OCT 2018

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WHITEPAPER

SUPPORT INFORMATION

LOW COST LOAD CELL TESTING

Low Cost Load Cell Testing

Technical White Paper

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Abstract

Often when we send a quote for an SP load cell we are met with the comment: "I have been offered a cheaper one elsewhere." So, we thought, let's buy one.

Due to the number of load cells from Asian manufacturers flooding the market, we can surmise that enough lifting operators and/or lifting equipment distributors choose to buy from these companies to make such operations worthwhile. We fear that many are compromising lifting safety by placing products of lower cost but also inferior standard into the marketplace, not backed by industry-recognised accreditations.

We wanted to order a load cell directly from a manufacturer, chosen at random, based in Asia in order to carry out a comparison test against a closely matched SP product to determine the differences. In short, our findings were shocking.

We wanted to compare the level of customer service we would receive from their salespeople, so we could determine how smooth the buying process might be. The other reason we wanted to order directly was to avoid any OEM adaptions that could possibly be made by outside partners or distributors, and to preserve the original state of the item from when it left the factory. We also wanted to see the condition of the product's packaging upon receipt, so we could assess whether or not the item and accessories had been packaged with care and attention to presentation.

N.B. Any test results that are to the detriment of the reputation of the Asian manufacturer's load cell will be used to support SP's future marketing endeavours to highlight product advantages. Our intent is to focus on reliability, accuracy, and specifications in terms of how they are advertised versus reality. Usability and effectiveness in completing a lifting operation safely were other key areas of our investigation.

Contents

1 - TESTING PROJECT SUMMARY

Testing period: April – June 2018

Product being tested: Generic Load Cell/Load link/Tensionmeter/Tensionmeter manufactured in Asia

Test Product Required Attributes:

- As close to 55te capacity as possible (within a +/- 5te range)
- Load link style load cell
- Wireless feature – connecting to a handheld device for remote monitoring
- Would fit industry standard specification load shackles
- Had to be ordered directly from the Asian manufacturer and not from a separate outlet for the manufacturer within a different country.

Purpose for testing: To test the product quality, precision, and usability of a generic manufactured load cell (as a close equivalent to SP's Radiolink plus [RLP]). The reason for this is so that we can use the test results to evaluate the comparisons between it and our own RLP product to:

- Aid research and development of our own products, especially if it were found that the competitor's load cell was superior in any way to our own.
- To ascertain whether or not our hypothesis that products from unknown/little-known Asian workshops are vastly inferior to our own and other well-known brand's products.
- To ascertain whether or not it improves lift safety and add value to a lifting job, as the type of product it is.

Tests conducted:

1. Initial visual inspection test
2. Load accuracy
3. Operational functionality
4. Telemetry distance testing using accompanying handheld device
5. Battery longevity
6. Environmental protection test
7. Internal inspection
8. Product stress (endurance) – Destruction

1.1 - Product Specifications (claimed within its official specifications list)

Capacity	50te
Dimensions	465mm(L) x 150mm(W) x 104mm(D)
Weight	20kg
Material	Alloy Steel
Reading Accuracy	Within 0.05%
Environmental Protection	Unknown (IP67/68 optional)
Proof Load	75te (150% of rated load)
Maximum Safety Load	62.5te (125%)
Ultimate Load	200te (400%)
Power On Zero Range	20%
Manual Zero Range	4%
Tare Range	20%
Stable Time	≤10 seconds
Overload Indication	100% +9e
Battery Life	≥ 40 Hours
Operating Temperature	-10% ~ +40°C
Operating Humidity	≤10 seconds
Remote Control Distance (Infrared)	Min 15m
Wireless Distance to Handheld Controller	Min 80m
Wireless Frequency	485MHz
ATEX/IECEx Protection	None (Zones 1 & 2 optional)
Batteries	3 x AA

1.2 - Features Comparison (With the most similar SP product)

Features	Competitor's Load Cell (Claimed)	SP Radiolink plus
Capacity	50te/110000lbs	55te/120000lbs
Weight	20Kg/44lbs	13Kg/28lbs
Safety Factor	4:1	5:1
IP Rating	No rating (IP67/68 optional)	IP67/NEMA6
Hazardous Zone Rating	Not present (Claims zones 1 & 2 protection is optional)	ATEX/IECEx Zones 0,1, & 2
Materials Used	Steel Alloy	Aircraft-grade aluminium
Telemetry Frequency	470MHz	2.4GHz
Data Rate	N/A	3 (up to 200Hz if ordered)
System Range	80m/262ft+	700m/2300ft
Batteries	3 x AA	4 x AA
Battery Life (Continuous)	40 hours +	1,200 hours
Approvals and Accreditations	None given/none seen on documentation or on order site	Design Validated F.E.A. DNV-GL (DNVGL-ST-0378 Standard for offshore and platform lifting appliances) ASME B30.26 conformity
Extra Features	Onboard LCD display (with backlighting) Onboard unit conversion (lbs – kg – te – kN) Onboard unit zeroing (also using handheld) Remote control (infrared direct line of sight) Low battery warning Overload warning (including handheld) Onboard voltage check Onboard power off button	90 Db Audible overload alarm Error free data transmission 100Hz Peak hold Bluetooth option Remote on-off switch (Using HHP) Push Button Tare (using HHP) Overload/underload warning (using HHP) Multiple units display te, lbs, kN & kg (using HHP)

2 - TEST SUBJECT EVALUATION

2.1 - Initial Product Inspection – Straight Out of the Box

Packing crate upon arrival - before opening

Photo taken when packaging crate was opened ("Calibration Certificate" and instruction manuals removed to reveal entire load cell)

Top section

Digital display and onboard functions

Lower section

2.2.1 - General Observations

- Thin wooden packaging crate that had held together for the journey from Asia, but could not be considered durable enough to be used as long-term storage or protection during load cell transit to lifting jobs.
- Minimal internal protective polystyrene that would not be adequate to sufficiently protect the internal componentry from excessive knocks and jolts during transit.
- Remote control and handheld device encased in bubble wrap, but both were unsecured and loose within the wooden crate.
- Multiple surface scratches and blemishes across the entire metal body of the load cell (looked in less than grade A condition—more like grade B).
- It appeared that little care was taken to preserve condition during warehouse storage of the product beyond the production stage.
- On board control and LCD panel not sitting flush within metal body; there was a gap showing all the way around it.
- The actual weight of the load cell is over twice as much as our equivalent model RLP (55te) at **47kg (they claim 20kg),** which required much effort to pick up by hand and transport.

2.2.2 - Comments from Joshua Young (SP calibration technician):

"First impressions of the load cell are not good; it's unnecessarily large and heavy, and the battery compartment is protected by a basic, almost TV-style remote control cover. The front of the load cell features three buttons offering the following functionality: Zero, Units, On/Off. This is also reflected in the remote that's supplied with the load cell, however, this also has extra buttons allowing peak hold and then a selection of buttons that appear to do nothing."

Load cell's IR remote control (with limited functionality)

2.2 - Load Accuracy Testing

2.2.1 - Testing Setup

- For every load cell SP produces, an accuracy and calibration check routine is carried out upon it to make sure that it is within a 0.5% allowable margin of error.
- We performed the same accuracy and calibration routine on the competitor's load cell using our in-house 100te capacity hydraulic calibration machine.
- The calibration machine sends load measurements from its reference loadcell that is third party verified to a computer, which has analysis software installed.

2.2.2 – Result

2.2.2.1 - Load accuracy test results:

Extract from Joshua Young's (SP calibration technician) report:

"…I pre-loaded the load cell three times to its 50 tonne capacity on our test machine, three times. This is good practice when testing as it prepares the load cell for use and allows me to see if there are any errors at zero, drift, etc."

Test 1				
Readings in the below table are in **Kilograms**				
Applied	Run 1	Run 2	Run 3	Average
0	0	0	0	0
10000	9500	9550	9550	9533
20000	19000	19050	19100	19050
30000	28550	28600	28650	28600
40000	38100	38150	38150	38133
50000	47650	47650	47700	47667

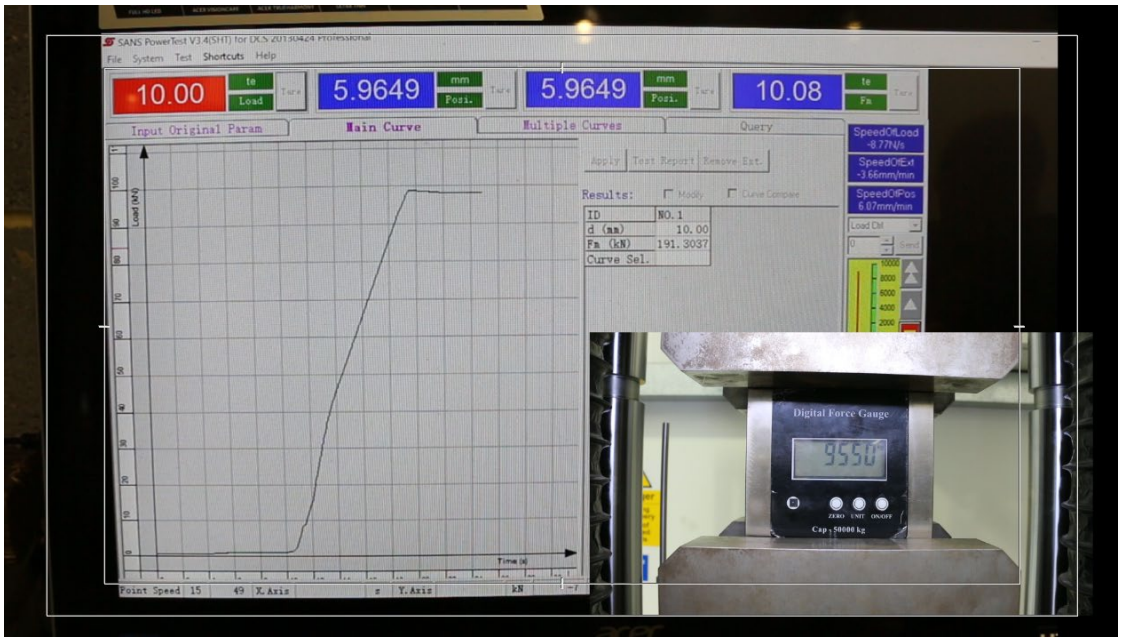
Test 2				
Readings in the below table are in **Tonnes**				
Applied	Run 1	Run 2	Run 3	Average
0.00	0	0	100	33
10.00	9600	9600	9600	9600
20.00	19100	19150	19150	19133
30.00	28650	28650	28650	28650
40.00	38200	38200	38200	38200
50.00	47700	47750	47750	47733

Test 3				
Readings in the below table are in **Pounds**				
Applied	Run 1	Run 2	Run 3	Average
0	0	0	0	0
22000	9550	9500	9500	9517
44000	19050	19050	19050	19050
66000	28600	28600	28600	28600
88000	38150	38150	38150	38150
110000	47650	47650	47650	47650

2.2.2.2 - Testing Sample

1st Measurement

Force Endured	10te (10000kg)
Force registered by load cell	9550kg (9.55te)
Inaccuracy amount	450kg (0.450te)
Inaccuracy percentage	4.5%

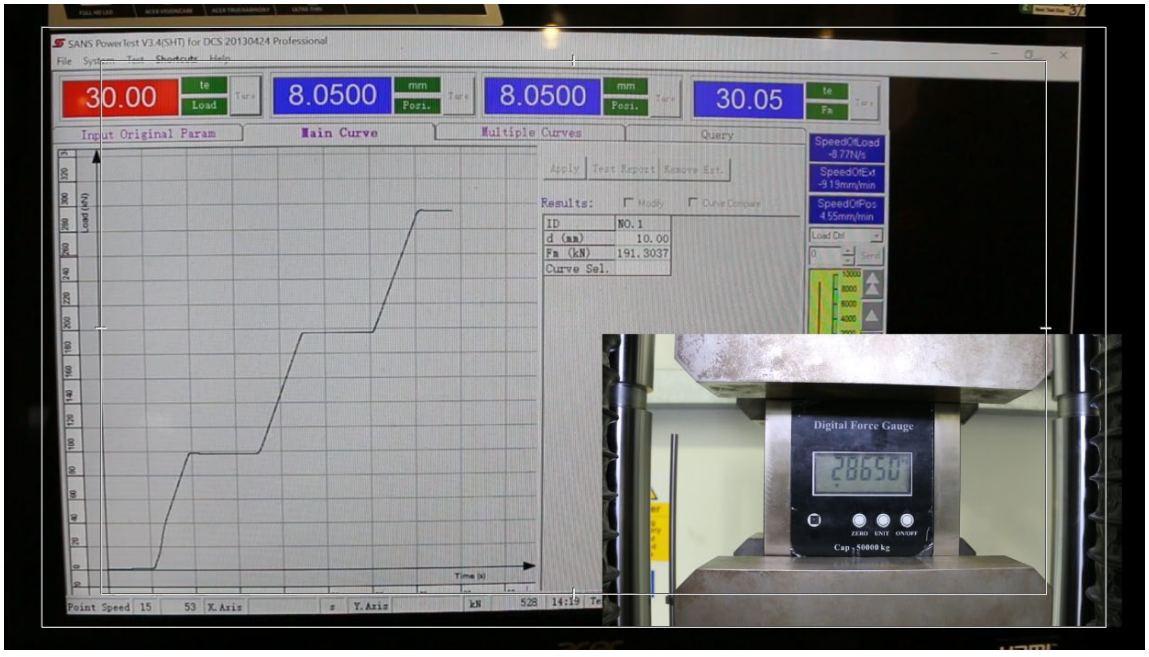


2nd Measurement

Force endured	20te (20000kg)
Force registered by load cell	19100kg (19.1te)
Inaccuracy amount	900kg (0.9te)
Inaccuracy percentage	4.5%

3rd Measurement

Force endured	30te (30000kg)
Force registered by load cell	28650kg (28.65te)
Inaccuracy amount	1350kg (1.35te)
Inaccuracy percentage	4.5%

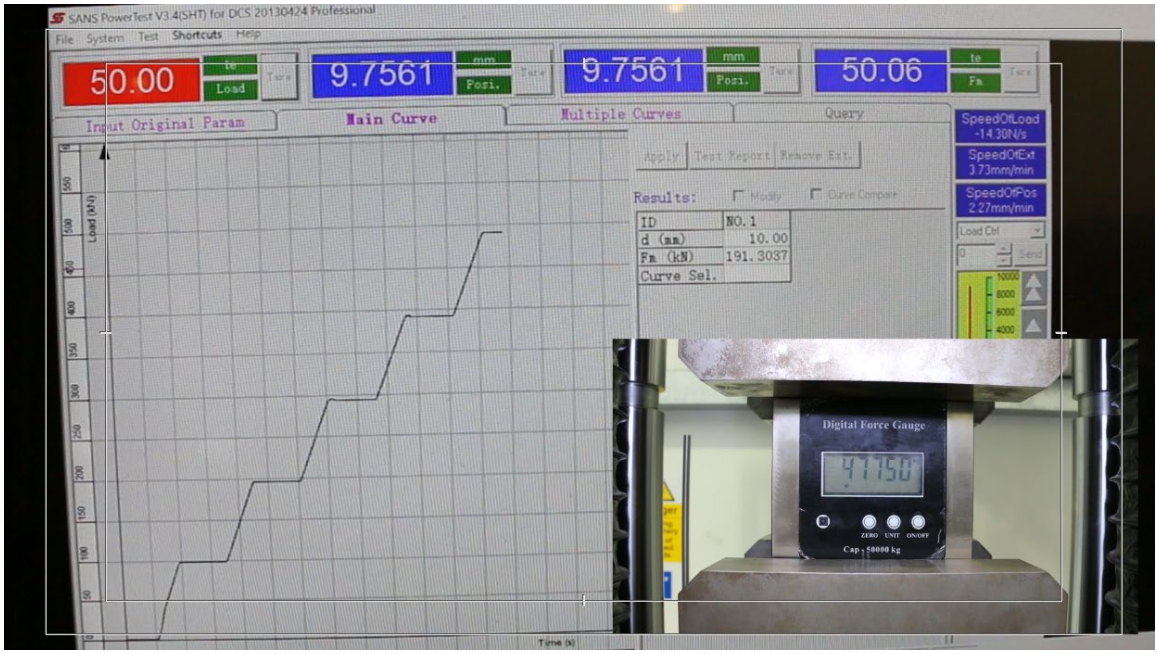


4th Measurement

Force Endured	40te (40000kg)
Force registered by load cell	38200kg (38.2te)
Inaccuracy amount	1800kg (1.8te)
Inaccuracy percentage	4.5%

5th Measurement

Force Endured	50te
Force registered by load cell	47750kg (47.75te)
Inaccuracy amount	2250kg (2.25te)
Inaccuracy percentage	4.5%



2.2.3 – Conclusion: Accuracy Testing

Final result: consistently inaccurate by 4.5 - 5%

- Nearly 10x more inaccurate than the industry standard.
- This inaccuracy is not due to long and persistent use before we received this product. The load cell was sold to us on the assurance that it is brand new (grade A) and it has not been preowned or used in any other than for post build testing.
- All of SP's products are guaranteed to not exceed 0.5% inaccuracy.
- One would only see a 4.5% inaccuracy in a load cell that had not been calibrated for many years, had seen hard/frequent use or is of poor design / material selection.

2.2.4 – Onboard control panel functionality test results

ZERO – zeroed display without issue when no load was applied, and when load was applied.

ON/OFF – worked without issue (powered load cell on and off when pressed)

UNIT – Discovered major issue with this function. **Here are Joshua Young's (SP calibration technician) observations whilst testing this function:**

"Upon powering up the load cell and pressing the unit's button it shows that you can display in the following units: kilograms, tonnes and pounds (lb). However, the zero did not change from "0" meaning that the divisions of the load cell do not alter based on what unit you're reading in…

…Once the pre-loading was complete I decided to test the load cell in all three units to see if my suspicions about the lack of divisional change were correct. "

Reading when unit is set to kg:

Reading when set to lbs

Reading when set tons (te)

Side-by-side comparison

2.2.5 – Conclusions – Onboard control panel functionality testing

Extract from Joshua Young's (SP calibration technician) report:

"What this testing did confirm is that despite the load cell offering three units, this makes no difference as it always outputs in kilograms. ***This is extremely dangerous as if it were being used in pounds without sufficient checks in place it would provide erroneous readings which at the least will halt any lift it's used on, or in the most extreme cases cause injury."***

2.3 - Wireless Distance and Handheld Device Testing

2.3.1 - Test Setup

- The test was undertaken outdoors.
- Direct line of sight was maintained between the handheld device and the load cell, with no solid objects obscuring/blocking the view between them.
- Test conducted away from any sources of radio frequency interference.
- Load cell placed upon a hydraulic lifting trolley, held at a height of 1 metre from the floor and kept static.
- No load is placed upon the load cell, so only '0' will be registered upon both the onboard display and the handheld, but will still mean a connection is present.
- Handheld is held by tester and is walked away from load cell in a straight line.
- Distance was measured using wheeled measure meter.

332.3.2 - Results

Figure A – Handheld device showing 'ERR 05' code saying that it has lost wireless connection with the load cell

Figure B – Showing test setup with handheld being walked away from load cell by tester

Figure C – Distance the handheld was away from the load cell (using a measurement wheel)

Test was carried out 5 times – Distances were recorded as soon as the 'ERR 05' (no connection) message was displayed more often than the '0' (full connection) being displayed.

Test No	Line of sight?	Distance measured
1	No	53.2m
2	No	57.9m
3	No	56.0m
4	Yes	63.1m
5	Yes	58.1m
6	Yes	55.7m
Average distance:		**57.33**

2.3.3 - Conclusion

- Load cell specifications state that the **minimum** distance for the wireless connection should be 80m. Our tests show that the handheld lost signal more than 30 meters under this minimum on average.
- It made no difference where the front side of the load cell was pointing whilst measuring the wireless connection distance, meaning the load cell's wireless signal broadcasts omnidirectionally. SP load cell's wireless telemetry signal strength goes out further from the front face of the RLP.
- For any large lift even around 80 meters would still be considered by any lifting professional as being an unsafe distance away to monitor the situation. The fact that the lifting manager would need to be as close as less than 60m to even get an adequate signal would be unacceptable and would be putting that person at risk.

2.4 - Battery Test

2.4.1 - Test Setup

Load cell specifications stated that the battery life would last for more than 40 hours. The unit takes 3 x AA normal batteries.

Two tests were performed:

1. Unit continuously powered on but without a connection to the handheld device.
2. Unit continuously powered on but with a connection to the handheld device.

The reason for the two tests was to see if there was of an added power draw from the connection to the handheld device over when it was not connected.

The point at which we deemed the batteries had fully discharged and were dry was when the LCD screen on the load cell was completely blank (i.e. not showing any display units).

2.4.2 – Results

Without connection to handheld device:

49hours 20mins

With connection to handheld device:

49hours 10mins

2.4.3 – Conclusion

- The battery life correlated to the battery length time stated in the specifications. This was true during both tests with and without connection to the handheld device.

2.5 - IP Performance Test

2.5.1 - Test Setup

The standard environmental protection rating for SP's load cell products is **IP67**, which means that our load cells prevent dust from getting inside and also can withstand being submerged into 1m of water for up to 30min without compromise.

No IP rating was specified to the load cell with its list of features, so we decided to test it the same way we would test our products to see if they meet the IP67 rating.

Test 1: Dust ingress protection

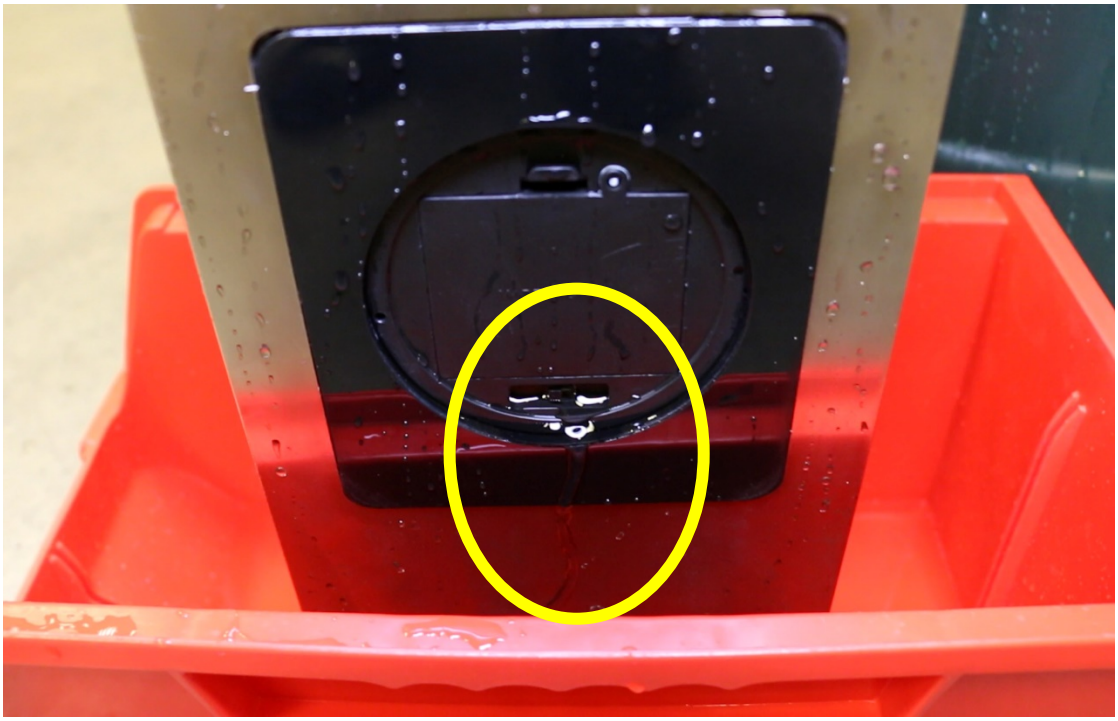
This was a general visual inspection test to see if there were any holes in the unit where dust could penetrate inside the unit and potentially degrading the electronics.

Test 2: Water ingress protection

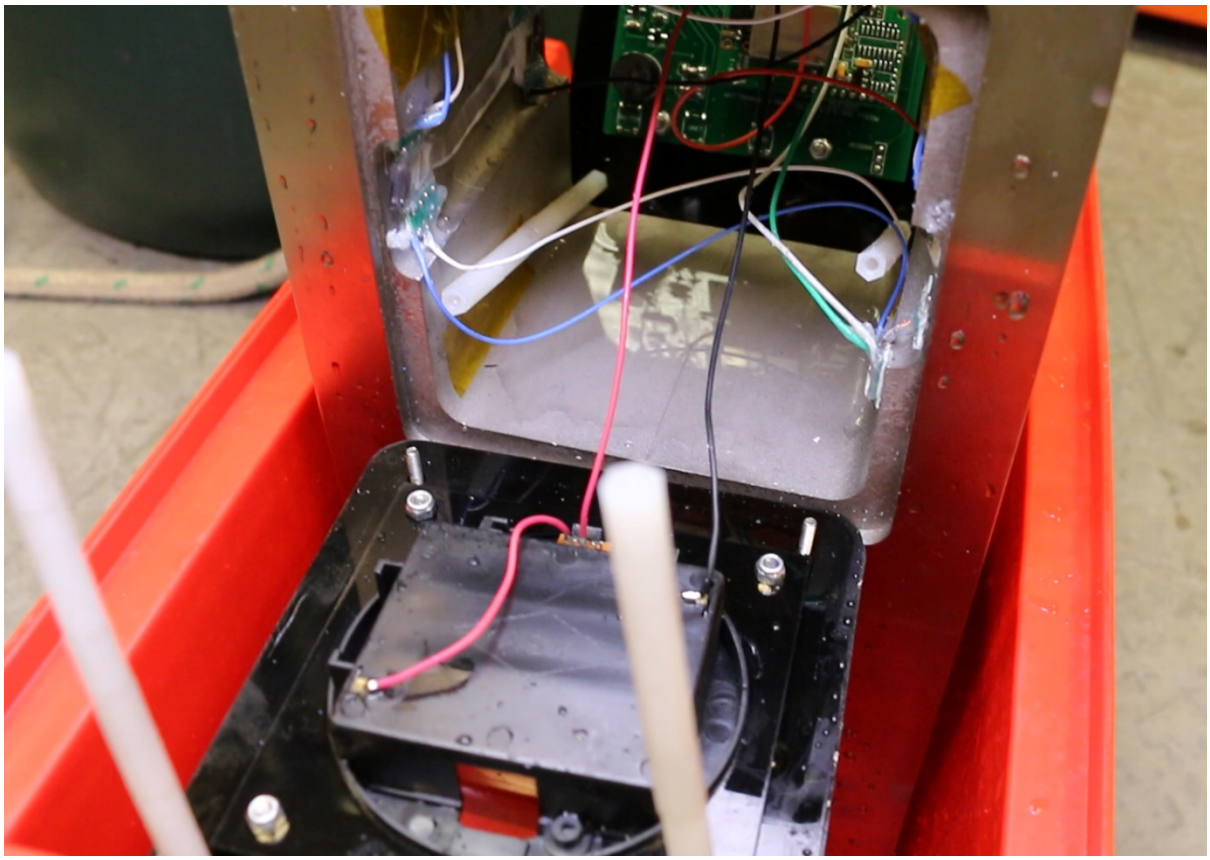
We filled a 1m-high water bucket with water and fully submerged the load cell. As soon as it was submerged we started a stopwatch so we could remove the load cell as soon as 30mins had gone by. We would then place the load cell into a bucket to collect any water leaking from within the load cell and to also open it up to check for internal moisture.

2.5.2 - Results

- As soon as the load cell was submerged a multitude of bubbles rose to the surface, signifying water was leaking into air pockets inside the unit.
- After 30mins of submergence we removed the unit from the water and placed it within a shallow bucket. It was immediately apparent that a large quantity of water was leaking out of the void where the circuitry was housed.



- Water had completely saturated the inside void, covering the circuitry and the gauging.



- When the batteries were reconnected the display panel initially turned on, performed general booting sequence and then shut off. Nothing showed on the screen and the unit failed to function when force was applied to it in order for it to display a measurement.

2.5.3 - Conclusion

- It was determined that the highest dust ingress protection we could place on the unit was **2** (protected from solid objects bigger than 12.5mm, e.g. a finger).
- It was determined that the highest water ingress protection we could place on the unit was **1** (protected against droplets of water hitting the unit vertically).
- A final IP rating of **IP21** was given to the load cell**.** Meaning that it would not be fully protected from general outdoor environments, even below levels of only mildly adverse weather involving moderate amounts of rain and wind. There is a high chance that even after a short amount of time of being used in the field the product would degrade enough to seriously affect its operational reliability.

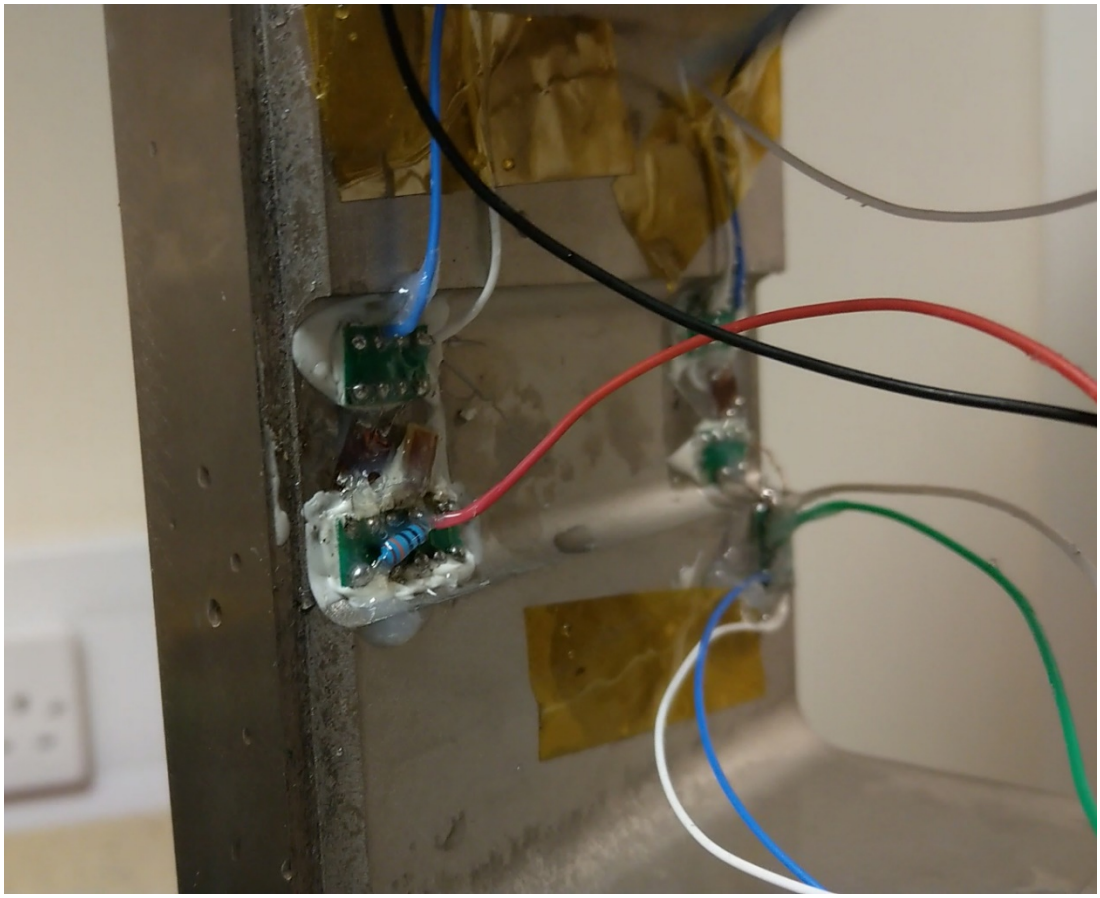
2.6 - Internal Inspection

2.6.1 - Inspection Brief

Here was the list of items to check whilst the front and back plates were opened to expose the inner componentry:

1. Wiring from gauging to circuit board
2. State of the gaskets
3. Strain gauging encapsulation state
4. General refinement and tidiness of connections and componentry
5. Condition of circuit board(s)
6. Construction method to seal unit together

2.6.2 – Conclusion



- Internal inspection found poorly fitted gauging and untidy wiring, which reflected the overall poor quality of the product.
- Wiring was poorly routed and was not tied down, which would mean the wires would move during use and transportation, leading to a possibility of wire disconnection.

- The internal gauging along with the wiring was poorly fitted. Reliability of the unit to product accurate readings would be questionable (through poor contact with the metal housing) and the longevity (life span of the product) would possibly be reduced in the event of rough handling. If it was dropped or hit any other hard object then the gauging and wires could dislodge and the product would become completely useless.
- There was no sign of any rubber gasket seal surrounding the front and back plates that would have been a relatively inexpensive addition by the manufacturer to protect the inner circuitry.

2.7 - Destruction Test

2.7.1 - Test Setup

Unit was sent to ATR Group in Scotland for destruction testing. This is where it was placed within their specialised hydraulic material strength capacity test machine and put under tension. Both ends of the load cell are rigged with shackles and attached to separate pulling arms, which pull in opposite directions until the load cell yields (i.e. snaps in half). One could compare the process to a Christmas cracker and two people pulling on it until it rips open with a bang.

The specifications for the competitor's load cell states that its "Ultimate Load" is 400% of stated 50t capacity (i.e. 200t/200,000kg). We also measured the hardness of the metal and it came out to have a Rockwell rating of 47 (HRC), meaning that it has hardness on the upper end of what tensile load cell elements should be.

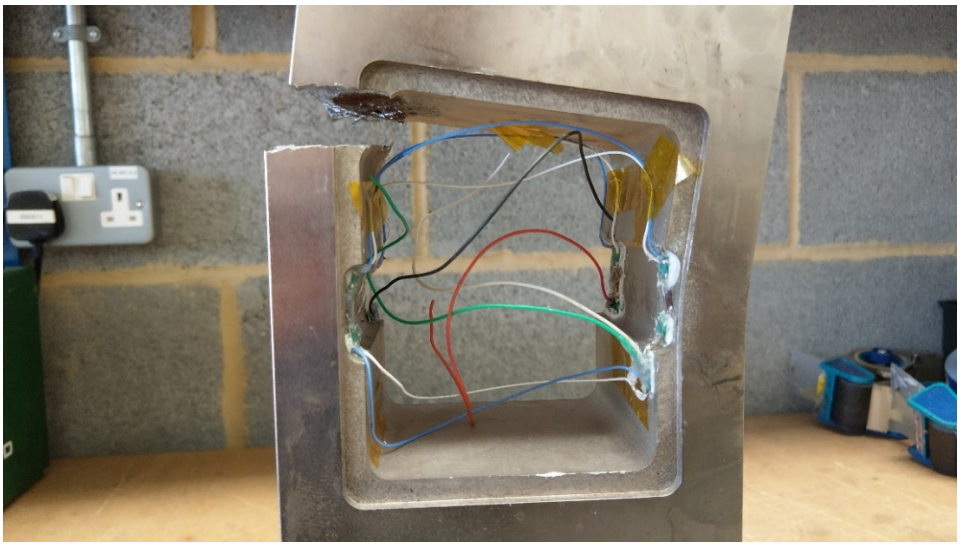
2.7.2 - Results

- The load cell surprisingly, and disconcertingly, yielded at 71,370kg / 71.37t.
- This is only 142.74% of stated capacity
- Which means that it was 128.63t (257.26%) off its "Ultimate load" or safety factor.

Destruction test machine's reading at the point where the load cell snapped (71.37te)

Photos of the load cell after it has yielded in the destruction test. As you can see it has snapped only on one side, which is highly unusual:

Closer view of snap on one side of the load cell

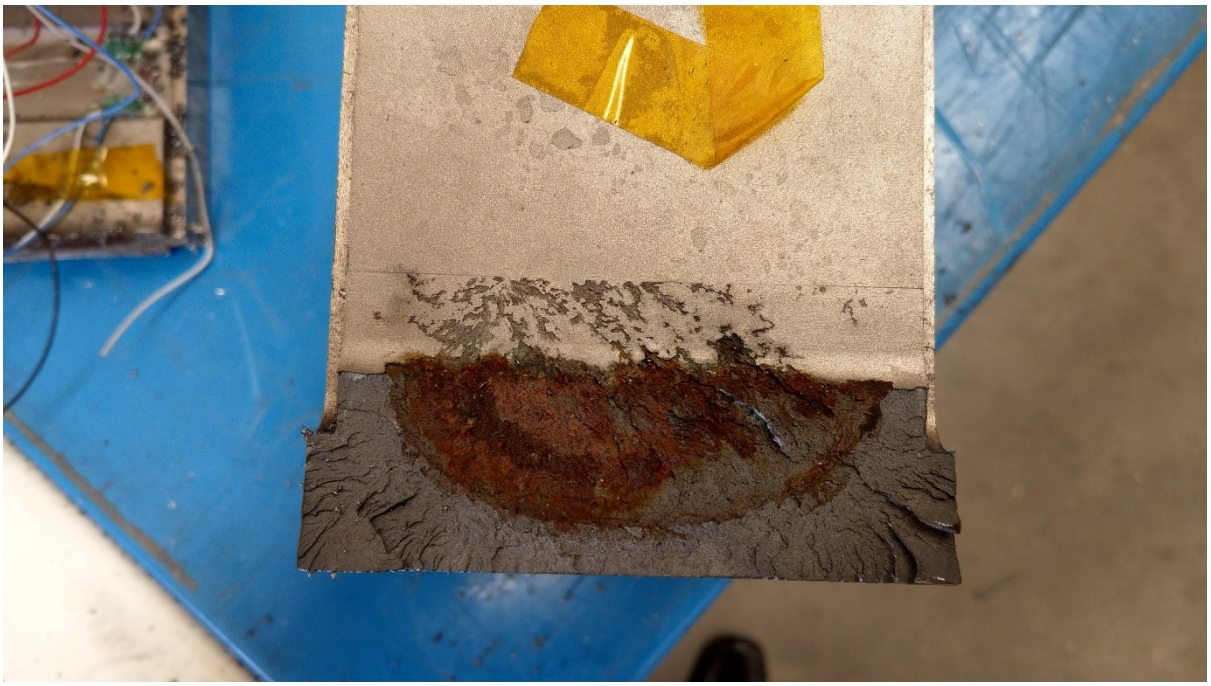


Extreme close up looking up into the snapped fault point

Extreme close up looking down into the snapped fault point

Top down close up shot of freshly cut through side that did not snap in the destruction test

Top down close up shot of the side that snapped in the destruction test



Results continued:

- After further inspection it was found that there had been a fault in the metal right at the point where the load cell snapped.
- The fault had rusted where the water from the IP water dunking test had ingressed through tiny fractures in one corner of the central void, into the fault.
- Tiny fractures can be seen in the oxidised metal fault area.

2.7.3 – Conclusion

Load cell had catastrophic failure at just 71.3 tonnes instead of 200 tonnes +.

Dangerous to use and totally unfit for purpose and could easily fail, causing a fatality.

3 - SUMMARY CONCLUSION

3.1 – Features and Specifications Testing Results

3.1.1 – Manufacturer Listed Specifications versus Actual Comparison

	Claimed Features/Specs	Actual Features/Specs	Conclusion
Capacity	50te	50te	**None**
Dimensions	465mm(L) x 150mm(W) x 104mm(D)	465mm(L) x 150mm(W) x 104mm(D)	**None**
Weight	20kg	47kg (+27kg)	**Over 135% heavier**
Material	Alloy Steel	Alloy Steel – Rockwell hardness rating: 47 HRC	**On the upper end on the hardness scale for a load cell**
Reading Accuracy	Within 0.05%	4.5 – 5%	**This is over 800% over their maximum accuracy allowance**
Environmental Protection	Unknown (IP67/68 optional)	IP21	**Not recommended for use in outdoor conditions**
Proof Load	75te (150% of rated load)	Based on destruction test: 24te	**Dangerous**
Maximum Safety Load	62.5te (125%)	Based on destruction test: 21te	**Dangerous**
Ultimate Load	200te (400%)	Based on destruction test: 72te	**Dangerous**
Battery Life	≥ 40 Hours	≥ 40 Hours	**Matched specified life span**
Remote Control Distance (Infrared)	Min 15m	Max 15m	**Load cell could not receive anything from the remote beyond 15m**
Wireless Distance to Handheld Controller	Min 80m	Max 57.33m	**Signal disconnection over 22m from stated minimum distance**

3.1.2 – Test Results Summary

Test enacted	Results	Conclusion
Product aesthetic inspection	(C Grade)	**Poor condition for a new product**
Load Accuracy	4.5-5% inaccurate	**Exceedingly bad for any load cell**
Operational Functionality	- Did not convert measured weight when switched to pounds and tonnes - IR remote control had limited use, only three buttons worked; the rest were functionless	**- Potentially dangerous as the lifting professional using the load cell may assume load is in pounds when the load cell is showing weight in kilograms** **- Poorly refined product**
Telemetry Distance	Signal loss – 57m	**This short range means that the wireless function is virtually redundant because the lifting professional would need to be dangerously close to the load**
Battery Life	• Without wireless connection to handheld: 49hours 15mins • With wireless connection to handheld: 49hours 10mins	**Performed as load cell's specification stated**
IP Performance	Failed IP67 dunk test. We believe that the highest rating it can have is IP21	**This load cell is not suitable for use in outdoor scenarios**
Internal Inspection	Found to be unprofessionally gauged and wired.	**- No quality to finishing, highly unprofessional** **- Virtually no wire tidying** **- Frayed Gauging** **- Messy gluing** **- Circuit board for transmitter/receiver, LCD, and power regulator OK** **- No sealant** **- Large hole in battery compartment leading to core cavity where gauging and electrical componentry is located.**
Destruction	Yielded at 713.7 Newtons (72.77te)	**Snapped at only 154.5% capacity load (specifications stated 400%)**

3.1.3 – General Test Results: Summary

Out of the seven main tests performed on the load cell it only managed to pass one of them. This one test pass, for the running battery life, is devalued by the fact the batteries used were not proprietary to the manufacturer and were provided by SP.

As a customer, one would instantly return something if they were to find it in the rough grade C condition this load cell was found in. That would be especially so as this was a “brand new” product with a price tag within the three-figure region. The box and packaging it came in, being flimsy and tatty, did not help portray this as a premium product, nor did it give one the impression that the manufacturer’s best interests were to keep it fully protected from being damaged whilst in transit.

The workmanship on the gauges, seen during the internal inspection, was extremely slapdash, shoddy, and untidy. Through sharp movement and heavy handling, as is the nature of the environment it would be used in, we cannot expect a long lifespan of reliability. There’s no guarantee that it will continue to function as intended beyond the first usage.

The telemetry distance was found to be so low that it would make it near useless. When it starts to lose connection it is barely striking the 50m-mark. In comparison the SP Handheld would not lose connection until a distance of 700m (that’s 14 times further away). Who would want to stand within 50m of a 50te lift?

The unsafe inaccuracy of the load readings and the inability for the unit to convert the load amount from kilograms, to pounds, or tonnes, could only eventually lead to disaster whilst lifting oversize loads. We say that the inability for the load cell to convert the units from kilograms is even more dangerous than its inaccuracy. When converting from kilograms to pounds, the number in pounds should be 2.2 times higher. A lifting professional, believing that it was showing the load’s weight as pounds, would be unaware the load is over two times heavier and would not know to abort the lift due to it possibly overloading the lifting equipment.

Even with the enormity of the aforementioned failings, they pale in comparison to the worst one: the fact that it snapped at only **154.5%** of its stated load capacity (stated safety factor: 4:1). It proves that the creators are not interested in carrying out a comprehensive, detailed, and intrinsic testing regime on its products but instead, it would seem, prefer to use guess-work to fill in the spec sheets. Their conscience is perhaps unaffected by the possibility of anything, and more importantly anyone, coming to harm. It could be considered that making a profit is more important to them than safety when their product is used.

3.3 - Final Conclusion

HIGHLY DANGEROUS TO USE – MAY LEAD TO FATALITIES, INJURIES AND SERIOUS ASSET DAMAGE/DESTRUCTION IN THE FIELD IF UTILISED WITHIN A LIFTING PROJECT.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making the lifting industry a safer place