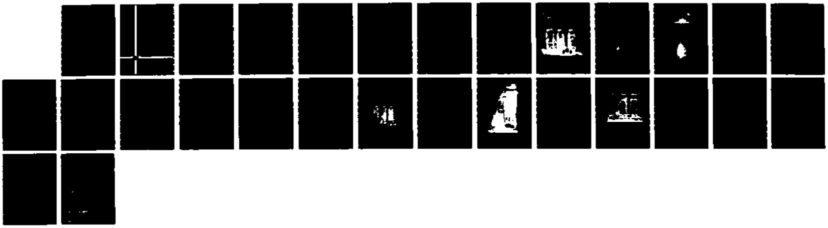
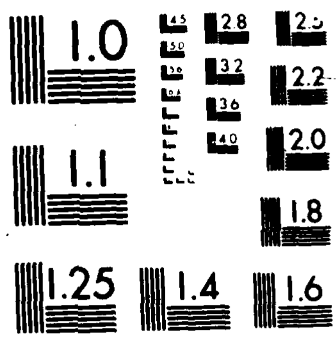
AD-A172 655 EVALUATION OF THE SAREX (TRADE NAME) 5 GPM OIL-WATER SEPARATOR TYPE B(U) ARMY BELVOIR RESEARCH DEVELOPMENT AND ENGINEERING CENTER FORT BELVOIR VA G D MUSA JUN 86 1/1

UNCLASSIFIED BRDEC-2435 F/G 13/11 NL




1.0
2.8
3.2
3.6
4.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

AD-A172 655

AD

Report 2435

EVALUATION OF THE SAREX® 5 GPM OIL-WATER SEPARATOR, TYPE B

by
Gregory D. Musa

June 1986

United States Army
Belvoir Research, Development & Engineering Center
Fort Belvoir, Virginia 22060-5606

Belvoir RD&E Center

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD A192 652

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Report Number 2435	5. MONITORING ORGANIZATION REPORT NUMBER(S) Same
6a. NAME OF PERFORMING ORGANIZATION Fuel & Water Supply Division — 6b. OFFICE SYMBOL (If applicable) STRBE-GS	7a. NAME OF MONITORING ORGANIZATION Same
6c. ADDRESS (City, State, and ZIP Code) Belvoir Research, Development and Engineering Center Fort Belvoir, VA 22060-5606	7b. ADDRESS (City, State, and ZIP Code) Same
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Same — 8b. OFFICE SYMBOL (If applicable) Same	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Same	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

EVALUATION OF THE SAREX® 5 GPM Oil-Water Separator, Type B

12. PERSONAL AUTHOR(S)
Gregory D. Musa

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final Report	FROM ____ TO ____		

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Oil-Water Separator, Oily Wastewater, Test Procedures, ROWPU, Coalescence, Prefilter Elements, Testing, Coalescer Elements, Test Apparatus, Prefilters

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report covers an investigation conducted to evaluate the operational effectiveness of the Sarex® 5 GPM Oil-Water Separator, Type B. The results of this study indicate that the Sarex® 5 GPM Oil-Water Separator, Type B, is an effective method for the removal of crude oil from feedwater. The Sarex® 5 GPM Oil-Water Separator, Type B, could be operated under field conditions.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

PREFACE

The investigation covered by this report is an evaluation of the operational effectiveness of Sarex® 5 GPM Oil-Water Separator, Type B, during the removal of crude oil from feedwater. Work covered by this report was conducted under Project/Task 1L162733AH20-EW, "Water and Wastewater Management."

The investigation was conducted by Gregory D. Musa, Maurice Pressman, and Janet O. Hall. Engineering technical assistance was provided by Peder B. Pedersen, Staff Sergeant Dennis L. Pathkiller, and James E. Christopher.

Sarex is a registered trade name.

CONTENTS

ILLUSTRATIONS

TABLES

EVALUATION OF THE SAREX® 5 GPM OIL-WATER SEPARATOR, TYPE B

I. INTRODUCTION

An efficient and effective oil-water separator device is imperative in certain areas of the world where crude-oil contaminated feedwater is found. The presence of crude oil in the feedwater adversely affects the performance of the reverse osmosis water purification units (ROWPUs) used by the Army and Marines to purify fresh, brackish, and salt water. Both the 600 GPH ROWPU and the 150,000 GPD ROWPU use multi-media and cartridge filters for the removal of suspended solids from the feedwater before they enter the reverse osmosis membranes. Removal of the crude oil, which affixes to the filters, is accomplished by a laborious cleaning process or by replacement of the filters. Crude oil or a derived soluble oil passing the filters and entering the reverse osmosis elements would result in decreased production rate, degradation of the membrane elements, and decreased quality of product water. Thus, satisfactory operation of the ROWPU in this scenario is dependent upon an efficient and effective oil-water separator device.

One such prospective oil-water separator device is the Sarex® 5 GPM Oil-Water Separator, Type B (Figure 1), because of its availability, portability, and standard usage on military watercraft. This oil-water separator is currently used on military and commercial vessels to remove oil from bilge water before the water is discharged overboard. For this reason, the Sarex® 5 GPM Oil-Water Separator, Type B, was chosen for evaluation of operational effectiveness in the removal of crude oil from feedwater.

II. INVESTIGATION

1. **Equipment.** The unit selected for this investigation, a Sarex® 5 GPM Oil-Water Separator, Type B (Figure 1), was previously used for other studies by a Belvoir Research, Development and Engineering Center contractor. The unit is manufactured by Separation and Recovery Systems, Inc., Irvine, CA. The company also sells other oil-water separators with the following capacities: 5 GPM, 10 GPM, 20 GPM, 60 GPM, 100 GPM, 200 GPM, and 600 GPM. The Sarex® 5 GPM Oil-Water Separator, Type B, is a three-stage coalescer oil-water separator which contains three pressure vessels (Figure 2). The vessels are constructed of carbon steel and are skid mounted. Each vessel is equipped with a cam-bar-secured cover to provide access to the filter elements, an automatic air-eliminator valve to vent air, a sight glass through which to view water clarity and oil level, a manual or automatic oil-discharge valve, a combination water sample/drain valve to either sample or drain water from each vessel, and zinc anodes mounted in the bottom of each vessel to minimize the effects of electrolysis on the tanks. Isolation of the individual stages or pressure vessels is permitted via three manual shut-off valves located in the flow line. The pump motor unit, used concurrently with the oil-water separator, is the Sher-Water, Model SI-251-DC-110 5 GPM pump with a 1,750 rpm motor. The oil-water separator uses the following elements:

- Prefilter primary separator element (MIL-F-52847, Type II, or Sarex® 614-501).
- Dual functional second and third stage coalescer elements (MIL-F-52847, Type III, or Sarex® 611-503) (Figure 3).

A control panel is also included. Pressure gauges indicating the inlet pressure to the prefilter primary separator and the pressure at the discharge side of each of the three vessels complete the system. A 500-gallon tank was used to hold the feedwater, and a high-speed pneumatic stirrer was attached to the tank to ensure thorough mixing of the solution.

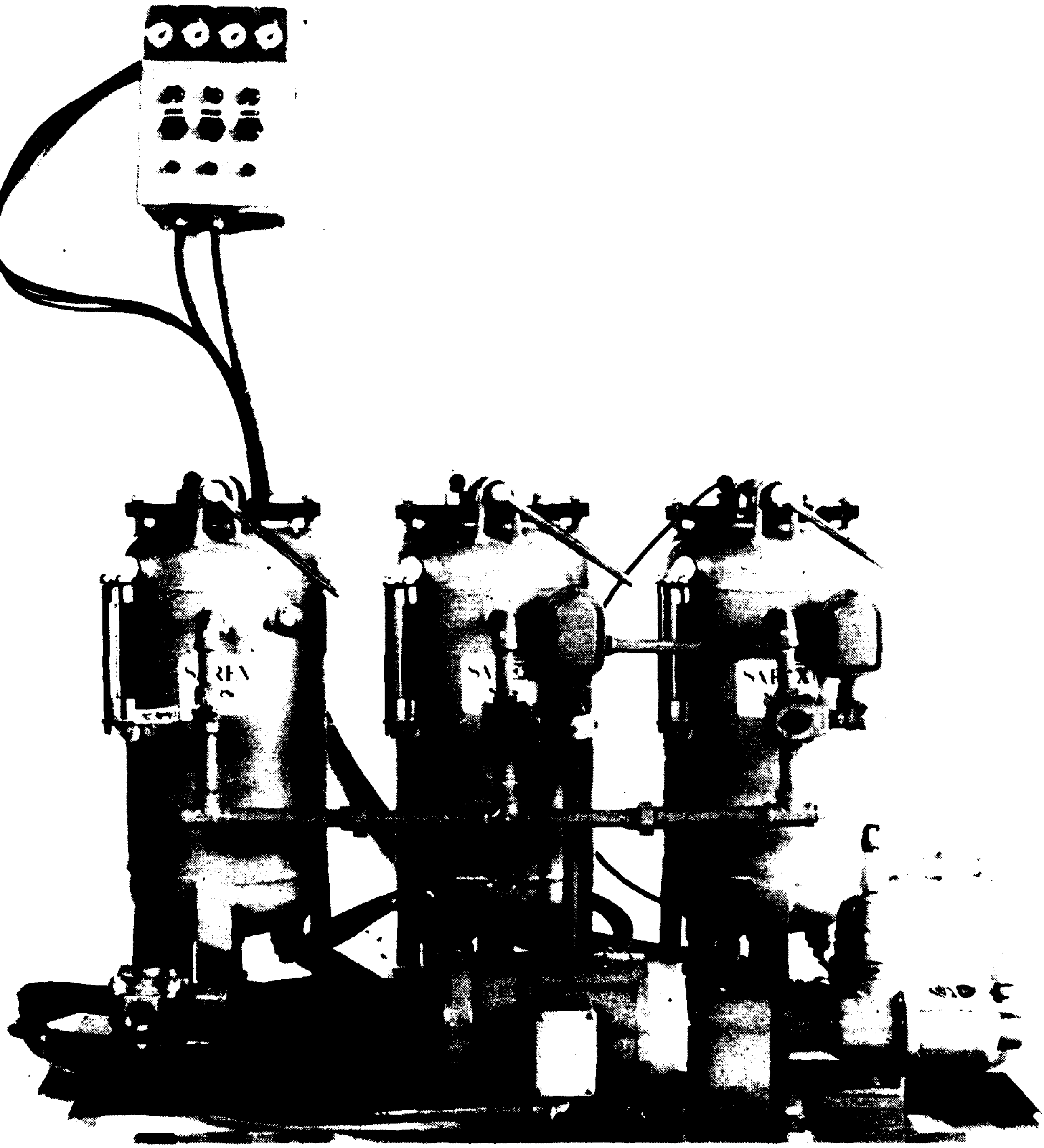


Figure 1. The Sarex® 5 GPM Oil-Water Separator, Type B.

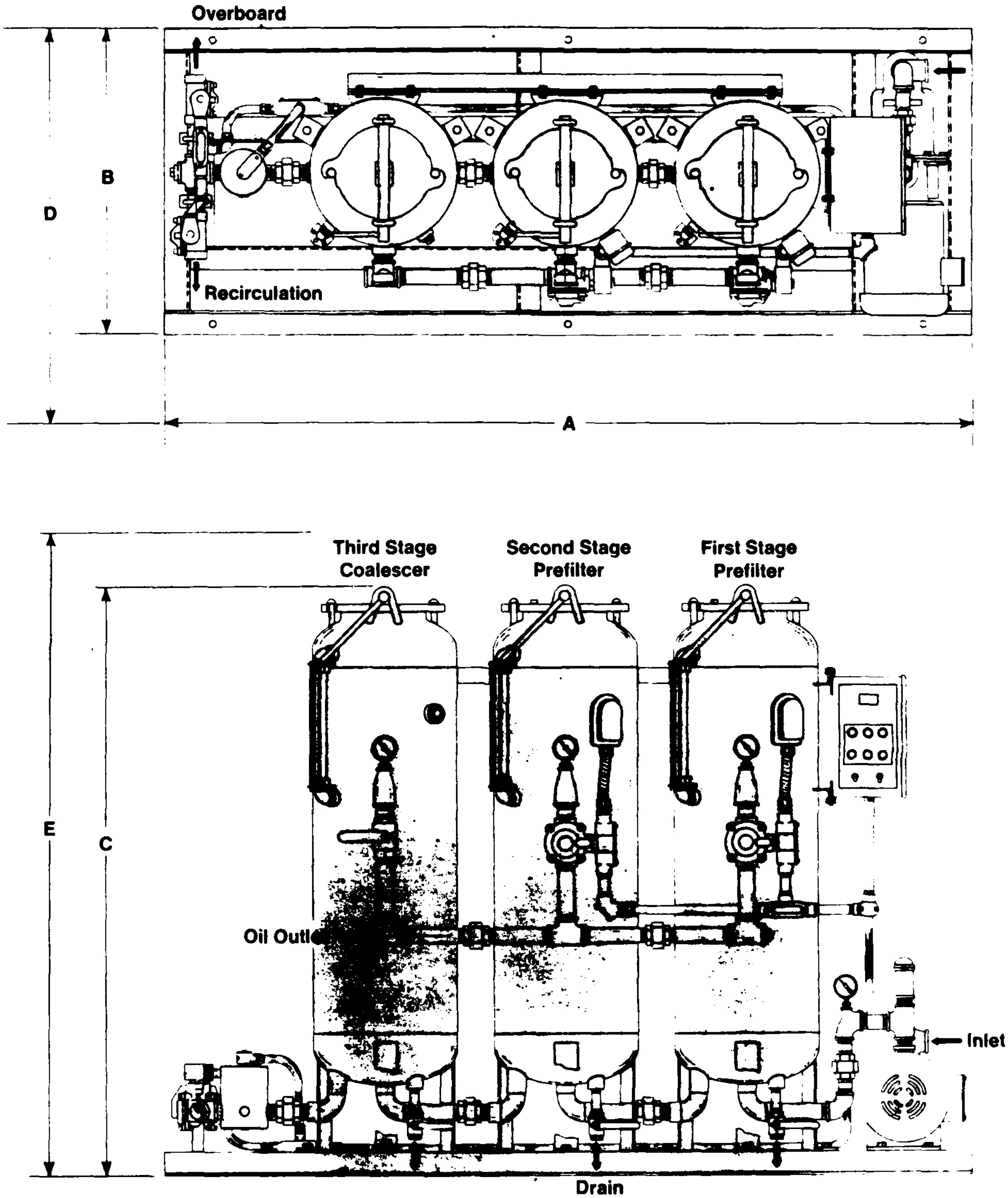


Figure 2. Schematic Description of the Sarex® 5 GPM Oil-Water Separator, Type B.

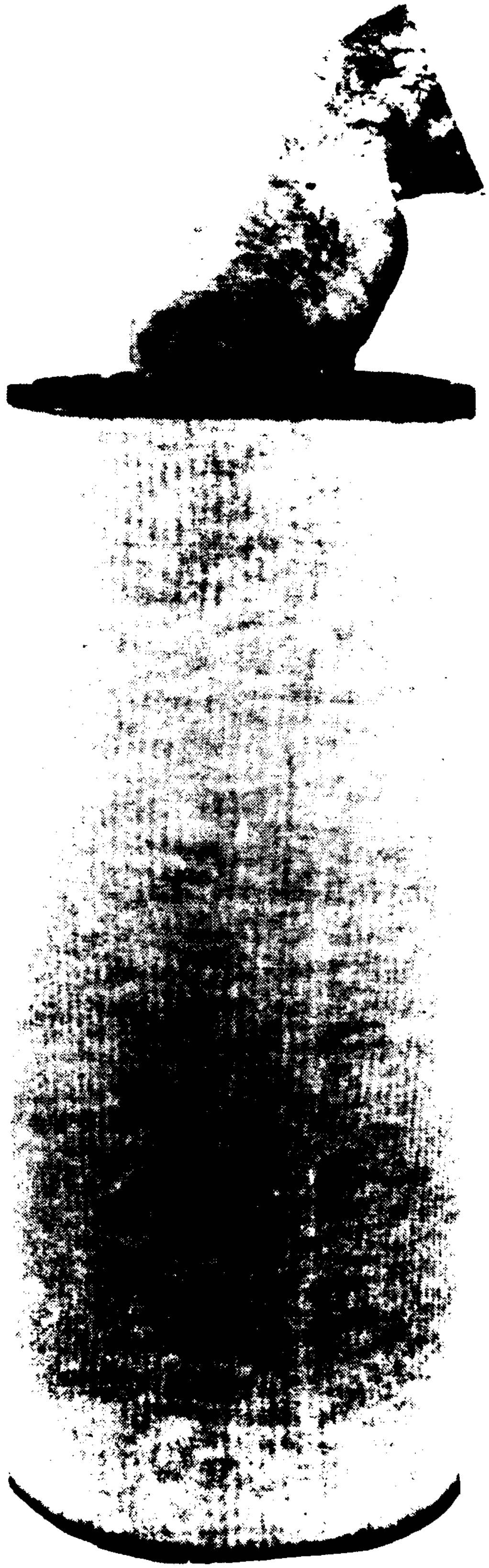


Figure 3. Handling of Filter Coalescer Element.

2. General System Description. The Sarex® 5 GPM Oil-Water Separator, Type B, is a three-stage, coalescent-type device which separates and removes insoluble oil, solids, and entrained air from an oily water mixture. The system does not require chemicals or other additives and can be operated either continuously or intermittently.

3. Functional Description. The principle of coalescence is the basis for the design of the Sarex® 5 GPM Oil-Water Separator, Type B (Figure 4). Oily water is first directed through specially constructed filters. These filters provide both an attaching surface for the miniscule droplets of insoluble oil dispersed in the water and a coalesce with oil droplets. As the oil droplets increase in size, they are pushed off the exterior surface of the filter by fluid flow and, thus, are separated from the water. Separation of the oil from the water occurs because of the difference in the specific gravity of the oil and the water.

Three pressure vessels, or stages, are arranged in series; and the influent, which contains oil, water, and solids, is pumped to this system by a supply pump. In the first stage, or prefilter primary separator, the primary separation and removal of oil from water occurs. The replaceable prefilter element removes both particulate matter and oil from the influent. This removal is accomplished as fluid entering the first stage via the pump flows upward through the hollow core of the prefilter element. The coalescing action occurs within the element as oil drops form on the exterior surface of the element. Fluid flow from the inside to the outside of the element forces the larger oil droplets off the surface of the element. The oil droplets then rise and accumulate at the top of the vessel because of the difference in specific gravity between the oil and the water. Oil is discharged from the first stage when the oil sensor determines the presence of oil and signals the opening of the first-stage, solenoid-operated oil discharge valve and the simultaneous closing of the solenoid-operated water discharge valve. Valves return to their normal position when a sufficient amount of oil is released. The purified effluent exits the bottom of the first stage through the outlet line and enters the second stage separator. The fluid then flows through the filter coalescer element which removes any residual oil not removed in the first stage. The operation of the second stage separator is identical to that of the first stage. Any residual oil in the water will coalesce as it passes through the element and finally accumulates at the top of the second stage. Automatic discharge of the oil occurs when sufficient oil accumulates to activate the oil sensor. The further purified effluent enters the third stage, which functions primarily as a polishing stage from which clean water is discharged via the outlet line. The third stage functions exactly as the previous two stages, but it contains a manually-operated, oil-discharge valve instead of a solenoid-operated valve. A manually-operated valve is used since very little oil is expected to accumulate in stage three.

4. Procedure. A Sarex® 5 GPM Oil-Water Separator, Type B, was refurbished and assembled for operation in this investigation. A three-stage system was employed using the cartridge filters, with the prefilter in the first stage and the skid mounted coalescers in the second and third stages. A 500-gallon tank held the feedwater; and a high-speed, pneumatic stirrer attached to the tank ensured thorough mixing of the solution. The feedwater consisted of 500 gal of tap water and 1,892.5 g of crude oil. Therefore, the crude oil concentration of the feedwater was 1,000 ppm. The contaminated feedwater was fed by gravity to the test unit influent pump. The oil-water separator system was operated for 110 minutes on 4 June 1985. Samples of feedwater and product water were obtained at 5 minute intervals of the test. Product rate, inlet pressure, and the pressure of vessel (stage) 2 were all monitored and data recorded at 15 minute intervals during the test. The feedwater tank was also manually stirred throughout the test with the use of paddles. The test was stopped after 30 minutes, 60 minutes, and 110 minutes, which was the completion of the test. The test was stopped at both the 30 minute and 60 minute marks to add a calculated quantity of tap water and its corresponding calculated quantity of crude oil to maintain the feed concentration at approximately 1,000 ppm.

5. Data Collected. Visual observations of the water samples were made and recorded. In the laboratory, the Partition-Gravimetric Method (Standard Methods for the Examination of Water and Wastewater, p. 46.) was used

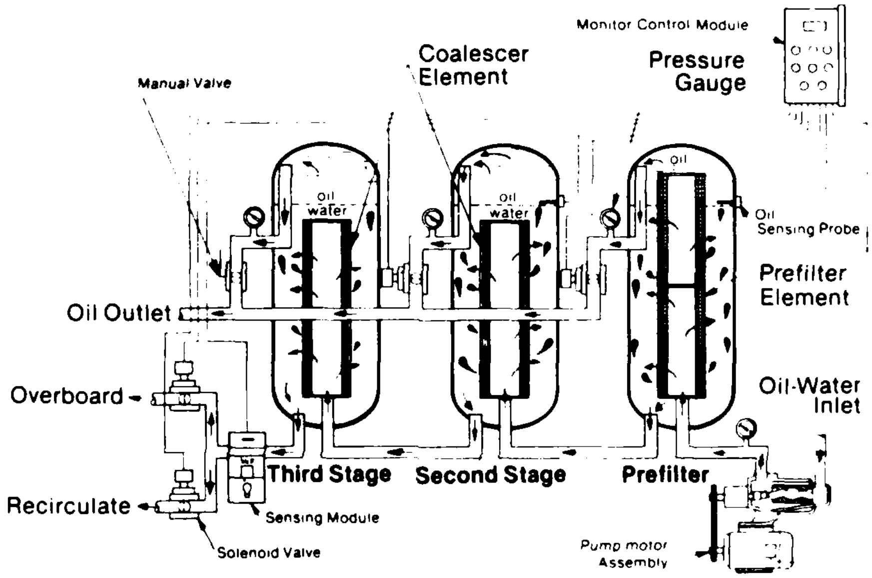


Figure 4. Functional Description of the Sarex® 5 GPM Oil-Water Separator, Type B.

to determine analytically the concentration of oil in the sample. The product water was analyzed with a Total Organic Carbon Model 700 analyzer to determine the organic carbon content.

III. RESULTS

The data and results obtained during the investigation of the Sarex® 5 GPM Oil-Water Separator, Type B, are given in Tables 1, 2, 3, and 4 beginning on the next page. Table 1 indicates the performance of the Oil-Water Separator with product rate, inlet pressure, and pressure of vessel 2 data included. Table 2 provides the results of the input feedwater concentration by the Partition-Gravimetric Method. Table 3 gives the total of both organic and inorganic carbon content of the tap water, prefilter water, and product water. Table 4 provides visual observation data on both the feedwater and the product water samples.

IV. DISCUSSION

1. Observations.

a. The subject separator system can be easily operated by one technician.

b. It provides a constant and reliable source of product water. The results of the data in Table 1 show that the product rate only varied from 3.9 to 4.8 gpm throughout the 110 minute test.

c. The inlet pressure and the pressure of Vessel 2 were also maintained at near constant pressures throughout the test. The inlet pressure fluctuated from 47 to 55 psi, and Vessel 2 pressure varied from 37 to 40 psi.

d. An increase in the inlet pressure resulted in increased product rate, while the pressure of Vessel 2 was not affected by these variations in inlet pressure.

2. Discussion. The oil-water separator is easily operable and provides a constant source of product water as Table 1 indicates. To determine the effectiveness of the oil-water separator, an input, or a feedwater oil contamination concentration, and an output, or a product water concentration, were needed for comparison. An analytical, input-feed concentration was provided by the Partition-Gravimetric Method. Table 2 shows the feed concentration of Sample 1 was 631.8 mg/L, the feed concentration of Sample 2 was 855.8 mg/L, and the feed concentration of Sample 3 was 254.8 mg/L. Therefore, the concentration of oil contamination in the feedwater varied from approximately 250 parts per million (ppm) to 850 ppm. However, this data indicates that the input-feed concentration was not a constant 1,000 ppm as suggested earlier in the "procedure" section of this report. This discrepancy was due to the difficulty of suspending the crude oil uniformly in the feedwater. Oil has an inherent tendency to rise to the top of the feed tank; and the feed-tank water was stirred manually, contributing to the variation of the input-feed concentration. Therefore, the predicted 1,000 ppm input-feed concentration was only a theoretical value which actually varied considerably under empirical conditions. Table 3 indicates the total organic carbon content of the tap water, the prefilter water, and the product water. The total organic carbon content of the tap water was 3.55 ppm, the prefilter water was 6.72 ppm, and the product water was 5.80 ppm. Therefore, the total organic carbon content of the product water was approximately 2 ppm greater than the noncontaminated tap water. In addition, this data confirms the hypothesis that the first stage, or prefilter, removes most of the oil from the water. The total organic carbon content of the water after passing through the prefilter element was 6.72 ppm, as stated earlier. The following two stages lower the total organic carbon content of the feedwater 0.92 ppm to a value of 5.80 ppm.

TABLE 1

Test of Sarex® 5 GPM Oil-Water Separator, Type B

DATE	TIME (hours)	PRODUCT RATE (gpm)	INLET (psi)	VESSEL 2 (psi)	TEST STATUS
6/4/85	1015	-	-	-	Start Test
6/4/85	1025	3.9 gpm	47 psi	40 psi	-
6/4/85	1040	4.2 gpm	48 psi	39 psi	-
6/4/85	1045	-	-	-	Stop Test
6/4/85	1100	-	-	-	Start Test
6/4/85	1100	4.2 gpm	49 psi	37 psi	-
6/4/85	1115	3.9 gpm	51 psi	39 psi	-
6/4/85	1130	4.2 gpm	52 psi	38 psi	-
6/4/85	1130	-	-	-	Stop Test
6/4/85	1320	-	-	-	Start Test
6/4/85	1335	4.5 gpm	54 psi	39 psi	-
6/4/85	1350	4.5 gpm	54 psi	38 psi	-
6/4/85	1405	4.8 gpm	55 psi	38 psi	-
6/4/85	1410	-	-	-	Stop Test

TABLE 2

Input Feedwater Concentration (mg/L Oil and Grease) by the Partition--Gravimetric Method

Feedwater Sample No. 1 at 1025 (hours)

850 ml sample starting volume

77.878 g	250 ml	Distilling Flask & Oil/Grease
77.341 g	250 ml	Distilling Flask
.537 g Oil/Grease		

$$\frac{.537\ g}{.850\ L} \times \frac{1000\ mg}{1\ g} = \frac{631.8\ mg\ oil/grease}{L\ sample}$$

Feedwater Sample No. 2 at 1030 (hours)

770 ml sample starting volume

77.915 g	250 ml	Distilling Flask & Oil/Grease
77.256 g	250 ml	Distilling Flask
.659 g Oil/Grease		

$$\frac{.659\ g}{.770\ g} \times \frac{1000\ mg}{1\ g} = \frac{855.8\ mg\ oil/grease}{L\ sample}$$

Feedwater Sample No. 3 at 1035 (hours)

840 ml sample starting volume

106.324 g	250 ml	Distilling Flask & Oil/Grease
106.110 g	250 ml	Distilling Flask
.214 g Oil/Grease		

$$\frac{.214\ g}{.840\ L} \times \frac{1000\ mg}{1\ g} = \frac{254.8\ mg\ oil/grease}{L\ sample}$$

TABLE 3

Total Organic Carbon Content Analysis
5 June 1985

Sample	Total Organic Carbon Content	Total Inorganic Carbon Content
Tap Water	-	11.14 ppm
Tap Water	3.55 ppm	-
Prefilter Water	-	12.58 ppm
Prefilter Water	6.72 ppm	-
Product Water	-	12.16 ppm
Product Water	5.80 ppm	-

TABLE 4

Visual Observation Data

Feedwater	Brown, murky water, heavy amount of suspended large brown particles, large amount of oily residue on top of jar, very strong oil odor.
Product Water	Clear, colorless water, slight amount of suspended particles, no detectable oil or other odor.

The visual observations (Table 4) further confirmed the effectiveness of the separator system. The product water showed no visual indication of oil contamination. It did not contain a sheen. A rule of thumb for oil contamination is that a visible sheen occurs at 13 to 15 ppm of the oil-contamination level. Furthermore, the product water did not contain any detectable odors. In contrast, the feedwater had obvious visual signs of oil contamination and a strong, highly detectable petroleum odor. In summary, the oil-water separator provided a product water with a concentration of 5.80 ppm of total organic carbon content (an increase of 2.25 ppm over the baseline) from an input feedwater concentration between 250 to 850 ppm of oil concentration.

V. CONCLUSIONS

The results of this investigation indicate that the Sarex® 5 GPM Oil-Water Separator, Type B, is a viable method for the purification of oil-contaminated water. This oil-water separator would make an effective and efficient pretreatment unit which would remove the crude oil contamination from feedwater prior to processing with the ROWPUs. During operation where the surf action is vigorous, a strainer of sufficient mesh, or another pretreatment for suspended solids such as the cyclone separator, would be required to prevent sand from clogging the filters. In conclusion, the Sarex® 5 GPM Oil-Water Separator, Type B, could be deployed as an effective separator of oil and water in any area where the presence of oil in water is anticipated.

APPENDIX

DETAILED ILLUSTRATIONS OF THE SAREX® 5 GPM OIL-WATER SEPARATOR, TYPE B, AND PARTS LIST.

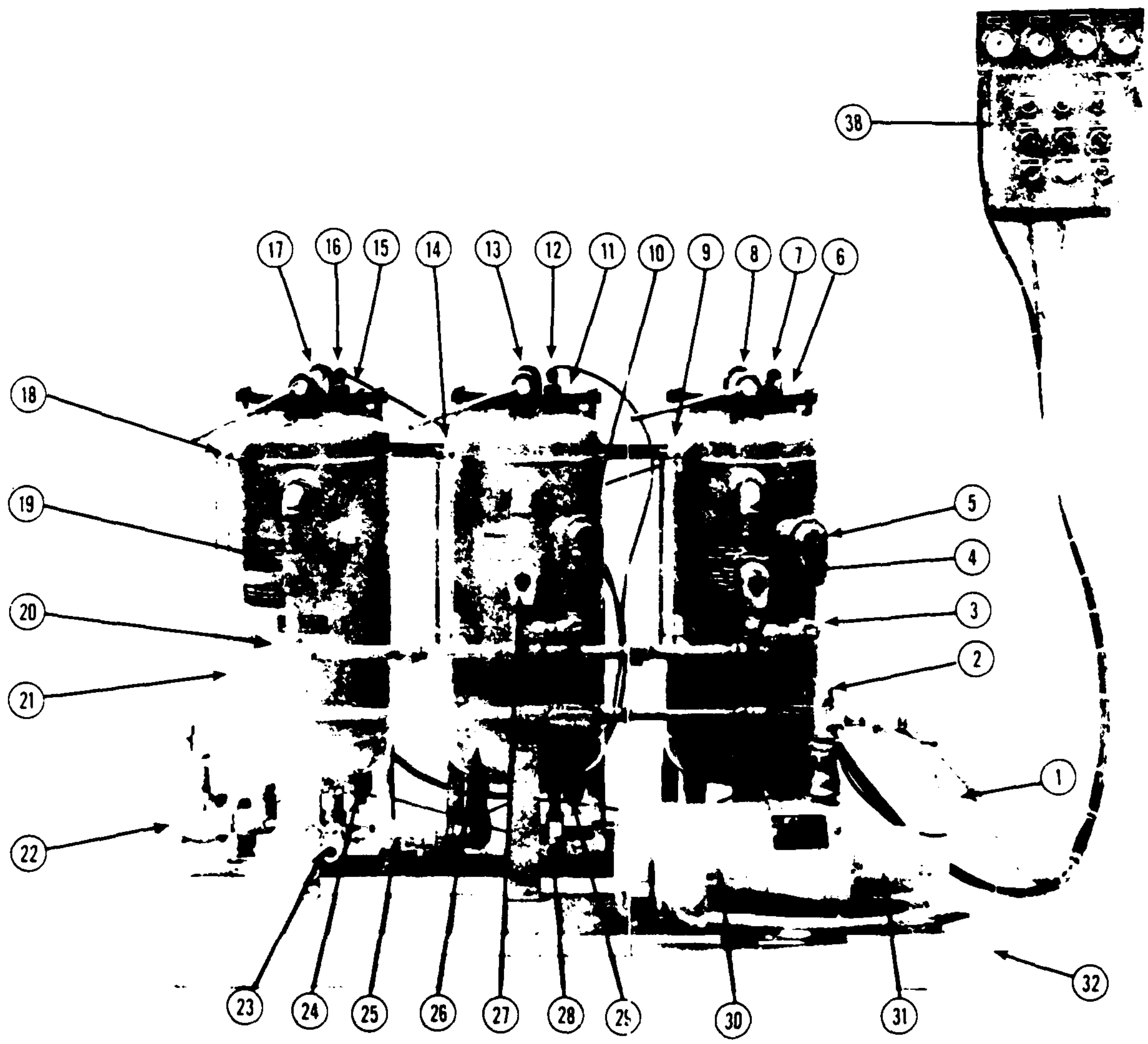


Figure A-1. Sarex® 5 GPM Oil-Water Separator, Type B.

TABLE A-1
Description of Parts for Figure A-1

Figure Number	SRS Part Number	Name
1	952-4	Pump Inlet
2	952-2	Pressure Relief Valve
3	071-2	Prefilter Primary Separator
4	934-7	Solenoid Operated Oil Discharge Valve - Prefilter Primary Separator
5	392	Sensor - Prefilter Primary Separator
6	080	Cover - Prefilter Primary Separator
7	306	Automatic Air Eliminator Valve - Prefilter Primary Separator
8	081	Cam Bar - Prefilter Primary Separator
9	423-1	Sight Glass - Prefilter Primary Separator
10	392	Sensor - Second Stage Separator
11	080	Cover - Second Stage Separator
12	306	Automatic Air Eliminator Valve - Second Stage Separator
13	081	Cam Bar - Second Stage Separator
14	423-1	Sight Glass - Second Stage Separator
15	080	Cover - Third Stage Separator
16	306	Automatic Air Eliminator Valve - Third Stage Separator
17	081	Cam Bar - Third Stage Separator
18	423-1	Sight Glass - Third Stage Separator
19	934-8	Manual Oil Discharge Valve - Third Stage Separator
20	---	Oil Discharge Line
21	071-2	Third Stage Separator
22	928-15	Solenoid Operated Water Discharge Valve
23	928-14	Water Sample/Drain Valve - Third Stage Separator
24	928-23	Anode - Third Stage Separator
25	928-13	Intervessel Shutoff Valve
26	071-2	Second Stage Separator
27	934-7	Solenoid Operated Oil Discharge Valve - Second Stage Separator
28	928-14	Water Sample/Drain Valve - Second Stage Separator
29	928-23	Anode - Second Stage Separator
30	952-1	Motor
31	952-1	Supply Pump
32	929	Skid
38	937	Control Panel

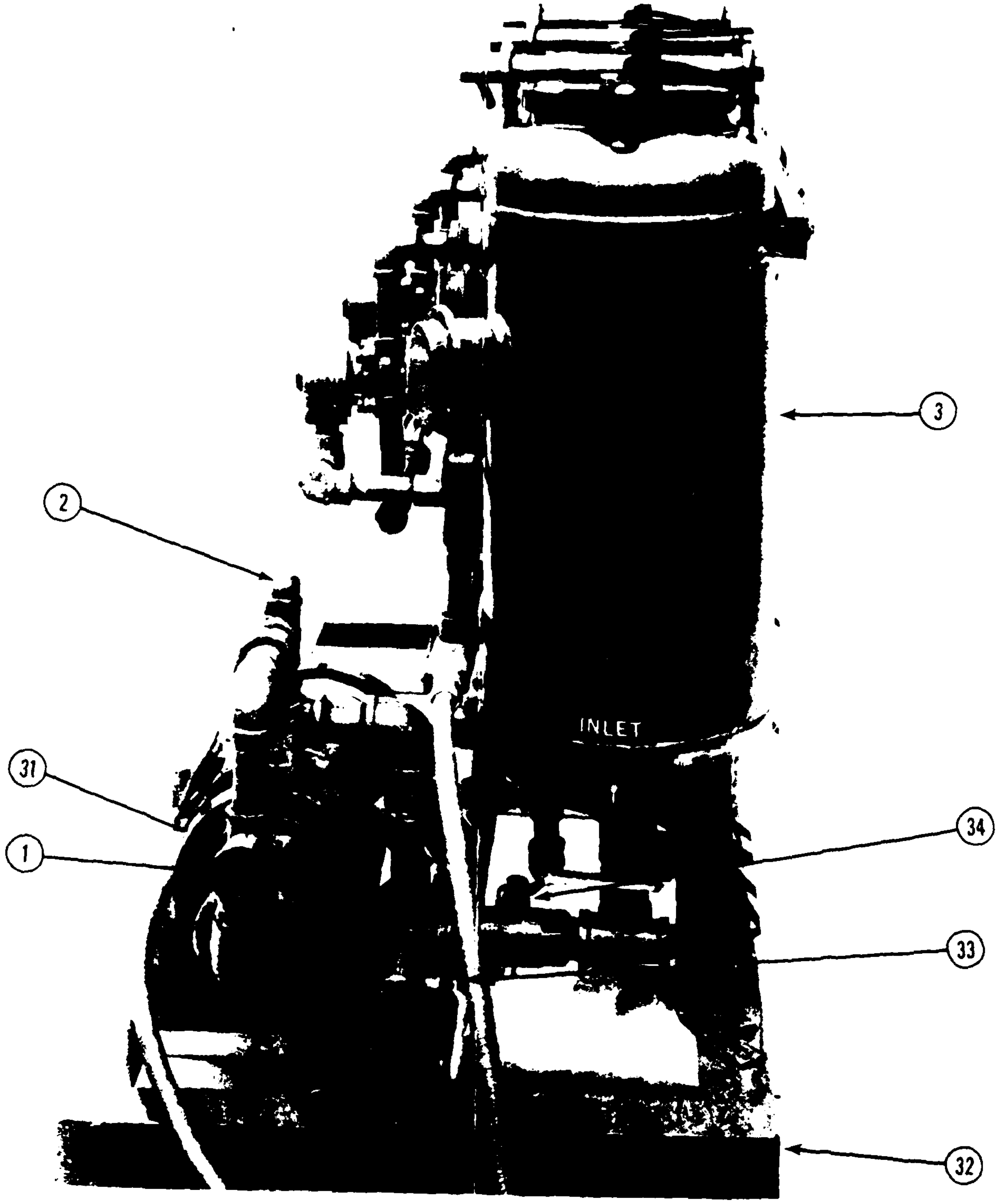


Figure A-2. Side View, Sarex® 5 GPM
Oil-Water Separator, Type B.

TABLE A-2

Description of Parts for Figure A-2

Figure Number	SRS Part Number	Name
1	952-4	Pump Inlet
2	952-2	Pressure Relief Valve
3	071-2	Prefilter Primary Separator
31	952-1	Supply Pump
32	929	Skid
33	952-3	Manual Shutoff Valve - Pump Discharge
34	928-13	Manual Shutoff Valve - Prefilter Primary Separator Inlet

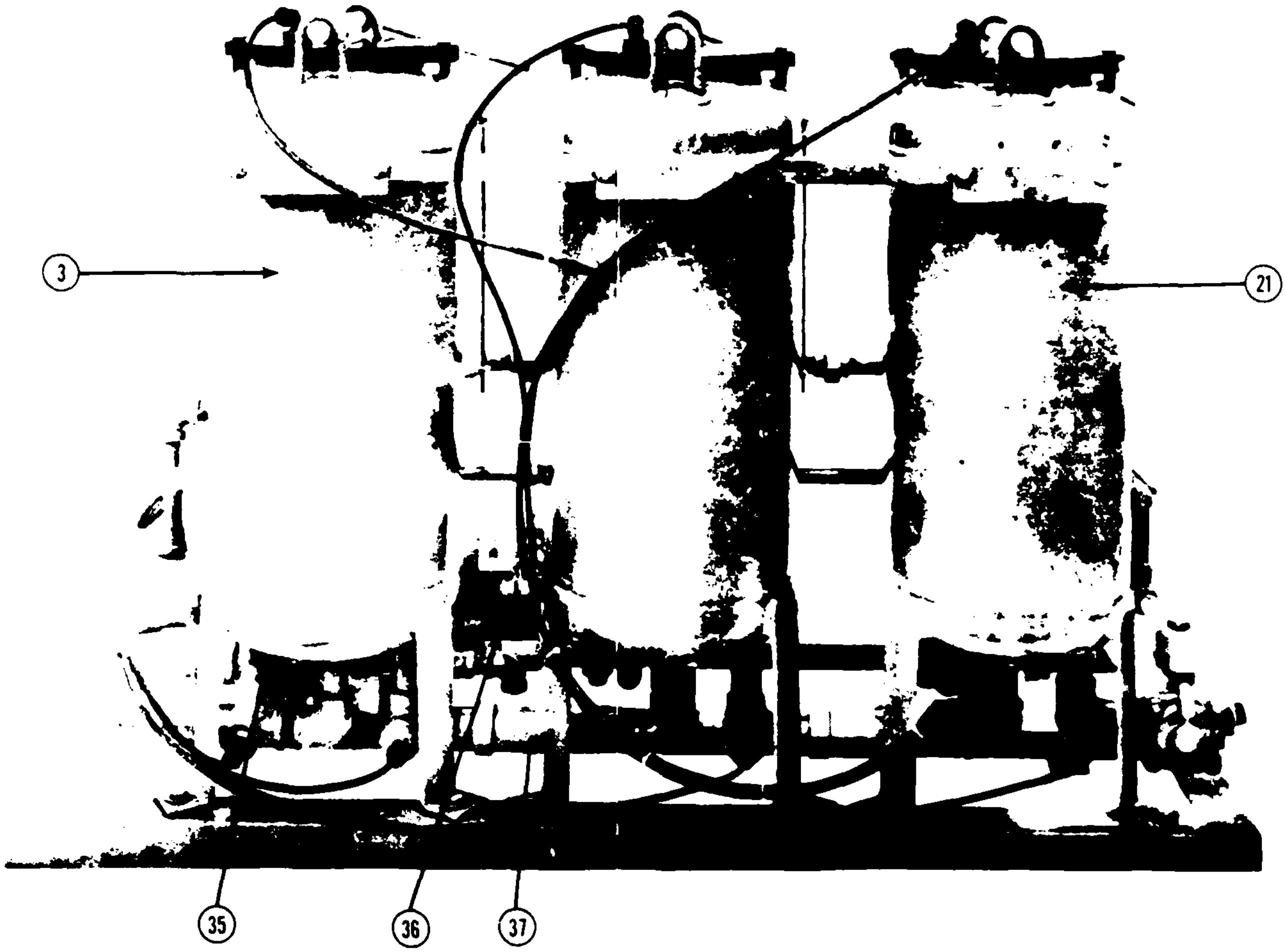


Figure A-3. Rear View, Sarex® 5 GPM
Oil-Water Separator, Type B.

TABLE A-3

Description of Parts for Figure A-3

Figure Number	SRS Part Number	Name
3	071-2	Prefilter Primary Separator
21	071-2	Third Stage Separator
35	928-23	Anode - Prefilter Primary Separator
36	928-14	Water Sample/Drain Valve - Prefilter Primary Separator
37	928-13	Intervessel Shutoff Valve

DISTRIBUTION FOR BRDEC REPORT NO. 2435

No. Copies	Addressee
	Department of Defense
1	Director, Technical Information Defense Advanced Research Projects Agency 1400 Wilson Blvd. Arlington, VA 22209
1	Director Defense Nuclear Agency ATTN: TITL Washington, DC 20305
2	Defense Technical Information Center Cameron Station ATTN: DTIC-FDAC Alexandria, VA 22314
	Department of the Army
1	HQDA (DAMA-AOA-M) Washington, DC 20310
1	HQDA (DAEN-RDL) Washington, DC 20314
1	HQDA (DAEN-MPE-T) Washington, DC 20314
1	Commander US Army Missile Research and Development Command ATTN: AMSMI-PR Redstone Arsenal, AL 35809
1	Director Army Materials and Mechanics Research Center ATTN: AMXMR-RL, Technical Library Watertown, MA 02172-0001
1	Commander Chemical Research R&D Center ATTN: SMCCR-SPS (Tech Library) Aberdeen Proving Ground, MD 21010
1	Commander US Army Aberdeen Proving Ground ATTN: STEAP-MT-U (GE Branch) Aberdeen Proving Ground, MD 21005
1	Director US Army Materiel Systems Analysis Agency ATTN: AMXSY-CM Aberdeen Proving Ground, MD 21005-5071
1	Director US Army Materiel Systems Analysis Agency ATTN: AMXSY-MP Aberdeen Proving Ground, MD 21005-5071
1	Director US Army Ballistic Research Laboratory ATTN: AMXBR-OD-ST (STINFO) Aberdeen Proving Ground, MD 21005-5066
1	Director US Army Engineer Waterways Experiment Station ATTN: Chief, Library Branch Technical Information Center Vicksburg, MS 39180
1	Commander US Army Armament Research and Development Command ATTN: SMCAR-TSS Dover, NJ 07801-5001
1	Commander US Army Troop Support and Aviation Materiel Readiness Command ATTN: DRSTS-MES (1) 4300 Goodfellow Blvd. St.Louis, MO 63120
2	Director Petrol & Field Services Department US Army Quartermaster School Fort Lee, VA 23801

No. Copies	Addressee
1	US Army Tank Automotive Command ATTN: DRSTA-TSL Warren, MI 48090
1	Commander US Army Electronics Research and Development Command Technical Library Division ATTN: DELSD-L Fort Monmouth, NJ 07703-5301
1	President US Army Aviation Test Board ATTN: STEBG-PO Fort Rucker, AL 36360
1	US Army Aviation School Library P.O. Drawer O Fort Rucker, AL 36360
2	HQ Army 193D Infantry Brigade (Pan) ATTN: AFZU-FE APO Miami 34004
2	Special Forces Detachment, Europe ATTN: PBO APO New York 09050
2	Engineer Representative USA Research & Standardization Group (Europe) Box 65 FPO 09510
1	Commander Rock Island Arsenal ATTN: SARRI-LPL Rock Island, IL 61201-7300
1	Plastics Technical Evaluation Center ARRADCOM, Bldg 3401 ATTN: A.M. Anzalone Dover, NJ 07801
1	Commandant US Army Engineer School ATTN: ATZA-CDD Fort Belvoir, VA 22060

No. Copies	Addressee
1	President US Army Airborne, Communications and Electronics ATTN: STEBF-ABTD Fort Bragg, NC 28307
1	Commander Headquarters, 39th Engineer Battalion (Cbt) Fort Devens, MA 01433
1	President US Army Armor and Engineer Board ATTN: ATZK-AE-PD-E Fort Knox, KY 40121
1	Commander and Director USA FESA ATTN: FESA-TS Fort Belvoir, VA 22060
1	HQ, USAEUR & Seventh Army Deputy Chief of Staff, Engineer ATTN: AEAEN-MT-P APO New York 09403
1	Director USA Army TRADOC Systems Analysis Activity ATTN: ATAA-SL (Tech Library) White Sands Missile Range, NM 88002
1	HQ, USAEUR & Seventh Army Deputy Chief of Staff, Operations ATTN: AEAGC-FMD APO New York, 09403
	BRDEC
1	Commander, STRBE-Z Deputy Commander, STRBE-ZD Technical Director, STRBE-ZT Assoc Tech Dir (E&A), STRBE-ZTE Assoc Tech Dir (R&D), STRBE-ZTR Executive Officer,STRBE-ZX Sergeant Major, STRBE-ZM Advanced Systems Concepts Dir, STRBE-H Program Planning Div, STRBE-HP Foreign Intelligence Div, STRBE-HF Systems and Concepts Div, STRBE-HC CIRCULATE

No. Copies	Addressee
	BRDEC
12	*Directorate for Logistics Support* Fuel and Water Supply Div., STRBE-FS ATTN: Gerald Eskelund
4	Tech Reports Ofc, STRBE-BPG
3	Security Ofc (for liaison officers), STRBE-S
2	Tech Lib, STRBE-BT
1	Public Affairs Ofc, STRBE-I
1	Ofc of Chief Counsel, STRBE-L
	Department of the Navy
1	Director, Physics Program (421) Office of Naval Research Arlington, VA 22217
2	Commander, Naval Facilities Engineering Command Department of the Navy ATTN: Code 032-B; 062 200 Stovall St. Alexandria, VA 22332
1	US Naval Oceanographic Office Navy Library/NSTL Station Bay St. Louis, MS 39522
1	Library (Code L08A) Civil Engineering Laboratory Naval Construction Battalion Center Port Hueneme, CA 93043
1	Director Earth Physics Program Code 464 Office of Naval Research Arlington, VA 22217
1	Naval Training Equipment Center ATTN: Technical Library Orlando, FL 32813
	Department of the Air Force
1	HQ USAF/RDPT ATTN: Commander Washington, DC 20330
1	HQ USAF/PREEU Chief, Utilities Branch Washington, DC 20330
1	US Air Force HQ Air Force Engineering & Services Ctr Technical Library FL 7050 Tyndall AFB, FL 32403
1	Chief, Lubrication Br Fuels & Lubrication Div ATTN: AFWAL/POSL Wright-Patterson AFB, OH 45433
1	Department of Transportation Library, FOA 10A, M494-6 800 Independence Ave., SW Washington, DC 20591
	Others
1	Professor Raymond R. Fox School of Engineering & Applied Science George Washington University Washington, DC 20052
1	Realiability Analysis Center Rome Air Development Center RADC/RBRAC (I.L. Krulac) Griffiss AFB, NY 13441
5	Gregory D. Musa 5703 Covehaven Drive Dallas, Texas 75252

END

11-86

DTIC