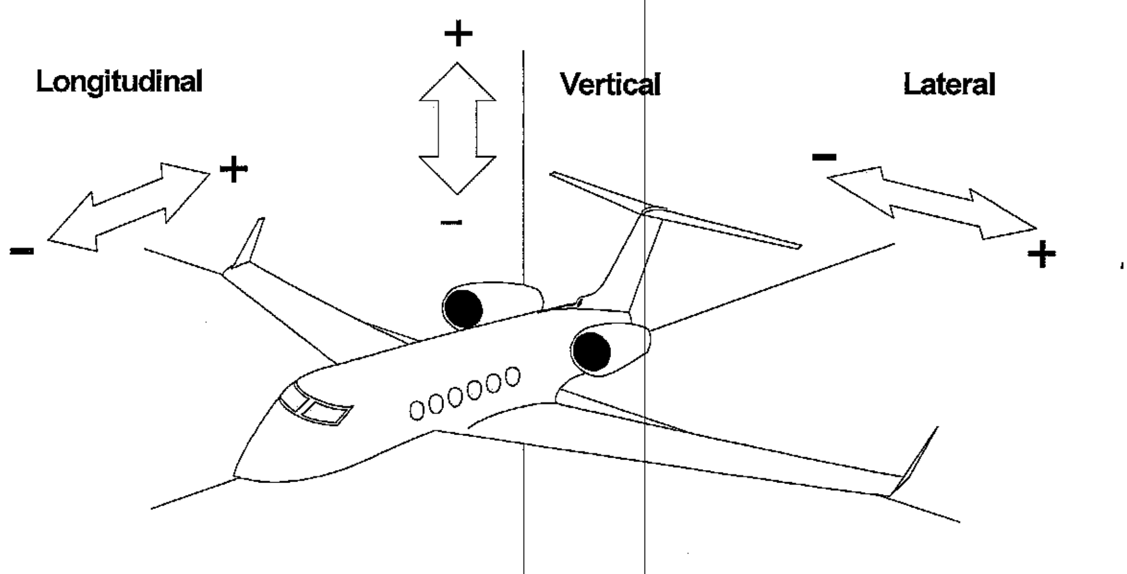
Flying Stablilzer Configuration

The second system is a variation of the classic system. Note that the classic system has the stabilizer pushing down. This reduces the potential lift of the wing. In some high performance aircraft, the horizontal stabilizer is also a lifting surface. The center of pressure is somewhere between the main wing and the stabilizer. A computer monitors the attitude of the aircraft and adjusts the stabilizer many times a second. This system depends on the computer for stability. While being more complex, you do get more lift for the same amount of wing and tail.



Canard Configuration

The third system is the canard. The horizontal stabilizer is placed forward of the wing, and again, it is a lifting surface. As the plane picks up speed, the stabilizer lifts the nose and slows the aircraft. If the nose drops the plane picks up speed and restores the nose. The stabilizer is designed to stall before the main wing, so there is a limit of how far the nose can be forced up with this system. This is desirable, as it makes the aircraft more forgiving, as it's hard to stall the main wing.



Coordinate Axis

Throughout the discussion of forces, we will use these standard conventions for up-down, left-right, and front-back.

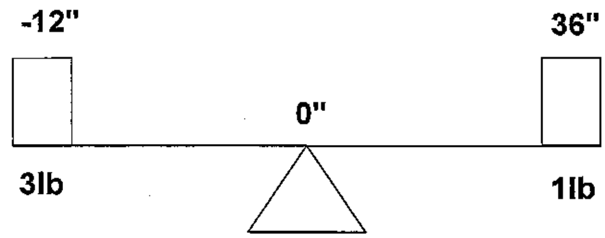
Note: SAWE RP-6A recommends that you use the "Right Hand Rule", with the positive direction to the right. See also: ANSI/AIAA R-004-1990 and MIL-A-8591G. Another popular convention is to take the side that the pilot sits on as the positive axis. For fixed wing aircraft this is the left side as shown, for rotary wing aircraft, this is the right side. In your own situation, the sign of any axis may be different than what is shown on this illustration. As long as the convention used is applied consistently during any calculations, and prominently noted on the weight report, the actual choice of convention is not important to the correct calculation of the CG values.

Introduction to levers, arms and moments

The wing may be thought of as a fulcrum in a lever system. All forces must balance at the fulcrum (wing) for the airplane to be stable.

Let's review some lever systems.

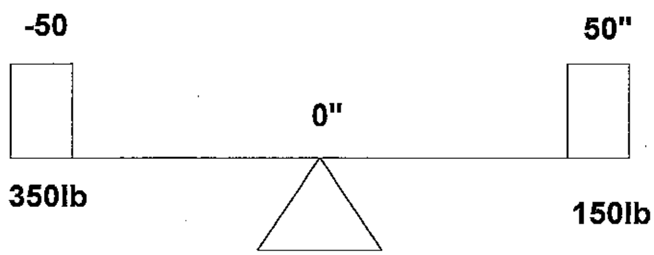
This is an example of a simple lever system.



A three pound weight is placed twelve inches to the left of the fulcrum, and a one pound weight is placed 36 inches to the right of the fulcrum. Each weight is a certain distance from the fulcrum. This distance is known as the ARM. The arm is combined with the weight to create a MOMENT.
A moment is a measure of the rotational tendency of a weight about a point. A moment is derived by multiplying an item's weight by its arm. Lets calculate the moment for both weights. The left most weight is 3 Lbs times -12 inches for -36 inch-pounds. Note that distances to the left of the fulcrum are given as minus values. The moment for the right hand weight is 36 inches times 1 pound for 36 inch-pounds. This system is in equilibrium, that is the forces on both sides of the fulcrum are in balance. A more formal statement is:

Equilibrium is achieved when the sum of moments about the fulcrum equals zero. (M1 + M2 = 0)

Lets look at some properties of levers. Please examine this lever system.



This system is not in balance. We can check this by calculating and comparing the moments.

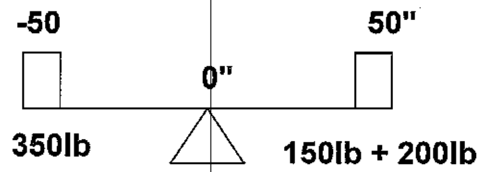
$$\mathbf{350\ lb \cdot -50\ in \neq 150\ lb \cdot 50\ in}$$

$$\mathbf{(-17500)\ in\text{-}lb \neq 7500\ in\text{-}lb}$$

How can we bring this system into balance? The condition of balance may be affected by changing either the weight(s), the position of the weights, or the position of the fulcrum.

Let's try each variation.

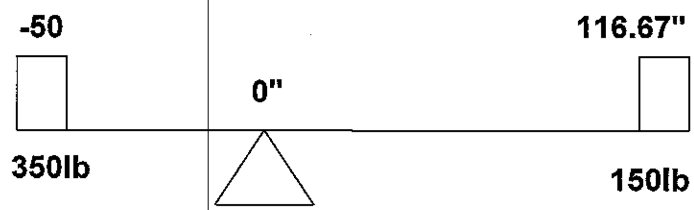
Adding weight:



$$350\text{ lb} \bullet -50\text{ in} = (150\text{lb} + 200\text{ lb}) \bullet 50\text{ in}$$

$$(-17500)\text{ in-lb} = 17500\text{ in-lb}$$

Moving Weight:

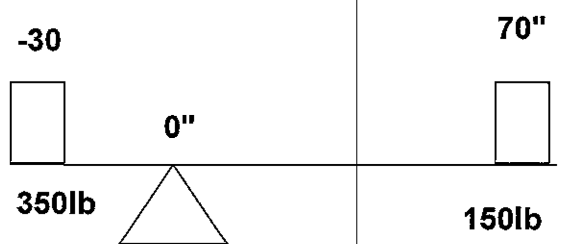


$$350\text{ lb} \bullet -50\text{ in} = 150\text{ lb} \bullet 116.67\text{ in}$$

$$(-17500)\text{ in-lb} = 17500.5\text{ in-lb}$$

Note the slight error caused by a repeating decimal on the 116.66 . . . number. You can extend this out to as many places as you need to get the desired accuracy.

Move the beam on the fulcrum:



$$350\text{ lb} \bullet -30\text{ in} = 150\text{ lb} \bullet 70\text{ in}$$

$$(-10500\text{ in-lb}) = 10500\text{ in-lb}$$

Restating what has just been presented: It is more convenient to represent the position of the weight and its value as a composite value, the MOMENT ARM, or more simply, the MOMENT. This is just the weight times its distance from a reference. Look at the examples above. In the bottom line of each example we were just comparing two moment arms. A moment arm can describe any weight on an airframe.

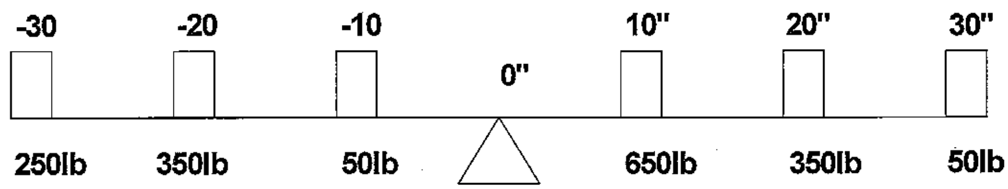
Look at the "adding weight" example given above.
Let's calculate the moments for each weight.

$$\begin{array}{rrcrr} & 150\ \text{lb} \bullet 50\ \text{in} & = & & 7500\ \text{in-lb} \\ + & 200\ \text{lb} \bullet 50\ \text{in} & = & + & 10000\ \text{in-lb} \\ \hline & 350\ \text{lb} \bullet 50\ \text{in} & = & & 17500\ \text{in-lb} \end{array}$$

Clearly, moments can be added together.

In general, any number of moments may be added to find the total effect

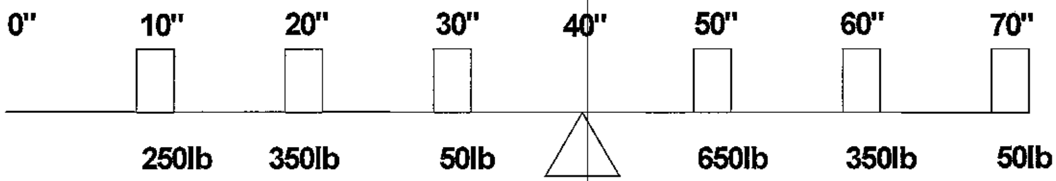
Example:



$$\begin{array}{rcrl} 250\ \text{lb} \bullet -30" & = & -7500 & \text{in-lb} \\ 350\ \text{lb} \bullet -20" & = & -7000 & \text{in-lb} \\ 50\ \text{lb} \bullet -10" & = & -500 & \text{in-lb} \\ \hline & & (-15000) & \text{in-lb} \end{array} = \begin{array}{rcrl} 650\ \text{lb} \bullet 10" & = & 6500 & \text{in-lb} \\ 350\ \text{lb} \bullet 20" & = & 7000 & \text{in-lb} \\ 50\ \text{lb} \bullet 30" & = & 1500 & \text{in-lb} \\ \hline & & 15000 & \text{in-lb} \end{array}$$

There is no particular reason the fulcrum has to be the zero location. Any point can be selected, as long as it is used for all calculations. This provides a bonus; all signs of numbers are the same. This makes it less likely to make a simple math error.

Lets redo the above example with the reference positioned 10" to the left of the leftmost weight. In addition, we will calculate the total moment for all the weights and compare this to the fulcrum.



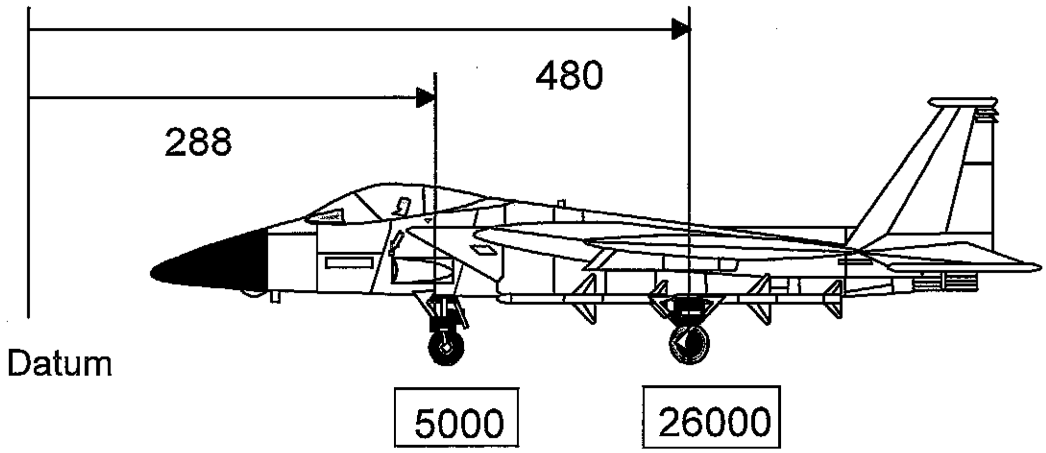
250 lb • 10"	=	2500	in-lb
350 lb • 20"	=	7000	in-lb
50 lb • 30"	=	1500	in-lb
650 lb • 50"	=	32500	in-lb
350 lb • 60"	=	21000	in-lb
50 lb • 70"	=	3500	in-lb
1700 lb		68000	in-lb

To find the center of gravity, we divide the total moment by the total weight.

$$\frac{68000 \text{ in-lb}}{1700 \text{ lb}} = 40.0\text{" C.G.}$$

The center of gravity is at the same point as the fulcrum. The system is in equilibrium.

Here is an example of levers and moments as they apply to a real aircraft: The scales incorporate inclinometers, altitude, and latitude correction, so we can ignore these factors.



Find Total Weight

$$\begin{array}{r} 5000 \\ +\ 26000 \\ \hline 31000 \end{array} \text{ Total Weight}$$

Find Total Moment

480 in X 26000 lb = 12480000 in-lb
+ 288 in X 5000 lb = 1440000 in-lb
13920000 in-lb Total Moment

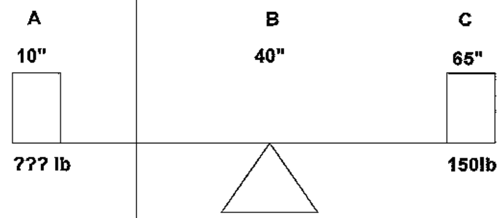
Find Center of Gravity

$$\frac{13920000 \text{ in-lb}}{31000 \text{ lb}} = 449 \text{ in Center of Gravity}$$

Sample Problems

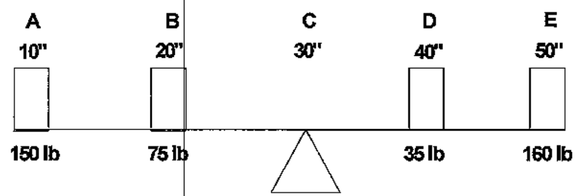
Problem 1.

How much weight has to be added to position A to get equilibrium?



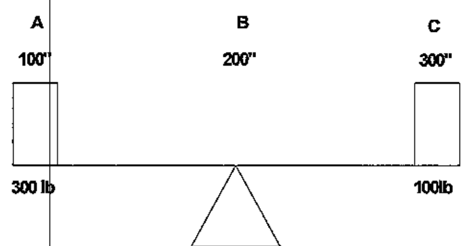
Problem 2.

a) Where is the balance point with the values given?
b) How much weight must be moved between positions A and E to get equilibrium?
c) Same thing with A and D.
d) Same thing with D and E.
e) Same thing with A and B.
f) Same thing with B and C.



Problem 3.

How does adding 100 pounds at position B affect the Center of Gravity?



In Summary:

1. Weight added forward of the CG will move the CG forward.
2. Weight added aft of the CG will move the CG aft.
3. Weight added at the existing CG will have little or no effect on the CG.
4. Weight removed forward of the CG will move the CG aft.
5. Weight removed aft of the CG will move the CG forward.
6. Weight removed at the existing CG will have little or no effect on the CG.

Put in another way: If weight is added forward of, or removed aft of, the existing CG, the CG will move forward. If the new CG is too far forward of the center of lift, a nose-heavy condition may result. Conversely, if the weight is added aft, or removed forward, of the existing CG, the CG will move aft. If too far aft of the center of lift a tail-heavy condition will result.

Fuel density and Temperature

Information on Fuel Weight and Moment tables is based on an average fuel density at fuel temperatures of 60°F. However, fuel weight increases about 0.1 lb/gal for each 25°F decrease in fuel temperature.

Any time fuel temperatures are different than shown in the chart headings a new fuel weight calculation should be made using the 0.1 lb/gal increase in fuel weight for each 25°F decrease in fuel temperature.

Example:

500 gallons of JP-4 at 32°f.

At 60°f this would be 3250 pounds.

Calculate revised weight:

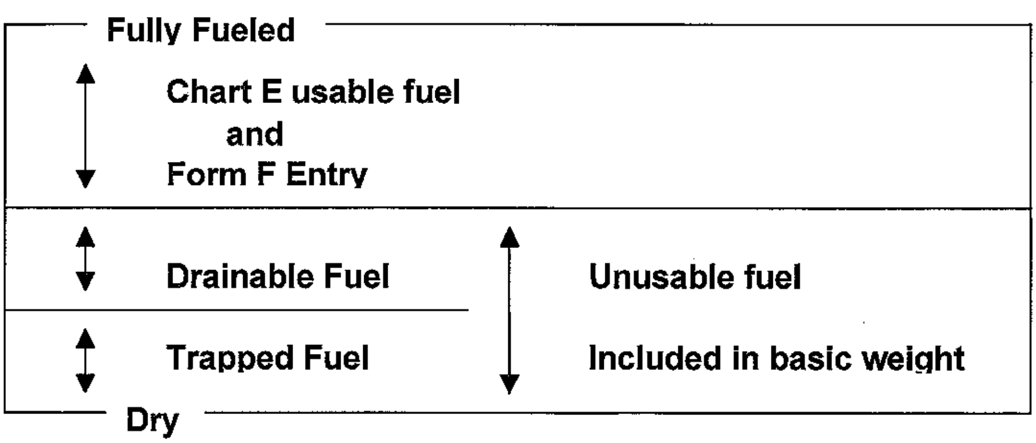
$$500 \bullet (6.5 + (0.1 \bullet (60-32)/25)) =$$

$$500 \bullet (6.5 + (0.1 \bullet 1.12) =$$

$$500 \bullet (6.5 + 0.112) =$$

$$500 \bullet 6.612 = 3306 \text{ pounds} \quad \text{(A 1.7 \% change).}$$

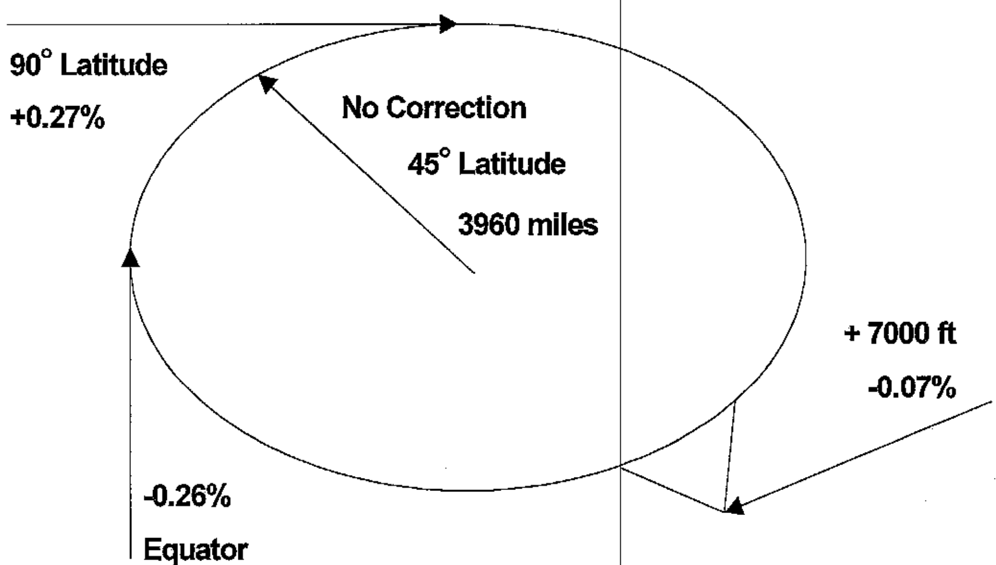
NOTE: The average density used in Chart E is:
Gasoline - 6.0 pounds per gallon.
JP-4 - 6.5 pounds per gallon.
JP-5 - 6.8 pounds per gallon.
JP-8 - 6.8 pounds per gallon.



Latitude Correction

This discussion applies only if your scale is calibrated with weights at one location, and used in a different location. If a scale is calibrated with weights at a given location, all the effects mentioned below are corrected in the calibration process.

NOTE: If you use a force style calibration press, the press is the same as calibration with weights at a location of 45° latitude. Latitude correction would **NOT** be required in this case.



Variations in gravity's attractions

The force of attraction of the earth to any object varies with latitude and altitude.

The formula that describes the attraction of gravity ($F=G\bullet M1\bullet M2/R^2$) says that the further something is from the center of the earth, the less the earth pulls on it. The earth bulges at the equator, and is flattened at the poles. This is the result of the centrifugal force exerted by the earth's rotation.

According to the WGS 1984 survey this bulge amounts to about 13 miles (21 km) from the equator to the poles. By convention, sea level at 45° latitude is taken as the standard reference point for measuring mass. From this it follows that the equator is higher than this reference point, and the poles are lower.

In general, an object weighs the most at sea level at the poles, and the least at the equator and to a lesser amount, higher altitudes. This effect is small, about 0.25%, but it must be considered for accurate weighing.

Latitude Correction Table

The following table gives correction factors for different latitudes and altitudes. To use this table, multiply the scale's indicated weight by the selected table entry giving the corrected weight at standard conditions (sea level at 45° of latitude).

Lat	Altitude above sea level (FT)								Accel of Gravity
	0	1000	2000	3000	4000	5000	6000	7000	
0	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	1.0034	32.0878
5	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	32.0891
10	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	32.0929
15	1.0023	1.0024	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030	32.0991
20	1.0021	1.0022	1.0023	1.0024	1.0025	1.0025	1.0026	1.0027	32.1076
25	1.0017	1.0018	1.0019	1.0020	1.0021	1.0022	1.0023	1.0024	32.1180
30	1.0014	1.0015	1.0016	1.0017	1.0017	1.0018	1.0019	1.0020	32.1302
35	1.0009	1.0010	1.0011	1.0012	1.0013	1.0014	1.0015	1.0016	32.1435
40	1.0005	1.0006	1.0007	1.0008	1.0009	1.0010	1.0011	1.0012	32.1578
45	1.0000	1.0001	1.0002	1.0003	1.0004	1.0005	1.0006	1.0007	32.1725
50	0.9996	0.9997	0.9998	0.9999	1.0000	1.0001	1.0002	1.0003	32.1873
55	0.9991	0.9992	0.9993	0.9994	0.9995	0.9996	0.9997	0.9998	32.2016
60	0.9987	0.9988	0.9989	0.9990	0.9991	0.9992	0.9993	0.9994	32.2151
65	0.9983	0.9984	0.9985	0.9986	0.9987	0.9988	0.9989	0.9990	32.2272
70	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985	0.9986	0.9987	32.2377
75	0.9978	0.9979	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984	32.2463
80	0.9976	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0.9982	32.2525
85	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981	32.2564
90	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981	32.2577

Example: An aircraft is weighed in a hangar at 10° latitude at an altitude of 1000 Ft. The scales were calibrated with a force style press, so the indicated weight must be corrected.

15000 lb • 1.0026 = 15039 lb

If the scale you are using has an altitude / latitude correction feature, this table will be applied automatically. You will enter the latitude and altitude and the scale does the correction.

Leveling Considerations

Throughout this text, and in others, you will find many references to the importance of level floors. Why is this so important? An aircraft should weigh the same no mater what the slope of the floor, right?

Yes and no. The force delivered to the scales is the same, but the weight displayed is only the amount sensed going in a direction perpendicular to the plane formed by the top of the scale. A scale SHOULD ignore any sideways component of the force imparted by the object being weighed. This greatly reduces any errors caused by the sideways flexing of rubber tires, or misalignment of the wheels. When a scale is not level, the force exerted by the scale is split into two components, a vertical force (weight) and a horizontal force. Any part of the force that is put into the horizontal part is not sensed as weight, thus reducing the sensed weight. The part left to be sensed as weight is just the weight times the cosine of the angle of the scale.

Example: A 10000 pound weight is placed on a scale sitting on a 3° slope.

$$\mathbf{10000\ lb \bullet cos.\ 3^{\circ} = 10000 \bullet 0.99863 = 9986.3\ lb}$$

This gives us an error of 0.14%, more than the entire error allowed by our scales. To reduce these errors to a negligible level, the scales should be level to better then 1.2°.

Repeating the example given above with a 1.2° angle:

$$\mathbf{10000\ lb \bullet cos.\ 1.2^{\circ} = 10000 \bullet 0.99978 = 9997.8\ lb}$$

This gives us an error of 0.02%

If you know the angle of the floor where the plane is being weighed you can apply a correction factor.

The correction factor is just:

$$\mathbf{Corrected\ Weight = Weight + weight \bullet (1 - cos.\ Angle)}$$

Some scales automatically sense the angle of the floor, calculate and apply this needed correction factor.

Reference Formulas

In an aircraft the reference datum is usually some point on or in front of the nose. During static flight, the fulcrum is the center of pressure, as defined by the manufacturer of the aircraft. This may be specified in units of MAC of the aircraft. The listed weights are things like engines, installed equipment, cargo, passengers, and fuel.

The moment to be added or subtracted from the basic moment is found by multiplying the weight of the object by its arm or distance from the reference datum. From this we derive these three formulas:

Weight (Pounds) x ARM (Inches) = Moment (Inch Pounds)

Moment (Inch Pounds) / Weight (Pounds) = ARM (Inches)

Moment (Inch Pounds) / ARM (Inches) = Weight (Pounds)

Total moment is the sum of the aircraft's basic moment and the moment(s) of the item(s) being loaded. Total weight is the sum of the aircraft's basic weight and the total weight of the load items. When total moment is divided by total weight the result is the composite CG position in inches (or meters) from the longitudinal reference datum. This gives us:

To compute Center of Gravity:

$$\text{Average arm (CG)} = \frac{\text{Total moment}}{\text{Total weight}}$$

To Compute Percent MAC:

$$\text{\% MAC} = \frac{\text{Longitudinal CG} - \text{Leading Edge of MAC}}{\text{MAC}} \bullet 100$$

The following group of formulas is used to calculate CG location when adding, subtracting or moving weights.

Adding Weight:

$$\text{New CG} = \frac{\text{Old moment} + \text{added moment}}{\text{Old weight} + \text{added weight}}$$

Removing Weight:

$$\text{New CG} = \frac{\text{Old moment} - \text{removed moment}}{\text{Old weight} - \text{removed weight}}$$

Moving Weight:

$$\text{New CG} = \frac{\text{Old moment } \subset\in \text{ moved moment}}{\text{Total Weight}}$$

CG Change:

$$\text{CG change} = \frac{\text{Change in moment}}{\text{Total weight}}$$

Weight Definitions Revealed

WEIGHT EMPTY

+

Unusable fuel, Oil, Ballast, Survival kits, oxygen, any other equipment not disposed of during flight and not listed in Chart E.

-

Any Chart A items that are missing from the aircraft.

=

BASIC WEIGHT

+

Crew, crew baggage, steward equipment, emergency equipment, special mission fixed equipment, and all other non-expendable items not in basic weight.

=

OPERATING WEIGHT

+

USABLE FUEL

+

Payload items such as cargo, passengers, stores and disposable fuel tanks.

=

TAKEOFF GROSS WEIGHT

-

Load items expended in flight such as fuel, stores, ammunition, cargo and paratroops.

=

LANDING GROSS WEIGHT

Terms and Definitions

AFT CENTER OF GRAVITY - The aft-most permissible aircraft center-of-gravity location for a specific weight condition.

AIRCRAFT WEIGHING RECORD - The form used to record data obtained from actual aircraft weighing.

ALL-UP WEIGHT - See Gross Weight.

ALLOWABLE GROSS WEIGHT (AGW) - The Not To Be Exceeded Weight of a loaded aircraft. The Aircraft Flight Manuals specify allowable weights that must not be exceeded for a particular configuration or specific mission. Some examples are: Allowable takeoff weight, Allowable landing weight, Allowable jacking weight, etc.

ARM (A) - A measurement of distance, in inches, feet, etc. used in weight and balance calculations. Normally only the longitudinal arm is of practical importance. The three axial arms are:

> ***Longitudinal Arm -*** The distance, parallel to the longitudinal axis, between the center of gravity of a load item and the reference plane for longitudinal load arms. By convention, the longitudinal arm is negative (-) when forward, positive (+) when aft, of the designated fuselage station reference datum.
>
> ***Lateral Arm -*** The distance parallel to the lateral axis between the center of gravity of a load item and the reference plane for lateral load arms. A popular convention is to take the side that the pilot sits on as the positive (+) axis. For fixed wing aircraft this is the left side as shown, for rotary wing aircraft, this is the right side. SAWE RP-6A recommends that you use the "Right Hand Rule", with the positive direction to the right. See also: ANSI/AIAA R-004-1990 and MIL-A-8591G.
>
> ***Vertical Arm -*** The distance parallel to the vertical axis between the center of gravity of a load item and the reference plane for vertical load arms. By convention, the vertical arm is positive (+) when above and negative (-) when below the designated waterline reference datum.

AVERAGE ARM - See Balance Arm.

BALANCE - The condition of stability that exists in an aircraft when all weights and forces are acting in such a way as to prevent rotation about an axis or pivot point.

BALANCE ARM - The arm, or distance from a reference datum. The Balance Arm is the result of dividing the total moment by the total weight.

BALANCE STATION - A point measured in inches from the horizontal reference datum. Balance Station 0.0 is the reference datum.

BALLAST - Any weight installed in the aircraft for balancing the aircraft so that it remains within permissible center of gravity limits. Ballast installation may be temporary, permanent, or any combination of it.

BASIC ARM - That distance from the reference datum to the aircraft Basic Weight Center of Gravity. The basic arm is determined by dividing the aircraft basic moment by the aircraft basic weight.

BASIC CENTER OF GRAVITY POSITION - The position of the center of gravity of an aircraft at its basic weight. Normally only the longitudinal (for-aft) position is considered. Still, both the vertical (up-down) and lateral (side-side) positions may require occasional considerations.

BASIC EQUIPMENT - The non-expendable equipment common to all the configurations for which the aircraft is designed.

BASIC MOMENT - The summation of the moments of all items included in the aircraft basic weight. Normally refers to "Basic Longitudinal Moment". Occasionally a requirement exists for "Basic Vertical Moment" and/or "Basic Lateral Moment". It is necessary, therefore, to use the proper qualifying adjective.

BASIC WEIGHT - The sum of weight empty plus the weight of items not in the useful Load Data. Examples of items contained in the basic weight are unusable fuel, trapped and unusable engine oil, ballast, survival gear/kits, and oxygen equipment. **THE AIRCRAFT'S CURRENT BASIC WEIGHT IS ALWAYS THE LAST ENTRY IN THE AIRCRAFT HISTORICAL RECORDS (DD Form 365-2) FOR THAT PARTICULAR AIRCRAFT, OR GROUP OF AIRCRAFT.**

BASIC WEIGHT CHECK LIST - A completed collection of DD Form 365-1 forms. Commonly called Chart A. It is a partial listing of items, by compartments, which are, or may be installed in the aircraft at the time of weighing. The primary purpose of the check list is to establish the aircraft equipment inventory at the time of the aircraft weighing.

BUTTLINES (BL) - Reference locations in the lateral (left or right) direction from aircraft lateral (side to side) reference datum or aircraft centerline. The axis is expressed from the pilots operating position. A popular convention is to take the side that the pilot sits on as the positive (+) axis. For fixed wing aircraft this is the left side as shown, for rotary wing aircraft, this is the right side. SAWE RP-6A recommends that you use the "Right Hand Rule", with the positive direction to the right. See also: ANSI/AIAA R-004-1990 and MIL-A-8591G.

CG - The abbreviation for the Center of Gravity.

CENTER OF GRAVITY (CG) - That point about which the aircraft would balance if suspended. For field weight and balance control, the center of gravity is normally calculated only along its longitudinal axis (nose to tail), disregarding both lateral and vertical location.

CENTER OF GRAVITY LIMITS - The extremes of movement that the center of gravity can have without making the aircraft unsafe for flight. The center of gravity of the loaded aircraft must always be, and remain, within these specified limits at takeoff, during flight, and at landing.

CENTER OF GRAVITY RANGE - The distance between the above mentioned center of gravity limits. The range may vary in length from 3 or 4 inches for a small aircraft or helicopter up to 150 to 300 inches for a large aircraft.

CENTROID - The average arm or center of gravity of a compartment, fuel tank, piece of equipment, etc.

CHART A – DD Form 365-1. Equipment inventory by description, weight, arm and simplified moment. See Basic Weight Check List.

CHART C – DD Form 365-3. The Historical Basic Weight and Balance Record, by aircraft serial number, of the weight and balance changes for a particular aircraft.

CHART E - Detail loading information, weighing instructions, fuel tables, and miscellaneous information. See Loading Data.

CHORD - An imaginary straight line joining the leading and trailing edges of an airfoil.

COMPARTMENT - A defined section of the aircraft's load-carrying space.

COMPARTMENT ARM - The horizontal distance from a defined reference datum to a compartment centroid.

CONFIGURATION - A particular arrangement and quantity of structure, systems, internal and external stores, fuel and/or other items. It's also used to define the flaps, slats, and landing gear position.

DD Form 365 - Record Of Weight And Balance Personnel.
DD Form 365-1 - Basic Weight Checklist. Chart A.
DD Form 365-2 - Aircraft Weighing Record. Form B.
DD Form 365-3 - Basic Weight And Balance Record. Chart C.
DD Form 365-4 - Weight And Balance Clearance. Form F.

DESIGN GROSS WEIGHT - The weight at which the aircraft is designed to fly and upon which performance calculations and manufacturers guidelines are based.

DRAINABLE FUEL - That portion of internal/external fuel that can be drained from the aircraft tanks though normal drain points after defueling.

ENGINE START - The loaded aircraft condition immediately prior to starting the engine See Ramp Weight.

EQUILIBRIUM - A condition in which all acting influences are canceled by others, resulting in a stable balanced, or unchanging system.

EXPENDABLE LOAD - Includes fuels, cargo/stores that may be air dropped, etc. These data are found in the -5 Chart E Loading Technical Manual for the particular aircraft type/model.

FLIGHT DESIGN GROSS WEIGHT - A variable condition based on the type of aircraft. Normally it is the weight of the aircraft including internal fuel, pilot/pilots and other required personnel.

FLIGHT GROSS WEIGHT - The weight of the aircraft, its contents, and external items during the flight. It's also known as flight weight and/or inflight weight.

FORM B - The Aircraft Weighing Record. Form DD Form 365-2.

FORM F - The Weight and Balance Clearance. DD Form 365-4.

FORWARD CENTER OF GRAVITY LIMIT - The most forward permissible aircraft center of gravity location for a specific weight and configuration.

FULCRUM - A pivot or support about which items can be balanced or rotated.

FUSELAGE STATION (FS) - Reference stations measured in the longitudinal direction (forward to aft) from a reference datum normally at, or well forward of the aircraft nose. See Reference Datum.

g FACTOR - The ratio of the force that is imposed upon the aircraft and its contents when accelerated or decelerated, in any direction, compared with its normal mass. It is expressed in relation to earth's gravitational force of 1g. For example: If an item of load that weighs 1000 pounds is subjected to an acceleration of 3 G's then a force of 3000 pounds has been imposed upon that item. The force may act in any direction.

GROSS WEIGHT (GW) (aircraft usage) - The total weight of the aircraft including its contents. The gross weight continually changes throughout ground and/or flight operations. (Called the All-Up weight in Europe).

Gross - Total weight on scales. Also associated with; total, all-inclusive, dozen dozen, in bulk, wholesale. French: big, thick.

GUMC - Gear up moment correction.

INDEX VALUE - See moment.

JIG POINT - A hole, fitting, or other location that is the same known distance from each reference datum for all aircraft of the same model designation.

LANDING GROSS WEIGHT - The weight of the aircraft, its contents, the estimated landing fuel, and all other non-expendables when the aircraft lands. An integral part of the Form F flight information.

LATERAL AXIS - An imaginary line passing though the center of gravity, parallel to the axis of pitch and at right angles to the reference plane for lateral load arms.

LEMAC - An abbreviation for "Leading Edge of the Mean Aerodynamic Chord". Identified as a fuselage station.

LEVELING LOCATIONS - Fixtures (Leveling Lugs) or locations (attached to, or built into the aircraft structure) whose purpose is supporting a spirit level, inclinometer, or suspended plumb bob. Visual reference readings showing the horizontal and/or lateral level condition of the aircraft.

LEVER - A simple machine consisting of a rigid body pivoted on a fixed fulcrum.

LOAD ARM - See ARM.

LOADING CONTROL - The use of weight and balance forms and loading data to ensure that the aircraft weight, center of gravity, and other loading limitations are not exceeded during flight and/or ground operations.

LOADING DATA - Part of the aircraft's -5 series technical manual. Commonly called Chart E. Contains instructions for weighing the aircraft, aircraft diagrams, loading limits, general instructions affecting loading of the aircraft, and the weight, arm, and moment information necessary to perform loading control.

LOADING LIMITS - Restrictions, such as permissible center of gravity range and gross weight, beyond which aircraft loading is not permitted.

LONGITUDINAL AXIS - An imaginary line passing through the center of gravity, parallel to the axis of roll and at right angles to the reference plane for longitudinal load arms.

M - See Moment.

MEAN AERODYNAMIC CHORD (MAC) - An engineering term representing an airfoil's chord in aircraft design. It is of constant length. Also used in the calculation of center of gravity location in terms of percent (%) MAC. The average of the entire wing chords on the applicable aircraft model. Infrequently called the Mean Aerodynamic Chord Line or MACL.

MAW - Moment, Arm, Weight.

MAXIMUM GROSS WEIGHT - See Allowable Gross Weight.

MOMENT (MOM) - A measure of the rotational tendency of a weight about a point. The weight of an item multiplied by its arm.

NEGLIGIBLE CHANGE - Unless specified in the -5 T.O.'s a negligible weight is any change of ± 0.1% of the basic weight and/or moment change that moves the center of gravity ± 0.1% of the MAC.

Net - The gross weight minus the tare weight. Also associated with; free of all charges, clear of tare. netting, netted. French: clean, clear.

NOSE HEAVY - A condition of improper balance in which the center of gravity is forward of the established limits.

OPERATING WEIGHT (OW) - The sum of the aircraft basic weight, crew, emergency equipment, special equipment for a mission, and all other non-expendable items as applicable. The starting point for determining the mission most forward and most aft center of gravity conditions.

OVERLOADING - The addition of weight to an aircraft increases the hazards of flying because the lifting and turning forces must be increased in proportion to the increase in weight. A heavily loaded aircraft is less maneuverable, has a higher stalling speed, a lower ceiling, and requires a longer takeoff run.

PERCENT MAC - A location expressed as a percentage of the Mean Aerodynamic Chord.

PERMISSIBLE GROSS WEIGHT - See Allowable Gross Weight.

PERMANENT BALLAST - Ballast that must be installed in the aircraft at all times.

RAMP WEIGHT - The engine start condition. Look at Form F – Ramp weight is prior to these conditions. Consider the extra fuel allowed for engine start, warmup, and taxi.

RECOMMENDED MAXIMUM GROSS WEIGHT - The maximum gross weight that an aircraft can be loaded to and still maintain the desired margins of safety established by the contracting authority.

RECOMMENDED MAXIMUM LANDING GROSS WEIGHT - The maximum weight that the aircraft can safely land at. Sometimes this weight is less than the recommended maximum gross weight.

RECORD OF WEIGHT AND BALANCE PERSONNEL - The DD Form 365 used to provide a continuous record of the weight and balance personal responsible for maintaining the aircraft weight and balance handbooks.

REFERENCE DATUM (RD) - The zero reference position from which all distances are measured for balance purposes. Aircraft have three zero reference datum lines from which locations are measured:

Lateral - Buttlines (BL).
Vertical - Waterlines(WL).
Longitudinal - Fuselage Stations (FS).

The longitudinal datum is normally at or near the nose but may be the wing leading edge, rotor centerline, etc.

REPRESENTATIVE AIRCRAFT - An aircraft chosen as typical of many aircraft of the same model/designation, with similar structure, systems, and equipment configurations.

ROUNDED WEIGHT - A weight rounded to the nearest whole number, either up or down. The convention being if less the 0.5 lbs. it is rounded down, 0.5 lbs. and above, rounded up.

SCALE FACTOR CORRECTION - Modifies scale readings because of the inherent accuracy of the scales. Others may be, but are not limited to scale calibration factors, inability of the electronic load cell zero set to return to zero after unloading the cells, latitude correction, etc.

SERVICE WEIGHT PICKUP - Known and unknown weight changes due to undocumented repairs and modifications, wear, dirt, moisture, etc.

SIMPLIFIED MOMENT - Moment(s) divided by an established constant such as 10, 100, 1000, etc.

STRUCTURAL STATION - A station or location such as a bulkhead labeled for reference on an engineering drawing. Structural stations may or may not be identical with balance or fuselage stations.

TAIL HEAVY - A condition of improper balance in which the center of gravity is aft of the aft limit.

TAKEOFF GROSS WEIGHT (TOGW) - The aircraft gross weight at the time the aircraft becomes airborne.

TARE (aircraft weighing) - The weight of any support equipment necessary to weigh the aircraft. For example: chocks, blocks, slings, jacks, etc., whose weight is included as part of the weighed total but is not part of the aircraft weight. It can be a scale factor correction. On all aircraft the jack pads are part of the tare correction when using a load cell/jack weighing procedure.

Tare (General scale use) - the weight of the container in which goods are packed and weighed, deducted from the gross weight in order to arrive at the net weight. Also associated with; taring, tared - ascertain the weight of a container. From Arab: Tarhah - the part that is thrown away.

Tare mechanism - A mechanism designed for determining or balancing out the weight of packaging material, containers, or other materials that are not part of the net weight determinations.

TEMPORARY BALLAST - Item(s) used to simulate, or replace any missing item. Temporary ballast may simulate a missing crew member, a piece of equipment, etc. to maintain the aircraft within specified center of gravity limits and/or simulate a specific aircraft condition or configuration.

TIME COMPLIANCE TECHNICAL ORDER (TCTO) - An addition, deletion, and/or rearrangement of equipment authorized by an approved contracting authority. A manufacturer's engineering change proposal.

TRAPPED FUEL - That fuel which remains in the aircraft after defueling the aircraft by the prescribed -5 T.O. procedure. Fuel which remains after draining that can only be removed by disconnecting fuel lines, dismantling components, etc.

UNACCOUNTABLE WEIGHT - Any change in the basic weight not referenced on the Chart C. It is also the difference between the expected scale reading(s) and the actual scale reading(s).

UNPUMPABLE FUEL - The fuel remaining in the internal fuel tanks after defueling at a specific attitude/condition.

UNUSABLE FUEL - That fuel remaining in the aircraft at fuel starvation or draining the aircraft at flight attitude. Includes trapped fuel.

VECTOR - A quantity completely specified by a magnitude and direction.

VECTOR PLOT - A presentation prepared using precalculated graphical grids on which the arithmetic calculations have been predetermined. Normally associated with fan grid and template devices.

VERTICAL AXIS - An imaginary line passing through the center of gravity parallel to the axis of yaw and at right angles to the reference plane for vertical load arms.

WATERLINE (WL) - Location in the vertical (up and down) direction measured from a reference below the aircraft.

WEIGHT (W) - A measurement of the heaviness of an object. The gravitational force exerted on an object equal to the product of the objects mass and the local value of the earth's gravitational acceleration. Any object used to exert a force by virtue of its gravitational attraction to the earth.

WEIGHING REACTION POINTS - Those points upon which aircraft weight is supported during a weighing operation. Examples: Jack pads, Main and nose gear, etc.

WEIGHING REFERENCE POINT - See Jig Point.

WEIGHT AND BALANCE HANDBOOK - The continuous and permanent record of the weight and balance condition of a specific aircraft.

WEIGHT EMPTY - An engineering term related primarily to aircraft design. It is the weight of the aircraft, by model designation, dry, clean and empty except fluids in closed systems such as hydraulics etc.

ZERO FUEL WEIGHT - The weight of the loaded aircraft less any usable fuel.