

NATURE OF DISCHARGE REPORT

Catapult Water Brake Tank and Post Launch Retraction Exhaust

1.0 INTRODUCTION

The National Defense Authorization Act of 1996 amended Section 312 of the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)) to require that the Secretary of Defense and the Administrator of the Environmental Protection Agency (EPA) develop uniform national discharge standards (UNDS) for vessels of the Armed Forces for "...discharges, other than sewage, incidental to normal operation of a vessel of the Armed Forces, ..." [Section 312(n)(1)]. UNDS is being developed in three phases. The first phase (which this report supports), will determine which discharges will be required to be controlled by marine pollution control devices (MPCDs)—either equipment or management practices. The second phase will develop MPCD performance standards. The final phase will determine the design, construction, installation, and use of MPCDs.

A nature of discharge (NOD) report has been prepared for each of the discharges that has been identified as a candidate for regulation under UNDS. The NOD reports were developed based on information obtained from the technical community within the Navy and other branches of the Armed Forces with vessels potentially subject to UNDS, from information available in existing technical reports and documentation, and, when required, from data obtained from discharge samples that were collected under the UNDS program.

The purpose of the NOD report is to describe the discharge in detail, including the system that produces the discharge, the equipment involved, the constituents released to the environment, and the current practice, if any, to prevent or minimize environmental effects. Where existing process information is insufficient to characterize the discharge, the NOD report provides the results of additional sampling or other data gathered on the discharge. Based on the above information, the NOD report describes how the estimated constituent concentrations and mass loading to the environment were determined. Finally, the NOD report assesses the potential for environmental effect. The NOD report contains sections on: Discharge Description, Discharge Characteristics, Nature of Discharge Analysis, Conclusions, and Data Sources and References.

2.0 DISCHARGE DESCRIPTION

This section describes the catapult water brake tank and post launch retraction exhaust and includes information on: the equipment that is used and its operation (Section 2.1), general description of the constituents of the discharge (Section 2.2), and the vessels that produce this discharge (Section 2.3).

2.1 Equipment Description and Operation

Every Navy aircraft carrier is equipped with four steam catapults for launching aircraft. High pressure steam from the catapult wet steam accumulator is used to operate each catapult. Each catapult has a dedicated water brake tank and catapult steam exhaust piping. During each catapult cycle, lubricating oil is applied to the catapult power cylinder. Different amounts of lubricating oil are applied depending on catapult model. Mod 2 catapults use more lubricating oil per catapult cycle than Mod 1 catapults (see Section 3.2.1).

Catapults are operated every time an aircraft is launched and for testing purposes. Catapults are normally tested after an aircraft carrier is built, before an aircraft carrier is sent out on deployment, and after major repairs and overhauls. Catapult testing before deployments is called “no-load” testing because there is no load applied to the catapult. Catapult testing after building and after major repairs and overhauls is called “dead-load” testing because a weight is applied to the catapult to simulate the weight of an aircraft. During catapult testing, lubricating oil is supplied to the catapult’s power cylinder in the same fashion as during aircraft launching operations.

The forward motion of the catapult piston is stopped by means of a water brake that is supplied by high pressure water from the water brake tank. As the catapult operates, the lubricating oil is carried into the water brake and subsequently into the water brake tank. During the retraction of the catapult piston, the steam left in the power cylinder and a small amount of residual oil are discharged overboard through the catapult exhaust piping. A smaller fraction of the residual oil also leaks by the catapult cylinder sealing strips and into the catapult trough. Catapult trough discharge is addressed in a separate NOD report on deck runoff.

2.1.1 Catapult Water Brake Tank

The catapult water brake tank supplies freshwater to the catapult water brake, which is used to stop the forward motion of the catapult piston. Water from the catapult water brake tank is injected into the water brake during each catapult cycle at approximately 1,300 gallons per minute (gpm) using two 650-gpm pumps.¹ When the catapult piston enters the water brake, it forces water from the water brake into the upper portion of the water brake tank. Figure 1 provides an illustration.

The oil used to lubricate the catapult power cylinder conforms to both SAE J1966, Grade 60 and Military Specification MIL-L-6082E grade 1100 standards.² During each catapult cycle, oil is sprayed onto the internal surface of the catapult power cylinder. As the catapult piston travels down the catapult power cylinder, lubricating oil is carried with the catapult piston into

the water brake.¹ Over the course of multiple launches, and because water is recirculated through the catapult water brake and the water brake tank, oil builds up in the water brake tank. The oil accumulates on the surface of the water in the water brake tank in the form of an oil-water emulsion. Heat is added to the water from heat accumulated in the oil, the action of the pistons, and by conduction from the steam-heated catapult piston. The accumulated oil also inhibits cooling at the surface of the water brake tank. Consequently, the water temperature rises. Excessive water temperature adversely affects the catapult water brake performance.

To prevent excessive water temperatures in the water brake tank, the accumulated oil is periodically skimmed. The water brake tank is equipped with an oil-skimming funnel and a 2.5-inch pipe for draining the oil from the tank. Fresh cool water is added to the water brake tank via a freshwater fill line to raise the water level in the tank, thus causing the floating oil and oil/water mixture to flow into the skimming funnel. The funnel drain piping discharges the oil and oil/water mixture overboard above the waterline. The contents of the water brake tank drain overboard until the liquid level falls below the top of the drain funnel. Oil accumulation in the water brake tank is directly related to the number of catapult cycles. During aircraft launch operations, the water brake tank is skimmed on an as-needed basis.³

As mentioned previously, aircraft carriers perform no-load catapult tests before leaving port on deployment and dead-load tests after building, major repairs and overhauls. The number of no-load and dead-load tests, however, do not generate enough lubricating oil in the water brake tank to require that the tank to be skimmed within 12 nautical miles (n.m.).

2.1.2 Post-Launch Retraction Exhaust

During the post-launch retraction of the catapult piston, the expended steam and residual oil from the catapult power cylinder walls are discharged overboard below the water line through copper/nickel piping. The exhaust steam exits the catapult power cylinder at approximately 350 °F (i.e., the operating temperature of the catapults) and cools and condenses as it flows through the exhaust piping overboard. The temperature of the final discharge is estimated to be 200 °F.

2.2 Releases to the Environment

2.2.1 Water Brake Tank

Discharge from the water brake tank is released overboard above the water line and consists of freshwater, lubricating oil, and small amounts of metals introduced by the catapult systems.

2.2.2 Post-Launch Retraction Exhaust

Discharge from the post-launch retraction exhaust is released overboard below the water line and consists of condensed steam with lubricating oil and small amounts of metals from the catapult.

2.3 Vessels Producing the Discharge

The Navy's aircraft carriers are the only armed forces vessels that generate this discharge. Of the 11 aircraft carriers that are homeported in the United States, eight are equipped with Mod 1 catapults, and the three newest aircraft carriers are equipped with Mod 2 catapults. There are a total of 12 aircraft carriers

3.0 DISCHARGE CHARACTERISTICS

This section contains qualitative and quantitative information that characterizes the discharge. Section 3.1 describes where the discharge occurs with respect to harbors and near-shore areas, Section 3.2 describes the rate of the discharge, Section 3.3 lists the constituents in the discharge, and Section 3.4 gives the concentrations of the constituents in the discharge.

3.1 Locality

3.1.1 Catapult Water Brake Tank

The catapult water brake tank discharge is generated on an as-needed basis during aircraft carrier flight operations, which occur beyond 12 n.m. from shore.^{1,4,5} Catapult testing, which occurs within 12 n.m. does not generate a sufficient quantity of oil in the water brake tank to require discharge. In addition, OPNAVINST 5090.1B prohibits oil from being discharged within 12 n.m. of shore, including the oil contained in this discharge.

Because this discharge does not occur within 12 n.m. of shore, it is not discussed further in this report.

3.1.2 Post-Launch Retraction Exhaust

The post-launch retraction exhaust discharge is generated during all catapult operations including aircraft launching and catapult testing. Because catapults are operated within 12 n.m. of shore during no-load/dead-load testing, the post-launch retraction exhaust discharge occurs on a limited basis within 12 n.m.

3.2 Rate

The discharge for the post-launch retraction exhaust discharge consists of condensed steam and the residual oil from lubricating the catapult power cylinders. During each catapult cycle, approximately 1,000 pounds of water from the wet accumulator are flashed to steam to drive the catapult piston down the flight deck, and 0.415 gallon of oil is injected onto the catapult power cylinder wall for Mod 1 catapults, and 0.83 gallon of oil for Mod 2 catapults.⁶ Based on operating experience, approximately 890 pounds of water and 0.10 gallon of oil from Mod 1 catapults, or 0.42 gallon of oil from Mod 2 catapults, are discharged overboard during each catapult cycle.⁶

An aircraft carrier performs approximately 50 no-load catapult tests per year.³ Therefore, all 11 aircraft carriers homeported in the United States perform approximately 550 no-load test shots per year. At a fleet-wide average rate of 0.19 gallon of oil (weighted average discharge of 0.10 gallon for Mod 1 catapults and 0.42 gallon for Mod 2 catapults) and 890 pounds of steam condensate per each catapult test, the annual fleet-wide discharge of oil and condensed steam from no-load catapult tests within 12 n.m. is approximately 105 gallons of oil and 490,000 pounds of condensed steam.

Major catapult overhauls and modifications are not normal occurrences for aircraft carriers. In general, one to two aircraft carriers annually undergo a major overhaul or modification that requires 60 dead-load catapult test shots to recertify the catapult. Assuming that on average, the catapults on 1.5 carriers are overhauled each year (i.e., six catapults), an estimated 360 dead-load catapult test shots are performed annually fleet-wide within 12 n.m. Thus, an estimated 69 gallons of oil (at a rate of 0.19 gallon per test) and 320,000 pounds of steam condensate (at a rate of 890 pounds per test) are discharged annually from dead-load catapult testing.

Thus, 174 gallons of oil and 810,000 pounds of condensed steam (~97,000 gallons) are discharged annually, fleetwide, from post-launch retraction exhaust during no-load and dead-load catapult testing.

3.3 Constituents

The post-launch retraction exhaust discharge consists of steam and condensed steam with associated non-organic metal constituents and lubricating oil. The lubricating oils are comprised primarily of higher chain (C₁₇ and higher) paraffins and olefins.^{7,8} Another UNDS discharge, Steam Condensate Discharge, is similar to the condensed steam discharge from the catapult retraction stroke, with the exception of the oil content. The Steam Condensate NOD Report analyzes steam condensate originating from shore-based facilities. The steam condensate from ship heating supplied from shore facilities consists primarily of condensed steam that is generally collected and pumped or drained overboard. The discharge from the catapult retraction exhaust is steam, condensed steam, and oil that is vented overboard under pressure. The condensed steam portion of both discharges will, however, be somewhat similar. Based on the data presented in that report, nitrogen (as ammonia, nitrate/nitrite, and total nitrogen), phosphorous, and the priority pollutants antimony, arsenic, benzidine, bis(2-ethylhexyl) phthalate, cadmium, copper, lead, nickel, selenium, thallium, and zinc can be present in the condensed steam in post-launch retraction exhaust. There are no known bioaccumulators in this discharge.

3.4 Concentrations

Approximately 890 pounds of catapult condensed steam and 0.19 gallon of oil is discharged during each catapult cycle. The density of water at 70 °F (i.e., ambient temperature) is 8.32 pounds per gallon (lbs/gal) or 0.998 kilograms per liter (kg/l) and the oil density is of 7.32 lbs/gal or 0.878 kg/l. Therefore, the concentration of oil in the exhaust discharge is approximately 1,560 mg/L. The calculation is presented below:

$$[(0.19 \text{ gal}_o) (7.32 \text{ lbs}_o / \text{gal}_o) (453,590 \text{ mg/lb})] / [(890 \text{ lbs}_w) (\text{gal} / 8.32 \text{ lbs}_w) (3.785 \text{ l/gal})] = \cong 1560 \text{ mg/l}$$

Where the subscripts *o* refer to oil and *w* refer to water.

Table 1 shows the concentrations of the priority pollutants identified in the Steam Condensate NOD Report. It is assumed that the same constituents would be found in the condensed steam from the catapult retraction exhaust in similar concentrations to those found in steam condensate originating from facilities.

4.0 NATURE OF DISCHARGE ANALYSIS

Based on the discharge characteristics presented in Section 3.0, the nature of the discharge and its potential impact on the environment can be evaluated. The estimated mass loadings are presented in Section 4.1. In Section 4.2, the concentrations of discharge constituents after release to the environment are estimated and compared with the water quality criteria. Section 4.3 discusses thermal effects. In Section 4.4, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

As estimated in Section 3.2, approximately 174 gallons of oil are discharged annually from no-load and dead-load testing in post-launch retraction exhaust. This results in an annual fleet-wide mass loading of 1,275 pounds (based on a conversion factor of 7.33 pounds of oil/gallon).

Of the non-oil constituents in the 810,000 pounds of catapult condensed steam generated annually fleet wide from post-launch retraction exhaust (see Section 3.2) less than one pound of pollutants are estimated to be discharged from no-load and dead-load testing. The mass loadings were estimated using the following equation:

$$(\log\text{-normal mean conc. } \mu\text{g/l})(\text{g}/1,000,000 \mu\text{g}) (\text{lbs}/453.593 \text{ g}) (\text{annual volume l/yr}) \cong \text{mass loading (lbs/yr)}$$

4.2 Environmental Concentrations

The condensed steam and oil from the post-launch retraction exhaust exits the ship via the exhaust piping. The estimated concentration of oil in the discharge is approximately 1,560 mg/L. This value exceeds the most stringent state water quality criteria (WQC), which is Florida's 5 mg/L criterion (Table 2). Concentrations this high are likely to cause a sheen in the receiving waters.

Assuming the concentrations of the priority pollutants shown in Table 1 are representative of condensed steam discharged in post-launch retraction exhaust discharge, there

would be four priority pollutants - benzidine, bis(2-ethylhexyl) phthalate, copper, and nickel - discharged in excess of Federal and/or the most stringent state WQC. Two other constituents, nitrogen (as ammonia, nitrate/nitrite, and total nitrogen) and phosphorous, exceed the most stringent state WQC. Table 2 shows the concentrations of these constituents and the applicable WQC.

4.3 Thermal Effects

The thermal effects of the post-launch retraction exhaust were screened for potential adverse effects to determine if the resulting thermal plume exceeded water quality criteria for temperature.⁹ Based upon the evaluation of the exhaust discharge, the thermal effects rapidly dissipate within a short distance of the point of discharge.⁹ Under the most stringent criteria (e.g., Washington State), the resulting plume from the post-launch retraction exhaust is estimated to be approximately 20 feet in diameter and extends to approximately 12 feet in depth.⁹ These dimensions are within limits established for Washington.⁹

4.4 Potential for Introducing Non-Indigenous Species

During catapult launch operations, seawater is not transported. Therefore, there is no potential for transporting non-indigenous species.

5.0 CONCLUSIONS

The catapult water brake tank discharge does not occur within 12 n.m. because flight operations are not conducted within this zone. Therefore, this discharge has no potential to cause an adverse environmental effect within 12 n.m.

The post-launch retraction exhaust has a potential for adverse environmental effect because significant amounts of oil are discharged at high concentrations during the short duration of the discharge event. The high concentrations exceed water quality criteria and discharge standards. The high concentrations of oil are likely to cause an oil sheen.

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. process information and assumption were used to estimate the rate of discharge. Based on this estimate and on the reported concentration of oil constituents, the concentration of the oil constituents in the environment resulting from this discharge were then estimated. Table 3 shows the source of the data used to develop this NOD report.

Specific References

1. UNDS Equipment Expert Meeting Minutes - Catapult Discharges. July 26, 1996.

2. Commander, Naval Sea Systems Command. Memorandum Ser PMS312B/1760. Pollution of Coastal Waters Attributed to Catapult Lube Oil. December 16, 1997.
3. Commander Naval Air Forces, U.S. Atlantic Fleet. Responses to TYCOM Questionnaire. M. Rosenblatt & Son, Inc. May 20, 1997.
4. UNDS Equipment Expert Meeting Minutes - Catapult Trough, Water Brake Tank, Jet Blast Deflector and Arresting Cables. August 22, 1996.
5. UNDS Equipment Expert Meeting Minutes - Catapult Wet Accumulator Steam Blowdown Discharge. August 20, 1997.
6. Steve Opet, NAWCADLKE. Information on Volume of Water and Temperature for Catapult Shots. April 11, 1997. Clarkson Meredith, Versar, Inc.
7. Perry and Chilton. Chemical Engineers' Handbook. Fifth Ed. McGraw Hill. 1953
8. Patty's Industrial Hygiene and Toxicology, 3rd Ed., Volume IIB. G.D. and F.E. Clayton, Editors. New York: 1981.
9. NAVSEA. Thermal Effects Screening of Discharges from Vessels of the Armed Services. Versar, Inc. July 3, 1997.

General References

- USEPA. Toxics Criteria for Those States Not Complying with Clean Water Act Section 303(c)(2)(B). 40 CFR Part 131.36.
- USEPA. Interim Final Rule. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Metals Criteria. 60 FR 22230. May 4, 1995.
- USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants. 57 FR 60848. December 22, 1992.
- USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, Proposed Rule under 40 CFR Part 131, Federal Register, Vol. 62, Number 150. August 5, 1997.
- Connecticut. Department of Environmental Protection. Water Quality Standards. Surface Water Quality Standards Effective April 8, 1997.
- Florida. Department of Environmental Protection. Surface Water Quality Standards, Chapter 62-302. Effective December 26, 1996.

Georgia Final Regulations. Chapter 391-3-6, Water Quality Control, as provided by The Bureau of National Affairs, Inc., 1996.

Hawaii. Hawaiian Water Quality Standards. Section 11, Chapter 54 of the State Code.

Mississippi. Water Quality Criteria for Intrastate, Interstate and Coastal Waters. Mississippi Department of Environmental Quality, Office of Pollution Control. Adopted November 16, 1995.

New Jersey Final Regulations. Surface Water Quality Standards, Section 7:9B-1, as provided by The Bureau of National Affairs, Inc., 1996.

Texas. Texas Surface Water Quality Standards, Sections 307.2 - 307.10. Texas Natural Resource Conservation Commission. Effective July 13, 1995.

Virginia. Water Quality Standards. Chapter 260, Virginia Administrative Code (VAC) , 9 VAC 25-260.

Washington. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A, Washington Administrative Code (WAC).

U.S. Navy Technical Manual NAVAIR 51-15ABD-3, Illustrated Parts Breakdown Catapults. December 1, 1986.

The Water Quality Guidance for the Great Lakes System, Table 6A. Volume 60 Federal Register, pg 15366. March 23, 1995.

Committee Print Number 95-30 of the Committee of Public Works and Transportation of the House of Representatives, Table 1.

Jane's Information Group, Jane's Fighting Ships. Capt. Richard Sharpe, Ed. Sentinel House: Surrey, United Kingdom, 1996.

UNDS Phase I Sampling Data Report, Volumes 1-13. October 1997.

Table 1. Estimated Post-Launch Retraction Exhaust Discharge Constituents, Concentrations, and Mass Loadings Based Upon Steam Condensate Sampling Data

Constituents From Steam Condensate ¹	Concentrations (µg/L)		Rate of Wet Accumulator Discharge (l/yr) ³	Fleet-Wide Mass Loading (pounds/yr)
	Log Normal Mean ²	Range		
<i>Antimony</i>				
Total	7.13	BDL - 26.8	367,000	5.8 x 10 ⁻³
<i>Arsenic</i>				
Total	0.74	BDL - 2.3	367,000	6.0 x 10 ⁻⁴
<i>Cadmium</i>				
Total	2.86	BDL - 6.1	367,000	2.3 x 10 ⁻³
<i>Copper</i>				
Dissolved	13.4	BDL - 49.0	367,000	1.1 x 10 ⁻²
Total	20.1	BDL - 91.0	367,000	1.6 x 10 ⁻²
<i>Lead</i>				
Dissolved	3.58	BDL - 12.7	367,000	2.9 x 10 ⁻³
Total	4.38	BDL - 18.9	367,000	3.5 x 10 ⁻³
<i>Nickel</i>				
Dissolved	10.3	BDL - 22	367,000	8.3 x 10 ⁻³
Total	11.6	BDL - 34.7	367,000	9.4 x 10 ⁻³
<i>Selenium</i>				
Total	2.87	BDL - 3.5	367,000	2.3 x 10 ⁻³
<i>Thallium</i>				
Dissolved	1.18	BDL - 13.3	367,000	9.5 x 10 ⁻⁴
<i>Zinc</i>				
Dissolved	13.94	7.15 - 21.9	367,000	1.1 x 10 ⁻²
Total	11.35	BDL - 23.0	367,000	9.2 x 10 ⁻³
Ammonia as Nitrogen	180	120 - 370	367,000	1.4 x 10 ⁻¹
Nitrate/Nitrite	440	300 - 810	367,000	3.4 x 10 ⁻¹
Total Kjeldahl Nitrogen	1240	NA	367,000	9.6 x 10 ⁻¹
Total Phosphorous	90	BDL - 270	367,000	7.1 x 10 ⁻²
Benzidine	32.8	BDL - 73.5	367,000	2.7 x 10 ⁻²
Bis(2-ethylhexyl) phthalate	19.4	BDL - 112	367,000	1.6 x 10 ⁻²

The constituents listed above are those expected to be found in the wet accumulator discharge. BDL denotes below detection limit.

1. Constituents listed are the priority pollutants detected in steam condensate samples.
2. Highest of the dissolved and total log average values.
3. This value is the product of the annual condensed steam released from no-load and dead-load testing (810,000 pounds combined) cited in Section 3.2.1 and the conversion factors 0.0175 cubic foot/pound (inverse density of water at 200 °F), 7.4805 gallons/cubic foot, and 3.785 liters/gallon.

Log-normal means were calculated using measured analyte concentrations. When a sample set contained one or more samples with the analyte below detection levels (i.e., “non-detect” samples), estimated analyte concentrations equivalent to one-half of the detection levels were also used to calculate the log-normal mean. For example, if a “non-detect” sample was analyzed using a technique with a detection level of 20 mg/L, 10 mg/L was used in the log-normal mean calculation.

**Table 2. Mean Concentrations of Constituents that Exceed Water Quality Criteria
Post-Launch Retraction Exhaust Condensed Steam Discharge**

Constituent	Log-Normal Mean Concentration (µg/L)	Federal Acute WQC (µg/L)	Most Stringent State Acute WQC (µg/L)
<i>Oil</i>	1,560,000	visible sheen ¹ /15,000 ²	5,000 (FL)
<i>Ammonia as Nitrogen</i>	180	None	6 (HI) ^A
<i>Nitrate/Nitrite</i>	440	None	8 (HI) ^A
<i>Total Nitrogen</i>	1240	None	200 (HI) ^A
<i>Total Phosphorous</i>	90	None	25 (HI) ^A
<i>Benzidine</i>	32.8	None	0.000535 (GA)
<i>Bis(2-Ethylhexyl) Phthalate</i>	19.4	None	5.92 (GA)
<i>Copper</i> ³			
Dissolved	13.4	2.4	2.4 (CT, MS)
Total	20.1	2.9	2.5 (WA)
<i>Nickel</i> ³			
Dissolved	10.3	74	74 (CA, CT)
Total	11.6	74.6	8.3 (FL, GA)

Notes:

Refer to federal criteria promulgated by EPA in its National Toxics Rule, 40 CFR 131.36 (57 FR 60848; Dec. 22, 1992 and 60 FR 22230; May 4, 1995)

A - Nutrient criteria are not specified as acute or chronic values.

¹ Discharge of Oil. 40 CFR 110, defines a prohibited discharge of oil as any discharge sufficient to cause a sheen on receiving waters.

² International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). MARPOL 73/78 as implemented by the Act to Prevent Pollution from Ships (APPS).

³ Assumes the constituents and their concentrations in this discharge are similar in concentration to the constituents found in steam condensate that originates from shore facilities.

CA = California
 CT = Connecticut
 FL = Florida
 GA = Georgia
 HI = Hawaii
 MS = Mississippi
 WA = Washington

Table 3. Data Sources

NOD Section	Data Source			
	Reported	Sampling	Estimated	Equipment Expert
2.1 Equipment Description and Operation	X			X
2.2 Releases to the Environment				X
2.3 Vessels Producing the Discharge	UNDS Database			X
3.1 Locality				X
3.2 Rate	X		X	
3.3 Constituents			X	X
3.4 Concentrations			X	
4.1 Mass Loadings			X	
4.2 Environmental Concentrations			X	
4.3 Thermal Effects			X	
4.4 Potential for Introducing Non-Indigenous Species				X

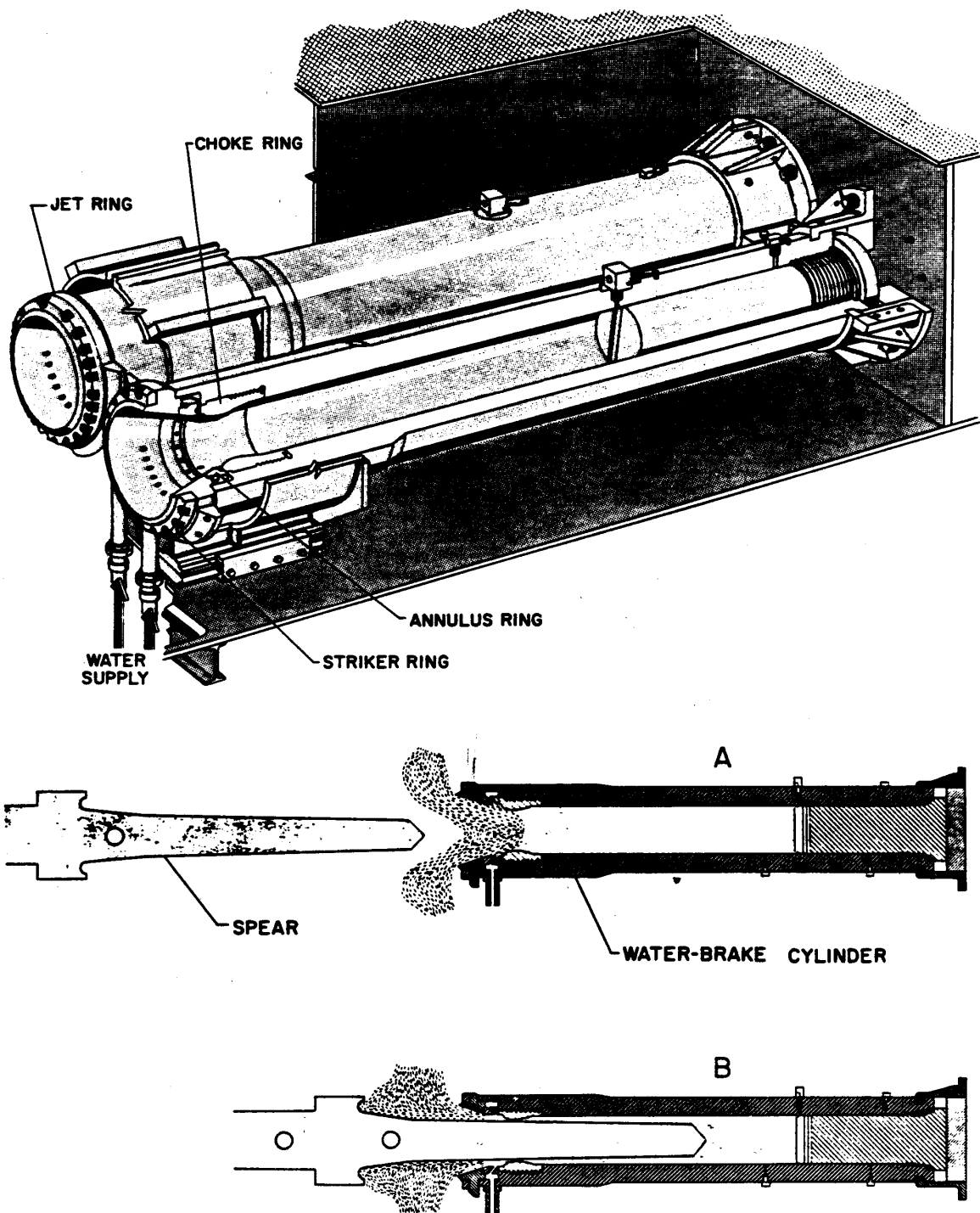


Fig. 1 Water Brakes

Catapult Water Brake Tank and Post Launch Retraction Exhaust