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WQAU-P/MULTIPARAMETER SENSOR  
DRAFT TEST PLAN  
(CDRL A012)

Contract: DAAK70-86-C-0106

Unclassified

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1. TEST PURPOSE/OBJECTIVE

The objective of this test program is to quantitatively determine the Phase III WQAU-P's ability to measure temperature, pH, total dissolved solids (TDS), turbidity and residual chlorine of water, and temperature of air. The parametric goals (measuring range, accuracy and operating range) are detailed in Table 1. (KR) ←

Table 1. WQAU-P Performance Specifications

Parameter	Measuring Range	Accuracy	Operating Range
Temperature (fluid)	32°-120°F	±2°F	NA
pH	2-12 pH units	.5 pH units	32°-120°F
TDS	0-500 mg/l 500-5,000 mg/l 5,000-50,000 mg/l	±25 mg/l ±250 mg/l ±2,500 mg/l	32°-120°F
Turbidity	0-50 NTU 50-150 NTU	±5 NTU ±10 NTU	32°-120°F
Residual Chlorine	0-15 mg/l	±1 mg/l	32°-120°F pH <9.0
Temperature	0°-160°F	±2°F	NA

## 2. LEVEL OF ASSEMBLY

Testing will be conducted utilizing the completed WQAU-P assembly. There will be no testing on a subassembly level.

### 3. TEST EQUIPMENT/SUPPLIES

Table 2 details the test equipment/supplies that will be required for conducting the proposed test program.

Table 2. WQAU-P Test Equipment/Supplies

Equipment/Supply	Purpose
Constant Temperature Baths (four)	Stabilize temperature of test fluids
pH Buffers (2, 7 and 12)	Test fluids for pH evaluation
Sodium Chloride (lab grade)	NaCl dissolved in deionized/demineralized water forms the TDS test fluids
Formazin Standard (4,000 NTU)	Formazin Std diluted with deionized/demineralized water forms the turbidity test fluids
Colloidal Suspension of Ultra Fine Bentonite	A clay turbidity standard may be required if the low temperature requirements of 32°F adversely affects the Formazin Standard
Clorox Bleach	Raw source for chlorine
DPD-50 Test Kit	Determines residual chlorine concentration to 0.2 mg/l
Thermometer (NBS certified)	Validate water and air temperature

Table 3. Parametric Test Matrix

Parameter	Measurement Level	Fluid Operating Range	Measurements	Measurements Per Sample	Total Measurements
pH	2, 7, 12 pH units	32°F, 75°F, 100°F, 120°F	12	10	120
TDS	50, 100, 500, 1500, 3000, 30,000 50,000 mg/l	32°F, 75°F, 100°F, 120°F	28	10	280
Turbidity	3, 10, 50, 100, 150 NTU	32°F, 75°F, 100°F, 120°F	20	10	200
Residual Chlorine	1, 7, 15	32°F, 75°F, 100°F, 120°F and 4, 6.5, 8.5 pH units	36	10	360
Temperature (Air)	10°F, 20°F, 140°F, 150°F, 160°F	N/A	5	10	50

#### 4. TEST MATRIX

Table 3 details the test matrix that will be followed when collecting process data on the Phase III WQAU-Ps. This table lists the measurement levels, fluid operating ranges (temperature and pH), number of measurements, number of measurements per sample and number of total measurements for each WQAU-P parameter.

## 5. TEST DATA SHEET

A sample test data sheet is illustrated in Figure 1. Individualized data sheets will be used for each monitored parameter and for each WQAU-P tested. Multiple data sheets can be used when one sheet is insufficient. Data sheet number and total number of sheets should be entered on each form.

The column on the left is used to enter the value of the standard that will be monitored. The next column is used to record the fluid temperature as measured by both the WQAU-P and the certified thermometer (actual). The third column is used to record the fluid's pH. This column will only be used during residual chlorine measurements. The remaining 10 columns are used for recording the 10 individual measurements of the monitored standard.



## 6. TEST PROCEDURES

The following test procedures describe how each of the WQAU-P parameters will be tested/monitored.

### 6.1 General

For any given parameter a sufficient quantity of appropriate test standards will be prepared and divided into four test containers (fluid chambers). Each test container is then placed in one of the four constant temperature baths (32°F, 75°F, 100°F and 120°F). The pH evaluation, for example, would have three standards (pH of 2, 7 and 12) in each of the four constant temperature baths. The pH of each standard is then measured at a single temperature. When the 30 readings (10 each for each pH standard) at a single temperature is completed, testing continues at the next temperature level. This cycle continues until all standards have been measured at each of the four temperatures. For pH this would result in a total of 120 measurements per WQAU-P. A sample WQAU-P Test Data Sheet for pH is illustrated in Figure 2. This is the general test sequence that will be used for all WQAU-P parameters except residual chlorine and air temperature.

Prior to collecting parametric data with the WQAU-P, a field calibration sequence must be performed on the pertinent WQAU-P parameters. These field calibration procedures will follow the field calibration procedures described in the Phase II WQAU-P Operation/Maintenance Manual (Contract DAAK70-85-C-0022). Table 4 details which parameters must be field calibrated before obtaining a specific parametric measurement.

WQAU-P TEST DATA SHEET

Monitored Parameter pH WQAU-P Unit 001  
 Sheet 1 of 1

Value of Standard	Temperature of Standard (WQAU-P/ Actual)	pH of Standard*	Measurement									
			1	2	3	4	5	6	7	8	9	10
2	32.4 / 32°F	-	2.1	2.2	1.9	etc...	...	...	...	...	...	...
7	32.6 / 32	-										
12	32.2 / 32	-										
	/											
2	75.0 / 75°F	-										
7	75.2 / 75	-										
12	75.1 / 75	-										
	/											
2	100.1 / 100°F	-										
7	100.4 / 100	-										
12	101.0 / 100	-										
	/											
2	119.3 / 120°F											
7	117.4 / 120											
12	117.9 / 120	-						...	...	...	...	12.1 12.2
	/											
	/											
	/											
	/											
	/											

\* ONLY USED FOR RESIDUAL CHLORINE MEASUREMENTS

Figure 2. Completed WQAU-P Test Data Sheet for pH

Table 4. Parametric Field Calibration Requirements

Monitored Parameter	Parameter(s) Requiring Field Calibration
Temperature (fluid and air)	None
TDS	TDS
pH	pH
Turbidity	Turbidity
Residual Chlorine	Residual Chlorine and pH

To obtain a parametric measurement with the WQAU-P, the user must press the "Press to Read" button. Since some sensors take time to stabilize (reach thermal equilibrium), the user should alternately press and release the "Press to Read" button until the WQAU-P reading (digital display) has stabilized at a fairly constant value. For example, if a room temperature (70°F) thermistor is immersed in cold water (40°F), the first few readings displayed by the WQAU-P (one reading each time the "Press to Read" button is pressed) should steadily decrease. The true temperature is reached when successive readings remain constant.

Specific procedures for each parameter are discussed in the following subsections.

#### 6.2 Temperature (Fluid)

The temperature of each fluid standard will be measured using both the WQAU-P and the certified thermometer prior to obtaining the 10 parametric measurements. Both of the measured fluid temperatures are documented in the temperature column of the Test Data Sheet.

### 6.3 TDS

TDS measurements will be obtained using fluid standards that have been prepared by dissolving laboratory grade NaCl in deionized/demineralized water. For each condition (salt concentration and temperature) the temperature of the standard must be measured with the WQAU-P prior to obtaining TDS readings. The multiparameter sensor should be flushed and dried prior to changing standards.

### 6.4 pH

Certified pH buffers will be used as standards during this phase of the test program. For each condition (pH value and temperature) the temperature of the standard must be measured with the WQAU-P prior to obtaining pH readings. The multiparameter sensor should be flushed in deionized/demineralized water prior to changing standards.

### 6.5 Turbidity

Turbidity measurements will be obtained using either Formazin or a colloidal suspension of ultrafine bentonitic clay as the turbidity standard. The NTU value of the turbidity standards will be verified using a recently calibrated HF Instruments (Model DRT-100D) laboratory turbidity monitor. Verification of an individual turbidity standard will be performed before a sequence (row) of measurements is initiated and after the sequence (row) of measurements is completed. The multiparameter sensor will be flushed with deionized/demineralized water and dried prior to changing standards.

### 6.6 Residual Chlorine

Residual chlorine will be the most difficult parameter to quantitatively evaluate, especially at the higher temperatures

of 100°F and 120°F. A chlorinated water liberates chlorine to the atmosphere. This rate of liberation increases with increasing water temperature. To account for this change in chlorine concentration, the chlorine concentration of the standard must be checked immediately before beginning and immediately after completing a sequence of measurements (one row - 10 measurements).

Determination of the chlorine standard's chlorine concentration will be achieved using a DPD-50 Residual Chlorine Test Kit. A DPD buffer/indicator is used to give the chlorinated water a rose-colored appearance. A RAF titrant is used to neutralize the color. Each drop of titrant is equivalent to 0.2 mg/l.

For each condition (chlorine concentration, pH and temperature), the pH and temperature of the chlorine standard must be measured by the WQAU-P prior to obtaining a chlorine measurement.

The WQAU-P chlorine sensor reacts with chlorine during the measurement process. This reaction results in the depletion of chlorine (i.e., drop in chlorine concentration). Due to this reaction, a sufficiently large volume of standard must be utilized to minimize changes in the chlorine concentration. Because of this volume requirement and the previously discussed chlorine liberation problem, only one sample can be analyzed at a given temperature. Multiple standards at a single temperature (procedure used for pH, TDS and turbidity) cannot be used for monitoring residual chlorine. This single parameter could utilize up to 50 percent of the allotted test plan hours.

6.7 Temperature (Air)

Extreme air temperature measurements will be made using a dry ice chamber for 10° and 20°F, and a drying oven for 140°, 150° and 160°F.

## 7. ACCEPTANCE CRITERIA

The accuracy requirements for each parameter are detailed in Table 5.

Table 5. WQAU-P Accuracy Requirements

Parameter	Range	Accuracy
Temperature (fluid)	32°-120°F	±2.0°F
TDS	0-500 mg/l 500-5,000 mg/l 5,000-50,000 mg/l	±25 mg/l ±250 mg/l ±2,500 mg/l
pH	2-12 pH units	±0.5 pH units
Turbidity	0-50 NTU 50-150	±5 NTU ±10 NTU
Residual Chlorine	0-15 mg/l	±1.0 mg/l
Temperature (air)	0°-160°F	±2.0°F

WQAU-Ps will be considered acceptable when a minimum of 95 percent of the parametric readings fall within the accuracy specifications listed in Table 5.

## 8. TEST PLAN SCHEDULE

The test plan schedule is detailed in Figure 3.

		MONTH OF MARCH																		
TEST PARAMETER		M	T	W	T	F		M	T	W	T	F		M	T	W	T	F		
PH																				
TDS																				
TURBIDITY																				
TEMPERATURE (AIR)																				
RESIDUAL CHLORINE																				

Figure 3. WQAU-P Test Plan Schedule