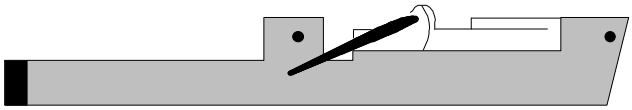
MODEL 5000 OPERATION AND MAINTENANCE MANUAL

DigiCOURSE

Contains Addendums:
4201-016-1
4201-016-2



MODEL 5000 OPERATION AND MAINTENANCE MANUAL

DigiCOURSE

ORDER No. 4200 - 016 (Manual Only)
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DigiCOURSE, Inc. manufactures products under one or more of the following U.S. patents:

3,927,474; 3,944,813; 3,975,621; 4,004,348; 4,027,398; 4,031,630; 4,038,528; 4,047,168; 4,075,619; 4,091,543; 4,093,946; 4,103,638; 4,117,602; 4,414,754; 4,425,716; 4,443,795; 4,471,534; 4,472,966; 4,503,621; 4,631,711; 4,671,120; 4,698,912; 4,711,194; 4,720,631; 4,725,995; 4,843,865; 4,912,684; 5,010,653; 5,031,159; 5,105,548; 5,142,507.

PREFACE

This manual is intended to provide specific information on use and care of Model 5000 DigiBIRD products. This manual assusmes that the user has a working knowledge of DigiSCAN or System 3 cable positioning programs. For information on the DigiSCAN or System 3 cable positioning and control systems, see their respective operator's manuals (DigiSCAN Operator's Manual, p/n 6301-293A-xxx; System 3 User's Manual, p/n 4200-007-xxx; xxx = version).

The following Field Service Bulletins (FSB) are superseded or replaced by this manual:

Old Number	New Number	Description
• 090188-1	FSB880901-001	Battery replacement storage of Model 396 and 5011 Compass Birds returned equipment reports
• 040189-3	FSB890401-002	Lithium batteries
• 050189-1	FSB890501-003	Lithium battery safety information
• 051590-1	FSB900515-005	Removal and Installation instructions for wing module
• 062790-3	FSB900627-007	Wing reset, Model 5000 series DigiBIRD
• 091790-1	FSB900917-008	Instructions for removal and installation of bird internals
• ----------	FSB911004-014	5000 DigiBIRD dovetail assembly replacement
• ----------	FSB911010-017	Safety strap option for 5000 series DigiBIRDS
• ----------	FSB920130-018	Bird repair/return report
• ----------	FSB920521-021	5000 series DigiBIRD lithium battery bank switching, lithium battery testing, battery management, and lithium battery safety and disposal
• ---------	FSB920630-022	Effects of sea water during bird storage
• ---------	FSB921001-024	Removal and installation instructions for wing module Model 5000 DigiBIRD
• ---------	FSB921001-025	Field disassembly and assembly instructions Model 5000 DigiBIRD

SECTION I - PRODUCT DESCRIPTION

1.1 GENERAL DESCRIPTION

The series 5000 DigiBIRD and Compass Bird family are microprocessor-based control and monitoring devices that mount externally on a marine seismic streamer cable.

Using an internally mounted transducer, both devices can monitor depth over a range of 0 to 400 feet, with a resolution of 0.1 ft and an accuracy of +/- 0.5 ft. Once programmed with an assigned operating depth, the bird operates independently to control streamer depth by adjusting its wings to provide up to 35 pounds of lift at 5 knots (15 degree wing angle). Depth control operating parameters may be adjusted by the user to maintain an optimum balance between depth control response and maximum battery life.

The assembly is housed in a non-corroding and non-magnetic molded polyurethane body that is streamlined to minimize flow-induced noise, and mounts on standard mounting collars on 22.5 inch centers. Modular construction simplifies field repair by allowing quick and easy replacement of individual modules by the field technician.

Each unit is powered by four high-energy-density lithium cells in a dual battery pack arrangement. Battery pack switching is automatic and battery condition can be monitored while in operation.

Communications occur via a DigiCOURSE DigiSCAN controller over a single twisted pair transmission line in the streamer using traditional inductive coupling techniques. (For more information on the DigiSCAN or System 3 cable positioning and control systems, see their respective operator's manuals). Standard series 5000 birds operate on a 26 kilohertz FSK communication link. There is also an optional series 5000/03 version designed for 28 kilohertz communication applications.

1.2 MODEL 5010 DIGIBIRD

The model 5010 DigiBIRD provides a variety of command and data acquisition functions and features including:

- Streamer depth control
- Streamer depth reporting
- Wing angle reporting
- Water temperature reporting
- Battery condition and bank-in-use reporting

1.3 MODEL 5011 COMPASS BIRD

The model 5011 Compass Bird offers all of the functions of the Model 5010 plus the addition of a DigiCOURSE Model 321 heading sensor in the body of the unit. This allows depth keeping ability, depth reporting, temperature measurement, plus heading reporting from a single externally mounted device.

The Model 5011 delivers 0.35 degree resolution heading data with an accuracy of +/- 0.5 degrees. Internal electronics provide automatic correction for A, B, and C compass error terms and user selectable internal filtering of heading data.

See Appendix A for complete Model 5000 product specifications and outline drawings.

1.4 MODEL 5010E DigiBIRD AND 5011E COMPASS BIRD

Operation of DigiCOURSE 5010E and 5011E birds is limited to depths not greater than 35 meters (115 feet). Within this depth range, operation and performance of the "E" series birds is exactly the same as DigiCOURSE Model 5010 and 5011 products.

- 5010E and 5011E birds will not accept set depth commands greater than 31 meters (103 feet).
- Depth data will be reported as 35.0 meters whenever actual bird depth exceeds 35 meters.
- Compass data will be reported as 0.0 whenever actual bird depth exceeds 35 meters.

CAUTION: Model 5010, 5011, 5010E, and 5011E birds WILL NOT operate with or on systems designed for Model 5014 or 5024 birds.

SECTION II - BATTERIES

-**WARNING**- Fire, explosion, and severe burn hazard. Do not short circuit, charge, force over discharge, disassemble, crush, penetrate, or incinerate. Batteries may leak or explode if heated above 100°C (212°F).

Carefully read Section 2.7 and Appendix G for lithium battery safety information before handling lithium batteries.

2.1 BATTERY SYSTEM DESCRIPTION/OPERATION

The Model 5010 DigiBIRD and 5011 Compass Birds operate from a dual bank battery system. Each bank contains two size "D" Lithium batteries rated under load at 3.3 to 3.4 volts each. Normal operating voltage for each bank is 6.6 to 6.8 volts. Figure 2.1 is a simplified diagram of the dual bank circuit.

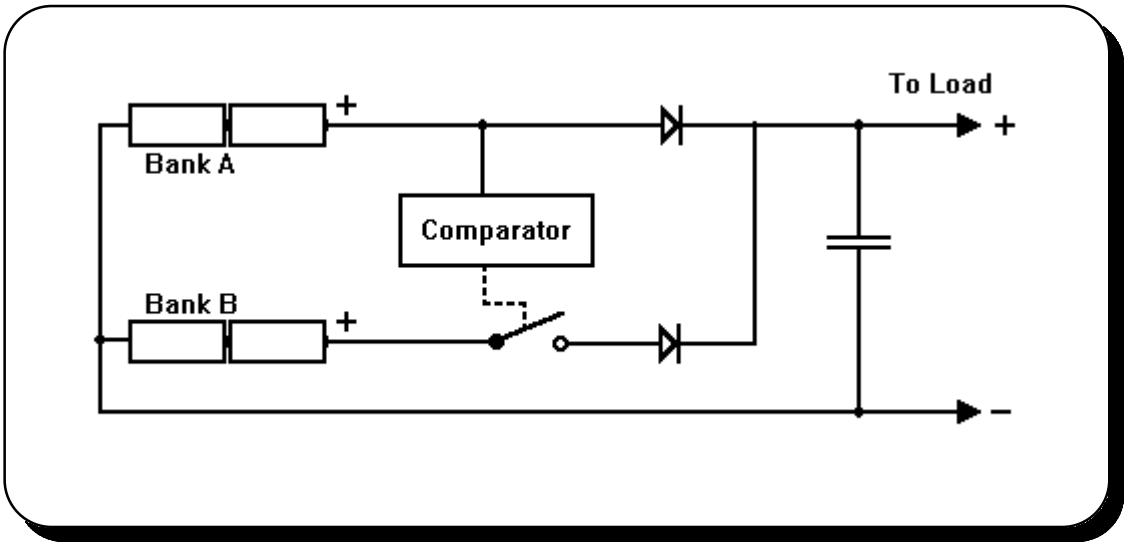

Figure 2.1. Dual bank battery circuit.

During operation, power requirements vary from 8mA (idle) to 120 mA (wing drive and transmit) depending on what bird functions are occurring. If the (primary) A bank cannot supply the necessary power, a "comparator" circuit switches in the (secondary) B bank. This switch closes whenever the A bank voltage drops below 4.5 volts, and re-opens whenever the A bank voltage returns to a level greater than 6.75 volts.

Although the term "battery switching" is often used when speaking of this switching of the B bank, note that the A bank is never actually switched out of the circuit. (This is why the A bank voltage continues to drop after the B bank switch indication occurs.)

2.2 CHECKING LITHIUM BATTERIES WITH A VOLTMETER

Always check lithium batteries with a 20 - 30 ohm 1/2 watt resistor across the battery terminals as shown in the figure below.

CAUTION: Batteries contain a 4 amp internal fuse that will blow if meter leads are shorted together while testing with a voltmeter.

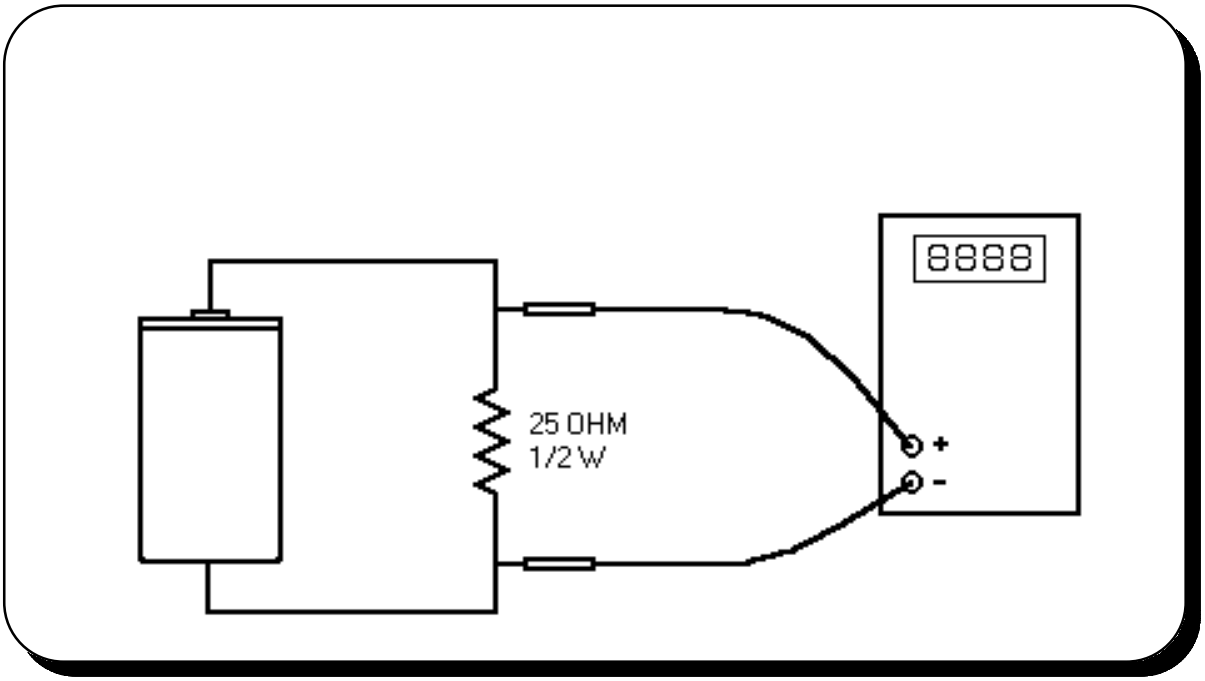

Figure 2.2. Battery test setup.

Battery Capacity Determination (Always wait 5 - 10 seconds after applying load before taking voltage reading.)	
If the measured Voltage across the load is:	Then remaining battery capacity is:
Greater than 3.6 volts:	Full capacity available
3.3 - 3.6 volts:	Used cell - some capacity remains
Less than 3.3 volts	Little or no useful capacity

LITHIUM BATTERIES CANNOT BE RELIABLY CHECKED WITHOUT A LOAD. After being discharged, lithium batteries can actually recover to some degree after the load is removed. For this reason batteries with virtually no remaining capacity can show no-load voltage values as high as 3.6 volts, but when measured under a loaded condition, voltages from these same batteries fall quickly.

Checking lithium batteries with a voltmeter can reliably identify "fresh" batteries and fully depleted batteries but unfortunately cannot give an accurate indication of how much capacity remains in used batteries. Estimating remaining capacity in used batteries can only be done through continuous monitoring and accurate record keeping while birds are in operation. See Section 2.5

2.3 BATTERY INSTALLATION

2.3.1 Tools required

- 3/16" Hex Wrench
- Battery Module Tool
- Electronic Spray Contact Cleaner
- O-ring lube

WARNING: Batteries may vent during operation causing pressure build up inside the housing. Always point nose of bird away from personnel when removing nose screw. If the nose bolt is hard to remove, this may indicate excessive pressure buildup in the battery area. Remove with caution and refer to lithium battery safety information (see Appendix G).

2.3.2 Installation procedure

Refer to the 5000 Service Diagram (0050-003) shown in Appendix B while performing the following procedure.

1. Wipe off the entire housing with a clean dry cloth and lay the bird on a clean, flat table.
2. Using a 3/16 hex wrench, remove the nose bolt (1/4" Allen cap screw) located in the center of the front pylon just behind the dovetail pin.

   NOTE: Some water may remain trapped in the seam between the front cap and the body. To prevent this trapped water from accidentally being introduced into the battery compartment, the bird should be tilted in a nose down position when removing front cap and battery module.

3. Remove the front cap (note the indentations on either side to allow a screwdriver to be used to aid in the removal).
4. Insert the battery removal tool into the front of the housing; rotate clockwise until the tabs engage the metal plate on the end of the battery module (do not try to rotate the battery module). Pull straight out to withdraw the battery module.
5. Slide back clear splash cover and push out old batteries using finger holes.
6. Inspect battery module connector and battery contacts for corrosion, and check battery module o-rings for nicks. Repair or replace if necessary. Flush battery module connector with spray electronic contact cleaner.

   NOTE: Use only Electrochem type BCX 72-N non-magnetic (3.9V) "D" size batteries in 5000 series DigiBIRDs. Do not attempt to use 1.5V alkaline batteries or any other "D" cell batteries.

   SAVE ORIGINAL BATTERY SHIPPING CONTAINERS FOR SAFE STORAGE OF USED AND DEPLETED BATTERIES.

7. Before installation, check batteries with voltmeter (see previous section) to be sure of their condition, then record bird serial number and installation date on new batteries with permanent marker.

   NOTE: ALWAYS USE AT LEAST TWO NEW BATTERIES, and be sure to install these in the B bank (away from the connector). If old batteries are used, be sure that they are a matched pair (see Section 2.6), and always install both in the A bank (connector end). NEVER MIX OLD AND NEW BATTERIES IN THE SAME BANK.

8. Slide back clear splash cover and install two batteries in each compartment noting proper orientation from decal on battery module. Reposition clear splash cover on center of battery module.
9. Insert the battery module fully into the nose of the unit until it bottoms. Using the battery module tool, rotate clockwise while applying light pressure until the battery module connector drops in place; then push to complete engagement.
10. When the battery module is properly engaged the unit performs a self test and then executes a wing reset to indicate that the bird is ready for operation. During a proper wing reset, the wings move to a full up position while several clicking sounds are heard (this is normal), then the wings return to zero (0) degrees. If proper wing reset does not occur, the bird fails its self test. Check the unit, using the bird diagnostics in DigiSCAN.
11. Clean and inspect the o-ring on the front end cap; replace if damaged. Coat o-ring with lube and install the front end cap; do not over-tighten the nose cap bolt. Recheck and record battery voltages using DigiSCAN Bird Diagnostics Menu Item 7 before deployment.

2.4 CHECKING BATTERY CONDITION DURING BIRD OPERATION

While the bird is in operation, a general indication of battery condition can be obtained through DigiSCAN using Bird Diagnostics Menu Item 7. This function displays continuously updated voltage readings from both A and B banks and also indicates if the B bank switch is closed at the time of the read.

NOTE: The DigiSCAN message "THE SENSOR IS CURRENTLY POWERED FROM BATTERY BANK B" actually means that both banks are in use.

Keep in mind that voltage readings from the battery banks are affected by how hard the bird is working at the time of the measurement. Highest loads and widest load variations occur when driving the wings during depth keeping or during a wing reset. Therefore, reported voltages from a bird that is working hard on a streamer are lower and tend to fluctuate more than from the same bird "idling" in a test bench.

It is normal to observe A/B switch readings going back and forth. As the A bank nears the end of its capacity it reaches a point where it can no longer supply the necessary energy for high current functions. At this point the system begins briefly switching in the B bank for high current requirements and returns to A bank only operation for low current demands. As the A bank is further depleted, switching in (and out) of the B bank continues until the A bank is completely exhausted. Only then does the B bank become the "full time" source of power.

Finally, battery information is also available from "Print Stats" in the DigiSCAN Multisensor Menu. Because this option provides a single voltage reading from one bank only, it does not allow one to observe voltage swings that give a better indication of battery condition, and is therefore less useful than screen information from Bird Diagnostics Menu Item 7.

The next section of this document "Battery Management" provides more detailed information on interpreting battery bank voltage readings.

2.5 BATTERY MANAGEMENT

The chart shown in Figure 2.5 represents typical A and B battery bank voltage measurements taken from birds during uninterrupted operation in depth keeping mode. They are provided to assist the user in estimating remaining battery capacity while birds are in operation.

NOTE: Hours shown are for reference only; actual hours vary depending on individual bird settings and operating conditions.

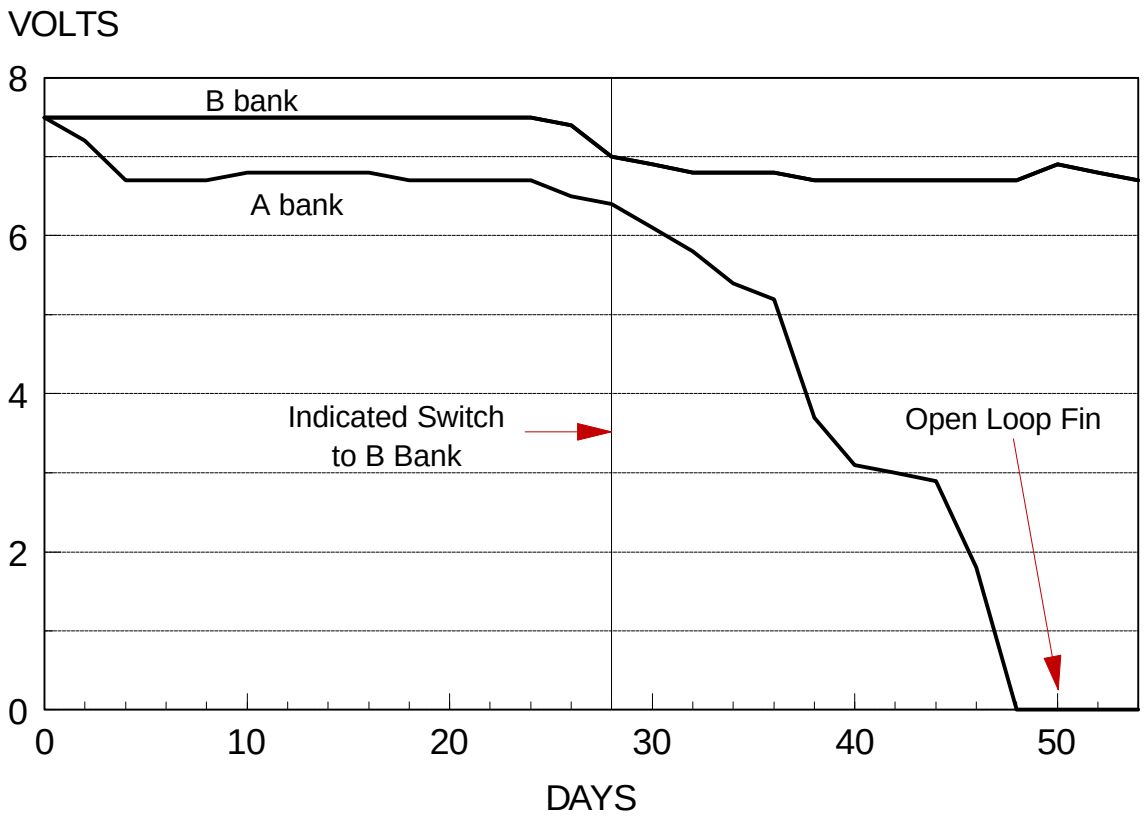

Figure 2.5. **Typical bird discharge** curves

In the example, both banks start with new batteries. A battery check on day 0 indicates 7.5 - 7.6 volts for each bank. Soon after operation begins, the A bank falls to the normal operating value of 6.6 - 6.8 volts and holds at this value while the unused B bank remains at 7.6 volts.

NOTE: A bird that starts out with a mix of new (bank B) and used (bank A) batteries can still be monitored with this chart, except that operation on the A bank would be shorter depending on the remaining life in the used batteries.

After 24 days, the B bank voltage drops (accompanied by a further drop in the A bank) indicating use of the B bank has begun. Note that a battery check at this time would probably still indicate "A bank" operation since use of the B bank starts out as very brief periods of high current demand not easily "seen" by the DigiSCAN battery check.

TIP: If both banks started with new batteries, then noting the time when this drop in B bank voltage occurred should provide a reasonable estimate of the mid point of battery life as long as bird operating conditions do not change.

The "permanent" switch to B bank does not occur until day 28, well after use of B bank actually begins. Note that after the B switch indication, the A bank voltage continues to drop as it is further depleted by use for low power needs.

The first indication that the B bank batteries are near exhaustion occurs on day 50 when they can no longer deliver the necessary power to drive the wings. When this occurs, the bird discontinues programmed depth keeping and reports that it has gone into "open loop fin" mode. Although the B bank may still indicate 6.7 - 6.8 volts it is actually near the end of its useful life. Without the need to drive the wings, the B bank can continue to support compass and depth data for several more days until loss of communication finally occurs (these functions require much less power than depth keeping).

TIP: Monitoring the A bank voltage gives a good indication of B bank battery condition. If the A bank is at or near zero volts when the bird goes to "open loop fin", then the B bank batteries are probably also near their end.

Note that it is not advisable to try a wing reset if low batteries are suspected. This may leave the bird in a wing up position, making depth control more difficult for the remaining birds.

2.6 OPTIMIZING LITHIUM BATTERY PERFORMANCE

The following steps can be taken to maximize useful battery life.

1. Use new batteries
   Always start out with at least two new batteries in bank B. Because of the extreme difficulty in estimating remaining capacity of used batteries, **GOING INTO THE WATER WITH FOUR OLD BATTERIES RESULTS IN UNPREDICTABLE BATTERY LIFE AND UNDEPENDABLE OPERATION.**

   If old cells are used, always install in the A bank; it's better to know early if you've underestimated the used batteries.

2. Test batteries
   Before installing batteries in a bird, always check with a voltmeter per Section 2.2. to determine their condition. Used batteries that have been left idle for a day or more can sometimes recover to a point where the voltage reported by DigiSCAN are artificially high for the first few hours of operation. Testing used batteries under load with a voltmeter before installation per Section 2.2 can detect these batteries and prevent their use.

3. Mark batteries
   Always mark new batteries with bird s/n and installation date; keep used pairs matched if moved to a different bird**. NEVER MIX USED BATTERIES!!!!!**

4. Record information
   While birds are in use, record battery information daily and compare reported voltages to curves in Section 2.5 to get indication of battery condition.

5. "Low Power" mode
   Before removing from service, set birds to Low-Power (sleep) mode (DigiSCAN Bird Diagnostics menu item 15 "Multisensor"). This mode minimizes power consumption while batteries are installed. For long term storage (more than 2 weeks), remove battery packs completely.

6. Discharge curves
   Always record voltage readings from DigiSCAN before removing battery packs. Use the discharge curves from Section 2.5 to determine if use of the "B" bank has begun.

   IF "B" BANK USE HAS STARTED, ALWAYS DISCARD "A" BANK BATTERIES REGARDLESS OF BANK SWITCH OR "A" BANK VOLTAGE READINGS.

2.7 LITHIUM BATTERY SAFETY

This section addresses issues and procedures relating to the use of DigiCOURSE equipment containing lithium batteries on seismic streamers.

DigiCOURSE requires that only Electrochem type BCX 72-N Non-Magnetic "D" cell batteries be used in its bird and acoustic products to insure consistent performance to published specifications. For maximum durability, these batteries are constructed with active cell components sealed in 304L Stainless steel cases with TIG-welded lids. A built-in 4 amp safety fuse prevents overheating in the event of an external short circuit.

When used as designed and properly handled, lithium batteries have demonstrated an excellent safety record. But excessive heat, puncturing, or crushing could result in an internal short circuit causing a runaway reaction that can release potentially hazardous gasses and generate high temperatures.

Refer to Appendix G (Electrochem Product Safety Data Summary) for general information on proper storage, use, and disposal of Electrochem type BCX lithium batteries.

The following information outlines recommended procedures to be followed in case of a streamer accident:

1. If a cable accident should occur causing birds to reach depths in excess of 1000 ft (300 meters), it should be assumed that a hazardous condition exists due to the possibility of lithium reactions from damaged batteries. Because of the danger of a lithium reaction igniting streamer fill fluids, it is not advisable to attempt retrieval for at least 24 hours. This is to allow any reaction to exhaust itself in the water.
2. When retrieving a potentially damaged streamer, use only the minimum number of personnel required to accomplish this task; all other personnel should remain clear of the area. Full fire fighting precautions should be exercised. A Lith-X (graphite) fire extinguisher should be on hand in case of lithium fire. NOTE: Lithium reacts with water; CO_2 and halogen are not effective on lithium fires.
3. If fire or violent reaction is observed during streamer retrieval, redeploy immediately and wait at least 24 hours before again attempting retrieval.
4. Persons handling birds or pods should wear protective clothing, including face shields and rubber gloves.
5. Upon removal, birds and pods should be moved to an isolated, well ventilated outdoor area away from flammable materials. A Lith-X (graphite) fire extinguisher should also be on hand in this area in case of lithium fire.
6. If strong fumes are present, avoid inhalation. If necessary, head ship in a direction to carry fumes away from inhabited areas.

7. Do not leave damaged birds unattended. Maintain a watch on hardware until reaction is complete or disassembly reveals a safe condition. Do not attempt to disassemble birds or pods until all evidence of any reaction has stopped.

8. Bird disassembly should be done with extreme caution. The cells contain lithium which, if combined with water, generates a vigorous reaction resulting in a strong hydroxide and hydrogen gas. Other chemicals which may be present include: Thionyl Chloride ($SOCl_2$), Bromine gas (Br_2), and Chlorine (Cl_2). $SOCl_2$ breaks down to form HCl and SO_2 in the presence of water. Protective clothing including rubber gloves and face shields should be worn. Since free gasses may be present, disassembly should be performed in an open area (outside) with good ventilation. A vise should be used to hold the housing as the nose cap fastener is removed. Pressure buildup in the housing is a distinct possibility; therefore care should be exercised when opening the battery compartment.

9. Battery remains should be stored in small plastic bags (zip-lock bags work nicely). Place this bag in a second zip-lock bag with a 50/50 mixture of baking soda and vermiculite to absorb any residual liquids or vapors. (Dry sand or clay based oil absorbents may be substituted for vermiculite). Remains should not be stored with fresh cells or depleted cells since the electrolyte may act as a corrosive agent. Preferably a metal drum with a top that can be labeled and resealed should be used. Proper disposal procedures should be followed upon reaching port.

10. Normal handling procedures should be maintained for undamaged batteries as summarized on the enclosed Product Data Summary Sheet (see Appendix G).

NOTE: Lith-X fire extinguishers can be purchased at your local safety supplier or from the following address:

FSG 1850 Dale Road Buffalo, New York 14225 1-716-897-4014

REFERENCE: "Lithium Handling Procedures for Seismic Operations Offshore" 21 April, 1989; Edward Thear of Electrochem Industries to Chuck Holt of DigiCOURSE.

2.8 LITHIUM BATTERY DISPOSAL

All batteries should be stored onboard for later disposal on land in accordance with appropriate federal, state, or local regulations. Used batteries should be stored in their original shipping containers.

DO NOT INCINERATE or subject cells to temperatures in excess of 212º F (100º C).

- For USA disposal information, contact:

  BDT Incorporated (716) 759-2868
  4255 Research Parkway (716) 634-6794
  Clarence, New York 14031

- For disposal in the UK, contact:

  Mr. John Fisher
  Biffa Waste Services
  Wakefield, England 0924 360231

SECTION III - MODEL 5000 LATCH MECHANISMS

3.1 MOUNTING COLLARS

Series 5000 DigiBIRDs and Compass Birds use two standard mounting collars for attachment to the seismic streamer. Each collar consists of a rotating aluminum outer ring riding on a plastic inner ring that clamps securely to the streamer skin. A keyhole-shaped mounting slot is located in each half of the aluminum outer ring for attachment of external streamer-mounted devices.

The front collar is normally installed just ahead of a bulkhead or between two bulkheads to maintain its position on the streamer with respect to the communication coil (see Figure 3.1). The rear collar is positioned 22.50 inches behind the front collar and is normally not retained by bulkheads. Although it fits securely over the outer skin, it can slide to maintain spacing as the skin stretches or relaxes during streamer deployment or retrieval.

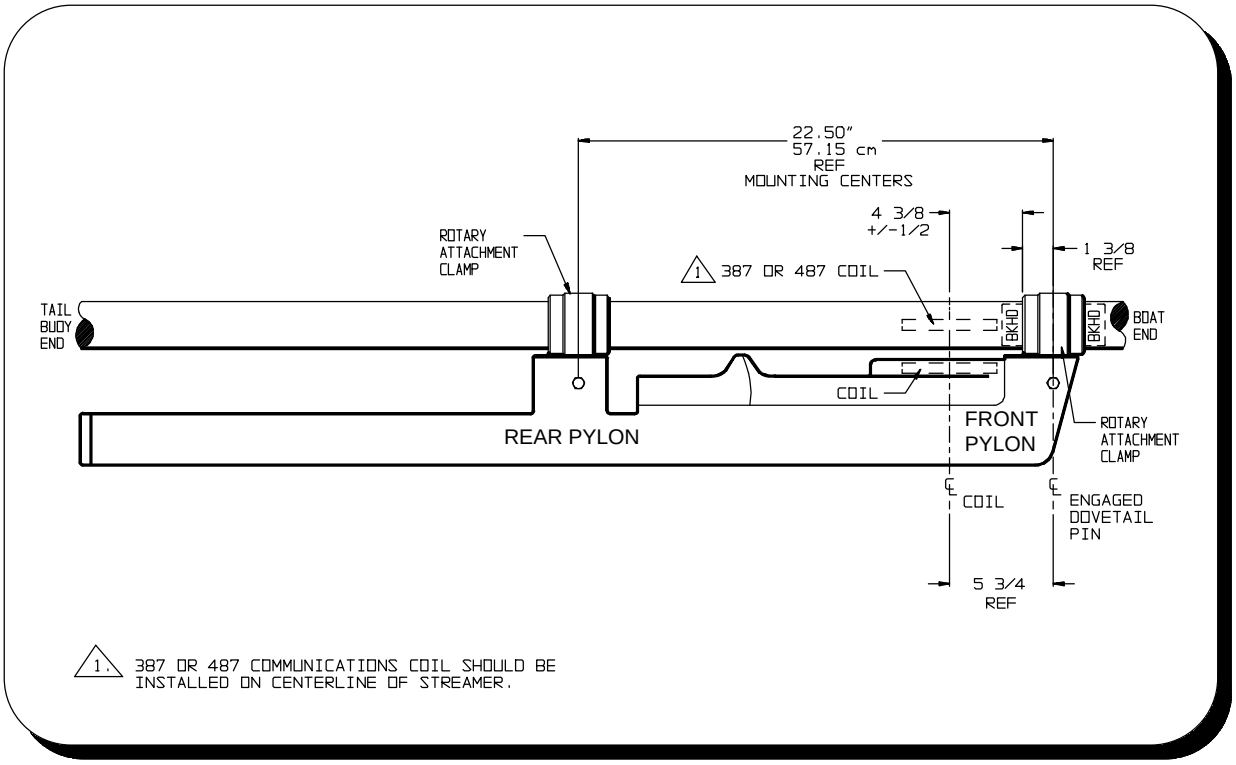

Figure 3.1. Bird mounting and collar placement on streamer.

NOTE: WHEN INSTALLING COLLARS ON A STREAMER, ALWAYS CHECK THAT:

- the aluminum outer ring rotates freely on the inner ring
- the collars are exactly 22.5 inches (57.1 cm) apart
- the hole in the keyhole slot is forward (when deployed)

Collar spacing is important to the proper latching of both pylons. If the collars are too close, the rear pylon may fully lock in before the front pylon locking pin can properly engage; if they are too far apart, then the rear pylon locking pin may not properly engage. In either case, as the streamer is deployed, the outer skin may shift or stretch causing the collar spacing to change. Depending on the direction of the shift, this could cause the partially latched pylon to either fully engage or completely disengage. Note that with both pylons properly latched, the bird actually maintains collar spacing as the streamer is deployed.

3.2 INSTALLATION ON THE STREAMER (ROUND LOCKING ROD, AFTER 9/92)

The following procedure describes the correct method for installing a Model 5000 bird (round locking rod type) on the seismic streamer. Refer to Figures 3.2a and 3.2b for part identification.

1. Extend the dovetail pin on the front pylon by rotating the hex head on the eccentric pin so that the white dot to one side of the screwdriver slot is up (toward the top of the pylon).
2. On the rear pylon, rotate the hex head so that the half-moon shaped plates on either side of the pylon contact the locking rod screws from the top moving them downward; this action extends the dovetail pin and, at the same time, retracts the locking rod.
3. As the bird is installed on the collars, be sure that front and rear dovetail pins fit into the hole on both collar rings at the same time.

   After inserting one dovetail pin into the hole in a collar, if it is necessary to slide the bird on that collar to engage the dovetail pin on the other collar, then collar spacing is incorrect and one of the latches may not fully engage (see collar spacing note in "MOUNTING COLLARS" section).
4. Slide the bird back on the collars as far as it can go. The leading edge of the front pylon should be even with or behind the front edge of the aluminum collar ring and the leading edge of the rear pylon should be no more than 1/8 inch ahead of the front edge of the rear collar ring (see Figures 3.2a and 3.2b).
5. On the rear pylon, rotate the hex head one quarter turn to allow the internal spring to extend the locking rod; then pull the bird back firmly to insure that both front and rear locking rods have extended into the forward (round hole) portion of the keyhole slot.

6. Retract the dovetail pin on the front pylon by rotating the hex head on the eccentric pin so that the white dot to one side of the screwdriver slot is down (away from the top of the pylon); the hex should rotate freely 1/4 turn either side of this position.
7. On the rear pylon, rotate the hex head so that the half-moon shaped plates on either side of the pylon contact the locking rod screws from the bottom; this action retracts the dovetail pin and, at the same time, extends the locking rod.

NOTE: BEFORE DEPLOYMENT, VISUALLY CHECK THAT:

- no portion of the slot is visible above the heads of the screws that retract the locking rods
- both white dots located behind the rear pylon eccentric pin are exposed.

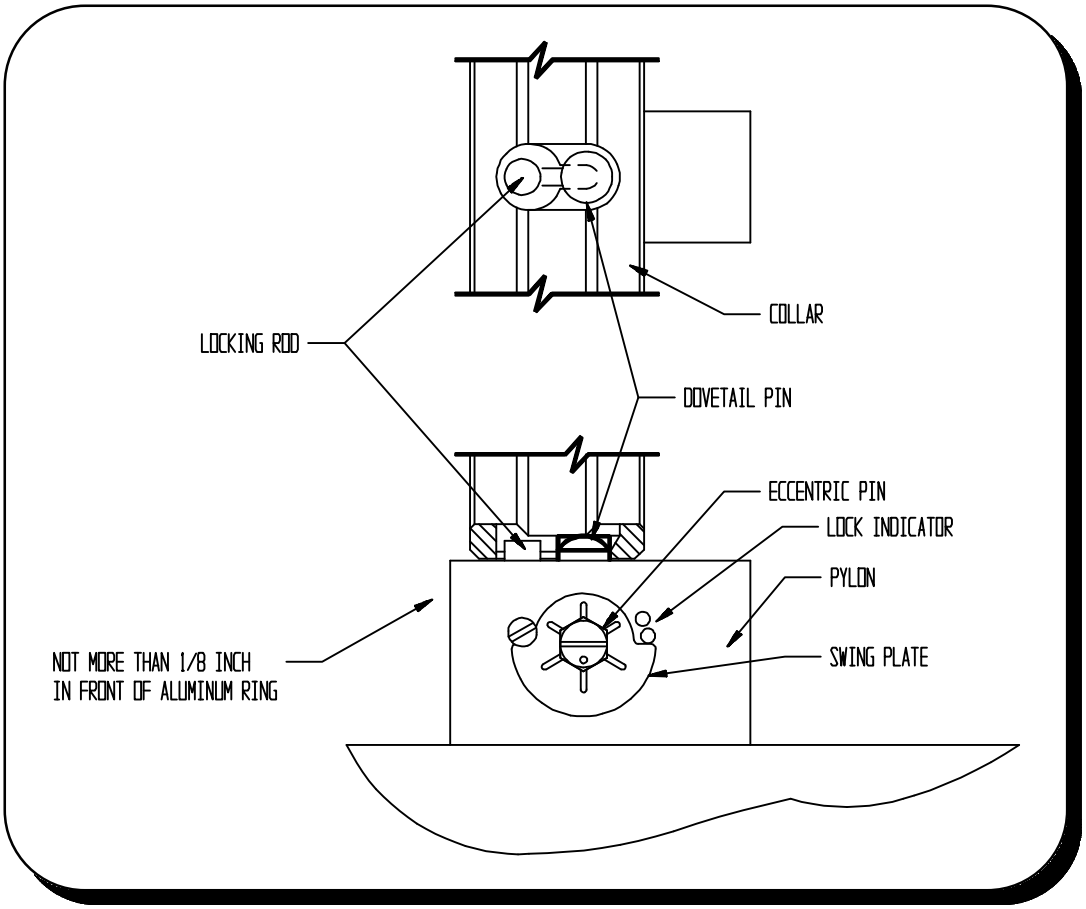

Figure 3.2a. Rear pylon with round locking rod (after 9/92), shown latched.

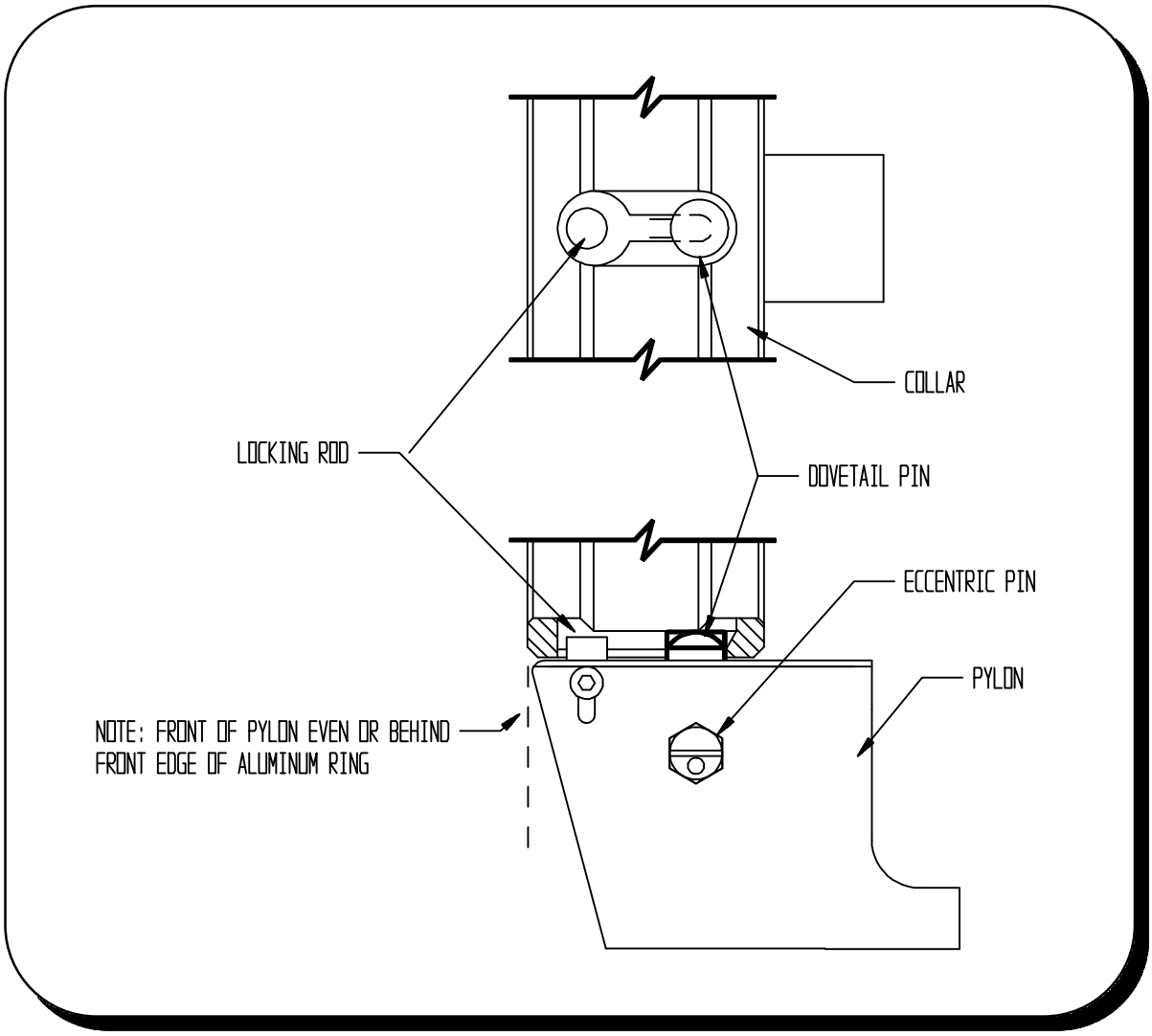

Figure 3.2b. Front pylon with locking rod, shown latched.

3.3 INSTALLATION ON THE STREAMER (RECTANGULAR LOCKING LINK, BEFORE 9/92)

The following procedure describes the correct method for installing a Model 5000 bird (rectangular locking link type) on the seismic streamer (refer to Figure 3.3):

1. Start with both dovetail pins in the extended (unlatched) position with the locking links more or less flush with the top of the pylon. Note that, when the small hole to one side of the screwdriver slot is up (toward the top of the pylon), the dovetail pin is in the fully extended position.
2. As the bird is installed on the collars, be sure that front and rear dovetail pins fit into the hole on both collar rings at the same time.

After inserting one dovetail pin into the hole in a collar, if it is necessary to slide the bird on that collar to engage the dovetail pin on the other collar, then collar spacing is incorrect and one of the latches may not fully engage (see collar spacing note in "MOUNTING COLLARS" section).

3. Slide the bird back on the collars as far as it can go, then rotate the hex on the eccentric pins so that the small hole is down (away from the top of the pylon); the hex should rotate freely 1/4 turn either side of this position.

4. Pull the bird back firmly to insure that both locking links have extended into the forward (round hole) portion of the keyhole slot, firmly locking the pylons onto the collar rings.

   The leading edge of the front pylon should be even with or behind the front edge of the aluminum collar ring and the leading edge of the rear pylon should be no more than 1/8 inch ahead of the front edge of the rear collar ring (see Figure 3.3). **If these conditions are not met, both latches may not be fully engaged. CHECK COLLAR SPACING BEFORE DEPLOYING.**

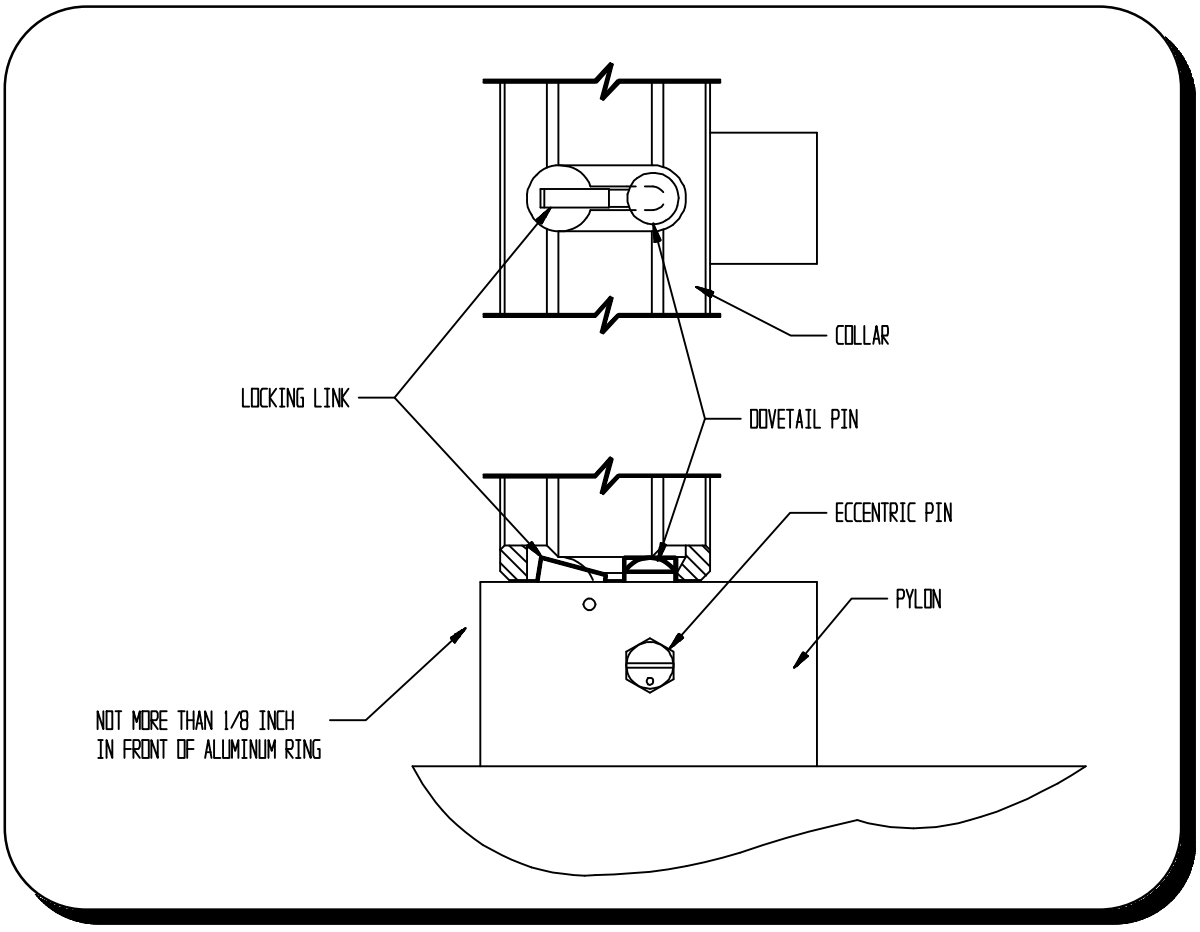

Figure 3.3. Rear pylon with rectangular locking link (before 9/92), shown latched.

3.4 LATCH MAINTENANCE

PRIOR TO STREAMER DEPLOYMENT: All bird latch assemblies should be checked for proper operation and, as necessary, cleaned and lubricated.

Check that dovetail pins on top of each pylon extend and retract fully as the eccentric pin (slotted hex head on either side of the pylon) is rotated. Spring loaded locking rods should snap back when retracted and then released. There should be no tendency for dovetail pins or locking rods to stick or bind. On older birds, the locking link (in front of the dovetail pin) should extend as the pin retracts.

Use a half collar outer ring to check latch operation. When retracted, the dovetail pin should retain the test collar tightly against the pylon with the locking rod or link (in front of pin) fully extended.

AFTER STREAMER RETRIEVAL: Accumulation of fine mud and sea salts can eventually impair proper operation of the latch mechanism. After streamer retrieval and especially before long term storage of birds, latch mechanisms should be flushed with a light oil or silicone lubricant to insure continued reliable operation.

REMEMBER: Use of birds with malfunctioning latches can result in poor compass performance and loss of or damage to the bird.

3.5 LATCH REPAIR AND DOVETAIL ASSEMBLY REPLACEMENT

This procedure describes the replacement of DigiBIRD latch components in the field including the dovetail pin assembly. Damaged or missing locking links or locking rods can easily be serviced in the field per these instructions, but due to the difficulty of the process without proper tools, and the possible effect of dovetail pin failure or damage on compass calibration, it is highly recommended that, whenever possible, DigiBIRDS be returned to a DigiCOURSE repair facility for dovetail pin service.

3.5.1 Tools needed

1. Machine caliper accurate to at least 0.001".
2. Bench mounted arbor press (Grainger p/n 4Z328 pg. 885 Cat No. 379 typical) or a large bench mounted vise. Use of a press is recommended and is significantly easier.
3. One 0.125" drift punch.
4. Half streamer collar outer ring.
5. Swing Plate Field Installation Kit, p/n 6500-064 (for birds shipped after 9/1/92)

3.5.2 Part identification

The following listing of latch parts and their DigiCOURSE part numbers is provided to aid the technician in identification and ordering.

- p/n 8000-890 Dovetail Pin Assembly
- p/n 2500-218 Locking Link (before 9/92)
- p/n 2800-245 Dowel Pin (before 9/92)
- p/n 2500-241 Eccentric Pin
- p/n 2500-511 Eccentric Pin with Dot (after 9/92)
- p/n 2500-K508 Rear Locking Rod Replacement Kit (after 9/92)
- p/n 2500-K510 Front Locking Rod Replacement Kit (after 9/92)
- p/n 2500-507 Swing Plate (after 9/92)

NOTES: (before 9/92); Latches with rectangular locking link
(after 9/92): Latches with round locking rod

3.5.3 Housing pylon inspection

If the dovetail assembly is being replaced primarily due to wear or corrosion, little or no error can be expected from direct replacement. However, if the pins are pulled out or the pylons significantly distorted or cracked due to impact, closer inspection must be made to verify the effect on compass calibration.

If a pin has been pulled out and caused noticeable cracking or tearing of the polyurethane in the area of the pylon, return the unit for repair. Reject a housing if the unstressed diameter of the pin holes (2 per bird) exceeds 0.560in.

3.5.4 Do nots

1. Do not attempt to remove the eccentric pins by impact. Polyurethane was selected to absorb energy. Damage to the sensitive compass is possible if a press or vise is not used.
2. Do not substitute non-DigiCOURSE parts for screws, dowel pins, or springs. DigiCOURSE parts are selected and screened for magnetic content.
3. Do not attempt to unscrew the eccentric pin from each side. It is a single machined part.

3.5.5 Front assembly repair

1. Remove nose bolt, nose, and battery pack.
2. Invert 5000 and remove gray potting material (if applicable). See Figure 3.5.5a.
3. Birds with rectangular link: Using a 0.125 drift punch, drive out the dowel pin that retains the locking link, then remove the locking link.
4. Birds with round locking rod: Remove the two screws on either side of the pylon that retain the locking rod then remove the locking rod, spring, and the small white dovetail key. See figure 3.5.5.b.
5. Install a half streamer collar onto the dovetail pin to provide mechanical advantage for removal. Rotate the collar 90 degrees (See Figure 3.5.5c) to extend the dovetail pin so that the eccentric pin can be removed.
6. Using a bench hand press (refer to section titled "Tools Needed", item 2) or vise, press the eccentric pin completely through per Figure 3.5.5c DETAIL A.
7. Disengage the collar and push the dovetail assembly from the top out of the bottom of the pylon.
8. Discard and replace any parts that are damaged.
9. Lubricate all sliding surfaces lightly with anti-seize compound (included in spares kit).
10. Reverse process to reinstall.

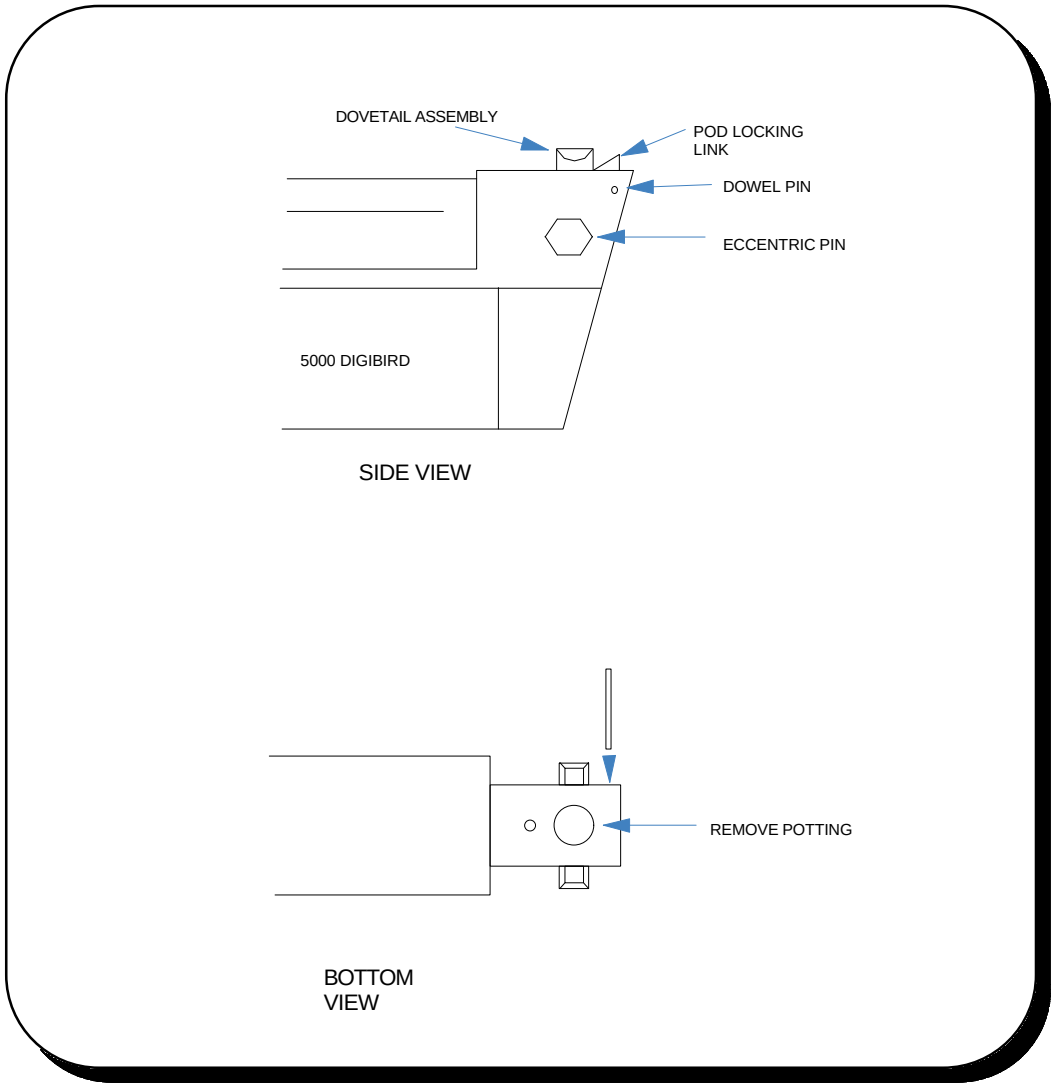

Figure 3.5.5a. Front 5000 latch (rectangular link).

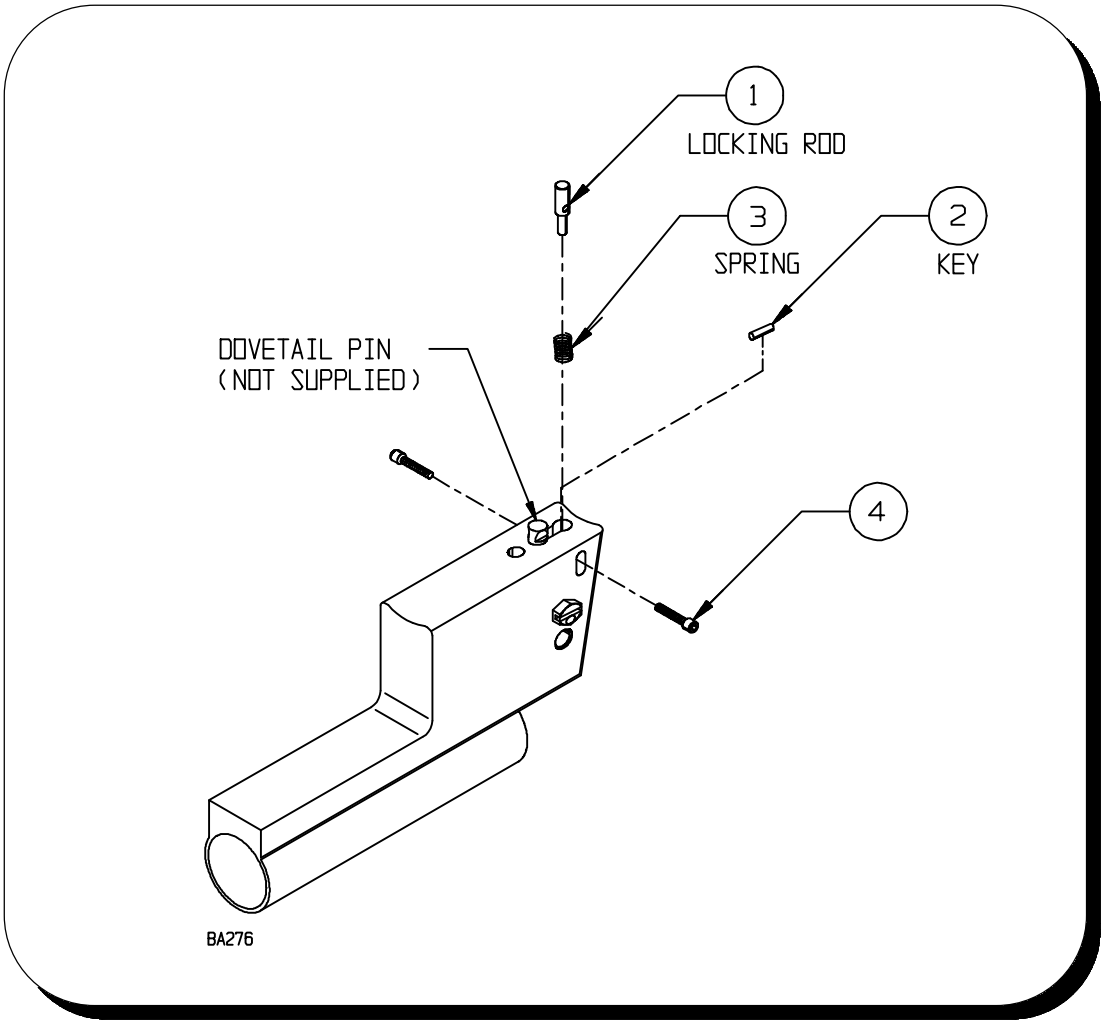

Figure 3.5.5b. Front 5000 latch (round locking rod).

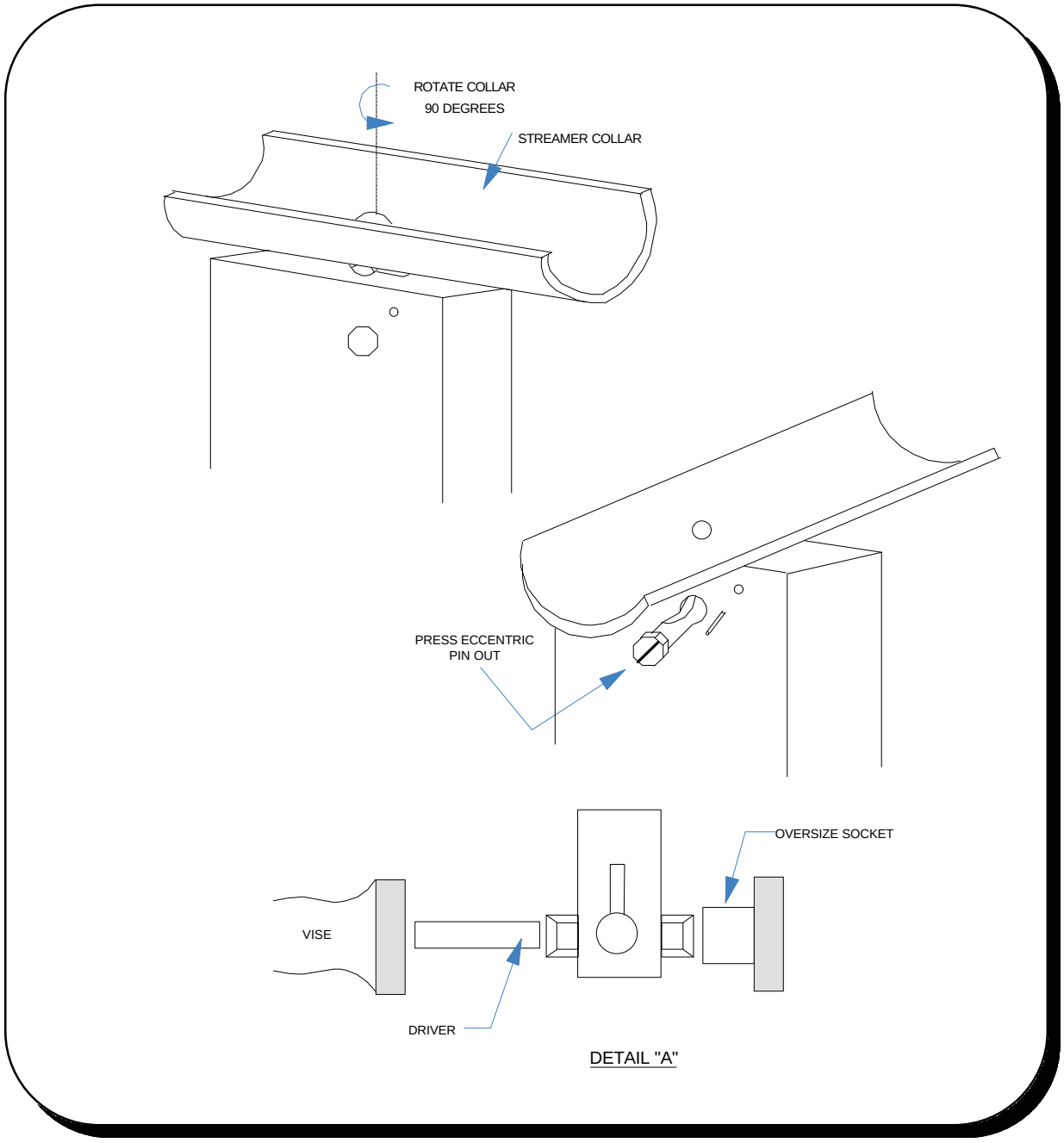

Figure 3.5.5c. Eccentric pin removal.

3.5.6 Rear assembly repair

1. Using a small screw driver, pry the black "rear access plug" out (see Figure 3.5.6a). If unsuccessful, drill a pilot hole and use a screw.
2. Birds with rectangular link: Using a 0.125 drift punch, drive out the dowel pin that retains the locking link, then remove the locking link.
3. Birds with round locking rod: Remove the two screws on either side of the pylon that retain the locking rod then remove the locking rod, spring and the small white dovetail key. See Figure 3.5.6.b.
4. Birds with round locking rod: Using a screwdriver, carefully pry off the two swing plates that fit over the eccentric pin hex on either side of the pylon.
5. Install a half streamer collar onto the dovetail pin to provide mechanical advantage for removal. Rotate the collar 90 degrees (See Figure 3.5.5c) to extend the dovetail pin so that the eccentric pin can be removed.
6. Using a bench hand press (refer to section titled "Tools Needed", item 2) or vise, press the eccentric pin completely through per Figure 3.5.5c DETAIL A.
7. Once the eccentric pin is removed, disengage the collar and push the dovetail assembly from the top until it can be removed through the access hole. If difficult, this job can be made easier by disassembling the dovetail assembly through the access hole, but if this is done, discard the entire dovetail assembly and replace with a new part.
8. Reverse process to reassemble. Use tools and instructions provided in the Swing Plate Field Installation Kit (p/n 6500-064) to install and locate swing plates on birds shipped after 9/1/92.

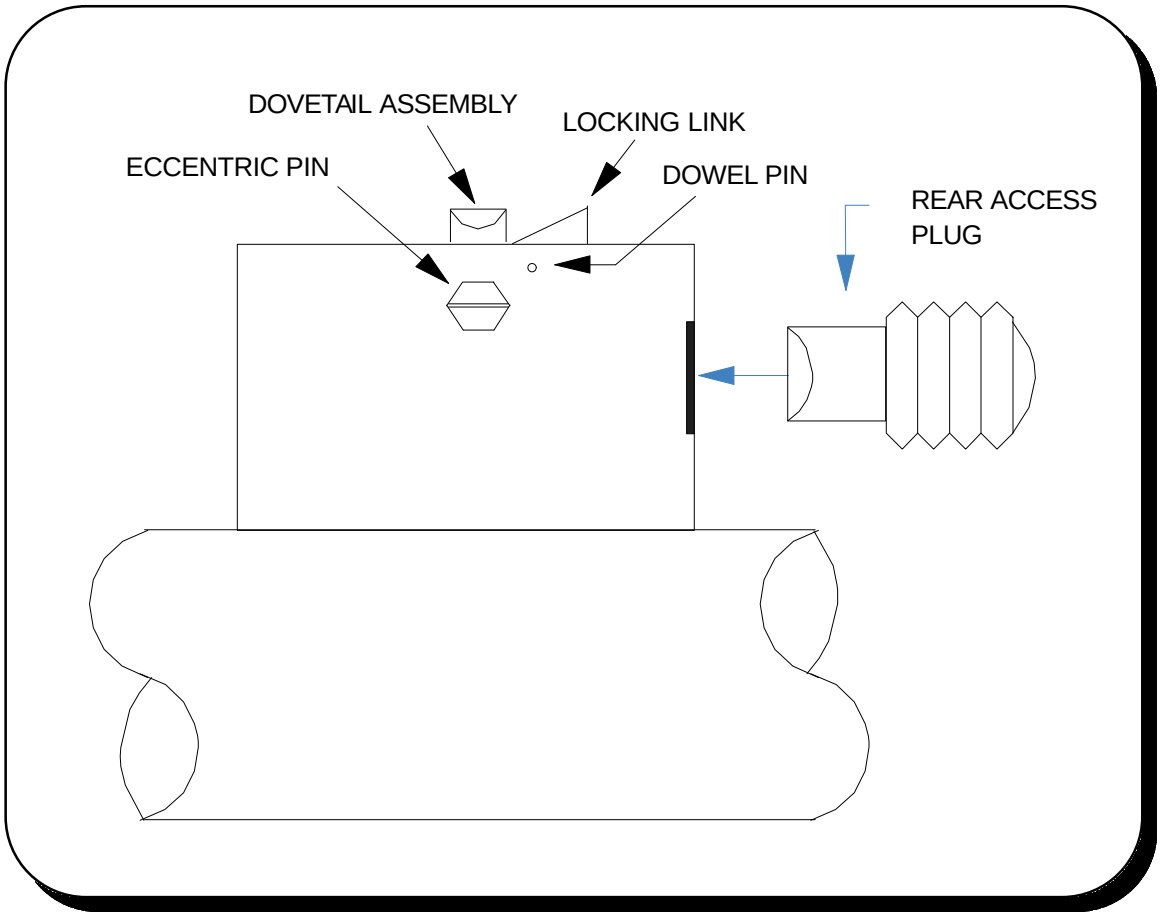

Figure 3.5.6a. Rear 5000 latch (with locking link).

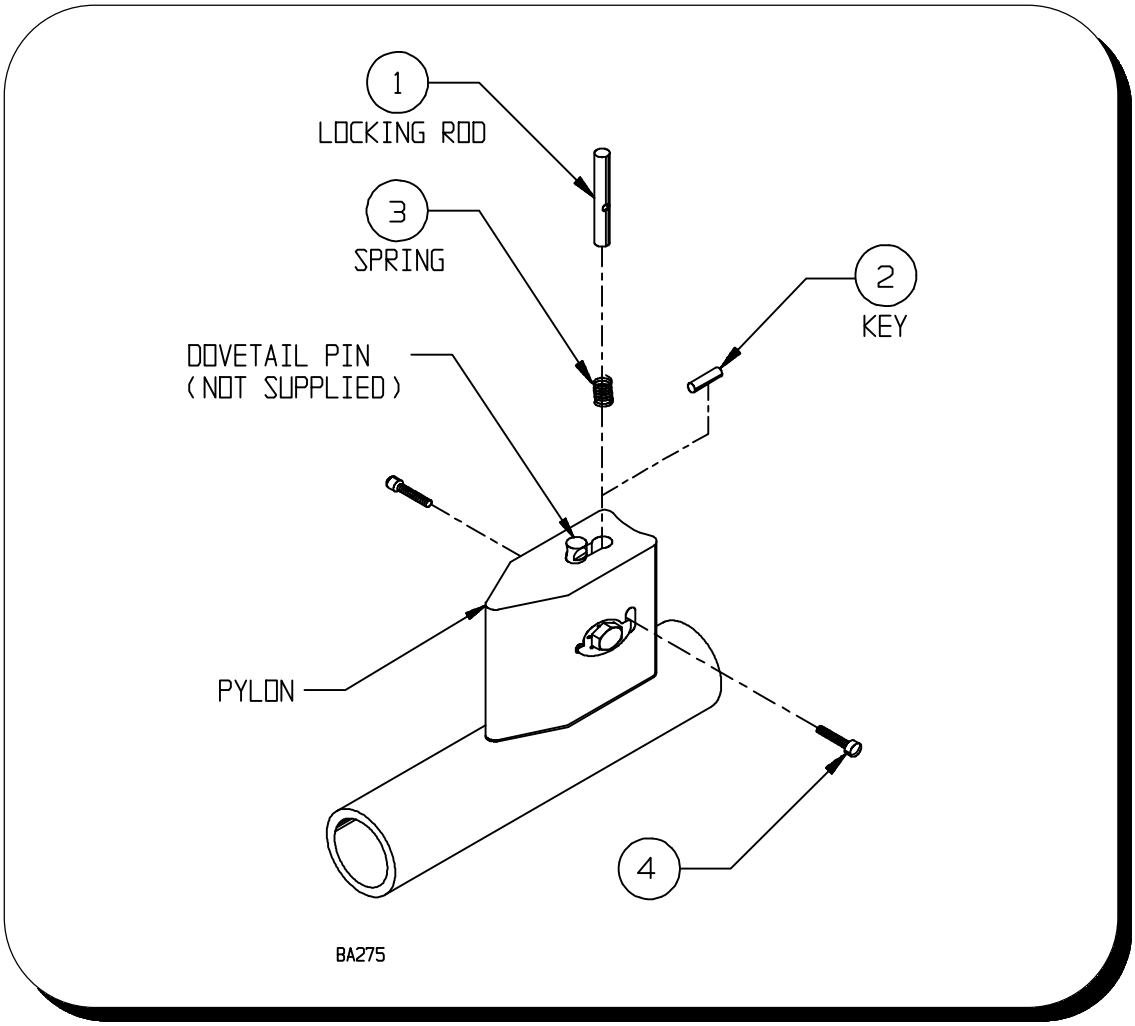

Figure 3.5.6b. Rear 5000 latch (with locking rod).

3.6 SAFETY STRAP OPTION

Effective October 1, 1991, a 0.531 inch diameter hole has been added through the front pylon directly below the eccentric pin on all new 5000 series DigiBIRDS. All birds repaired at the DigiCOURSE New Orleans and U.K. locations after this date will be reworked to include this feature.

Because the possibility of collision, improper latching, or a faulty latch mechanism always exists, it is strongly recommended that some type of safety retaining device be used to prevent total loss should the unit become disengaged from the mounting collars.

DigiCOURSE suggests one of the following:

- A plastic tie wrap: the reusable strap shown in the figure is manufactured by Thomas & Betts, and is 1/2 in (12.7mm) wide by 18 in (450mm) long. See Figure 3.6.

- A loose-fitting rope-based safety strap: DigiCOURSE part no. 8000-627

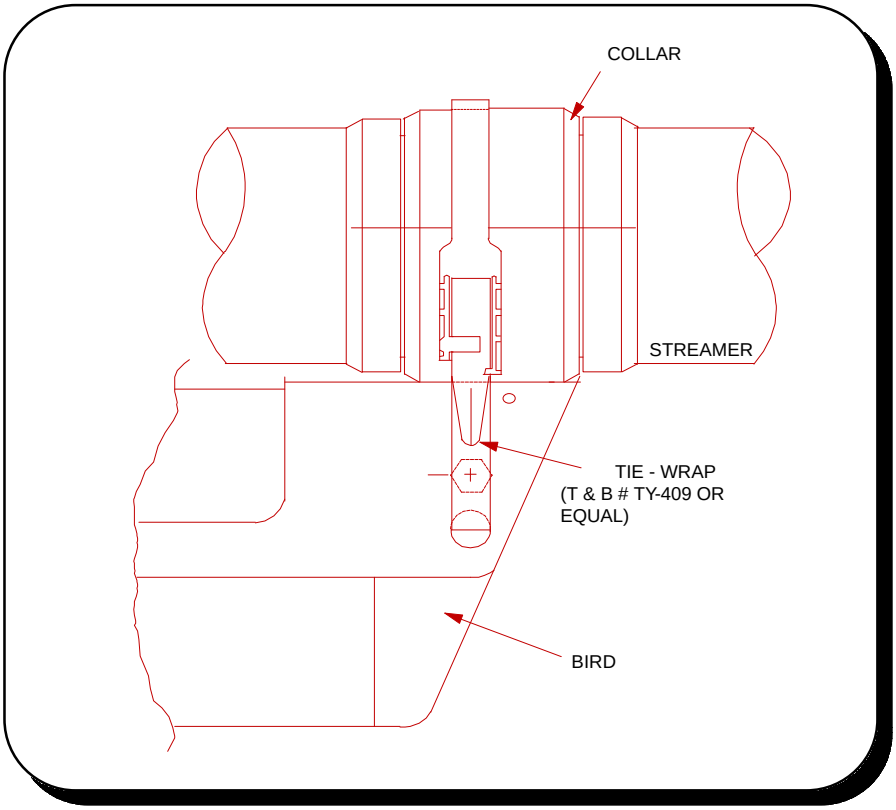

Figure 3.6. Safety strap.

SECTION IV - DEPTH KEEPING

This section presents a description of the DigiBIRD depth keeping system in a form that can be easily and quickly understood by the operating technician. This information is based on standard control system theory and supported by observations and measurements made in the field. Because all operating conditions cannot be observed or anticipated there is always more that can be discovered about any control system. DigiCOURSE welcomes any feedback, suggestions, or personal observations regarding Model 5000 depth control settings.

4.1 SYSTEM DESCRIPTION

The **Model 5000 DigiBIRD** measures actual depth during operation through an onboard sensor located in the wing module. Assignment of a **TARGET DEPTH** through DigiSCAN communications places a bird in automatic **DEPTH KEEPING** mode causing the depth control logic to continuously monitor **DEPTH ERROR** by comparing the averaged measured depth to the TARGET DEPTH. It then makes periodic adjustments to the angle of the bird's wings (also referred to as "fins") to drive the bird (and streamer) back toward the assigned target depth.

The frequency, magnitude, and direction of these wing angle corrections depend on the value of the calculated DEPTH ERROR along with the values of **CONTROL GAINS** stored in the bird's memory. The control gains can be adjusted by the user to alter the operating characteristics of the bird.

4.2 CONTROL GAINS

CONTROL GAIN	DEFAULT VALUE	GAIN INDEX @ DSR=2
Depth/Heading Sample Rate (DSR)	2.0 seconds	<--
Depth Averaging	14.0 seconds	2
Proportional Gain	0.8 deg/ft DT error	5
Integral Gain	64.0	<--
Rate Gain	0.0	<--
Controller Update Rate	20.0 seconds	10
Fin Angle Dead Band	0.4 degrees	3

All birds are factory set to the **DEFAULT** values shown in the table. **These are recommended starting values from which all adjustments should be made.** They have been found to provide a reasonable balance between battery usage and depth control effectiveness when used for moderate sea conditions in water of somewhat uniform salinity and temperature.

However, as sea conditions worsen and/or fresh water currents are encountered, adjustment of the control gains may be necessary to maintain streamer depth control. Conversely, as operating conditions improve, adjustment of the gains to reduce control responsiveness is desirable in order to maximize battery life.

Note that some control gains are functions of other control gain values and therefore cannot be entered directly. These require the entry of a **GAIN INDEX** from which the actual gain value is calculated.

4.2.1 Control gain access

For DigiSCAN systems using the Model 293 controller with Model 272 modems, adjustment of control gains by the system operator is accomplished via the BIRD DIAGNOSTICS module (option 4 from the main menu).

> **CAUTION:** When using DigiSCAN, do not attempt control gain changes while collecting seismic data (on-line). **Exiting the DigiSCAN "RUN" mode to enter BIRD DIAGNOSTICS halts data logging.**

For System 3 users, control gains can be accessed using the BIRD DIAGNOSTICS option under the System 3 Operator Interface Menu. One can also enter Bird Diagnostics by using the "Quick Entry" feature from the bird DEPTH TEXT and DEPTH GRAPHICS displays, HEADING TEXT display, and INTEGRATED graphics display.

With System 3, the operator can view and change control gain settings while in the run mode without interrupting data logging.

4.2.2 Depth/heading sample rate

The Depth/Heading Sample Rate (DSR) defines the time period, in seconds, between readings of the bird depth sensor and compass. It is the fundamental time base for the depth controller calculations. Model 5000 birds accept DSR values from .5 seconds to 25.5 seconds in 0.5 second intervals. **The recommended (default) value for DSR is 2 seconds.**

The DSR value is used to calculate DEPTH AVERAGING, INTEGRAL GAIN, and CONTROLLER UPDATE RATE values from their respective gain indices. Since any change to the DSR also changes these other gain values, effects can be wide-ranging and difficult to predict. Since it is usually possible to achieve desired depth keeping performance by adjusting other gain parameters without the confusion that could arise from changing the DSR, **changing the Depth Sample Rate should be avoided** for typical operating conditions.

But in cases where unusually short shot point intervals are encountered, it may be necessary to reduce the DSR to 1 second to acquire sufficient heading samples to insure good data quality. In these cases, the following control gain indexes should be also changed to keep their recommended default values:

- Increase Depth Averaging index to 3
- Decrease Integral Gain to 32
- Increase Controller Update Rate index to 20

This produces the same depth keeping characteristics as the original default settings, shown in Section 4.2 but also causes an observable decrease in battery life.

4.2.3 Depth averaging

Depth Averaging is accomplished using a rate-corrected rolling exponential filter to provide a rolling average of the measured depth over a selectable number of readings. The effective time over which the depth readings are averaged (EFFECTIVE AVERAGING TIME) is equal to the number of samples averaged multiplied by the depth sample rate.

The effective number of readings averaged is selected by entering the appropriate AVERAGING GAIN INDEX as follows:

AVERAGING INDEX	EFFECTIVE NO. OF SAMPLES AVERAGED	EFFECTIVE AVERAGING TIME (2 SECOND SAMPLE RATE)
0	NONE	NONE
1	3	6
2 (DEF)	7	14
3	15	30
4	31	62
5	63	126

NOTE: Changing the sample rate also changes the averaging time.

The default value for depth averaging is 2, which gives an effective averaging time of 14 seconds (when the DSR = 2 seconds). This value should provide good results in moderate to heavy seas, suppressing the tendency of the bird to follow sea swells, thus keeping the streamer running level while conserving batteries.

Increased averaging delays response to rapid depth changes. These might be encountered when high wing angles (usually in birds at the head of a streamer) combine with sudden changes in streamer velocity at the beginning and end of a turn. This can result in temporary instability in the form of target depth overshoot and oscillation.

Decreased averaging improves response to depth changes and decreases overshoot but also increases battery use and may cause the bird to try to follow swells. Use of zero (no) averaging is not recommended.

NOTE: Depth averaging is applied to the depth measurements logged to the host computer. Therefore adjustments to depth averaging to increase or decrease depth control response also affects the quality of recorded data. When data logging requirements limit adjustments to depth averaging, it is necessary to adjust other control gains to achieve desired effects.

4.2.4 Proportional gain

Proportional Gain determines the amount of wing angle change that occurs in response to the calculated DEPTH ERROR. With integral and rate gain values set to zero, wing angle is simply the product of the calculated depth error and proportional gain.

DEPTH ERROR = MEASURED DEPTH - TARGET DEPTH

WING ANGLE = PROPORTIONAL GAIN X DEPTH ERROR

The relationship between proportional gain **value** and proportional gain **index** is shown in the following table.

PROP. GAIN INDEX	PROPORTIONAL GAIN (deg/ft depth error)	PROPORTIONAL GAIN (deg/meter depth error)
0	0.00	0.00
1	0.05 **	0.16
2	0.1	0.3
3	0.2	0.6
4	0.4	1.2
5 (DEF)	0.8	2.5
6	1.5	4.9
7	3.0	9.9

NOTES: DigiSCAN displays proportional gain values in deg/ft.
** DigiSCAN displays 0 deg/ft due to rounding

A higher proportional gain results in a larger wing angle for a given depth error.

EXAMPLE: A bird with proportional gain index set to 5 (0.8 deg/ft DT error), that has a target depth of 30 ft, and is running at 40 ft would adjust the wing angle to +8 degrees. A proportional gain of 3 would result in a +2 degree wing angle for the same 10 ft depth error. Note that in this example the integral and rate gains are set to zero.

Proportional gain counters the effects of sea state and fluctuating tow speed. The default value for proportional gain is 5, which gives a wing angle deflection of 0.8 degrees per foot of depth error. This value has proved to be acceptable for sea states up to 10 ft (3 meters). In flat calm seas it may be possible to stay within contract depth specifications with a lower index and, since there is a direct relationship between proportional gain setting and battery life, one should keep the index as low as conditions and contract permit. A flat calm sea may allow an index as low as three, while an extreme swell may require an index of seven.

When experimenting with the effects of changing the proportional gain index, it is best to make changes in increments of one. **In order to maximize battery life and provide adequate streamer control, the proportional gain index should be adjusted as often as sea state changes allow.**

4.2.5 Integral gain

Integral gain counters the effects of any **long term** force (bias) that tends to hold the streamer away from its assigned target depth. Such forces are always present to some degree and are usually due to heavy or light streamer ballasting, or the effect of the tow cables' leading to the paravane or tail buoy trying to lift the ends of the streamer.

Because wing angle correction from proportional gain only is always zero when a bird is at its target depth (depth error = zero), and a zero degree wing angle cannot provide the lift needed to maintain depth when biases are present, **proportional gain alone cannot bring an "unbalanced" streamer to the target depth**. An additional correction must be made to the wing angle to counteract these forces before a bird can reach and maintain operation at the target depth.

Integral gain provides a time-dependent correction to the wing angle calculated from proportional gain. As long as there is a depth error, this second correction or "offset" accumulates at a constant rate that is determined by the integral gain INDEX. The integral gain term is added to the proportional term if the bird is below the target depth and is subtracted from the proportional term if the bird is above target depth.

The rate of change of wing angle due to integral gain **is independent of proportional gain** and is a function only of the integral gain INDEX and the depth sample rate (Caution: changing the DSR changes the integral gain).

INTEGRAL GAIN INDEX	INTEGRAL GAIN in degrees per minute (2 second depth sample rate)
0	0.00
32	0.58
64 (default)	1.15
96	1.73
128	2.30
160	2.88
192	3.45
224	4.03
255	4.60

NOTE: Integral gain index is not limited to the values shown above. One may select any value between 0 and 255.

EXAMPLE: A bird running at 35 ft with a target depth of 30 ft has a proportional gain index set to 5 (0.8 deg/ft DT error). The wing angle **from proportional gain only** is +4 degrees. In this example a 4 degree wing angle creates just enough lift to balance the weight of a heavy streamer so the streamer cannot move toward the target depth unless the integral gain further adjusts the wing angle.

With the integral gain set at the default value of 64, the wing angle would increase at a rate of 1.15 degrees per minute. It would take approximately 3.5 minutes to accumulate an additional 4 degrees of positive wing angle that lifts the bird to the target depth where the proportional term goes to zero leaving only the 4 degree integral term to maintain depth against the weight of the streamer.

The value of integral gain determines how quickly the depth control system adjusts for these biases. In areas of uniform salinity, a lower value of integral gain is sufficient, because once the streamer has settled, its buoyancy does not change appreciably. Areas with fresh water currents result in constantly changing streamer weight which requires a higher value of integral gain in order to correct in a short period of time.

The default value (64) has proved to be satisfactory in waters of uniform salinity. In areas where fresh water currents are encountered, the integral gain can be increased to a maximum of about 128, which increases the rate of accumulation. Higher settings usually result in unacceptable oscillation about the target depth. A good value for a tricky prospect is 100. There is no net benefit to increasing integral gain for high sea states. Adjust the proportional gain as the sea state changes; adjust the integral gain as fresh water currents are encountered.

4.2.6 Rate gain

Rate Gain provides an additional wing angle correction that is proportional to the **rate of change** of depth error and would, in theory, provide quick response to sudden changes in depth. This type of response is undesirable for streamer depth control, and experience has shown that use of this term can cause extreme instability. **Therefore, it is recommended that this value always be set to zero.**

4.2.7 Controller update rate

The Controller Update Rate determines the time interval at which the wing angle is updated, (i.e., how often the wings can move). The update rate **index** defines **the number of depth sample intervals between wing angle adjustments**, so the controller update rate **value** (the time period, in seconds, between possible wing angle adjustments) is simply the product of the Controller Update Rate index and the Depth Sample Rate.

Increasing the Update Rate index causes the wings to update less often, decreasing battery usage but also decreasing the overall effectiveness of the depth controller. "Legal" values for the Controller Update Rate index are from 1 to 255; the recommended (default) value is 10, which allows wing movement every 20 seconds with a 2 second DSR.

To extend battery life when shooting in areas with no currents and during periods of flat calm seas, try increasing the Update Rate index. A good starting value is 15 with a maximum of 25.

A vessel on standby with birds in the water can reduce battery consumption by increasing the Update Rate index to 20 in rough seas, 35 in moderate seas, and 50 in flat calm seas. **Remember to lower the index before starting a line.**

Use extreme caution when increasing the Update Rate as control of the streamer could be lost if the Update Rate is set too high. For the sake of safety, do not reduce the Update Rate index above 20 in a shallow water area or in a shipping lane.

If cable control cannot be maintained by adjustment of the other control parameters, the update rate index can be decreased, with care, to a minimum of 5. This should be done only as a last resort as battery life is effectively halved when the Update Rate is halved. If the index is decreased to a low value, it is suggested that it be returned to the default value (10) during line changes.

4.2.8 Fin angle dead band

Fin Angle Dead Band defines the minimum wing angle correction that can be applied at a wing update cycle. If the **wing angle correction** calculated by the depth control logic is less than the dead band value, no wing motion takes place. By ignoring minor wing corrections, battery usage can be reduced with very little loss of streamer depth control. Listed below are dead band indices and their associated values.

INDEX (degrees)	DEAD BAND	INDEX (degrees)	DEAD BAND
0	0.0	8	1.2
1	0.1	9	1.3
2	0.3	10	1.5
3 (DEF)	0.4	11	1.6
4	0.6	12	1.8
5	0.7	13	1.9
6	0.9	14	2.0
7	1.0	15	2.2

The default value of the Dead Band index is 3, corresponding to a dead band of 0.4 degrees. The dead band can be increased in calm weather but be careful if the update rate has also been increased. Dead band settings over 6 impair cable control, but extend battery life.

Decreasing the dead band, along with increasing proportional gain, improves depth control in rough weather. This is preferable to a decrease in the update rate, which should be done only as a last resort. The dead band index can be set as low as one to increase depth control. A zero value is not recommended, as it results in an extreme drop in battery life.

4.3 SUMMARY

Adjustment of the DigiBIRD control gains allows the operator to maximize battery life by adjusting the depth control response to suit the operating conditions at the time.

An operator can become skilled in control gain adjustment by making adjustments in small increments to one parameter at a time, while following the guidelines given in this section, and then observing the effects on depth control and wing action.

The following table (Figure 4.3) provides a condensed outline of the control gain information and adjustment recommendations contained in this section. It can be easily copied, posted, and used as a quick reference for making control gain adjustments during system operation.

CONTROL GAIN	INDEX RANGE	VALUE RANGE	VALUE UNITS	DEFAULT VALUE	DEFAULT INDEX
Depth Sample Rate (DSR) Use default value for most operating conditions	N/A	0.5 - 25.5	seconds	2	<--
Depth Averaging Decrease to increase response to depth changes or reduce overshoot. (Caution: affects depth data logging).	0 - 5	DSR*[2^(N+1)-1]	seconds	14	2
Proportional Gain Increase for high sea states; decrease for calm seas.	0 - 7	0 - 3.0	deg/ft DT error	0.8	5
Integral Gain Increase in areas with fresh water currents (salinity changes).	0 -255	---	---	---	64
Rate Gain Always set to 0.	0 -7	---	---	---	0
Controller Update Rate Decrease for increased depth control in extreme conditions (last resort). Increase to save batteries when off line for long periods in moderate/light seas.	1 - 255	N x DSR	seconds	20	10
Fin Angle Dead Band Decrease for rough weather (with increase in prop. gain).	0 - 15	0 - 2.2	degrees	0.4	3

Figure 4.3. Control gain information.

SECTION V - GENERAL MAINTENANCE

5.1 PREVENTIVE MAINTENANCE BEFORE LONG TERM STORAGE

During actual operation, the corrosive effects of sea water on Series 5000 DigiBIRDs are minimized due to the extensive use of nonmetallic materials combined with the use of high grade corrosion-resisting stainless steel for metal components.

However, when birds are taken out of service and placed in storage or in shipping, small amounts of sea water can remain trapped in joints and openings. As this sea water evaporates, dried residues consisting of sea salts and fine silt can accumulate in these areas and eventually build up to the point where they could affect depth calibration, latch operation, and, in extreme cases, the wing drive mechanism.

To avoid problems due to the effects of these sea water residues, the following actions are recommended whenever birds are removed from the water and are to be placed in storage.

5.1.1 Flush the depth sensing port

The **DEPTH SENSING PORT** should be thoroughly flushed with a moisture-displacing lubricant such as WD-40, LPS, or a silicone spray. This port is located forward of the coil center on the right side of the wing module.

1. Stand the bird on its nose and allow any water in the depth port to drain.
2. Position the bird with the nose up and liberally spray lubricant into the depth port.
3. Position the bird nose down to allow excess lubricant (and water) to drain. Note if liquid is clear or cloudy (mud or silt).
4. In heavy silt conditions, it may be necessary to repeat this process several times until draining liquid is clear.

5.1.2 Check latch mechanisms

Check **LATCH MECHANISMS** for any damage and flush with an oil or silicone-based lubricant while operating the latch. Insure that all parts of the latch move freely with no tendency to stick or bind. Use a collar ring to check latch operation. When retracted, the dovetail pin should hold the test collar tightly against the pylon with the locking rod or link (in front of the dovetail pin) fully extended.

5.2 OPERATION IN WATERS WITH HIGH CONCENTRATION OF FINE SILT

When operating in high silt conditions, it is also recommended that the WING MODULE be removed and the WING DRIVE CAVITY be flushed first with water, then with a moisture-displacing lubricant.

In heavy silt conditions, it is especially important that these procedures be followed as soon as possible after streamer retrieval. Large amounts of silt can easily be removed while still wet, but if allowed to dry, wing module or motor module replacement may be necessary to correct any problems that may occur.

5.3 ORIENTATION DURING STORAGE

Model 5011 Compass Birds should always be stored in a near horizontal position (less than 45 degrees). Storage in the vertical position causes the compass mechanism to rest against the pitch gimbal stops. Prolonged storage in this condition under continued vessel motion could result in accelerated wear and premature compass failure. It is okay to orient birds in a vertical position for brief periods during use, maintenance, or when changing batteries.

SECTION VI - TEAR DOWN AND REASSEMBLY

The following is a set of instructions for removal and installation of the internal modules of the 5000 DigiBIRD. It is important that no steps be omitted especially those that involve electrostatic discharge protection or removal of residual water. These procedures were taken from Field Service Bulletin 921001-025, which superseded FSB 900017-008.

C A U T I O N: Failure to comply with the following instructions on cleaning housings, inspecting o-rings, and cleaning connectors can result in one or more of the following: erratic depth keeping behavior, failure to maintain depth and/or communication, corrosion of electronics, and flooding of the unit.

6.1 DISASSEMBLY OF THE 5000 DIGIBIRD

6.1.1 Tools required

- 5000 Series Spares Kit (p/n 6500-041; see Appendix B)
- 7/64 Hex Wrench (for compass module screws prior to 6/91)
- 5000 Series Tool Kit (p/n 6500-042; see Appendix B) including :

1. 3/16 Hex Wrench
2. 5/16 Hex Wrench
3. 9/64 Hex Wrench
4. 3/32 Hex Wrench
5. 5/16 Open End Wrench
6. DigiCOURSE Battery Module Removal Tool
7. DigiCOURSE Push Pole*

* A PVC pipe or cylinder may be substituted for this item. Do not use a broom stick, as this can damage the connector on the front of the motor module. The substitute must be able to transmit its force to the black casing of the motor module, not its connector.

Note: Refer to Model 5000 service diagram (0050-003) as shown in Appendix B for visual assistance during disassembly and reassembly.

6.1.2 Disassembly instructions

1. Wipe off the entire outside of the bird with a clean dry towel, and lay the bird on a clean, flat table.
2. Remove the nose bolt using a 3/16 Hex wrench. If the nose bolt is hard to remove this may indicate an internal pressure in the battery module area. Remove with caution and refer to the lithium battery safety bulletin (see Appendix G).
3. Remove the front end cap.
4. Use the battery removal tool to remove the battery module.
5. Remove the three (3) nylon screws that retain the compass module. Depending on the type of screw that is used, this requires a 7/64 Hex wrench or a flat blade screwdriver. To relieve any tension on the screws, stand the unit on the front end and apply downward pressure with your hand on the compass module.
6. Remove the compass module slowly; the wires connected to the compass are short. Remove the wires from the compass terminals.

CAUTION: Do not remove compass from plastic compass module housing!

CAUTION: Do not attempt to remove compass fill screw (large slotted screw next to terminal screws). Compasses are 100% filled and degassed in a vacuum chamber during assembly to insure that no gasses are present. If fill screw is removed, contamination is likely and compass performance will be affected.

7. Remove the wings. Save wing plates and screws.
8. Remove the two (2) large Hex bolts retaining the wing module on the housing with a 5/16 Hex wrench.
9. Remove the four (4) Socket Head Cap Screws in the rear of the wing module with a 9/64 Hex wrench.
10. Turn the unit upside down and disengage the wing module from the housing by pulling down on the wing shaft and the front end of the module, keeping the module as horizontal as possible. A small amount of water will come out of the openings in the platform on the top of the orange housing (see Figure 6.1.2 for a diagram of the area of the bird that floods when submerged). Remove the gasket from around the wing lever that was sandwiched between the wing module and platform.
11. With a clean towel wipe off the under side of the wing module and the platform on the orange housing on which the module sits. Clean and replace the gasket as necessary.
12. Inspect linear actuator cavity for grit or excessive corrosion; flush with lubricant such as WD-40, LPS, or spray silicone.

13. Flood the male connector on the wing module and the female connector (the connector that can be seen through the circular hole in the top of the housing) with any electronic contact spray (in aerosol can form) that disperses water. Blow out both connectors thoroughly with compressed air.

14. Insert the push pole into the front of the outer housing. Rotate the outer housing and pole so that it is as vertical as possible. This allows any water in the linear actuator and around the motor module to fall away from the electronics module. Never use the push pole or other objects to push on the internal modules from the compass end as this could cause damage to the electronic module. Slide the outer housing down the push pole, pushing the internal modules out the rear of the orange housing.

CAUTION: Electrostatic discharge (ESD) procedures must be used when the electronic modules are removed from the outer housing. Use a well-grounded antistatic pad with a wrist strap.

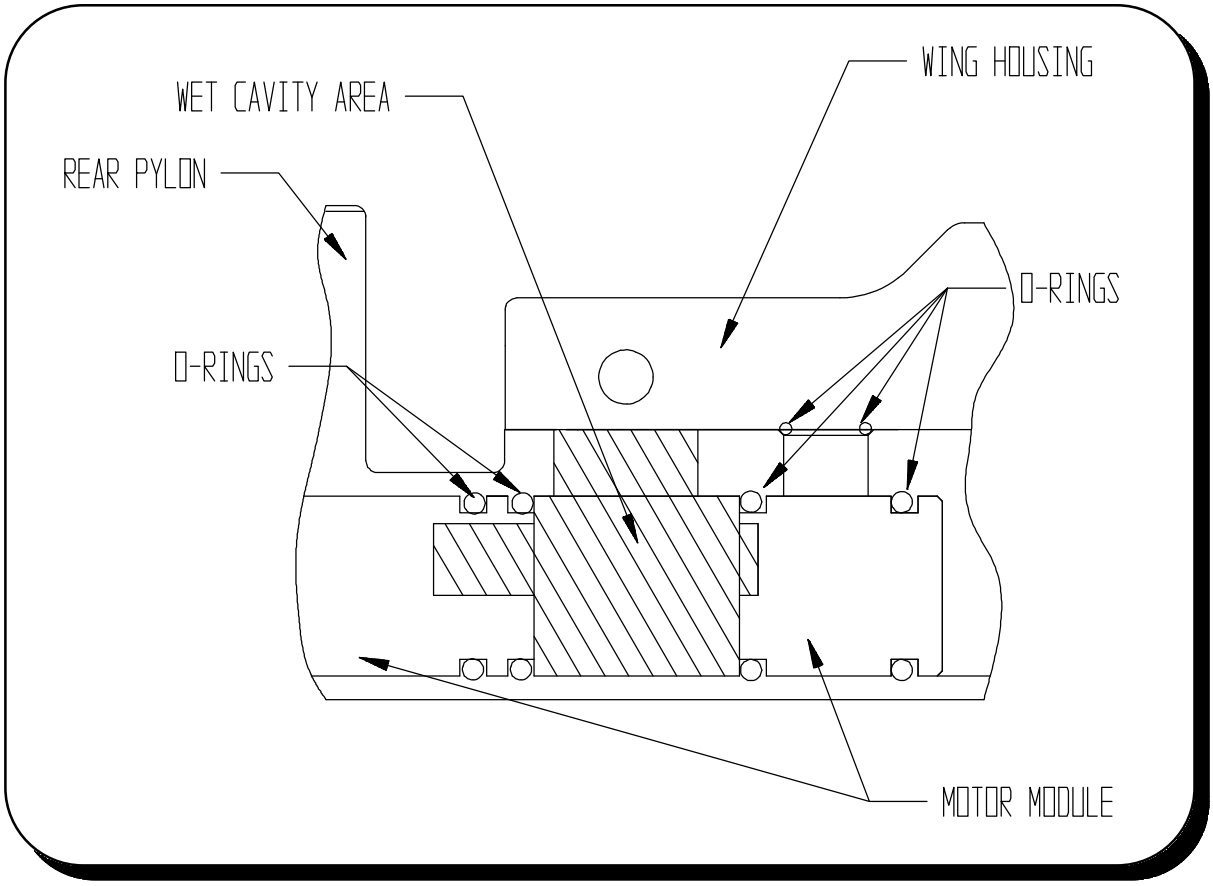

Figure 6.1.2 5000 wet cavity.

6.2 MODULE REPLACEMENT

6.2.1 Motor module replacement

1. Using the 3/32 Hex wrench, remove the two (2) screws that hold the motor module to the backplane. Gently pull the electronic module backplane from the motor module. Remove the two connectors using a small blade screwdriver. Loosen the screw on one side of the connector a small amount and then the opposite screw the same amount, alternately loosening the screws the same amount until the connector is disconnected.

> **C A U T I O N:** Trying to completely loosen the screw on one side of the connector without loosening the opposite screw can damage the connector.

2. A small tie wrap is used to hold the desiccant pack to the wires on the 10-pin connector. If the desiccant pack is dry, the tie wrap can be cut and the desiccant pack can be reused. If the desiccant pack is wet, it can be dried and reused. To dry the desiccant pack, place it in an oven at no more than 180 degrees Fahrenheit for four to five hours or until dry.
3. Replace o-rings on the motor module. The o-rings on the old motor module can be removed and reused if they are not damaged. Refer to the Model 5000 service diagram (0050-003) shown in Appendix B for correct size of replacement o-rings.
4. Position the motor module on the antistatic pad next to the electronics module. Attach the two connectors from the motor module to the connectors on the backplane. The connector should come straight from the motor module to the proper connector on the backplane without crossing. Alternately tighten one screw and then the opposite screw until the connector is fully engaged and tightened. Using a small plastic tie wrap, attach the desiccant pack to the wires just behind the 10-pin connector.
5. Gently insert the backplane into the motor module slot. Using a 3/32 Hex wrench, install the screws that hold the motor module to the backplane. Make sure these screws are seated properly, such that they do not protrude above the edge of the motor module. If these screws are not properly installed, they will score the inside of the orange housing when the internal module is installed, causing water intrusion. Push the desiccant pack that is tie-wrapped to the 10-pin connector wires into the motor module cavity.
6. Check all o-rings on the motor module and on the compass end of the electronics module. Replace if necessary. Check that all screws are tight and properly seated. Refer to Model 5000 service diagram (0050-003) for correct size of replacement o-ring.

6.2.2 Wing shaft / wing lever replacement

1. Use a 5/16 Open End wrench to remove the wing lever. If the wing lever is broken, remove the access plug from the hole on the top of the wing module and use a screwdriver to reach the wing lever through the hole. If necessary, apply heat with a heat gun to soften thread locker. Do not use flame as a source of heat.
2. Install the new wing shaft in module housing.
3. Apply three (3) drops of red Loctite 272 to the threads of new lever arm, and install the lever arm into the counter-bored side of threaded hole in the wing shaft. Tighten the lever arm firmly.

6.3 REASSEMBLY OF THE 5000 DIGIBIRD

1. Clean and inspect the orange housing. Ball up a clean, lint-free rag and push it through the housing with the push pole. **Be careful not to scratch the inner bore of the housing with the pole**. Next, use dry compressed air to blow out the inside of the main housing. The purpose of this is to remove any drops of water that may be on the surface of the inner bore. It is okay to leave o-ring lube on the inner bore, but inspect it to see that all drops of water have been removed. Also inspect for any scratches on the inner bore. If scratches are found on the inner surface of the main housing, finish assembly of the bird and ship it back to DigiCOURSE, Inc. for repair. Please include a description of the scratches in the problem report.
2. Inspect all o-rings on the control module (motor module with the electronic package attached) for nicks, gouges, and general wear and fatigue. Replace as necessary. Be sure to replace any old o-ring with one that is the same size. Refer to Model 5000 service diagram (0050-003) for correct size of replacement o-rings.
3. Lube all o-rings on the control module with Dow Corning #4 insulating compound. Once o-rings have been lubed, immediately move on to the next step. Do not place the module on the work bench, because the lubed o-rings attract dirt and small particles.
4. Insert the control module (with the slot and connector of the motor module facing up to the latches on the orange housing) into the front of the orange housing, electronics end first. Once the motor module is pushed into the front, use the push pole to position the motor module such that its slot and connector line up with the slot and the round hole in the platform for the main housing.
5. Inspect the two o-rings on the white cylinder on the bottom of the wing module (that the connector is attached to) for wear, nicks, and general damage. Replace if necessary. Lube o-rings with Dow Corning #4 insulating compound.
6. Flood the male connector on the wing module and the female connector (the connector that can be seen through the circular hole in the top of the housing) with any electronic contact spray (in aerosol can form) that disperses water. Blow out both connectors thoroughly with dry compressed air.

7. Make sure that the hole in the pivot pin (the white piece that can be seen in the slot of the housing) is facing up so it can engage the wing lever arm protruding from the bottom of the module.
8. Lube wing lever gasket with Dow Corning #4 insulating compound, and place over the wing lever slot on the orange housing.
9. Lower the wing module vertically onto the platform on the orange housing while being careful to engage the lever arm with the hole in the pivot pin and the connector with its mate in the large round hole. Make sure the wing lever gasket is in position.
10. Install the two (2) large Hex bolts and the four (4) Socket Head Cap Screws. Tighten down the wing module evenly.
11. Install wings with wing plates and wing screws. Do not use thread locker.
12. Inspect the o-ring on the compass module for nicks, gouges, and general wear and fatigue. Replace if necessary and lube with Dow Corning #4 insulating compound. Be sure to replace the old o-ring with one that is the same size. Refer to Model 5000 service diagram (0050-003) for correct size of replacement o-rings.

CAUTION: Always reinstall the same compass module that was supplied with the bird when delivered. Using a compass module from a different bird will invalidate the bird compass calibration.

13. Attach the compass wires to the terminals on the compass, red to positive (+) and blue to negative (-). Place the internal-tooth lockwasher between the ring terminals and the compass body. Use only the beryllium copper screws and washers provided on the compass. Do not substitute any other screw or washer for the beryllium copper items.
14. Install the compass module into the rear of the main housing while rotating it in the end of the housing, and retain with the three (3) nylon screws provided.

CAUTION: Do not substitute any other screws for the nylon screws. Replacement nylon screws can be found in the spares kit. Any unauthorized metal screw may cause errors in compass readings.

15. Replace non-magnetic lithium batteries in battery module, if necessary.
16. Inspect the o-rings on battery module for nicks, gouges, and general wear and fatigue. Replace if necessary and lube with Dow Corning #4 insulating compound. Be sure to replace the old o-ring with one that is the same size. Refer to Model 5000 service diagram (0050-003) for correct size of replacement o-ring.
17. Insert the battery module, connector end first, into the front of the main housing. Use the battery module tool, if necessary, to rotate the module to engage connector.

18. Inspect the o-ring on the nose cap for nicks, gouges, and general wear and fatigue. Replace, if necessary, and lube with Dow Corning #4 insulating compound. Be sure to replace the old o-ring with one that is the same size. Refer to Model 5000 service diagram (0050-003) for correct size of replacement o-ring.

19. Install the nose cap in the front of the main housing and retain with the nose bolt. **Only snug the nose bolt. Do not overtighten the nose bolt.**

SECTION VII - DIGIBIRD CHEK-OUT SOFTWARE

7.1 GENERAL DESCRIPTION

DigiBIRD CHEK-OUT software allows the technician to perform a series of basic functional tests on DigiCOURSE bird products with an option to re-calibrate the depth sensor (note equipment requirements). The program also prints a hard-copy report listing the results of all performance tests. **DigiBIRD CHEK-OUT** functions include:

- Verify basic communication (by serial no.)
- Read and record serial no. and unit no.
- Execute a wing reset (5000 series)
- Record reset status word (5000 series)
- Depth Sensor Calibration Option
- Test depth sensor performance and record depth parameters
- Record bird control gains at time of test
- Check and record signal-to-noise ratio
- Check batteries and battery module
- Test fin for full travel
- Record compass parameters (compass birds)
- Check basic compass operation (compass birds)

7.2 HARDWARE REQUIREMENTS FOR DIGIBIRD CHEK-OUT

- Computer: IBM PC or compatible (80286 or better recommended) with COMM1 serial port and LPT1 parallel port
- Model 271 MODEM TEST BOX (includes 388/01 Test Coil) or any Model 272 Sensor Interface Unit (modem).
- Model 388/01 Test Coil (p/n 9000-388/01)
  Note: included with Model 271 Modem and Model 272 SIU
- Printer, Parallel

- For Depth Calibration:
  DigiBIRD Depth Calibration Kit; p/n 6500-065/01 (115Vac) or p/n 6500-065/02 (220Vac); both kits include a 0-100psia Digital Pressure Manometer (±0.2%)
- For Depth Performance Verification ONLY:
  DigiBIRD Depth verification Kit; P/N 6500-043
  (0-100 psig Pressure gauge, +/- 0.5%)

7.3 BIRD POWER-UP NOTES

1. **Before running DigiBIRD CHEK-OUT**, determine if batteries have been installed in the bird(s). If already powered up, it is not necessary to remove batteries and reinstall to execute a wing reset before running DigiBIRD CHEK-OUT; a wing reset option is provided in the check-out process.
2. If batteries have not been installed in the bird, insert a battery module with known good (new or tested) batteries in both banks.
3. Look for a "Wing Reset" action: (wings move to a full up position while several clicking sounds are heard, then the wings return to zero degrees). A successful wing reset at battery installation indicates that the unit is running and has passed internal diagnostics.

   Note: A wing reset WILL NOT occur if batteries are installed while pressure is applied to the depth sensing port (or if the depth calibration is incorrect).
4. If bird does not attempt a wing reset, it may still be capable of communicating (only failed internal diagnostics). Go on to DigiBIRD CHEK-OUT.

7.4 RUNNING DIGIBIRD CHEK-OUT

DigiBIRD CHEK-OUT may be copied to a hard drive or run directly from a floppy disc. The program file name is "BCMAIN.EXE".

- **To start the program, type BCMAIN, <ENTER>** (NOTE: <ENTER> indicates pressing the key marked "ENTER" or "RETURN"). The program responds:

```
DigiBIRD Chek-out Program Version X.X

STATUS OF SENSOR BY SERIAL NUMBER
SERIAL NUMBER OF THE SENSOR (0 TO EXIT) -- ?
```

NOTES:

- In all test sections that require an input from the technician, the "default" response is indicated by the use of brackets [] in the selection table. If <ENTER> is pressed with no selection indicated, the program assumes the default selection.
- To abort the test without exiting, press the <F10> key. NOTE: If DigiBIRD CHEK-OUT is waiting for a numerical value, also press <ENTER> after <F10>.
- To exit the DigiBIRD CHEK-OUT program at any time, press the CONTROL and BREAK keys at the same time.

7.5 DIGIBIRD CHEK-OUT FUNCTIONS

7.5.1 Address bird by serial number

1. Position the test coil near the coil location on the DigiBIRD under test.
2. Type in the serial number of the DigiBIRD (located on the I.D. label on the bird body), and press <ENTER>.
3. DigiBIRD CHEK-OUT then asks for the bird Model number. Select by typing 1 - 4, then press <ENTER>. Note that, on the display, selection number 4 is bracketed. If <ENTER> is pressed with no selection, DigiBIRD CHEK-OUT "defaults" to selection #4 (assumes that a model 5011 compass bird is under test).
4. If the wrong model number is indicated, testing continues, but the bird will fail some of the tests.

7.5.2 Communication verification

Communication with the bird is acknowledged by the screen response "SENSOR WITH SERIAL NUMBER XXXX HAS RESPONDED". Next, the current unit number is displayed on the monitor, with an option to change to unit number 1.

- Type Y <ENTER> to change to unit #1 or N <ENTER> (or just <ENTER>) to keep the existing unit number.

The printer begins the bird checkout status sheet by printing the time, form title, and date, and then records the serial number and unit number of the bird under test. **If a "device fault" message is displayed, check the printer mode, paper, or connections.**

7.5.3 Print reset status word (5000 series only)

Next, the reset (self-test) status word is printed and displayed on the monitor with a PASS/FAIL indication.

If the status word indicates a FAILED condition, detailed status error messages are displayed and printed. **Press <ENTER> to continue.** See Section 8.4.2 for status error messages and explanations.

7.5.4 Wing reset (5000 series only)

A message on the monitor asks if a WING RESET is desired. Press Y <ENTER> to command a wing reset. The technician is then asked to indicate P for PASSED if a valid wing reset was observed or F for FAILED if no reset occurs. The status report records the results of this test.

If batteries were installed just prior to running DigiBIRD CHEK-OUT, and a normal wing reset was observed at that time, then this step can be omitted to save time by typing P <ENTER>. The report will indicate a PASSED condition.

Press S <ENTER> to skip the wing reset and not indicate a passed condition. The report indicates "WING RESET TEST NOT PERFORMED".

7.5.5 Depth calibration option

A message on the monitor then asks "DO YOU WISH TO DEPTH CALIBRATE?" If depth calibration is not desired, or if proper equipment is not available, type N, <ENTER> to skip this process.

> **CAUTION:** Do not proceed with depth calibration without a regulated air source capable of at least 75 psi connected to a precision (± 0.2 psi) manometer that reads **ABSOLUTE pressure (psia)**, not gauge pressure (psig). Failure to use proper equipment for depth calibration results in loss of depth-keeping accuracy.

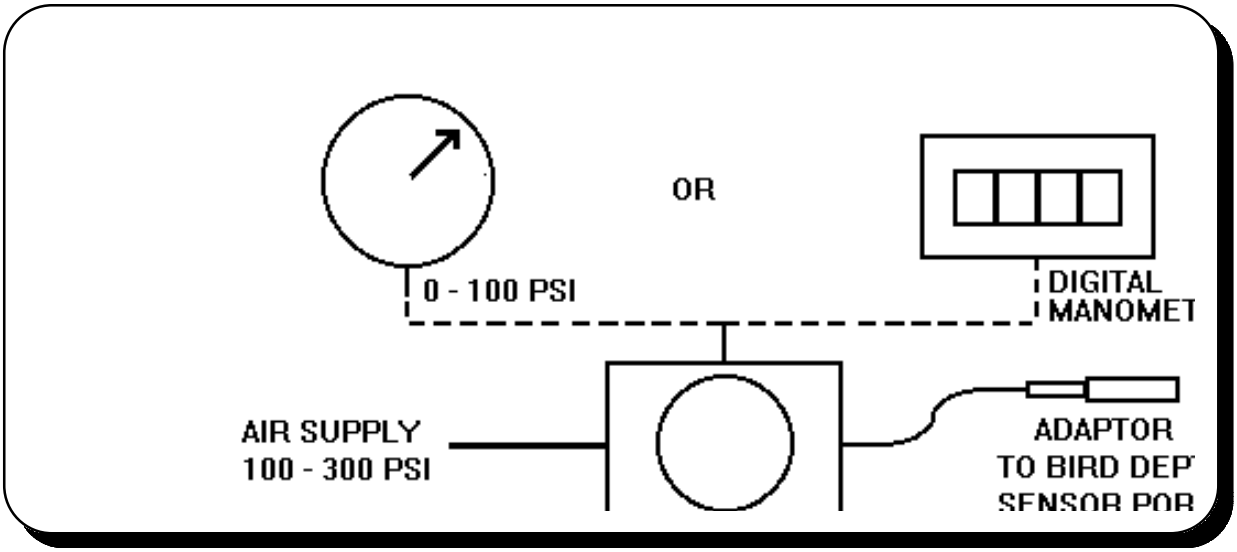

Figure 7.5.5. Equipment for depth calibration/verification.

If depth calibration is desired, type Y, <ENTER>.

NOTE: To abort the depth calibration process and restore depth calibration coefficients to the original values, press the **<F1>** key.

CAUTION: Aborting by pressing the <F10> key or CONTROL and BREAK keys leaves the bird in an uncalibrated condition.

The user is then prompted through the following steps:

1. Enter the current temperature IN **DEGREES C** and then press the <ENTER> key. !!! Deg C = (Deg F - 32) * 5/9
2. Vent the digital manometer to atmosphere (disconnect bird and manometer from air source) to obtain the current ATMOSPHERIC PRESSURE in **psia**. Type in this value and press the <ENTER> key.
3. The monitor displays unscaled depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.
4. DigiBIRD CHEK-OUT then instructs the technician to connect the pressure source to the bird depth port and adjust the regulated air supply to a value displayed on the monitor (approximately 81.5 **PSIA** for 5010/5011 or 54.7 **PSIA** for 5010E/5011E). Adjust until the digital manometer indicates within 1 psi of this value, then type in the value shown on the manometer and press the <ENTER> key.
5. The monitor again displays unscaled depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.
6. The monitor then displays depth and temperature calibration parameters. These values should fall within the following ranges (for Model 5000 series birds only):

   DEPTH SLOPE -- 1.25 +/- 0.25
   DEPTH OFFSET -- 25 +/- 10
   TEMP OFFSET -- TBD

7. Type Y <ENTER> if values are within ranges specified above.
8. Type N <ENTER> or just <ENTER> to recalibrate.

7.5.6 Depth performance test selection

If depth sensor calibration has not been performed, a message on the monitor asks the technician which type of pressure instrument is available for the depth sensor performance test.

- Press M <ENTER> if using a digital manometer (+/- 0.2%) that indicates absolute pressure (psia).
- Press G <ENTER> if using a test gauge (+/- 0.5psi) that indicates gauge pressure (psig).
- If no pressure instrument is available, press G <ENTER> and then follow the procedure as if an air source was present. For test steps requiring pressure inputs of 14.5 and 66.6 psig, type in the requested value as if a gauge was present. The bird should pass the atmospheric pressure (0 ft) test, and then fail test steps 2 and 3.

If depth sensor calibration has been performed, it is assumed that the technician is using a digital manometer, and DIGIBIRD CHEK-OUT proceeds directly to depth performance verification using the manometer.

7.5.7 Depth sensor performance test (digital manometer)

This test verifies depth sensor performance only, and does not alter depth calibration values. It also requires precision pressure inputs (+/- 0.2 psi) in **psia** for best results. If the depth sensor output error is greater than +/- 1.0 ft, DigiBIRD CHEK-OUT indicates a "FAILED *****" condition on the status printout.

NOTE: If depth sensor calibration has not been performed, the order of the following steps is reversed. This is normal, and is done to save operator time.

1. DigiBIRD CHEK-OUT instructs the technician to adjust the regulated air supply to a value displayed on the monitor (approximately 81.5 **PSIA** for 5010/5011 or 54.7 **PSIA** for 5010E/5011E). Adjust until the digital manometer indicates within 1 psi of this value, then type in the value shown on the manometer and press the <ENTER> key.
2. The monitor then display depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.
3. DigiBIRD CHEK-OUT instructs the technician to adjust the regulated air supply to a new value (approximately 29.4 **psia**). Adjust until the digital manometer indicates within 1 psi of this value, then type in the value shown on the manometer and press the <ENTER> key.
4. The monitor again displays depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.

5. Vent the digital manometer to atmosphere (disconnect bird and manometer from air source) to obtain the current ATMOSPHERIC PRESSURE in **psia**. Type in this value and press the <ENTER> key.
6. When the indicated value is stable, press the <ENTER> key.

Depth sensor performance test results are printed on the status sheet followed by depth and temperature calibration parameters.

7.5.8 Depth sensor performance test (pressure gauge)

A reasonable indication of depth sensor performance can be obtained using the +/- 0.5 psi precision gauge supplied in the DigiCOURSE 6500-043 Field Depth Verification Kit. Because of the reduced accuracy of this gauge, a "failed" indication on the test form may be disregarded if the recorded depth sensor output is within +/- 2.0 ft of the value shown on the printout in parenthesis.

1. DigiBIRD CHEK-OUT instructs the technician to enter the current ATMOSPHERIC PRESSURE (if available) in **psia**.

   Use only atmospheric pressure readings from an accurate manometer or barometer located in the same room as the bird under test. Do not use information from uncalibrated instruments, weather reports, or from distant locations.

   If the current atmospheric pressure is not known, press the <ENTER> key and the test will proceed using a standard value of 14.70 psia. Note that extreme high or low barometric pressure conditions may further reduce the accuracy of this test. **Be sure that the pressure line is not connected to the bird for this step.**

   NOTE: To convert inches of mercury to psia, multiply by 0.4912
   To convert millibars to psia, multiply by 0.0145
2. The monitor displays depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.
3. DigiBIRD CHEK-OUT instructs the technician to connect the pressure source to the bird and then adjust the regulated air supply so that the gauge indicates approximately 14.5 psig. Adjust until the gauge indicates within 1 psi of this value, then type in the value shown on the gauge and press the <ENTER> key.
4. The monitor again displays depth transducer output in "counts". When the indicated value is stable, press the <ENTER> key.
5. DigiBIRD CHEK-OUT instructs the technician to adjust the regulated air supply so that the gauge indicates approximately 66.5 **PSIG** for 5010/5011; 39.7 **PSIG** for 5010E/5011E. Adjust until the gauge indicates within 1 psi of this value, then type in the value shown on the gauge and press the <ENTER> key.
6. When the indicated value is stable, press the <ENTER> key.

Depth sensor performance test results are printed on the status sheet followed by depth and temperature calibration parameters.

7.5.9 Record/change control gains

The current control gain values are first displayed on the monitor with an option to change individual values, or to change all gain values to the factory "DEFAULT" settings indicated below:

CONTROL GAIN	DEFAULT VALUE		GAIN INDEX
Depth/Heading Sample Rate (DSR)	2.0	seconds	<--
Depth Averaging	14.0	seconds	2
Proportional Gain	0.8	deg/ft DT error	5
Integral Gain	64.0		<--
Rate Gain	0.0		<--
Controller Update Rate	20.0	seconds	10
Fin Angle Dead Band	0.4	degrees	3

After completing any desired changes, press <ENTER> (with no number). Control gain values are printed on the status sheet.

7.5.10 Signal-to-noise ratio test

Indicate PASS (P or <ENTER>) if HIGH and LOW (V) values are 0, and OFF (offset) value is 2.3V or greater.

NOTE: Excessive noise from other equipment in the test area may cause problems during this test. To shield the bird from interference, place a large metal can or bucket over the front of the bird so that it extends over the communication coil area.

7.5.11 Battery test

Displays battery voltages and battery bank in use. Indicate P or <ENTER> if report agrees with known battery condition.

"Good" batteries should indicate 6.6 to 6.8 volts. Fresh batteries can indicate as high as 7.6 volts. Test should indicate "BANK B" in use if A bank voltage is less than 6.5 volts. Results are recorded on the status sheet.

7.5.12 Fin movement test

Acknowledge -15, 0, and +15 wing positions as indicated with a P or <ENTER> for passed. Results are recorded on the status sheet.

7.5.13 Display/clear motor runtime/starts

Uncleared values for motor runtime and starts are recorded on the status sheet. Indicate Y <ENTER> to clear values or N <ENTER> to retain existing values.

7.5.14 Print compass parameters (compass birds only)

Compass correction coefficients, sample interval, and averaging time values are printed on the status sheet.

Next, the compass module (self-test) status byte is printed and displayed on the monitor with a PASS/FAIL indication. If the status byte indicates a FAILED condition, detailed status error messages are displayed and printed.

Press <ENTER> to continue.

7.5.15 Compass read test (compass birds only)

Move bird or excite compass with iron object or small magnet. Indicate P <ENTER> (or just <ENTER>) for passed if heading change is observed. Results are recorded on the status sheet.

7.5.16 Status record printout

DigiBIRD CHEK-OUT concludes the testing by printing spaces for technician's name, Q.C. approval, and date at the bottom of the Bird Status sheet. An example status sheet is shown in Figure 7.5.16.

```
12:31:26              DigiBIRD Chek-out Program Version 2.42              01-21-1993

STATUS OR MODEL 5011 COMPASS BIRD


SENSOR WITH SERIAL NUMBER   5890   HAS RESPONDED
ITS CURRENT UNIT NUMBER IS   1

RESET STATUS WORD IS  ----     Oh                                          PASSED

WING RESET TEST                                                           PASSED
***** DEPTH CALIBRATION ROUTINE NOT PERFORMED

DEPTH SENSOR PERFORMANCE TEST        -- GAUGE     14.7
 0.00      PSI          (   0.0  FT.)          SENSOR ==    0.0 FT.      PASSED
14.50      PSI          (  32.6  FT.)          SENSOR ==   31.8 FT.      PASSED
66.50      PSI          (149.6  FT.)          SENSOR ==  147.7 FT.      FAILED *****

DEPTH PARAMETERS
DEPTH SLOPE --       1.2480                  (1.25 +/- 0.25)
      OFFSET --      24.75                   (  25 +/- 10   )
TEMP OFFSET --       30.00

CONTROL GAINS
DEPTH/HEADING SAMPLE RATE                     2.0 SECONDS (DSR)
DEPTH AVERAGING                              14.0 SECONDS
PROPORTIONAL GAIN                             0.8 DEG/FT DT ERROR
INTEGRAL GAIN                                64.0
RATE GAIN                                     0.0
CONTROLLER UPDATE RATE                       20.0 SECONDS
FIN ANGLE DEAD BAND                           0.4 DEGREES

SIGNAL TO NOISE RATIO
HIGH 0.0  (V)        LOW 0.0  (V)            OFF 2.5  (V)                 PASSED

BATTERY TEST
BATT A ==   7.0 V              BATT B ==  7.3 V          BANK A           PASSED

FIN MOVEMENT TEST
FIN ANGLE AT          -15.1 DEG                                           PASSED
FIN ANGLE AT            0.0 DEG                                           PASSED
FIN ANGLE AT           15.0 DEG                                           PASSED

MOTOR RUNTIME = 000:00:59             STARTS  =  5                        CLEARED

COMPASS PARAMETERS
A=  0.96    B=  0.12    C=  -0.02                    DEGREES
ITS CORRENT SAMPLING INTERVAL  IS     2.0           SECONDS
ITS CURRENT AVERAGING TIME      IS   14.0           SECONDS
THE COMPASS MODULE STATUS BYTE IS  ----             2h                    PASSED

COMPASS READ TEST                                                         PASSED


TEST CONDUCTED BY  _____

Q. C.   APPROVAL BY  _____ DATE _____
```

Figure 7.5.16. Bird status sheet.

SECTION VIII - MODEL 5000 FIELD CHECKOUT AND TROUBLESHOOTING

The following procedure is intended to assist the technician in field checkout and troubleshooting of Model 5000 DigiBIRD products using the DigiBIRD CHEK-OUT software and parts supplied in the DigiCOURSE 6500-041 Model 5000 Spares Kit. If problems are found that are not solved by taking the suggested action(s), return the unit to DigiCOURSE for repairs.

NOTE: Whenever possible, include DigiBIRD CHEK-OUT status sheet with birds that are returned for repair.

8.1 CHECK FOR PHYSICAL DAMAGE

1. Inspect bird housing carefully for evidence of overpressure or distortion.
2. Inspect latches for damage and check for smooth operation. Clean and lubricate all moving parts!
3. Replace bent/broken wing shafts or levers. If wing housing is damaged, replace entire wing module.
4. Model 5011 COMPASS birds must be returned to DigiCOURSE for complete
5. checkout and recalibration if the housing or latch assemblies have been damaged due to overpressure or collision. **Housings can be replaced in the field for Model 5010 DigiBIRDS only.**

8.2 BATTERY MODULE

1. Check battery module connector sockets for corrosion or damage.
2. Note that the connector location on the end of the battery module is off center. While looking at the connector end of the battery module with the connector down, the topmost socket closest to the center of the battery module housing is be socket 2; with socket 3 to its left and socket 1 to the right.
3. With batteries installed in both banks and VOM common lead on socket 3, there should be battery voltage (7.5 volts) present on sockets 1 (A bank) and 2 (B bank) when probed with the V+ lead.

CAUTION: Accidental shorting of battery module terminals will blow safety fuses in batteries.

8.3 BIRD POWER-UP CHECK

1. Install battery module with known good (new or tested) batteries in both banks.
2. Look for "Wing Reset" function: Installation of the battery module initiates an automatic self-test of the following systems:

   microprocessor
   depth keeping
   wing drive circuits
   power circuits
   batteries and battery module

   If no faults are detected in these systems, the bird performs a "WING RESET" operation (wings move to a full up position while several clicking sounds are heard, then the wings return to zero degrees). A successful wing reset indicates that the unit is at least "functioning" and has passed internal diagnostics.

   Note: A wing reset WILL NOT occur if batteries are installed while pressure is applied to the depth sensing port (or if the depth calibration is incorrect).

3. If wings start to move but wing reset is not completed, or if motor is heard running but wings do not move, remove wing module and check that wing lever is not loose or broken. If wing lever is okay, try new motor module.
4. If bird does not attempt a wing reset, the bird may have only failed its self test and may still be "alive" and capable of communication. **Go on to next step.**

8.4 RUN DIGIBIRD CHEK-OUT PROGRAM

8.4.1 No/poor communications

1. If no reset check batteries, if batteries okay then try a new battery module.
2. Remove wing module and check/clean mating connectors.
3. Try new wing module.

8.4.2 Reset status word indicates a failure

ERROR MESSAGE:	ACTION:
EPROM CHECKSUM ERROR	**Not field repairable.**
EXTERNAL RAM ERROR	**Not field repairable.**
NO DATA ACQUISITION ERROR	**Not field repairable.**
BATTERY "B" INCOMPATIBILITY	Replace batteries; try new battery module.
BATTERY "A" INCOMPATIBILITY	Replace batteries; try new battery module.
MISSING PULSE ERROR	Check wing lever and shaft. Check/try new motor module.
(MOTOR) VOLTAGE MONITOR ERROR	Try new motor module.
NO COMPASS INTERFACE MODULE	Return 5011's to DigiCOURSE N.O. for repair. **Normal on 5010's**
MOTOR FAILURE ERROR	Try new motor module
COMPASS MODULE LOW	Try new batteries; try new battery module.
VOLTAGE BAD EEPROM	Replace batteries; try new battery module. Check compass calibration coefficients.
NO COMPASS DETECTED	Check compass connections (see Section 8.4.8).

8.4.3 Fails depth sensor performance test

1. Check depth slope and offset values.
2. Clean depth transducer port.
3. Remove wing module and check/clean mating connectors.
4. Try new wing module.
5. Recalibrate depth.

8.4.4 Fails signal-to-noise ratio test

1. Excessive noise from other equipment in the test area may cause problems during this test. To shield bird from interference, place a large metal can or bucket over the front of the bird so that it extends over the communication coil area.
2. Remove wing module and check/clean mating connectors.
3. Try new wing module.

8.4.5 Fails battery test

- Check batteries, if batteries okay then try new battery module.

8.4.6 Fails fin movement test

1. Check wing shaft, wing lever for damage. Check that wing lever is tight in shaft (Loctite!!).
2. Try new motor module if:
    - Motor runs, but no wing movement
    - Bird indicates "Motor Failure Error"
    - Bird indicates "Missing Pulse Error"

8.4.7 Compass factory calibration values changed

- If A, B, and C calibration coefficients are different from factory values shown on the original bird status check out sheet shipped with the bird, then the unit must be returned to DigiCOURSE New Orleans for recalibration.

8.4.8 Fails compass test (reads 0 or constant value)

1. Use DigiBIRD CHEK-OUT (or DigiSCAN) to observe compass heading while carefully removing compass module, taking care to check compass terminal connections. If loose connection is suspected (compass begins working), tighten and recheck compass operation.
2. If compass terminal connections look okay remove compass and check operation on another bird.
    - If compass does not work on another bird, reinstall in original bird and return to DigiCOURSE N.O. for repair.
    - If compass works on another bird, reinstall in original bird, check compass wiring connections at compass board. If it still does not work, return to DigiCOURSE N.O. for repair.

8.5 COMPASS ACCURACY PROBLEMS

All suspected compass accuracy problems must be returned to DigiCOURSE New Orleans for service!

8.6 DIGICOURSE BIRD REPAIR RETURN REPORT

As part of the continuous improvement program, DigiCOURSE, Inc. has developed its own DigiCOURSE Bird Repair / Return Report (1000-180) to act as a tool for fault identification purposes. These report forms accompany all shipments of birds.

DigiCOURSE would most appreciate the completion of these reports so that the information can be used to provide increased reliability in our products. Reference Appendix B for the DigiCOURSE Bird Repair / Return Report.

SECTION IX - COMPASS PERFORMANCE VERIFICATION

The Model 5011 Compass Birds are factory calibrated in a controlled environment. Every compass bird is subjected to an identical process, thereby ensuring unit-to-unit repeatability. Latitude insensitive design, stable nonmagnetic manufacturing process, and a highly accurate repeatable calibration process combined with stringent performance criteria ensure worldwide performance.

The model 5011 does not require field calibration. The compass correction terms (A, B, and C) can be determined only in a factory calibration process and must not be altered in the field. Any field alteration of the coefficients automatically voids the stated 5011 bird performance specifications. Field performance verification is not required, but may be performed, on request, by DigiCOURSE field service personnel.

– U.K. contact:	(phone)	0342 844555
	(fax)	0342 844505
– U.S.A. contact:	(phone)	(713) 784-4292
	(fax)	(713) 784-6961

MODEL 5000 PRODUCT SPECIFICATIONS

The performance specifications for the Model 5011 Compass Bird and the Model 5010 DigiBIRD are shown in the following documents contained in this appendix:

- Product Data Sheet for the Model 5011 Compass Bird
- Product Data Sheet for the Model 5010 DigiBIRD
- 5000 Outline and Mounting Drawing (0050-017)

The enclosed documents reflect the latest revision at the time of printing. Later revisions may be obtained from any DigiCOURSE office.

DigiCOURSE®

Model 5011 Compass Bird

THE SERIES 5000 CONCEPT

The series 5000 is the third generation of seismic streamer system components developed by DigiCOURSE. The 5000 provides a platform on which various cable control products are based. Its modular construction allows common mechanical and electronic subassemblies to provide different cable control functions.

- Modular construction.
- Noncorrosive outer body.
- Dual battery pack.
- Multiple processor architecture
- Communications to support longer streamers.
- Multiple watertight seals provide greater reliability.

MODEL 5011 COMPASS BIRD

The Model 5011 is the Compass Bird member of the 5000 family. It is an advanced, microprocessor-based device mounted externally on a marine seismic streamer cable. The Compass Bird has a variety of functions and features, including:

- Compass heading information.
- Heading data corrected for A, B and C terms.
- Internal filtering of heading data.
- Depth measurement.
- Depth control.
- Adjustable Depth Control Algorithm parameters.
- Provides Ballast information.
- Nonmagnetic outer body

Model 5011 Compass Bird Specifications

PHYSICAL CHARACTERISTICS

Length: 1.2 m (48.2 in)

Weight: 8.32 kg (18.3 lb) in air
2.78 kg (6.1 lb) in sea water with batteries

Mounting: Industry standard collars on 0.57 m (22.5 in) centers

COMMUNICATIONS

Type: Serial FSK

Frequency: 26 or 28 kHz

Data Rate: 2400 bit/s

DEPTH MEASUREMENT

Operating Range: 122 m (0 to 400 feet)

Resolution: 0.5 feet (0.15 m)

HEADING MEASUREMENT

Accuracy: ± 0.5°

Resolution: 12 bits

DIVING PLANE

Lift: 15.9 kg (35 lb) at 5 knots and 15° wing angle

Airfoil: NACA 651-012 Airfoil section

Wing Span: 48.3 cm (19 in)

BATTERY

Cells: 4 D cell Lithium

Life: 60 days typical operation

DigiCOURSE®
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DigiCOURSE®

Model 5010 DigiBIRD

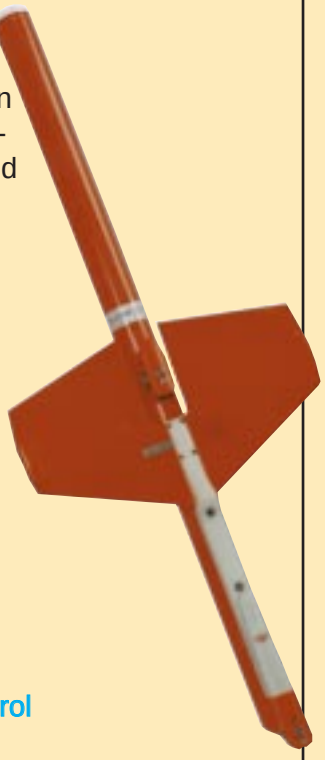
THE SERIES 5000 CONCEPT

The series 5000 is the third generation of seismic streamer system components developed by DigiCOURSE. The 5000 provides a platform on which various cable control products are based. Its modular construction allows common mechanical and electronic subassemblies to provide different cable control functions. As other functional modules become available, additional cable control features can be easily added to the system. The modular concept ensures that the DigiSCAN™ system will continue to be the most flexible, accurate and comprehensive solution to cable control.

- Modular construction.
- Noncorrosive outer body.
- 400 foot depth measurement.
- Compatible with prior DigiSCAN generations
- Supports a larger repertoire of features
- Dual battery pack.
- Communications to support longer streamers.
- Multiple watertight seals provide greater reliability.

MODEL 5010E DigiBIRD

The Model 5010 is the DigiBird member of the 5000 family. It is an advanced, microprocessor-based device mounted externally on a marine seismic streamer cable. The DigiBird has a variety of functions and features, including:



- Depth measurement.
- Depth control.
- Adjustable Depth Control Algorithm parameters.
- Provides ballast information.

Model 5010 DigiBird Specifications

PHYSICAL CHARACTERISTICS

Length: 1.2 m (48.2 in)

Weight: 7.8 kg (17.2 lb) in air
2.32 kg (5.1 lb) in sea water with batteries

Mounting: Industry standard collars on 0.57 m (22.5 in) centers

COMMUNICATIONS

Type: Serial FSK

Frequency: 26 kHz

Data Rate: 2400 bit/s

DEPTH MEASUREMENT

Operating Range: 0 to 122 m (400 ft)

Resolution: ± 0.5 feet (1.5 m)

DIVING PLANE

Lift: 15.9 kg (35 lb) at 5 knots and 15° wing angle

Airfoil: NACA 651-012 Airfoil section

Wing Span: 48.3 cm (19 in)

BATTERY

Cells: 4 D cell Lithium

Life: 2000 hours typical operation

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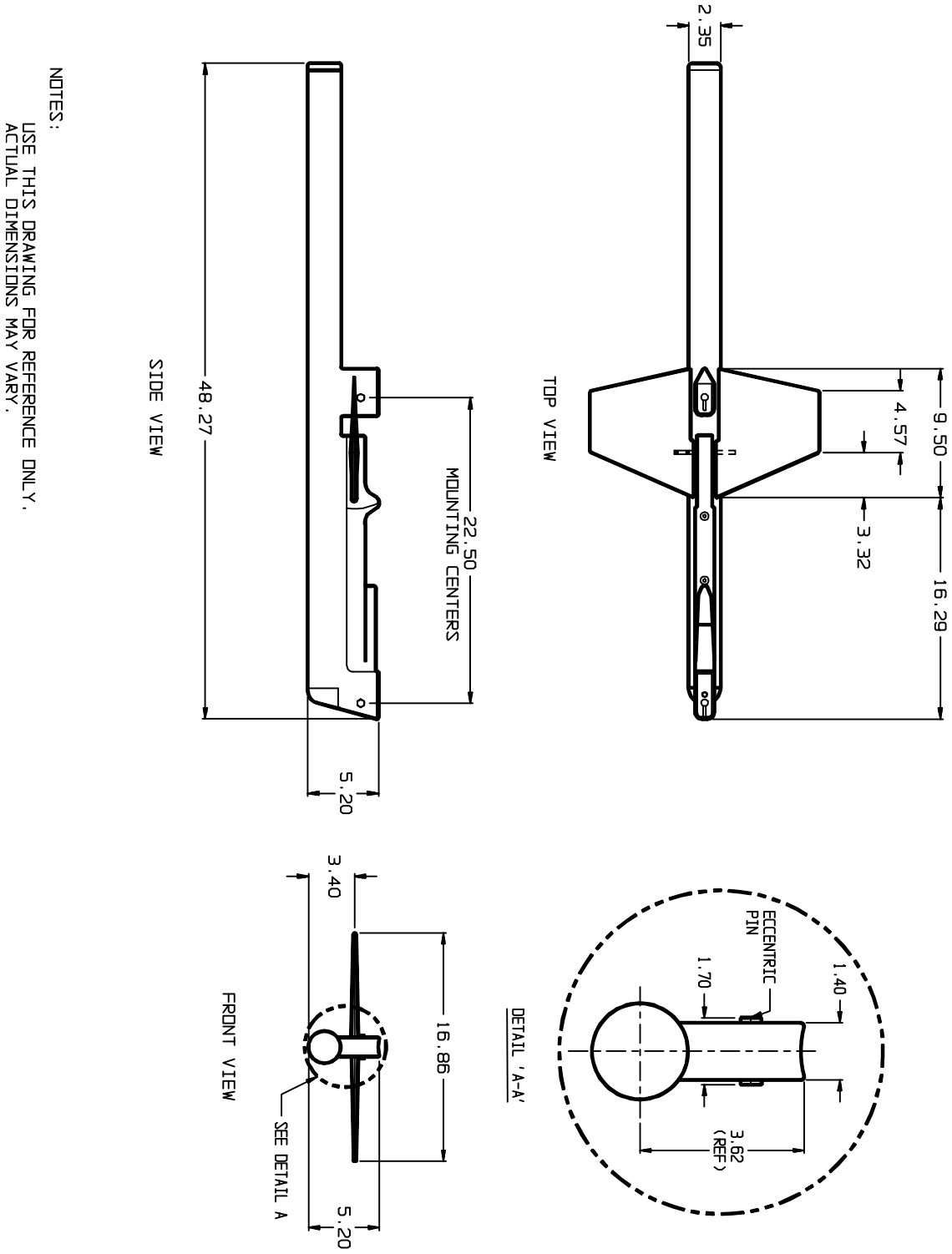

Figure A. 5000 Outline and Mounting (0050-017).

SPECIAL TOOLS AND RECOMMENDED SPARES

The following pages contain:

- Parts list for the 5010/5011 Spares Kit (p/n 6500-041)
- Parts list for the 5000 Tool Kit (p/n 6500-042)
- 5000 Service Diagram (0050-003)
- DigiCOURSE Repair / Return Report (1000-180)

The enclosed documents reflect the latest revision at time of printing. Later revisions may be obtained from any DigiCOURSE office.

PARENT ITEM NO. 6500-041
DESCRIPTION: KIT SPARE 5010/5011
ENGR DRAW: 6500-041 REVISION L

SEQ NO.	QUANTITY	U/M	ITEM	DESCRIPTION
0001	2.000	EA	2500-174	WING PLATE 5000
0002	4.000	EA	2800-161	SCREW FLAT SLOT 10-32X1" 316SS
0003	1.000	EA	8000-K726	REPLACEMENT KIT WING MODULE
0004	6.000	EA	2500-431	WING SHAFT 5000
0006	3.000	EA	2701-053	0-RING 1.475 ID W=. 210 BUNA-N
0007	24.000	EA	2800-501	SCREW FILL 6-32 X 3/8" NYLON
0009	2.000	EA	2800-460	SCREW SHCS 3/8-24X1 1/4 SS
0011	1.000	EA	8000-K720	REPLACEMENT KIT MOTOR MODULE
0013	1.000	EA	2800-226	SCREW SHCS 1/4-20 X 3 SS
0014	3.000	EA	2500-K510	REPLACEMENT KIT FRONT LKNG ROD
0015	3.000	EA	2500-K508	REPLACEMENT KIT REAR LKNG ROD
0019	4.000	EA	2701-066	0-RING 1.484 ID W=.139 BUNA-N
0021	1.000	EA	8000-K724	REPLACEMENT KIT BATTERY MODULE
0023	12.000	EA	6000-008	CABLE TIE 3.9 X .10,.87 BNDL
0024	12.000	EA	1600-009	DESICCANT PACKET
0025	4.000	EA	2800-356	SCREW SHCS 8-32X1-1/2 SS
0026	24.000	EA	2700-031	GASKET WING MODULE 5000
0027	4.000	EA	2500-283	PIN CROSS
0028	6.000	EA	2701-059	0-RING 1.614 ID W=.070 BUNA-N
0029	10.000	EA	2701-020	0-RING .739 ID W=.070 BUNA-N
0030	6.000	BA	2500-432	LEVER ARM
0031	6.000	EA	2850-010	PLUG
0032	10.000	EA	2801-418P	SCREW PAN SLOT 4-40X3/16 BR CU

PARENT ITEM NO. 6500-041
DESCRIPTION: KIT SPARE 5010/5011
ENGR DRAW: 6500-041 REVISION _L

SEQ NO.	QUANTITY	U/M	ITEM	DESCRIPTION
0033	10.000	EA	2800-490	WASHER LOCK #4 INT BRONZE NM
0034	6.000	EA	2500-507	PLATE SWING
0100	1.000	EA	0050-003	SERVICE DIAGRAM MODEL 5000

PARENT ITEM NO. 6500-042
DESCRIPTION: KIT TOOL 5000
ENGR DRAW: 6500-042 REVISION F

SEQ NO.	QUANTITY	U/M	ITEM	DESCRIPTION
0001	1.000	EA	8000-258	ASSY PUSH POLE
0002	1.000	EA	7000-0426	TOOL SCREWDRIVER ¼" FLAT BLD
0003	1.000	EA	7000-0517	REMOVAL TOOL BATTERY MODULE
0004	1.000	EA	7000-0938	TOOL WRENCH HEX 3/16 T HANDLE
0005	1.000	EA	7000-0939	TOOL WRENCH HEX 5/16 T HANDLE
0007	1.000	EA	7000-0941	TOOL WRENCH ADJUSTABLE 6"
0008	1.000	EA	7000-0942	TOOL WRENCH COMB. 1/2 INCH
0009	1.000	EA	1600-019	COMPOUND ELECTRICAL INSULATING
0010	1.000	EA	7000-1651	TOOL LUBE ANTI-SEI2E 3 OZ TUBE
0011	1.000	EA	7000-0944	TOOL WRENCH HEX 9/64 T HANDLE
0012	1.000	EA	7000-0943	TOOL WRENCH HEX 3/32 T HANDLE
0013	1.000	EA	1600-022	LOCTITE RED 10 ML
0014	1.000	EA	6500-064	KIT SWING PLATE FIELD INSTALL

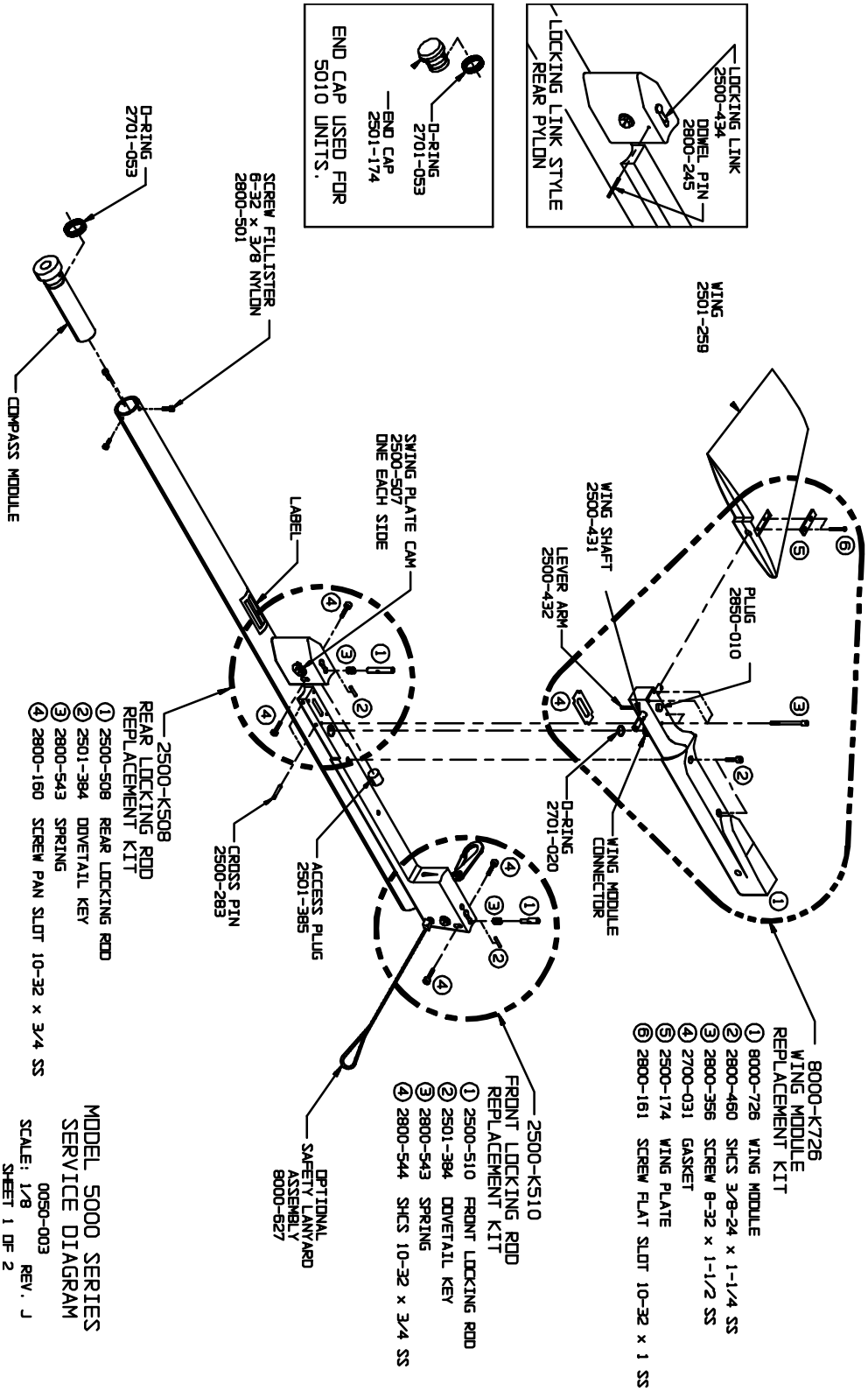

Figure B.1. 5000 Service diagram (p. 1).

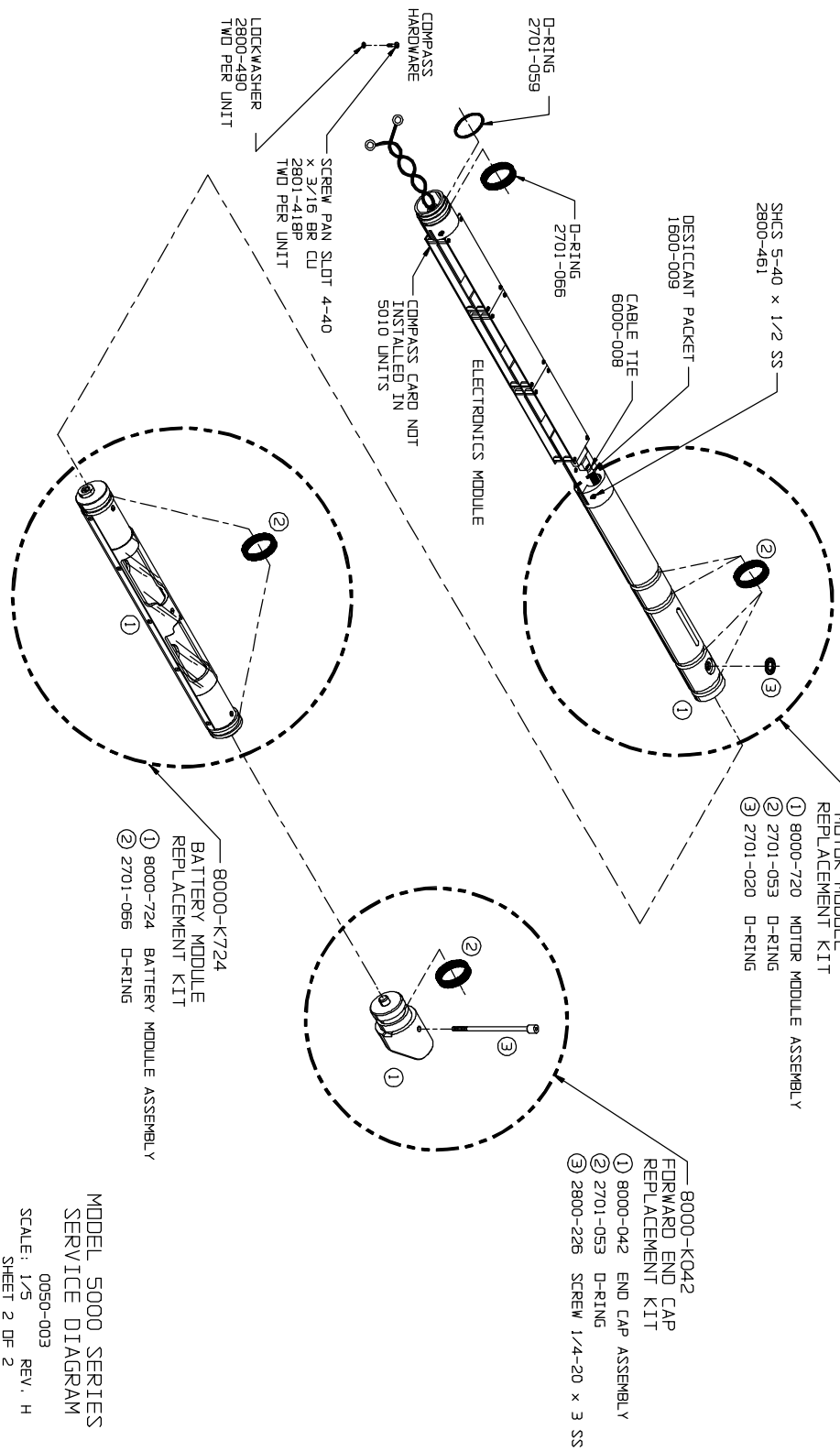

Figure B.2. 5000 Service diagram (p. 2).

DigiCOURSE BIRD REPAIR/RETURN REPORT

HELP US SERVE YOU BETTER! Please use this form for all returned items

CUSTOMER:_____ VESSEL:_____

CUSTOMER CONTACT:_____ DATE:_____

MODEL (circle): 5010 5011 395 396 365 SER NO.:_____

REASON FOR RETURN:

___ GENERAL MAINTENANCE: (check operation, upgrade, recalibrate)

___ COMMUNICATION PROBLEM: _____On Streamer _____Bench Test

___ PHYSICAL DAMAGE: ___Housing ___Latches ___Wing drive mechanism

___ DEPTH READING INACCURATE: (Reads _____ on surface.)

___ NO FIN MOVEMENT, JAMMED MECHANISM, ETC.

___ COMPASS PROBLEM Note: Compass problems can be very difficult to diagnose without a complete description. Please provide as much information as possible on all compass problems.

___ Constant heading error (bias) _____ degrees.

___ Erratic (noisy) output. Include description and/or data.

Was a different bird tried in the same location? ___Yes ___No.

Sample rate_____ Avg Constant_____ Line Heading_____

___ Compass appears stuck on heading _____

___ Failed cal verification (calibration check) Include data.

___ OTHER:_____

_____

_____

FAILURE OBSERVED: _____On Streamer _____Test Bench

___ NO/INCOMPLETE WING RESET AT POWER UP (check for status messages)

CIRCLE ANY STATUS ERROR MESSAGES (5000 SERIES ONLY):

12 - EPROM Checksum Error	11 - External RAM Error
10 - NO Data Acquisition Error	9 - Battery "B" Incompatability
8 - Battery "A" Incompatability	7 - Missing Pulse Error
6 - (MOTOR) Voltage Monitor Error	5 - NO Compass Module
4 - Motor Failure Error	2 - Compass Module Low Voltage
1 - Bad EEPROM	0 - NO Compass Detected

NOTE: Return battery module with unit (remove batteries).

BATTERY MODULE INCLUDED? ___ Yes ___ No
If no, is replacement battery module required? ___ Yes ___ No
NOTE: All birds received without a battery module will be returned with a new battery module unless indicated otherwise above.

I.D. No._____ (Customer use)	Signed:	CRG No. _____ (DigiCOURSE use only)

WARNING!!! Do not ship batteries with unit.

FIELD SERVICE BULLETINS

The following Field Service Bulletins are still active (not replaced by this manual) at time of printing:

Old Number	New Number	Description
• 060590-1	FSB900605-006	Do not use wings from Model 395 or 396 birds on Model 5000 units.
• 111690-1	FSB901116-009	All motor module repairs must be carried out at a DigiCOURSE repair facility. Do not attempt to disassemble in the field. Repair / exchange service available for motor modules.
• 011891-1	FSB910118-010	See FSB901116-009 (above).
• ----------	FSB911004-015	New push pole for Model 5000 series DigiBIRDS
• ----------	FSB911004-016	365 Compass Pod, 396 and 5000 series Compass Bird accuracy, using lithium versus alkaline batteries
• ---------	FSB920205-019	Model 5010 and 5011 series DigiBIRD/ Compass Bird loose wing lever arms
• --------	FSB920324-020	Model 5010, 5011, 5014, and 5024 DigiBIRD/Compass Bird wing lever arm and wing shaft replacement

COLLAR APPLICATION INFORMATION

Bird Collar Size Table

Digi P/N	I.D. in	I.D. mm	O.D. in	Inner Race P/N
9000-170	1.70	(43.18)	2.75	2501-248-17
9000-260	2.60	(66.04)	3.75	2501-250-26
9000-270	2.70	(68.58)	3.75	2501-250-27
9000-280	2.80	(71.12)	3.75	2501-250-28
9000-295	2.95	(74.93)	4.25	2501-252-295

Notes:

1. Replacement inner race assemblies may be purchased separately.

RELATED REFERENCE DOCUMENTS

DOCUMENT	PART NUMBER
– DIGISCAN OPERATOR'S MANUAL	6301-293A-xxx
– SYSTEM 3 USER'S MANUAL	4200-007-xxx
– RECOMMENDED PRACTICES FOR TWISTED PAIR COMMUNICATIONS IN SEISMIC STREAMERS	1000-243
– VIDEO VHS DISS / ASSY USA	VT-001-NTSC
– VIDEO VHS DISS / ASSY EUR	VT-001-PAL
– VIDEO VHS DISS / ASSY FRANCE	VT-001-SECAM

-xxx refers to current version number

These documents may be obtained from any DigiCOURSE office.

MODEL 5000 DIGIBIRD PRODUCT IMPROVEMENTS

The following pages list improvements to the 5000 series DigiBIRDs since introduction to the field and the effective dates of the improvements.

PRODUCT IMPROVEMENT	PURPOSE	WHEN
MANUFACTURING PROCESS CHANGES AND 100% PRESSURE TESTING OF WING HOUSINGS	REDUCE POSSIBILITY OF WATER INTRUSION INTO WING MODULE HOUSING	1/90
THICKER SUPPORT O-RINGS IN ELECTRONICS MODULE	PREVENT O-RING DAMAGE AT ASSEMBLY	1/90
ADDED SPRING PLUNGER INTO NOSE CAP	MORE RELIABLE BATTERY ENGAGEMENT	2/90
ADDED CENTER LINE SEAL SCREW AND 100% PRESSURE TESTING OF MOTOR MODULE HOUSINGS	PREVENT WATER INTRUSION INTO MOTOR MODULE CAVITY	3/90
ADDED DESICCANT TO WING, BATTERY, AND MOTOR MODULE	ABSORB ANY MOISTURE INTRODUCED DURING BATTERY MAINTENANCE	4/90
INCREASED STRENGTH OF MOTOR/ENCODER HOUSING	PREVENT ENCODER DAMAGE DURING SERVICE OR REPAIR	5/90
STRONGER MOTOR SHAFT COUPLING	PREVENT COUPLING FAILURES	5/90
ADDED GASKET & SKT HD SCREWS BETWEEN WING HOUSING AND MAIN HOUSING AT WING SHAFT	PREVENT ACTUATOR JAMMING OR FAILURE DUE TO GRIT INTRUSION	9/90
BRASS/DELRIN LINEAR ACTUATOR REPLACES OLD ALL-DELRIN PART; LARGER STRONGER PIVOT CYLINDER	REDUCE WING ACTUATOR COMPONENT FAILURES	10/90
RELEASED NEW BIRD DEPTH VERIFICATION KIT	INCREASED ACCURACY OF FIELD DEPTH VERIFICATION PROCESS	10/90
100% HYDROSTATIC TESTING OF BIRD HOUSINGS (INCL REPAIRS); 100% VACUUM TESTING OF FINISHED ASSEMBLIES	PREVENT WATER INTRUSION INTO BATTERY AND ELECTRONICS CAVITIES	1/91
ADDED MORE O-RINGS; 100% REDUNDANCY IN MOTOR MODULE HOUSING SEALS	PREVENT WATER INTRUSION INTO BATTERY AND ELECTRONICS CAVITIES	2/91

NEW 0-RING SEALS; DRY WING MODULE CONNECTOR CAVITY	PREVENT WATER INTRUSION INTO WING HOUSING CONNECTOR	2/91
NEW WING LEVER; RESET RETURN SPRING MOVED INSIDE MAIN TUBE	EASIER FIELD REPLACEMENT OF WING LEVER	3/91
CHANGED TO SLOTTED COMPASS MODULE SCREWS	ELIMINATE STRIPPING COMMON TO SOCKET HEAD SCREWS	6/91
NEW MORE RIGID PUSH POLE	EASIER REMOVAL OF BIRD INTERNALS	8/91
REPAIR RETURN DISPOSITION FORM SHIPPED WITH ALL REPAIRS	BETTER COMMUNICATION OF REPAIR DETAILS TO BOAT	9/91
ADDED HOLE ON NOSE PYLON FOR SAFETY STRAP	PROVISION FOR SAFETY STRAP REQUESTED BY CUSTOMERS	9/91
MOVED/PROTECTED I.D. LABEL; ADDED 1/2" HIGH SERIAL NUMBER MARKING	SERIAL NUMBER MORE DURABLE & READABLE FROM A DISTANCE	10/91
ADDED SPACER, CHANGED WASHER, ASSEMBLY PROCEDURE CHANGES, WING ACTUATOR LEADSCREW	PREVENT LOOSENING OF ACTUATOR SHAFT LOCK NUT	10/91
ADDED TOOTHED LOCKWASHERS AND PROTECTIVE GEL TO COMPASS TERMINAL SCREWS	MORE RELIABLE ELECTRICAL CONTACT	11/91
RELEASE STANDARD DIGICOURSE FAULT REPORT FORM	BETTER INFORMATION FROM FIELD ON FAULT SYMPTOMS	1/92
STRONGER LEVER ARM; NEW WING SHAFT	REDUCE LEVER ARM DAMAGE DURING RETRIEVAL IN ROUGH CONDITIONS	2/92
NEW LOCKING LINK	BETTER VISUAL INDICATION OF IMPROPERLY LATCHED UNITS	3/92
REDESIGNED LATCH MECHANISM - LOCK PIN REPLACES LINK, SWING PLATES ON REAR PYLON	DECOUPLES LOCKING LINK FROM DOVETAIL PIN	9/92
INTRODUCED SAFETY LANYARD OPTION - DIGI P/N 8000-627	REDUCE BIRD LOSSES	9/92
AUTOMATED BIRD CHECKOUT & DEPTH CALIBRATION SOFTWARE	FIELD REPAIR SUPPORT	1/93
MODEL 5000 OPERATION AND MAINTENANCE MANUAL	FIELD REPAIR SUPPORT	1/93

BATTERY SAFETY

The following documents are product safety information provided by the manufacturer of the lithium batteries:

ELECTROCHEM Industries
Clarence, NY 14031
U.S.A.

- Product Safety Data Summary
- General Handling Guidelines
- Safe Handling of Lithium Batteries Under Inordinate Conditions

PRODUCT SAFETY DATA SUMMARY

ELECTROCHEM IND., DIV. OF WILSON GREATBATCH LTD.
CLARENCE, NY 14031 PHONE: (716) 759 6901

date: 13 Dec 90
superceding sheet dated: 12 Feb 90

This product is classified as an ARTICLE under OSHA regulation 1910.1200 ¶ (b) (6) (iv) & (c) - (7-1-89 Edition)

NOT DESIGNED FOR CHARGING OR RECHARGING

Product Name: Lithium Oxyhalide Primary Battery
Model : BCX & HRT
Chemistry System: Lithium / Bromine Chloride in Thionyl Chloride
Chemical Formulas: Li / BrCl in $SOCl_2$

I TOXIC, CAUSTIC, OR IRRITANT CONTENT

IMPORTANT NOTE: THE BATTERY CONTAINER SHOULD NOT BE OPENED OR INCINERATED SINCE THE FOLLOWING INGREDIENTS CONTAINED WITHIN COULD BE HARMFUL UNDER SOME CIRCUMSTANCES IF EXPOSED.

MATERIALS

ithium (Li) - Lithium is included in this section due to its vigorous reaction with water forming a strong hydroxide. (CAS # 7439-93-2)
$)Cl_2$ - Thionyl Chloride (CAS # 7719-09-7)
r_2 - Bromine (CAS # 7726-95-6)
l_2 - Chlorine (CAS # 7782-50-5)
n case of accidental ingestion of a cell or its contents, obtain prompt medical advice.

II STORAGE AND DISPOSAL TIPS

TORAGE: Store in a cool place but prevent condensation on cells or batteries. Elevated temperatures n result in shortened battery life.
case of fire in an adjacent area, use water, CO_2 or dry chemical extinguishers if cells are packed in eir original containers since the fuel for the fire is basically paper products.
r bulk quantities of unpackaged cells or if cells are involved in flame, use LITH-X (Graphite Base). this case use no water, CO_2, or Halogen extinguishers. Avoid fume inhalation (LiOH, $SOCl_2$, SO_2, HCl, Br_2, Cl_2).

SPOSAL: DO NOT INCINERATE or subject cells to temperatures in excess of 212°F (100°C). Such abuse n result in loss of seal, leakage, and / or cell explosion. Dispose of in accordance with appropriate deral, State, and Local regulations.

III HANDLING AND USE PRECAUTIONS

ECHANICAL CONTAINMENT: Encapsulation (potting) of these cells will not allow cell venting at low essure. Such enclosure can result in high pressure explosion from inadvertent charging or high mperature environments (ie. in excess of 100°C)

IORT CIRCUIT: Batteries packaged in bulk containers should not be jumbled. Bulk quantities of short -cuited cells may produce high temperatures which may cause loss of seal, leakage and /or cell plosion.

IARGING: This cell is a primary cell and is not designed to be charged or recharged. To do so may use the cell to leak or explode.

THER: If soldering or welding to the terminals of the cell (battery) is required, exercise proper ecautions to prevent damage to the cell which may result in loss of cell capacity, seal, leakage, d/or cell explosion. DO NOT SOLDER to the case.

1.0 INTRODUCTION:

1.1 Wilson Greatbatch Ltd. (WGL) produces a wide variety of lithium batteries including, solid state, solid cathode and liquid cathode chemistries. The success of these systems is partially due to the fact that they contain more energy per unit weight than conventional batteries. However, the same properties which result in a high energy density also contribute to potential hazards if the energy is released at a fast uncontrolled rate.

Because of the recognition of hazards associated with high energy density systems, safety has been incorporated into the design and manufacture of lithium cells and batteries. For example, all commercial cells utilizing spirally wound electrodes are internally fused to protect the user against the hazards associated with short circuits. In addition, the implantable grade cells are of moderate rate design with limited ability to sustain high currents under inadvertent short circuit conditions.

Wilson Greatbatch Ltd. has safely manufactured millions of lithium batteries over the last 14 years. Indeed, thousands of cells are safely handled in a production environment, on a weekly basis. While a few incidents involving liquid cathode lithium batteries have occurred, almost all of them involve either unfused cells or cells subjected to severe mechanical or electrical abuse. Once the cells are fused, their reaction to abusive conditions is reduced. In addition, proper training of personnel in safe handling procedures minimizes the exposure to abusive conditions.

Our intent is to provide any user with guidelines necessary for safe handling of cells under normal manufacturing conditions. This document will address three principle areas:

(1) Receiving inspection and subsequent storage of cells.
(2) Handling procedures during product assembly.
(3) Packaging for shipment.

2.0 RECEIVING INSPECTION AND STORAGE OF CELLS:

2.1 In general, the conditions that cause damage to cells and jeopardize the safety of personnel are summarized on the label of each cell. These conditions include:

- Short circuit
- Charging
- Forced Overdischarging
- Excessive heating or incineration Crush, puncture or disassembly

Rough handling or excessive shock and vibration could also cause problems

2.2 The most frequent forms of cell abuse can be easily identified and controlled in the workplace. It is our experience that inadvertent short circuits are the largest single cause of field failures. In addition, random short circuiting is a common problem in receiving inspection, since cells are handled frequently at this stage.

Each cell chemistry manufactured by WGL has its own unique properties. Because of the low rate capability of solid state cells, no hazards are encountered when shorting a LiI cell. Moderate rate SVO, CFx and TC medical cells are current limited by their design. Therefore, short circuiting these cells would result only in a rise in the cell and a subsequent degradation in performance. However, no other hazards should be encountered. The high rate SVO cells typically reach temperatures of 140^0C when shorted under bench top conditions. However, they could overheat and possibly rupture if shorted under insulating conditions.

All E•I cells are internally protected against the hazards associated with short circuits. This is accomplished by incorporating a fast acting fuse under the terminal cap. while the fused cells will neither heat, vent, nor explode under a direct short circuit condition, they will be rendered useless. However, cells subjected to an intermediate short (a current limited to just below the fuse value) could overheat resulting in a venting situation. This is especially true if the cells are in an insulating environment. Therefore, shorting all medical and commercial cells should be avoided.

Problems associated with shorting as well as other hazardous conditions can be greatly reduced by observing the following guidelines:

- Cover all metal work surfaces with an insulating material.
- The work area should be clean and free of sharp objects that could puncture the insulating sleeve on each cell.
- Never remove the shrink wrap from a cell or battery pack.
- All personnel handling cells should remove jewelry items such as rings, wristwatches, pendants, etc., that could come in contact with the battery terminals.
- If cells are removed from their original packages for inspection, they should be neatly arranged to preclude shorting. Do not stack or jumble up the cells. They should be placed in plastic carrying trays with individual compartments for each cell.
- Cells should be transported in plastic trays set on push carts. This will reduce the chances of cells being dropped on the floor causing shorting or other physical damage.

- All inspection tools (including calipers, rulers, etc.) should be made from a non conductive material such as plastic.

- Cells should be inspected for physical damage, possibly caused by dropping the cell. Cells with dented cases or terminal caps should be inspected for electrolyte leakage. If any is noted, the cell should be disposed of in the proper manner. (See PRS-001 "Safe Handling of Lithium Batteries Under Inordinate Conditions," Section 3.0 for handling procedures of leaking or vented cells.)

- After a cell has been inspected it should be returned to its original container. Note: An open circuit voltage of 0.0 volts is indicative of a blown fuse. This cell should also be removed from inventory and returned to the factory for rework.

- If leads on solder tabs need to be shortened, only cut one lead at a time. Cutting both leads at the same time can short the cell.

- The cells must never be disassembled. In addition, never attempt to repair a blown fuse. This must only be replaced at the factory.

3.0 CELL STORAGE:

Storage of hazardous materials is regulated by state and local codes. These codes may regulate the location and amount of material that may be stored in a designated area.

- Cells should be stored in their original containers.

- Store the cells in a well ventilated, dry area. The temperature should be as cool as possible to maximize shelf-life. The terminal pins on the SVO cells are particularly susceptible to corrosion when exposed to moisture.

- Store the cells in an isolated area, away from combustible materials: Store depleted cells in an area separate from fresh cells.

- Any lithium battery storage area should have immediate access to a class D fire extinguisher and respirators.

- Never stack heavy objects on top of boxes containing lithium batteries to preclude crushing or puncturing the cell case. Such severe damage can lead to internal short circuits resulting in a cell venting or explosion.

- Do not allow excessive quantities of cells to accumulate in any storage area.

4.0 HANDLING PROCEDURES DURING PRODUCT ASSEMBLY:

Since isolated incidents involving lithium cells have happened periodically, we recommend that safety glasses be worn by all production personnel. The above guidelines concerning the reduction of short circuit incidents should be incorporated in all areas of the facility. Additional precautionary measures should be observed in production areas to avoid more serious problems associated with heat, especially around soldering equipment or during routine performance testing at elevated temperatures.

One way to limit the number of incidents that could occur in a manufacturing area is to reduce your exposure to the cells. This can be accomplished by utilizing "just in time" concepts when delivering cells to the production area. Deliver only the requisite amount of cells (on a daily basis) to production. Keep additional cells in the stock area.

- Written work instructions should be generated for each manufacturing procedure.

- Transport cells in plastic trays set on push carts. This will reduce the chances of cells being dropped on the floor causing shorting or other damage.

- Heat sensitive sheets can be placed over the plastic trays. Hot cells, indicative of a potential problem, are easily identified using this technique. (Refer to PRS-001 for handling of hot cells.)

- Never touch a cell case directly with a hot soldering iron. Heat sinks should be used when soldering to the tabs and contact with the solder tabs should be limited to a few seconds.

- Exercise caution when handling cells around solder pots. If leads need to be tinned do only one at a time. Also, guards should be in place to prevent cells from falling into solder pots.

- Only the QTC PC, 1/2 AA, 2/3 A and AA-size cells as well as the BCX PC cell can be wave soldered. All other cells incorporate a fuse under the terminal cap. The wave soldering operation will blow the fuse rendering the cell useless. Hand solder all spirally wound cells. The LiI, TC and SVO cells are unfused and, therefore, should be hand soldered into the equipment.

- Cells should not be forced into battery holders or other types of housings. This could deform the bottom of the case causing an internal short circuit. Furthermore, the terminal cap could be crushed putting pressure on the glass-to-metal seal. This could result in a cell venting. Check for proper fit before inserting the cells into any type of housing

- For the same reasons stated above, excessive force should never be used to free a cell or battery lodged inside a housing.

- Cells and/or batteries, should not be exposed to high voltage AC sources or other DC power supplies. This could result in subjecting the cells to charging or forced-discharging currents.

- All ovens or environmental chambers used for testing cells or batteries should be equipped with an overtemperature controller to protect against excessive heat.

5.0 PACKAGING FOR SHIPMENT:

U.S. domestic transportation is regulated by the Department of Transportation (DOT) through Title 49 Code of Regulation (49 CFR), HM-181 part 173.185.

Internationally, air transportation is regulated by the International Air Transport Association (IATA). DOT regulations agree with IATA with regards to packaging, labeling and documentation requirements. However, DOT and IATA do differ on the following points:

DOT requires pre-approval from the Associate Administrator for Hazardous Materials Safety * before shipping batteries contained in equipment. Rechargeable cells must also be pre-approved before shipment. IATA has no such requirements.

DOT allows cells with a solid cathode containing up to one gram of lithium to be transported on passenger aircraft. IATA allows up to three grams of lithium per cell.

Pursuant to 49 CFR 173.185, all shipments of hazardous materials must comply with new packaging regulations based on recommendations made by the United Nations. The new regulations require "performance oriented" packaging that must pass the following tests designed to demonstrate package integrity:

- Drop test
- Leak proof test (where applicable)
- Internal pressure (hydraulic) test (where applicable)
- Stacking test

* *Phone numbers for the various DOT agencies are listed in Appendix A.*

These tests are usually performed by authorized independent testing organizations.** Once certified the package is assigned a UN code identifying it as such.

There are three classifications for lithium batteries:

- Lithium batteries, liquid cathode - UN3090
- Lithium batteries, solid cathode - UN 3090
- Lithium batteries contained in equipment - UN 3091

The category "Lithium batteries contained in equipment" may be used outside the U.S. only or within the U.S. with pre-approval from the Associate Administrator for Hazardous Materials Safety.

Certain lithium cells/batteries are considered non-dangerous and are not restricted if they meet the following requirements:

- Each liquid cathode cell must contain 0.5 g or less of lithium (or lithium alloy).
- Each solid cathode cell must contain 1.0 g or less of lithium (or lithium alloy).
- Each cell must be hermetically sealed.
- Cells must be separated to prevent shorting.
- Each battery with a liquid cathode must contain an aggregate quantity of one gram or less of lithium.
- Each battery with a solid cathode must contain an aggregate quantity of two grams or less of lithium.
- Batteries must be separated to prevent short circuits.
- If a liquid cathode battery contains more than 0.5 grams of lithium, or if a solid cathode battery contains more than 1.0 grams of lithium, it must not contain a liquid or gas which is considered dangerous unless the liquid or gas, if free, would be completely absorbed or neutralized by other materials in the battery.

If cells or batteries exceed the above lithium content limitations then the following general restrictions and requirements apply:*

Lithium batteries, liquid cathode - UN3090

-- Cells must not contain more than 12 grams of lithium and are permissible on cargo aircraft only.
-- Cells or batteries must be packed in UN packaging with not more than 500 g of lithium per inner box.
-- Maximum allowable gross weight per package is not to exceed 35 kg.

* *All restricted cells are listed in Table I*
* *Third party packaging certification agencies are listed in Appendix B.*

-- They must be packed in such a manner as to prevent movement or short circuiting.
-- Labels required: "Miscellaneous" and "cargo aircraft only".
-- Packaging required: UN approved.
-- Shipper's Declaration of Dangerous Goods must be completed.
-- This regulation does not apply to depleted cells with open circuit voltage of less than 2 volts or 2/3 voltage of the undischarged cell.
-- Markings "lithium batteries, liquid cathode - UN 3090" must appear on box.

Lithium batteries solid cathode - UN3090
(currently applies only to Electrochem's PMX-HT Series 3B1750 "C" *cell)*

-- Cells must not contain more than 12 grams of lithium and are permissible on cargo aircraft only. IATA allows cells containing up to 3 grams of lithium to be shipped on passenger aircraft, but this pertains only to shipments moving outside U.S. boundaries.
-- Cells or batteries must be packed in UN packaging with not more than 500 g of lithium per packaging for cargo aircraft and 125 g of lithium for passenger aircraft.
-- Maximum allowable gross weight per package is not to exceed 35 kg for cargo aircraft or 5 kg for passenger aircraft.
-- Cells must be packed in such a manner as to prevent movement or short circuiting.
-- Labels required: "miscellaneous" and "cargo aircraft only" ("cargo aircraft only" label used only when applicable).
-- Packaging required: UN approved.
-- Shipper's Declaration of Dangerous Goods must be completed.
-- This regulation does not apply to depleted cells with open circuit voltage of less than two volts or 2/3 voltage of the undischarged cell.
-- Markings "lithium batteries, solid cathode - UN3090" must appear on box.
-- Cells or batteries must be packed in strong inner fiberboard packaging with not more than 125 g of lithium in each packaging for passenger aircraft or 500 g of lithium for cargo aircraft.

Lithium batteries, contained in equipment - UN3091
(Shippers inside the U.S. must have pre-approval from DOT to ship this commodity.)

-- The quantity of lithium metal contained in any piece of equipment must not exceed 3 g per cell and 125 g per battery for shipment aboard passenger aircraft or 12 g per cell and 500 g per battery for shipment aboard cargo aircraft.
-- Not more than 5 kg of lithium batteries may be contained in any piece of equipment.
-- Labels required: "miscellaneous" and "cargo aircraft only" ("cargo aircraft only" label required when cells contain over three grams of lithium).

-- Equipment containing lithium batteries must be contained in strong outer packaging which is waterproof.
-- Requirements of 5.0 in the IATA book must be met.
-- Requirements in IATA packaging Instruction 912 must be met in addition to the general packaging requirements in Instruction 903.
-- Cells must not be capable of being discharged during transport to the extent that the open circuit voltage is less than the lower of two volts or 2/3 of the voltage of the undischarged cell.
-- Markings "Lithium Batteries contained in equipment UN3091" must appear on box.

As of January 1, 1991 the DOT requires shippers of hazardous materials, such as manufacturers and distributors, to be in compliance with the Emergency Response Communication Standard per Title 49, Part 171 et. al. This regulation requires that the shipper of hazardous materials use the proper shipping name, have a 24-hour emergency response information system and provide emergency response mitigation information with each shipment.

Lithium batteries, for disposal, may be transported to a permitted storage facility and/or disposal site by motor vehicle only. They must be packaged in a strong outer box and isolated with an effective means to prevent external short circuits.

APPROVED BY: Manager, Product Safety
Director, Process & Product Quality
Vice President, Technology

TABLE I

Restricted Commercial Models

BCX	CSC	PWR
3B64	3B24	3B2030
3B70	3B665	
3B1600	3B30	PMX
3B75	3B1850	3B90
3B1320	3B35	3B2800
3B76	3B36	
3B2892	3B1873	PMX-HT
3B3100		3B1750
3B1910		
		OTC
		3B2030

Restricted Implantable Grade Models

(Proprietary cells are not listed. Check with WGL for specific cell restrictions.)

SVO	TC
8512	8602

APPENDIX A

1) Department of Transportation
Research and Special Programs Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

General Information **(202) 366-4000**

Exemptions Branch **(202) 366-4535**
Suzanne Hedgepeth, Chief
Donald Smith, Transport Specialist
James Carter, Transport Specialist

Sciences Branch **(202) 366-4545**
Charles Schultz, Chief

Approvals Division **(202) 366-4511**
James Jones, Chief

2) International Air Transport Association
Montreal, Quebec, Canada H3A 2R4
(for IATA/ICAO advice)

Dangerous Goods **(514) 844-6311**
Harold Pike, Senior Manager

3) United Parcel Service
Greenwich, CT 06830

General Information **(203) 622-6000**

APPENDIX B

APPROVED THIRD-PARTY PACKAGING CERTIFICATION AGENCIES

The following third-party packaging certification agencies have been approved by the department of Transportation to certify conformance of packaging with UN standards pursuant to 49 CFR; Part 107 Subpart E as of January 5, 1992.

ALABAMA
Wyle Laboratories
7800 Governor's Drive West
P.O. Box 077777
Huntsville, AL 35807
205-837-4411

CALIFORNIA
Charles F. Tudor CP-P/MH
3869 Mammoth Cave Court
Pleasanton, CA 94588
415-462-4493

Lansmont Corporation
Ryan Ranch Research Park
5 Harris Court Bldg. N
Monterey, CA 93940
408-373-3800

Wyle Laboratories
1841 Hillside Avenue
Norco, CA 91760
714-737-0871

CONNECTICUT
Package Design & Testing Corp.
of New England
10 Hazelwood Road
East Granby, CT 06026
203-653-8086

Park City Packaging, Inc.
490 Sniffen Lane
Stratford, CT 06497
203-378-7384

DELAWARE
Smurfit Plastic Packaging, Inc.
1204 East 12th Street
Wilmington, DE 19802
302-573-2581

FLORIDA
Stone Container Corp.
P.0. Box 105
Contonment, FL 32533
904-968-5414

Yowell International
7805 Ellis Road
Melbourne, FL 32940
407-725-3611

ILLINOIS
Construction Technology Laboratories, Inc.
5420 Old Orchard Road
Skiokie, IL 60077
708-965-7500

Caynes Testing Laboratories, Inc.
1642-52 West Fulton Street
Chicago, IL 60612
312-421-5257

Jefferson-Smurfit Corp.
& Container Corp. of America
450 East North Ave.
Carol Stream, IL 61088-2195
708-260-3590

Pro-Pack Testing Laboratory, Inc.
15 N. Florida
Belleville, IL 62221
618-277-1163

MARYLAND
Hedwin Corporation
1600 Roland Heights Avenue
Baltimore, MD 21~1
301-467-8209, Ext. 312

Westinghouse Elec. Corp. ISLD
111 Schilling Road, MS 7980
Hunt Valley, MD 21030
301-584-5368

APPENDIX B (Cont'd.)

MINNESOTA
Distribution Dynamics Labs, Inc.
14958 Martin Drive
Eden Prairie, MN 55344
642-937-4746

Ecolab, Inc.
940 Lone Oak Road
Eagan, MN 55121
642-452-1460

TEN-E Packaging Services
3670 Dodd Road
Eagan, MN 55123
612-683-0063

NEW JERSEY
Package Research Laboratory
41 Pine Street
Rockaway, NJ 07866
201-627-4400

Union Camp
P.O. Box 3301
Princeton, NJ 08543
609-986-1200

Union Carbide Corporation
P.O. Box 670
Bound Brook, NJ 08805
203-563-5000

United States Testing Company, Inc.
1415 Park Avenue
Hoboken, NJ 07030
201-575-5252

NEW YORK
Container Testing Laboratory, Inc.
607 Fayette Avenue
Mamaroneck, NY 10543
914-381-2600

OHIO
Georgia Pacific
1660 Indian Wood Circle
Maumee, OH 43537
419-891-5963

GH Package-Product Testing
& Consulting, Inc.
11301 Jefferson Avenue
Sharonville, OH 45241
513-733-8378

Owens - Illinois
One Seagate-25-L-GC
Toledo, OH 43666
419-247-7424

PENNSYLVANIA
Delvalco Consultants
2 McKinley Avenue
Malvern, PA 19355
215-644-9117

Professional Services Industries, Inc. (PSI)
850 Poplar Street
Pittsburg, PA 15220
412-922-4000

Pro Pack, Inc.
76 Jansen Avenue
Essington, PA 19029
215-521-4050

TEXAS
RVR Package Testing Center
1702 Taylor Street
Houston, TX 77007
713-864-8221

1.0 INTRODUCTION:

1.1 Wilson Greatbatch Ltd. (WGL) produces a variety of lithium cells for medical implantable components such as pacemakers, defibrillators and drug delivery systems. Wilson Greatbatch Ltd. also manufactures, under the Electrochem Industries (E•I) label, a wide variety of lithium batteries for use in military and commercial applications. The specific cell chemistries manufactured by the WGL are summarized in Table I.

TABLE I

Product Designation	Chemistry	OCV	Operating Temp. Range (°C)
LiI*	PVP/I_2	2.8	37
CFX*	CFx	3.2	20 to 55
SVO*	AgV_2O_5	3.2	20 to 55
QTC & TC*	$SOCl_2$	3.6	-40 to 85
BCX	$SOCl_2$/BrCl	3.9	-40 to 72
CSC	$S0_2Cl_2/Cl_2$	3.9	-32 to 93
PMX	$S0_2Cl_2/Cl_2$	3.9	0 to 150
PMX-HT	CFx	3.2	-20 to 180

*implantab1e grade batteries

With proper use and handling, these cells have demonstrated an excellent safety record. Indeed, over one million LiI cells have been implanted in the body powering heart pacemakers. In addition, over 20,000 SVO solid cathode cells have been used to power the implantable defibrillator. The cells produced by E•I are being used successfully by NASA and in other military applications where safety is of utmost importance. For example, the Li/BCX D cell is the only lithium cell qualified for in-cabin use on the space shuttle. They also power the EVA helmet mounted lights and television cameras on the space suit. Other packs utilizing the CSC chemistry have passed all of the requirements of the U.S. NAVY's NAVSEA 9310 safety document.

While we have designed our cells and battery packs to be tolerant to adverse conditions, these very active chemical systems have limitations. Certain hazards are associated with exposure to heat and its subsequent effects on sealed cells. These hazards include possible battery venting, explosion and/or fires. The initial source of heat can be external (fire, soldering iron) or internal, such as heating caused by short circuit, forced overdischarge, charging conditions or excessive mechanical abuse.

Specifically mechanical abuse in the form of excessive shock or vibration, can result in case deformation or crushing and damage to the electrodes and/or separator material.

Most primary lithium cells, excluding solid state cells such as LiI, have a warning printed on their label that cautions against the following conditions:

- short-circuit
- charging
- forced overdischarge
- excessive heating or incineration
- crush1 puncture or disassembly

Not guarding against these conditions may result in a hot cell or battery pack that could either vent or explode. With our cells, the ensuing hazards associated with a hot cell do not occur the instant the cell is abused. Rather, the cell heats up over a period of time and subsequently vents or explodes when its critical temperature is reached. The rate of heating is proportional to the extent of the abusive condition. For example, if a charging current is limited to the leakage current through a blocking diode, no heat will be generated. However, a 3A charge will cause a cell to heat to its critical temperature over a period of 8-10 minutes. Our cells are designed to operate over the temperature range listed in Table I. The critical temperature (as measured on the cell case) for the BCX, CSC and QTC cells is in the range of 125°C to 150°C. The critical temperature for the PMX cells is 165-180°C and 195-2l0°C for the FMX-HT cells. The critical temperature for LiI cells is above 180°C and can only be attained through an external source. The critical temperature for SVO cells is between 140 and 180°C.

One condition that could lead to a sudden explosion would be severe structural deformation of the case or internal components due to excessive mechanical abuse. One exception to this is the LiI solid state cell. The low rate capability intrinsic to solid state systems causes them to be less reactive than liquid cathode systems, even under these extremely abusive conditions.

1.2 The aforementioned abusive conditions must be avoided to ensure safe handling of our cells. However, if mistakes are made in battery pack design or in cell handling that result in a cell venting or exploding, the user should be equipped to cope with such emergencies. Our intent is to provide any handler with knowledge which is needed for safe handling of cells that have been subjected to these extreme conditions. This document will address four principle areas:

(1) Hot cells
(2) Cells that have leaked or vented
(3) Cells that have exploded
(4) Fires involving lithium batteries

2.0 PROCEDURES FOR HANDLING A HOT CELL:

2.1 As soon as it has been determined that a hot cell situation exists, the first action is to completely evacuate all personnel from the area. The area should be secured such that no unnecessary persons enter.

2.1.1 Before leaving, the person who first noticed the cell should quickly determine if an external short-circuit is present and remove it as quickly as possible. After the short has been removed, the cell should start to cool. However the area should remain evacuated until the cell has cooled to room temperature and has been removed from the area. The temperature of the cell should be monitored periodically with a remote sensing device such as an infrared temperature probe.

2.2 If the hot cell situation persists, then one of two courses of action can be taken.

2.2.1 **Response #1**

Minimum Equipment Required:

- Infrared temperature probe
- Safety glasses
- Helmet with impact resistant face shield
- Non-conductive extended pliers

2.2.1.1 Procedure:

- As soon as a hot cell is detected, completely evacuate the area of all personnel.

- Periodically monitor the temperature of the cell with the remote probe for the first two hours or until one of the three fo1lowing situations occurs:

  - the cell starts to cool;
  - the cell vents; or
  - the cell explodes.

- If the cell starts to Cool, monitor its temperature once an hour until it returns to ambient temperature.

- If remote temperature sensing equipment is not available, do not handle the cell for a period of 24 hours.

- Remove the cell from the work area once it has cooled and return to normal operations.

- Dispose of the cell in accordance with local, state and federal hazardous waste regulations.

- Procedures for handling cells that continue to heat and, resultantly, either vent or explode will be addressed in Sections 3.0 and 4.0.

2.2.2 **Response #2**

The following outlines the response action taken when a hot cell is discovered at WGL. This procedure may be modified to meet your specific requirements.

Minimum Equipment Required:

- Riot helmet with impact resistant face shield and safety glasses
- Bullet proof vest with arm guards
- Thermal resistant gloves
- Ear protection
- Non-conductive extended pliers
- Infrared temperature probe
- Respirator suitable for organic vapors, chlorine, HCl, and SO_2
- Bomb can
- Bomb blanket
- Riot shield
- Keviar jacket and gloves

2.2.2.1 Procedure:

- In order to respond adequately to any emergency situation a primary response team should be established. After training in safety and handling procedures, along with first aid and fire fighting methods, the primary response team will be able to respond to situations involving lithium batteries. Our team consists of nine (9) members. Typically,

only three (3) or four (4) members will actually respond to an emergency. More may respond if necessary.

- When a "hot" cell is detected, the operator will issue a verbal warning to evacuate the room. Personnel should exit through the closest door without passing by the "hot" cell. The last person exiting should place the DANGER sign on the door. The supervisor should then be notified as to cell type, location and problem. Operators should not try to take care of hot cells by themselves.

- The primary response team is paged to the area where the hot cell is located. The team is informed of any pertinent information regarding the situation by the person who noticed the cell.

- Two members of the Primary Team (each will be dressed to a different level of protection) will then enter the room containing the "hot" cell with the appropriate safety equipment. This equipment is:

  Level One

  - Police grade riot helmet with impact resistant face shield
  - Police grade bullet proof vest and arm guards
  - Non-conductive extended pliers
  - Thermal resistant gloves
  - Temperature probe
  - Safety glasses

  Level Two

  - Police grade riot helmet with impact resistant face shield
  - Safety glasses
  - Riot shield
  - Kevlar gloves and jacket

  The team member dressed in Level One protection, should enter the area containing the "hot" cell first. The team member dressed in Level Two protection should act as the watch guard and assistant to the Level One personnel.

- Level One personnel should take the temperature of the cell using a temperature probe. If the exact cell is not known, the temperature probe will be used to determine which cell is hot.

- Level One person should pick up the cell with non-conductive pliers and transfer cell into bomb can[1] and cover with the bomb blanket. Level Two person may assist in maneuvering bomb can for Level One person.

- Other members of the responding team will be responsible for making sure that there is a clear path to the bomb can storage area and all doors get opened.

- The bomb can containing the "hot" cell should then be transferred to the storage area and placed in the appropriate space.

- The DANGER DO NOT ENTER sign shall be put on the storage area door and shall remain there for a minimum of four (4) hours. After that time, access to the room will be allowed by authorized personnel.

- After overnight storage in the bomb can, the temperature of the cell should be checked by a primary team member. If the cell temperature is ambient, it may be disposed of as a waste cell. If the cell is still "hot", allow to sit for an additional 24 hours. Cells should be checked again after additional storage.

- The Supervisor shall maintain a log book recording date, cell type, size and date code, location, cell temperature and the action taken. It is the Supervisor's responsibility to assure the disposal of cells involved in a “hot” cell incident.

- The "hot" cell incidents will be reviewed at the monthly safety meeting.

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[1] Our bomb can was designed and fabricated in-house. The can is of double walled steel construction. A 30 gallon fire fighter safety waste paper receptacle was used as the outer canister. This was fitted with an inner sleeve fabricated from 22 gage steel sheet (cold finish). The area between the inner and outer walls was filled with sand. The receptacles' specially designed extinguishing head is held in place with three 7 x 7 strand core stainless steel wire ropes.

The finished canister was tested by exploding a D-size cell inside the can. It is important to verify the integrity of any design to be certain that the contents of an explosion (excluding gasses) can be contained.

3.0 PROCEDURE FOR HANDLING CELLS THAT HAVE VENTED:

3.1 INTRODUCTION

All of our lithium batteries are hermetically sealed in a 304L stainless steel case. A glass-to-metal seal is used as an electrical feedthrough for the positive terminal. Under normal operating conditions, a cell will not leak or vent. However, cell leakage or venting could occur if the cell is overheated or the glass seal is compromised by excessive physical abuse.

The severity of a vent condition can range from a slight leak around the glass-to-metal seal to a violent expulsion of material through the glass seal, thereby causing the cell to become a projectile.

The electrolyte contained within the lithium cells can cause severe irritation to the respiratory tract, eyes and skin. In addition, violent cell venting could result in a room full of either corrosive or flammable vapors summarized in Table II.

TABLE II

Cell Chemistry	Vent Products	Properties
Li/BCX and QTC and TC	$SOCl_2$	Non-flammable; eye irritation
	Br_2, $C1_2$, HCl	Corrosive, inhalation hazard, causes chemical burns to skin.
	SO_2	Negligible fire hazard, inhalation hazard.
Li/CSC and PMX	SO_2C1_2	Non-flammable, eye irritation
	$C1_2$, HCl	corrosive, inhalation hazard,
	H_2SO_3	causes chemical burns to skin.
	SO_2	Negligible fire hazard, inhalation hazard.
Li/PMX-HT and CFX	Gamma Butyrolactone	Flammable-flash point 92°C, eye irritation.
Li/SVO	Glyme	Flammable-flash point -6°C, mild eye irritant, inhalation, skin and ingestion hazard.
	Propylene Carbonate	Combustible-flash point 135°C, mild eye irritant, skin and inhalation irritant.
Li/I_2	I_2	Not combustible but is a strong oxidizer. Severe inhalation, ingestion, skin and eye irritant.

All precautions should be taken to limit exposure to the electrolyte vapor. Material safety data sheets (MSDS) are attached in appendix A for our particular cell chemistries. Refer to the appropriate MSDS for specific gas content and appropriate precautions.

3.2 Minimum Equipment Required:

- A Class D fire extinguisher
- Eye protection or face shield
- Respirator suitable for organic vapors, chlorine, HCl and SO_2 or air pack
- Neoprene rubber gloves
- Lab coat or chemically resistant apron
- Bicarbonate of soda (baking soda), calcium oxide (lime) -or-acid spill clean up kit (J.T. Baker Co.)
- Vermiculite
- Individual thick plastic bags with sealing mechanism
- A solution of 5g sodium thiosulfate in a 70/30 wt% mixture (1*l*) of ethanol/water (for LiI cells only).

3.21 Procedure:

Should electrolyte leak from a cell the following actions should be taken:

- Evacuate personnel from all areas which are affected by the gas.

- Ventilation should be initiated and continued until after the cell is removed from the area and the pungent odor is no longer detectable.

- If the cell vented as a result of excessive heating, it must be allowed to cool to ambient temperature before handling. (Refer to hot cell procedure)

- Put on lab coat, rubber gloves, safety glasses and respirator. Remove the cell to a well ventilated area.

- Place each leaking cell in a separate, sealable plastic bag. Eliminate excess air and seal the bag.

- Place one cup of lime or baking soda in a second bag along with the first bag. Eliminate excess air and seal. This step can be eliminated when handling PMX-HT, CFX, SVO or LiI cells.

- Place the double-bagged. cell in a third bag containing approximately one cup of vermiculite. Seal. the bag.

- Neutralize spilled BCX, CSC, QTC, TC or PMX electrolyte with baking soda. Electrolyte from. PMX-HT, SVO or CEX cells can be soaked up in an absorbent material such as vermiculite.

- Sweep contaminated baking soda or absorbent material into a sealable plastic bag for disposal.

- Clean the area with copious amounts of water. For LiI cell only use a solution of 5g of sodium thiosulfate in a 70/30% mixture (*l/*) of ethanol/water.

- Dispose of the vented cell and contaminated absorbent material in accordance with local, state and federal hazardous waste disposal regulations.

3.3 **First Aid Procedures in Case of Contact with Electrolyte:**

EYES -- Immediately flush eyes with a direct stream of water for at least 15 minutes while forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue. GET IMMEDIATE MEDICAL ATTENTION.

SKIN -- Flush with cool water or get under a shower, remove contaminated garments. Continue to flush for at least 15 minutes. Get medical attention, if necessary.

INHALATION -- Move to fresh air. If breathing is difficult have trained person administer oxygen. If respiration stops, give mouth-to-mouth resuscitation. GET MEDICAL ATTENTION IMMEDIATELY.

4.0 PROCEDURE FOR CELLS THAT HAVE EXFLODED:

4.1 INTRODUCTION:

Our Li/BCX and Li/CSC cells have the highest energy density of any commercial lithium battery on the market. It is a combination of high voltage and capacity, coupled with light weight, that makes our cells attractive for many specialty applications. However, when a large amount of energy is contained in a small package, the results can be energetic if the system is abused.

Our lithium batteries have an energy density of 1.1 wh cc^{-1}. Gasoline has an energy content of 43 MJ kg^{-1}, which converts to an energy density of approximately 8 wh cc^{-1}. Therefore, gasoline has. an explosive force approximately eight (8) times that of our batteries on a unit volume basis. Taking dynamite as another;. comparative example, its energy content is equivalent to 924 wh kg^{-1}. Our batteries have a gravimetric energy density of 475-

500 wh kg^{-1}. Also taking size into consideration, a D-size cell is equivalent to approximately one-quarter stick of dynamite. These comparisons serve only to inform the user of the force with which a battery could explode if improperly handled.

It is unlikely that any lithium battery would involuntarily explode. These events are rare and are usually the result of an abusive condition that raises the cells temperature above its critical point. However, in the event of a lithium battery explosion, a room could fill quickly with dense white smoke which could cause severe irritation to the respiratory tract, eyes and skin. An explosion involving a LiI cell would also add purple I_2 vapors to the air. All precautions must be taken to limit exposure to these fumes.

4.2 Minimum Equipment Required:

- A Class D fire extinguisher
- ABC Class fire extinguisher (for possible secondary fires)
- Respirator suitable for organic vapors, chlorine, HCl and SO_2 or air pack
- Eye protection or face shield
- Rubber gloves, lab coat or chemically resistant apron
- Bicarbonate of soda or calcium oxide (lime) -or- acid spill clean up kit (J.T. Baker Co.)
- Vermiculite
- Individual thick plastic bags with sealing mechanism, glass jars.
- A solution of 5g sodium thiosulfate in a 70/30 wt% mixture (1*l*) of ethanol/water (for LiI cells only).

4.2.1 Procedure:

Should a cell explode the following actions should be taken:

- Evacuate personnel from all areas which are affected by the smoke.

- Ventilation should be initiated and continued until after the cell is removed from the area and the pungent odor is no longer detectable.

- Although this scenario is unlikely, should there be a fire resulting from an explosion, methods for dealing with this contingency are addressed in Section 5.0.

- The exploded cell may be hot. It must be allowed to cool to ambient temperature before handling. (See hot cell procedures)

- Put on a lab coat, rubber gloves, safety glasses and respirator.

- If a BCX, CSC, QTC, TC or PMX cell explodes the surrounding area may be covered with black carbonaceous material along with metal parts from the cell. Cover the black carbonaceous material with a 50/50 mixture of baking soda (or lime) with vermiculite.

- If PMX-HT, CFX, SVO or LiI cells are involved in an explosion use a wet sweeping compound or mist area with water to avoid dust.

- Sweep the contaminated baking soda/vermiculite mixture into a sealable plastic bag. Gather in such a way as to avoid excessive dust. Metal parts can also be included in this container. Note: Metal fragments should never be packaged with live cells. This could cause the cell to become shorted.

- Seal the plastic bags in a glass jar and dispose of contents in accordance with local, state and federal hazardous waste disposal regulations.

- Clean the area with copious amounts of a baking soda/water solution.

- For LiI cells only clean area with a solution of 5g of sodium thiosulfate in a 70/30% (1*l*) of ethanol/water. Clean the area a second time with a solution of soap and water.

4.3 **First Aid Procedures in Case of Contact with electrolyte**:

EYES -- Immediately flush eyes with a direct stream of water for at least 15 minutes while forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue. GET IMMEDIATE MEDICAL ATTENTION.

SKIN -- Flush with cool water or get under a shower, remove contaminated garments. Continue to flush for at least 15 minutes. Get medical attention, if necessary.

INHALATION -- Move to fresh air. If breathing is difficult have trained person administer oxygen. If respiration stops, give mouth-to-mouth resuscitation. GET MEDICAL ATTENTION IMMEDIATELY

5.0 FIRES INVOLVING LITHIUM BATTERIES

5.1 INTRODUCTION:

All metals will burn under proper conditions depending on such factors as physical form, oxidizing atmosphere, and severity of the ignition source. Alkali metals such as lithium will burn in a normal atmosphere. It should also be noted that lithium reacts explosively with water to form hydrogen. The presence of minute amounts of water may ignite the material and the hydrogen gas.

Once ignited, a metal fire is difficult to extinguish with ordinary means. This is due to the intense heat produced by the burning metal, the temperature of which may reach as high as 3000°F.

Specially formulated extinguishing agents are required to control or put out a lithium fire. In particular, a graphite based extinguisher (Lith-x) should be used. These agents function generally by forming a layer or crust of material over the burning metal, thereby excluding air that is required to sustain combustion. Lith-x, which is a popularly used graphite based agent, may be applied from an extinguisher or by shoveling the loose powder onto the fire.

In the event of a lithium fire, a room could become filled with dense white smoke, mostly comprised of lithium oxide and/or other metal oxides. This condition could cause severe irritation to the respiratory tract, eyes and skin. All precautions must be taken to limit exposure to these fumes.

It should also be noted that the following procedures are only applicable to fires involving a single cell. Larger fires involving multiple cells should be handled by professionally trained people.

In addition, it is our practice to use an extinguishing agent best suited to quench the bulk of the fuel available. For example, if a single cell were to start burning during a destructive analysis a lith-x extinguisher would be used to quench the fire. If other combustibles catch fire as result of the lithium battery then use the appropriate extinguishing agent to douse these secondary fires. A BC type or CO_2 extinguisher could be used on solvent/electrical fires or a general purpose ABC type could be used on all combustible materials. It is important to address the lithium fire first and secondary fires later.

DO NOT USE ABC OR $C0_2$ TYPE EXTINGUISHERS ON LITHIUM METAL FIRES.

5.2 Minimum Equipment Required

- A Class D fire extinguisher (Lith-x)
- An ABC class fire extinguisher (for possible secondary fires)
- Bomb blanket (optional)
- Self-contained breathing apparatus
- Full fire-fighting protective clothing
- Heat resistant gloves
- Goggles or safety glasses
- Non-conductive extended pliers
- Shovel, mineral oil
- A solution of 5g sodium thiosulfate in a 70/30 wt% mixture (1*l*) of ethanol/water (for LiI cells only).

5.2.1 Procedure:

INITIAL RESPONSE

- In order to respond adequately to any emergency situation a primary response team should be established. After training in safety and handling procedures, along with first aid and fire fighting methods, the primary response team will be able to respond to situations involving lithium batteries. Our team consists of nine (9) members. Typically, only three (3) or four (4) members will actually respond to an emergency. More may respond if necessary.

- When a fire is detected the first action is to completely evacuate all personnel from the area and sound the fire alarm immediately.

- The primary response team is paged to the area where the fire is located. The team is informed of any pertinent information regarding the situation by the person who reported the fire.

- Quarantine the area. Ventilation should be initiated and continued until the burning material is removed from the area and the pungent odor is no longer detectable.

- Two members of the team will then enter the area with the appropriate fire-fighting and safety equipment.

NOTE: Lithium melts at 180°C. It becomes highly reactive and when ignited, lithium fires can throw off molten lithium metal particles. Furthermore, cells adjacent to any burning material could overheat causing a violent explosion. Firefighting teams must be made aware of any hazardous materials in the vicinity of the fire.

- Completely bury the burning material with Lith-x to extinguish the fire. Never leave the fire unattended because it may reignite.

- If necessary, attend to any secondary fires with the appropriate extinguishing agent.

- After all material has apparently burned and cooled, carefully turn over the remaining residue and be prepared to extinguish, should re-ignition occur.

- Carefully place the residue in a steel drum using a long-handled shovel, and cover with excess Lith-x. The residue may contain unreacted lithium, therefore limit exposure to moisture. This can be accomplished by covering the residue with mineral oil.

CLEAN-UP

- A lab coat, rubber gloves, safety glasses or goggles and respirator should be worn during cleanup.

- The surrounding area may be covered with black carbonaceous material along with metal parts from the cell. Cover the black carbonaceous material with a 50/50 mixture of baking soda (or lime) with vermiculite. A wet sweeping compound may also be used to avoid dust. Nonetheless, gather the material in such a way as to avoid excessive dust.

- Sweep the contaminated baking soda/vermiculite mixture into a sealable plastic bag. Metal parts can also be included in this container.

- Seal the plastic bags in a glass jar or other suitable container.

- Clean the area with copious amounts of a baking soda/water solution. Areas that were contaminated with residue from LiI cells should first be cleaned with a solution of 5g sodium thiosulfate in a 70/30 wt% mixture (1*l*) of ethanol/water. Clean the area a second time with a solution of soap and water.

- Dispose of all materials in accordance with local, state and federal hazardous waste disposal regulations.

5.3 **First Aid Procedures in Case of Contact with Electrolyte and Molten Lithium Metal:**

EYES -- Immediately flush eyes with a direct stream of water for at least 15 minutes while forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue. GET IMMEDIATE MEDICAL ATTENTION.

SKIN -- Flush with cool water or get under a shower, remove contaminated garments. Continue to flush for at least 15 minutes. Get medical attention, if necessary. IF MOLTEN LITHILIM METAL IS EMBEDDED IN THE SKIN AND CANNOT BE REMOVED, COVER WITH MINERAL OIL AND GET MEDICAL ATTENTION IMMEDIATELY.

INHALATION -- Move to fresh air. If breathing is difficult have trained person administer oxygen. If respiration stops, give mouth-to-mouth resuscitation. GET MEDICAL ATTENTION IMMEDIATELY.

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