REPAIR MANUAL

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INTRODUCTION

Congratulations! Your company has purchased the finest pressure gauge in the world. The 3D Instruments Direct-Drive principle will greatly reduce the need for gauge repair and calibration adjustments. In the 3D Gauge, the standard C-shaped Bourdon element, gears, levers and pinions are totally replaced by a single helically-wound Bourdon tube. The 3D Bourdon tube, made of Inconel X-750, provides a full 270 degrees of rotation with an inherently linear motion. This motion is translated to an Elgiloy (nickel-cobalt alloy) shaft, which is supported by two jewel bearings of synthetic sapphire. The pointer is therefore moved directly by the Bourdon coil, eliminating all mechanical amplification and transmission devices (Figure 1). Before beginning repairs, it must be understood that 3D warrants its gauges for six years provided they are not dismantled.The technician is advised that carrying out many of the repairs given here, because they do involve dismantling, will void the warranty.

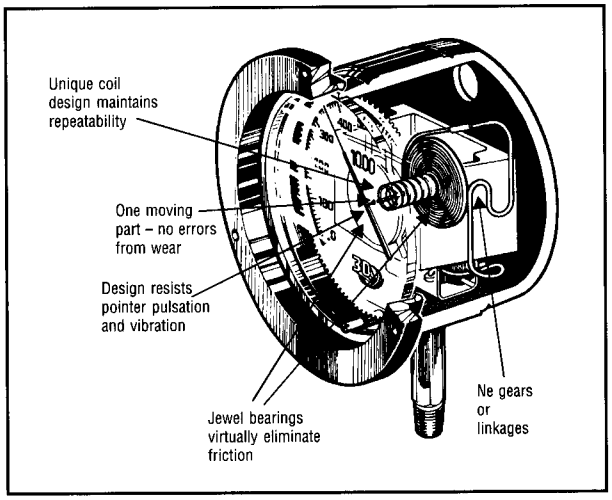

Figure 1

I. REPAIR SUPPLIES

One of the main benefits in using the 3D Gauge is reduced maintenance in even the most severe service. The 3D Gauge is designed to take high vibration, high pulsation, full vacuum and, for ranges up to 15,000 psi, overpressure to 150% of maximum rating. If your application has exceeded these bounds, or some other problem should occur, there are several procedures for field repair that virtually any instrument shop can perform. Recommended tools and supplies are listed below. The items listed in Group 2 are for repairs that are more difficult than those for Group1.

GROUP 1:

- Aerosol electrical contact cleaner (CRC or equivalent) with capillary tube
- Razor knife
- Pointer puller (3D Part No. 14-6-07)
- Heat gun (400° F capability)
- 3D Gauge-Glass Popper (4-1/2" process gauge only).
- Allen wrench, 5/32" size
- Armor-all Anti-Static Lens Cleaner
- Epoxy (BFG A1177B or equivalent)
- Small stick, such as a Q-tip without cotton, or a toothpick
- Dead-weight tester or other primary standard

GROUP 2:

- Brazing torch (2000° F)
- Small saw, such as a jeweller's saw
- Nicro-Braze LM
- Liquid solvent

II. CALIBRATION CHECK

All 3D Gauges are checked for calibration with primary standards traceable to the National Institute of Standards & Technology. Precision gauges of 1/4 % accuracy are furnished with calibration certificates. The span and linearity of the gauge are permanent and should not change under normal use. However, it is good practice to periodically verify

compliance. The calibration device used should have an accuracy at least four times better than the gauge being verified. A dead-weight tester or other primary standard is recommended for this. The gauge should be resolved to 1/4 of the smallest division. Example: a precision gauge with a dial range of 0-300 psig will have 1.0 psig minor graduations; this should be interpolated to 0.25 psig.

The restricted fluid path in the gauge is easily plugged and the medium used for testing must be very clean. 3D uses air for pressures to 600 psig and distilled water for pressures above that. If oil or hydraulic fluid is used as the calibration medium, the following precautions are advised:

1. Remove the standard stem-mounted filter if present (not required if any gauge protector is installed). The filter could cause a very long time lag in decreasing pressure response if left in place.

2. Allow extra time for the relatively viscous fluid to flow through the gauge element.

3. It is not uncommon for oil or hydraulic dead-weight testers to pick up contamination from field-mounted pressure devices. This could cause sluggish movement, blockage, or error. If this occurs, see section on "Simple Fluid Path Cleaning."

4. Allow several minutes for oil or hydraulic fluid to drain from the fluid path, or clean as described in "Simple Fluid Path Cleaning."

To verify compliance with specified accuracy:

A. With gauge in vertical position, at about 70°F, and with no pressure applied, carefully set zero so that the pointer is in exact center of zero graduation. (Refer to Section III-A, Zero Adjust)

B. Calculate allowable tolerances, which will be the accuracy deviation times the full-scale pressure. Example: a 0-300 psi precision gauge with 0.25% accuracy will have a tolerance of (300 X 0.0025)±0.75 psi.

C. Apply pressure to the gauge to 20% of full-scale reading (e.g. 60 psi on a 300 psi gauge). Compare the applied pressure to the gauge reading and record any deviation. Repeat this procedure for 40%, 60%, 80% and 100%. This is upscale calibration.

D. Release pressure on the gauge to 80% of full-scale. Compare gauge reading to applied pressure and record any deviation. Repeat for 60%, 40%, and 20%. This is down scale calibration.

E. Release pressure completely and check for zero. If the gauge does not repeat zero, allow time for calibration fluid to drain.

If the gauge does not comply with the specified accuracy, refer to section on "Span Adjustment" or " Linearity Adjustment". 3D Gauges are warranted to hold accuracy for six years from date of purchase, if not abused. (e.g. overpressure, fluid path contamination, etc.)

III. COMMON GAUGE PROBLEMS AND BASIC (GROUP1) SERVICING

III-A. Zero Adjustment: If Gauge Is Off Zero at Zero Pressure

This procedure is easier on a 3D Gauge than on virtually any other instrument. On all but the 2 1/2" dial size and stainless steel case gauges, simply rotate the screw found at the 6 o'clock position of the dial. Turning the screw rotates the dial. This screw is accessible from the front of the gauge with no disassembly required. The zero adjustment does not affect span or linearity. Turn the dial until the pointer indicates zero.

On the 2-1/2" plastic case there are two indentations on the gauge crystal. Use a tool (3D Part No. RS 432) to engage one or both of these indentations, and turn. The crystal will turn, which also turns the dial. Rotate dial until pointer is at zero.

With the stainless steel gauges, one of two methods of zero adjustment will apply. If the dial has a horizontal slot on the face near the 12 o'clock position (4-1/2" dial size, 1989

and newer gauges), the gauge can be zeroed through the rear blowout plug hole. Remove the sticker at the back of the gauge marked DO NOT OBSTRUCT. Place a small screwdriver through the hole so the blade goes through the slot. Pivot the screwdriver right or left until the pointer is at zero.

Other stainless steel gauges require crystal removal. (Refer to Section III-C) Place a pointed tool into the tooling hole at the 6 o'clock position on the dial and pivot right or left until zero is indicated. If no tooling hole is found, place a small screwdriver in the gear teeth at bottom of the dial and rotate to zero.

If the dial is excessively misaligned from zero, the pointer can be repositioned. (Refer to Section III-D). It is advisable to check gauge for span and linearity if a zero adjustment of more than ten degrees is required. A large zero shift is often a symptom of overpressure (over 150% of full scale) or severe shock.

III-B. Simple Fluid Path Cleaning for Sluggish or no Pointer Movement

Abnormal pointer movement could be caused by a blockage of the fluid path. Visual inspection of the pointer and the exposed portion of the shaft will rule out a bent shaft or the pointer touching the dial or crystal.

Unless ordered with gauge protectors, all 3D Gauges are equipped with a stem-mounted internal filter. This filter is made of porous stainless steel. It can be cleaned or replaced (3D No. RS 380-1). Remove the filter from the gauge stem with a 5/32" Allen wrench. Check the filter for contamination and clean or replace as necessary.

If the filter is not in place, or if the fluid medium is viscous, the blockage may be in the capillary or coil. Many times this can easily be cleared with an aerosol electrical contact cleaner. Insert the long spray tube into the nozzle of the aerosol can. (Figure 2) With the filter removed from the stem, run the tube as far into the gauge stem as possible. After a five- to ten-second spray, allow the excess liquid to drain and evaporate. If allowed to drain onto a clean paper surface the residue will reveal the source of contamination. Repeat this procedure two or three times, then check the gauge's performance. If performance remains unsatisfactory, it is advisable to return the unit to 3D. The user may also flush the coil. (Refer to Sect. IV-C)

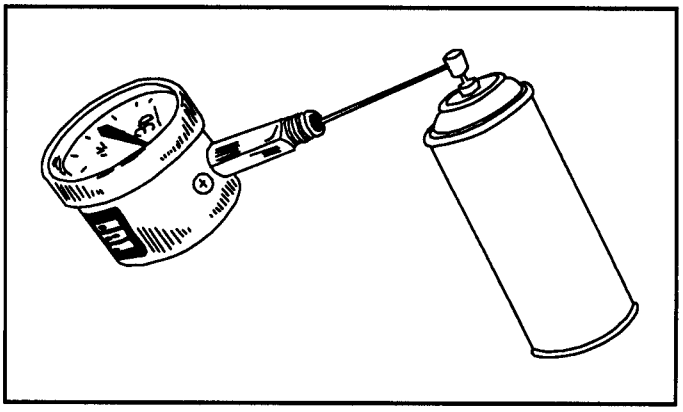

Figure 2

III-C. Gauge Crystal Removal and Replacement

Most 3D Gauges use a stainless steel snap ring to hold the crystal in place. To remove the snap ring. place a srewdriver or other flat tool under the tapered portion at the end of the snap ring. Ease the ring off carefully. Lift out the crystal, using the screwdriver as a lever if needed. With the crystal off, check the integrity of the elastomer seal and the zero adjustment screw. (The 2-1/2" size has no adjusting screw but uses the gauge crystal to directly move the dial.)

To re-install the crystal, first be sure the seal material is in the groove and distributed evenly around the case and clear of the zero-adjust screw. Place the crystal with its beveled edge facing outward (away from dial) so that the slot on the crystal fits around the adjustment screw. On the 2-1/2" size, be sure the two tabs on the crystal engage the slots in the dial. Work the snap ring into its slot around the crystal. On the 4-1/2" process gauge the crystal is snapped into the case. To remove the crystal, take out the blowout plug at the back of the case marked DO NOT OBSTRUCT. Use a long thin slotted screwdriver inserting it through the blow-out hole and over the top of the dial. This will allow the crystal to be pushed out from behind.Push the crystal until its top comes

out of the case. Then remove the crystal from the front. Replace the blowout plug.

To replace the 4-1/2" process crystal, align the crystal so that its slot fits over the zero adjust screw and seal. Press the crystal into place until it pops in all around.
Note: It is recommended that crystals be cleaned with Armor-all or equivalent to reduce static electricity. Static charge can affect the pointer.

On the stainless steel gauges, the crystal is secured by a stainless steel locking ring. To remove the ring, place the gauge on its back on a flat surface. Press down on the locking ring and rotate it about 10 degrees counterclockwise. This unlocks the ring, allowing the ring, crystal and gasket to be removed. To refit the crystal on the 4-1/2" stainless gauge, be sure the gasket is in place with the flange or ridge facing the dial and the flat side facing out. Place the crystal on the gasket with stepped side of the crystal facing the dial (smooth side facing out). Loosely install the locking ring until the three tabs catch the corresponding slots and the ring drops evenly. With the gauge on its back, press down firmly on the ring to compress the gasket and rotate the ring clockwise until locked.

The 2-1/2" stainless steel gauge is the same as the 4-1/2" except that the gasket and crystal may be put on either side up. Be sure the gasket is against the case.

III-D. Gauge Pointer Removal, Repositioning, Replacement

The 3D pointer may be repositioned anywhere on the dial. Examples of where repositioning may be helpful:

- To zero out a static pressure, such as a "water leg,"
- If the gauge is mildly overpressured beyond 150% of scale, a zero adjust ment could return the gauge to operation with only a slight degradation to span. Pointer repositioning would eliminate a cocked dial.

Remove the crystal. (Refer to Section III-C) At the hub of the pointer shaft is a small convex area. This is hardened epoxy, painted black. Shave this epoxy off with a razor knife, leaving the flat pointer surface. The pointer shaft may now show through the pointer hub. Heat the shaft and hub with a blower-type heat gun to soften the epoxy. (a soldering iron is also acceptable) When the epoxy has softened after about five seconds of heat, position the pointer puller so that its jaws are under the pointer and the center post is on the pointer shaft. Apply gentle pressure by squeezing the puller. If the pointer does not come off the shaft, apply more heat and repeat the pulling. To refit the pointer, set the dial to a normal position. Aim the pointer at zero and press it firmly onto shaft. Apply a drop or two of epoxy using a small stick or toothpick. Heat the epoxy with a heat gun to cure it, then allow the assembly to dry and cool.

If pointer repositioning is frequently required, an adjustable pointer is available. Contact a local 3D representative or the factory.

IV. REPAIRS REQUIRING TOOLS IN GROUP II

IV-A. Span Adjustment–If Gauge Falls Out of Specified Tolerance

The span of the 3D Gauge is designed into the Bourdon coil (determined by tube size, flatness, heat treating, etc.), with the final calibration determined by a calibration clip. Rotation of this clip, which translates coil rotation into pointer shaft rotation, takes portions of the coil into or out of the shaft rotation.

For access to the calibration clip the gauge must be disassembled. Remove the crystal and the six or eight Phillips-head screws from the case (two are under the serial number label; remove the label carefully for re-use). This frees the stem bracket and mounting frame from the case. The dial, coil, capillary and stem assembly can now

be removed through the front of the case. Remove the pointer. (Refer to Section III-D) Remove the dial by pulling off the large metal clip behind the dial. The Bourdon coil, pointer shaft and calibration clip will now be exposed. (Fig. 3)

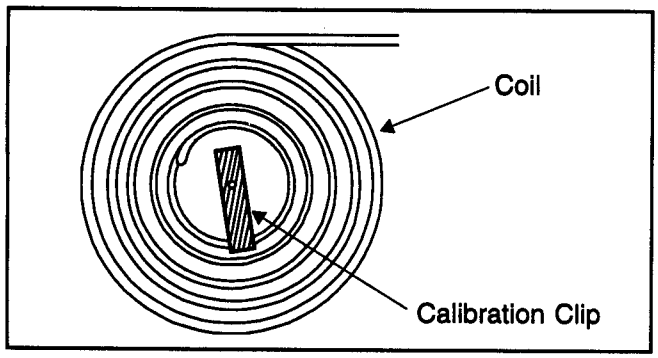

Figure 3

Check the coil for mechanical alignment. Any obvious distortions may be caused by severe shock (more likely in the 30 and 60 psi ranges) or overpressure beyond 150% of rated pressure. If this is the case the coil may be irrepairable; return the gauge to 3D or replace it.

The calibration clip is epoxy-bonded in position for permanent span setting. Remove the epoxy with careful use of a brazing torch. Rotate the clip down the coil (clockwise) to reduce span and up (counterclockwise) to increase span.

To check span before reassembly it is not necessary to epoxy the clip. Re-install the dial, carefully placing the pointer shaft through the bearing hole. Hold the dial in place with tape or the large clip. Position the pointer onto the shaft so the pointer is at zero (the friction-fit will hold the pointer during the test). Connect the assembly to a dead-weight tester or other primary standard and check the span at various points upscale and downscale and compare the readings to the standard (Section II). If the gauge does not meet specified accuracy, disassemble and repeat the span adjustment procedure. If only one or two points cannot be brought into tolerance, see the following section, "Linearity Adjustment". If the span adjustment does not bring the gauge into tolerance, it is advisable that the gauge be returned to 3D. A coil replacement may be required.

When the span is properly adjusted, epoxy the calibration clip in position. Apply epoxy carefully to both sides of the clip using a small stick. Care must be taken to keep the epoxy away from adjacent turns of the coil. When the epoxy is dry, re-check the span before reassembling gauge. Reassemble the gauge, starting with dial installation and dial clip (be sure to include the stainless steel shim under the dial clip). Install the pointer. Re-fit the movement into the case and replace the screws and serial number label. Install the crystal and snap ring.

IV-B. Linearity Adjustment

The linearity of the 3D Bourdon coil is unaffected by normal use, but could be altered by severe shock. If in checking the span only one or two of several points cannot be brought into tolerance, the linearity of the coil is suspect. Remove the movement from the case as described in Section IV-A, "Span Adjustment". Linearity is adjusted by the installation of a balance clip to counterweight the coil. Attach a balance clip (3D Part No. 2034-0019) to the outside of the coil. (Figure 4) Check for any linearity change, then move the clip if required to a better position.

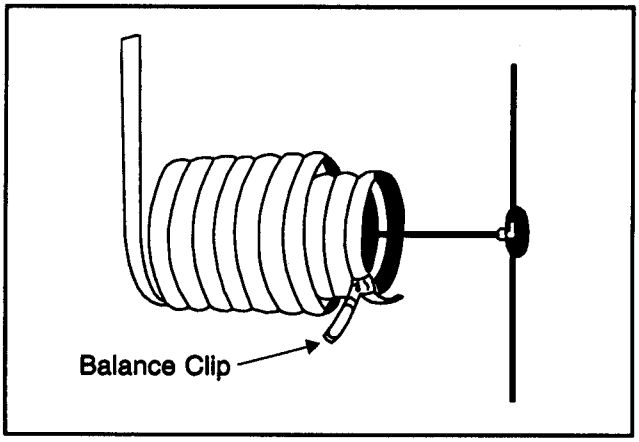

Figure 4

It is possible to do a complete adjustment with one or two clips, but they must be very carefully located. Installation of up to five balance clips is permisible. When the clip (s) are properly positoned, epoxy them in place. Be very careful not to epoxy adjacent turns of the coil. Perform a span check before reassembling gauge. Carefully zero the gauge then check span and linearity and record the results.

IV-C. Fluid Path Flushing

If the standard stem-mounted filter is removed, or if a viscous fluid is used, the fluid path of the gauge may become contaminated with dirt or viscous fluid. If the steps given in Section III-B "Simple Fluid Path Cleaning" are unsuccessful or if a thorough cleaning is required, the coil must be flushed.

Disassemble the gauge as described in Section IV-A, "Span Adjustment." This exposes the free end of the coil, the end that is Nicro-brazed closed. Open the free end by cutting it off with a small jeweler's saw. (Figure 5) Do this cutting very carefully so the coil is not distorted or the next turn cut. It may be necessary to move the calibration clip out of the way.

Flush the fluid path by pumping liquid freon or similar solvent into the fitting so it flows out of the free end of the coil. By using filter paper the contaminant can be caught and identified. Continue flushing until the blockage clears, being careful not to apply pressure in excess of the gauge rating.

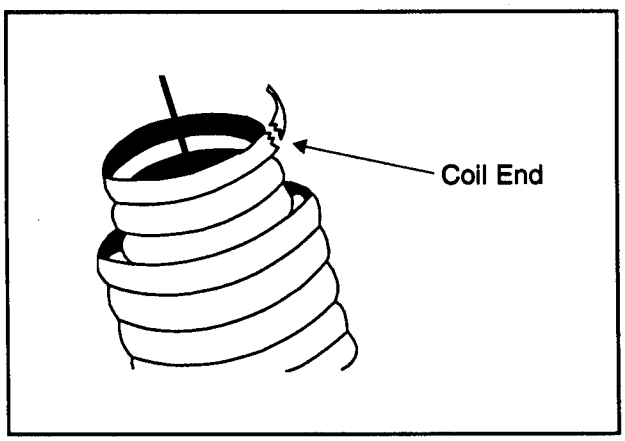

Figure 5

When the flush is completed and the coil is dry, Nicro-braze the free end closed. Care must be taken when brazing not to distort or damage the mounting frame. When the braze has cooled, check the coil for pressure integrity by applying 150% of full-scale pressure.

Reassemble the gauge and install into the case. Check the calibration and record the results.

Notice and Recommendations

While 3D has attempted to make this manual as complete as possible, it is difficult to impart the techniques of repair of a sophisticated assembly. The best method to learn these techniques is by personal tutoring or demonstration. 3D strongly recommends that factory training be arranged for repair technicians.

DISCLAIMER

3D INSTRUMENTS, INC. does not assume responsibility for the quality or performance of repairs, replacements or calibrations not performed by 3D personnel. 3D assumes no liability for any damages, losses, or injuries, whether direct or consequential, resulting from gauges which have been repaired, recalibrated, tampered with, or in any way disassembled.