APECS OPERATIONAL INSTRUCTIONS (v. 2.01j) Addendum to v2.00

Revision 1
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APECS OPERATIONAL INSTRUCTIONS (v. 2.01j)

Introduction:

The ISC **A**dvanced **P**ersonal **E**nvironmental **C**ontroller **S**ystem (APECS™) is a family of CCR electronics designed to be used in a variety of diving roles to fit the operational needs of the end user. The APECS family is designed to be used in Saturation, military, and recreational roles providing reliability, user friendly operation with room for ISC factory customization to further meet the end users needs. The APECS has a simple self intuitive menu and confirm system and essential information dive screen that minimizes the task loading of the diver by providing a "quick look" ability of essential information and the ability to quickly change on the fly operational changes to the breathing media. This addendum is intended to be used as supplementary information with the v2.00 manual. Included are the additions and changes to the functionality and setup procedures for the additions.

New Functions/Features/Changes:

- Solenoid Diagnostic at startup. A solenoid injection test was added to the startup of the **primary subsystem**. The purpose of the test is to inform the user that the oxygen injection solenoid properly functions. The behavior of the test is as follows:
    - Power on Megalodon display shows for about 2.5 seconds.
    - The screen is cleared, the logo is redisplayed, and the text "**TESTING SOLENOID**" is displayed during the test.
    - The test consists of 3 cycles of oxygen injection through the injection solenoid, assuming the oxygen was connected to the MEG head and the gas turned on, otherwise just the solenoid firing 3 times is performed. Each injection lasts approximately 0.25 seconds with a 0.25 second off period.

- HUD Diagnostic at startup. A HUD test was added to the startup of the **secondary subsystem**. The purpose of the test is to visually inform the user the HUD is properly performing through its 3 color states. The behavior of the test is as follows:
    - Power on Megalodon display shows for about 5 seconds.
    - The screen is cleared, the logo is redisplayed, and the text "**TESTING HUD**" is displayed during the test.
    - The test consists of 3 cycles of **RED**, **ORANGE**, **and GREEN** on the HUD.
    - The test is completed and normal operation begins.

- On Demand HUD Diagnostic. A HUD diagnostic test (same HUD display characteristics as the startup diagnostic) can be initiated by the diver at any time on the **secondary**, including during the dive. The purpose of this test capability is to visually inform the diver the color sequence behavior at different lighting conditions during the dive. Some users have a hard time distinguishing red from ORANGE or ORANGE from green during the dive, yet can see the colors properly on the surface. The same test sequence of the **HUD** is displayed. This test does not interfere with the normal display functions of the **secondary handset**. To initiate the test, perform the following:
    - Use the **MENU** button to cycle down to the **HUD-ENABLE/DISABLE/TEST** submenu, then depress the **CONFIRM** button to enter that submenu.
    - Use the **MENU** button to cycle down to the **TEST** option, then depress the CONFIRM button to initiate the test.
    - The HUD will then go rapidly through the 3 cycles of **RED**, **ORANGE**, and **GREEN** with a short break between cycles.
    - The **HUD** follows with normal operations. If the HUD was disabled, then the **HUD** remains disabled. The state of DISABLED is ignored during the test.

- Oxygen selection menu. Adds the ability of selecting the calibration oxygen quality percentage from 70-99%. This allows the user to safely use oxygen of limited purity. Availability of 99.9% oxygen in some parts of the world and some dive resort areas is many times unfavorable. The ability to calibrate your system with these gasses has been a requested function by many Megalodon users. This selection, like **CALIBRATE**, is only available within the first two minutes after powering on the system. It is available on both the primary and secondary systems. To enter the oxygen quality menu, depress the **MENU** button until the "**SET OXYGEN PERCENT**" is displayed. It displays the current percentage the system has in its menu from recent or previous settings of this entry. Selecting the **CONFIRM** button enters this function. The user can increment the current percentage to the next percentage, having a range from 70% to 99%. Stepping beyond 99 wraps back around to 70. There is a new feature of the switch hits called a **LONG SWITCH** which is used here for the first time in the APECS software. A long switch is holding the switch for greater than 2 seconds. The **MENU LONG SWITCH** has the effect here of adding 10 to the current setting, allowing the user quicker setting of the desired oxygen percentage. We recommend watching the "**HEARTBEAT**" character in the lower right corner of the display screen for the 3rd character change, indicating approximately 3

seconds have passed, before releasing the switch to increment by 10. Wrap around past 99 is affected by subtracting 20 from the last displayed percentage, providing the desired wraparound effect. This oxygen percentage is only used during the **CALIBRATE** mode to provide proper parameters for the determination of the mathematical formula later used in displaying the setpoint of each oxygen sensor during operation (i.e. sensor millivolt output vs. PO2 display calculations). It is highly recommended the MEG diver use an oxygen analyzer to determine the quality of the oxygen in the O2 cylinder used during calibration. **KNOW YOUR OXYGEN QUALITY**. One question frequently asked is "Will the oxygen percentage affect my PO2s during the dive?" The answer is **NO**. Once breathing from the loop, the partial pressure of oxygen in the mix you are breathing is attempted to be maintained at the selected setpoint by the electronics and is appropriately displayed on the handsets and HUD as that PO2. A low oxygen percentage results in more of the oxygen gas mix to be used up faster since the other gasses are treated as part of the diluent gas.

- The **100% OXYGEN prompt** during calibration **has been changed to MAXIMUM OXYGEN** to accommodate the various oxygen quality percentages available, and makes the prompt more accurate to the situation.

- Maximum Oxygen setpoint submenu has new checks to attempt to prevent the user from selecting the maximum O2 while the sensors are still exposed to ambient air. The effect is the **CONFIRM** switch is **ignored** until the system reads a **millivolt** reading on all 3 sensors exceeding 20 mv. Pushing the confirm button several times with no action should alert the user to read the millivolt output readings on that page of the display to determine that the oxygen level is not high enough for the **HiPO2** point. Many users have accidentally hit the confirm button for the air point calibration too many times and resulted in having to restart the entire calibration procedure needlessly. This check helps reduce that agony. ISC recommends the user become familiar with the millivolt readings of the 3 oxygen sensors at various PO2s (in air, calibration gas, and at depth) to familiarize the healthy outputs of the sensors for later real-time analysis during a dive of the health of a suspected bad sensor. Becoming familiar with the normal voltage readings of each sensor at the normal setpoint used will assist in analyzing sensor behavior and add another tool for potential problem analysis during a dive, should the need arise, and during sensor calibration.
- Altitude zone selections. This addition has been revisited to refine our approach to high altitude diving. The altitude submenu section of the sensor

calibration has been enhanced to provide a High PO2 limit. ISC has implemented an ambient air PO2 for the low point calibration along with the Maximum O2 PO2 for the high point. The oxygen quality percentage is used to adjust the new high point PO2 to properly represent the calibration maximum oxygen PO2 for the selected altitude zone. This adjusted high point is displayed on the altitude menu during calibration and changes with each altitude zone selection. APECS v 2.00 had an altitude zone feature added to attempt to fill the needs of the high altitude divers. Altitude Zone selections during sensor calibration of both the primary and secondary subsystems are documented as follows:

- Enter calibrate menu within two minutes of power on.
- Answer **CONFIRM** to "**ARE YOU SURE?**" and "**ARE YOU REALLY SURE?**".
- **CALIBRATE ALTITUDE** submenu is displayed.
- Initial display shows "Current PO2 = .21. This is the current setting as last calibrated. Prompt line initially asks > 000 FT and shows = .21 .98
  The .21 is the low point PO2 at 0 feet (sea level) and the .98 assumes 99% O2 quality and PO2 at the midpoint in the altitude zone to be .99. Multiplying the two, .99 x .99 = .98 (2 decimal place with truncation). The high PO2 is always multiplied by the currently set oxygen percentage to calculate the HiPO2 to store for this calibration, if this setting is selected.
- The **MENU** button becomes **SELECT** in this submenu. Select increments to the next altitude zone and the midpoint in the zone represents the **HiPO2** result as just described.
- Example, 99%O2, altitude is 6,500 feet. LoPO2=0.16, HiPO2=0.76 (.77x.99).
- The following table illustrates the permissible altitude zones.

Altitude Zone in FEET (Meters)	Midpoint Altitude in FEET	LoPO2 at 100% Oxygen	HiPO2 at 100% Oxygen
> 0 (0)	250	0.21	0.99
> 500 (150)	1,000	0.20	0.96
> 1,500 (450)	2,250	0.19	0.92
> 3,000 (900)	3,750	0.18	0.87
> 4,500 (1,350)	5,250	0.17	0.82
> 6,000 (1,800)	7,000	0.16	0.77
> 8,000 (2,400)	8,750	0.15	0.72
> 9,500 (2,850)	10,500	0.14	0.67
> 11,500 (3,450)	12,000	0.13	0.64
> 13,500 (4,050)	14,750	0.12	0.57

- Selecting the **CONFIRM** button at this point locks in the selected altitude zone for this calibration, then resumes the rest of the calibration cycle. (See the APECS v2.00 Operational Instructions for further details).

The HiPO2 is selected from the midpoint between the upper and lower altitudes of the zone that is closest to a whole 2 decimal point oxygen percentage. The purpose of the midpoint is to provide a safe PO2 for calculating any of the sensor PO2s at a reasonable level of accuracy during any point of the dive.

Once calibrated, the breathing mix PO2s should properly display regardless of current altitude.

The following table provides the numeric data used in establishing the midpoint PO2 values.

Elevation (ft)	Pressure (psia)	Atmosphere	PO2 at Altitude FO2=100
0	14.70	1.000	1.000
250	14.57	0.991	0.991
500	14.44	0.982	0.982
1000	14.18	0.964	0.964
1500	13.92	0.947	0.947
2250	13.54	0.921	0.921
3000	13.17	0.896	0.896
3750	12.81	0.872	0.872
4500	12.46	0.848	0.848
5250	12.12	0.824	0.824
6000	11.78	0.801	0.801
7000	11.34	0.772	0.772
8000	10.92	0.743	0.743
8750	10.61	0.722	0.722
9500	10.31	0.701	0.701
10500	9.91	0.674	0.674
11500	9.53	0.649	0.649
12000	9.35	0.636	0.636
13500	8.81	0.599	0.599
14500	8.46	0.576	0.576

- Effective with version 2.01j, the following changes/additions were made
    - Changed oxygen injection selections to accommodate the new Jaksa CE rated injection solenoid. Old selections: 0.25, 0.50, & 1.00 seconds. New selections: 0.75, 1.50, & 2.50 seconds. This accommodates the smaller orifice in the solenoid resulting in longer injection times needed.
    - Voting logic tolerances have changed. Prior to 2.01j a sensor is voted out if it is greater than 0.05 ata pO2 away from the other two sensors. This was changed to 0.10 ata pO2 to reduce the sensitivity of the voting logic. Previous settings would frequently vote out a sensor if it was faster or slower than the other sensors in catching up with the pO2 changes.
    - Voting Logic re-vote timing was changed from 2 minutes to 5 seconds. Instead of waiting for 2 minutes after voting a sensor out to recheck the state of the sensor for consideration of returning it to service, the software now waits 5 seconds to re-vote or recheck.
    - Hardware change from the Snap-Tite Wattmiser solenoid to the Jaksa solenoid was made to provide a more corrosion resistant as well as CE rated solenoid. Characteristics of the Jaksa solenoid:
        - CE approved
        - Body made of 316 stainless steel
        - Precleaned for oxygen service
        - Supply pressure range of 120-150 PSI over ambient
        - Orifice size 0.0195”
    - First load voltage measurement on the primary now occurs at the end of the 3rd test injection in the power-up diagnostics instead of waiting for the first normal injection.

Megalodon Water Trap Modification.
Effective 19 June 2005 all Megalodon units delivered shall include the modified water trap. The following describes this modification:

Some units coming in to us for repairs and/or upgrades have shown that users are not properly maintaining their water trap on the sensor carriage. Some are closed off by the exhaust tube pressed in fully, thus closing off the water trap. Some have shown that a lot of crud has hardened on the water trap flapper valve thus causing a leaky valve. Pressing the tube in fully then backing it out by 1/16” before performing the inhale and exhale test through the water trap would show a very low pressure leak while lightly blowing in to the water trap tube. Some of the crud deposits have been traced back to dusty CO2 absorbent that has gotten

moist and settled down. Some scrubber materials are real dusty, if not pre-filtered before loading into the scrubber cylinder, the dust remains in the scrubber. This dust also can make it through the screens and into the rest of the breathing loop. The effect on the system is with the water trap leak. The water trap may allow small amounts of CO2 from the exhaled gas to leak into the inhale side of the loop. Our fix for this is all new Megs are being delivered with a gasket in lieu of the water trap valve. Units coming in for servicing and upgrades receive this water trap upgrade. In time, we hope to send out an upgrade kit to all known users of the Meg. If the user is properly trained on the water trap maintenance and follows the pre-dive checklist, the problem is minimized or eliminated. In the future, the remaining valve hole in the water trap cap may be used for another option.

We feel this is a precautionary measure for upgrading the water trap and the trapped moisture should not be a problem for normal, nor extreme, dive activities. For continued use of the water trap, we ask all MEG divers to properly test and service the water trap each time the MEG is assembled during the pre-dive check.

SUMMARY:

The bulk of these new features have been aimed at aiding the **high altitude** diver with the intent of providing a more accurate PO2 display and O2 injection representing the altitude at which the dive is to commence. The **additional** feature of **selecting oxygen quality** helps those traveling divers with the ability to calibrate with an increased accurate HighPO2 level, rather than assuming a 98% oxygen quality. HUD and solenoid diagnostics have been added at startup along with on-demand HUD testing. Descriptions of changes to the voting logic, the power-on diagnostics, the water trap modification, and the new oxygen injection solenoid have been included.

This addendum replaces the APECS Operational Instructions v2.01 addendum to v2_00.

In closing, user suggestions for corrections and enhancements of this manual are encouraged. If you have any contributions to better improve this document, feel free to contact us.

REVISION INDEX

Date	Revision	CHANGES
28 APRIL 2005	New	
15 November 2005	1	Added description of the new CE rated oxygen solenoid, changes to voting logic tolerance, and description of the water trap modification.