



XLDS PRESSURE GAUGE COMPARATOR MANUAL



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Gauge Comparator System Overview

The Dive Lab pressure gauge comparator was originally intended and designed to compare the high and low pressure gauges installed in, or used with, the Dive Lab Extreme Lightweight Diving System (XLDS) including the pneumofathometer (pneumo) gauges. The comparator can also be used to compare other "CLEAN" life support gauges installed or removed from their system. The comparator system is a small suitcase size system that weighs approximately 38 LBs, and unlike deadweight testers where the gauges need to be removed from the system and pressurized with water, the Dive Lab Comparator uses breathing quality air or high grade nitrogen as a test media to simply compare all diving system gauges without having to remove them from the system which eliminates and minimizes system generated contamination as well as reducing wear on the gauge pipe threads. The system comes with two high precision digital test gauges which are certified to have a full scale accuracy of 0.05% and allow for an unsurpassed level of onsite (in the field) accuracy normally only achieved within a laboratory type test facility setting. The only disadvantage to this system is you are limited when testing the high pressure gauges to the maximum supply pressure you have to work with. For most this is not a problem because they simply use their normal HP supply system as their supply source.

For many, this may be using a 3000 psig or maybe a 4350 psig SCUBA or SCBA cylinder. Regardless, as you can compare the gauges to within 20% of the maximum supply pressure, this will give a good assurance of the accuracy of gauges being compared.

Understanding Gauge Calibration/Comparison

The term calibration is often mis-used. The term calibrate means to adjust or correct to a certain standard or level of accuracy. Gauge comparison is not calibration it is just comparison. Comparison identifies and quantifies the error in an instrument so a proper correction can be applied providing the error is constant and not erratic. If comparison shows that the readings are erratic, then the gauge must be repaired or replaced. Minor discrepancies can be quantified and noted.

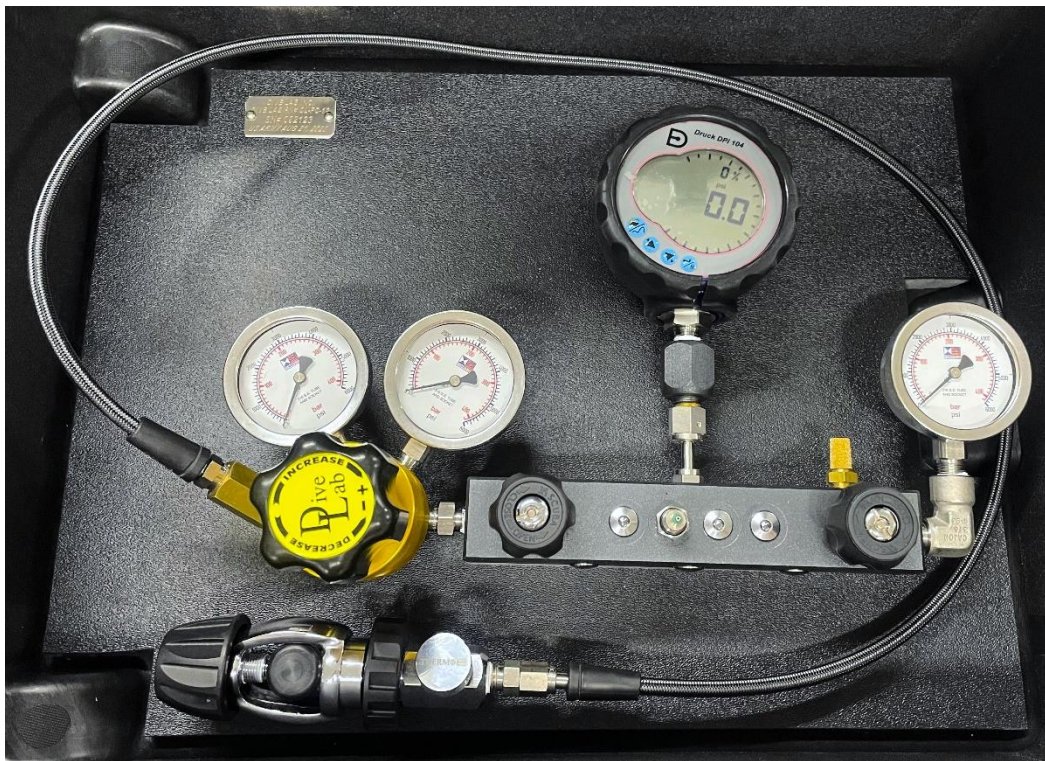
Accurate Gauge Comparison/Calibration

For accurate gauge comparison, it is generally accepted that the master gauge has a full-scale accuracy at least 4 times greater than the gauge being checked. As an example, a typical 2.5" diameter pressure gauge as used in many support systems will usually have a stated accuracy of between 1.5-3% of the full-scale rating. This means a typical 5000 psig gauge could be off as much as 75-150 psig and still be within specs. Some gauges state a 3-2-3 accuracy, this means 3 % accuracy in the first 1/3 of the reading, 2% in the middle of the reading, and one third in the last part of the dial reading. The master gauge that you would need to use for comparison should have a stated accuracy at least 4 times greater than the gauge being checked. This means you would use a master gauge with an accuracy no less than 0.25 %. A 5000 psig master gauge with a full-scale accuracy of 0.25% would have an allowable error of $5000 \times 0.0025 = 12.5$ psig over the 5000 psig span. The 5000 psig Druck® gauge used on the Dive Lab comparator has a stated full-scale accuracy of 0.05%, $5000 \times 0.0005 =$ this allows an error of up to 2.5 psig over 5000 psig range this makes it 5 times more accurate than a 0.25 gauge and over 50 times the accuracy of a typical 3% stated accuracy pressure gauge installed XLDS HP

gauge. The digital gauges used in the Dive Lab comparator are usually never off by more than 0.5 psig, when they are recertified, and have a long service life can be expected.

Dive Lab Gauge Comparator

The basic comparator system consists of a high pressure manifold and regulator assembly which acts as the foundation and mounting structure to which the HP test gauge and whips attach to. The manifold is mounted to a plastic plate that mounts into a Pelican® case. The manifold and whip assemblies have a maximum rated working pressure of 5000 psig (345 bar) when used with the properly rated fittings. In 2017, there was a separate LP whip assembly designed to be used strictly for pneumo gauges which uses a small hand pump. With this system, the 300 psig gauge is used for comparing the pneumo gauges is used totally separate from the manifold. This new assembly can also be used with older gauge comparators. In August of 2023 there were a few other changes made which will be shown in this revision.



Comparator Manifold

High and Low Pressure Test Gauge Assemblies

There are two electronic digital test gauges used with the system. These gauges have a full scale accuracy of 0.05 % making gauge comparison extremely accurate giving laboratory quality comparison. The 5000 psig gauge has a ZCO O-ring attachment which mates to the main manifold. The type same ZCO fittings attach the inlet and outlet supply whips for quick easy interface. The 5000 psig gauge is used for comparing the high and low-pressure gauges or any gauge up to 5000 psig. The 300 psig test gauge has now been replaced with a 100 psig gauge which is only used for testing the

pneumo gauges on the control console. The high-pressure gauge attaches to the comparator manifold when testing HP and LP gauges. In the past it could also be mounted on the XLDS console to any of the low-pressure circuits. With the new method mounting the HP master gauge to the XLDS manifold is no longer recommended and should only be mounted to the gauge comparator manifold.



Druck® Test Gauges 0-100 to the left and 0-5000 psig on the right

Comparator HP Supply Whip Assembly

The high pressure supply whip assembly that sends air from the test pressure source (usually a SCUBA cylinder) to the inlet of the comparator HP regulator. This whip is 48 inches long and has a DIN / "A" Yoke assembly on one end for the supply source and a female ZCO fitting on the other end that attaches to the male ZCO male fitting on the manifold regulator as shown below. The new version no longer uses the 9/16" ZCO but instead a 7/16" straight thread with O-ring spool piece. The new version is permanently mounted and does not require removal for storage.



Old Version inlet Fitting w/ 3/8"-24 adapter



New version Inlet Fitting w/ZCO adapter

Comparator HP Routing Whip/Block Assembly

The outlet whip and block assembly is used for supplying gas from the manifold to the HP and intermediate pressure gauges being tested on the XLDS. This assembly is rated for a maximum working pressure of 4350 psig consists of a 48 inch long whip attached to a routing block assembly with three 30 inch long whips for attachment to the inlet of the XLDS console. The assembly is rated for 4350 psig (300 Bar) working pressure. The assembly can also be used separately with the 100 psig gauge for testing the pneumofathometer gauges with the hand pump.



Routing block/with HP regulator Inlet Adapters



Attaching HP system

XLDS Low Pressure Gauge Comparison Configuration

The RDC low pressure gauge calibration configuration has been changed slightly, and now uses a single adapter fitting. This fitting is simple modified A/N adapter assembly that mates to the female oxygen on one side, by 7/16 straight thread with a Spool Piece on the other as shown below. The three leg manifold is configured by plugging two of the 30" whips and attaching the third to the adapter as shown below.



The 48" whip is then attached to the top of the gauge comparator manifold using a Spool Piece

Pneumofathometer Gauge Configuration

The pnetmo gauges are configured using the triple male QD "T" assembly. The basic configuration has each of the three Diver pneumo hoses female QD attached to the "T" and the 48" whip attached to the LP gauge and block manifold. Unlike earlier configurations, pre 2017 comparators, changes have been made that use a small hand pump and the LP gauge is no longer attached to the RDC manifold. This change reduces the possibility of over pressurizing of the 100 psig Druck Gauge. The addition of a shut off valve on the pneumo gauge block assembly allows for more precise pressure increment control.



Pneumo QD Adapter - Allows Testing of all three depth gauges at the same time



Pneumo Gauge Configuration

XLDS Gauge Comparison Configuration and Line Up

WARNING

Only use diver's quality breathing air or a supply of high purity nitrogen for gauge comparison. Never use oxygen or oxygen enriched gases or any other type of gas to supply the gauge comparator. Using oxygen enriched gases could lead to a fire or explosion resulting in great bodily harm or death.

WARNING

Only use this system for comparing gauges that are used for life support equipment only. Do not use the XLDS comparator for comparing gauges that have been used in systems that have not cleaned for breathing life support use.

NOTE

You will only be able to compare the HP gauges to the highest supply pressure that is attached to HP inlet. For SCUBA tanks with "A" yokes this would be a maximum of 3500 psig and for DIN this could be as high 4350 psig. The XLDS HP gauges are 0-6000 gauges. As a rule, mechanical gauges (analog gauges) should not be pressurized to more than 80% of their range. Pressurizing to the full gauge pressure can in time, stress the gauge, causing gauge error.

NOTE

At the present time this new version of the XLDS gauge user guide is intended to replace the older system of XLDS gauge comparison. Older versions of the gauge comparator can be upgraded at minimal expense. For information, please contact Dive lab Inc.

This guide will explain the basic set up for testing first, the HP gauges, followed by the LP gauges, and

lastly the diver pneumofathometer gauges. The high accuracy 0-5000 psig digital gauge is used for both the HP and LP gauges. The pneumo gauges are compared with the 0-100 psig gauge using the hand pump only.

XLDS RDC Configuration for HP Gauge Calibration

NOTE

The fittings that use the special double "Spool Piece" need only be hand tight due to the O-ring sealing. Occasionally lightly lubricate O-ring using Christo Lube ®.

1. On the XLDS RDC, back off counterclockwise Red, Green and Yellow supply regulators until the knob spins freely, and there is no pressure being supplied to any of the regulators
2. Ensure Red, Green and Yellow LP gauges are reading zero pressure
3. Check shut Red, Green and Yellow Pneumo valves
4. Open XC-1 and XC-2 cross connect valves
5. Open ALP-2G Green Dive umbilical outlet valve
6. Check shut, ALP-1R Red and ALP-3Y Yellow umbilical outlet valves

HP Gauge Comparator System Set Up

NOTE

The following steps when done in order will ensure the best results when comparing the HP gauges

1. On the gauge comparator, ensure the gauge comparator regulator has been backed off counterclockwise and both the manifold inlet valve, and manifold vent valve have been shut
2. Ensure the three analog gauges read zero
3. Remove the protective plugs from both the 5,000 psig digital test gauge, and the gauge comparator ZCO attachment points on manifold
4. Attach the 5,000 psig digital test gauge to the female ZCO fitting
5. Remove the DIN/Yoke HP inlet assembly from the mounting post and attach to the air supply to be used, minimum 3,000 psi

NOTE

The pre-2021 gauge comparators did not have a DIN/Yoke mount in the box which required removal and stowage of the inlet supply system from the manifold. The new system allows the HP supply to stay installed.

6. On the gauge comparator, attach the HP routing block 48" hose to the top of the gauge comparator manifold and hand tighten only



7. On the RDC, remove the protective caps from the ZCO face seal fittings on Red, Green and Yellow regulator inlet fittings and ensure each fitting has an O-ring in place
8. Install an interface adapter to Red, Green, and Yellow RDC ZCO HP inlet fitting and hand tighten
9. Remove the HP plugs from the end of the three 30" hoses, then attach each hose to each ZCO adapter, making sure each has the Spool Piece installed. Hand tighten only



10. Turn on the Druck® digital gauge by depressing the button to the left on the gauge and zero if necessary

NOTE

The Druck® digital gauge shuts itself off after 10 minutes. If this happens with pressure on the system, simply press the on button but do not re-zero if there is any pressure on the system. Re-zeroing with pressure on the system will result in a "Tare Reading" which will be obvious and will require bleeding off all pressure and then re-zeroing again. For more information on the digital gauge refer to the Druck user guide.

11. Slowly open the cylinder supply valve and bring pressure up to the comparator regulator, as read on the regulator inlet gauge

NOTE

For safety, the gauge comparator supply system has a built in flow limiter which only allow pressurizing slowly.

12. Open the manifold supply valve $\frac{1}{4}$ to $\frac{1}{2}$ turn, then slowly load the hand loader to approximately 3,000 psig as read on the digital gauge. The manifold analog gauges will follow, as well as the RDC HP gauges. Once 3,000 psi has been achieved, secure the manifold supply valve, and vent the system
13. Repeat step 12, two or three times to exercise the gauges which helps improve accuracy. Once several cycles of exercising has been completed, comparison/calibration can be started

NOTE

Dive Lab recommends doing the RDC HP gauges at minimum of 10 points down and 6 points up. Recording the readings on the HP gauge sheet.

XLDS Comparing the High Pressure Gauges

NOTE

Maximum supply pressure for the XLDS would be 3,500 psig if "A" yokes are used with SCUBA cylinders, or up to 4350 psig (300 bar) if the DIN connections are used.

NOTE

Use the Dive Lab HP comparison log sheet to document and record the comparison. Customized log sheets can be made up by the user.

NOTE

Dive Lab recommends checking at least 10 points at increasing pressure, and at least 5 points at decreasing pressure.

1. Back off comparator regulator counterclockwise until there is zero pressure and vent the system through comparator vent valve until there is zero pressure on the digital gauge
2. Shut the vent valve
3. Open the manifold supply valve
4. On the comparator, slowly load the regulator to the first check point, allow to stabilize and document the observed pressure on Red, Green and Yellow HP Gauges. Lightly tap on the gauges being tested with your finger to settle the needle.
5. This exact digital setting can be achieved by slowly loading the regulator and manipulating the manifold vent valve.

NOTE

Another option, is to go slightly beyond the desired test point pressure that you are checking, then using the vent valve slowly bring the master gauge to the exact desired test point pressure, then check the three HP gauges tapping lightly on each of the gauges.

NOTE

The high pressure analog gauges have an accuracy of 2% full scale. Maximum allowable deviation is 120 psig.

NOTE

Pressure changes needs to be made slowly to avoid temperature variation - which will affect pressure reading.

6. Continue step 4 with each increment, until the maximum desired pressure increment, has been reached
7. After the RDC HP gauges has been checked to the maximum desired pressure, check at least 5 increments by decreasing the pressure
8. Upon completion of HP gauge testing, back off on the gauge comparator loader and vent all pressure from the system. Close the vent valve

RDC Low Pressure Gauge Calibration

Once the HP Gauges on the RDC have been calibrated proceed with steps below

1. On the gauge comparator, back off the regulator counterclockwise until there is no pressure on the gauge comparator manifold
2. Remove the three 30" whips from the 7/16 - ZCO adapters on each RDC regulator and cap Red, Green, and Yellow ZCO inlet fittings on the RDC
3. Install the HP SS plugs with Spool Pieces in two of the 30" whips and hand tight
4. On the RDC, install the 7/16 to O2 adapter to Green Divers umbilical outlet fitting and tighten the Oxygen nut, using a 11/16 open end wrench with the force of three fingers. See picture
5. Ensure Red, Green, and Yellow pneumo valves are shut
6. Check shut ALP-1R and ALP-3Y
7. Open XC 1 and XC 2 cross connect valves
8. Open ALP-1G

NOTE

Dive Lab recommends testing in 50 psig increments - to 350 psig.

9. On the comparator, slowly load the regulator to the first check point, allow to stabilize and document the observed pressure on Red, Green and Yellow LP Gauges. Lightly tap on the gauges being tested with your finger to settle the needle.
10. This exact digital setting can be achieved by slowly loading a regulator and manipulating the manifold vent valve.

NOTE

Another option, is to go slightly beyond the desired test point pressure that you are checking, then using the vent valve slowly bring the master gauge to the exact desired test point pressure, then check the three HP gauges tapping lightly on each of the gauges.

NOTE

The high pressure analog gauges have an accuracy of 2% full scale. Maximum allowable deviation is 12 psig.

NOTE

Pressure changes needs to be made slowly to avoid temperature variation - which will affect pressure reading.

11. Continue step 4 with each increment, until the maximum desired pressure increment, has been reached
12. After the RDC LP gauges has been checked to the maximum desired pressure, check at least 5 increments by decreasing the pressure
13. Upon completion of LP gauge testing, back off on the gauge comparator loader and vent all pressure from the system. Close the vent valve

Comparing the XLDS Depth/Pneumofathometer Gauges Using the Hand Pump

The first few gauge comparators that Dive Lab made were configured so that the LP digital test gauge was installed in the center of Green Divers manifold using the 3/8" straight thread O-ring port. After 2016 things were changed and the gauge is now attached to a small "T" assembly that connects the digital test gauge and a small bicycle hand pump to the pneumo QD circuit and allows pressurization of all three gauges at the same time. The hand pump allows very fine and accurate control during the comparison process.

In 2023 this was changed again by slightly increasing the size of the low pressure gauge manifold, and adding a gauge shut off valve to isolate pump leakage.

CAUTION

The 100 psig gauge and hand pump are only intended to use for testing pneumo gauges and should never be attached to the comparator manifold or gauge damage could occur from inadvertent over pressure.

1. Ensure there is zero pressure on Red, Green, and Yellows LP gauges and the three pneumo gauges valves are shut, then mate Red, Green, and Yellow female quick connects to the triple plug adapter.



Pneumo Triple plug adapter attached to the gauge and pump

NOTE

There are two Schrader valves on the small manifold that the pump attaches to. The hand pump is only attached to the Schrader valve that has the flush tip. The other Schrader valve has the tip extending out of the threaded shoulder and is for venting off pressure only.



Schrader vent valve flush tip
for pump attachemnet



Schrader vent tip sticking out – for venting only

2. Attach the hand pump to the 100 psi gauge assembly by screwing it onto the flush Schrader valve, until finger tight

3. Attach the comparator block whip assembly to the 100 psig gauge assembly



4. With the pneumo configuration, using the hand pump, pump up the system until the digital test gauge reads between 90 and 100 psig. The three pneumo gauges should track together and should show just over 200 fsw then vent the system to zero using one of the three umbilical supply valves or by depressing the Schrader valve. Exercise the gauges in this manner at least two times prior to taking readings
5. Vent all pressure, and then zero the three pneumo gauges using a small screwdriver. Zero the pneumo gauges by lining up the mirrored background to the needle and the lines on the bezel and adjusting using a small screwdriver



6. After the XLDS pneumo gauges have been exercised, slowly pressurize the test gauge to the desired increments as shown on the Dive Lab pneumo comparison sheet. Use the hand pump and the Schrader vent valve to vary the pressure as necessary, to arrive at the required pressure on the digital gauge. Record the pneumo gauge readings on calibration sheets for Red, Green and Yellow Diver

NOTE

Dive Lab recommends checking in descending order starting at 5, 10, 15 and 20 fsw, then every 10 fsw increments to the deepest depth of 200 fsw. Then check in 20 fsw increments back to 20 fsw. After 20 fsw, recheck 15, 10 and 5 fsw.

7. After checking and documenting the results, ensure all pressure is vented, then remove the digital test gauge. Cap/plug all fittings to maintain cleanliness

Care and Storage of the Gauge Comparator

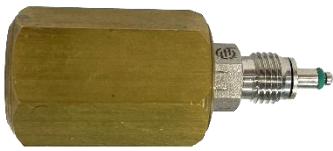
The gauges as well as all hoses and attachment fittings must be plugged and capped to maintain foreign material exclusion. The gauges should be inserted in the padded fabric pouches, and test fittings should be placed in bags and sealed. The supply and outlet hose assemblies should also be placed in the fabric padded cases.

Yearly Digital Gauge Certification

The two digital gauges are considered test standard gauges and because of their high accuracy they must only be compared by those that have the capability and equipment necessary to perform the certified comparison. Dive Lab has the gauges certified by INNOCAL prior to commissioning the system. Dive Lab recommends sending the gauges back to INNOCAL once a year for re-certification. Before sending the gauges carefully remove the adapters from the gauges and store. Cap the end of the gauges with plastic caps and carefully wrap up and pad the gauges to prevent shipping damage. Prior to sending the gauges back, contact Innocal by phone or e-mail and fill out the required forms. When the gauges come back from Innocal, remove, and replace the 9 volt battery in each of the gauges. Normally the battery will last at least a full year. Changing the battery at least once a year will minimize the possibility of damaged from acid leakage.



Gauge w/ Universal 1/4" FPT Gauge Adapter



Universal 1/4" FPT Gauge Adapter
Allows testing an individual High & Low Pressure Gauges



7/16-24 Stainless Steel Hose Plug w/Spool Piece



High Pressure Inlet Adapters
Allows testing all three HP gauges at the same time



Pneumo QD Adapter
Allows Testing of all three depth gauges at the same time



Spool Piece with 90 Durometer O-Rings

The spool piece comes from standard SCUBA High Pressure submersible pressure gauge hoses. Dive Lab modifies these for a use with all the 7/16" - 24 fittings



Low Pressure Inlet Adapter

Allows testing all three Low Pressure gauges at the same time



CERTIFICATION SHEET

XLDS HIGH PRESSURE GAUGE COMPARISON

Gauge Range: 0 - 5000 psig	Stated Accuracy:
----------------------------	------------------

System used on	Test Gauge Used	Date last certified

HP	↓	RED	↑	↓	GREEN	↑	↓	YELLOW	↑
0									
500									
1000									
1500									
2000									
2500									
3000									
3500									
4000									
4500									
5000									

Remarks:

Print Name	Signature	Test Date:



CERTIFICATION SHEET

XLDS LOW PRESSURE GAUGE COMPARISON

Gauge Range: 0 - 5000 psig

Stated Accuracy:

System used on	Test Gauge Used	Date last certified

HP	↓ RED ↑	↓ GREEN ↑	↓ YELLOW ↑
0			
50			
100			
150			
200			
250			
300			
350			
400			
500			
550			

Remarks:

Print Name

Signature

Test Date:



CERTIFICATION SHEET

XLDS DEPTH GAUGE COMPARISON

Test Gauge used	Date Last Certified

System Serial #				System Serial #				System Serial #				SUBJECTIVE PRESSURE PSIG
FS W	DOWN	UP	PASS / FAIL	FS W	DOWN	UP	PASS / FAIL	FS W	DOWN	UP	PASS / FAIL	
5				5				5				2.225
10				10				10				4.45
15				15				15				6.67
20				20				20				8.9
30				30				30				13.35
40				40				40				17.8
50				50				50				22.25
60				60				60				26.7
70				70				70				31.15
80				80				80				35.6
90				90				90				40.05
100				100				100				44.5
110				110				110				48.95
120				120				120				53.4
130				130				130				57.85
140				140				140				62.3
150				150				150				66.75
160				160				160				71.2
170				170				170				75.65
180				180				180				80.1
190				190				190				84.55
200				200				200				89

Remarks:

Print Name	Signature	Date



CERTIFICATION SHEET

PRESSURE GAUGE COMPARISON

Test Gauge Used Make/Model	Serial Number	Range	Stated Accuracy	Last Certified

Gage Being Tested Make/Model	Serial Number	Range	Stated Accuracy

Master Gauge Reading	Gauge Under Comparison Indicated Value	Numerical Deviation	% Deviation	Remarks

Print Name	Signature	Date