A force is a force of course.....of course?

What is a force? According to Newton's second law a force is defined as a mass undergoing an acceleration. It is most common in load cell applications to refer to the force as, you guessed it, load. This load can have a multitude of units such as pounds, kilograms, tons, Newtons, etc. In the case of the load being in kilograms, the load has been applied to a load cell using a weight set having "x" number of kilogram masses. Gravity (the "a" in F=ma) supplies the acceleration needed to provide a force to the load cell utilizing kilogram masses. Thankfully, gravity is relatively constant here on the earth and for the most part, kilogram masses and Newton loads can usually be interchanged in order to calibrate load cells or force measuring devices even though a kilogram is technically a unit of mass and a Newton is technically a unit of force.

So what, you may be ask, does this have to do with load cells? Well, that all depends upon your application of a load cell. It also ties in to what we've already discussed regarding the definition of force or a load. It is that "a" term or acceleration that dictates the accuracy of one's load cell data, with respect to the calibration data. A load cell is a precise device that is calibrated precisely, depending of course, on the calibration methodology and quality control. Load cells are calibrated using either a set of known loads being in the form of precise masses or an alternative load application such as through hydraulic means utilizing a precisely calibrated standard load cell.

While force has a value or magnitude, it has another component called a vector or direction. When you use a level, you can see the effects of the direction of gravity. When you use a load cell (believe it or not) you also can see the effects of the direction of gravity. How so? Well, if you are measuring pig snouts utilizing a load cell, change the angle of the load cell and re-measure your pig snouts. You'll notice that the load changes. We know that the pig snouts did not change in mass, but we do know that the load’s direction changed, thereby impacting the load’s magnitude or value.

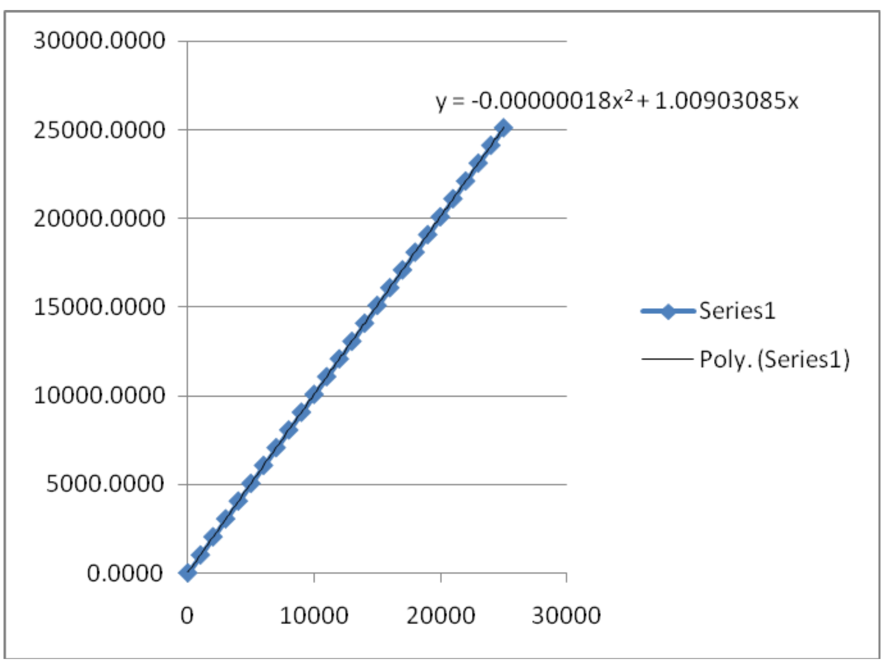
Okay, so what does this have to do with the quality of the measurement? Frankly, everything. The quality of a measurement is judged based upon the precision of the measurement (the ability to repeat the measurement) and the accuracy of the measurement (how close the measurement's value is to the actual value). As was previously mentioned, the load cell is precisely calibrated and it is calibrated in a universal fashion. That is the objective of the calibration, to provide an ideal output based upon ideal loading conditions so that a universal standard may apply. In other words, load cells are calibrated such that if they are calibrated in Warrenton, Virginia, they can be calibrated to achieve the same results in Sydney, Australia (within manufacturer's specifications, that is.)

However, the way in which the load may have been applied in Warrenton, Virginia will most likely not be the same as it is applied in the shop in Sydney, Australia. The reason for this deviation comes down to setup error.

Again, the quality of the calibration of load cells should be very high from the standpoint of precision or repeatability and accuracy or the proximity of the measurement to the actual true value. This is why there are criteria for the use of load cells such as the mounting and loading interface geometry. This is also why load cells are designed to reject certain types of loading geometrical errors such as off axis or tilt. But questions will always arise: How much error does one induce into the measurement by a typical application where fixturing is employed? How much is the "perfect" axial loading of the device altered through the application? Does way in which the load cell is used alter its original calibrated output or has the calibrated output drifted over time? How about this dreaded scenario? "I dropped my load cell and don't know if it is still reading correctly."

Time and money. That's what it takes to answer those questions. How much of each depends on what methods a company may have at their disposal. Hands down, the best means by which to calibrate a load cell is to use a universal testing machine. That requires lots of money to bring the capability in-house. The problems are keeping up with the quality standards associated with getting your standard calibrated and also training the employees to run the system. Another option would be to send the load cell itself and/or the entire setup to an outside facility for calibration. This typically takes a long time, which of course can add up to a lot of money if an entire process is down.

So how can one satisfy the quality requirements while reducing the time and money burden? Cooper Instruments has developed a test system that is extremely economical for use in testing compression-based systems. The standard system does not utilize a secondary load cell standard, yet easily approaches load cell level uncertainties. The following graph shows the data for a 25000 lb test. Three sets of data taken at 1000 lb increments were taken. The standard deviation was calculated to be 18.65 lbs. From ASTM E74, the uncertainty is calculated as the standard deviation multiplied by 2.4. This gives us an uncertainty of 45 lbs, which gives a repeatability of 0.18%



This uncertainty is achieved without an expensive load cell system that would itself need to be sent out for calibration each year, depending on the quality requirements of the company. This uncertainty allows this system to be utilized as a quick check system in harsh environments without the concern of damaging critical and expensive components. The Force Calibration/Check Machine (FCM) has been developed to provide adjustability to accommodate a company's load cell application/setup conditions in order to verify any offset that may be caused by that setup. A CAD model of the system is shown below.

The FCM was developed to complement a company's quality system and help to reduce the time and money associated with the implementation and maintenance of load cells in the company's processes. The FCM allows for the quick checks associated with fixturing that may cause offsets in the load cells measurements. While it is recommended that load cells be calibrated once per year, the FCM allows a company to implement a quality standard system by which the load cells are checked utilizing a relatively low uncertainty. Because it is a low cost system, calibration costs associated with maintaining equipment become affordable.

Best of all, it helps to potentially save both time and money if you've dropped your load cell and don't know if it's still reading right. Best of all, that is, if you were the one to drop that expensive load cell.