OPERATION AND MAINTENANCE MANUAL

LABORATORY SALINOMETER

MODEL 6220

HYTECH MARINE PRODUCTS
SAN DIEGO, CALIFORNIA

ERRATA NOTE NO. 1

Date: 19 September 1967
Sheet 1 of 2

MANUAL: 6220 Salinometer

PURPOSE: Incorporate Engineering Changes

Page	Change
ii	Delete line "4-3 - Sample Cell Chemical Cleaning - 4-1"
3-8	Update Figure 3-1 per corrected log sheet shown in attachment A
4-1	Delete paragraph 4-3 and 4-4 down to but not including CAUTION.
4-1	Change paragraph 4-6 to read "To lessen the possibility of damage, the cell should be removed and cleaned only when obviously dirty. To remove and clean, proceed as follow: etc"
4-3	Paragraph 4-6 (step b) - Delete "or non-ionic mild detergent"
4-5	Paragraph 4-9 - change caution to read "When packing thermometer, care should be taken not to bend probe."
4-5	Paragraph 4-9 (step b) - change to read "b) The platinum thermometer must be sealed into the cap. This is accomplished with self-leveling RTV-118, General Electric.
4-5	Paragraph 4-9 (step c) - Add to last line "Seal with self-leveling RTV."
6-1/6-2	Paragraph 6-4 (Fourth line) - Change to read "ous Electronic Components (Rear Panel)." Delete "and Overflow Circuit Components."
<u>UNESCO Tables</u> Page 79	Change to answer of computation (line 11) to read "From table Ia, salinity S= 29.763‰" Also change answer for corresponding language translations
UNESCO Tables Page 111	Change answer of computation (line 11) to read "From table IIa, salinity = 29.763‰" Also change answer for corresponding language translations.

Page No. ________, Date ______________, Station No. ___________, Operators Name ______________________.
Inductive Salinometer ______________________, Room Temp. ___________ C.,
Conductivity Ratio for Copenhagen Standard Sea Water ______________________, Salinity ______________,
Conductivity Ratio for Carboy Sub Standard Sea Water ______________________, Salinity ______________,

SAMPLE BOTTLE NUMBER	SAMPLE TEMP. DIAL READING	STANDARDIZATION / REMARKS	CONDUCTIVITY RATIO: BRIDGE READING	CONDUCTIVITY RATIO: AVERAGE BRIDGE READING	UNCORRECTED SALINITY S ‰	APPLIED TO UNCORRECTED SALINITY: TEMP. CORR.	APPLIED TO UNCORRECTED SALINITY: DRIFT CORR.		CORRECTED SALINITY S ‰
P-36	23.0	4903	1.00005	STANDARDIZATION	VALUE				
		4900							
		4900							
		4900	1.00005		35.002	0	0.000		35.002
250	22.7		.99915	.99917	34.968	0	0.000		34.968
			.99919						
251	22.5		.99933	.99934	34.974	0	0.001		34.973
		BUBBLES	———						
			.99934						
254	22.0		.99835	.99834	34.935	0	0.001		34.934
			.99834						
257	22.3		.99602	.99602	34.844	0	0.002		34.842
			.99602						
258	22.8		.99527	.99530	34.816	0	0.002		34.814
			.99532						
P-36	23.1		1.00009	1.00010	35.004	0	-0.002		35.002
			1.00010						
			1.00010						
			1.00010						
275	22.5		1.00400	1.00402	35.158	0	-0.002		35.156
		BUBBLES	1.00513						
			1.00404						
276	21.8		1.00077	1.00076	35.030	0	-0.002		35.028
			1.00074						
277	22.0		.99995	.99993	34.997	0	-0.002		34.995
			.99991						
282	22.4		.99007	.99008	34.611	0	-0.002		34.609
			.99008						
283	23.8		.98644	.98644	34.469	-.001	-.003		34.465
			.98644						
22	SAMPLES	RUN;	DATA	NOT SHOWN					
285	23.9		.97988	.97986	34.210	-.001	-0.005		34.208
			.97984						
286	24.0		.97642	.97641	34.074	-.001	-0.005		34.068
			.97640						
P-36	23.2		1.00018	1.00020	35.007	0	-0.005		35.002
			1.00020						
			1.00020						
			1.00020						

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Figure 3-1. Specimen Salinity Log Sheet

ACKNOWLEDGEMENT

Tables Ia through IIb printed in this manual are reproduced through the kind permission of the UNESCO Office of Oceanography and the late Dr. Roland A. Cox (National Institute of Oceanography, England).

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Figure 1-1. Model 6220 Laboratory Salinometer

CHAPTER 1
GENERAL DESCRIPTION

1-1. GENERAL

1-2. The Bissett-Berman Corporation Model 6220 Portable Laboratory Salinometer (Figure 1-1) is a precision instrument for measuring the salinity of sea water samples. The Model 6220 is a conductivity-type measuring device which utilizes an inductively-coupled conductivity sensor to establish a conductivity ratio between an unknown sample and a standard at approximately 35 ppt salinity. Actual salinity is then easily and quickly determined by reference to the tables at the rear of this handbook. A dual-element platinum thermometer and associated circuitry senses the temperature of the sample and applies appropriate compensation. For temperature differences up to ±3°C between the sample and the standard, compensation is fully automatic over the range 0° to 40°C.

1-3. Physical Characteristics. (Figures 1-1 and 1-2). The salinometer is completely contained in a molded fiberglass case which has a carrying handle at the top and feet at the bottom. The front of the case is removed when operating the instrument. All operating controls are conveniently located on the front panel. The instrument is equipped with two motors: a pump drive that provides a vacuum for filling the sample cell, and a stirrer which agitates the sample to maintain temperature uniformity during measurements. Overflow from the sample cell during filling is drained into a water trap. A switch at the rear of the instrument selects either 115 or 230 vac line power.

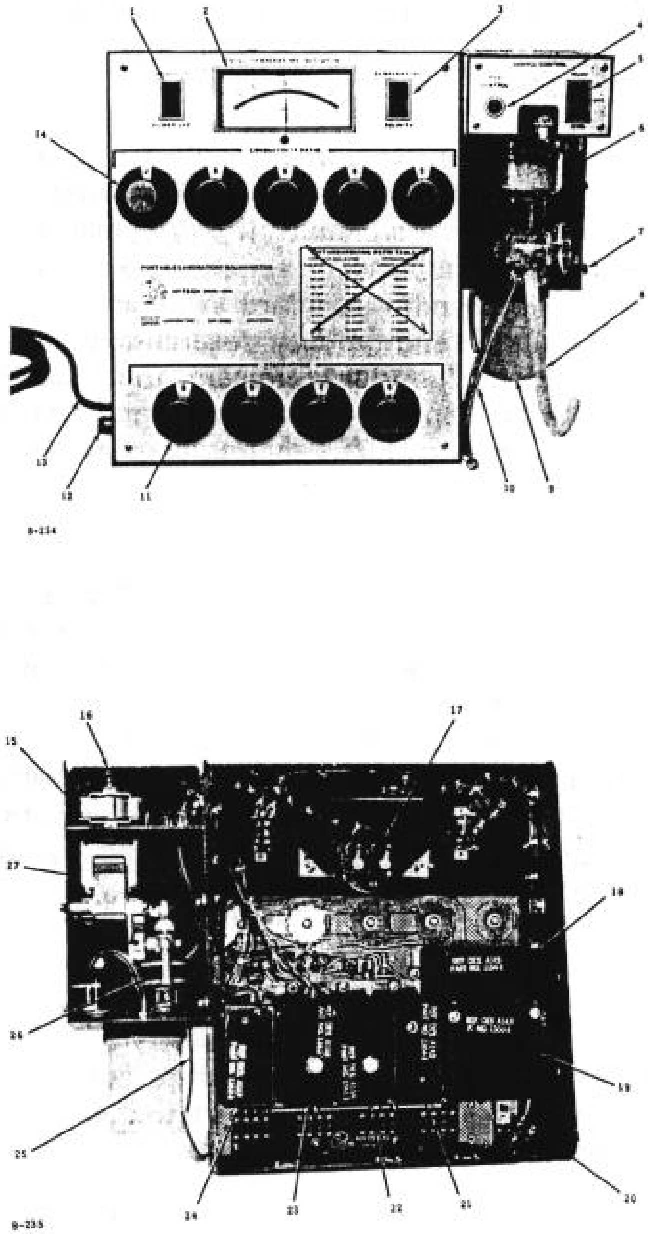
NOTE

> The line-power switch is ordinarily a factory adjustment which is set to customer requirements when the instrument is ordered.

1-4. Sample Cell. The sample cell (Figure 1-2) is formed of molded lexan. It is fitted with a stopcock that has three positions: fill, drain, or closed. Contained within the sample cell are a toroidal transformer that forms an inductive coupling with the sea water, a platinum resistance thermometer, a thermistor, and the stirrer. Plastic hoses lead from the cell to the sample bottle and to the overflow jar.

1-5. Overflow Water Trap. The overflow water trap (Figure 1-2) is a reservoir which catches surplus water from the sample cell. The trap has screw threads at the top and is easily removed for emptying.

1-6. Vacuum Pump. Filling the sample cell is accomplished by a vacuum pump located at the rear of the instrument (Figure 1-2). During sample cell



1. AC Power Switch
2. Null/Temperature Indicator
3. Temperature/Salinity Switch
4. Fill Control
5. Pump/Off/Stir Switch
6. Sample Cell
7. Vacuum Control
8. Fill Tube
9. Overflow Jar
10. Drain Tube
11. Standardize Dials
12. AC Power Fuse
13. AC Power Cord
14. Conductivity Ratio Dials
15. Stirrer Motor
16. Stirrer Drive Belt
17. Null/Temperature Indicator
18. Ratio Transformer Module (A1A5)
19. Power Supply Module (A1A3)
20. 115/230 Line Power Switch
21. Oscillator Module (A1A2)
22. Summation Amplifier Module (A1A4)
23. Detector Amplifier Module (A1A6)
24. Temperature Compensation Module(A1A7)
25. Overflow Tube
26. Pump
27. Pump Drive Motor

Figure 1-2. Front and Rear Views of Instrument With Cover Removed filling, the operator places a finger over the FILL CONTROL opening on the front panel, above the sample cell. A vacuum control needle valve (Figure 1-2) located near the overflow water trap is adjustable to regulate the vacuum. This allows precise control over filling. A three-position switch located on the front of the instrument actuates the pump in the PUMP position, and the stirrer (Paragraph 1-7) in the STIR position.

1-7. Stirrer. A motor-driven stirrer in the sample cell agitates the sea water being measured to assure that the temperature throughout the sample remains uniform. The stirrer is actuated by the PUMP-OFF-STIR switch.

1-8. OPERATING CONTROLS

1-9. All operating controls for the instrument are located on the front panel (Figures 1-1 and 1-2). They consist of a POWER ON - POWER OFF switch, a TEMPERATURE-SALINITY switch, a NULL/TEMPERATURE INDICATOR meter, CONDUCTIVITY RATIO dials, STANDARDIZE dials, a FILL CONTROL, and a PUMP-OFF-STIR switch. These are described in detail in the following paragraphs.

1-10. POWER ON - POWER OFF Switch. This two-position switch applies line power to the instrument. A lamp in the switch illuminates when power is on.

1-11. TEMPERATURE-SALINITY Switch. This is a two-position switch, normally in the SALINITY position, which is a spring-loaded momentary switch in the TEMPERATURE position. In the SALINITY position, the circuitry of the instrument is applied to salinity measurements. In the momentary TEMPERATURE position, the temperature of the sample is shown on the NULL/TEMPERATURE INDICATOR.

1-12. NULL/TEMPERATURE INDICATOR Meter. This is a dual-purpose meter that indicates the null condition when establishing conductivity ratios of samples during salinity measurements, and displays temperature (°C) during temperature measurements. The readout obtained at the meter is dependent on the position of the TEMPERATURE-SALINITY switch (Paragraph 1-11). This meter has a slotted zero-adjust.

1-13. CONDUCTIVITY RATIO Dials. The CONDUCTIVITY RATIO dials (Figure 1-2), when adjusted to null the NULL/TEMPERATURE INDICATOR, give a direct reading of the ratio of the conductivity of the unknown sample to that of the standard sea water used to standardize the instrument. These dials are initially set by comparing the indicated chlorinity of a sample of Copenhagen Standard Sea Water with the STANDARDIZING RATIO TABLE on the front of the instrument, and determining the conductivity ratio. With an unknown sample in the instrument, these dials are adjusted until the meter nulls. The dial readings obtained are converted to salinity units of measure by reference to the tables at the rear of this handbook.

1-14. STANDARDIZE Dials. The STANDARDIZE dials are used during initial standardization of the instrument when establishing the precise conductivity ratio of a standard sea water sample. After setting the CONDUCTIVITY RATIO dials as described in Paragraph 1-13, the STANDARDIZE dials are set to precisely null the NULL/TEMPERATURE INDICATOR. Thereafter, the setting is not changed, except for each new "salinity run."

1-15. FILL CONTROL. The FILL CONTROL is a small opening that controls the vacuum to the sample cell. During all filling, the FILL CONTROL is sealed with the finger. An adjustable needle valve (Figure 1-2) provides control over filling rate.

1-16. PUMP-OFF-STIR Switch. The three-position PUMP-OFF-STIR switch controls both the vacuum pump and the stirrer. In the PUMP position, the vacuum pump operates to fill the sample cell. In the OFF position, the motors are inoperative. In the STIR position, the stirrer is actuated to maintain a uniform temperature in the water sample while measurements are being made.

1-17. SPECIFICATIONS

1-18. Specifications for the salinometer are provided in Table 1-1.

Table 1-1. Specifications

SALINITY MEASUREMENT	
Range	0 to 51 ppt
Least Count	0.0004 ppt
Accuracy	±0.003 ppt
Temperature Compensation	±0.002 ppt for variation of ±3°C between sample and standard
TEMPERATURE MEASUREMENT	
Range	0°C to 40°C
Accuracy	±0.5°C
GENERAL	
Dimensions	9 x 15 x 20 inches
Sample Cell Capacity	50 cc
Weight	36 lbs.
Power Required	115 or 230 vac, 50-60 cps, 1 ph

CHAPTER 2
INSTALLATION

2-1. UNPACKING

2-2. When the instrument is received, the packing case should be examined for evidence of rough handling. Although the salinometer is ruggedly built to withstand shock, it should be examined for damage. If damage is seen, notify carrier. There is no packing material within the instrument.

2-3. INSTALLATION

2-4. The salinometer should be set up on a work table or other suitable surface with drain facilities close by. If a sink is not available, a bucket or large bottle resting on the floor can be used. The instrument may be permanently secured to a desk or other work surface by removing the screws which attach the rubber feet and installing bolts in the tapped holes from the underside of the table. See Figure 2-1 for mounting points. If it is desirable to attach the salinometer to a table from the top side, a secondary bar with suitable holes may be fastened to the rubber feet, and the unit secured by bolting the bar to the table. In any case, the instrument should be secured well enough to prevent damage from ship's movement and insulated from major vibrations. Remove the front of the base by opening the latches on the sides of the unit and lifting the front off. Connect the power cord to a standard source of 60 cps 115V or 230V AC power (refer to Paragraph 1-3 for line-power switch adjustment). Note that a three-wire cord (with ground plug) is used.

2-5 PRELIMINARY ADJUSTMENTS

2-6. No preliminary adjustments are required to operate the Model 6220. However, (with power off) the NULL/TEMPERATURE INDICATOR needle should be set to 20°C (centered) using the zero-adjust screw below it, before operating the instrument. In addition, (with power on) adjust the CONDUCTIVITY RATIO dials to .00010, .00020, and so forth, to observe meter sensitivity. Meter deflection should be perceptible for the smallest change, and should be reasonably linear for the first few steps of deflection (approximately 1°C deflection on NULL/TEMPERATURE INDICATOR for the initial steps, and then diminishing). The instrument is now ready to operate as described in Section 3.

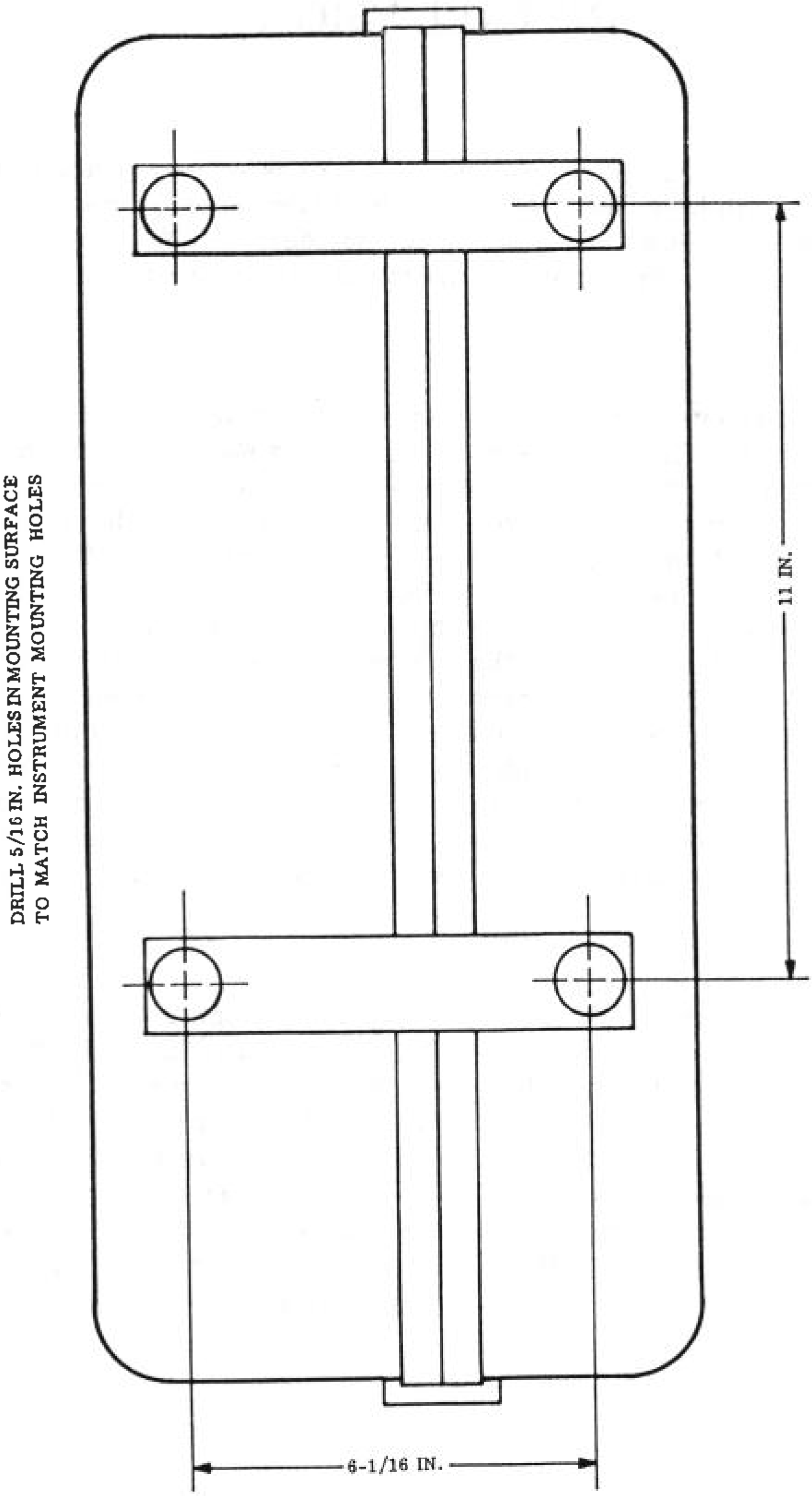


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Figure 2-1. Mounting Points

CHAPTER 3
OPERATION

3-1. GENERAL

3-2. Basic Procedures. The Model 6220 Laboratory Salinometer is quite simple to operate, and personnel completely unfamiliar with the instrument can learn to use it and make precise measurements in a short period of time. The first operational step is to standardize the instrument using Copenhagen Standard Sea Water. Standardization is necessary to allow for small drifts in precision components, small drifts in the geometry of the conductivity cell, and to compensate for physical changes due to ambient temperature conditions and aging. After standardization, the instrument will indicate a conductivity ratio of 1.00000 for sea water having a salinity of 35 ppt. However, Copenhagen Standard Sea Water does not always have a salinity of 35 ppt, so the conductivity ratio will vary from unity, depending upon the salinity of the standard.

NOTE

Standard sea water is obtained from the following source: I.A.P.O. Standard Sea Water Service, Charlottenlund Slot, Charlottenlund, Denmark.

The second step in operating the instrument after it has been standardized is to determine the conductivity ratio of the unknown sample. This is accomplished by filling the sample cell with the unknown sample and adjusting the CONDUCTIVITY RATIO dials until a null is obtained on the NULL/TEMPERATURE INDICATOR. The CONDUCTIVITY RATIO dial reading is the ratio-of-conductivity of the unknown sample to the conductivity of a standard having a salinity of exactly 35 ppt. This conductivity ratio is used in conjunction with the tables at the rear of the handbook to arrive at the salinity of the unknown sample.

3-3. Ambient Temperature Conditions. During the process of making salinity measurements, the standard sea water, the unknown samples, the instruments, and the room in which measurements are performed should be at a temperature of within ±3°C of each other. This is best accomplished by storing the samples and instrument in the room where measurements are to be made. Larger differences in temperature can be tolerated if lower accuracies are acceptable.

3-4. SAMPLE CELL FILLING PROCEDURE

3-5. General. Inasmuch as the purpose of the instrument is to perform highly precise measurements of sea water to determine its salinity, it is important that the sample being measured in the sample cell is truly representative of the unknown specimen. For this reason, the cell must be clean, free from bubbles, and uncontaminated by previous samples. Paragraphs 3-6 through 3-11 describe the use of filling controls and recommended filling and rinsing procedures.

3-6. Use of Filling Controls. The filling controls are comprised of the FILL CONTROL opening on the front panel, the vacuum control needle valve behind the sample cell, the sample cell stopcock, and the various tubes used for filling and draining.

3-7. FILL CONTROL Opening. The FILL CONTROL is a small air inlet that taps into the suction line between the sample cell and the overflow trap to preclude accidental drawing of liquid into the cell, by normally relieving pump suction. The opening is closed with operator's finger to fill the cell.

3-8. Vacuum Control Needle Valve. The vacuum control needle valve, which is located adjacent to the sample cell, controls the amount of suction to the sample cell and, consequently, the vacuum at the FILL CONTROL opening. A satisfactory filling rate can be obtained by adjustment of the needle valve.

3-9. Stopcock. The stopcock is a three-position valve that is used for filling and draining the sample cell. The stopcock has two ports through which liquid flows, and is placed in a mid-position between the ports for retaining the sample.

3-10. Tubes. The plumbing in the instrument is comprised of tubing for air suction and for sample draining and filling. The two tubes attached to the stopcock are for sample cell draining and filling. Air suction and overflow drainage are provided by the tube connecting the overflow jar to the sample cell and fill control opening. The other hose from the overflow jar connects to the needle valve which is in series with the vacuum line. From the needle valve, a hose returns to the pump. If the overflow jar is not emptied when full, excess fluid flows from the pump through a hose that hangs loose beside the overflow jar.

3-11. Rinsing. In order to assure that the sea water in the sample cell is representative of the collected sample being measured, all residual traces of the previous sample tested must be removed from the cell. This is accomplished by rinsing the cell with a sample of the specimen to be measured.

The sample, at the temperature at which measurements will be made, should be introduced into the cell and drained at least twice.

NOTE

When samples being measured are very close in salinity (±1 ppt), one rinse per reading is sufficient. This is because the sample cell, when drained, only retains approximately one percent of the previous sample, so an error cannot exceed one percent of the difference between successive samples. For this reason, if the sample quantity is not sufficient to use part of it for rinsing the cell, accurate measurements can still be made with the instrument.

To rinse the sample cell, proceed as follows:

a) Turn power on.

b) Place the fill tube in the sample bottle.

c) Turn the three-way valve to the fill position. RED END UP

d) Set the PUMP-OFF-STIR switch to PUMP and place finger over the FILL CONTROL opening.

NOTE

The finger should completely close the FILL CONTROL opening. Filling rate is controlled by the needle valve. Filling too rapidly will cause bubble formation.

e) Allow complete filling of the cell as indicated by liquid starting to enter the air tube at the top of the cell. Allow some liquid to pass through the air tube to assure adequate rinsing of the stirrer. Before moving finger from air relief inlet close the three-way valve to retain the liquid in the cell.

f) Set the PUMP-OFF-STIR switch to STIR for a few seconds to thoroughly mix the rinse solution. Set the switch to OFF.

g) Turn the three-way valve to the drain position. Repeat the rinsing cycle at least two times.

NOTE

The three-way valve should be left open following each draining to assure thorough emptying of the cell and fill tube. Visually check that all liquid is drained before inserting the fill tube in a new sample.

3-12. Establishing Conductivity Ratios.

a) Note the stated chlorinity value on the Copenhagen Standard Sea Water ampoule and refer to STANDARDIZATION RATIO TABLE (STANDARDIZE AT CONDUCTIVITY RATIO column) on front panel of instrument to determine applicable CONDUCTIVITY RATIO dial settings.

b) Set CONDUCTIVITY RATIO dials to figure given in STANDARDIZE AT CONDUCTIVITY RATIO column for chlorinity of standard sample being used. Record this on the log sheet in the CONDUCTIVITY RATIO column. Refer to Paragraph 3-18 for instructions on recording data in log sheets.

c) Place stopcock in fill position (black marks aligned) and fill sample bowl from sea water ampoule. This is accomplished by breaking off one end of the ampoule and inserting it in the filler tube from the sample cell, and then holding it vertically while opening the other end of the ampoule.

d) Elevate the ampoule slightly above the sample cell to allow for a gravity fill. Close stopcock when sample cell is full and overflowing into the water trap.

NOTE

Observe that bubbles do not appear in cell during filling because they will cause erroneous readings. If bubbles are present, drain and refill. Filling bowl slowly will help preclude bubble formation. At least 15 to 20 seconds should be taken to fill cell.

e) When sample cell is filled, start stirrer.

f) Adjust the STANDARDIZE dials until the NULL INDICATOR reads zero.

g) Momentarily close SALINITY TEMPERATURE switch and read temperature of sample on null meter.

h) Record temperature reading on log sheet. The first filling represents a rinse of the cell and successive fillings may differ slightly in STANDARDIZE dial readings. For this reason the first reading should not be recorded.

i) Turn off the stirrer and drain the sample from the cell.

j) Fill the sample cell again, following the procedure of step c) On this second filling, adjust STANDARDIZE dials until meter nulls. Record this reading in the STANDARDIZATION column of the log sheet.

k) Repeat steps c) through i) two or three times more, depending on the amount of water in the ampoule. Record each of these STANDARDIZE dial readings on the log sheet. The last two successive readings recorded must be identical before the instrument can be considered standardized. Repeat steps c) through j) if necessary. After the last filling of the cell is read, turn stopcock to fill position. The sample will then drain back into the ampoule by gravity, which allows complete emptying of the filling tube.

NOTE

Do not change the STANDARDIZE dial readings once the instrument is standardized during subsequent salinity measurements of unknown samples. However, the instrument must be restandardized each 20 samples, or hourly, whichever is first.

3-13. Measuring Salinity of Unknown Sample. After the instrument has been standardized, and the standard sea water drained from the sample cell, measurements of unknown samples can be made. This is accomplished as follows:

a) Turn pump on, insert sample cell filling tube in sample bottle, and slowly fill cell as described in Paragraph 3-12, steps c) through e). Do not fill so rapidly that bubbles appear.

b) When sample cell has been rinsed and is filled with sample, start stirrer.

c) Turn off the stirrer and drain the sample from the instrument.

d) Repeat above procedure until two successive fillings (excluding the first filling-rinse) agree within 5 units of conductivity ratio (±0.00005).

e) Adjust the CONDUCTIVITY RATIO dials until the NULL/TEMPERATURE INDICATOR reads zero.

f) Momentarily close SALINITY-TEMPERATURE switch and read temperature of sample on meter.

g) Record temperature and conductivity ratio readings on log sheet. These values are used as described in Paragraph 3-18 to determine the salinity of the sample.

h) After the last filling of the cell is read, turn stopcock to fill position. The sample will then drain back into the sample bottle by gravity, allowing complete emptying of the filling tube.

i) Run 5 bottled salinity samples in this manner then run a standard water sample as an unknown. This provides a check on the initial standardization value of the instrument. If the standard water run as an unknown differs in conductivity ratio reading by more than ±0.00030 from the value of the conductivity ratio set at the time of standardization (Paragraph 3-12, step b)) the drift correction is considered excessive. Restandardization should be performed at this time.

j) Continue running additional samples. Run a standard water sample as an unknown at the completion of salinometer run. Always run a standard water sample as an unknown at least every 20 samples. If the total number of samples exceeds 30, but is less than 45, test at least one standard water sample as an unknown halfway through the run.

3-14. GENERAL COMMENTS

3-15. Slow filling is essential to prevent bubble formation, particularly on the bottom surface of the toroid assembly. If bubbles are present after the stirrer has been started, the liquid must be drained back into the sample bottle and refilled. Any bubbles in the sampled liquid will decrease the apparent conductivity and result in erroneous salinity values. (Do not drain sample back into bottle on the first rinse filling.)

3-16. The three-way valve should be left open following each draining to assure thorough emptying of the cell and fill tube. Visually check that all liquid is drained before inserting the fill tube in a new sample.

3-17. When large droplets of water cling to inside surface of cell, cleaning is required (refer to Paragraph 4-3).

CAUTION

Before closing the case or storing the equipment, be sure to remove all moisture. Drain the cell thoroughly with distilled or fresh water and empty then dry the overflow trap. Wipe all liquid from the machine surfaces. Do not store standards in the instrument case because they can break accidentally resulting in glass and water within the case.

3-18. COMPUTING SALINITY

a) Examine specimen salinity log sheets (Figure 3-1). During a run, the operator will log sample bottle number, sample temperature dial reading, standardization and remarks, and bridge reading.

b) Once the standardization value is obtained and recorded, it need not be written each time (since its value must stay the same throughout a run). Use this same column for all pertinent remarks, such as bubbles, insufficient sample for two or more runs, bottle lid broken, mud in sample, etc.

c) The average bridge reading is determined either by taking an average of all readings (two or three) or, if "remarks" column indicates a questionable value, by weighing the values accordingly.

d) Enter the Salinity Conversion Tables at rear of handbook with average bridge conductivity ratio reading to obtain the uncorrected salinity. In most cases it will be necessary to interpolate for the last figure of salinity.

e) Enter the Temperature Correction Tables at rear of handbook with temperature and conductivity ratio to obtain the first correction. Enter this value under Temperature Correction Column.

f) The drift correction is determined each time a standard is run as an unknown. This is obtained by taking the difference between the readings of the standard water (corrected for temperature) run as unknowns. The difference in salinity between the two standards is applied proportionately for the number of samples. If a standard is run every thirtieth sample, then the difference in readings would be divided by thirty and applied to each sample, rounding to the nearest thousandth of salinity as shown on attached sample salinity log sheet. The final drift correction obtained at the end of one set of drift corrections must be added to the next set of drift corrections because they are all based on the initial standardization value.

Page No. ________, Date ____________, Station No. __________, Operators Name ______________________,
Inductive Salinometer ______________, Room Temp. __________C.,
Conductivity Ratio for Copenhagen Standard Sea Water ______________________, Salinity ______________,
Conductivity Ratio for Carboy Sub Standard Sea Water ______________________, Salinity ______________,

SAMPLE BOTTLE NUMBER	SAMPLE TEMP. DIAL READING	STANDARDIZATION / REMARKS	CONDUCTIVITY RATIO: BRIDGE READING	CONDUCTIVITY RATIO: AVERAGE BRIDGE READING	UNCORRECTED SALINITY S ‰	APPLIED TO UNCORRECTED SALINITY: TEMP. CORR.	APPLIED TO UNCORRECTED SALINITY: DRIFT CORR.		CORRECTED SALINITY S ‰
P-36	23.0	4903	1.00005	STANDARDIZATION VALUE					
		4900							
		4900							
		4900	1.00005		35.002	0	0.000		35.002
250	22.7		.99915	.99917	34.968	0	0.000		34.968
			.99919						
251	22.5		.99933	.99934	34.974	0	0.001		34.974
		Bubbles	——						
			.99934						
254	22.0		.99835	.99834	34.935	0	0.001		34.935
			.99834						
257	22.3		.99602	.99602	34.844	0	0.002		34.844
			.99602						
258	22.8		.99527	.99530	34.816	0	0.002		34.816
			.99532						
P-36	23.1		1.00009	1.00010	35.004	0	-0.002		35.002
			1.00010						
			1.00010						
			1.00010						
275	22.5		1.00400	1.00402	35.159	0	-0.002		35.197
		Bubbles	1.00513						
			1.00404						
276	21.8		1.00077	1.00076	35.030	0	-0.002		35.028
			1.00074						
277	22.0		.99995	.99993	34.997	0	-0.002		34.995
			.99991						
282	22.4		.99007	.99008	34.611	0	·0.002		34.609
			.99008						
283	23.8		.98644	.98644	34.469	-.001	-.003		34.465
			.98644						
22	Samples	Run;	Data	Not Shown					
285	23.9		.97988	.97986	34.210	-.001	-0.005		34.208
			.97984						
286	24.0		.97642	.97641	34.074	-.001	-0.005		34.068
			.97640						
P-36	23.2		1.00018	1.00020	35.007	0	-0.005		35.002
			1.00020						
			1.00020						
			1.00020						

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Figure 3-1. Specimen Salinity Log Sheet

3-19. SAMPLE DRIFT CORRECTION

3-20. Referring to specimen salinity log sheets (Figure 3-1), drift corrections are computed as follows:

a) Difference in salinity between standardization value and first standardization value and first standard sample (P-36) as an unknown (after the temperature correction is applied):

```
 35.002
-35.004
- 0.002
```

b) Number of samples:

5

c) Drift correction per sample:

$$\frac{-0.002}{5} = -0.00040$$

3-21. Add this drift to each sample salinity value in a cumulative manner, rounding off to 3 decimal places. For example, the drift correction of the standardization value is 0.000; the next value, for bottle number 250 on the log sheet, is -0.00040 which rounds to 0.000; next bottle, number 251, is -0.00080 which rounds to 0.001; then, bottle number 254 is -0.00120, which still rounds to 0.001; and so on until the end of the drift interval is reached. At this point, the last standard sample run as an unknown will have a drift correction equal to the difference between it and the initial standardization value. In this example the last correction value, rounded to 3 decimal places is -0.002. If a second or third set of corrections is required, the procedure is the same as the previous example. However, the difference between standards is now the difference between the two consecutive standard samples that were run as unknowns. For example:

a) Salinity difference of first and second standard sample (P-36) run as an unknown as shown on the specimen log sheet (after the temperature correction is applied):

```
 34.004
-34.007
- 0.003
```

b) Number of samples:

30

c) Drift correction:

$$\frac{-0.003}{30} = -.00010$$

3-22. This drift correction is added cumulatively as described in the preceding paragraph. However, the drift correction of the standard sample at the end of the last drift correction set must be carried forward as it also applies to the next set of drift corrections. This same process must be repeated if there is a third set of corrections to be made. In this second case, the drift works out to be -.00010. As the cumulative totals of -.00010, -.00020, -.00030, -.00040 and so on, are added to the uncorrected salinity, the base level of -0.002 must be also carried over from the first set of drift corrections and added to the uncorrected salinity as shown on the log sheet. At the end of the drift interval, the standard that is run as an unknown ends up with a drift correction of -0.003 plus the value of -0.002 from the base drift correction carried forward, giving a total drift correction of -0.005. At the end of the drift corrections, the final drift correction value should be equal to the difference between the true salinity of the standard water and the indicated salinity of the final standard that was run as an unknown.

3-23. Corrected Salinity. The corrected salinity is the sum of the uncorrected salinity and the two corrections (temperature and drift).

3-24. PREVENTIVE MAINTENANCE

3-25. Daily. After each day's run, fill the cell with fresh or distilled water allowing the water to run into the overflow jar. Shut stopcock and run stirrer for approximately fifteen seconds; then remove and dry the overflow jar.

3-26. Every Second Day. At least every other day, when taking stations, remove and wipe clean the stopcock and internal portion of cell where stopcock fits. Then coat both units lightly with DC-4 lubricant and reassemble.

3-27. At Completion of Stations and Prior to Storage. When all stations are completed, and prior to storage, perform steps described in Paragraphs 3-25 and 3-26.

CHAPTER 4
MAINTENANCE

4-1. GENERAL

4-2. Maintenance requirements for the Model 6220 Laboratory Salinometer are minimal and consist primarily of keeping the instrument clean and free from sea water encrustation, occasional cleaning of the sample bowl, and replacement of components that may fail during the life of the equipment. The salinometer has been carefully designed and constructed, and ordinarily should require no maintenance attention other than routine cleaning.

4-3. SAMPLE CELL CHEMICAL CLEANING

4-4. When large droplets of water cling inside the cell, cleaning is required. Do not dismantle cell for mechanical cleaning. Use the 10% Tergital (non-ionic NPX) cleaning solution provided for this purpose. Introduce this solution into the cell like a sample and turn on stirrer for about 10 minutes. Rinse the cell thoroughly with sea water. If droplets persist, repeat the operation. The occurrence of bubbles in this case is desirable due to the scouring action provided by them.

CAUTION

The following procedures are to be performed under the direction of a trained instrument technician and should not be attempted at sea except under emergency conditions.

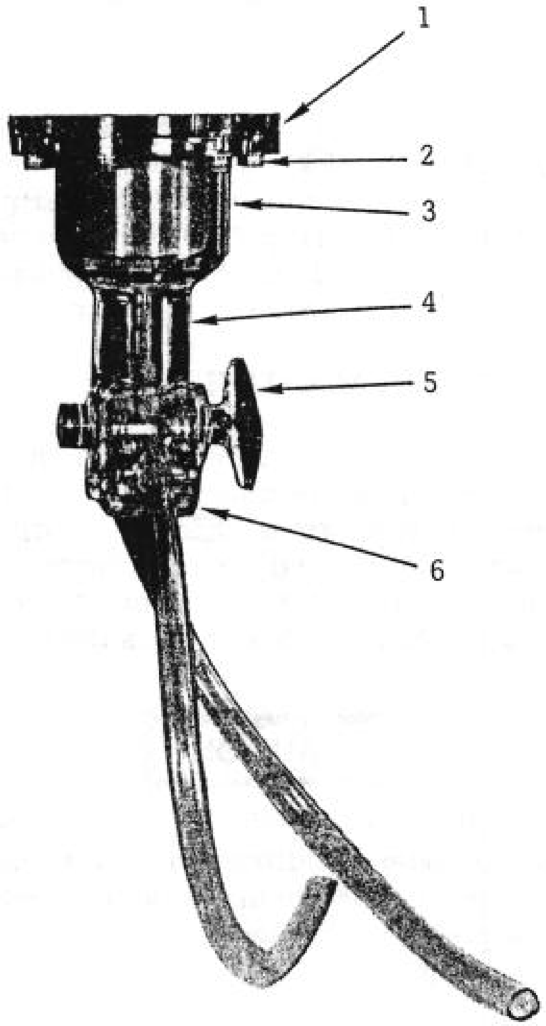
4-5. SAMPLE CELL REMOVAL AND CLEANING

4-6. To lessen the possibility of damage the cell should be removed and cleaned only when obviously dirty, and when chemical cleaning procedures listed in Paragraph 4-3 have failed to clean cell. To remove and clean, proceed as follows:

CAUTION

Exercise care to avoid damaging platinum thermometer and thermistor probe when removing or replacing sample cell.

a) Loosen six cap screws (Figure 4-1) and remove sample cell.



1. Cap
2. Cap Screw (6)
3. Cell
4. Stopper
5. Stopcock
6. Clamp

Figure 4-1. Sample Cell Details

CAUTION

Do not use acetone, tricholorethylene, toluene, or MEK for cleaning cell.

b) Wipe conductivity sensor and inner surface of cell with lint-free filter paper. If especially dirty, isopropyl alcohol or non-ionic mild detergent may be used to clean the lexan sample cell.

c) Lubricate mating surface between cell and cap with light coating of Dow-Corning DC-4 lubricant.

d) Reinstall sample cell.

4-7. REPLACEMENT OF SAMPLE CELL

4-8. Sample Cell Assembly Removal. If the sample cell is accidentally damaged or otherwise requires replacement, the cell, cap, stirrer, and stop-cock are replaced as a unit (Figure 4-2). To remove and replace this assembly, proceed as follows:

a) Disconnect electrical leads to toroid and platinum thermometer from circuit board at rear of instrument.

b) Remove sample cell as described in Paragraph 4-5.

c) Remove thermistor by removing three screws and carefully lifting it out of sample cell cap.

d) Remove nameplate from front of instrument and remove PUMP-OFF-STIR switch.

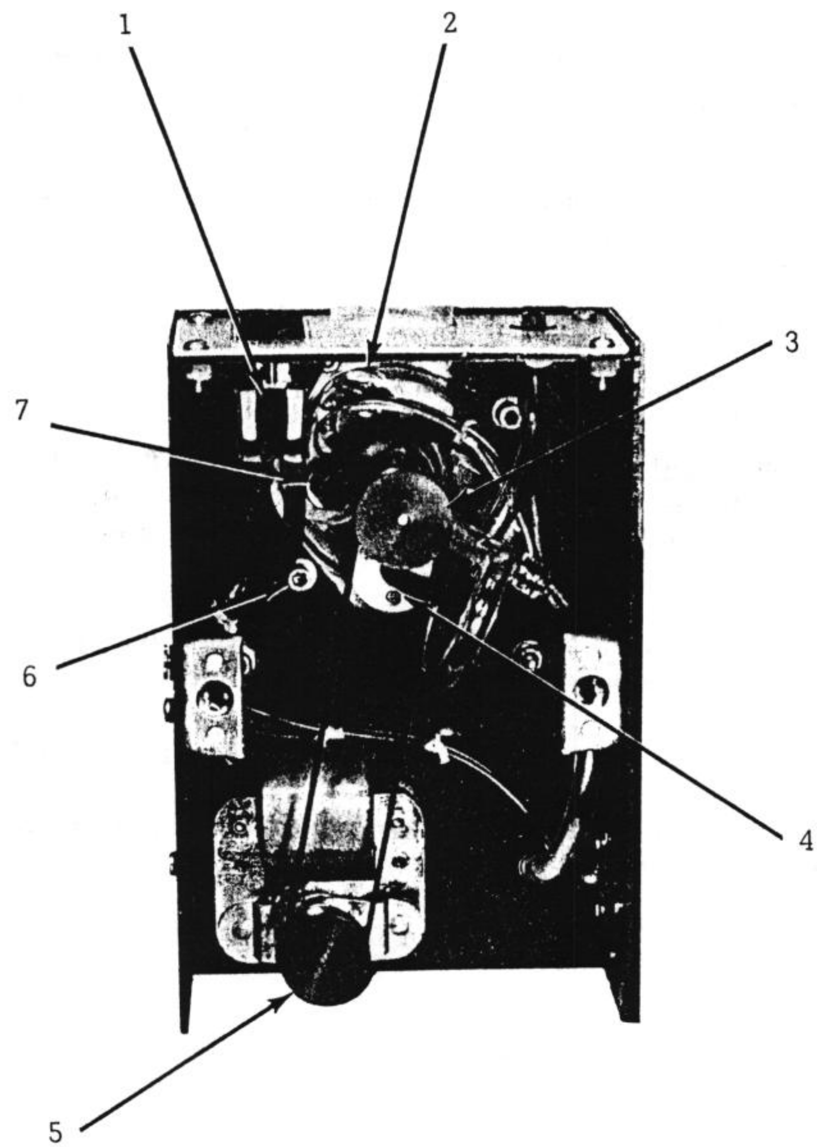
e) Remove sample cell cap from instrument by removing four attaching screws.

f) Remove conductivity sensor from sample cell cap by removing retaining nut and passing leads through the hole in the cap.

g) Remove platinum thermometer by removing three screws.

4-9. Sample Cell Assembly Installation. To install the sample cell assembly (Figure 4-2), proceed as follows:

a) Carefully insert platinum thermometer through proper opening in sample cell.



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1. Pump/Off/Stir Switch
2. Thermistor
3. Stirrer Pulley
4. Platinum Thermometer
5. Stirrer Motor Pulley
6. Sample Cell Cap Screw (4)
7. Salinity Sensor (Toroid)

Figure 4-2. Top View of Stirrer Drive and Sample Cell

CAUTION

When packing thermometer, care should be taken so as not to puncture probe insulation.

b) The platinum thermometer must be sealed into the cap. This is accomplished by starting with a small piece of packing material (Airseal, James R. Kearney Corp., 4236 Clayton Avenue, St. Louis 10, Mo., Catalog No. 18415) about 1/16-inch diameter by 1-1/2-inches long. Form the packing into a ring, and pack around the thermometer using a small nonmetallic probe. Remove excess Airseal.

c) Install conductivity sensor. It must be located so that stirrer is exactly centered in the hole of the toroid. It should not butt against the thermometer or thermistor, but should be equidistant from each (approximately 0.035-inch). Install attaching hardware and tighten nut until toroid is secure.

d) Install bowl cap.

e) Install thermistor.

f) Connect electrical leads from thermometer and toroid.

4-10. STIRRER BEARING CLEANING OR REPLACEMENT

4-11. After the instrument has been in use a considerable period of time, saline buildup may occur between the stirrer and stirrer bearing in the sample cell, causing the stirrer to be inoperable. To remove the stirrer and bearing for cleaning or replacement, proceed as follows:

a) Remove sample cell as described in Paragraphs 4-5 and 4-7.

b) Remove drive pulley from stirrer and, working carefully, free stirrer from bearing and pull from sample cell cap.

c) Push bearing out of sample cell.

d) Clean bearing and stirrer in clear water. Bearing may be reused unless it shows wear or has been damaged.

e) Lubricate bearing and stirrer shaft (at bearing surface) with silicone grease and reinstall.

f) Reassemble and install sample cell as described in Paragraph 4-7.

4-12. PUMP REPLACEMENT

4-13. The vacuum and sample bowl filling pump is easily replaced without removing the pump motor by the removal of one set screw located on the side of the mounting bracket (Figure 4-3). This is accomplished as follows:

a) Remove set screw using an L Allen wrench.

b) Slide pump out from mounting bracket.

c) Disconnect hoses. There are four outlets on the bottom of the pump (Figure 1-2): two are vacuum (metal), and two are pressure (plastic); however, only one vacuum and one pressure outlet is used. The other two outlets are sealed with RTV 108 SILICON RUBBER, General Electric, Waterford, New York.

d) Installation of the pump is the reverse of removal. When installing, depress pump piston with finger to provide clearance under motor-shaft cam.

4-14. MODULE REPLACEMENT

4-15. The electronic plug-in modules on the rear of the instrument (Figure 1-2) are replaced as follows:

a) Remove two screws securing module to circuit board.

b) Pull out module.

4-16. NULL/TEMPERATURE INDICATOR REPLACEMENT

4-17. The meter is replaced as follows:

a) Remove knobs and front panel from instrument.

b) Disconnect two electrical leads to meter.

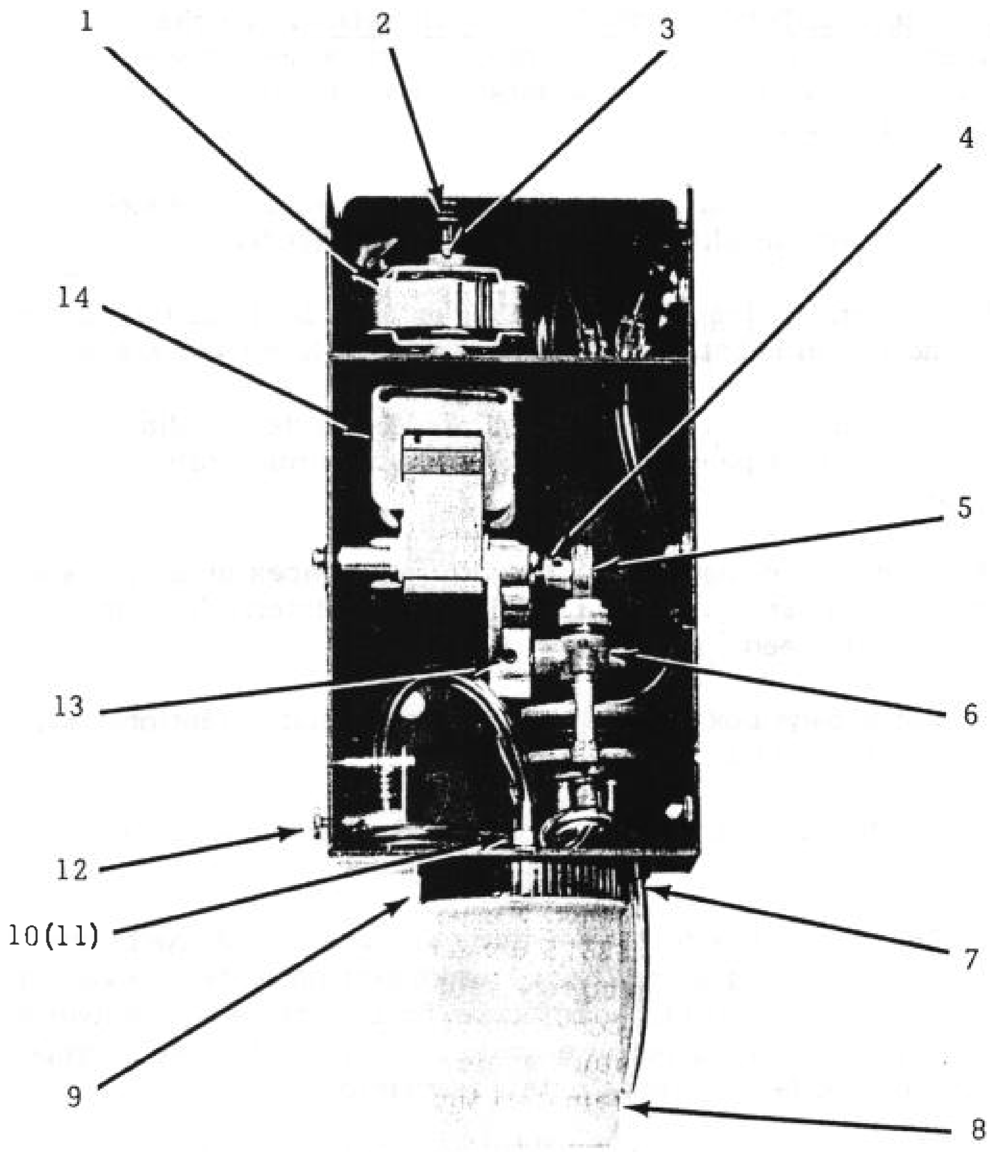
c) Remove wing nuts retaining meter.

d) Lift meter out of mounting bracket through front of instrument.

e) Installation is the reverse of removal.

4-18. CALIBRATION AND ADJUSTMENT PROCEDURES

4-19. Paragraphs 4-22 and 4-23 provide procedures for determining that the instrument is properly calibrated and adjusted. If the calibration of the



1. Stirrer Drive Motor
2. Stirrer Motor Pulley
3. Collar
4. Cam
5. Bearing
6. Pump
7. Overflow Tube
8. Overflow Jar
9. Overflow Jar Cap
10. Hollow Screws (2)
11. Nuts and Washers (2)
12. Vacuum Control Valve
13. Set Screw
14. Pump Drive Motor

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Figure 4-3. Overflow Bowl and Pump Details instrument is questionable, or if a plug-in module has been replaced, perform the calibration and adjustment procedures provided in the following paragraphs.

4-20. Sample Cell Temperature Circuit Calibration. To check the accuracy of the temperature circuit, the leads to the thermistor are disconnected at the rear of the instrument and a decade resistance box substituted. To perform this test, proceed as follows:

a) With instrument power off, turn front panel meter mechanical zero-adjust screw until needle is precisely centered (20°C).

b) Disconnect leads to thermistor on main board at rear of instrument (pins 4 and 6) and substitute decade resistance box (Figure 4-4).

c) Turn instrument power on and place decade box dials to settings shown in Table 4-1; front panel meter should indicate temperature equivalent to resistances used.

d) If indicated readings agree with resistances given in Table 4-1, disconnect decade box and reinstall leads from thermistor. If indicated readings do not agree, proceed with steps e) through g).

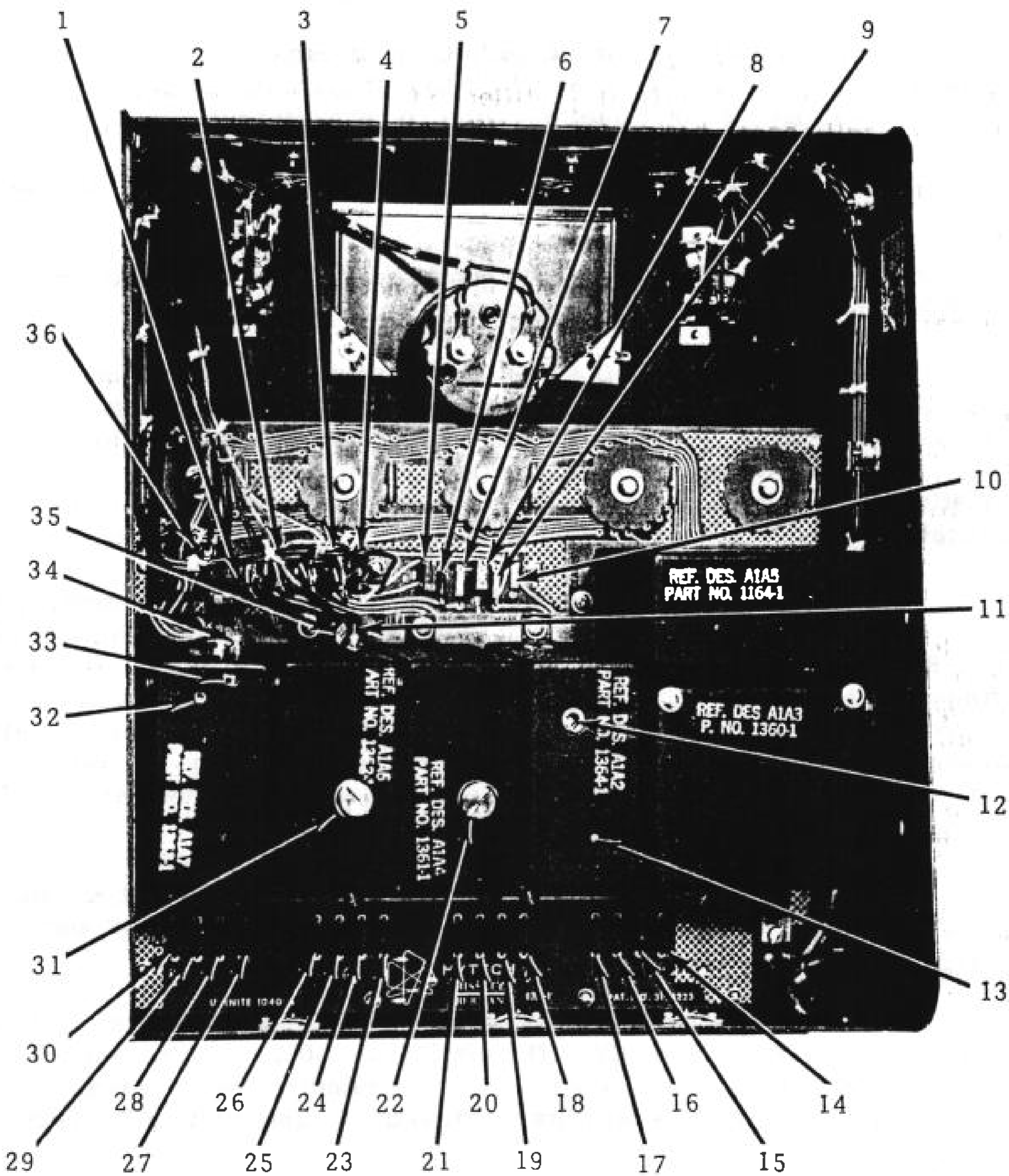
e) Set decade box to 2379.5 ohms and adjust potentiometer R6 until front panel meter reads 20°C.

f) Set decade box to 5548.1 ohms and adjust potentiometer R10 until front panel meter reads 0°C.

g) Set decade box to 1123.5 ohms and check that front panel meter reads 40°C. If this reading is incorrect, return setting of decade box to 5548.1 ohms and slightly readjust R10 to compensate for the interaction between the upper and lower end of the temperature scale. When instrument is properly adjusted, remove decade box and reinstall thermistor leads.

Table 4-1. Decade Resistance Box Settings For Temperature Calibration

TEMP.	RESISTANCE
0°C	5548.1 Ohms
5°C	4446.7 Ohms
10°C	3587.7 Ohms
15°C	2913.0 Ohms
20°C	2379.5 Ohms
25°C	1954.9 Ohms
30°C	1615.2 Ohms
35°C	1345.0 Ohms
40°C	1123.5 Ohms



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1. Pin 13
2. Pin 10
3. Pin 6
4. Pin 4
5. R10
6. RN60C1872F
7. RN60C1821F
8. R6
9. R4 (-6V0
10. R5 (+6V0
11. Detector TP
12. Osc Freq Adjust
13. Zero Adjust
14. 0123-3A10-500
15. 0123-3A10-1000
16. 0123-3A10-2000
17. 0123-3A10-1500
18. 0123-3C50-50
19. 0123-3C20-100
20. 0123-3C20-200
21. 0123-3C20-150
22. Freq Adjust
23. 0123-3E50-5.0
24. 0123-3E50-10
25. 0123-3E50-20
26. 0123-3E50-15
27. 0123-3E50-0.5
28. 0123-3E50-1.0
29. 0123-3E50-2.0
30. 0123-3E50-1.5
31. Freq Adjust
32. R1
33. R5
34. TP for R7
35. Pin 12 (Osc Output)
36. Pin 14

Figure 4-4. Components, Adjustments and Test Points

4-21. Salinity Circuit Adjustment. To determine that the instrument is correctly aligned to perform salinity measurements, proceed as follows:

a) With no water in sample cell, connect oscilloscope (Tektronix Model 502A or equivalent) vertical amplifier to test point on detector amplifier module, and oscilloscope horizontal amplifier to oscillator pin 12 (Figure 4-4).

b) Set CONDUCTIVITY RATIO and STANDARDIZE dials on front panel to zero.

c) Apply power to instrument, but do not turn on stirrer; observe that Lissajous pattern appears on oscilloscope.

d) Turn stirrer on and observe oscilloscope for amount of noise created. Normal noise generated by stirrer is approximately twice that observed when stirrer is not running. If noise is appreciably greater with stirrer on, salinity sensor head must be demagnetized as described in step e). (If head is magnetized, it tends to be magnetostrictive, and therefore sensitive to mechanical vibration.) If stirrer noise appears normal, proceed to step f).

e) To demagnetize sensor head, remove power from instrument, disconnect leads at pins 13 and 14 at rear of instrument, and connect an oscillator (Hewlett-Packard, Model 200 CD, or equivalent) to sensor leads. Set oscillator frequency to 500 cps and gradually increase amplitude of signal to maximum. Slowly increase frequency of oscillator to 20, 000 cps and then gradually reduce amplitude to zero. Repeat procedure for other side of head at leads which go to pins 10 and 12. Remove oscillator and reconnect leads at rear of instrument. Check Lissajous pattern as described in step d).

f) With power applied to instrument and all front dials set to zero, observe that front panel meter is precisely nulled. If it is not, adjust zero adjust potentiometer on oscillator module until needle nulls.

g) Observe precise crossover point of Lissajous pattern on oscilloscope and then set CONDUCTIVITY RATIO dials to .10000. If crossover point shifts at new dial setting, turn the adjustment on detector amplifier module until crossover point coincides with its position at the zero setting of the front panel dials.

h) With oscilloscope still connected to salinometer, fill sample cell with sea water and observe Lissajous pattern. If pattern does not crossover, install a decade capacitance box in parallel with resistor R7 (test points are either of two center terminals and single terminal designated by key 36, Figure 4-4) and determine the capacitance required to attain crossover. Remove capacitance decade box and install a capacitor of the proper value.

4-22. TROUBLESHOOTING

4-23. Table 4-2 provides a troubleshooting chart for isolating and remedying possible malfunctions that may occur in the instrument. It is recommended, in the event of suspected failure of a plug-in module, that a spare module be substituted as a prompt and sure method of troubleshooting. Faulty modules should be returned to the factory for repair.

NOTE

If an instrument malfunction should occur, before proceeding to the troubleshooting chart, check to determine if all module P.C. board contacts and switchboard connectors are clean. Connectors can be cleaned using trichlorethylene and a stiff brush. Printed circuit contacts should be cleaned with trichlorethylene and rubbed gently with a soft eraser.

Table 4-2. Troubleshooting Chart

Trouble	Probable Cause	Remedy
Pump inoperative	Overflow jar not screwed in tightly	Tighten overflow jar
	Overflow jar seal faulty	Replace cork gasket
	Pump defective	Replace pump (refer to Paragraph 4-12)
Stirrer does not function	Drive belt broken	Replace drive belt
	Motor defective	Replace motor
	Stirrer bearing frozen	Replace stirrer bearing (refer to Paragraph 4-10)
Sample cell will not fill without bubbles	Filling too rapidly	Turn vacuum control to slow filling rate

Table 4-2. Troubleshooting Chart (continued)

Trouble	Probable Cause	Remedy
Sample cell will not fill without bubbles (cont)	Bowl or stopcock dirty	Clean sample cell (refer to Paragraph 4-3)
	Air pulling in through thermistor, platinum thermometer, or sensor seals in cap of sample cell	Replace faulty O ring seal (refer to Paragraph 4-7)
	Air leaking in from stopcock	Lubricate stopcock with silicon grease
Meter needle pegs full scale when making temperature measurements	Sample cell thermistor shorted	Replace thermistor (refer to Paragraph 4-7)
Meter needle pegs low end of scale when making temperature measurements	Sample cell thermistor open	Replace thermistor (refer to Paragraph 4-7)
Meter needle remains at 20°C when making temperature measurements	No voltage from power supply	Check for 6V at R5 (see Figure 4-4); if absent, replace power supply
Meter needle erratic when making salinity measurements	Thermistor, thermometer, or salinity sensor faulty (refer to Paragraph 4-18)	Replace faulty element (refer to Paragraph 4-7)
	Stirrer not turning	Repair stirrer (refer to Paragraph 4-10)
	Bubbles in sample cell	Drain and refill; clean or otherwise remove source of bubbles
Meter needle pegs low end of scale when making salinity measurements	Summation amplifier faulty	Replace summation amplifier

Table 4-2. Troubleshooting Chart (continued)

Trouble	Probable Cause	Remedy
Meter needle pegs high end of scale when making salinity measurements	Salinity sensor (toroid) open (refer to Paragraph 4-21)	Replace sensor (refer to Paragraph 4-7)
Meter needle stays at null position when making salinity measurements	Power supply faulty	Check power supply; replace if faulty (A1A3)
	Detector amplifier faulty; check Lissajous pattern (refer to Paragraph 4-21). If pattern is quite clean without normal noise, detector amplifier faulty	Replace detector amplifier (A1A6)
	Oscillator faulty; connect oscilloscope to pin 12 and ground. Signal should be 43V p-p at approximately 3KC	Replace oscillator (A1A2)

CHAPTER 5
THEORY OF OPERATION

5-1. SALINITY MEASUREMENT CIRCUITRY

5-2. The salinity sensing circuit (Figures 5-1 and 5-2) consists primarily of the inductively coupled sensor (T1 and T2) and the compensation circuit. The operation of the salinity bridge is as follows: The current I_W induced in the sea water loop by the application of a voltage E_i to the input of T1 from a 3KC oscillator sets up a 3KC magnetomotive force (mmf) on T2. This mmf is balanced by an equal and opposite mmf set up by the output current I_S from the temperature compensation network. Exact balance of these two mmf's is indicated by E_O being equal to zero. If exact balance does not exist, E_O will not be zero and will be amplified in the error amplifier and detected in the phase sensitive detector and, consequently, the null/temperature indicator will not read a null. To null the meter, the conductivity ratio dials are rotated. The voltage from the ratio transformer will be applied to the summation amplifier and then to T3. The output of the amplifier will increase or decrease the output of the temperature compensation network (I_S) in such a way that the mmf due to I_S exactly neutralizes the mmf due to I_W.

5-3. TEMPERATURE COMPENSATION NETWORK

5-4. The temperature compensation network, which includes platinum thermometers RT1 and RT2 and thermistor RT3, functions as follows: Thermometers RT1, RT2, and thermistor RT3 are submerged in the sea water sample so the net current I_O ($I_O = I_1 - I_2$) into T4 and subsequently to T2 changes with temperature. The ratios of windings W1 and W2 of T3; W3 and W4 of T4; and the resistors R2, R7, R4, R8, and R9 provide an I_O with a temperature coefficient that accurately matches that of sea water from 5° to 40°C.

5-5. TEMPERATURE CIRCUIT

5-6. With the TEMPERATURE SALINITY switch in the temperature position, the meter is connected to a Wheatstone bridge in which resistance changes in RT4 due to temperature changes cause current to flow through meter, indicating the temperature of sample.

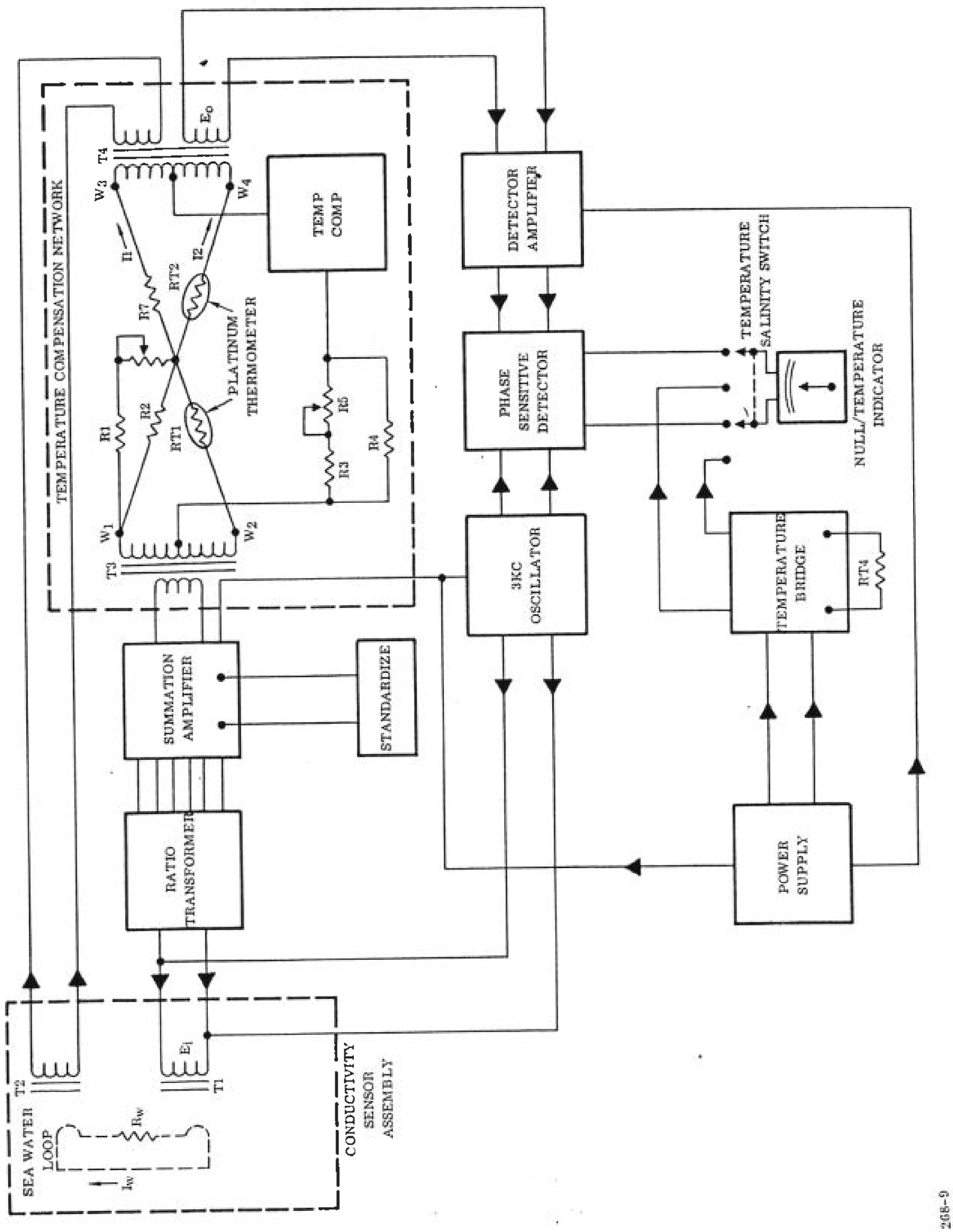

Figure 5-1. Salinometer Simplified Block Diagram

CHAPTER 6
PARTS LIST

6-1. GENERAL

6-2. This section provides a list of replaceable components for the Model 6220 Salinometer. Contained in this list are both mechanical and electronic parts. Standard hardware has not been included.

6-3. PARTS LIST ARRANGEMENT

6-4. Sections. The parts list is arranged in sections by major subassemblies as follows: Front Panel Components; Rear Panel Modules; Sample Bowl Components; Pump, Stirrer Drive, and Overflow Bowl Components; Miscellaneous Electronic Components (Rear Panel); and Overflow Circuit Components.

6-5. Format. The parts list is arranged in a five-column format. The R/D column provides the reference designation where applicable; the PART NO. column is the manufacturer's part number; the DESCRIPTION is the name of the part; the MFR column provides the five-digit code assigned in the Federal Item Identification Guide for Supply Cataloging (H6) (a cross reference between manufacturer's code and manufacturer is provided in Paragraph 6-6); the FIG column provides a reference to the illustrations and key number which shows the part. For example, 4-3-1 refers to Figure 4-3, key number 1. References in which the final digit is in parenthesis, for example, 4-3-(8) means that the item in the parts list is related in an obvious fashion to the key number parenthesized.

6-6. LIST OF MANUFACTURERS

6-7. The following list cross references the H-6 manufacturer's code number in the MFR column to the manufacturer of the item. Where this column is blank, the manufacturer is The Bissett-Berman Corporation (except for MS parts). COML in the MFR column means that the item is available as a standard item from a number of sources.

CODE	MANUFACTURER
07497	Amphenol-Borg Electronics Corp., Chicago, Ill.
12139	PIC Design Corp., Van Nuys, California
56289	Sprague Products Co., North Adams, Mass.
71400	Bussman Fuse Div., McGray-Edison Co., St. Louis, Mo.
73559	Carling Electric Co., Hartford, Conn.
78488	Stackpole Carbon Co., St. Marys, Pa.
83259	Parker Seal Co., Culver City, California

MODEL 6220 LABORATORY SALINOMETER   BISSETT-BERMAN PART NO. 1331-1

R/D	PART NO.	DESCRIPTION	QTY	MFR	FIG
FRONT PANEL COMPONENTS					
	1309-1	KNOB	1		1-2-14
	1310-1	KNOB	8		1-2-11
M1	1183-1	METER, Null/Temperature	1		1-2-2
S2	LT 1GK62-IL-BL-RC	SWITCH, Power	1	73559	1-2-1
S3	T1GL-6C-1L-BL	SWITCH, Salinity/Temperature	1	73559	1-2-3
S1	T1GM62-IL-BL	SWITCH, Pump/Off/Stir	1	73559	1-2-5
F1	Type AGC	FUSE, 1 ampere	1	71400	1-2-12
REAR PANEL MODULES					
A1A7	1363-1	TEMPERATURE COMPENSATION MODULE	1		1-2-24
A1A6	1362-1	DETECTOR AMPLIFIER MODULE	1		1-2-23
A1A4	1361-1	SUMMATION AMPLIFIER MODULE	1		1-2-22
A1A2	*1364-1	OSCILLATOR MODULE	1		1-2-21
A1A3	1360-1	POWER SUPPLY MODULE	1		1-2-19
A1A5	1164-1	RATIO TRANSFORMER MODULE	1		1-2-18
		*First 50 units only (otherwise use 1562-1)			
SAMPLE BOWL COMPONENTS					
	1290-1	CAP, Sample Cell	1		4-1-1
	2-35	O RING, Cap	1	83259	4-1-(1)
	1289-1	BODY, Sample Cell	1		4-1-3
	MS16995-26	SCREW, Cap	6		4-1-2
	0159-7	CLAMP, Sample Cell	1		4-1-6
	MS16995-20	SCREW, Cap	2		4-1-(6)
	1293-1	STOPCOCK, Sample Cell	1		4-1-5
	1261-7	STOPPER, Sample Cell	1		4-1-4
	0163-1	STIRRER, Sample Cell	1		

MODEL 6220 LABORATORY SALINOMETER BISSETT-BERMAN PART NO. 1331-1

R/D	PART NO.	DESCRIPTION	QTY	MFR	FIG
	1298-1	THERMISTOR, Sample Cell	1		4-2-2
	2-12	O RING, Thermistor		83259	4-2-(2)
	1147-9	SENSOR, Salinity (toroid)	1		4-2-7
	2000-1	THERMOMETER, Platinum	1		4-2-4
	2-9	O RING, Thermometer	1	83259	4-2-(4)
	1813-7	BEARING	1		
PUMP, STIRRER DRIVE, AND OVERFLOW BOWL COMPONENTS					
	1330-1	MOTOR, Stirrer	1		4-3-1
	1292-7	PULLEY, Stirrer Drive	2		4-3-2
	C1-1	COLLAR, Pulley	2	12139	4-3-3
	2-43-E540-8	O RING, Stirrer Drive	1	83259	4-3-2
	0415-1	PUMP, Vacuum	1		4-3-6
	1336-1	VALVE, Vacuum Control	1		4-3-12
	70 mm	JAR, Overflow	1		4-3-8
	1279-7	CAP, Overflow Jar	1		4-3-9
	1285-7	SCREW, Hollow	2		4-3-10
	MS35690-430	NUT	2		4-3-11
MISCELLANEOUS ELECTRONIC COMPONENTS (REAR PANEL)					
S10	SS72	SWITCH, 110/220 Vac	1	78488	1-2-20
R10	2900W	POTENTIOMETER, 2K ohm	1	07497	4-4-5
R6	2900W	POTENTIOMETER, 200 ohm	1	07497	4-4-8
R5	RN60C2321F	RESISTOR	1	COML	4-4-10
	RN60C1821F	RESISTOR	2	COML	4-4-7
	RN60C1822F	RESISTOR	1	COML	4-4-6
	0123-3E50-0.5	RESISTOR	1		4-4-27
	0123-3E50-1.0	RESISTOR	1		4-4-28
	0123-3E50-1.5	RESISTOR	1		4-4-30
	0123-3E50-2.0	RESISTOR	1		4-4-29
	0123-3E50-5.0	RESISTOR	1		4-4-23
	0123-3E50-10	RESISTOR	1		4-4-24

MODEL 6220 LABORATORY SALINOMETER BISSETT-BERMAN PART NO. 1331-1

R/D	PART NO	DESCRIPTION	QTY	MFR	FIG
	0123-3E50-15	RESISTOR	1		4-4-26
	0123-3E50-20	RESISTOR	1		4-4-25
	0123-3C50-50	RESISTOR	1		4-4-18
	0123-3C20-100	RESISTOR	1		4-4-19
	0123-3C20-150	RESISTOR	1		4-4-21
	0123-3C20-200	RESISTOR	1		4-4-20
	0123-3A10-500	RESISTOR	1		4-4-14
	0123-3A10-1000	RESISTOR	1		4-4-15
	0123-3A10-1500	RESISTOR	1		4-4-17
	0123-3A10-2000	RESISTOR	1		4-4-16
	RC20GF102K	RESISTOR	1	COML	
	RC20GF101K	RESISTOR	4	COML	

APPENDIX

CONDUCTIVITY RATIO TO SALINITY CONVERSION TABLES

The following tables, Ia through IIb, provide conversion of conductivity ratio to salinity. However, the temperature corrections referred to in paragraph 3-18, step 5, and in figure 3-18, the Specimen Salinity Log Sheet (Tabular Heading - TEMP. CORR.), located in the preceding sections are intended to be in the form of corrections to SALINITY. Tables Ib and IIb list the temperature corrections as corrections to CONDUCTIVITY RATIO. Therefore, the user may elect to use either method for calculating salinity.

However, where the log sheet shown in figure 3-1 is used, it is necessary to apply temperature corrections as corrections to SALINITY as listed in Tables A and B. Table A must be used only with Table Ia and Table B only with Table IIa.

Tables A and B were prepared from the data listed in the Tables Ib and IIb by simply multiplying the data in Table IIa and IIb by the "slope" of the salinity-conductivity relationship.

For example:

$$\Delta S_{20} = \Delta_{20} \times \frac{dS}{dR}$$

Where:

S = Salinity (ppt)

R = Conductivity Ratio

Δ_{20} = Correction to Conductivity Ratio listed in Table IIa

Or:

$$\Delta S_{15} = \Delta_{15} \times \frac{dS}{dR}$$

Where:

Δ_{15} = Correction to Conductivity Ratio listed in Table Ib

TEMPERATURE °C

CONDUCTIVITY RATIO	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0.85	+.016	+.013	+.010	+.006	+.003	0	-.003	-.006	-.009	-.012	-.014	-.017	-.020	-.022	-.024	-.027	-.029	-.031	-.033	-.035	-.037	-.039
0.86	+.015	+.012	+.009	+.006	+.003	0	-.003	-.006	-.008	-.011	-.013	-.016	-.018	-.021	-.023	-.025	-.027	-.029	-.031	-.033	-.035	-.037
0.87	+.014	+.012	+.008	+.005	+.003	0	-.003	-.005	-.008	-.010	-.013	-.015	-.017	-.020	-.021	-.024	-.026	-.028	-.030	-.031	-.033	-.035
0.88	+.013	+.011	+.008	+.005	+.003	0	-.002	-.005	-.007	-.010	-.012	-.014	-.016	-.018	-.020	-.022	-.024	-.026	-.027	-.029	-.031	-.032
0.89	+.012	+.010	+.007	+.005	+.002	0	-.002	-.005	-.007	-.009	-.011	-.013	-.015	-.017	-.018	-.020	-.022	-.024	-.025	-.027	-.028	-.030
0.90	+.012	+.009	+.007	+.004	+.002	0	-.002	-.004	-.006	-.008	-.010	-.012	-.014	-.015	-.017	-.019	-.020	-.022	-.024	-.025	-.026	-.027
0.91	+.010	+.008	+.006	+.004	+.002	0	-.002	-.004	-.006	-.007	-.009	-.011	-.012	-.014	-.015	-.017	-.019	-.020	-.021	-.022	-.024	-.025
0.92	+.009	+.007	+.005	+.004	+.002	0	-.002	-.004	-.005	-.007	-.008	-.010	-.011	-.013	-.014	-.016	-.017	-.018	-.019	-.020	-.021	-.022
0.93	+.009	+.007	+.005	+.003	+.002	0	-.002	-.003	-.005	-.006	-.007	-.009	-.010	-.011	-.012	-.014	-.015	-.016	-.017	-.018	-.019	-.020
0.94	+.007	+.006	+.004	+.003	+.002	0	-.001	-.003	-.004	-.005	-.006	-.007	-.009	-.010	-.011	-.012	-.013	-.014	-.015	-.016	-.016	-.017
0.95	+.006	+.005	+.004	+.002	+.001	0	-.001	-.002	-.003	-.004	-.005	-.006	-.007	-.008	-.009	-.010	-.011	-.012	-.012	-.013	-.014	-.014
0.96	+.005	+.004	+.003	+.002	+.001	0	-.001	-.002	-.003	-.004	-.004	-.005	-.006	-.007	-.007	-.008	-.009	-.009	-.010	-.011	-.011	-.012
0.97	+.004	+.003	+.002	+.002	+.001	0	-.001	-.002	-.002	-.003	-.003	-.004	-.004	-.005	-.006	-.006	-.007	-.007	-.007	-.008	-.009	-.009
0.98	+.002	+.002	+.002	+.001	0	0	0	-.001	-.001	-.002	-.002	-.003	-.003	-.004	-.004	-.004	-.004	-.005	-.005	-.006	-.006	-.006
0.99	+.001	+.001	+.001	0	0	0	0	0	-.001	-.001	-.001	-.001	-.002	-.002	-.002	-.002	-.002	-.002	-.003	-.003	-.003	-.003
1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.01	-.001	-.001	-.001	0	0	0	0	0	+.001	+.001	+.001	+.001	+.002	+.002	+.002	+.002	+.002	+.002	+.003	+.003	+.003	+.003
1.02	-.003	-.002	-.002	-.001	0	0	0	+.001	+.002	+.002	+.002	+.003	+.003	+.004	+.004	+.004	+.005	+.005	+.006	+.006	+.006	+.006
1.03	-.004	-.003	-.002	-.002	-.001	0	+.001	+.002	+.002	+.003	+.004	+.004	+.005	+.006	+.006	+.007	+.007	+.008	+.008	+.009	+.009	+.010
1.04	-.006	-.004	-.003	-.002	-.001	0	+.001	+.002	+.003	+.004	+.005	+.006	+.006	+.007	+.008	+.009	+.010	+.010	+.011	+.011	+.012	+.013
1.05	-.007	-.006	-.004	-.003	-.001	0	+.001	+.002	+.004	+.005	+.006	+.007	+.008	+.009	+.011	+.011	+.012	+.013	+.014	+.015	+.015	+.016
1.06	-.008	-.007	-.005	-.003	-.002	0	+.002	+.003	+.004	+.006	+.007	+.009	+.010	+.011	+.012	+.014	+.015	+.016	+.017	+.018	+.019	+.019
1.07	-.010	-.008	-.006	-.004	-.002	0	+.002	+.004	+.005	+.007	+.009	+.010	+.012	+.013	+.015	+.016	+.017	+.019	+.020	+.021	+.022	+.023
1.08	-.012	-.009	-.007	-.004	-.002	0	+.002	+.004	+.006	+.008	+.010	+.012	+.014	+.015	+.017	+.018	+.020	+.021	+.023	+.024	+.025	+.027
1.09	-.013	-.010	-.008	-.005	-.002	0	+.002	+.005	+.007	+.009	+.012	+.014	+.016	+.018	+.019	+.021	+.023	+.024	+.026	+.027	+.029	+.030
1.10	-.015	-.012	-.009	-.006	-.003	0	+.003	+.005	+.008	+.010	+.013	+.015	+.017	+.020	+.022	+.024	+.026	+.028	+.029	+.031	+.032	+.034
1.11	-.016	-.013	-.010	-.006	-.003	0	+.003	+.006	+.009	+.012	+.014	+.017	+.019	+.022	+.024	+.026	+.028	+.030	+.032	+.034	+.036	+.038
1.12	-.018	-.014	-.010	-.007	-.004	0	+.003	+.006	+.010	+.013	+.016	+.018	+.021	+.024	+.026	+.029	+.031	+.034	+.036	+.038	+.040	+.042
1.13	-.020	-.016	-.012	-.008	-.004	0	+.004	+.007	+.011	+.014	+.017	+.020	+.023	+.026	+.029	+.032	+.034	+.037	+.039	+.042	+.044	+.046
1.14	-.022	-.017	-.013	-.008	-.004	0	+.004	+.008	+.012	+.015	+.019	+.022	+.025	+.029	+.032	+.035	+.037	+.040	+.043	+.045	+.048	+.050
1.15	-.023	-.019	-.014	-.009	-.004	0	+.004	+.008	+.013	+.017	+.021	+.024	+.028	+.031	+.034	+.037	+.041	+.043	+.046	+.049	+.051	+.054
1.16	-.025	-.020	-.015	-.010	-.005	0	+.005	+.009	+.014	+.018	+.022	+.026	+.030	+.033	+.037	+.041	+.044	+.047	+.050	+.053	+.055	+.058
1.17	-.027	-.021	-.016	-.011	-.005	0	+.005	+.010	+.015	+.019	+.024	+.028	+.032	+.036	+.040	+.044	+.047	+.050	+.054	+.057	+.060	+.063
1.18	-.030	-.023	-.017	-.011	-.006	0	+.005	+.011	+.016	+.021	+.025	+.030	+.034	+.039	+.043	+.047	+.051	+.054	+.058	+.061	+.064	+.067
1.19	-.031	-.025	-.018	-.012	-.006	0	+.006	+.011	+.017	+.022	+.027	+.032	+.037	+.041	+.046	+.050	+.054	+.058	+.062	+.065	+.069	+.072

Table A. Additional Corrections to Salinity.

CONDUCTIVITY RATIO	TEMPERATURE °C																				
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0.10	+.025	+.022	+.020	+.017	+.014	+.012	+.010	+.007	+.005	+.003	0	-.002	-.005	-.007	-.009	-.011	-.013	-.015	-.018	-.019	-.021	-.023
0.15	+.035	+.031	+.028	+.024	+.020	+.017	+.013	+.010	+.007	+.003	0	-.003	-.006	-.010	-.013	-.016	-.019	-.022	-.024	-.027	-.030	-.033
0.20	+.044	+.039	+.034	+.030	+.025	+.021	+.017	+.012	+.008	+.004	0	-.004	-.008	-.012	-.016	-.019	-.023	-.027	-.030	-.033	-.037	-.040
0.25	+.050	+.045	+.040	+.034	+.029	+.024	+.019	+.014	+.009	+.005	0	-.005	-.009	-.014	-.018	-.022	-.027	-.030	-.034	-.038	-.042	-.046
0.30	+.056	+.050	+.044	+.038	+.032	+.027	+.021	+.016	+.011	+.005	0	-.005	-.010	-.015	-.020	-.024	-.029	-.033	-.038	-.042	-.047	-.051
0.35	+.059	+.053	+.047	+.040	+.034	+.028	+.023	+.017	+.011	+.006	0	-.006	-.011	-.016	-.021	-.026	-.031	-.035	-.040	-.045	-.049	-.053
0.40	+.061	+.055	+.048	+.042	+.036	+.030	+.023	+.017	+.012	+.006	0	-.006	-.011	-.016	-.022	-.027	-.032	-.036	-.041	-.046	-.050	-.055
0.45	+.063	+.056	+.049	+.043	+.036	+.030	+.024	+.018	+.012	+.006	0	-.006	-.011	-.017	-.022	-.027	-.032	-.037	-.042	-.046	-.051	-.055
0.50	+.062	+.056	+.049	+.042	+.036	+.030	+.024	+.017	+.011	+.006	0	-.006	-.011	-.016	-.021	-.027	-.032	-.036	-.041	-.046	-.050	-.054
0.55	+.061	+.054	+.048	+.041	+.035	+.029	+.023	+.017	+.011	+.005	0	-.005	-.011	-.016	-.021	-.026	-.031	-.035	-.040	-.044	-.049	-.053
0.60	+.059	+.052	+.046	+.040	+.034	+.028	+.022	+.016	+.011	+.006	0	-.005	-.010	-.015	-.020	-.025	-.029	-.034	-.038	-.042	-.046	-.050
0.65	+.055	+.049	+.043	+.037	+.032	+.026	+.021	+.015	+.010	+.005	0	-.005	-.010	-.014	-.019	-.023	-.027	-.031	-.035	-.039	-.043	-.047
0.70	+.051	+.045	+.039	+.034	+.029	+.024	+.019	+.014	+.009	+.005	0	-.005	-.009	-.013	-.017	-.021	-.025	-.029	-.032	-.036	-.039	-.042
0.75	+.045	+.040	+.035	+.030	+.026	+.021	+.017	+.012	+.008	+.004	0	-.004	-.008	-.011	-.015	-.018	-.022	-.025	-.028	-.031	-.034	-.037
0.80	+.038	+.034	+.030	+.026	+.022	+.018	+.014	+.011	+.007	+.003	0	-.003	-.006	-.010	-.013	-.016	-.019	-.021	-.024	-.027	-.029	-.031
0.85	+.031	+.027	+.024	+.021	+.017	+.014	+.011	+.008	+.005	+.003	0	-.003	-.005	-.008	-.010	-.012	-.015	-.017	-.019	-.021	-.023	-.025
0.86	+.029	+.026	+.023	+.020	+.016	+.013	+.011	+.008	+.005	+.003	0	-.002	-.005	-.007	-.010	-.012	-.014	-.016	-.018	-.020	-.021	-.023
0.87	+.027	+.024	+.021	+.018	+.015	+.013	+.010	+.007	+.005	+.002	0	-.002	-.005	-.007	-.009	-.011	-.013	-.015	-.017	-.018	-.020	-.022
0.88	+.025	+.022	+.020	+.017	+.014	+.012	+.009	+.007	+.005	+.002	0	-.002	-.004	-.006	-.008	-.010	-.012	-.014	-.016	-.017	-.019	-.020
0.89	+.023	+.021	+.018	+.016	+.013	+.011	+.009	+.007	+.004	+.002	0	-.002	-.004	-.006	-.008	-.010	-.011	-.013	-.014	-.016	-.017	-.019
0.90	+.022	+.019	+.017	+.015	+.012	+.010	+.008	+.006	+.004	+.002	0	-.002	-.004	-.005	-.007	-.009	-.010	-.012	-.013	-.015	-.016	-.017
0.91	+.020	+.017	+.015	+.013	+.011	+.009	+.007	+.005	+.004	+.002	0	-.002	-.004	-.005	-.007	-.008	-.009	-.011	-.012	-.013	-.015	-.016
0.92	+.018	+.016	+.014	+.012	+.010	+.008	+.007	+.005	+.003	+.002	0	-.002	-.003	-.004	-.006	-.007	-.009	-.010	-.011	-.012	-.013	-.014
0.93	+.016	+.014	+.012	+.011	+.009	+.007	+.006	+.004	+.003	+.002	0	-.001	-.003	-.004	-.005	-.006	-.007	-.009	-.010	-.011	-.012	-.012
0.94	+.014	+.012	+.011	+.009	+.008	+.006	+.005	+.004	+.002	+.001	0	-.001	-.002	-.004	-.004	-.005	-.007	-.007	-.008	-.009	-.010	-.011
0.95	+.011	+.010	+.009	+.008	+.007	+.005	+.004	+.003	+.002	+.001	0	-.001	-.002	-.003	-.004	-.005	-.005	-.006	-.007	-.008	-.009	-.009
0.96	+.009	+.008	+.007	+.006	+.006	+.004	+.004	+.002	+.002	+.001	0	-.001	-.002	-.002	-.003	-.004	-.004	-.005	-.006	-.006	-.007	-.007
0.97	+.007	+.006	+.006	+.005	+.004	+.003	+.003	+.002	+.001	+.001	0	-.001	-.001	-.002	-.002	-.003	-.004	-.004	-.004	-.005	-.005	-.006
0.98	+.005	+.004	+.004	+.003	+.003	+.002	+.002	+.001	+.001	0	0	0	-.001	-.001	-.002	-.002	-.002	-.003	-.003	-.003	-.004	-.004
0.99	+.002	+.002	+.002	+.002	+.001	+.001	+.001	+.001	0	0	0	0	0	-.001	-.001	-.001	-.001	-.001	-.002	-.002	-.002	-.002
1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.01	-.002	-.002	-.002	-.002	-.002	-.001	-.001	-.001	0	0	0	0	0	+.001	+.001	+.001	+.001	+.001	+.002	+.002	+.002	+.002
1.02	-.005	-.004	-.004	-.003	-.003	-.002	-.002	-.001	-.001	0	0	0	+.001	+.001	+.002	+.002	+.002	+.003	+.003	+.003	+.004	+.004
1.03	-.008	-.007	-.006	-.005	-.004	-.004	-.003	-.002	-.001	-.001	0	+.001	+.001	+.002	+.002	+.003	+.004	+.004	+.005	+.005	+.006	+.006
1.04	-.010	-.009	-.008	-.007	-.006	-.005	-.004	-.003	-.002	-.001	0	+.001	+.002	+.002	+.003	+.004	+.005	+.006	+.006	+.007	+.008	+.008
1.05	-.013	-.012	-.010	-.009	-.008	-.006	-.005	-.004	-.002	-.001	0	+.001	+.002	+.003	+.004	+.005	+.006	+.007	+.008	+.009	+.010	+.010
1.06	-.016	-.014	-.012	-.011	-.009	-.007	-.006	-.004	-.003	-.001	0	+.001	+.003	+.004	+.005	+.006	+.007	+.008	+.010	+.010	+.012	+.012
1.07	-.019	-.016	-.014	-.012	-.010	-.009	-.007	-.005	-.003	-.002	0	+.002	+.003	+.004	+.006	+.007	+.009	+.010	+.011	+.012	+.014	+.014
1.08	-.021	-.019	-.017	-.014	-.012	-.010	-.008	-.006	-.004	-.002	0	+.002	+.004	+.005	+.007	+.008	+.010	+.012	+.013	+.014	+.016	+.017
1.09	-.024	-.022	-.019	-.016	-.014	-.012	-.009	-.007	-.004	-.002	0	+.002	+.004	+.006	+.008	+.010	+.012	+.013	+.015	+.016	+.018	+.019
1.10	-.028	-.024	-.022	-.018	-.016	-.013	-.010	-.008	-.005	-.002	0	+.002	+.004	+.007	+.009	+.011	+.013	+.015	+.016	+.018	+.020	+.021
1.11	-.031	-.027	-.024	-.020	-.017	-.014	-.011	-.008	-.006	-.003	0	+.002	+.005	+.008	+.010	+.012	+.014	+.016	+.018	+.020	+.022	+.024
1.12	-.034	-.030	-.026	-.023	-.019	-.016	-.012	-.009	-.006	-.003	0	+.003	+.006	+.008	+.011	+.013	+.016	+.018	+.020	+.022	+.024	+.026
1.13	-.037	-.033	-.029	-.025	-.021	-.017	-.014	-.010	-.006	-.003	0	+.003	+.007	+.009	+.012	+.014	+.017	+.020	+.022	+.024	+.026	+.028
1.14	-.041	-.036	-.031	-.027	-.023	-.019	-.015	-.011	-.007	-.004	0	+.003	+.007	+.010	+.013	+.016	+.019	+.021	+.024	+.027	+.029	+.031
1.15	-.044	-.039	-.034	-.029	-.025	-.021	-.016	-.012	-.008	-.004	0	+.004	+.007	+.011	+.014	+.017	+.020	+.023	+.026	+.029	+.031	+.034
1.16	-.048	-.042	-.037	-.032	-.027	-.022	-.017	-.013	-.009	-.004	0	+.004	+.008	+.012	+.015	+.019	+.022	+.025	+.028	+.031	+.034	+.036
1.17	-.051	-.045	-.040	-.034	-.029	-.024	-.019	-.014	-.009	-.004	0	+.004	+.009	+.013	+.016	+.020	+.023	+.027	+.030	+.034	+.036	+.039
1.18	-.055	-.048	-.042	-.037	-.031	-.025	-.020	-.015	-.010	-.005	0	+.005	+.009	+.013	+.017	+.021	+.025	+.029	+.032	+.036	+.039	+.042
1.19	-.058	-.052	-.045	-.039	-.033	-.027	-.021	-.016	-.011	-.005	0	+.005	+.010	+.014	+.019	+.023	+.027	+.031	+.034	+.038	+.041	+.045

Table B. Additional Corrections to Salinity.

International oceanographic tables

Prepared under the supervision of the Joint Panel on Oceanographic Tables and Standards, and published jointly by the National Institute of Oceanography, Great Britain, and the United Nations Educational, Scientific and Cultural Organization.

Tables océanographiques internationales

Dressées sous la direction du Comité international d'experts pour les tables et étalons océanographiques, et publiées conjointement par l'Institut océanographique national de Grande-Bretagne et l'Organisation des Nations Unies pour l'éducation, la science et la culture.

Tablas oceanográficas internacionales

Preparadas bajo la dirección de la Comisión Conjunta de Normas y Tablas Oceanográficas y publicadas conjuntamente por el National Institute of Oceanography de Gran Bretaña, y la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura.

Международные океанологические таблицы

Подготовлены под наблюдением Объединенной группы по океанологическим таблицам и стандартам и опубликованы совместно Национальным институтом океанографии Великобритании и Организацией объединенных наций по вопросам образования, науки и культуры.

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National Institute of Oceanography of Great Britain
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England

(B. 2190) Price/Prix/Precio/Цена: $ 5.00 - £ 1:5:0 - 17,50 F.

GENERAL INTRODUCTION

In 1964 a panel of scientists was appointed jointly by the several international oceanographic organizations to advise on the establishment of international tables and standards. The first task of this panel has been to prepare tables for computing salinity from determinations of electrical conductivity. Before this was possible, a programme of research was necessary to establish the relationships between the conductivity and chlorinity of natural sea water. Most of this work has been done at the National Institute of Oceanography, England, with help from many countries in the collection of the samples, with the financial participation of Unesco.

Before the tables connecting conductivity and salinity could be prepared, it was necessary to agree on a precise definition of salinity. The discussions on this point are reported at length in the first and second reports of the Joint Panel on Oceanographic Tables and Standards (JPOTS), which have been published by Unesco. The final decision was that as conductivity is the most precise method available for salinity determination, salinity should be redefined in terms of conductivity.

In consequence, the Tables I and II of this series, and the expressions given in the introductions to these tables, constitute the new definition of salinity adopted by JPOTS; the introductions also indicate how chlorinity may be calculated from the conductivity, and the probable uncertainty in such calculations.

It is intended that further tables shall be prepared in this series. Already under consideration are:

(a) effect of pressure on the conductivity of sea water,
(b) specific gravity of sea water from temperature and salinity,
(c) chlorosity from salinity or chlorinity,
(d) velocity of sound, from salinity, temperature and pressure,
(e) salinity from refractive index.

The panel will welcome suggestions for additions or improvements to the tables. These may be sent to any member of JPOTS, or to the Office of Oceanography, Unesco.

For the Joint Panel on Oceanographic Tables and Standards,

Roland A. Cox, Chairman

February, 1966

INTRODUCTION GENERALE

En 1964, un Comité d'hommes de science, le Comité international d'experts pour les tables et étalons océanographiques (CITEO) a été désigné par les diverses organisations océanographiques internationales pour procéder à l'élaboration de tables et d'étalons océanographiques internationaux. La première tâche de ce Comité a été de dresser des tables pour le calcul de la salinité à partir des résultats de mesures de la conductivité électrique. Pour y parvenir, un programme de recherches a dû être exécuté afin de définir les relations pouvant exister entre la conductivité et la chlorinité de l'eau de mer naturelle à une température donnée. La majeure partie de ce travail a été effectuée à l'Institut océanographique national de Grande-Bretagne avec l'aide de plusieurs pays pour la collecte des échantillons, et avec la participation financière de l'Unesco.

Avant de pouvoir dresser des tables de correspondance entre la conductivité et la salinité, il a fallu s'entendre sur une nouvelle définition précise de la salinité. Les discussions sur ce point sont largement exposées dans les premier et deuxième rapports du Comité international des experts, publiés par l'Unesco. Etant donné que la conductivité constitue la méthode la plus précise actuellement disponible pour déterminer indirectement la salinité, il a été finalement décidé de définir la salinité par rapport à la conductivité.

En conséquence, les tables I et II de cette série, de même que les formules indiquées dans les introductions à ces tables, représentent la nouvelle définition de la salinité adoptée par le CITEO. Les introductions indiquent également comment la chlorinité peut être calculée à partir de la valeur de la conductivité, et l'incertitude qui affecte le résultat de ce calcul.

Il a été, en outre, convenu que d'autres tables seraient ultérieurement préparées dans cette série. D'ores et déjà, il est envisagé de dresser des tables donnant :

(a) L'effet de la pression sur la conductivité de l'eau de mer
(b) La densité, à partir de la température et de la salinité
(c) La chlorosité, à partir de la chlorinité ou de la salinité
(d) La vitesse du son, à partir de la salinité, de la température et de la pression
(e) La salinité à partir de l'indice de réfraction.

Le Comité accueillerait avec gratitude toute suggestion tendant à l'extension ou à l'amélioration de ces tables. De telles suggestions pourraient être adressées à n'importe quel membre du CITEO, ou à l'Office d'océanographie de l'Unesco.

Roland A. Cox, président du CITEO

Février 1966

Table IIa

FOR CONVERTING CONDUCTIVITY RATIO AT 20° C TO SALINITY OF SEA WATER

Table IIa is based on the same measurements as tables Ia and Ib (see the introduction to table Ia). This table is intended especially for use with non-thermostate salinometers, and is correct for ratios measured at 20°. This means that in temperate climates the temperature corrections (table IIb) will usually be small, and for approximate work it will often be legitimate to neglect them. When the corrections are neglected, however, the third decimal of salinity given in the table IIa will not be reliable and normally salinity should be quoted only to two decimal places.

Table IIa is computed from the same polynomial as table Ia, with a temperature correction derived from table Ib.

$$R_{15} = R_{20} + (R_{15} - R_{20}) = R_{20} + \Delta_{15}(20°)$$

Table IIb gives corrections (Δ_{20}) to conductivity ratios measured at temperatures other than 20°. The formula from which this table is computed is derived directly from that used to compute table Ib;

$$\Delta_{20}(t) = 10^{-5} R_t(R_t - 1)(t-20)\left\{90\cdot4 - 72\cdot0\,R_t + 35\cdot2\,R_t^2 - (0\cdot63 + 0\cdot21\,R_t^2)(t-20)\right\}$$

Any observation of conductivity ratio above 0.85 may be converted to salinity by the use of either tables Ia and Ib, or of tables IIa and IIb, and the derived salinity will be the same except occasionally for one unit in the third decimal of salinity (0.001‰) due to rounding errors. In this range, therefore, the operator may select whichever tables are more convenient. Ratios below 0·85 are not covered by table Ia, and tables IIa and IIb must be used.

Table IIa

PERMETTANT DE DETERMINER LA SALINITE DE L'EAU DE MER D'APRES LE RAPPORT DE CONDUCTIVITE A 20°C

La table IIa est fondée sur les mêmes mesures que les tables Ia et Ib (voir introduction à la table Ia). Cette table est spécialement destinée à servir pour les mesures faites avec des salinomètres sans thermostat. Elle donne les valeurs de la salinité correspondant à celles du rapport de conductivité mesuré à 20°C (R_{20}). En climat tempéré, les corrections de température (table IIb) qui permettent de passer des valeurs de R_t à celles de R_{20} sont généralement faibles et, lorsqu'il ne s'agit pas de mesures de haute précision, peuvent être négligées sans inconvénient. Dans ce cas, la 3e décimale de la salinité risque d'être fausse. La salinité ne doit alors être exprimée qu'avec deux décimales.

La table IIa est calculée à l'aide du même polynôme que la table Ia, avec une correction de température tirée de la table Ib :

$$R_{15} = R_{20} + (R_{15} - R_{20}) = R_{20} + \Delta_{15} \quad (20°)$$

La table IIb donne la correction (Δ_{20}) à apporter au rapport de conductivité mesuré à une température différente de 20°C pour obtenir R_{20} . La formule à partir de laquelle cette table a été calculée découle directement de celle qui a servi au calcul de la table Ib :

$$\Delta_{20}(t) = 10^{-5} R_t (R_t-1)(t-20)\{90,4 - 72,0 R_t + 35,2 R_t^2 - (0,63 + 0,21 R_t^2)(t-20)\}$$

Toute valeur du rapport de conductivité supérieure à 0,85 peut être convertie en salinité à l'aide soit des tables Ia et Ib, soit des tables IIa et IIb. Les valeurs de la salinité obtenues dans les deux cas, seront les mêmes au millième près : une différence de 0.001 ‰ pourrait en effet apparaître occasionnellement entre les deux résultats, par suite du fait que les chiffres sont arrondis à 3 décimales. Pour toutes les valeurs supérieures à 0,85 donc, l'opérateur peut choisir le groupe de tables qui lui convient le mieux. Pour les valeurs inférieures à 0,85, qui ne sont pas comprises dans la table Ia, l'opérateur utilisera les tables IIa et IIb.

Tabla IIa

PARA CONVERTIR LA RAZON DE CONDUCTIVIDAD A 20°C EN SALINIDAD DEL AGUA DE MAR

La Tabla IIa está basada en las mismas determinaciones que las Tablas Ia y Ib (véase la introducción a la Tabla Ia). Esta tabla está destinada especialmente a las mediciones practicadas con salinómetros sin termostato a 20°. Esto significa que, en los climas templados, las correcciones de temperatura (Tabla IIb) serán generalmente pequeñas y para cálculos aproximados podrá muchas veces prescindirse de ellas. Sin embargo, en este caso la tercera cifra decimal de la salinidad dada en la Tabla IIa no será segura, y la salinidad sólo deberá darse con dos cifras decimales.

La Tabla IIa está calculada con ayuda del mismo polinomio que la Tabla Ia mediante una corrección de temperatura deducida de la Tabla Ib.

$$R_{15} = R_{20} + (R_{15} - R_{20}) = R_{20} + \triangle_{15}\ (20^\circ)$$

La Tabla IIb da las correcciones ($\triangle_{20}$) que deben aplicarse a las razones de conductividad medidas a temperaturas diferentes de 20° para obtener R_{20}. La fórmula con la que se ha calculado esta tabla se deduce directamente de la utilizada para calcular la Tabla Ib:

$$\triangle_{20}\ (t) = 10^{-5} R_t(R_t-1)\ (t-20)\ \left\{90,4-72,0R_t+35,2R_t^2 - (0,63+0,21\ R_t^2)\ (t-20)\right\}$$

Las razones de conductividad superiores a 0,85 pueden convertirse en salinidades mediante las Tablas Ia y Ib o las Tablas IIa y IIb. Los valores obtenidos en ambos casos serán iguales, con la excepción a veces de una unidad en la tercera cifra decimal de la salinidad (0,001 ‰) a causa de los errores que se producen al redondear los números. En este intervalo, por lo tanto, el operador puede elegir las tablas que prefiera. La Tabla Ia no contiene razones inferiores a 0,85, y se deben utilizar en este caso las Tablas IIa y IIb.

Таблица IIa

ДЛЯ ОПРЕДЕЛЕНИЯ СОЛЕНОСТИ МОРСКОЙ ВОДЫ ПО ОТНОСИТЕЛЬНОЙ ЭЛЕКТРОПРОВОДНОСТИ ЕЕ ПРИ 20° С

В основу таблицы IIa положены те же определения, что и для таблицы Ia и Ib (см. введение к таблице Ia). Эта таблица предназначена прежде всего для использования при работе с солемерами без термостатов. Она дает точные значения относительно электропроводности при 20°. Это означает, что в умеренном поясе температурная поправка (таблица IIb) обычно будет мала и для приближенных расчетов ею зачастую можно будет пренебречь. Однако, если поправкой пренебрегают, то третий десятичный знак солености, приведенный в таблице IIa, не будет надежен и соленость следует давать тогда, как правило, с двумя десятичными знаками.

Таблица IIa рассчитана по тому же полиному, что и таблица Ia, причем введена температурная поправка по таблице Ib.

$$R_{15} = R_{20} + (R_{15} - R_{20}) = R_{20} + \Delta_{15}\ (20°)$$

Таблица II дает поправку(Δ_{20})к значению относительной электропроводности, измеренному при температуре, отличной от 20°. Формула, по которой рассчитана эта таблица, получена непросредственно из формулы для таблицы Ib.

$$\Delta_{20}(t) = 10^{-5}\ R_t(R_t-1)\,(t-20)\ \left\{90.4 - 72.0R_t + 35.2\,R_t^2 - (0.63 + 0.21\,R_t^2)\ (t-20)\right\}$$

По любому наблюденному значению относительной электропроводности, превышающему 0,85, можно определить соленость с помощью, либо таблиц Ia и Ib, либо таблиц IIa и IIb. Полученные значения будут совпадать с точностью до единицы третьего десятичного знака солености 0,001 из-за ошибок округления. Поэтому, в данном интервале можно выбрать те таблицы, которые представляются более удобными. Значения относительной электропроводности меньшие 0,85 таблицей Ia не охватываются и в этом случае следует пользоваться таблицами IIa и IIb.

20°

$R_{20} \longrightarrow S$ ‰

			0	1	2	3	4	5	6	7	8	9
0.10	0	2.	846	849	852	855	858	861	864	867	870	873
	1		876	879	882	885	888	892	895	898	901	904
	2		907	910	913	916	919	922	925	928	931	934
	3		937	940	943	946	949	953	956	959	962	965
	4		968	971	974	977	980	983	986	989	992	995
	5		998	001	004	008	011	014	017	020	023	026
	6	3.	029	032	035	038	041	044	047	050	053	056
	7		060	063	066	069	072	075	078	081	084	087
	8		090	093	096	099	102	105	108	112	115	118
	9		121	124	127	130	133	136	139	142	145	148
0.11	0		151	154	158	161	164	167	170	173	176	179
	1		182	185	188	191	194	197	200	204	207	210
	2		213	216	219	222	225	228	231	234	237	240
	3		243	247	250	253	256	259	262	265	268	271
	4		274	277	280	283	286	290	293	296	299	302
	5		305	308	311	314	317	320	323	326	330	333
	6		336	339	342	345	348	351	354	357	360	363
	7		366	370	373	376	379	382	385	388	391	394
	8		397	400	403	407	410	413	416	419	422	425
	9		428	431	434	437	440	444	447	450	453	456
0.12	0		459	462	465	468	471	474	477	481	484	487
	1		490	493	496	499	502	505	508	511	515	518
	2		521	524	527	530	533	536	539	542	545	548
	3		552	555	558	561	564	567	570	573	576	579
	4		582	586	589	592	595	598	601	604	607	610
	5		613	617	620	623	626	629	632	635	638	641
	6		644	647	651	654	657	660	663	666	669	672
	7		675	678	682	685	688	691	694	697	700	703
	8		706	709	713	716	719	722	725	728	731	734
	9		737	740	744	747	750	753	756	759	762	765
0.13	0		768	772	775	778	781	784	787	790	793	796
	1		799	803	806	809	812	815	818	821	824	827
	2		831	834	837	840	843	846	849	852	855	859
	3		862	865	868	871	874	877	880	883	886	890
	4		893	896	899	902	905	908	911	915	918	921
	5		924	927	930	933	936	939	943	946	949	952
	6		955	958	961	964	967	971	974	977	980	983
	7		986	989	992	996	999	002	005	008	011	014
	8	4.	017	020	024	027	030	033	036	039	042	045
	9		049	052	055	058	061	064	067	070	074	077
0.14	0		080	083	086	089	092	095	098	102	105	108
	1		111	114	117	120	123	127	130	133	136	139
	2		142	145	148	152	155	158	161	164	167	170
	3		174	177	180	183	186	189	192	195	199	202
	4		205	208	211	214	217	220	224	227	230	233
	5		236	239	242	246	249	252	255	258	261	264
	6		267	271	274	277	280	283	286	289	293	296
	7		299	302	305	308	311	314	318	321	324	327
	8		330	333	336	340	343	346	349	352	355	358
	9		362	365	368	371	374	377	380	383	387	390

20° $R_{20} \longrightarrow S$ ‰

			0	1	2	3	4	5	6	7	8	9
0.15	0	4.	393	396	399	402	405	409	412	415	418	421
	1		424	427	431	434	437	440	443	446	449	453
	2		456	459	462	465	468	471	475	478	481	484
	3		487	490	494	497	500	503	506	509	512	516
	4		519	522	525	528	531	534	538	541	544	547
	5		550	553	556	560	563	566	569	572	575	579
	6		582	585	588	591	594	597	601	604	607	610
	7		613	616	620	623	626	629	632	635	638	642
	8		645	648	651	654	657	661	664	667	670	673
	9		676	679	683	686	689	692	695	698	702	705
0.16	0		708	711	714	717	721	724	727	730	733	736
	1		739	743	746	749	752	755	758	762	765	768
	2		771	774	777	781	784	787	790	793	796	800
	3		803	806	809	812	815	819	822	825	828	831
	4		834	838	841	844	847	850	853	857	860	863
	5		866	869	872	876	879	882	885	888	891	895
	6		898	901	904	907	910	914	917	920	923	926
	7		929	933	936	939	942	945	948	952	955	958
	8		961	964	967	971	974	977	980	983	986	990
	9		993	996	999	002	006	009	012	015	018	021
0.17	0	5.	025	028	031	034	037	040	044	047	050	053
	1		056	060	063	066	069	072	075	079	082	085
	2		088	091	094	098	101	104	107	110	114	117
	3		120	123	126	129	133	136	139	142	145	149
	4		152	155	158	161	164	168	171	174	177	180
	5		184	187	190	193	196	199	203	206	209	212
	6		215	219	222	225	228	231	235	238	241	244
	7		247	250	254	257	260	263	266	270	273	276
	8		279	282	286	289	292	295	298	301	305	308
	9		311	314	317	321	324	327	330	333	337	340
0.18	0		343	346	349	353	356	359	362	365	369	372
	1		375	378	381	384	388	391	394	397	400	404
	2		407	410	413	416	420	423	426	429	432	436
	3		439	442	445	448	452	455	458	461	464	468
	4		471	474	477	480	484	487	490	493	496	500
	5		503	506	509	512	516	519	522	525	528	532
	6		535	538	541	544	548	551	554	557	560	564
	7		567	570	573	576	580	583	586	589	592	596
	8		599	602	605	609	612	615	618	621	625	628
	9		631	634	637	641	644	647	650	653	657	660
0.19	0		663	666	669	673	676	679	682	685	689	692
	1		695	698	702	705	708	711	714	718	721	724
	2		727	730	734	737	740	743	747	750	753	756
	3		759	763	766	769	772	775	779	782	785	788
	4		792	795	798	801	804	808	811	814	817	820
	5		824	827	830	833	837	840	843	846	849	853
	6		856	859	862	865	869	872	875	878	882	885
	7		888	891	894	898	901	904	907	911	914	917
	8		920	923	927	930	933	936	940	943	946	949
	9		952	956	959	962	965	969	972	975	978	981

20° $R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
0.20	0	5.985	988	991	994	998	001	004	007	011	014
	1	6.017	020	023	027	030	033	036	040	043	046
	2	049	052	056	059	062	065	069	072	075	078
	3	082	085	088	091	094	098	101	104	107	111
	4	114	117	120	124	127	130	133	136	140	143
	5	146	149	153	156	159	162	166	169	172	175
	6	178	182	185	188	191	195	198	201	204	208
	7	211	214	217	221	224	227	230	233	237	240
	8	243	246	250	253	256	259	263	266	269	272
	9	276	279	282	285	289	292	295	298	301	305
0.21	0	308	311	314	318	321	324	327	331	334	337
	1	340	344	347	350	353	357	360	363	366	370
	2	373	376	379	383	386	389	392	395	399	402
	3	405	408	412	415	418	421	425	428	431	434
	4	438	441	444	447	451	454	457	460	464	467
	5	470	473	477	480	483	486	490	493	496	499
	6	503	506	509	512	516	519	522	525	529	532
	7	535	538	542	545	548	551	555	558	561	564
	8	568	571	574	577	581	584	587	590	594	597
	9	600	603	607	610	613	616	620	623	626	629
0.22	0	633	636	639	643	646	649	652	656	659	662
	1	665	669	672	675	678	682	685	688	691	695
	2	698	701	704	708	711	714	717	721	724	727
	3	730	734	737	740	744	747	750	753	757	760
	4	763	766	770	773	776	779	783	786	789	792
	5	796	799	802	805	809	812	815	819	822	825
	6	828	832	835	838	841	845	848	851	854	858
	7	861	864	868	871	874	877	881	884	887	890
	8	894	897	900	903	907	910	913	917	920	923
	9	926	930	933	936	939	943	946	949	952	956
0.23	0	959	962	966	969	972	975	979	982	985	988
	1	992	995	998	002	005	008	011	015	018	021
	2	7.024	028	031	034	038	041	044	047	051	054
	3	057	060	064	067	070	074	077	080	083	087
	4	090	093	097	100	103	106	110	113	116	119
	5	123	126	129	133	136	139	142	146	149	152
	6	156	159	162	165	169	172	175	178	182	185
	7	188	192	195	198	201	205	208	211	215	218
	8	221	224	228	231	234	238	241	244	247	251
	9	254	257	261	264	267	270	274	277	280	284
0.24	0	287	290	293	297	300	303	307	310	313	316
	1	320	323	326	330	333	336	339	343	346	349
	2	353	356	359	362	366	369	372	376	379	382
	3	385	389	392	395	399	402	405	408	412	415
	4	418	422	425	428	431	435	438	441	445	448
	5	451	455	458	461	464	468	471	474	478	481
	6	484	487	491	494	497	501	504	507	510	514
	7	517	520	524	527	530	534	537	540	543	547
	8	550	553	557	560	563	567	570	573	576	580
	9	583	586	590	593	596	599	603	606	609	613

20° $R_{20} \longrightarrow S$ ‰

			0	1	2	3	4	5	6	7	8	9
0.25	0	7.	616	619	623	626	629	632	636	639	642	646
	1		649	652	656	659	662	665	669	672	675	679
	2		682	685	689	692	695	699	702	705	708	712
	3		715	718	722	725	728	732	735	738	741	745
	4		748	751	755	758	761	765	768	771	775	778
	5		781	784	788	791	794	798	801	804	808	811
	6		814	817	821	824	827	831	834	837	841	844
	7		847	851	854	857	860	864	867	870	874	877
	8		880	884	887	890	894	897	900	904	907	910
	9		913	917	920	923	927	930	933	937	940	943
0.26	0		947	950	953	957	960	963	966	970	973	976
	1		980	983	986	990	993	996	000	003	006	010
	2	8.	013	016	019	023	026	029	033	036	039	043
	3		046	049	053	056	059	063	066	069	073	076
	4		079	083	086	089	092	096	099	102	106	109
	5		112	116	119	122	126	129	132	136	139	142
	6		146	149	152	156	159	162	166	169	172	175
	7		179	182	185	189	192	195	199	202	205	209
	8		212	215	219	222	225	229	232	235	239	242
	9		245	249	252	255	259	262	265	269	272	275
0.27	0		279	282	285	289	292	295	299	302	305	308
	1		312	315	318	322	325	328	332	335	338	342
	2		345	348	352	355	358	362	365	368	372	375
	3		378	382	385	388	392	395	398	402	405	408
	4		412	415	418	422	425	428	432	435	438	442
	5		445	448	452	455	458	462	465	468	472	475
	6		478	482	485	488	492	495	498	502	505	508
	7		512	515	518	522	525	528	532	535	538	542
	8		545	548	552	555	558	562	565	568	572	575
	9		578	582	585	588	592	595	598	602	605	608
0.28	0		612	615	619	622	625	629	632	635	639	642
	1		645	649	652	655	659	662	665	669	672	675
	2		679	682	685	689	692	695	699	702	705	709
	3		712	715	719	722	725	729	732	735	739	742
	4		746	749	752	756	759	762	766	769	772	776
	5		779	782	786	789	792	796	799	802	806	809
	6		812	816	819	822	826	829	833	836	839	843
	7		846	849	853	856	859	863	866	869	873	876
	8		879	883	886	889	893	896	900	903	906	910
	9		913	916	920	923	926	930	933	936	940	943
0.29	0		946	950	953	956	960	963	967	970	973	977
	1		980	983	987	990	993	997	000	003	007	010
	2	9.	013	017	020	024	027	030	034	037	040	044
	3		047	050	054	057	060	064	067	071	074	077
	4		081	084	087	091	094	097	101	104	107	111
	5		114	118	121	124	128	131	134	138	141	144
	6		148	151	155	158	161	165	168	171	175	178
	7		181	185	188	191	195	198	202	205	208	212
	8		215	218	222	225	228	232	235	239	242	245
	9		249	252	255	259	262	265	269	272	276	279

20° $R_{20} \longrightarrow S‰$

R_{20}			0	1	2	3	4	5	6	7	8	9
0.30	0	9.	282	286	289	292	296	299	302	306	309	313
	1		316	319	323	326	329	333	336	340	343	346
	2		350	353	356	360	363	366	370	373	377	380
	3		383	387	390	393	397	400	404	407	410	414
	4		417	420	424	427	430	434	437	441	444	447
	5		451	454	457	461	464	468	471	474	478	481
	6		484	488	491	495	498	501	505	508	511	515
	7		518	522	525	528	532	535	538	542	545	549
	8		552	555	559	562	565	569	572	576	579	582
	9		586	589	592	596	599	603	606	609	613	616
0.31	0		619	623	626	630	633	636	640	643	646	650
	1		653	657	660	663	667	670	673	677	680	684
	2		687	690	694	697	700	704	707	711	714	717
	3		721	724	728	731	734	738	741	744	748	751
	4		755	758	761	765	768	772	775	778	782	785
	5		788	792	795	799	802	805	809	812	815	819
	6		822	826	829	832	836	839	843	846	849	853
	7		856	859	863	866	870	873	876	880	883	887
	8		890	893	897	900	904	907	910	914	917	920
	9		924	927	931	934	937	941	944	948	951	954
0.32	0		958	961	965	968	971	975	978	981	985	988
	1		992	995	998	002	005	009	012	015	019	022
	2	10.	026	029	032	036	039	043	046	049	053	056
	3		059	063	066	070	073	076	080	083	087	090
	4		093	097	100	104	107	110	114	117	121	124
	5		127	131	134	138	141	144	148	151	155	158
	6		161	165	168	171	175	178	182	185	188	192
	7		195	199	202	205	209	212	216	219	222	226
	8		229	233	236	239	243	246	250	253	256	260
	9		263	267	270	273	277	280	284	287	290	294
0.33	0		297	301	304	307	311	314	318	321	324	328
	1		331	335	338	341	345	348	352	355	358	362
	2		365	369	372	376	379	382	386	389	393	396
	3		399	403	406	410	413	416	420	423	427	430
	4		433	437	440	444	447	450	454	457	461	464
	5		467	471	474	478	481	484	488	491	495	498
	6		502	505	508	512	515	519	522	525	529	532
	7		536	539	542	546	549	553	556	559	563	566
	8		570	573	577	580	583	587	590	594	597	600
	9		604	607	611	614	617	621	624	628	631	635
0.34	0		638	641	645	648	652	655	658	662	665	669
	1		672	675	679	682	686	689	693	696	699	703
	2		706	710	713	716	720	723	727	730	734	737
	3		740	744	747	751	754	757	761	764	768	771
	4		775	778	781	785	788	792	795	798	802	805
	5		809	812	816	819	822	826	829	833	836	839
	6		843	846	850	853	857	860	863	867	870	874
	7		877	881	884	887	891	894	898	901	904	908
	8		911	915	918	922	925	928	932	935	939	942
	9		946	949	952	956	959	963	966	969	973	976

20° $R_{20} \longrightarrow S‰$

			0	1	2	3	4	5	6	7	8	9
0.35	0	10.	980	983	987	990	993	997	000	004	007	011
	1	11.	014	017	021	024	028	031	035	038	041	045
	2		048	052	055	059	062	065	069	072	076	079
	3		083	086	089	093	096	100	103	106	110	113
	4		117	120	124	127	130	134	137	141	144	148
	5		151	155	158	161	165	168	172	175	179	182
	6		185	189	192	196	199	203	206	209	213	216
	7		220	223	227	230	233	237	240	244	247	251
	8		254	257	261	264	268	271	275	278	281	285
	9		288	292	295	299	302	306	309	312	316	319
0.36	0		323	326	330	333	336	340	343	347	350	354
	1		357	360	364	367	371	374	378	381	385	388
	2		391	395	398	402	405	409	412	415	419	422
	3		426	429	433	436	440	443	446	450	453	457
	4		460	464	467	470	474	477	481	484	488	491
	5		495	498	501	505	508	512	515	519	522	526
	6		529	532	536	539	543	546	550	553	556	560
	7		563	567	570	574	577	581	584	587	591	594
	8		598	601	605	608	612	615	618	622	625	629
	9		632	636	639	643	646	649	653	656	660	663
0.37	0		667	670	674	677	680	684	687	691	694	698
	1		701	705	708	711	715	718	722	725	729	732
	2		736	739	743	746	749	753	756	760	763	767
	3		770	774	777	780	784	787	791	794	798	801
	4		805	808	812	815	818	822	825	829	832	836
	5		839	843	846	849	853	856	860	863	867	870
	6		874	877	881	884	887	891	894	898	901	905
	7		908	912	915	919	922	925	929	932	936	939
	8		943	946	950	953	956	960	963	967	970	974
	9		977	981	984	988	991	995	998	001	005	008
0.38	0	12.	012	015	019	022	026	029	033	036	039	043
	1		046	050	053	057	060	064	067	071	074	077
	2		081	084	088	091	095	098	102	105	109	112
	3		116	119	122	126	129	133	136	140	143	147
	4		150	154	157	160	164	167	171	174	178	181
	5		185	188	192	195	199	202	205	209	212	216
	6		219	223	226	230	233	237	240	244	247	251
	7		254	257	261	264	268	271	275	278	282	285
	8		289	292	296	299	302	306	309	313	316	320
	9		323	327	330	334	337	341	344	348	351	354
0.39	0		358	361	365	368	372	375	379	382	386	389
	1		393	396	400	403	406	410	413	417	420	424
	2		427	431	434	438	441	445	448	452	455	458
	3		462	465	469	472	476	479	483	486	490	493
	4		497	500	504	507	511	514	517	521	524	528
	5		531	535	538	542	545	549	552	556	559	563
	6		566	570	573	577	580	583	587	590	594	597
	7		601	604	608	611	615	618	622	625	629	632
	8		636	639	643	646	649	653	656	660	663	667
	9		670	674	677	681	684	688	691	695	698	702

20°

$R_{20} \longrightarrow S$ ‰

	0	1	2	3	4	5	6	7	8	9
0.40 0	12. 705	709	712	716	719	722	726	729	733	736
1	740	743	747	750	754	757	761	764	768	771
2	775	778	782	785	789	792	795	799	802	806
3	809	813	816	820	823	827	830	834	837	841
4	844	848	851	855	858	862	865	869	872	876
5	879	883	886	889	893	896	900	903	907	910
6	914	917	921	924	928	931	935	938	942	945
7	949	952	956	959	963	966	970	973	977	980
8	984	987	990	994	997	001	004	008	011	015
9	13. 018	022	025	029	032	036	039	043	046	050
0.41 0	053	057	060	064	067	071	074	078	081	085
1	088	092	095	099	102	106	109	113	116	119
2	123	126	130	133	137	140	144	147	151	154
3	158	161	165	168	172	175	179	182	186	189
4	193	196	200	203	207	210	214	217	221	224
5	228	231	235	238	242	245	249	252	256	259
6	263	266	270	273	277	280	284	287	291	294
7	298	301	305	308	312	315	318	322	325	329
8	332	336	339	343	346	350	353	357	360	364
9	367	371	374	378	381	385	388	392	395	399
0.42 0	402	406	409	413	416	420	423	427	430	434
1	437	441	444	448	451	455	458	462	465	469
2	472	476	479	483	486	490	493	497	500	504
3	507	511	514	518	521	525	528	532	535	539
4	542	546	549	553	556	560	563	567	570	574
5	577	581	584	588	591	595	598	602	605	609
6	612	616	619	623	626	630	633	637	640	644
7	647	651	654	658	661	665	668	672	675	679
8	682	686	689	693	696	700	703	707	710	714
9	717	721	724	728	731	735	738	742	745	749
0.43 0	752	756	760	763	767	770	774	777	781	784
1	788	791	795	798	802	805	809	812	816	819
2	823	826	830	833	837	840	844	847	851	854
3	858	861	865	868	872	875	879	882	886	889
4	893	896	900	903	907	910	914	917	921	924
5	928	931	935	938	942	945	949	952	956	960
6	963	967	970	974	977	981	984	988	991	995
7	998	002	005	009	012	016	019	023	026	030
8	14. 033	037	040	044	047	051	054	058	061	065
9	068	072	075	079	082	086	089	093	097	100
0.44 0	104	107	111	114	118	121	125	128	132	135
1	139	142	146	149	153	156	160	163	167	170
2	174	177	181	184	188	191	195	199	202	206
3	209	213	216	220	223	227	230	234	237	241
4	244	248	251	255	258	262	265	269	272	276
5	279	283	286	290	294	297	301	304	308	311
6	315	318	322	325	329	332	336	339	343	346
7	350	353	357	360	364	367	371	375	378	382
8	385	389	392	396	399	403	406	410	413	417
9	420	424	427	431	434	438	441	445	449	452

20° $R_{20} \longrightarrow S‰$

			0	1	2	3	4	5	6	7	8	9
0.45	0	14.	456	459	463	466	470	473	477	480	484	487
	1		491	494	498	501	505	508	512	515	519	523
	2		526	530	533	537	540	544	547	551	554	558
	3		561	565	568	572	575	579	582	586	590	593
	4		597	600	604	607	611	614	618	621	625	628
	5		632	635	639	642	646	650	653	657	660	664
	6		667	671	674	678	681	685	688	692	695	699
	7		702	706	710	713	717	720	724	727	731	734
	8		738	741	745	748	752	755	759	763	766	770
	9		773	777	780	784	787	791	794	798	801	805
0.46	0		808	812	816	819	823	826	830	833	837	840
	1		844	847	851	854	858	861	865	869	872	876
	2		879	883	886	890	893	897	900	904	907	911
	3		915	918	922	925	929	932	936	939	943	946
	4		950	953	957	960	964	968	971	975	978	982
	5		985	989	992	996	999	003	006	010	014	017
	6	15.	021	024	028	031	035	038	042	045	049	053
	7		056	060	063	067	070	074	077	081	084	088
	8		091	095	099	102	106	109	113	116	120	123
	9		127	130	134	137	141	145	148	152	155	159
0.47	0		162	166	169	173	176	180	184	187	191	194
	1		198	201	205	208	212	215	219	223	226	230
	2		233	237	240	244	247	251	254	258	262	265
	3		269	272	276	279	283	286	290	293	297	301
	4		304	308	311	315	318	322	325	329	332	336
	5		340	343	347	350	354	357	361	364	368	371
	6		375	379	382	386	389	393	396	400	403	407
	7		410	414	418	421	425	428	432	435	439	442
	8		446	450	453	457	460	464	467	471	474	478
	9		481	485	489	492	496	499	503	506	510	513
0.48	0		517	521	524	528	531	535	538	542	545	549
	1		552	556	560	563	567	570	574	577	581	584
	2		588	592	595	599	602	606	609	613	616	620
	3		624	627	631	634	638	641	645	648	652	656
	4		659	663	666	670	673	677	680	684	688	691
	5		695	698	702	705	709	712	716	720	723	727
	6		730	734	737	741	744	748	752	755	759	762
	7		766	769	773	776	780	784	787	791	794	798
	8		801	805	808	812	816	819	823	826	830	833
	9		837	841	844	848	851	855	858	862	865	869
0.49	0		873	876	880	883	887	890	894	897	901	905
	1		908	912	915	919	922	926	930	933	937	940
	2		944	947	951	954	958	962	965	969	972	976
	3		979	983	987	990	994	997	001	004	008	011
	4	16.	015	019	022	026	029	033	036	040	044	047
	5		051	054	058	061	065	068	072	076	079	083
	6		086	090	093	097	101	104	108	111	115	118
	7		122	126	129	133	136	140	143	147	150	154
	8		158	161	165	168	172	175	179	183	186	190
	9		193	197	200	204	208	211	215	218	222	225

20°

$R_{20} \longrightarrow S$ ‰

R			0	1	2	3	4	5	6	7	8	9
0.50	0	16.	229	233	236	240	243	247	250	254	258	261
	1		265	268	272	275	279	283	286	290	293	297
	2		300	304	308	311	315	318	322	325	329	332
	3		336	340	343	347	350	354	357	361	365	368
	4		372	375	379	382	386	390	393	397	400	404
	5		408	411	415	418	422	425	429	433	436	440
	6		443	447	450	454	458	461	465	468	472	475
	7		479	483	486	490	493	497	500	504	508	511
	8		515	518	522	525	529	533	536	540	543	547
	9		550	554	558	561	565	568	572	576	579	583
0.51	0		586	590	593	597	601	604	608	611	615	618
	1		622	626	629	633	636	640	643	647	651	654
	2		658	661	665	669	672	676	679	683	686	690
	3		694	697	701	704	708	711	715	719	722	726
	4		729	733	737	740	744	747	751	754	758	762
	5		765	769	772	776	780	783	787	790	794	797
	6		801	805	808	812	815	819	823	826	830	833
	7		837	840	844	848	851	855	858	862	865	869
	8		873	876	880	883	887	891	894	898	901	905
	9		909	912	916	919	923	926	930	934	937	941
0.52	0		944	948	952	955	959	962	966	969	973	977
	1		980	984	987	991	995	998	002	005	009	012
	2	17.	016	020	023	027	030	034	038	041	045	048
	3		052	056	059	063	066	070	073	077	081	084
	4		088	091	095	099	102	106	109	113	117	120
	5		124	127	131	134	138	142	145	149	152	156
	6		160	163	167	170	174	178	181	185	188	192
	7		196	199	203	206	210	213	217	221	224	228
	8		231	235	239	242	246	249	253	257	260	264
	9		267	271	275	278	282	285	289	293	296	300
0.53	0		303	307	310	314	318	321	325	328	332	336
	1		339	343	346	350	354	357	361	364	368	372
	2		375	379	382	386	390	393	397	400	404	408
	3		411	415	418	422	426	429	433	436	440	443
	4		447	451	454	458	461	465	469	472	476	479
	5		483	487	490	494	497	501	505	508	512	515
	6		519	523	526	530	533	537	541	544	548	551
	7		555	559	562	566	569	573	577	580	584	587
	8		591	595	598	602	605	609	613	616	620	623
	9		627	631	634	638	641	645	649	652	656	659
0.54	0		663	667	670	674	677	681	685	688	692	695
	1		699	703	706	710	713	717	721	724	728	731
	2		735	739	742	746	749	753	757	760	764	767
	3		771	775	778	782	786	789	793	796	800	804
	4		807	811	814	818	822	825	829	832	836	840
	5		843	847	850	854	858	861	865	868	872	876
	6		879	883	886	890	894	897	901	904	908	912
	7		915	919	923	926	930	933	937	941	944	948
	8		951	955	959	962	966	969	973	977	980	984
	9		987	991	995	998	002	006	009	013	016	020

20°

$R_{20} \longrightarrow S$ ‰

	0	1	2	3	4	5	6	7	8	9
0.55 0	18. 024	027	031	034	038	042	045	049	052	056
1	060	063	067	070	074	078	081	085	089	092
2	096	099	103	107	110	114	117	121	125	128
3	132	135	139	143	146	150	154	157	161	164
4	168	172	175	179	182	186	190	193	197	201
5	204	208	211	215	219	222	226	229	233	237
6	240	244	247	251	255	258	262	266	269	273
7	276	280	284	287	291	294	298	302	305	309
8	313	316	320	323	327	331	334	338	341	345
9	349	352	356	360	363	367	370	374	378	381
0.56 0	385	389	392	396	399	403	407	410	414	417
1	421	425	428	432	436	439	443	446	450	454
2	457	461	464	468	472	475	479	483	486	490
3	493	497	501	504	508	512	515	519	522	526
4	530	533	537	541	544	548	551	555	559	562
5	566	569	573	577	580	584	588	591	595	598
6	602	606	609	613	617	620	624	627	631	635
7	638	642	646	649	653	656	660	664	667	671
8	675	678	682	685	689	693	696	700	704	707
9	711	714	718	722	725	729	733	736	740	743
0.57 0	747	751	754	758	762	765	769	772	776	780
1	783	787	791	794	798	801	805	809	812	816
2	820	823	827	830	834	838	841	845	849	852
3	856	859	863	867	870	874	878	881	885	888
4	892	896	899	903	907	910	914	917	921	925
5	928	932	936	939	943	947	950	954	957	961
6	965	968	972	976	979	983	986	990	994	997
7	19. 001	005	008	012	015	019	023	026	030	034
8	037	041	045	048	052	055	059	063	066	070
9	074	077	081	084	088	092	095	099	103	106
0.58 0	110	114	117	121	124	128	132	135	139	143
1	146	150	153	157	161	164	168	172	175	179
2	183	186	190	193	197	201	204	208	212	215
3	219	223	226	230	233	237	241	244	248	252
4	255	259	263	266	270	273	277	281	284	288
5	292	295	299	303	306	310	313	317	321	324
6	328	332	335	339	343	346	350	353	357	361
7	364	368	372	375	379	383	386	390	393	397
8	401	404	408	412	415	419	423	426	430	434
9	437	441	444	448	452	455	459	463	466	470
0.59 0	474	477	481	484	488	492	495	499	503	506
1	510	514	517	521	525	528	532	535	539	543
2	546	550	554	557	561	565	568	572	576	579
3	583	586	590	594	597	601	605	608	612	616
4	619	623	627	630	634	637	641	645	648	652
5	656	659	663	667	670	674	678	681	685	688
6	692	696	699	703	707	710	714	718	721	725
7	729	732	736	739	743	747	750	754	758	761
8	765	769	772	776	780	783	787	791	794	798
9	801	805	809	812	816	820	823	827	831	834

20° $R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
0.60 0	19.	838	842	845	849	853	856	860	863	867	871
1		874	878	882	885	889	893	896	900	904	907
2		911	915	918	922	926	929	933	936	940	944
3		947	951	955	958	962	966	969	973	977	980
4		984	988	991	995	999	002	006	009	013	017
5	20.	020	024	028	031	035	039	042	046	050	053
6		057	061	064	068	072	075	079	083	086	090
7		093	097	101	104	108	112	115	119	123	126
8		130	134	137	141	145	148	152	156	159	163
9		167	170	174	178	181	185	189	192	196	199
0.61 0		203	207	210	214	218	221	225	229	232	236
1		240	243	247	251	254	258	262	265	269	273
2		276	280	284	287	291	295	298	302	306	309
3		313	316	320	324	327	331	335	338	342	346
4		349	353	357	360	364	368	371	375	379	382
5		386	390	393	397	401	404	408	412	415	419
6		423	426	430	434	437	441	445	448	452	456
7		459	463	467	470	474	477	481	485	488	492
8		496	499	503	507	510	514	518	521	525	529
9		532	536	540	543	547	551	554	558	562	565
0.62 0		569	573	576	580	584	587	591	595	598	602
1		606	609	613	617	620	624	628	631	635	639
2		642	646	650	653	657	661	664	668	672	675
3		679	683	686	690	694	697	701	705	708	712
4		716	719	723	727	730	734	738	741	745	749
5		752	756	760	763	767	771	774	778	782	785
6		789	793	796	800	804	807	811	815	818	822
7		826	829	833	837	840	844	848	851	855	859
8		862	866	870	873	877	881	884	888	892	895
9		899	903	906	910	914	917	921	925	928	932
0.63 0		936	939	943	947	950	954	958	961	965	969
1		972	976	980	983	987	991	994	998	002	005
2	21.	009	013	016	020	024	027	031	035	038	042
3		046	049	053	057	061	064	068	072	075	079
4		083	086	090	094	097	101	105	108	112	116
5		119	123	127	130	134	138	141	145	149	152
6		156	160	163	167	171	174	178	182	185	189
7		193	196	200	204	207	211	215	219	222	226
8		230	233	237	241	244	248	252	255	259	263
9		266	270	274	277	281	285	288	292	296	299
0.64 0		303	307	310	314	318	321	325	329	332	336
1		340	344	347	351	355	358	362	366	369	373
2		377	380	384	388	391	395	399	402	406	410
3		413	417	421	424	428	432	436	439	443	447
4		450	454	458	461	465	469	472	476	480	483
5		487	491	494	498	502	505	509	513	516	520
6		524	528	531	535	539	542	546	550	553	557
7		561	564	568	572	575	579	583	586	590	594
8		597	601	605	609	612	616	620	623	627	631
9		634	638	642	645	649	653	656	660	664	667

20° $R_{20} \longrightarrow S‰$

			0	1	2	3	4	5	6	7	8	9
0.65	0	21.	671	675	679	682	686	690	693	697	701	704
	1		708	712	715	719	723	726	730	734	738	741
	2		745	749	752	756	760	763	767	771	774	778
	3		782	785	789	793	797	800	804	808	811	815
	4		819	822	826	830	833	837	841	844	848	852
	5		856	859	863	867	870	874	878	881	885	889
	6		892	896	900	903	907	911	915	918	922	926
	7		929	933	937	940	944	948	951	955	959	962
	8		966	970	974	977	981	985	988	992	996	999
	9	22.	003	007	010	014	018	022	025	029	033	036
0.66	0		040	044	047	051	055	058	062	066	070	073
	1		077	081	084	088	092	095	099	103	106	110
	2		114	118	121	125	129	132	136	140	143	147
	3		151	154	158	162	166	169	173	177	180	184
	4		188	191	195	199	203	206	210	214	217	221
	5		225	228	232	236	239	243	247	251	254	258
	6		262	265	269	273	276	280	284	288	291	295
	7		299	302	306	310	313	317	321	325	328	332
	8		336	339	343	347	350	354	358	361	365	369
	9		373	376	380	384	387	391	395	398	402	406
0.67	0		410	413	417	421	424	428	432	435	439	443
	1		447	450	454	458	461	465	469	472	476	480
	2		484	487	491	495	498	502	506	509	513	517
	3		521	524	528	532	535	539	543	546	550	554
	4		558	561	565	569	572	576	580	584	587	591
	5		595	598	602	606	609	613	617	621	624	628
	6		632	635	639	643	646	650	654	658	661	665
	7		669	672	676	680	684	687	691	695	698	702
	8		706	709	713	717	721	724	728	732	735	739
	9		743	746	750	754	758	761	765	769	772	776
0.68	0		780	784	787	791	795	798	802	806	809	813
	1		817	821	824	828	832	835	839	843	847	850
	2		854	858	861	865	869	873	876	880	884	887
	3		891	895	898	902	906	910	913	917	921	924
	4		928	932	936	939	943	947	950	954	958	962
	5		965	969	973	976	980	984	988	991	995	999
	6	23.	002	006	010	013	017	021	025	028	032	036
	7		039	043	047	051	054	058	062	065	069	073
	8		077	080	084	088	091	095	099	103	106	110
	9		114	117	121	125	129	132	136	140	143	147
0.69	0		151	155	158	162	166	169	173	177	181	184
	1		188	192	195	199	203	207	210	214	218	221
	2		225	229	233	236	240	244	247	251	255	259
	3		262	266	270	273	277	281	285	288	292	296
	4		299	303	307	311	314	318	322	325	329	333
	5		337	340	344	348	351	355	359	363	366	370
	6		374	377	381	385	389	392	396	400	404	407
	7		411	415	418	422	426	430	433	437	441	444
	8		448	452	456	459	463	467	470	474	478	482
	9		485	489	493	496	500	504	508	511	515	519

20° $R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
0.70 0	23.	523	526	530	534	537	541	545	549	552	556
1		560	563	567	571	575	578	582	586	590	593
2		597	601	604	608	612	616	619	623	627	630
3		634	638	642	645	649	653	657	660	664	668
4		671	675	679	683	686	690	694	697	701	705
5		709	712	716	720	724	727	731	735	738	742
6		746	750	753	757	761	765	768	772	776	779
7		783	787	791	794	798	802	805	809	813	817
8		820	824	828	832	835	839	843	846	850	854
9		858	861	865	869	873	876	880	884	887	891
0.71 0		895	899	902	906	910	914	917	921	925	928
1		932	936	940	943	947	951	955	958	962	966
2		969	973	977	981	984	988	992	996	999	003
3	24.	007	011	014	018	022	025	029	033	037	040
4		044	048	052	055	059	063	066	070	074	078
5		081	085	089	093	096	100	104	108	111	115
6		119	122	126	130	134	137	141	145	149	152
7		156	160	163	167	171	175	178	182	186	190
8		193	197	201	205	208	212	216	219	223	227
9		231	234	238	242	246	249	253	257	261	264
0.72 0		268	272	276	279	283	287	290	294	298	302
1		305	309	313	317	320	324	328	332	335	339
2		343	346	350	354	358	361	365	369	373	376
3		380	384	388	391	395	399	403	406	410	414
4		417	421	425	429	432	436	440	444	447	451
5		455	459	462	466	470	474	477	481	485	489
6		492	496	500	503	507	511	515	518	522	526
7		530	533	537	541	545	548	552	556	560	563
8		567	571	575	578	582	586	589	593	597	601
9		604	608	612	616	619	623	627	631	634	638
0.73 0		642	646	649	653	657	661	664	668	672	676
1		679	683	687	690	694	698	702	705	709	713
2		717	720	724	728	732	735	739	743	747	750
3		754	758	762	765	769	773	777	780	784	783
4		792	795	799	803	807	810	814	818	822	825
5		829	833	837	840	844	848	851	855	859	863
6		866	870	874	878	881	885	889	893	896	900
7		904	908	911	915	919	923	926	930	934	938
8		941	945	949	953	956	960	964	968	971	975
9		979	983	986	990	994	998	001	005	009	013
0.74 0	25.	016	020	024	028	031	035	039	043	046	050
1		054	058	061	065	069	073	076	080	084	088
2		091	095	099	103	106	110	114	118	121	125
3		129	133	136	140	144	148	151	155	159	163
4		166	170	174	178	181	185	189	193	196	200
5		204	208	211	215	219	223	226	230	234	238
6		241	245	249	253	256	260	264	268	271	275
7		279	283	286	290	294	298	301	305	309	313
8		316	320	324	328	331	335	339	343	347	350
9		354	358	362	365	369	373	377	380	384	388

20°

$R_{20} \longrightarrow S$ ‰

			0	1	2	3	4	5	6	7	8	9
0.75	0	25.	392	395	399	403	407	410	414	418	422	425
	1		429	433	437	440	444	448	452	455	459	463
	2		467	470	474	478	482	485	489	493	497	501
	3		504	508	512	516	519	523	527	531	534	538
	4		542	546	549	553	557	561	564	568	572	576
	5		579	583	587	591	594	598	602	606	610	613
	6		617	621	625	628	632	636	640	643	647	651
	7		655	658	662	666	670	673	677	681	685	688
	8		692	696	700	704	707	711	715	719	722	726
	9		730	734	737	741	745	749	752	756	760	764
0.76	0		767	771	775	779	783	786	790	794	798	801
	1		805	809	813	816	820	824	828	831	835	839
	2		843	847	850	854	858	862	865	869	873	877
	3		880	884	888	892	895	899	903	907	911	914
	4		918	922	926	929	933	937	941	944	948	952
	5		956	959	963	967	971	975	978	982	986	990
	6		993	997	001	005	008	012	016	020	024	027
	7	26.	031	035	039	042	040	050	054	057	061	065
	8		069	072	076	080	084	088	091	095	099	103
	9		106	110	114	118	121	125	129	133	137	140
0.77	0		144	148	152	155	159	163	167	170	174	178
	1		182	186	189	193	197	201	204	208	212	216
	2		220	223	227	231	235	238	242	246	250	253
	3		257	261	265	269	272	276	280	284	287	291
	4		295	299	302	306	310	314	318	321	325	329
	5		333	336	340	344	348	352	355	359	363	367
	6		370	374	378	382	386	389	393	397	401	404
	7		408	412	416	419	423	427	431	435	438	442
	8		446	450	453	457	461	465	469	472	476	480
	9		484	487	491	495	499	503	506	510	514	518
0.78	0		521	525	529	533	537	540	544	548	552	555
	1		559	563	567	571	574	578	582	586	589	593
	2		597	601	605	608	612	616	620	623	627	631
	3		635	639	642	646	650	654	657	661	665	669
	4		673	676	680	684	688	691	695	699	703	707
	5		710	714	718	722	725	729	733	737	741	744
	6		748	752	756	759	763	767	771	775	778	782
	7		786	790	794	797	801	805	809	812	816	820
	8		824	828	831	835	839	843	846	850	854	858
	9		862	865	869	873	877	881	884	888	892	896
0.79	0		899	903	907	911	915	918	922	926	930	933
	1		937	941	945	949	952	956	960	964	968	971
	2		975	979	983	986	990	994	998	002	005	009
	3	27.	013	017	021	024	028	032	036	039	043	047
	4		051	055	058	062	066	070	074	077	081	085
	5		089	092	096	100	104	108	111	115	119	123
	6		127	130	134	138	142	146	149	153	157	161
	7		164	168	172	176	180	183	187	191	195	199
	8		202	206	210	214	217	221	225	229	233	236
	9		240	244	248	252	255	259	263	267	271	274

20°

$R_{20} \longrightarrow S‰_{0}$

R			0	1	2	3	4	5	6	7	8	9
0.80	0	27.	278	282	286	290	293	297	301	305	308	312
	1		316	320	324	327	331	335	339	343	346	350
	2		354	358	362	365	369	373	377	381	384	388
	3		392	396	399	403	407	411	415	418	422	426
	4		430	434	437	441	445	449	453	456	460	464
	5		468	472	475	479	483	487	491	494	498	502
	6		506	509	513	517	521	525	528	532	536	540
	7		544	547	551	555	559	563	566	570	574	578
	8		582	585	589	593	597	601	604	608	612	616
	9		620	623	627	631	635	639	642	646	650	654
0.81	0		658	661	665	669	673	677	680	684	688	692
	1		696	699	703	707	711	715	718	722	726	730
	2		734	737	741	745	749	753	756	760	764	768
	3		772	775	779	783	787	791	794	798	802	806
	4		810	813	817	821	825	829	832	836	840	844
	5		848	851	855	859	863	867	870	874	878	882
	6		886	889	893	897	901	905	908	912	916	920
	7		924	927	931	935	939	943	946	950	954	958
	8		962	965	969	973	977	981	984	988	992	996
	9	28.	000	003	007	011	015	019	022	026	030	034
0.82	0		038	041	045	049	053	057	060	064	068	072
	1		076	080	083	087	091	095	099	102	106	110
	2		114	118	121	125	129	133	137	140	144	148
	3		152	156	159	163	167	171	175	178	182	186
	4		190	194	198	201	205	209	213	217	220	224
	5		228	232	236	239	243	247	251	255	258	262
	6		266	270	274	277	281	285	289	293	297	300
	7		304	308	312	316	319	323	327	331	335	338
	8		342	346	350	354	357	361	365	369	373	377
	9		380	384	388	392	396	399	403	407	411	415
0.83	0		418	422	426	430	434	438	441	445	449	453
	1		457	460	464	468	472	476	479	483	487	491
	2		495	499	502	506	510	514	518	521	525	529
	3		533	537	540	544	548	552	556	560	563	567
	4		571	575	579	582	586	590	594	598	601	605
	5		609	613	617	621	624	628	632	636	640	643
	6		647	651	655	659	663	666	670	674	678	682
	7		685	689	693	697	701	705	708	712	716	720
	8		724	727	731	735	739	743	747	750	754	758
	9		762	766	769	773	777	781	785	788	792	796
0.84	0		800	804	808	811	815	819	823	827	831	834
	1		838	842	846	850	853	857	861	865	869	873
	2		876	880	884	888	892	895	899	903	907	911
	3		915	918	922	926	930	934	937	941	945	949
	4		953	957	960	964	968	972	976	980	983	987
	5		991	995	999	002	006	010	014	018	022	025
	6	29.	029	033	037	041	044	048	052	056	060	064
	7		067	071	075	079	083	087	090	094	098	102
	8		106	109	113	117	121	125	129	132	136	140
	9		144	148	152	155	159	163	167	171	175	178

20°

$R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
0.85 0	29.	182	186	190	194	197	201	205	209	213	217
1		220	224	228	232	236	240	243	247	251	255
2		259	263	266	270	274	278	282	285	289	293
3		297	301	305	308	312	316	320	324	328	331
4		335	339	343	347	351	354	358	362	366	370
5		374	377	381	385	389	393	396	400	404	408
6		412	416	419	423	427	431	435	439	442	446
7		450	454	458	462	465	469	473	477	481	485
8		488	492	496	500	504	508	511	515	519	523
9		527	531	534	538	542	546	550	554	557	561
0.86 0		565	569	573	577	580	584	588	592	596	600
1		603	607	611	615	619	623	626	630	634	638
2		642	646	649	653	657	661	665	669	672	676
3		680	684	688	692	695	699	703	707	711	715
4		718	722	726	730	734	738	741	745	749	753
5		757	761	764	768	772	776	780	784	787	791
6		795	799	803	807	810	814	818	822	826	830
7		834	837	841	845	849	853	857	860	864	868
8		872	876	880	883	887	891	895	899	903	906
9		910	914	918	922	926	929	933	937	941	945
0.87 0		949	953	956	960	964	968	972	976	979	983
1		987	991	995	999	002	006	010	014	018	022
2	30.	025	029	033	037	041	045	049	052	056	060
3		064	068	072	075	079	083	087	091	095	098
4		102	106	110	114	118	122	125	129	133	137
5		141	145	148	152	156	160	164	168	171	175
6		179	183	187	191	195	198	202	206	210	214
7		218	221	225	229	233	237	241	245	248	252
8		256	260	264	268	271	275	279	283	287	291
9		295	298	302	306	310	314	318	321	325	329
0.88 0		333	337	341	345	348	352	356	360	364	368
1		371	375	379	383	387	391	395	398	402	406
2		410	414	418	421	425	429	433	437	441	445
3		448	452	456	460	464	468	472	475	479	483
4		487	491	495	498	502	506	510	514	518	522
5		525	529	533	537	541	545	548	552	556	560
6		564	568	572	575	579	583	587	591	595	599
7		602	606	610	614	618	622	626	629	633	637
8		641	645	649	652	656	660	664	668	672	676
9		679	683	687	691	695	699	703	706	710	714
0.89 0		718	722	726	730	733	737	741	745	749	753
1		757	760	764	768	772	776	780	784	787	791
2		795	799	803	807	810	814	818	822	826	830
3		834	837	841	845	849	853	857	861	864	868
4		872	876	880	884	888	891	895	899	903	907
5		911	915	918	922	926	930	934	938	942	945
6		949	953	957	961	965	969	972	976	980	984
7		988	992	996	999	003	007	011	015	019	023
8	31.	027	030	034	038	042	046	050	054	057	061
9		065	069	073	077	081	084	088	092	096	100

20° $R_{20} \longrightarrow S$ ‰

	0	1	2	3	4	5	6	7	8	9
0.90 0	31. 104	108	111	115	119	123	127	131	135	138
1	142	146	150	154	158	162	165	169	173	177
2	181	185	189	193	196	200	204	208	212	216
3	220	223	227	231	235	239	243	247	250	254
4	258	262	266	270	274	278	281	285	289	293
5	297	301	305	308	312	316	320	324	328	332
6	335	339	343	347	351	355	359	363	366	370
7	374	378	382	386	390	393	397	401	405	409
8	413	417	421	424	428	432	436	440	444	448
9	451	455	459	463	467	471	475	479	482	486
0.91 0	490	494	498	502	506	509	513	517	521	525
1	529	533	537	540	544	548	552	556	560	564
2	568	571	575	579	583	587	591	595	598	602
3	606	610	614	618	622	626	629	633	637	641
4	645	649	653	657	660	664	668	672	676	680
5	684	687	691	695	699	703	707	711	715	718
6	722	726	730	734	738	742	746	749	753	757
7	761	765	769	773	777	780	784	788	792	796
8	800	804	808	811	815	819	823	827	831	835
9	839	842	846	850	854	858	862	866	870	873
0.92 0	877	881	885	889	893	897	901	904	908	912
1	916	920	924	928	932	935	939	943	947	951
2	955	959	963	966	970	974	978	982	986	990
3	994	997	001	005	009	013	017	021	025	028
4	32. 032	036	040	044	048	052	056	059	063	067
5	071	075	079	083	087	090	094	098	102	106
6	110	114	118	122	125	129	133	137	141	145
7	149	153	156	160	164	168	172	176	180	184
8	187	191	195	199	203	207	211	215	219	222
9	226	230	234	238	242	246	250	253	257	261
0.93 0	265	269	273	277	281	285	288	292	296	300
1	304	308	312	316	319	323	327	331	335	339
2	343	347	351	354	358	362	366	370	374	378
3	382	385	389	393	397	401	405	409	413	417
4	420	424	428	432	436	440	444	448	452	455
5	459	463	467	471	475	479	483	487	490	494
6	498	502	506	510	514	518	521	525	529	533
7	537	541	545	549	553	556	560	564	568	572
8	576	580	584	588	591	595	599	603	607	611
9	615	619	623	626	630	634	638	642	646	650
0.94 0	654	658	661	665	669	673	677	681	685	689
1	693	696	700	704	708	712	716	720	724	728
2	731	735	739	743	747	751	755	759	763	766
3	770	774	778	782	786	790	794	798	802	805
4	809	813	817	821	825	829	833	837	840	844
5	848	852	856	860	864	868	872	875	879	883
6	887	891	895	899	903	907	911	914	918	922
7	926	930	934	938	942	946	949	953	957	961
8	965	969	973	977	981	985	988	992	996	000
9	33. 004	008	012	016	020	023	027	031	035	039

20° $R_{20} \longrightarrow S‰$

		0	1	2	3	4	5	6	7	8	9
0.95 0	33.	043	047	051	055	059	062	066	070	074	078
1		082	086	090	094	097	101	105	109	113	117
2		121	125	129	133	136	140	144	148	152	156
3		160	164	168	172	175	179	183	187	191	195
4		199	203	207	211	214	218	222	226	230	234
5		238	242	246	250	253	257	261	265	269	273
6		277	281	285	289	292	296	300	304	308	312
7		316	320	324	328	331	335	339	343	347	351
8		355	359	363	367	370	374	378	382	386	390
9		394	398	402	406	410	413	417	421	425	429
0.96 0		433	437	441	445	449	452	456	460	464	468
1		472	476	480	484	488	491	495	499	503	507
2		511	515	519	523	527	531	534	538	542	546
3		550	554	558	562	566	570	573	577	581	585
4		589	593	597	601	605	609	613	616	620	624
5		628	632	636	640	644	648	652	656	659	663
6		667	671	675	679	683	687	691	695	699	702
7		706	710	714	718	722	726	730	734	738	742
8		745	749	753	757	761	765	769	773	777	781
9		785	788	792	796	800	804	808	812	816	820
0.97 0		824	828	831	835	839	843	847	851	855	859
1		863	867	871	874	878	882	886	890	894	898
2		902	906	910	914	917	921	925	929	933	937
3		941	945	949	953	957	961	964	968	972	976
4		980	984	988	992	996	000	004	007	011	015
5	34.	019	023	027	031	035	039	043	047	051	054
6		058	062	066	070	074	078	082	086	090	094
7		098	101	105	109	113	117	121	125	129	133
8		137	141	145	148	152	156	160	164	168	172
9		176	180	184	188	192	195	199	203	207	211
0.98 0		215	219	223	227	231	235	239	242	246	250
1		254	258	262	266	270	274	278	282	286	289
2		293	297	301	305	309	313	317	321	325	329
3		333	337	340	344	348	352	356	360	364	368
4		372	376	380	384	387	391	395	399	403	407
5		411	415	419	423	427	431	435	438	442	446
6		450	454	458	462	466	470	474	478	482	486
7		489	493	497	501	505	509	513	517	521	525
8		529	533	537	540	544	548	552	556	560	564
9		568	572	576	580	584	588	591	595	599	603
0.99 0		607	611	615	619	623	627	631	635	639	642
1		646	650	654	658	662	666	670	674	678	682
2		686	690	694	697	701	705	709	713	717	721
3		725	729	733	737	741	745	748	752	756	760
4		764	768	772	776	780	784	788	792	796	800
5		803	807	811	815	819	823	827	831	835	839
6		843	847	851	855	858	862	866	870	874	878
7		882	886	890	894	898	902	906	910	914	917
8		921	925	929	933	937	941	945	949	953	957
9		961	965	969	972	976	980	984	988	992	996

20° $R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
1.00 0	35.	000	004	008	012	016	020	024	028	031	035
1		039	043	047	051	055	059	063	067	071	075
2		079	083	087	090	094	098	102	106	110	114
3		118	122	126	130	134	138	142	146	149	153
4		157	161	165	169	173	177	181	185	189	193
5		197	201	205	208	212	216	220	224	228	232
6		236	240	244	248	252	256	260	264	268	271
7		275	279	283	287	291	295	299	303	307	311
8		315	319	323	327	331	334	338	342	346	350
9		354	358	362	366	370	374	378	382	386	390
1.01 0		394	398	401	405	409	413	417	421	425	429
1		433	437	441	445	449	453	457	461	464	468
2		472	476	480	484	488	492	496	500	504	508
3		512	516	520	524	528	531	535	539	543	547
4		551	555	559	563	567	571	575	579	583	587
5		591	595	599	602	606	610	614	618	622	626
6		630	634	638	642	646	650	654	658	662	666
7		669	673	677	681	685	689	693	697	701	705
8		709	713	717	721	725	729	733	737	740	744
9		748	752	756	760	764	768	772	776	780	784
1.02 0		788	792	796	800	804	808	812	815	819	823
1		827	831	835	839	843	847	851	855	859	863
2		867	871	875	879	883	887	890	894	898	902
3		906	910	914	918	922	926	930	934	938	942
4		946	950	954	958	962	966	969	973	977	981
5		985	989	993	997	001	005	009	013	017	021
6	36.	025	029	033	037	041	045	048	052	056	060
7		064	068	072	076	080	084	088	092	096	100
8		104	108	112	116	120	124	128	131	135	139
9		143	147	151	155	159	163	167	171	175	179
1.03 0		183	187	191	195	199	203	207	211	214	218
1		222	226	230	234	238	242	246	250	254	258
2		262	266	270	274	278	282	286	290	294	298
3		301	305	309	313	317	321	325	329	333	337
4		341	345	349	353	357	361	365	369	373	377
5		381	385	389	392	396	400	404	408	412	416
6		420	424	428	432	436	440	444	448	452	456
7		460	464	468	472	476	480	484	487	491	495
8		499	503	507	511	515	519	523	527	531	535
9		539	543	547	551	555	559	563	567	571	575
1.04 0		579	583	586	590	594	598	602	606	610	614
1		618	622	626	630	634	638	642	646	650	654
2		658	662	666	670	674	678	682	686	690	693
3		697	701	705	709	713	717	721	725	729	733
4		737	741	745	749	753	757	761	765	769	773
5		777	781	785	789	793	797	800	804	808	812
6		816	820	824	828	832	836	840	844	848	852
7		856	860	864	868	872	876	880	884	888	892
8		896	900	904	908	912	916	919	923	927	931
9		935	939	943	947	951	955	959	963	967	971

20° $R_{20} \longrightarrow S$ ‰

		0	1	2	3	4	5	6	7	8	9
1.05 0	36.	975	979	983	987	991	995	999	003	007	011
1	37.	015	019	023	027	031	035	039	042	046	050
2		054	058	062	066	070	074	078	082	086	090
3		094	098	102	106	110	114	118	122	126	130
4		134	138	142	146	150	154	158	162	166	170
5		174	177	181	185	189	193	197	201	205	209
6		213	217	221	225	229	233	237	241	245	249
7		253	257	261	265	269	273	277	281	285	289
8		293	297	301	305	309	313	317	321	324	328
9		332	336	340	344	348	352	356	360	364	368
1.06 0		372	376	380	384	388	392	396	400	404	408
1		412	416	420	424	428	432	436	440	444	448
2		452	456	460	464	468	472	476	480	484	487
3		491	495	499	503	507	511	515	519	523	527
4		531	535	539	543	547	551	555	559	563	567
5		571	575	579	583	587	591	595	599	603	607
6		611	615	619	623	627	631	635	639	643	647
7		651	655	659	663	667	671	675	678	682	686
8		690	694	698	702	706	710	714	718	722	726
9		730	734	738	742	746	750	754	758	762	766
1.07 0		770	774	778	782	786	790	794	798	802	806
1		810	814	818	822	826	830	834	838	842	846
2		850	854	858	862	866	870	874	878	882	886
3		890	894	898	902	906	909	913	917	921	925
4		929	933	937	941	945	949	953	957	961	965
5		969	973	977	981	985	989	993	997	001	005
6	38.	009	013	017	021	025	029	033	037	041	045
7		049	053	057	061	065	069	073	077	081	085
8		089	093	097	101	105	109	113	117	121	125
9		129	133	137	141	145	149	153	157	161	165
1.08 0		169	173	177	181	185	189	193	197	201	205
1		209	213	217	221	225	229	233	237	240	244
2		248	252	256	260	264	268	272	276	280	284
3		288	292	296	300	304	308	312	316	320	324
4		328	332	336	340	344	348	352	356	360	364
5		368	372	376	380	384	388	392	396	400	404
6		408	412	416	420	424	428	432	436	440	444
7		448	452	456	460	464	468	472	476	480	484
8		488	492	496	500	504	508	512	516	520	524
9		528	532	536	540	544	548	552	556	560	564
1.09 0		568	572	576	580	584	588	592	596	600	604
1		608	612	616	620	624	628	632	636	640	644
2		648	652	656	660	664	668	672	676	680	684
3		688	692	696	700	704	708	712	716	720	724
4		728	732	736	740	744	748	752	756	760	764
5		768	772	776	780	784	788	792	796	800	804
6		808	812	816	820	824	828	832	836	840	844
7		848	852	856	860	864	868	872	876	880	884
8		888	892	896	900	904	908	912	916	920	924
9		928	932	936	940	944	948	952	956	960	964