CATEGORY 1

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50-389 St. Lucie Plant, Unit 2, Florida Power & Light Co. 05000389

AUTH.NAME AUTHOR AFFILIATION
STALL,J.A. Florida Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
Document Control Branch (Document Control Desk)

See Enviro Report

SUBJECT: Forwards info copy of rev to permit application of Florida Wastewater Permit (FL0002208),formerly NPDES Permit, submitted to State of FL on 980610.

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Florida Power & Light Company, 6351 S. Ocean Drive, Jensen Beach, FL 34957

FPL

June 26, 1998

L-98-180
10 CFR 50.36b
10 CFR 50.4
EPP 3.2.4

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
Florida Wastewater Permit Revision of the Permit Application

Attached is an information copy of a revision to the permit application of the Florida Wastewater Permit (FL0002208), formerly the National Pollutant Discharge Elimination System (NPDES) Permit, which was submitted to the State of Florida on June 10, 1998. This document is being sent pursuant to Section 3.2.4 of the St. Lucie Units 1 and 2 Environmental Protection Plans.

Should you have any questions on this information, please contact us.

Very truly yours,

J. A. Stall
Vice President
St. Lucie Plant

JAS/GRM

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, St. Lucie Plant

Attachment

C001

FPL

6501 S. Ocean Drive, Jensen Beach, FL 34957

June 12, 1998

CERTIFIED MAIL
RETURN RECEIPT REQUESTED
P 061 656 321

Mr. Craig Diltz
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: FLORIDA POWER & LIGHT COMPANY
ST. LUCIE POWER PLANT
WASTEWATER PERMIT NO. FL0002208
REVISION TO PERMIT APPLICATION - APRIL 1996

Dear Mr. Diltz:

Enclosed please find revision (Attachment 1) to the above-referenced Wastewater Permit Application Item IVB Attachment. This section describes the St. Lucie Plant and associated major processes. The revision includes, under the "Once-Through Cooling Water and Auxiliary Cooling Water - OSN 001" section, the addition of two biocides, glutaraldehyde and isothiazolin, and a dispersant, polyglycol. These are to be used in the Plant's closed cooling water system. A detailed description of each is included (see Attachments 2-4). Please note that Best Management Practices will be used to preclude the discharge of these products while in an active state.

Also revised is section "Steam Generator Blowdown - OSN 005". Added is the description of the amine, dimethylamine, similar to that described in the previous Wastewater Permit renewal application dated April 22, 1992 for St. Lucie Plant (see Attachment 5). Dimethylamine breaks down to ammonia. The use of the hydrazine substitute, carbohydrazide, is also added to the revision. This product, compared to hydrazine, has reduced SARA/CERCLA liabilities although it breaks down to hydrazine at plant operating temperatures. Information pertaining to both of these products, commonly used in the nuclear industry, are also included (see Attachments 6 and 7) .

FPL believes that the use of the above-mentioned biocides, in the manner proposed, should be acceptable to the Department as long as they are not discharged in their active state. Also, the use of the amine, dimethylamine should be acceptable in that this type of product was identified in the permit renewal application under which the plant is currently operating. FPL will pursue the use of carbohydrazide unless otherwise instructed by the Department.

Thank you very much for your consideration. If you should have any questions, please contact Mr. Nick Whiting at (561) 467-7167.

Sincerely,

J. A. Stall
Vice President, St. Lucie Plant

JAS/ljs
vppsl057.jun

Attachments

cc: Ron Hix, FPL Environmental Services
FDEP - Port St. Lucie

ATTACHMENT 1

REVISION TO ST. LUCIE PLANT WASTEWATER PERMIT APPLICATION - APRIL 1996 (ITEM IVB ATTACHMENT - NEW LANGUAGE IN *BOLD ITALICS*, FORMER LANGUAGE IN ~~BOLD STRIKEOUT~~)

ATTACHMENT 1

REVISION TO ST. LUCIE PLANT WASTEWATER PERMIT APPLICATION - APRIL 1996 (ITEM IVB ATTACHMENT - NEW LANGUAGE IN ***BOLD ITALICS***, FORMER LANGUAGE IN ~~**BOLD STRIKEOUT**~~)

9806300130

ITEM IVB ATTACHMENT

ST. LUCIE PLANT GENERAL DESCRIPTION AND DISCUSSION OF MAJOR PROCESSES AND ASSOCIATED WASTE STREAMS

The FPL, St. Lucie Plant is located on Hutchinson Island in St. Lucie County, at latitude 27°20'54" and longitude 80°14'44", about twelve miles north of Stuart, Florida. FPL property covers 1,132 acres and is at about the midpoint of Hutchinson Island. See attached site location map (Figure 1).

The plant site contains two nuclear units. Both St. Lucie nuclear units are 850 MW net facilities utilizing pressurized water reactors. Construction, design and operational aspects are essentially the same for both units. Both units share common once-through cooling water intake and discharge canals. Separate ocean intake and discharge pipes withdraw from and discharge to the Atlantic Ocean from the canals. Individual ocean discharge pipes may be isolated independently. See attached outfall location map (Figure 2).

There are three ocean intake structures for Unit 1 and Unit 2. The intake structures in the Atlantic Ocean contain vertical sections to prevent sanding and velocity caps to minimize entrapment of marine organisms. Horizontal entrance velocities at the velocity cap boundaries are estimated to be about one foot per second.

The NPDES wastewater discharges from the St. Lucie Plant presently include once-through cooling water, steam generator blowdown, radwaste discharge, neutralization basin discharge, sewage treatment plant discharge (Unit No. 1), intake screen wash waste water and stormwater associated with industrial activity. Equipment area floor drains are routed to oily waste separation systems prior to ultimate discharge to the two storm water settling basins. (See Form 2CG for details). FPL proposes a new discharge from the Southeast Basin, which receives overflow from these two basins. This discharge outfall would be used during periods of heavy rainfall which could potentially damage important plant equipment. Figure 2 shows the location of these basins as well as the NPDES serialed discharge points. Two other point source discharges are present on the site that, as determined through discussions with EPA, are not serialed discharges. They are:

- Mangrove flushing water
- Mariculture facility

<u>Mangrove Flushing Water</u>

In order to enhance the growth of isolated mangrove trees located on the east side of the plant and bounded by the plant discharge canal, State Road A1A, and the plant intake canal, seawater is pumped from the intake canal on a seasonal basis onto the discharge canal side of the mangrove area. This seawater is allowed to flow, by gravity, back toward the intake canal. At the discharge pipe into the intake canal, stop logs are used to regulate water level in the mangrove area and simulate flushing that would naturally occur due to tidal action. The flushing and water level control are optimized to help control mosquito growth as well. At the proper time, the stop logs are removed and the uncontaminated seawater is returned to the intake canal. In a letter from Bruce Barrett, dated August 11, 1987, EPA concurred that, "... such a discharge would not require an NPDES permit."

Mariculture Facility

In 1990, FPL requested permission from EPA and the Florida Department of Environmental Regulation (now the DEP) to construct and operate a spiny lobster (*Panulirus argus*) culturing project. Larval lobsters are captured in the plant's intake canal, allowed to grow to a predetermined size and then released into the Atlantic Ocean. This facility can accommodate up to two thousand lobsters annually and may be utilized for the culture of other marine organisms in the future. This facility is not considered a point source for NPDES purposes (40 CFR 122.24 and Appendix C) since the facility would produce less than 100,000 pounds of aquatic animals per year.

Major Plant Processes Generating Wastewater

Major processes at the St. Lucie Plant which generate wastewater as a function of operating activities for the purpose of steam production to generate electricity are:

- Once-through cooling water and auxiliary cooling water systems
- Steam generator makeup water purification (neutralization basin)
- Radwaste system
- Steam generator blowdown
- Intake traveling screen water wash

Once-Through Cooling Water and Auxiliary Cooling Water - OSN 001

The plant utilizes a total of eight circulating water pumps (four per unit) having a nominal total capacity of 968,000 gpm (800,000 gpm minimum to 1,120,000 gpm maximum depending on condenser cleanliness) to supply once-through cooling water to Units 1 and 2. The once-through condenser and auxiliary cooling water systems discharge through pipelines into the Atlantic Ocean. One discharge pipe utilizes a Y-port diffuser which discharges approximately 1500 feet from shore. The other discharge pipe utilizes a multi-port diffuser designed with 58 ports, each port being about 16 inches in diameter. The length of the multi-port diffuser is 1,416 feet beginning 1959 feet from shore. The spacing between ports is 24 feet. The diffuser manifold is optimized with ports alternately oriented north and south at an angle of 25 degrees from the manifold. The discharge of heated water through the Y-port and multi-port diffusers ensures distribution over a wide area and enables a more rapid and efficient mixing with ambient waters.

Two additional minor effluent streams addressed in the current NPDES permit as discharging into the discharge canal are from the steam generators, with monitoring for boron at the POD (see Figure 2 for location), and the refueling water storage tank / non-aerated water hold-up tanks. The latter of these two effluent streams is normally treated in by the liquid radwaste system for further reduction of radioactivity. The refueling water storage tank, whose contents are used for safety injection and refueling water, contains 500,000 gallons of water with a 2000 ppm boron content. There are four, forty thousand gallon non-aerated water hold-up tanks which hold reactor coolant bleed-off or drain down water. Both of these discharges occur very infrequently.

Boron discharges from the steam generator to the discharge canal are described under steam generator blowdown. Based on FPL's calculations, the maximum concentration of boron anticipated at the NPDES compliance point (the POD) during release of the steam generator would be less than 0.1 ppm. This determination is based on the following assumptions: The lowest possible dilution from one operating unit at 30% power would be two circulating water pumps plus two auxiliary cooling water pumps. The subsequent flow in the discharge canal would be 271,000 gpm. Using the maximum blowdown possible from both steam generators (240 gpm) at ten times the upper limit of anticipated boron concentration (100 ppm), the maximum increase of boron in the discharge canal would be less than 0.1 ppm. The ambient boron concentration of the receiving body of water (the Atlantic Ocean) is approximately 4.0 ppm. Thus, the increase in the discharge canal boron concentration from the steam generator blowdown discharge is not significant.

The once-through cooling water system is presently chlorinated at a maximum of two hours per day per unit for micro- and macrobiofouling control. In addition, the present NPDES permit allows the use of Betz Clam-Trol (CT-1) as a biocide for treatment of these systems. FPL is no longer using this biocide and is, therefore, requesting that any language concerning the use of CT-1, along with the whole effluent toxicity testing associated with the use of this biocide, be deleted from the renewed permit.

As a replacement for the biocide treatment, FPL is in the process of installing mechanical condenser tube cleaning systems on both units. A system on Unit 2 went into operation in January 1996 and a system is planned for installation on Unit 1 in the spring of 1996. These systems utilize sponge balls that are about 23 mm in diameter, which are forced through the condenser tubes. Approximately 1800 sponge balls are utilized at one time per condenser waterbox. There are four waterboxes per condenser on each unit. The sponge balls scrub the tubes as they pass through. Downstream of the condensers, the sponge balls are captured by a ball strainer. The ball strainers have grills with 5 mm spacings that prevent the balls from passing through the waterbox outlets and into the plant discharge system. The ball strainer grills funnel the sponge balls to pipes on the side of the strainer housings where the balls are sucked out of the circulating water flow by a recirculating pump. The sponge balls pass through the recirculating pump to the ball collectors. Ft. Pierce City water is utilized for seal water for the recirculation pumps at a rate of approximately 3.5 gpm. The sponge balls normally pass through the ball collectors and are returned to the inlet side of the condensers for another cycle through the condensers. When the sponge balls begin to wear out, they are collected in the ball collector. The recirculating pump is shutdown and the worn out balls are removed and new balls added to the ball collector.

The St. Lucie Plant employs Best Management Practices for the control of sponge ball loss to the environment from the tube cleaning systems. For example, sponge balls are being inventoried and sponge ball loss to the environment reported to FDEP Bureau of Protected Species during the first year of operation. If sponge ball loss poses adverse impact to local sea turtle populations, FPL shall initiate measures to eliminate known causes of the losses.

In addition to Once-Through Cooling, up to 58,000 gpm of ocean cooling water is pumped using auxiliary cooling water pumps through the auxiliary equipment heat exchangers. The solution being cooled by these heat exchangers, which in turn directly cools in-plant machinery, contains 200-500 ppm of sodium molybdate, 200-500 ppm of sodium nitrate, and 10-30 ppm of tolytriazole. ***A biocide and biodispersant, with a short active chemical life, are added to control microbiological activity.*** Normally this part of the system is closed, i.e., it recirculates much like an automobile cooling system. Should a leak occur in a heat exchanger, a small amount of the molybdate solution could be released. The water level in this system is carefully monitored so leaks can be identified and repairs made. Due to the large volume being discharged to the common discharge canal through the "open" part of the cooling water system, it is anticipated that these minor leaks would not be detectable at the heat exchanger outlet and certainly would not be detectable at the POD in the discharge canal. ***Biocides and biodispersants are not added when any leakage is known to occur. Furthermore, these products are not added during normal scheduled maintenance on the system, which could increase the chance of discharge to the environment.*** Low-level chlorination of the auxiliary cooling water is utilized.

Neutralization Basin - OSN 002

Water for general plant use is purchased from the City of Fort Pierce and stored in the City Water Storage Tanks. Water for plant system make-up is further processed by carbon filtration for removal of suspended solids (organic and inorganic), as well as removal of any residual chlorine that may be present. It is then treated by use of a cation resin where cations such as Mg^{++} and Ca^{++} are removed. Next, the water passes through an anion resin where anions such as SO_4^{-} and $C1^-$ are removed. Finally it passes through a polishing mixed bed consisting of anion and cation resins.

After repeated use, ion exchange capacity of the anion and cation resins becomes exhausted and must be returned to its original capacity (regenerated). Cation resins are regenerated with H_2SO_4 (sulfuric acid) where H^+ replaces the cations exchanged by the resin during the demineralization process. The anion resin bed is regenerated with NaOH (sodium hydroxide) where OH^- replaces anions exchanged by resins during demineralization. The final polishing mixed bed anion/cation resin demineralizer also requires regeneration with $NaOH/H_2SO_4$ but at a lesser frequency than the cation and anion demineralizers.

Certain steps from the anion and cation demineralizer regeneration process which generates corrosive (RCRA) wastes are routed to a Totally Enclosed Treatment Facility where pH is adjusted to between 2 and 12.5 SU. This effluent is then routed to the lined neutralization basin which already contains effluent from anion and cation demineralizer regeneration which is not corrosive by RCRA criteria. From the neutralization basin, the pH of each batch is checked and adjusted as necessary prior to discharge to the evaporation/percolation basins or the intake canal.

The carbon filters are backwashed with city water to remove trapped, suspended solids previously filtered from that water. This water is discharged to the evaporation/percolation basins.

Liquid Radwaste System Batch Releases - OSN 003

The flow from the radwaste treatment system is intermittent. The system has been modified to permit a maximum estimated flow of 250 gpm. This waste stream originates from various maintenance and operational activities which take place in the reactor auxiliary building (RAB) and is processed for radioactive reduction by ion exchange resins and low micron filtration systems. Effluent from this system does not normally contain any metal cleaning wastes.

FPL is considering process for the reduction of radioactive solid waste which could increase the chemical characteristics of the above effluent. It involves the use of consumable materials made of Polyvinyl Alcohol, which can be dissolved in hot water and discharged via the liquid radwaste system. Preliminary testing indicates that this process would increase the BOD of the effluent dependent upon the amount of material processed.

Steam Generator Blowdown - OSN 005

As mentioned previously, high purity make-up water is generated at the St. Lucie Plant by a water treatment plant by way of carbon filtration and ion exchange demineralization. Much of this high quality water is routed to the secondary system and steam generators as makeup for the water/steam cycle. ~~Ammonium hydroxide is added for pH control and catalyzed hydrazine (Amerzine) is added for oxygen removal.~~ ***An amine such as ammonia or dimethylamine may be added for pH control and hydrazine, catalyzed hydrazine (Amerzine), or a hydrazine substitute such as carbohydrazide is added for oxygen removal.*** Undesirable contaminants such as chlorides from condenser leaks can contaminate the steam generator water. Strict operating specifications require that suspended and dissolved solids be maintained at very low levels, therefore, to keep the contaminants at these low levels, a continuous steam generator blowdown is required. This blowdown is either recovered or routed to the discharge canal. The concentration of hydrazine in these discharges during plant operation normally ranges from 25 ppb to 2 ppm.

During overhauls and/or refueling outages the steam generators, feedwater systems, and/or condensers may be placed in a static mode where the internal metal surfaces of these components must be protected from corrosion. The typical method used is to fill the system with a hydrazine/ammonia/demineralized water solution. This solution which contains up to 300 ppm hydrazine must then be drained and discharged to the plant's discharge canal. These discharges normally occur approximately every eighteen months per unit during refueling operations or during any periods of extended maintenance.

FPL has monitored the discharge canal extensively at EPA's request from 1989-1993 during periods of "wet lay-up" discharge and found the hydrazine values, due to the rapid break-down of hydrazine upon exposure to oxygen in the environment and through dilution, to be between <5 ppb and 16 ppb at the point of discharge (POD) with most of the values being <5 ppb (the detection limit for hydrazine).

During normal plant operations, each steam generator contains 5 - 10 ppm boric acid. The plant's current NPDES permit allows boron discharges up to 4.0 ppm above ambient (as defined in Serial 001 of the permit). This limitation allows for discharges from the refueling water storage tank and nonaerated water hold-up tanks. The steam generator does not discharge at exactly the same location, but the point of discharge is less than two hundred feet away from the condenser outlet.

Based on FPL's calculations, the maximum concentration of boron anticipated at the NPDES compliance point (the POD) would be less than 0.1 ppm. This determination was based on the following assumptions. The least possible dilution flow from one operating unit at 305 MW power would be two circulating water pumps plus two auxiliary cooling water pumps. The subsequent flow in the discharge canal would be 271,000 gal/min. Using the maximum blowdown possible from both steam generators (240 gal/min) at twice the upper limit of anticipated boron concentration (e.g. 100 ppm) the maximum increase of boron in the discharge canal would be less than 0.1 ppm. The ambient boron concentration of the receiving water body (e.g., the Atlantic Ocean) is greater than 4.0 ppm).

Intake Traveling Screen Wash Water - OSN 007

Two 1060 gpm capacity traveling screen wash pumps located on both Units 1 and 2 at the St. Lucie Plant intake structure withdraw ocean water for traveling screen cleaning. The traveling screens are used to prevent debris from reaching the condensers. One pump (the other standby) is normally in operation on each unit for two hours per day, at an average wash flow of 90 gpm per unit. The wash water is returned to the intake canal through a collection sump and drain system.

Other Processes Generating Wastewater

There are two waste streams at the St. Lucie Plant which are not a function of electrical generation operating activities. They are:

- Sewage treatment plants
- Non-equipment area storm water runoff

Unit 1 Sewage Treatment Plant - OSN 004

Sanitary wastes from shower, water closets, and other personnel-related waste waters; and some spent plant laboratory wastes are routed to the Unit 1 sewage treatment plant (OSN 004). The Unit 1 sewage treatment plant (STP) has a design capacity of 17,000 gpd. It discharges into the intake canal. Domestic sludge generated from this plant is analyzed annually for 40 CFR 503 pollutants. The sludge is transported to the Indian River County Regional Treatment Facility in Gifford, Florida.

Non-equipment Area Storm Water Run-off - OSN 006

Two non-equipment area stormwater discharges are made to the cooling water intake canal or mangrove impoundments. These streams originate from areas of the plant such as roadways, parking lots, and building storm drains and are covered in section 2F of this application.

Proposed Outfall from Southeast Evaporation/Percolation Basin

FPL proposes a discharge from the Southeast Evaporation/Percolation Basin to the plant intake canal. This discharge would be used when local rainfall amounts result in pond levels that threaten plant operating equipment. The discharge opening would be designed higher than normal basin operating level and would have a valve that would normally be locked closed. A staff gauge located in the basin would be routinely checked and when levels are such that a discharge becomes necessary, the valve could be opened, and the discharge monitored for flow and required chemical parameters. Previous history indicates that this discharge would be required approximately two times per year.

This discharge is in the planning stage. Engineering design will be submitted upon completion.

ATTACHMENT 2

GLUTARALDEHYDE (NALCO 7338)

MATERIAL SAFETY DATA SHEET

NALCO

PRODUCT

NALCO 7338 LIQUID

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 1 PRODUCT IDENTIFICATION

TRADE NAME: NALCO 7338 LIQUID
DESCRIPTION: An aqueous solution of glutaraldehyde

NFPA 704M/HMIS RATING: 3/3 HEALTH 1/1 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 COMPOSITION/INGREDIENT INFORMATION

Our hazard evaluation has identified the following chemical ingredient(s) as hazardous under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Consult Section 15 for the nature of the hazard(s).

INGREDIENT(S)	CAS #	APPROX.%
Glutaraldehyde	111-30-8	40-70

SECTION 3 HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:
DANGER! Corrosive. Causes irreversible eye damage. Causes skin burns. Harmful if inhaled. May be fatal if swallowed. Harmful if absorbed through skin. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Causes asthmatic signs and symptoms in hyper-reactive individuals. Do not get in eyes, on skin or on clothing. Avoid breathing vapor. Do not swallow. Wear goggles, protective clothing and rubber gloves. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin, Inhalation

EYE CONTACT: Corrosive to the eyes with possible permanent damage depending on the length of exposure and on the first aid action given.

SKIN CONTACT: Can cause moderate to severe skin irritation. Depending on the length of exposure and on the first aid action given, prolonged contact may be corrosive to skin. Can cause allergic contact dermatitis in susceptible individuals. Can be harmful if absorbed.

INGESTION: Can be harmful or fatal.

INHALATION: Can cause severe respiratory tract irritation.

NALCO CHEMICAL COMPANY ONE NALCO CENTER • NAPERVILLE, ILLINOIS 60563-1198
AREA 708-305-1000

PRECAUTIONARY STATEMENTS: HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

KEEP OUT OF REACH OF CHILDREN

Corrosive. Causes irreversible eye damage. Causes skin burns. Harmful if inhaled. May be fatal if swallowed. Harmful if absorbed through skin. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Causes asthmatic signs and symptoms in hyper-reactive individuals. Do not get in eyes, on skin, on clothing. Avoid breathing vapor. Do not swallow. Wear goggles, protective clothing, and rubber gloves. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

STORAGE AND HANDLING

Solutions of this product are incompatible with many commonly used materials of construction such as steel, galvanized iron, aluminum, tin, and zinc. These solutions can be stored and handled in baked phenolic-lined steel, polyethylene, stainless steel, or reinforced epoxy-plastic equipment. This product freezes at about 1 deg F (-17 deg C). Therefore, unless the storage tank is inside or underground, heating and insulation may be required. If heating is needed, exposure to high temperatures should be avoided. For short storage times (up to about 1 month), temperatures of up to 100 deg F (37.8 deg C) can be tolerated but the preferred maximum storage temperature is about 80 deg F (26.7 deg C). A stainless steel centrifugal pump is suggested for transfer service. Spiral wound stainless steel with Teflon(R) is suitable for gaskets and packing.

STORAGE AND DISPOSAL

PESTICIDE DISPOSAL: Do not contaminate water, food or feed by storage or disposal. Open dumping is prohibited. Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or your Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Metal Containers or Plastic Containers: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or other procedures approved by state and local authorities. Plastic Containers: May be incinerated, or, if allowed by state and local authorities, by burning. If burned, st[illegible] of smoke. Metal Containers: Must not be incinera[illegible]t cut or weld on or near metal containers.

NALCO®

7338

MICROORGANISM CONTROL CHEMICAL

A MICROBIOCIDE FOR USE IN CONTROLLING SLIME FORMING BACTERIA, SULFATE-REDUCING BACTERIA, AND ALGAE IN AIR WASHERS AND INDUSTRIAL SCRUBBING SYSTEMS, SERVICE WATER AND AUXILIARY SYSTEMS, RECIRCULATING COOLING AND PROCESS WATER SYSTEMS INCLUDING THOSE THAT CONTAIN REVERSE OSMOSIS MEMBRANES AND WASTEWATER SYSTEMS INCLUDING WASTEWATER SLUDGE AND HOLDING TANKS.

ACTIVE INGREDIENT:
Glutaraldehyde.................................... 45.0%
INERT INGREDIENTS.................................... 55.0%

100.0%

KEEP OUT OF REACH OF CHILDREN

DANGER

STATEMENT OF PRACTICAL TREATMENT

IF IN EYES: Immediately flush with plenty of water for at least 15 minutes. Get immediate medical attention.
IF ON SKIN: Immediately wash with plenty of soap and water. Get medical attention.
IF INHALED: Remove to fresh air. If breathing is difficult, administer oxygen. If symptoms persist, call a physician.
IF SWALLOWED: DO NOT INDUCE VOMITING. Do not give anything to drink. Seek medical advice with urgency.
NOTE TO PHYSICIAN: Aspiration may cause lung damage. Probable mucosal damage may contraindicate the use of gastric lavage.

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS.

EPA Reg. No. 10352-22-1706
EPA Est. No. 10352-WV-2 EPA Est. No. 1706-CA (J)

Letter in () that matches first letter in batch number identifies the establishment number.

NET CONTENTS SHOWN ELSEWHERE ON CONTAINER.
BEFORE HANDLING OR USING, READ AND UNDERSTAND CURRENT NALCO MATERIAL SAFETY DATA SHEET FOR THIS PRODUCT.

SOLD BY:

NALCO CHEMICAL COMPANY
6216 WEST 66TH PL[illegible], CHICAGO, IL 60638
EMERGENCY PHON[illegible]: (800) 462-5378

DIRECTIONS FOR USE

GENERAL CLASSIFICATION
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

AIR WASHERS AND INDUSTRIAL SCRUBBING SYSTEMS/RECIRCULATING COOLING AND PROCESS WATER SYSTEMS

This product may be used only in industrial air washers and air washer systems which have mist-eliminating components. This product should be added at the application rates described below, to a water treatment system at a convenient point of uniform mixing such as the basin area. Addition may be made intermittently (SLUG DOSE) or continuously. Badly fouled systems can be shock treated with this product. Under these conditions, blowdown should be discontinued for up to 24 hours. This product can be used in industrial process water systems that contain ultra filtration units and non-medical reverse osmosis membranes (where approved for compatibility by the membrane manufacturer) and associated distribution systems.

INTERMITTENT (SLUG DOSE) METHOD
Initial Dose: When the system is noticeably fouled, apply 14.2 to 28.2 fluid ounces of this product per 1000 gallons of water in the system. Repeat until control is achieved.
Subsequent Dose: When microbial control is evident, add 5.7 to 14.2 fluid ounces of this product per 1000 gallons of water in the system weekly, or as needed to maintain control. Badly fouled systems must be cleaned before treatment is begun.

CONTINUOUS FEED METHOD
Initial Dose: When the system is noticeably fouled, apply 14.2 to 28.2 fluid ounces of this product per 1000 gallons of water in the system.
Subsequent Dose: Maintain this treatment level by starting a continuous feed of 2.8 to 14.2 fluid ounces of this product per 1000 gallons of water in the system per day. Badly fouled systems must be cleaned before treatment is begun.

SERVICE WATER AND AUXILIARY SYSTEMS

This product should be used at the same application rates, and in the same manner as described above. It should be added to the system at a point that will allow for uniform mixing throughout the system.

HEAT TRANSFER SYSTEMS

(Evaporative Condensers, Dairy Sweetwater Systems, Hydrostatic Sterilizers and Retorts, and Pasteurizers and Warmers and Once-Through Cooling Water Systems)
This product should be used at the same application rates, and in the same manner as described above. It should be added to the system at a point of uniform mixing such as a basin area, sump area or other reservoir or collecting area from which the treated water will be circulated uniformly throughout the system.

INDUSTRIAL WASTEWATER SYSTEMS

(Wastewater Systems, Wastewater Sludge and Wastewater Holding Tanks) This product should be added to a wastewater system or sludge at a convenient point of uniform mixing such as the digester. Add 0.5 to 2.5 gallons (500 to 2500 ppm this product) per 1000 gallons of wastew[illegible] or sludge.

14.1192/0[illegible]

CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S., 8, NA3265, II (Glutaraldehyde)

SECTION 3 HAZARD IDENTIFICATION (CONTINUED)

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

SECTION 4 FIRST AID INFORMATION

EYES:	Immediately flush for at least 15 minutes while holding eyelids open. Call a physician at once.
SKIN:	Immediately flush with water for at least 15 minutes. For a large splash, flood body under a shower. Call a physician at once.
INGESTION:	Do not induce vomiting. Do not give anything to drink. Seek medical advice with urgency.
INHALATION:	Remove to fresh air. Treat symptoms. Call a physician at once.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsions may be needed.

SECTION 5 FIRE FIGHTING

FLASH POINT: None (PMCC) ASTM D-93

EXTINGUISHING MEDIA: This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use water to cool containers exposed to fire.

UNUSUAL FIRE AND EXPLOSIVE HAZARD: Vapors are irritating.

SECTION 6 ACCIDENTAL RELEASE MEASURES

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

SECTION 6 ACCIDENTAL RELEASE MEASURES (CONTINUED)

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

For large indoor spills, evacuate employees and ventilate area. Those responsible for control and recovery should wear the protective equipment specified in Section 8 .,

SECTION 7 HANDLING AND STORAGE

Storage : Keep container closed when not in use.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

RESPIRATORY PROTECTION: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant mists are generated, use either a chemical cartridge respirator with a dust/mist prefilter or supplied air.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended. Additionally, local exhaust ventilation is recommended where vapors, mists or aerosols may be released.

PROTECTIVE EQUIPMENT: Wear impermeable gloves, boots, apron, and a face shield with chemical splash goggles. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton, and butyl (compatibility studies have not been performed. A full slicker suit is recommended if gross exposure is possible.

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

HUMAN EXPOSURE CHARACTERIZATION: Based on Nalco's recommended product application and our recommended personal protective equipment,

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION (CONTINUED)

the potential human exposure is: MODERATE.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

COLOR:	Clear	FORM: Liquid
ODOR:	Characteristic aldehyde	
DENSITY:	9.3 lbs/gal.	
SOLUBILITY IN WATER:	Completely	
SPECIFIC GRAVITY:	1.12 @ 68 Degrees F	ASTM D-1298
pH (NEAT) =	3.1-4.5	ASTM E-70
VISCOSITY:	13.6 cps @ 68 Degrees F	ASTM D-2983
FREEZE POINT:	1.4 Degrees F/-17 Degrees C	ASTM D-1177
BOILING POINT:	213 Degrees F @ 760 mm Hg	ASTM D-86
FLASH POINT:	None (PMCC)	ASTM D-93
VAPOR PRESSURE:	16 mm Hg @ 68 Degrees F	ASTM D-323
EVAPORATION RATE: (Butyl acetate = 1)	0.99	ASTM D1901

NOTE: These physical properties are typical values for this product.

SECTION 10 STABILITY AND REACTIVITY

INCOMPATIBILITY: Avoid contamination with strong inorganic acids and bases. Contact with these may cause a heat-generating reaction which is not expected to be violent.

STORAGE: Avoid storage at temperatures above 100 Degrees F. Storage stability is dependent on pH and temperature. Optimum stability when stored at pH of 3.7 - 4.5 and 25 - 37 Degrees C.

THERMAL DECOMPOSITION PRODUCTS: In the event of combustion CO, CO2 may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICITY STUDIES: Acute toxicity studies have been conducted on various concentrations of glutaraldehyde. The results are shown below. (A.I. refers to active ingredient basis.)

ACUTE ORAL TOXICITY (ALBINO RATS):
LD50 for 50% solution = 1.3 ml/kg (733 mg/kg A.I.)
LD50 for 45% solution = 1.2 ml/kg (605 mg/kg A.I.)
LD50 for 25% solution = 1.54-1.87 ml/kg (409-497 mg/kg A.I.)
LD50 for 10% solution = 1.07-1.62 ml/kg (111-168 mg/kg A.I.)

SECTION 11 TOXICOLOGICAL INFORMATION (CONTINUED)

ACUTE DERMAL TOXICITY (ALBINO RABBITS):
LD50 for 50% solution = 1.59-2.54 ml/kg (897-1432 mg/kg A.I.)
LD50 for 45% solution = 2.00-2.71 ml/kg (1004-1360 mg/kg A.I.)
LD50 for 25% solution = 8.0-12.80 ml/kg (2128-3045 mg/kg A.I.)

COMMENTS: A major determinant of the acute percutaneous toxicity of glutaraldehyde solution is concentration. Cumulative toxicity is also possible by repeated dermal contact with 25-50% solution of glutaraldehyde.

PRIMARY SKIN IRRITATION TEST (ALBINO RABBITS): At 10% or greater, glutaraldehyde solutions may cause moderate to severe irritation, with possible necrosis after prolonged contact.

DOT CORROSIVITY TEST: Aqueous solutions up to, and including, 45% do not produce corrosive lesions when tested under DOT conditions, but at 50% two of six animals developed local necrosis in 4 hours or less.

SKIN SENSITIZATION: At levels of 0.2% and lower no sensitization occurred in human studies. Higher levels produced allergic contact dermatitis. Cross reaction with formaldehyde or from lower concentrations of glutaraldehyde does not occur.

PRIMARY EYE IRRITATION TEST (ALBINO RABBITS): Severely irritating
COMMENTS: At levels of 0.2% and below of glutaraldehyde no eye irritation was noted. Levels above 0.2% of glutaraldehyde produced moderate to severe irritation and corneal injury.

ACUTE INHALATION TOXICITY (ALBINO RATS): LC = Greater than 2.5 L/minute (saturated vapor for 6-8 hours produced irritant effects, but resulted in no deaths.)

COMMENTS: Examination of all sacrificed animals at the end of the study showed no abnormalities.

OTHER TOXICITY RESULTS: Laboratory studies have shown that glutaraldehyde is not teratogenic, and several studies have shown the material not to be a mutagen.

Doses of 25 and 50 mg/kg given by gavage to pregnant rats produced decreases in maternal body weight. There were no other indications of maternal toxicity nor were there evidence of fetotoxicity or external, visceral or skeletal abnormalities. Mice (CD-1 strain) given 100 mg/kg by gavage showed fetotoxicity as evidenced by decreased body weight. At lower doses, there was

SECTION 11 TOXICOLOGICAL INFORMATION (CONTINUED)

no evidence of fetotoxicity or skeletal abnormalities. No evidence of teratogenic effects were noted in either species.

Mutagenicity in vitro tests of Chinese hamster ovary, sister chromatid exchange and unscheduled DNA synthesis did not produce dose-related responses. Oral doses of 30 and 60 mg/kg to mice showed no effect in the dominant lethal assay. In all five strains of Salmonella, with and without metabolic activation by S 9 liver homogenate, no mutagenic response was noted.

Glutaraldehyde incorporated into the diet of rats up to 1.6 g/kg for seven days resulted in no deaths. An eleven week drinking water study of glutaraldehyde at up to 0.5% showed no effect.

Preliminary histopathological findings in the 24-month sacrifice of a combined oncogenicity/chronic study in Fischer 344 rats given glutaraldehyde in drinking water showed an increase in the incidence of the spontaneously occurring large granular cell lymphocytic leukemia (LGL) at all dosages (50, 250, 1000 ppm) compared with the controls only for the female rats. Male rats had the same incidence as controls at all levels of exposures. The significance of this observation to humans remains to be determined.

HUMAN HAZARD CHARACTERIZATION: Based on our hazard characterization, the potential human hazard is: HIGH.

SECTION 12 ECOLOGICAL INFORMATION

AQUATIC DATA: Aquatic toxicity studies have been performed on various concentrations of glutaraldehyde solutions with results as follows.

Bluegill sunfish:
96-hour static acute LC50 for 100% glutaraldehyde = 11 ppm
96-hour static acute LC50 for 50% solution = 22.4 ppm
96-hour static acute LC50 for 25% solution = 37.6 ppm
96-hour NOEL for 25 and 50% solutions = 10 ppm
96-hour NOEL for 100% glutaraldehyde = 5 ppm

Rainbow trout:
96-hour static acute LC50 for 100% glutaraldehyde = 12 ppm
96-hour static acute LC50 for 50% solution = 23.7 ppm
96-hour static acute LC50 for 25% solution = 42.1 ppm
96-hour NOEL for 50% solution = 18 ppm
96-hour NOEL for 25% solution = 32 ppm
96-hour NOEL for 25 and 100% glutaraldehyde = 9 ppm

SECTION 12 ECOLOGICAL INFORMATION

(CONTINUED)

Daphnia magna:
48-hour static acute LC50 for 100% glutaraldehyde = 8 ppm
48-hour static acute LC50 for 50% solution = 11.5 ppm
48-hour static acute LC50 for 25% solution = 16.9 ppm
48-hour NOEL for 25 and 50% solutions = 5 ppm
48-hour NOEL for 100% glutaraldehyde = 16 ppm

Fathead minnow:
96-hour static acute LC50 for 100% glutaraldehyde = 6 ppm
96-hour NOEL for 100% glutaraldehyde = 4 ppm

Sheepshead minnow:
96-hour static acute LC50 for 100% glutaraldehyde = 32 ppm
96-hour NOEL for 100% glutaraldehyde = 24 ppm

Mysid shrimp:
96-hour static acute LC50 for 100% glutaraldehyde = 7.1 ppm
96-hour NOEL for 100% glutaraldehyde = 0.78 ppm

Data for 25% solutions and 100% glutaraldehyde using other species:
48-hour static acute LC50 in Oyster larvae = 2.1 ppm
96-hour static acute LC50 in Green crabs = 465 ppm
96-hour static acute LC50 in Grass shrimp = 41 ppm

AVIAN DATA: Wildlife toxicity studies have been performed on 25 and 50% solutions of glutaraldehyde with results as follows.

8-day dietary LC50 to Bobwhite Quail = 10,000 ppm
8-day dietary LC50 to Mallard Duck = 10,000 ppm
Acute oral LD50 to Mallard Duck = 933 mg/kg for 50% solution
Acute oral LD50 to Mallard Duck = 1631 mg/kg for 25% solution

DEGRADATION: In the standard BOD test, glutaraldehyde was degraded at greater than 50% in less than 5 days.

AQUATIC DATA: Results below are based on the active ingredient.

96 hour static acute LC50 to sewage microorganisms = 34 ppm

96 hour no observed effect concentration is 10 ppm based on no mortality or abnormal effects.

If released into the environment, see CERCLA in Section 15.

SECTION 12 ECOLOGICAL INFORMATION (CONTINUED)

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION: Based on our Hazard Characterization, the potential environmental hazard is: MODERATE. Based on Nalco's recommended product application and the product's characteristics, the potential environmental exposure is: HIGH.

SECTION 13 DISPOSAL CONSIDERATIONS

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be deep-well injected in accordance with local, state, and federal regulations.

SECTION 14 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES	:	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
UN/ID NO	:	UN 3265
HAZARD CLASS - PRIMARY	:	8 - CORROSIVE
PACKING GROUP	:	II
IMDG PAGE NO	:	8147-1
IATA PACKING INSTRUCTION	:	CARGO: 812
IATA CARGO AIRCRAFT LIMIT	:	30 L (MAX NET QUANTITY PER PACKAGE)
FLASH POINT	:	NONE
TECHNICAL NAME(S)	:	GLUTARALDEHYDE
RQ LBS (PER PACKAGE)	:	NONE
RQ COMPONENT(S)	:	NONE

SECTION 15 REGULATORY INFORMATION

The following regulations apply to this product.

SECTION 15 REGULATORY INFORMATION (CONTINUED)

FEDERAL REGULATIONS:

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, the following ingredient in this product is hazardous and the reason is shown below.

Glutaraldehyde - Corrosive, sensitizer

Glutaraldehyde = Ceiling 0.2 ppm, 0.82 mg/m3 ACGIH/TLV

Glutaraldehyde = Ceiling,0.2 ppm, 0.8 mg/m3 OSHA/PEL

CERCLA/SUPERFUND, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found this product to be hazardous. The product should be reported under the following EPA hazard categories:

XX Immediate (acute) health hazard
XX Delayed (chronic) health hazard
-- Fire hazard
-- Sudden release of pressure hazard
-- Reactive hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain ingredients on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
This product is exempted under TSCA and regulated under FIFRA. The inerts are on the Inventory List.

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SECTION 15 REGULATORY INFORMATION (CONTINUED)

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA):
EPA Reg. No. 10352-22-1706. This product is registered for use as a microorganism control chemical used in industrial recirculating cooling water tower systems and used in air washer systems. In all cases follow instructions on the product label.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 13 for RCRA classification.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
None of the ingredients are specifically listed.

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments),
Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
This product does not contain any chemicals which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS:
This product does not contain ingredients listed on the Michigan Critical Materials Register.

STATE RIGHT TO KNOW LAWS:
Regulated in those states using the TLV for glutaraldehyde as a criteria for listing.

INTERNATIONAL REGULATIONS:

This product is a registered biocide and is exempt from WHMIS under The House of Commons of Canada Bill C-70.

SECTION 16 OTHER INFORMATION

None

SECTION 17 RISK CHARACTERIZATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our

NALCO CHEMICAL COMPANY ONE NALCO CENTER • NAPERVILLE, ILLINOIS 60563-1198
AREA 708-305-1000

SECTION 17 RISK CHARACTERIZATION (CONTINUED)

recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: MODERATE.

* The environmental risk is: MODERATE.

Any use inconsistent with Nalco's recommendations may affect our risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

SECTION 18 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (CD-ROM version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (CD-ROM version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

SECTION 18 REFERENCES (CONTINUED)

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, Ohio (CD-ROM version), Micromedex, Inc., Englewood, CO.

Shepard's Catalog of Teratogenic Agents (CD-ROM version), Micromedex, Inc., Englewood, CO.

Suspect Chemicals Sourcebook (a guide to industrial chemicals covered under major regulatory and advisory programs), Roytech Publications (a Division of Ariel Corporation), Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, Washington (CD-ROM version), Micromedex, Inc., Englewood, CO.

PREPARED BY: William S. Utley, PhD., DABT, Manager, Product Safety
DATE CHANGED: 03/25/97 DATE PRINTED: 08/21/97

PRODUCT BULLETIN

NALCO® 7338

Microorganism Control Chemical

C-7338

PRODUCT BENEFITS

- Broad spectrum non-oxidizing biocide
- Helps control slime deposits, thereby improving heat transfer
- Compatible with phosphate, phosphonate, and chromate-based corrosion programs

PRINCIPAL USES

NALCO 7338 is a broad spectrum, non-oxidizing biocide that helps control algae, fungi, and bacterial slime in:

- Recirculating cooling towers
- Closed loop cooling systems
- Air washers
- Brewery pasteurizers

Note: NALCO 7338 is intended for industrial use only. Use NALCO 7338 only as specified on drum label.

GENERAL DESCRIPTION

NALCO 7338 is an organic compound formulated in an aqueous solution. For typical chemical and physical properties, refer to the NALCO 7338 Material Safety Data Sheet.

DOSAGE

The specific dosage of NALCO 7338 will vary depending upon the operating characteristics of your system, the waters' chemistry, and the severity of problems encountered.

Your Nalco representative will recommend the optimum dosage for maximum performance in your system.

FEEDING

NALCO 7338 should be fed on an intermittent basis, generally to the tower sump, but always to a point of adequate agitation.

STORAGE AND HANDLING

NALCO 7338 has a freeze point of 1.4°F (–17°C) and should be stored appropriately. Recommended in-plant storage limit is one year.

Refer to the label and Material Safety Data Sheet for complete handling information before using this product.

This product is toxic to fish. Do not discharge effluent containing this product into lakes, streams, ponds, or public waters unless in accordance with an NPDES permit. For guidance, contact your Regional Office of the EPA. Do not contaminate water by cleaning of equipment or disposal of wastes.

(Continued on Reverse Side)

NALCO CHEMICAL COMPANY One Nalco Center • Naperville, Illinois 60563-1198

NALCO

SHIPPING

NALCO 7338 is shipped from manufacturing and regional distribution locations in returnable 55-, 200- and 400-gallon PORTA-FEED® units.

DRUM DISPOSAL

Triple rinse all containers, puncture and dispose in a sanitary landfill approved for pesticide containers, or incinerate, if allowed by state and local authorities. If burned, stay out of smoke.

REMARKS

If you need assistance or information, please call your nearest Nalco representative, or our Naperville office at (630) 305-1000.

For Medical and Transportation Emergencies involving Nalco products call (24-hour response): (800) I-M-ALERT or (800) 462-5378.

UNION CARBIDE

Aqucar®

WATER TREATMENT MICROBIOCIDES

Glutaraldehyde Half-Life in Cooling Towers

Introduction

The half-life of chemical additives in a cooling system is primarily a function of blowdown and capacity. However, many water treatment chemicals are depleted at a faster rate. In the case of biocides, this can be due to reaction with other additives or contaminants, microorganisms, and general system conditions. Because of environmental constraints, it is desirable in many areas that a biocide be non-persistent yet fast-acting, so that biofouling can be controlled while minimizing concerns about discharge. In the examples below, a field test kit was utilized to monitor the depletion of glutaraldehyde in a series of cooling towers. In all cases, the half-life of glutaraldehyde was shorter than the system half-life. However, it is important to note that in all the examples, microorganisms, which initially ranged from 10^5–10^6 cfu/mL, were reduced by at least 90% within one hour of addition.

Case Histories

Case # 1 • Industrial Cooling Tower

System Parameters	
ΔT, °C	10
Volume, gal (L)	35,000 (132,475)
Cycles	5
pH	8.3
Corrosion Inhibitors	Molybdate, organophosphonate

Time	Initial	1 hr	3 hr	5 hr	8 hr
Glutaraldehyde Concentration, ppm active	82	70	58	42	20

Half-life of the system is 41 hours. Glutaraldehyde half-life is approximately 5 hours.

UC-957

Case # 2 • Office Complex Cooling Tower

System Parameters	
ΔT, °C	8
Volume, gal (L)	30,000 (113,550)
Cycles	5–8
pH	7.5–8.0
Corrosion Inhibitors	Phosphate/phosphonate

Time	Initial	3 hr	5 hr	20 hr
Glutaraldehyde Concentration, ppm active	30	23	19	0

Half-life of the system is 48 hours. Glutaraldehyde half-life is approximately 7 hours.

Case # 3 • Industrial Plant Cooling Tower

System Parameters	
ΔT, °C	8
Volume, gal (L)	1500 (5,680)
Cycles	8–9
pH	7.5–7.7
Blowdown, gal/hr (L/hr)	90 (340)
Corrosion Inhibitor	Orthophosphate

Time	Initial	1 hr	3 hr	5 hr	8 hr
Glutaraldehyde Concentration, ppm active	50	46	34	19	11

The system half-life is approximately 8 hours. Glutaraldehyde half-life is approximately 4 hours.

Case # 4 • Ammonia Plant Cooling Tower

System Parameters	
ΔT, °C	8
Volume, gal (L)	57,000 (215,745)
Hardness	115
Cycles	6–7
pH	7.8–8.2
Blowdown, gal/hr (L/hr)	1000 (3,785)
Corrosion Inhibitor	Molybdate

Time	Initial	1 hr	3 hr	6 hr	8 hr
Glutaraldehyde Concentration, ppm active	100	88	80	47	20

The system half-life is 28.5 hours. Glutaraldehyde half-life is approximately 6 hours.

Case # 5 • Industrial Cooling Tower

System Parameters	
ΔT, °C	10
Volume, gal (L)	115,000 (435,275)
Circulation Rate, gal/min (L/min)	10,000 (37,850)
pH	7.5
Corrosion Inhibitors	Phosphate/Phosphonate

Time	Initial	1 hr	3 hr	5 hr	24 hr
Glutaraldehyde Concentration, ppm active	80	70	55	44	6

The calculated half-life of the system is 36 hours. The glutaraldehyde half-life is approximately 6 hours.

Conclusions

As the examples above show, the half-life of glutaraldehyde in a typical cooling tower is significantly less than that predicted by the blowdown and volume calculations. This demonstrates that glutaraldehyde is non-persistent due to reactions with organic materials, microorganisms, and other system additives and contaminants. Even though glutaraldehyde was non-persistent in these towers, it was able to control the growth of microorganisms, providing a minimum 90% reduction in bacterial population within one hour of addition.

Since tower conditions vary, the stability of glutaraldehyde in any system should be checked with the use of a test kit. This will allow the operator to accurately calculate the half-life of glutaraldehyde and also aid in determining the optimal treatment program.

ATTACHMENT 3

ISOTHIAZOLIN (NALCO 7330)

PRECAUTIONARY STATEMENTS: HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

CORROSIVE.
CAUSES EYE DAMAGE AND SKIN BURNS.
MAY CAUSE ALLERGIC SKIN REACTION.
MAY BE HARMFUL IF INHALED.
MAY BE FATAL IF SWALLOWED OR ABSORBED THROUGH THE SKIN.

Do not get in eyes, on skin or on clothing. Wear goggles or face shield and rubber gloves when handling. Avoid breathing vapor or mist. Avoid contamination of food. Do not take internally. Wash thoroughly after handling.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and wildlife. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA. Do not contaminate water by cleaning of equipment or disposal of waste. Apply this pesticide only as specified on this label.

STORAGE AND DISPOSAL

STORAGE: Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited.

DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

METAL CONTAINERS: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorites.
PLASTIC CONTAINERS: Do not reuse empty container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or, if allowed by state and local authorites, by burning. If burned, stay out of smoke.

EPA REG. NO. 1706-153
EPA EST. NO. 1706-LA-1 (G)
EPA Est. No. 1706-CH-1 (B)

Letter in () that matches first letter in batch number identifies the establishment number.

NET CONTENTS SHOWN ELSEWHERE ON CONTAINER
Weight = 8.5 lbs. per gallon.

Container made in U.S.A.;
Contents made in Canada.

NALCO®

7330

A MICROBIOCIDE FOR CONTROL OF BACTERIA, FUNGI AND ALGAE IN INDUSTRIAL RECIRCULATING WATER COOLING TOWERS, INDUSTRIAL PROCESS WATER SYSTEMS, AIR WASHER SYSTEMS AND BREWERY PASTEURIZERS.

ACTIVE INGREDIENTS:	
5-Chloro-2-methyl-4-isothiazolin-3-one	1.15%
2-Methyl-4-isothiazolin-3-one	0.35%
INERT INGREDIENTS:	98.50%
TOTAL	100.00%

KEEP OUT OF REACH OF CHILDREN
DANGER

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Do not induce vomiting. Drink promptly a large quantity of egg whites, gelatin solution or, if these are not available, drink large quantities of water. Avoid alcohol. Call a physician immediately.
IF INHALED: Remove immediately to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Call a physician.
IF ON SKIN: Wash thoroughly with soap and water. Remove and wash contaminated clothing before reuse.
IF IN EYES: Flush with plenty of water for at least 15 minutes. Call a physician.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS.

NALCO CHEMICAL COMPANY
6216 WEST 66th PLACE CHICAGO, IL 60638

EMERGENCY TELEPHONE NUMBER
(800) 462-5378

DIRECTIONS FOR USE:

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

INDUSTRIAL COOLING TOWER SYSTEMS AND PROCESS WATER SYSTEMS

(Such as pretreatment systems and process waters used for washing metal or plastic parts and/or paint reduction.)
For control of bacteria, fungi and algae, add NALCO 7330 to the tower basin, distribution box or some other point in the system to insure uniform mixing. Badly fouled systems must be precleaned before treatment is begun.

INITIAL DOSE: When the system is noticeably fouled apply 2.46 to 7.46 lbs (37 to 113 fluid ounces) of NALCO 7330 per 1000 gallons of water in the system. Repeat until control is achieved.

SUBSEQUENT DOSE: When microbial control is evident, add 1.26 to 1.86 lbs (19 to 28 fluid ounces) of NALCO 7330 per 1000 gallons of water in the system weekly or as needed to maintain control.

INDUSTRIAL RECIRCULATING CLOSED LOOP WATER COOLING SYSTEMS

For the control of bacteria, algae and fungi, add NALCO 7330 to the reservoir, recirculating line or some other point in the system to insure uniform mixing.

INITIAL DOSE: When the system is noticeably fouled, apply 1.26 to 7.46 lbs (19 to 113 fluid ounces) of NALCO 7330 per 1000 gallons of water in the system. Repeat until control is achieved.

SUBSEQUENT DOSE: When microbial control is evident, add 35 to 219 ppm NALCO 7330 (0.3 to 1.86 pounds or 4.5 to 28 fluid ounces of NALCO 7330 per 1000 gallons of water in the system) weekly or as needed to maintain control. Badly fouled systems must be cleaned before treatment is begun.

AIR WASHER SYSTEMS AND BREWERY PASTEURIZERS

For control of bacteria, algae and fungi, add NALCO 7330 to a point in the system where uniform mixing can occur such as the basin. FOR USE IN INDUSTRIAL AIR WASHER SYSTEMS THAT MAINTAIN EFFECTIVE MIST ELIMINATING COMPONENTS. Badly fouled systems must be precleaned before treatment is begun.

INITIAL DOSE: When the system is noticeably fouled, add 1.26 to 7.46 lbs (19 to 113 fluid ounces) of NALCO 7330 per 1000 gallons of system water. Repeat until control is achieved.

SUBSEQUENT DOSE: When microbial control is evident, add 0.3 to 1.86 lbs (4.5 to 28 fluid ounces) of NALCO 7330 per 1000 gallons system water weekly or as needed to maintain control.

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CORROSIVE LIQUID ACIDIC ORGANIC

NALCO

Cooling Water Chemicals | **Product Bulletin**

NALCO® 7330

MICROORGANISM CONTROL CHEMICAL

Product Benefits

- Helps to minimize slime problems which can cause costly reductions in heat transfer
- Minimum discharge problems; active molecules are environmentally degradable
- Simple control; effective against a broad spectrum of microorganisms
- Easy application; active at low dosages

Principal Uses

NALCO 7330 is a broad spectrum, nonoxidizing microbicide for industrial open recirculating systems, air washers, and brewery pasteurizers. It is designed to provide excellent control of microbiological growth and associated deposits. NALCO 7330 is particularly well suited for use in installations with high levels of process contamination, such as ammonia plants, refineries, and chemical plants.

Note: NALCO 7330 is intended for industrial use only. Use NALCO 7330 only as specified on drum label.

General Description

NALCO 7330 is a combination of organic compounds formulated in an aqueous solution. For typical chemical and physical properties, refer to the NALCO 7330 Material Safety Data Sheet.

Dosage

The specific dosage of NALCO 7330 will vary depending upon the operating characteristics of your system, the water's chemistry, and the severity of problems encountered. Your Nalco representative will recommend the optimum dosage to ensure maximum program performance in your system.

Feeding

NALCO 7330 can be fed on an intermittent basis, generally to the tower sump, but always to a point of sufficient agitation. Feed must be accomplished with the Nalco BIODUCTOR® or the Nalco FE1000.

Materials Compatibility

NALCO 7330 is compatible with the following materials of construction: 316L, Plasite, vinyl, polyethylene, PVC, Hypalon, Teflon, Buna-N and polypropylene. All other materials are not compatible.

(Continued on Reverse Side)

NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198

Operations in Argentina, Australia, Austria, Belgium, Brazil, Canada, Caribbean, Chile, Colombia, Ecuador, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Portugal, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Taiwan, Thailand, Turkey, United Kingdom, U.S.A., Venezuela and Yugoslavia.

NALCO

Storage and Handling

NALCO 7330 has a freeze point of 25 F (−4 C) and should be stored appropriately. The recommended in-plant storage limit is six months.

Read the label and Material Safety Data Sheet for complete handling information before using this product.

This product is toxic to fish. Do not discharge into lakes, streams, waterways, ponds or public waters unless in accordance with an NPDES permit. For guidance, contact your Regional Office of the EPA. Do not contaminate water by cleaning of equipment or disposal of wastes.

Shipping

NALCO 7330 is shipped from manufacturing and regional distribution locations in 30- and 55-gallon nonreturnable polyethylene-lined drums containing 240 and 466 lb. respectively, and in 200-gallon returnable PORTA-FEED® units containing 1487 lb.

Remarks

If you need assistance or information, please call your nearest Nalco representative, or our Naperville office at (708) 305-1000.

For **Medical and Transportation Emergencies** involving Nalco products call (24-hour response): (800) I-M-ALERT or (800) 462-5378.

MATERIAL SAFETY DATA SHEET

NALCO

PRODUCT

NALCO 7330 MICROBIOCIDE

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 1 PRODUCT IDENTIFICATION

TRADE NAME: NALCO 7330 MICROBIOCIDE
DESCRIPTION: An aqueous solution of substituted isothiazolinone

NFPA 704M/HMIS RATING: 3/3 HEALTH 0/0 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 COMPOSITION/INGREDIENT INFORMATION

Our hazard evaluation has identified the following chemical ingredient(s) as hazardous under OSHA's Hazard Communication Rule, 29 CFR 1910.1200. Consult Section 15 for the nature of the hazard(s).

INGREDIENT(S)	CAS #	APPROX.%
5-chloro-2-methyl-4 isothiazolin-3-one	26172-55-4	1.15
2-methyl-4-isothiazolin-3-one	2682-20-4	0.35

SECTION 3 HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:
DANGER: Corrosive. Causes eye damage and skin burns. May cause allergic skin reaction. May be harmful if inhaled. May be fatal if swallowed or absorbed through the skin. Do not get in eyes, on skin, or on clothing. Wear goggles and face shield and rubber gloves when handling. Avoid breathing vapor or mist. Avoid contamination of food. Do not take internally. Wash thoroughly after handling.

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin, Inhalation

EYE CONTACT: Corrosive to the eyes with possible permanent damage depending on the length of exposure and on the first aid action given.

SKIN CONTACT: Corrosive to the skin, possibly resulting in third degree burns depending on the length of exposure and on the first aid action given. Can be harmful if absorbed. Can cause allergic contact dermatitis in susceptible individuals.

INGESTION: Can be fatal.

INHALATION: Can be corrosive to the mucous membranes and the lungs. Can cause an allergic reaction in susceptible individuals.

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not

NALCO CHEMICAL COMPANY ONE NALCO CENTER • NAPERVILLE, ILLINOIS 60563-1198
AREA 708-305-1000

SECTION 3 HAZARD IDENTIFICATION (CONTINUED)

identify any worsening of existing conditions.

SECTION 4 FIRST AID INFORMATION

EYES: Immediately flush for at least 15 minutes while holding eyelids open. Call a physician at once.

SKIN: Wash thorougly with soap and rinse with water. Remove and wash contaminated clothing before reuse.

INGESTION: Do not induce vomiting. Drink promptly a large quantity of milk, egg whites, gelatin solution, or, if these are not available, drink large quantities of water. Avoid alcohol. Call a physician immediately.

INHALATION: Remove immediately to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Call a physician.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsions may be needed.

SECTION 5 FIRE FIGHTING

FLASH POINT: None

EXTINGUISHING MEDIA: Not applicable

UNUSUAL FIRE AND EXPLOSION HAZARD: May evolve NOx, SOx or HCl under fire conditions. Containers exposed in a fire should be cooled with water to prevent vapor pressure buildup leading to a rupture. Do not let material evaporate to dryness.

SECTION 6 ACCIDENTAL RELEASE MEASURES

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

SECTION 6 ACCIDENTAL RELEASE MEASURES (CONTINUED)

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 15.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 15.

For large indoor spills, evacuate employees and ventilate area. Those responsible for control and recovery should wear the protective equipment specified in Section 8 .

This product is toxic to fish. It should not be directly discharged into lakes, ponds, streams, waterways or public water supplies.

SECTION 7 HANDLING AND STORAGE

Storage : Keep container closed when not in use.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

RESPIRATORY PROTECTION: If it is possible to generate significant levels of vapors or mists, a NIOSH approved or equivalent respirator is recommended.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended. Additionally, local exhaust ventilation is recommended where vapors, mists or aerosols may be released.

PROTECTIVE EQUIPMENT: Wear gloves, boots, apron and a face shield with chemical splash goggles. (Based on test data obtained from materials of construction, the following recommendations are listed for gloves along with their break-through times: Butyl rubber (greater than 8 hours); polyvinyl chloride (greater than 7.5 hours) and neoprene coated (greater than 6 hours). A full slicker suit is recommended if gross exposure is possible.

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION (CONTINUED)

HUMAN EXPOSURE CHARACTERIZATION: Based on Nalco's recommended product application and our recommended personal protective equipment, the potential human exposure is: LOW.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

COLOR: Pale yellow to green	FORM: Liquid	ODOR: Mild
DENSITY:	8.6 lbs/gal.	
SOLUBILITY IN WATER:	Completely	
pH (NEAT) =	3 - 5	ASTM E-70
FREEZE POINT:	25 Degrees F	ASTM D-1177
FLASH POINT:	None	
VOLATILE ORGANIC COMPOUND (VOC):	0.07 lbs/gal.	EPA METHOD 24

NOTE: These physical properties are typical values for this product.

SECTION 10 STABILITY AND REACTIVITY

INCOMPATIBILITY: None known

THERMAL DECOMPOSITION PRODUCTS: In the event of combustion CO, CO2, NOx, SOx, HCl may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICITY STUDIES: Toxicity studies have been conducted on this product. The results are shown below.

ACUTE ORAL TOXICITY (ALBINO RATS): LD50 = 3,810 mg/kg

95% Confidence Limit = 3,530 - 4,220 mg/kg

ACUTE DERMAL TOXICITY (ALBINO RABBITS):
LD50 = Greater than 5,000 mg/kg

ACUTE INHALATION TOXICITY (ALBINO RATS):
For solution of 1% active ingredients LC50 = 13.7 mg/L

COMMENTS: Four-hour nominal concentration for a solution containing 1% active ingredients.

SKIN IRRITATION INDEX DRAIZE RATING: Severe irritant

SECTION 11 TOXICOLOGICAL INFORMATION (CONTINUED)

EYE IRRITATION INDEX DRAIZE RATING: Corrosive (corneal damage)

SKIN SENSITIZATION: This product is a human sensitizer in its undiluted form.

A Guinea pig (Buehler Technique) sensitization study with an induction dosage of 90 ppm of active ingredients followed by a insult of 429 ppm of active ingredients was positive.

A human repeated insult patch study of 28 ppm active ingredients followed by a insult of 56 ppm of active ingredients resulted in no effect to the subjects tested.

SUBCHRONIC TOXICITY RESULTS: A 90-day dietary study in dogs of 840 ppm of the product's active ingredients resulted in no mortalities or pathological findings. A 90-day dermal study in rabbits of 0.4 mg/kg/day of the product's active ingredients resulted in irritation but no pathological effects.

CHRONIC TOXICITY RESULTS: A teratology study with rabbits and rats was negative with dosages of active ingredient ranging from 1.5 mg/kg to 15 mg/kg. Mutagenicity results were equivocal. A 30-month skin painting mouse study with applications of 400 ppm of active ingredients three times per week showed no increase tumor frequency over control animals.

HUMAN HAZARD CHARACTERIZATION: Based on our hazard characterization, the potential human hazard is: HIGH.

SECTION 12 ECOLOGICAL INFORMATION

CHEMICAL OXYGEN DEMAND (COD): 670,000 ppm

TOTAL ORGANIC CARBON (TOC): 7,850 mg/L

AQUATIC DATA: Active ingredient.

6 day static acute LC50 to Bluegill Sunfish = 0.54 ppm
Standard Deviation of 6 day LC50 = 0.47 - 0.62 ppm

6 day dynamic acute LC50 to Fathead Minnow = 0.12 ppm
Standard Deviation of 6 day LC50 = 0.06 - 0.15 ppm

48 hour acute LC50 to Daphnia Magna = 0.13 - 0.18 ppm

SECTION 12 ECOLOGICAL INFORMATION (CONTINUED)

6 day dynamic acute LC50 to Rainbow Trout = 0.14 ppm
Standard Deviation of 6 day LC50 = 0.12 - 0.17 ppm

96 hour static acute LC50 to Sheepshead minnow = 0.3 ppm
Standard Deviation of 96 hour LC50 = 0.18 - 0.50 ppm

Results below are based on a 1.5% solution of the active ingredients

48 hour acute LC50 to Ceriodaphnia Dubia = 15 mg/L

48 hour no observed effect concentration is 10 mg/L based on no mortality or abnormal effects.

OTHER STUDIES: Avian species:

Acute oral LD50 to Bobwhite Quail = 97 mg/kg

Standard Deviation of LD50 = 64 - 114 mg/kg

8 day dietary LD50 to Pekin Duck = 560 ppm of active ingredients

AQUATIC DATA: Product.

96 hour static acute LC50 to Mysids = 18 mg/L

96 hour no observed effect concentration is less than 10 mg/L based on no mortality or abnormal effects.

TOXICITY RATING: Moderately toxic

96 hour static acute LC50 to Sheepshead Minnow = 32 mg/L

96 hour no observed effect concentration is 18 mg/L based on no mortality or abnormal effects.

TOXICITY RATING: Moderately toxic

If released into the environment, see CERCLA in Section 15.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION: Based on our Hazard Characterization, the potential environmental hazard is: HIGH.
Based on Nalco's recommended product application and the product's characteristics, the potential environmental exposure is: LOW.

SECTION 13 DISPOSAL CONSIDERATIONS

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

PESTICIDE DISPOSAL: Pesticide wastes are hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instruction, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

METAL CONTAINERS: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

PLASTIC CONTAINERS: Do not reuse empty container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

SECTION 14 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES	:	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
UN/ID NO	:	UN 3265
HAZARD CLASS - PRIMARY	:	8 - CORROSIVE
PACKING GROUP	:	II
IMDG PAGE NO	:	8147-1
IATA PACKING INSTRUCTION	:	CARGO: 812
IATA CARGO AIRCRAFT LIMIT	:	30 L (MAX NET QUANTITY PER PACKAGE)
FLASH POINT	:	NONE
TECHNICAL NAME(S)	:	ISOTHIAZOLINONE MICROBIOCIDE
RQ LBS (PER PACKAGE)	:	NONE
RQ COMPONENT(S)	:	NONE

SECTION 15 REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

NALCO

PRODUCT

NALCO 7330 MICROBIOCIDE

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 15 REGULATORY INFORMATION (CONTINUED)

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, the following ingredients in this product are hazardous and the reasons are shown below.

5-chloro-2-methyl-4 isothiazolin-3-one - Corrosive, sensitizer
2-methyl-4-isothiazolin-3-one - Corrosive, sensitizer

5-chloro-2-methyl-4 isothiazolin-3-one =
TWA 0.1 mg/m3, STEL 0.3 mg/m3 TLV
Manufacturer's recommendation

CERCLA, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986
(TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found this product to be hazardous. The product should be reported under the following EPA hazard categories:

XX Immediate (acute) health hazard
-- Delayed (chronic) health hazard
-- Fire hazard
-- Sudden release of pressure hazard
-- Reactive hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product contains the following ingredient(s), (with CAS # and % range) which appear(s) on the List of Toxic Chemicals.

Magnesium nitrate (nitrate compounds)	10377-60-3	1-5

TOXIC SUBSTANCES CONTROL ACT (TSCA):

NALCO

PRODUCT

NALCO 7330 MICROBIOCIDE

Emergency Telephone Number
Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 15 REGULATORY INFORMATION (CONTINUED)

The active ingredients are exempted under TSCA and regulated under FIFRA as follows. All the inert ingredients are found on the TSCA Master Inventory List.

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA):
EPA Reg. No. 1706-153. This product is registered for use as a microorganism control chemical used in industrial recirculating cooling water tower systems, used in brewery pasteurizers, and used in air washer systems. In all cases follow instructions on the product label.

U. S. DEPARTMENT OF AGRICULTURE (USDA):
USDA Inspection and Grading Programs - Food Safety and Inspection Service: This product is authorized by USDA for use in federally inspected meat and poultry plants. Authorized use is under category G7.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 13 for RCRA classification.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
This product contains the following ingredients covered by the Clean Water Act:

Cupric nitrate - Section 307, 311

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments), Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
This product does not contain any chemicals which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS:
This product contains the following substance(s) identified on the Michigan Critical Materials Register:

Copper, as Cu = 0.025%

STATE RIGHT TO KNOW LAWS:
The following state(s) identify the ingredient(s) shown below as hazardous:

California - Copper

MATERIAL SAFETY DATA SHEET

NALCO

PRODUCT

NALCO 7330 MICROBIOCIDE

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 15 REGULATORY INFORMATION (CONTINUED)

Massachusetts, New Jersey, Pennsylvania - magnesium nitrate

INTERNATIONAL REGULATIONS:

This is not a WHMIS controlled product under The House of Commons of Canada Bill C-70.

SECTION 16 OTHER INFORMATION

Note: Other toxicological results are available upon request.

It is strongly recommended that this product be educted for safety reasons. If pumping is the only viable alternative, use special care when doing maintenance on either the pump or feed lines. Do not dump buckets of this product.

SECTION 17 RISK CHARACTERIZATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: LOW.

* The environmental risk is: LOW.

Any use inconsistent with Nalco's recommendations may affect our risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

NALCO

PRODUCT

NALCO 7330 MICROBIOCIDE

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 18 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (CD-ROM version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (CD-ROM version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, Ohio (CD-ROM version), Micromedex, Inc., Englewood, CO.

Shepard's Catalog of Teratogenic Agents (CD-ROM version), Micromedex, Inc., Englewood, CO.

Suspect Chemicals Sourcebook (a guide to industrial chemicals covered under major regulatory and advisory programs), Roytech Publications (a Division of Ariel Corporation), Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, Washington (CD-ROM version), Micromedex, Inc., Englewood, CO.

PREPARED BY: William S. Utley, PhD., DABT, Manager, Product Safety
DATE CHANGED: 04/15/97 DATE PRINTED: 08/21/97

7330

Cooling Water Treatment Biocide

Confidential Product Profile

NALCO 7330 should be slug-fed to the cooling tower basin for open recirculating applications. For other applications, feed NALCO 7330 to the system in such a way to achieve maximum dispersion and exposure to the areas of the system with the highest level of microorganisms.

NALCO 7330 contains 2.5% magnesium and 0.025% copper. Both act to stabilize NALCO 7330. Because of the presence of these stabilizers, NALCO 7330 is not typically used in closed systems. Additionally, NALCO 7330 is deactivated by sulfides, making it inadequate for those systems where sulfate reducing bacteria are present.

HANDLING AND STORAGE

NALCO 7330 is a CORROSIVE MATERIAL that may cause allergic skin reactions. All precautions described in Section 4 of the Material Safety Data Sheet should be strictly followed when handling NALCO 7330.

The recommended in-plant storage limit is six months.

DOSAGE REQUIREMENTS

As with any biocide, the dosage for a given system is dependent upon the type and level of microorganisms present in the system. As the level of microorganisms in a system increases, the concentration of biocide required to perform effectively in that system also increases. A SELECTICIDE (see CPP Presection PAC-3, Section 4) should be run to determine initial dosage of NALCO 7330 in a system. Generally, for heavily fouled systems, NALCO 7330 is fed at dosages of 100 to 300 ppm based on system volume. For maintaining control, NALCO 7330 are typically between 50 and 100 ppm based on system volume. For both clean-up and maintenance programs, NALCO 7330 should be slug fed into the system as quickly as possible.

The frequency of slugs of NALCO 7330 will be dependent upon the speed at which the product dissipates and the holding time index of the system. Use planktonic and sessile monitoring tools to determine in each system the appropriate feeding sequence of NALCO 7330.

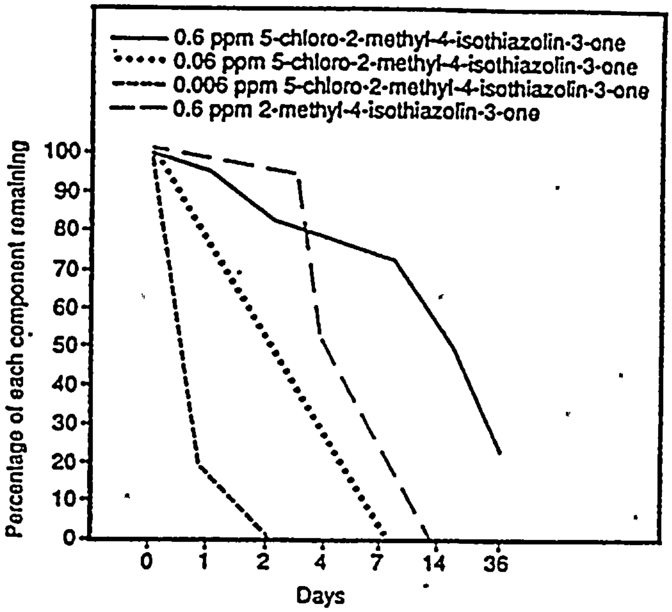

Figure 1 — *NALCO 7330 dissipation in river water*

ADDITIONAL INFORMATION

Product half-life

As with all biocides, the half-life of the product is dependent upon various characteristics within the treated cooling system. Several factors will dictate the half life of NALCO 7330, including:

- pH – as pH increases, half-life decreases
- Presence of sulfides – as sulfides increase, half-life decreases
- Presence of chlorine – as chlorine increases, half-life decreases
- Presence of hardness – as hardness increases, half-life increases
- Presence of microorganisms – as microorganisms increase, half-life decreases

In a heavily microbiologically fouled system, the half-life of NALCO 7330 will be less than that in a non-fouled system (assuming all other characteristics are the same). Figure 1 illustrates the half-lives of the two components in NALCO 7330.

NOTE: *[metric values]*

ATTACHMENT 4

POLYGLYCOL (NALCO 7348)

MATERIAL SAFETY DATA SHEET

NALCO

PRODUCT

NALSPERSE 7348 BIODISPERSANT

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) **(800) I-M-ALERT**

SECTION 1 PRODUCT IDENTIFICATION

TRADE NAME: NALSPERSE 7348 BIODISPERSANT
DESCRIPTION: A polyglycol

NFPA 704M/HMIS RATING: 0/0 HEALTH 0/0 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 HAZARDOUS INGREDIENTS

Our hazard evaluation of the ingredient(s) under OSHA's Hazard Communication Rule, 29 CFR 1910.1200 has found none of the ingredient(s) hazardous.

SECTION 3 PRECAUTIONARY LABEL INFORMATION

CAUTION: May cause irritation to skin and eyes. Avoid contact with skin, eyes and clothing. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

SECTION 4 FIRST AID INFORMATION

EYES:	Flush with water for 15 minutes. Call a physician.
SKIN:	Flush with water for 15 minutes.
INGESTION:	Induce vomiting. Give water. Call a physician.
INHALATION:	Remove to fresh air. Treat symptoms. Call a physician.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

SECTION 5 HEALTH EFFECTS INFORMATION

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin

EYE CONTACT:	May cause irritation with prolonged contact.
SKIN CONTACT:	May cause irritation with prolonged contact.

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

SECTION 6 TOXICOLOGY INFORMATION

ACUTE TOXICITY STUDIES: Acute toxicity studies have been conducted on this product. The results are shown below.

ACUTE ORAL TOXICITY (ALBINO RATS): LD50 = 2,229 mg/kg

95% Confidence Limit = 1,400 - 3,085 mg/kg

TOXICITY RATING: Moderately toxic

COMMENTS: Pharmocotoxic signs noted following product administration included anorexia, diarrhea, decreased activity, salivation, and ataxia. All surviving animals appeared normal 72-hours post dosing. Deaths occurred 24-48 hours after administration of the test article.

PRIMARY SKIN IRRITATION TEST (ALBINO RABBITS):
SKIN IRRITATION INDEX DRAIZE RATING: 0.57/8.0 Slightly irritating

COMMENTS: Application of 0.5 ml to a 6 cm2 site on the shaven back of each of a group of six albino rabbits (4-hour occluded contact) resulted in very mild redness and no swelling. At the end of 72-hours, all sites had returned to normal.

PRIMARY EYE IRRITATION TEST (ALBINO RABBITS):
EYE IRRITATION INDEX DRAIZE RATING: 2.7/110.0 Minimally irritating

COMMENTS: Instillation of 0.1 ml into the conjunctival sac of one eye of each of a group of six albino rabbits produced very slight redness one hour after instillation. By the end of 24-hours, all eyes had essentially returned to normal.

HUMAN HAZARD CHARACTERIZATION: Based on our hazard characterization, the potential human hazard is: LOW

SECTION 7 PHYSICAL AND CHEMICAL PROPERTIES

COLOR: Clear	FORM: Liquid	ODOR: None
DENSITY:	8.5 lbs/gal.	
SOLUBILITY IN WATER:	Completely .	
SPECIFIC GRAVITY:	1.00-1.04 @ 68 Degrees F	ASTM D-1298
pH (at 2.5%) =	5.0 - 7.5	ASTM E-70
VISCOSITY:	273 cps @ 78 Degrees F	ASTM D-2983
FREEZE POINT:	None	ASTM D-1177
FLASH POINT:	Greater than 200 Degrees F (PMCC)	ASTM D-93

SECTION 7 PHYSICAL AND CHEMICAL PROPERTIES (CONTINUED)

VAPOR PRESSURE:	Less than 0.01mm Hg @ 68 Degrees F	ASTM D-323
VOLATILE ORGANIC COMPOUND (VOC):	0.06 lbs/gal.	EPA METHOD 24

NOTE: These physical properties are typical values for this product.

SECTION 8 FIRE AND EXPLOSION INFORMATION

FLASH POINT: Greater than 200 Degrees F (PMCC) ASTM D-93

EXTINGUISHING MEDIA: Based on the NFPA guide, use dry chemical, foam, carbon dioxide or other extinguishing agent suitable for Class B fires. Use water to cool containers exposed to fire. For large fires, use water spray or fog, thoroughly drenching the burning material.

UNUSUAL FIRE AND EXPLOSION HAZARD: None

SECTION 9 REACTIVITY INFORMATION

INCOMPATIBILITY: Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

THERMAL DECOMPOSITION PRODUCTS: In the event of combustion CO, CO2 may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 10 PERSONAL PROTECTION EQUIPMENT

RESPIRATORY PROTECTION: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant vapors, mists or aerosols are generated, wear a NIOSH approved or equivalent respirator.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a positive pressure, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended. Additionally, local exhaust ventilation is recommended where vapors, mists or aerosols may be released.

PROTECTIVE EQUIPMENT: Use impermeable gloves and chemical splash goggles when attaching feeding equipment, doing maintenance or handling product. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton, and butyl (compatibility studies have not been performed).

SECTION 10 PERSONAL PROTECTION EQUIPMENT (CONTINUED)

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

HUMAN EXPOSURE CHARACTERIZATION: Based on Nalco's recommended product application and our recommended personal protective equipment, the potential human exposure is: MODERATE.

SECTION 11 SPILL AND DISPOSAL INFORMATION

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 14.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA in Section 14.

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be incinerated in accordance with local, state, and federal regulations.

SECTION 12 ENVIRONMENTAL INFORMATION

CHEMICAL OXYGEN DEMAND (COD): 2,000,000 mg/L

TOTAL ORGANIC CARBON (TOC): 540,000 mg/L

AQUATIC DATA:

96 hour static acute LC50 to Bluegill Sunfish = Greater than 1,000 ppm

SECTION 12 ENVIRONMENTAL INFORMATION (CONTINUED)

96 hour static acute LC50 to Rainbow Trout = Greater than 1,000 mg/L
96 hour no observed effect concentration is 320 mg/L based on no mortality or abnormal effects.

TOXICITY RATING: Essentially non-toxic

48 hour static acute LC50 to Daphnia Magna = Greater than 1,000 mg/L
48 hour no observed effect concentration is 180 mg/L based on no mortality or abnormal effects.

TOXICITY RATING: Essentially non-toxic

96 hour static acute LC50 to Channel Catfish, Largemouth Bass, Grass Shrimp, Shore Crabs = Greater than 1,000 ppm

96 hour static acute LC50 to Eastern Oysters = 307 ppm

96 hour static acute LC50 to Quahog Clams = 567 ppm

48 hour EC50 to Ceriodaphnia dubia = 240 mg/L
48 hour no observed effect concentration is 130 mg/L based on no mortality or abnormal effects.

7-day chronic reproductive IC25 and IC25 to Ceriodophnia dubia is 17 mg/L and 13 mg/L, respectively

The 7-day NOEL based on reproduction is 12.5 mg/L
The 7-day LOEL based on reproduction is 25 mg/L

If released into the environment, see CERCLA in Section 14.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION: Based on our Hazard Characterization, the potential environmental hazard is: LOW.
Based on Nalco's recommended product application and the product's characteristics, the potential environmental exposure is: HIGH.

SECTION 13 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CLASS MAY VARY BY PACKAGING, PROPERTIES, AND MODE OF TRANSPORTATION. TYPICAL PROPER SHIPPING NAMES FOR THIS PRODUCT ARE:

ALL TRANSPORTATION MODES : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

SECTION 13 TRANSPORTATION INFORMATION (CONTINUED)

SECTION 14 REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, this product is not hazardous.

CERCLA, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986
(TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain ingredients on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
The chemical ingredients in this product are on the 8(b) Inventory List (40 CFR 710).

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act:
When use situations necessitate compliance with FDA regulations, this product is acceptable under 21 CFR 176.180 - components of paper and paperboard in contact with dry food.

U. S. DEPARTMENT OF AGRICULTURE (USDA):
USDA Inspection and Grading Programs - Food Safety and Inspection Service:

SECTION 14 REGULATORY INFORMATION (CONTINUED)

This product is authorized by USDA for use in federally inspected meat and poultry plants. Authorized uses are under category G5, G7.

This product has been certified as KOSHER/PAREVE for year-round use EXCEPT FOR THE PASSOVER SEASON by the CHICAGO RABBINICAL COUNCIL.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 11 for RCRA classification.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
None of the ingredients are specifically listed.

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments),
Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
This product contains ethylene oxide, known to the State of California to cause cancer, birth defects or other reproductive effects, as an impurity or residue.

MICHIGAN CRITICAL MATERIALS:
This product does not contain ingredients listed on the Michigan Critical Materials Register.

STATE RIGHT TO KNOW LAWS:
The following ingredient(s) are disclosed for compliance with State Right To Know Laws:

Polyglycol	Trade secret

INTERNATIONAL REGULATIONS:

This is not a WHMIS controlled product under The House of Commons of Canada Bill C-70.

SECTION 15 ADDITIONAL INFORMATION

Nalco internal number 308644

SECTION 16 RISK CHARACTERIZATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: LOW.

* The environmental risk is: LOW.

Any use inconsistent with Nalco's recommendations may affect our risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommenadtions. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to unsure safe workplace operations. Please consult your local sales representative for any further information.

SECTION 17 BIBLIOGRAPHY

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Title 29 Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

THRESHOLD LIMIT VALUES FOR CHEMICAL SUBSTANCES AND PHYSICAL AGENTS IN THE WORKROOM ENVIRONMENT WITH INTENDED CHANGES, American Conference of Governmental Industrial Hygienists, OH.

PREPARED BY: William S. Utley, PhD., DABT, Manager, Product Safety
DATE CHANGED: 06/13/95 DATE PRINTED: 06/10/96

ATTACHMENT 5

ST. LUCIE PLANT NPDES PERMIT RENEWAL APPLICATION - APRIL 1992 (DESCRIPTION OF STEAM GENERATOR BLOWDOWN - PERTINENT INFORMATION IS <u>UNDERLINED</u>)

Liquid Radwaste System Batch Releases

The flow from the radwaste treatment system is intermittent. The system has been modified to permit a maximum design flow of 170 gpm. This waste stream originates from various maintenance and operational activities which take place in the reactor auxiliary building (RAB) and is processed for radioactive reduction by ion exchange resins and low micron filtration systems. Effluent from this system does not normally contain any metal cleaning wastes, however there are times, such as during steam generator channel head cleaning, when some metal cleaning waste could be discharged.

Steam Generator Blowdown

High purity water is generated at the St. Lucie Pant by a water treatment plant by way of carbon filtration and anion and cation exchange demineralization. Much of this high quality water is routed to the secondary system and steam generators as makeup for the water/steam cycle. An amine such as ammonia or morphaline may be added for pH control and hydrazine or (catalyzed hydrazine) is added for oxygen removal. Undesirable contaminants such as chlorides from condenser leaks can contaminate the steam generator water. Strict operating specifications require that suspended and dissolved solids be maintained at very low levels. Therefore, to keep the contaminants at these low levels, a continuous steam generator blowdown is required. This blowdown is normally recycled but may be routed to the discharge canal. The concentration of hydrazine in these discharges normally ranges from 25 ppb to 2 ppm.

During overhauls and/or refueling outages the steam generators, feedwater systems, and/or condensers may be placed in a static mode where the internal metal surfaces of these components must be protected from corrosion. The typical method used is to fill the system with a hydrazine (or catylized hydrazine) ammonia/demineralized water solution. A steam generator wet lay-up requires 140,000 gallons of water while condenser lay-up requires 750,000 gallons. This solution, which contains up to 300 ppm hydrazine, must then be drained. Steam generators are discharged to the plant's discharge canal. Condensers are drained through a temporary hose to the intake canal where intake cooling water pumps (auxiliary equipment cooling water pumps) move the effluent to the discharge canal. These discharges occur approximately every eighteen months per unit during refueling operations or during any periods of extended maintenance. FPL has monitored the discharge canal extensively at EPA's request since 1989 during periods of "wet lay-up" discharge and found the hydrazine values, due to the rapid break-down of hydrazine upon exposure to oxygen in the environment and through dilution, to be between <5 ppb and 16 ppb at the POD with most of the values being <5 ppb (the detection limit for hydrazine).

The plant also operates the steam generator at concentrations of up to 10 ppm boric acid. Discharge of this boric acid via blowdown was discussed previously under the once through cooling water description.

At some point during the next permit cycle, it may be necessary to conduct a chemical cleaning of the steam generator. Should this event occur, FPL will supply information on the method of cleaning that will be utilized prior to the cleaning event.

Intake Traveling Screen Wash Water

Two 1060 gpm capacity traveling screen wash pumps located on both Units 1 and 2 at the St. Lucie Plant intake structure withdraw ocean water for traveling screen cleaning. The traveling screens are used to prevent debris from reaching the condensers. One pump (the other standby) is normally in operation on each unit for two hours per day, at an average wash flow of 90 gpm per unit. The wash water is returned to the intake canal through a collection sump and drain system.

There are two waste streams at the St. Lucie Plant which are not a function of electrical generation operating activities. They are:

- Sewage treatment plants
- Non-equipment area storm water runoff

Sewage Treatment Plants

Sanitary wastes from shower, water closets, and other personnel-related waste waters as well as spent plant laboratory wastes are routed to the Unit 1 sewage treatment plant. The Unit 1 sewage treatment plant (STP) has a design capacity of 17,000 gpd. It discharges into the intake canal.

The Unit 2 STP consists of two parallel, 10,000 gpd units which discharge to the solids settling basins from which there is no discharge to navigable waters of the U.S.

Non-equipment Area Storm Water Run-off

Various non-equipment area stormwater discharges are made to the cooling water intake canal and the adjacent Big Mud Creek. These streams originate from areas of the plant such as roadways, parking lots, and building storm drains and are covered the attached application Form 2F..

ATTACHMENT 6

DIMETHYLAMINE (PRE-TECT 9002)

Pre-Tect 9002

CALGON CORPORATION

P.O. Box 1346
Pittsburgh, PA 15230-1346
Phone--(412)494-8000

MATERIAL SAFETY DATA SHEET

Section 1. PRODUCT IDENTIFICATION

PRODUCT NAME: Pre-Tect 9002

CHEMICAL DESCRIPTION: Aqueous amine solution
PRODUCT CLASS: Boiler water treatment
MSDS CODE: 0F04-10-27-95

Section 2. INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	% by Weight	OSHA PEL	ACGIH TLV
Dimethylamine (DMA)	124-40-3	2	TWA 10 ppm, 18 mg/m^3	TWA 5 ppm, 9.2 mg/m^3; STEL 15 ppm, 27.6 mg/m^3

Section 3. HAZARDS IDENTIFICATION

********************* EMERGENCY OVERVIEW *********************

DANGER!
May cause severe eye and skin damage.
May cause severe digestive tract burns if swallowed.
May cause allergic skin reaction.
May cause respiratory tract irritation.
Flammable/Combustible liquid and vapor.
Flash point: 127°F
May form suspected cancer-causing nitrosamines if mixed with nitrites.

****

PRIMARY ROUTES OF ENTRY: Eye and skin contact, inhalation, skin absorption, ingestion

TARGET ORGANS: Eye, skin, lung, mucous membranes, liver

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:

- Asthma
- Skin disorders and allergies
- Chronic respiratory disease, e.g., bronchitis, emphysema
- Eye disease

Continued on Page 2

Pre-Tect 9002

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: This product may cause irreversible eye damage upon contact depending on the length of exposure, solution concentration and first aid measures. DMA vapor in low concentrations can cause tearing, conjunctivitis and corneal edema when absorbed into the tissue of the eye from the atmosphere. Corneal edema may give rise to a perception of "blue haze" or "fog" around lights. The condition is transient and has no known residual effect.

SKIN CONTACT: This product may produce burns upon contact with the skin. The severity of the burn is generally determined by the concentration of the solution and the duration of the exposure. DMA vapors are irritating to the skin. DMA may cause an allergic skin reaction and may be absorbed through the skin causing nausea and headache.

INGESTION: Ingestion of this product may cause severe irritation or burns of the mucous membranes of the mouth, throat, esophagus and stomach.

INHALATION: DMA vapors are irritating to the respiratory tract. Inhalation of vapors may produce chemical pneumonitis, pulmonary edema, and delayed scarring of the airway. Repeated and/or prolonged exposure to vapors may cause chronic irritation of the respiratory tract and bronchopneumonia.

SUBCHRONIC, CHRONIC:
DMA added to the diet of rats at 150 mg/kg for 3.5 months increased liver demethylase activity even in the presence of the enzyme inducer casein. In a subchronic study, 15 rats, 15 guinea pigs, 3 rabbits, 2 dogs, and 3 monkeys were exposed continuously by inhalation at approximately 5 ppm of DMA for 90 days. There were no deaths or signs of toxicity and all hematologic values were normal. On histopathologic examination, interstitial inflammatory changes were noted in the lungs of each species. Further, the 3 rabbits and 2 monkeys showed dilatation of the bronchi.

In a 2-year inhalation study, groups of 95 male and 95 female rats and mice were exposed 6 hours/day, 5 days/week at 10, 50, or 175 ppm of DMA. Concentration-dependent toxicity was characterized by decreased body weight (175 ppm only) and progressive inflammatory, degenerative, and hyperplastic lesions of the nasal passages. Nasal toxicity was similar in both rats and mice (no sex differences) affecting respiratory and olfactory epithelia. Lesions were severe at 175 ppm, moderate at 50 ppm, and focal and mild at 10 ppm.

CARCINOGENICITY:
NTP:
No ingredients listed in this section
IARC:
No ingredients listed in this section
OSHA:
No ingredients listed in this section

Section 4. FIRST AID MEASURES

EYE CONTACT: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Seek medical aid immediately.

SKIN CONTACT: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Seek medical aid immediately. Wash clothing before reuse. Destroy contaminated leather apparel. Victims with major skin contact should be maintained under medical observation for at least 24 hours due to the possibility of delayed reaction.

Continued on Page 3

Pre-Tect 9002

INGESTION: If swallowed, do NOT induce vomiting. Give large quantities of water. Seek medical aid immediately. Never give anything by mouth to an unconscious person.

Note to Physicians: This product is highly injurious to all tissues, similar to that of ammonia or ammonia gas. Chemical pneumonitis, pulmonary edema, laryngeal edema and delayed scarring of the airway or other affected tissues may occur following exposure. There is no specific treatment. Clinical management is based on supportive treatment, which is similar to that for thermal burns.

INHALATION: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid.
Prevent aspiration of vomit. Turn victim's head to the side. Assure mucous does not obstruct airway.

Section 5. FIRE-FIGHTING MEASURES

FLASH POINT: 127°F (COC)
This product is a fire hazard.

LOWER FLAMMABLE LIMIT: Not available UPPER FLAMMABLE LIMIT: Not available

AUTO-IGNITION TEMPERATURE: Not available

EXTINGUISHING MEDIA: Use CO_2, dry chemical, alcohol foam.

FIRE-FIGHTING INSTRUCTIONS: Exercise caution when fighting any chemical fire. A self-contained breathing apparatus and protective clothing are essential.
Use water to keep fire-exposed containers cool.

FIRE & EXPLOSION HAZARDS: Product emits toxic gases under fire conditions. Product vapors are heavier than air and may travel a considerable distance to a source of ignition and flash back. Vapors may collect in closed spaces such as sewers, caves or closed structures.

DECOMPOSITION PRODUCTS: Upon decomposition, ammonia.vapors are liberated. Upon combustion in the presence of sufficient oxygen, product generates harmful carbon monoxide, carbon dioxide, and nitrogen oxide gases. Nitrogen oxide can react with water vapor to yield nitric acid. Combustion of product under oxygen-starved conditions can be expected to produce numerous toxic products including: nitriles, cyanic acid, isocyanates, cyanogens, nitrosamines, amides, carbamates.

NFPA RATINGS: Health = 3 Flammability = 2 Reactivity = 0 Special Hazard = None

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Section 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Ventilate area of spill. Eliminate all ignition sources. Approach release from upwind. Use water spray to cool and disperse vapors, protect personnel, and dilute spills to form nonflammable mixtures. Five percent sulfuric acid may be used to neutralize diluted pools. Wearing appropriate personal protective equipment, contain spill, collect onto noncombustible absorbent like sand or earth and place into suitable container. Vapors tend to remain close to the ground and collect in out-of-the-way places. Use non-sparking blowers or ventilation facilities to remove potential explosive or toxic accumulations.

Continued on Page 4

Pre-Tect 9002

Section 7. HANDLING AND STORAGE

HANDLING: Do not get in eyes, on skin or clothing.
Avoid breathing vapor or mist.
Keep away from heat and flame.
Use with adequate ventilation.
Wash thoroughly after handling.
Keep container closed when not in use.
Remove all equipment which may be a source of ignition from vicinity while handling. Empty containers may contain explosive vapors. Flush empty containers with water to remove residual flammable liquid and vapors.

STORAGE: Keep away from oxidizers, heat or flames. Store away from ignition sources. Ground all containers during transfer. Store in steel containers preferably located outdoors, above ground, and surrounded by dikes to contain spills or leaks. Electrical installations should be in accordance with Article 501 of the National Electrical Code for Class I Division 2 locations.

Section 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

EYE/FACE PROTECTION: Chemical splash goggles and face shield
SKIN PROTECTION: Chemical resistant gloves and protective clothing
RESPIRATORY PROTECTION: If airborne concentrations exceed published exposure limits, use a NIOSH approved respirator in accordance with OSHA respiratory protection requirements (29 CFR 1910.134).

ENGINEERING CONTROLS: Local exhaust ventilation may be required in addition to general room ventilation to maintain airborne concentrations below exposure limits.

WORK PRACTICES: Eye wash station and safety shower should be accessible in the immediate area of use.

UNSATISFACTORY MATERIALS OF CONSTRUCTION: DMA corrodes copper, aluminum, zinc, and galvanized surfaces. Other unsatisfactory materials include neoprene, polyethylene, and viton.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT: Not available

VAPOR PRESSURE: 2 torr @ 10°C (for DMA)

VAPOR DENSITY (air=1): 1.55 (for DMA)

%VOLATILE BY WEIGHT: 100

SOLUBILITY IN WATER: Complete

SPECIFIC GRAVITY: 0.988 - 0.994 @ 25°C

pH: 11.5 - 12.0 @ 25°C

FREEZING POINT: Not available

APPEARANCE AND ODOR: Clear, colorless liquid with ammoniacal/fishy odor.

Continued on Page 5

Pre-Tect 9002

Section 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable HAZARDOUS POLYMERIZATION: Will not occur

CONDITIONS TO AVOID: Keep away from heat and flame.

INCOMPATIBILITY: Strong oxidizers, acids, copper, aluminum, zinc and galvanized surfaces.

DECOMPOSITION PRODUCTS: Upon decomposition, ammonia vapors are liberated. Upon combustion in the presence of sufficient oxygen, product generates harmful carbon monoxide, carbon dioxide, and nitrogen oxide gases. Nitrogen oxide can react with water vapor to yield nitric acid. Combustion of product under oxygen-starved conditions can be expected to produce numerous toxic products including: nitriles, cyanic acid, isocyanates, cyanogens, nitrosamines, amides, carbamates.

Section 11. TOXICOLOGICAL INFORMATION

ON PRODUCT:
See the following information on active ingredient.

ON INGREDIENTS:

Chemical Name	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	Inhalation LC_{50} (rat)
Dimethylamine (DMA)	698 mg/kg	Not available	4540 ppm/6H

Section 12. ECOLOGICAL INFORMATION

ON PRODUCT:

Aquatic toxicity data on a 10% solution of DMA:

48 hr LC_{50} (Daphnia magna): 675 ppm
96 hr LC_{50} (fathead minnow): > 1000 ppm
96 hr LC_{50} (bluegill sunfish): > 1000 ppm

Section 13. DISPOSAL CONSIDERATIONS

RCRA STATUS: The EPA Hazardous Waste Number is U092.

DISPOSAL: Dispose of in accordance with local, state and federal regulations. Incineration is acceptable and the preferred method of disposal. However, nitrogen oxide emission controls may be required to meet specifications. Chemical and/or biological degradation is feasible. A suitable industrial or municipal waste treatment system can be used depending on the quality and quantity of waste to be treated, the treatment plant capability, and discharge water quality standards. Incinerate in an open container. Do not dump into municipal sewers or enclosed drains that present a fire or explosion hazard.

Continued on Page 6

Pre-Tect 9002

Section 14. TRANSPORT INFORMATION

DOT CLASSIFICATION:
Class/Division: 3
Proper Shipping Name: Amines, flammable, corrosive, n.o.s. (contains Dimethylamine)
Label: Flammable liquid, Corrosive
Packing Group: III
ID Number: UN 2733

Section 15. REGULATORY INFORMATION

OSHA Hazard Communication Status: Hazardous
TSCA: The ingredients of this product are listed on the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.
CERCLA reportable quantity of EPA hazardous substances in product:

Chemical Name	RQ
Dimethylamine (DMA)	1000 lb

Product RQ: 50,000 lb (Notify EPA of product spills exceeding this amount.)

SARA TITLE III:

Section 302 Extremely Hazardous Substances:

Chemical Name	CAS #	RQ	TPQ
There are no SARA 302 Extremely Hazardous Substances in this product.			

Section 311 and 312 Health and Physical Hazards:

Immediate	Delayed	Fire	Pressure	Reactivity
[yes]	[yes]	[yes]	[no]	[no]

Section 313 Toxic Chemicals:

Chemical Name	CAS #	% by Weight
Dimethylamine (DMA)	124-40-3	2

Section 16. OTHER INFORMATION

HMIS RATINGS: Health = 3* Flammability = 2 Reactivity = 0
Personal Protective Equipment = X (to be specified by user depending on use conditions)

*There are potential chronic health effects to consider.

Hazard rating scale: 0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

Continued on Page 7

Pre-Tect 9002

MSDS REVISION SUMMARY: Supersedes MSDS issued on 09/24/96. The MSDS has been changed in Sections 3, 8 and 9.

PREPARED BY: P.J. Maloney

DATE: March 04, 1998

TO: The person at phone/ext: 56146535503556

FROM: Health & Environmental Affairs Department

The following documents were requested on your behalf by Gay, Catherine.

Thank you for calling .

ATTACHMENT 7

CARBOHYDRAZIDE (NALCO 1250)

Eliminox or Carbohydrazide

NALCO

MATERIAL SAFETY DATA SHEET

PRODUCT

NALCO 1250 OXYGEN SCAVENGER

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 1 PRODUCT IDENTIFICATION

TRADE NAME: NALCO 1250 OXYGEN SCAVENGER
DESCRIPTION: An aqueous solution of a modified amino compound

NFPA 704M/HMIS RATING: 1/1 HEALTH 1/1 FLAMMABILITY 0/0 REACTIVITY 0 OTHER
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

SECTION 2 HAZARDOUS INGREDIENTS

Our hazard evaluation of the ingredient(s) under OSHA's Hazard Communication Rule, 29 CFR 1910.1200 has found none of the ingredient(s) hazardous.

SECTION 3 PRECAUTIONARY LABEL INFORMATION

CAUTION: May cause irritation to skin and eyes. Avoid contact with skin, eyes, and clothing. Avoid prolonged or repeated breathing of vapor. Use with adequate ventilation. Do not take internally.

Empty containers may contain residual product. Do not reuse container unless properly reconditioned.

SECTION 4 FIRST AID INFORMATION

EYES:	Flush with water for 15 minutes. Call a physician.
SKIN:	Flush with water for 15 minutes.
INGESTION:	Induce vomiting. Give water. Call a physician.
INHALATION:	Remove to fresh air. Treat symptoms. Call a physician.

NOTE TO PHYSICIAN: Based on the individual reactions of the patient, the physician's judgment should be used to control symptoms and clinical condition.

CAUTION: If unconscious, having trouble breathing or in convulsions, do not induce vomiting or give water.

SECTION 5 HEALTH EFFECTS INFORMATION

PRIMARY ROUTE(S) OF EXPOSURE: Eye, Skin

EYE CONTACT:	May cause irritation with prolonged contact.
SKIN CONTACT:	May cause irritation with prolonged contact.
INGESTION:	Can be harmful.

SYMPTOMS OF EXPOSURE: A review of available data does not identify any symptoms from exposure not previously mentioned.

NALCO CHEMICAL COMPANY ONE NALCO CENTER • NAPERVILLE, ILLINOIS 60563-1198
AREA 708-305-1000

SECTION 5 HEALTH EFFECTS INFORMATION (CONTINUED)

AGGRAVATION OF EXISTING CONDITIONS: A review of available data does not identify any worsening of existing conditions.

SECTION 6 TOXICOLOGY INFORMATION

TOXICITY STUDIES: Acute toxicity studies have not been conducted on this product, but studies have been conducted on a similar product. The results are shown below.

ACUTE ORAL TOXICITY (ALBINO RATS): LD50 = Greater than 5,000 mg/kg

ACUTE DERMAL TOXICITY (ALBINO RABBITS): LD50 = Greater than 2,000 mg/kg

PRIMARY SKIN IRRITATION TEST (ALBINO RABBITS):
SKIN IRRITATION INDEX DRAIZE RATING: 0.33/8.0 Minimal irritation

PRIMARY EYE IRRITATION TEST (ALBINO RABBITS):
EYE IRRITATION INDEX DRAIZE RATING: 0.33 /110.0 Practically non-irritating

OTHER TOXICITY RESULTS: Ames test was weakly positive.

SECTION 7 PHYSICAL AND CHEMICAL PROPERTIES

COLOR: Clear, colorless FORM: Liquid

DENSITY:	8.7-lbs/gal.	
SOLUBILITY IN WATER:	Completely	
SPECIFIC GRAVITY:	1.04-1.05 @ 77 Degrees F	ASTM D-1298
pH (NEAT) =	8.4	ASTM E-70
VISCOSITY:	3 cps @ 75 Degrees F	ASTM D-2983
FREEZE POINT:	28 Degrees F	ASTM D-1177
BOILING POINT:	211 Degrees F @ 760 mm Hg	ASTM D-86
FLASH POINT:	None	

NOTE: These physical properties are typical values for this product.

SECTION 8 FIRE AND EXPLOSION INFORMATION

FLASH POINT: None

EXTINGUISHING MEDIA: This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use water to cool containers exposed to fire.

UNUSUAL FIRE AND EXPLOSION HAZARD: May evolve NOx under fire conditions.

SECTION 9 REACTIVITY INFORMATION

INCOMPATIBILITY: Mineral acids, nitrites.

Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromates, nitric acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

THERMAL DECOMPOSITION PRODUCTS: In the event of combustion CO, CO2, NOx may be formed. Do not breathe smoke or fumes. Wear suitable protective equipment.

SECTION 10 PERSONAL PROTECTION EQUIPMENT

RESPIRATORY PROTECTION: Respiratory protection is not normally needed since the volatility and toxicity are low. If significant vapors, mists or aerosols are generated, wear a NIOSH approved or equivalent respirator.

For large spills, entry into large tanks, vessels or enclosed small spaces with inadequate ventilation, a pressure-demand, self-contained breathing apparatus is recommended.

VENTILATION: General ventilation is recommended.

PROTECTIVE EQUIPMENT: Use impermeable gloves and chemical splash goggles when attaching feeding equipment, doing maintenance or handling product. Examples of impermeable gloves available on the market are neoprene, nitrile, PVC, natural rubber, viton and butyl (compatibility studies have not been performed).

The availability of an eye wash fountain and safety shower is recommended.

If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse.

SECTION 11 SPILL AND DISPOSAL INFORMATION

IN CASE OF TRANSPORTATION ACCIDENTS, CALL THE FOLLOWING 24-HOUR TELEPHONE NUMBER (800) I-M-ALERT or (800) 462-5378.

SPILL CONTROL AND RECOVERY:

Small liquid spills: Contain with absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal. Refer to CERCLA in Section 14.

Large liquid spills: Dike to prevent further movement and reclaim into recovery or salvage drums or tank truck for disposal. Refer to CERCLA

SECTION 11 SPILL AND DISPOSAL INFORMATION (CONTINUED)

in Section 14.

DISPOSAL: If this product becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous liquid waste, it should be solidified with stabilizing agents (such as sand, fly ash, or cement) so that no free liquid remains before disposal to an industrial waste landfill. A non-hazardous liquid waste can also be deep-well injected in accordance with local, state, and federal regulations.

SECTION 12 ENVIRONMENTAL INFORMATION

AQUATIC DATA:

Results below are based on a similar product.

96 hour static acute LC50 to Bluegill Sunfish = 190 ppm

96 hour static acute LC50 to Rainbow Trout = 360 ppm

Results below are based on the product.

7-day chronic static renewal IC25 for
Ceriodaphnia Dubia reproduction = 17.3 mg/L

7-day no observed effect concentration is 8.1 mg/L
based on no effect on reproduction.

48 hour static acute LC50 to Ceriodaphnia Dubia = 85 mg/L

48 hour no observed effect concentration is 31 mg/L based on no mortality.

TOXICITY RATING:

If released into the environment, see CERCLA in Section 14.

SECTION 13 TRANSPORTATION INFORMATION

PROPER SHIPPING NAME/HAZARD CODE - (DEPENDENT UPON MODE, PACKAGE)	PRODUCT IS NOT REGULATED DURING TRANSPORTATION

NALCO

PRODUCT

NALCO 1250 OXYGEN SCAVENGER

Emergency Telephone Number

Medical (800) 462-5378 (24 hours) (800) I-M-ALERT

SECTION 14 REGULATORY INFORMATION

The following regulations apply to this product.

FEDERAL REGULATIONS:

OSHA'S HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
Based on our hazard evaluation, none of the ingredients in this product are hazardous.

CERCLA/SUPERFUND, 40 CFR 117, 302:
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312 AND 313:

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
This product does not contain ingredients listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 and 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370):
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
This product does not contain ingredients on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA):
The chemical ingredients in this product are on the 8(b) Inventory List (40 CFR 710).

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), 40 CFR 261 SUBPART C & D:
Consult Section 11 for RCRA classification.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 (formerly Sec. 307), 40 CFR 116 (formerly Sec. 311):
None of the ingredients are specifically listed.

CLEAN AIR ACT, Sec. 111 (40 CFR 60), Sec. 112 (40 CFR 61, 1990 Amendments),
Sec. 611 (40 CFR 82, CLASS I and II Ozone depleting substances):
This product does not contain ingredients covered by the Clean Air Act.

STATE REGULATIONS:

CALIFORNIA PROPOSITION 65:
Hydrazine is known to the State of California to cause cancer. This product

SECTION 14 REGULATORY INFORMATION (CONTINUED)

contains levels of hydrazine at less than 0.1%.

MICHIGAN CRITICAL MATERIALS:
This product does not contain ingredients listed on the Michigan Critical Materials Register.

STATE RIGHT TO KNOW LAWS:
This product does not contain ingredients listed by State Right To Know Laws.

SECTION 15 ADDITIONAL INFORMATION

None

SECTION 16 USER'S RESPONSIBILITY

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to ensure safe workplace operations. Please consult your local sales representative for any further information.

SECTION 17 BIBLIOGRAPHY

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SECTION 17 BIBLIOGRAPHY (CONTINUED)

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REGISTRY OF TOXIC EFFECTS ON CHEMICAL SUBSTANCES, U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1983 supplement of 1981-1982 edition, Vol. 1-3, OH, 1984.

Title 29 Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA).

THRESHOLD LIMIT VALUES FOR CHEMICAL SUBSTANCES AND PHYSICAL AGENTS IN THE WORKROOM ENVIRONMENT WITH INTENDED CHANGES, American Conference of Governmental Industrial Hygienists, OH.

PREPARED BY: Ricky A. Stackhouse PhD., Toxicologist
DATE CHANGED: 05/16/94 DATE PRINTED: 08/12/94

Department of
Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

STATE OF FLORIDA

INDUSTRIAL WASTEWATER FACILITY PERMIT

PERMITTEE:

Florida Power & Light Company
6501 S. Ocean Drive
Jensen Beach, Florida 34957

PERMIT NUMBER: FL0002208-Major
ISSUANCE DATE: January 10, 2000
EXPIRATION DATE: January 9, 2005

FACILITY:

St. Lucie Power Plant
Units 1 and 2
Hutchinson Island
St. Lucie County, Florida

Latitude: 27° 20' 54" Longitude: 80° 14' 44"

This permit is issued under the provisions of Chapter 403, Florida Statutes, and applicable rules of the Florida Administrative Code and constitutes authorization to discharge to waters of the state under the National Pollutant Discharge Elimination System. The above named permittee is hereby authorized to operate the facilities shown on the application and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

OPERATION: The facility consists of two nuclear powered steam electric generating units (Unit 1 and Unit 2) and each unit is nominally rated at 850 MW. The facility discharge consists of once-through cooling water, auxiliary equipment cooling water, wastewater plant makeup water, treatment system wastewater, steam generator blowdown, industrial and non-industrial stormwater, canal debris, equipment area floor drains and treated non-radioactive wastes/liquid radiation waste.

WASTEWATER TREATMENT: Consists of screening and chlorination of the once-through cooling water, neutralization, settling, ion exchange and micron filtration to the intake and discharge canal.

EFFLUENT DISPOSAL: An existing 1477 MGD annual average daily flow of treated effluent is discharged via outfall D-001(Condenser once through cooling water and auxiliary equipment cooling water) to the site discharge canal to the point of discharge (POD) (latitude: 27° 21' 05" longitude: 80° 14' 26") thence to the Atlantic Ocean, a Class III marine water. This permit authorizes discharge from existing internal outfalls I-003 (Liquid radiation waste), I-005 (Steam generator blowdown), I-06B (Former oil storage area), I-06C (Non-industrial related storm water), I-007 (Intake screen wash water), and I-008 Evaporation percolation basin

IN ACCORDANCE WITH: The limitations, monitoring requirements and other conditions set forth in Part I through Part VIII on pages 2 through 28 of this permit.

PERMITTEE:
Florida Power & Light
St. Lucie Power Plant
Unit 1 & 2
6501 S. Ocean Drive
Jensen Beach, Florida 34957

PERMIT NUMBER: FL0002208
ISSUANCE DATE: January 10, 2000
EXPIRATION DATE: January 9, 2005

I. Effluent Limitations and Monitoring Requirements

A. Surface Water Discharges

1. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from outfalls D-001 [formerly (OSN) 001] - Condenser once through cooling water and auxiliary equipment cooling water from Units 1 & 2 to the discharge canal thence the Atlantic Ocean.

   a. Such discharges shall be limited and monitored by the permittee as specified below:

	DISCHARGE LIMITATIONS	MONITORING REQUIREMENTS		
EFFLUENT CHARACTERISTIC	Instantaneous Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Hourly	Pump Logs	INT-1
Discharge Temperature, °F	113 [1,2]	Hourly	Recorders	EFF-2
Temperature Rise, °F	30 [1,2]	Hourly	Recorders	
Total Residual Oxidants (TRO), mg/l	0.10 (See item A.1.b.)	Continuous	Recorders [3]	EFF-2
Time of Condenser Chlorine Addition, minutes/day/unit	120	Daily	Log	EFF-2
Free Available Oxidants, mg/l	0.5 (See item A.1.b.)	1/ 2 months	Multiple Grabs [4]	EFF-1
Toxicity (Acute)	(See section I.B.12)			EFF-2

   b. Free available oxidants (FAO) shall not exceed an average concentration of 0.2 mg/l and maximum instantaneous concentration of 0.5 mg/l at the outlet corresponding to an individual condenser during any chlorination period. Neither FAO nor total residual oxidants (TRO) may be discharged from either unit condensers for more than two hours in any one day and not more than one unit may discharge FAO or TRO from its condensers at any one time. Additionally, TRO shall not exceed a maximum instantaneous concentration of 0.10 mg/l at any one time as measured at the POD prior to discharge to the Atlantic Ocean. Auxiliary equipment cooling water may receive continuous low-level chlorination.

[1] At the point of discharge, the heated water temperature from the diffusers shall not exceed 113°F or 30°F above ambient at any time except that the maximum discharge temperature shall be limited to 117°F or 32°F above ambient during condenser and/or circulating water pump maintenance, throttling circulating water pumps to minimize use of chlorine, and/or fouling of circulating water system. This temperature may be measured at a point within the discharge canal. (In determining the temperature differential, the time of travel through the plant may be considered). In the event that discharge temperature exceeds 113°F the permittee shall notify the Department within 5 days.

[2] The ambient ocean surface temperature shall not exceed 97°F as an instantaneous maximum at any point.

[3] During periods of monitor outage of more than 7 days, monitoring for TRO shall be conducted 1/week on not less than three grab samples during daylight hours. Additional grab samples shall be conducted during periods of TRO discharge from condensers.

[4] Multiple grabs shall consist of grab samples collected at the approximate beginning of FAO/TRO discharge and once every 15 minutes thereafter until the end of FAO/TRO discharge.

c. Samples taken in compliance with the monitoring requirements specified in item 1.a. shall be taken at the following locations: Intake temperature and flow at plant intakes (INT-1), free available chlorine at the outlet corresponding to an individual condenser (EFF-1), and all other parameters at the POD prior to discharge to the Atlantic Ocean (EFF-2).

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2. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-003 [formerly (OSN) 003] - Liquid radiation waste discharge to the discharge canal to the Atlantic Ocean.

a. Such discharges shall be limited and monitored by the permittee as specified below:

	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS		
EFFLUENT CHARACTERISTIC	Daily Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Report	1/Batch	Calculation	EFF-3
Oil and Grease, mg/l	15.0	20.0	Annually	Grab	EFF-3
Total Suspended Solids, mg/l	30.0	100.0	1/Batch	Grab	EFF-3

b. This discharge is regulated by the U.S. Regulatory Commission (NRC) under the provisions of its operating license and is monitored and reported to the NRC. No additional monitoring of the radiological aspects of this discharge is required.

c. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., Atlantic Ocean).

d. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations: discharge from the radiation waste system prior to mixing with any other waste stream (EFF-3).

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EXPIRATION DATE: January 9, 2005

3. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-005 [formerly (OSN) 005] - Steam generator blowdown to the discharge canal to the Atlantic Ocean.

a. Such discharges shall be limited and monitored by the permittee as specified below:

	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS		
EFFLUENT CHARACTERISTIC	Daily Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Report	1	Calculation	EFF-5
Oil and Grease, mg/l	15.0	20.0	1	Grab	EFF-5
Total Suspended Solids, mg/l	30.0	100.0	1	Grab	EFF-5
Boron, mg/l	---------	4.0	1, 2	Calculation [3]	EFF-2
Hydrazine, mg/l	---------	0.30	1, 2	Calculation [3]	EFF-2
Dimethylamine, mg/l	---------	Report	1, 2	Calculation [3]	EFF-2
Carbohydrazide, mg/l	---------	Report	1, 2	Calculation [3]	EFF-2

b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

c. Samples taken in compliance with the monitoring requirements specified above shall be taken at the point of discharge prior to entering the discharge canal (EFF-5 or at EFF-2 (POD)).

[1] One per discharge event or one per week which ever is more frequent, unless there is no discharge for that week. Total volume of batch and period of discharge shall be reported.

[2] Boron and hydrazine or carbohydrazide shall be monitored once per batch by a grab sample, during wet lay-up discharges that result from the start-up of a unit following a refueling outage.

[3] A grab sample shall be taken at the discharge of the steam generator to the discharge canal and the following calculations shall be used to determine the concentration from the discharge canal to the Atlantic Ocean [point of discharge (POD)]:

$$\frac{\text{Steam Generator Blowdown Flow} \times \text{Blowdown Boron Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Boron at the POD}$$

$$\frac{\text{Steam Generator Blowdown Flow} \times \text{Blowdown Hydrazine Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Hydrazine at the POD}$$

$$\frac{\text{Steam Generator Blowdown Flow} \times \text{Blowdown Dimethylamine Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Dimethylamine at the POD}$$

$$\frac{\text{Steam Generator Blowdown Flow} \times \text{Blowdown Carbohydrazide Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Carbohydrazide at the POD}$$

4. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-06B [formerly (OSN) 006B] – Former oil storage area - industrial related storm water to the intake canal.

   a. Such discharges shall be limited and monitored by the permittee as specified below and in Section I.B.:

	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS [1]		
EFFLUENT CHARACTERISTIC	Daily Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Report	Annually	Estimate	EFF-6
Total Suspended Solids, mg/l	Report	Report	Annually	Grab	EFF-6
Oil and Grease, mg/l	Report	Report	Annually	Grab	EFF-6

   b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

   c. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations: nearest accessible point after final treatment but prior to discharge to the receiving stream (EFF-6).

[1] Monitoring requirements apply once per year during the first 30 minutes of a rainfall event.

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5. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-06C [formerly (OSN) 006C] - Non-industrial related storm water to the Mangrove Impoundment 8E.

   a. Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS[1]		
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Report	1/Annually	Estimate	EFF-7
Oil and Grease, mg/l	Report		1/Annually	Grab	EFF-7

   b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

   c. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations: nearest accessible point after final treatment but prior to discharge to the receiving stream (EFF-7).

[1] Monitoring requirements apply annually during the first 30 minutes of a rainfall event.

6. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-007 [formerly (OSN) 007] - Intake screen wash water to the intake canal.

   a. Discharge of intake screen wash water is permitted without limitations or monitoring requirements.

   b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

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St. Lucie Power Plant
Unit 1 & 2
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PERMIT NUMBER: FL0002208
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EXPIRATION DATE: January 9, 2005

7. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from internal outfall I-008 – Evaporation percolation basin - industrial related storm water to the intake canal.

    a. Such discharges shall be limited and monitored by the permittee as specified below and in Section I.B.:

	DISCHARGE LIMITATIONS		MONITORING REQUIREMENTS		
EFFLUENT CHARACTERISTIC	Daily Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Point
Flow, MGD	Report	Report	1/Week	Calculation	EFF-8
Total Suspended Solids, mg/l	30.0	100.0	1/Week	Composite	EFF-8
Oil and Grease, mg/l	15.0	20.0	1/Week	Grab	EFF-8

    b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

    c. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations: nearest accessible point after final treatment but prior to discharge to the receiving stream (EFF-8).

    d. Monitoring requirements are applicable only during discharge of the evaporation percolation basin.

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PERMIT NUMBER: FL0002208
ISSUANCE DATE: January 10, 2000
EXPIRATION DATE: January 9, 2005

B. Other Limitations and Monitoring and Reporting Requirements

1. The Sampling and Testing Methods and Method of Detection Limits applicable to this permit shall be in accordance with Department established and published approved analytical methods and corresponding Department established MDLs (method detection limits) and PQLs (practical quantification limits). The approved list, which is titled "Florida Department of Environmental Protection Table Required By Rule 62-4.246(4) Testing Methods for Discharge to Surface Water" dated June 21, 1996, is available from the Department on request. Any method and corresponding MDL and PQL listed in the above described table may be used for reporting as long as it meets the following requirements;

   a) The PQL for the specific parameter measured is less than or equal to the permit limit or the water quality criteria stated in the applicable section of 62-302 FAC. Parameters that are listed as "report only" in the permit shall use methods which provide a PQL which is equal to or less than the applicable water quality criteria stated in 62-302 FAC.

   b) If the PQL's for all methods available in the approved list are above the stated permit limit or applicable water quality criteria for that parameter then the method with the lowest available PQL shall be used.

   In general the MDLs and PQLs as described above shall constitute the minimum reporting levels and the Department shall not accept results for which the laboratory's MDLs or PQLs are greater than those described above. However, minimally higher MDL/PQLs may be used if those MDL/PQLs are included in an update of the Permittee's Department Approved Comprehensive Quality Assurance Plan (CompQAP) and the permittee has notified the Department's Industrial Wastewater Section. In Addition, certain other method MDL/PQLs may be acceptable if the PQL value for a particular method is less than the permit limit, the MDL/PQL is included in the Department approved CompQAP, and the permittee has notified the Department's Industrial Wastewater Section.

   Unless otherwise specified, sample results shall be reported as indicated on the instructions included with the Discharge Monitoring Report:

2. Monitoring results obtained for each calendar month shall be summarized for that month and reported on a Discharge Monitoring Report (DMR), Form 62-620.910(10), postmarked no later than the 28th day of the month following the completed calendar month. For example, data for January shall be submitted by February 28. Signed copies of the DMR shall be submitted to the address specified below:

   Florida Department of Environmental Protection
   Mail Station 3551
   Twin Towers Office Building
   2600 Blair Stone Road
   Tallahassee, Florida 32399-2400

   If no discharge occurs during the reporting period, sampling requirements of this permit do not apply. The statement "No discharge" shall be written on the DMR form. If, during the term period of this permit, the facility ceases to discharge, the Department shall be notified immediately upon cessation of discharge. Such notification shall be in writing.

3. Unless specified otherwise in this permit, all other reports and notifications required by this permit, including twenty-four hour notifications, shall be submitted to or reported to, as appropriate, the address specified below:

   Florida Department of Environmental Protection
   Southeast District Office
   Industrial Wastewater Section
   1801 SE Hillmoor Drive, Suite C-204
   Port St. Lucie, Florida 34952
   (561)871-7662

4. The permittee shall report all visible discharges of floating materials contributed by plant operations, such as ash or an oil sheen, when submitting DMR's.

5. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

6. Discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act to any waste stream which ultimately may be released to waters of the State is prohibited unless specifically authorized elsewhere in this permit. This requirement is not applicable to products used for lawn and agricultural purposes or to the use of herbicides if used in accordance with labeled instructions and any applicable State permit. The company shall notify the Department in writing no later than six (6) months prior to instituting use of any biocide or chemical (except as authorized elsewhere in this permit) used in the cooling systems or any other portion of the treatment system which may be toxic to aquatic life. Such notification shall include:

   a. Name and general composition of biocide or chemical
   b. Frequencies of use
   c. Quantities to be used
   d. Proposed effluent concentrations
   e. Acute and/or chronic toxicity data (laboratory reports shall be prepared according to Section 12 of EPA document no. EPA/600/4-90/027 entitled, Methods for Measuring the Acute Toxicity of Effluents a Receiving Waters for Freshwater and Marine Organisms, or most current addition.)
   f. Product data sheet
   g. Product label

   The Department shall review the above information to determine if a major or minor permit revision is necessary. Permit revisions shall be processed in accordance with the requirements of Chapter 62-620, F.A.C. Discharge associated with the use of such biocide or chemical is not authorized without prior approval by the Department.

7. The permittee shall provide safe access points for obtaining representative samples which are required by this permit.

8. The permittee shall ensure that all laboratory analytical data submitted to the department as required by this permit is from a laboratory which has a currently valid and Department-approved Comprehensive Quality Assurance Plan (ComQAP) [or a ComQAP pending approval] for all parameters being reported as required by Chapter 62-160, Florida Administrative Code.

PERMITTEE:
Florida Power & Light
St. Lucie Power Plant
Unit 1 & 2
6501 S. Ocean Drive
Jensen Beach, Florida 34957

PERMIT NUMBER: FL0002208
ISSUANCE DATE: January 10, 2000
EXPIRATION DATE: January 9, 2005

9. The discharge of any waste resulting from the combustion of chemical metal cleaning wastes, toxic wastes, or hazardous wastes to any waste stream which ultimately discharges to waters of the United States is prohibited, unless specifically authorized elsewhere in this permit.

10. No direct discharge from any solid waste storage area to waters of the United States is authorized by this permit without prior approval by the Department.

Additionally, except as specifically permitted, there shall be no point source discharge of the following categories of wastes to waters of the United States or to any waste stream which enters such waters:

a. Low Volume Wastes
Includes, but is not limited to, boiler blowdown, wet scrubber air pollution control systems, ion exchange water treatment systems, water treatment evaporator blowdown, laboratory and sampling streams, floor drainage, cooling tower basin cleaning wastes and blowdown from recirculating house service water systems.

b. Metal Cleaning Wastes
Any wastewater resulting from cleaning, with or without chemical cleaning compounds, any metal process equipment including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning. Wastewater not classified as metal cleaning waste includes wastewater generated from hydrolasing (high pressure water jets) equipment to remove radioactive contaminants, including the reactor cavity, fuel transfer canal and various plant components such as valves, motor parts, and sections of pipe and stainless steel insulation.

11. The permittee is authorized to utilize the following chemical additives in accordance with the conditions of this permit pursuant to sections I.A.3.a.: Boron, Hydrazine, Dimethylamine, Carbohydrazide. Glutaraldehyde, Isothiazolin and Polyglycol are approved for use in the "closed-cooling water" system. If any discharges of these biocides occur to "waters of the US" in other than deminimus amounts where as the active ingredient is a detectable level, the facility shall immediately notify the Department.

12. The permittee shall initiate the series of tests described below, within the fourth year after permit issuance, to evaluate whole effluent toxicity of the discharge from outfall D-001 [formerly (OSN) 001]. All test species, procedures and quality assurance criteria used shall be in accordance with Methods for Measuring Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA/600/4-90/027F, or the most current edition. The control water and dilution water used will be moderately hard water as described in EPA/600/4-90/027F, Table 6, or the most current edition. A standard reference toxicant quality assurance acute toxicity test shall be conducted concurrently or no greater than 30 days prior to the initiation of each bioassay test with each species used in the toxicity tests. Results of all toxicity tests shall be submitted with the discharge monitoring report (DMR). Any deviation of the bioassay procedures outlined herein shall be submitted in writing to the Department for review and approval prior to use.

a.) 1. The permittee shall conduct 96-hour acute static renewal toxicity tests using the mysid shrimp, Mysidopsis bahia and the silverside minnow, Menidia beryllina. All tests will be conducted on four separate grab samples collected at evenly-spaced (6-hr) intervals over a 24-hour period and used in four separate tests in order to catch any peaks of toxicity and to account for daily variations in effluent quality.

2. If control mortality exceeds 10% for either species in any test, the test(s) for that species (including the control) shall be repeated. A test will be considered valid only if control mortality does not exceed 10% for either species. If, in any separate grab sample test, 100% mortality occurs prior to the end of the test, and control mortality is less than 10% at that time, that test (including the control) shall be terminated with the conclusion that the sample demonstrates unacceptable acute toxicity.

b.) 1. The toxicity tests specified above shall be initiated during the fourth year after permit issuance during a condenser chlorination application.

2. Results from "routine" tests shall be reported according to EPA/600/4-90/027F, Section 12, Report Preparation (or the most current edition), and shall be submitted to:

Florida Department of Environmental Protection
Industrial Wastewater Section
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

c.) 1. Each grab sample shall be run as a separate test and shall be conducted using a control (0% effluent) and one test concentration of 100% final effluent.

2. Mortalities of equal to or greater than 50% in a 100% effluent sample or any LC50 < 100% identified in additional tests will constitute a violation of these permit conditions, and Rule 62-302.200(1), Rule 62-302.500(1)(d) and Rule 62-4.244(3)(a), F. A. C.

d.) 1. If mortalities of greater than 20% are identified for either test species in any of the *four separate* grab sample tests within the specified time, the Department reserves the right to require additional toxicity testing to determine the source of the observed toxicity.

2. The first additional test shall be conducted using a control (0% effluent) and a minimum of five dilutions: 100%, 50%, 25%, 12.5% and 6.25% effluent and a control (0% effluent). The dilution series may be modified in the second and third test to more accurately identify the toxicity, such that at least two dilutions above and two dilutions below the target toxicity and a control (0% effluent) are run.

3. For each additional test, the sample collection requirements and the test acceptability criteria specified in Section 1 above must be met for the test to be considered valid. The first test shall begin within two weeks of the end of the "routine" tests, and shall be conducted weekly thereafter until *six* additional, valid tests are completed. The additional tests will be used to determine if the toxicity found in the "routine" test is still present.

4. Results from additional tests, required due to unacceptable acute toxicity in the "routine" tests, shall be submitted in a single report prepared according to EPA/600/4-90/027F, Section 12, or the most current edition and submitted within 45 days of completion of the additional, valid test. If the additional test(s) demonstrate unacceptable acute toxicity, the permittee will meet with the Department within 30 days of the report submittal to identify corrective actions necessary to remedy the observed acute toxicity.

13. If any manatee are observed in the intake canal, DEP shall be contacted and actions shall be taken for the safe and expeditious removal of the manatee. Florida Fish & Wildlife Conservation Commission (FWC), Tequesta, Florida shall be contacted at (561) 575-5408.

14. Monitoring requirements specified in Section I.A.1 through I.A.7 of this permit shall begin on the first day of the month following the issuance of this permit.

C. Reopener Clause

1. The permit shall be modified, or alternatively, revoked and reissued to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b)(23)(C) and (D), 304(b)(2) and 307(a)(2) of the Clean Water Act (the Act), as amended, if the effluent standard or limitation so issued or approved:

a.) Contains different conditions or is otherwise more stringent than any condition in the permit/or;

b.) Controls any pollutant not addressed in the permit.

The permit as modified or reissued under this paragraph shall contain any other requirements of the Act then applicable.

2. The permit may be reopened to adjust effluent limitations or monitoring requirements should future wasteload allocation determinations, water quality studies, DEP approved changes in water quality standards, or other information show a need for a different limitation or monitoring requirement.

D. Stormwater to Intake/Discharge Canal from Diked Petroleum Storage or Handling Area

Permittee is authorized to discharge stormwater from diked petroleum storage or handling areas, provided the following conditions are met:

Such discharges shall be limited and monitored by the permittee as specified below:

1. The facility shall have a valid SPCC Plan pursuant to 40 CFR 112.

2. In draining the diked area, a portable oil skimmer or similar device or absorbent material shall be used to remove oil and grease (as indicated by the presence of a sheen) immediately prior to draining.

3. Monitoring records shall be maintained in the form of a log and shall contain the following information, as a minimum:
   a.) Date and time of discharge,
   b.) Estimated volume of discharge,
   c.) Initials of person making visual inspection and authorizing discharge, and
   d.) Observed conditions of storm water discharged.

4. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of a visible oil sheen at any time.

E. Combined Waste Streams

In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property attributable to each controlled waste source shall not exceed the specified limitation for that waste source (ref. 40 CFR Section 423.15(k);1974).

F. Definitions

1. Calendar day for the purposes of flow and temperature measurement is from midnight to midnight.

2. Continuous measurement frequency is defined as measurements taken at intervals of no greater than one hour each, except for TRO, which shall be taken at intervals of no greater than per 10 minutes.

3. Daily Average Value is defined as the average of all daily sampling results for a parameter during a reporting period (i.e. month).

4. **Daily Maximum Concentration** is the maximum concentration of a pollutant discharged during any calendar day of a reporting period (i.e. month).

5. **Day of Discharge** shall be defined as a 24 hour period beginning 12 hours prior to commencement of discharge and hence ending 12 hours after completion of discharge.

6. **Multiple Grabs** shall consist of grab samples collected at the beginning of the period of chlorination discharge, and once every 15 minutes, thereafter. In addition, one grab sample shall be collected at the end of the period of chlorine discharge. The "period of chlorine discharge" refers to all chlorination sessions conducted during a 24-hour period.

7. **Three-hour rolling average for temperature** means the average of the most recent value with those collected over the previous 180 minutes.

8. **Total Residual Oxidants (TRO)** means the value obtained using the amperometric titration method for total residual chlorine. Testing for TRO shall be conducted according to either the amperometric titration method, the DPD colormetric method, or electrode as specified in Section 4500-Cl E., 4500-Cl G., or 4500-Cl I, respectively, Standard Methods for the Examination of Water and Wastewater, 18th edition (or most current edition).

9. **Free Available Oxidants (FAO)** means the value obtained using the amperometric titration method for free available chlorine. Testing for FAO shall be conducted according to either the amperometric titration method, or DPD colormetric method as specified in Section 4500-Cl E. or 4500-Cl G., respectively, Standard Methods for the Examination of Water Wastewater, 18th edition (or most current edition).

10. **Fully Operational** shall mean when on-site demineralizer regeneration is eliminated pursuant to the installation and operation of the proposed reverse osmosis system.

G. Condenser Maintenance Program

The permittee is authorized to use the Taprogge condenser tube cleaning system pursuant to the the plant's Best Management Practices for control of sponge ball loss to the environment.

H. Burning Toxic and Hazardous Wastes

Discharge of any waste resulting from the combustion of toxic, hazardous, or metal cleaning wastes to any waste stream which ultimately discharges to waters of the state is prohibited, unless specifically authorized elsewhere in this permit.

II. Industrial Sludge Management Requirements

The disposal of sludge or other solids generated from the facility shall be reused, reclaimed, or otherwise disposed of in accordance with the requirement of Chapter 62-701, F.A.C.

III. Ground Water Monitoring Requirements

This section is not applicable to this facility.

IV. Other Land Application Requirements

This section is not applicable to this facility.

V. Operation and Maintenance Requirements

A. Operation of Treatment and Disposal Facilities

1. The permittee shall ensure that the operation of this facility is as described in the application and supporting documents.
2. The operation of the pollution control facilities described in this permit shall be under the supervision of a person who is qualified by formal training and/or practical experience in the field of water pollution control appropriate for those facilities.

B. Record keeping Requirements:

1. The permittee shall maintain the following records on the site of the permitted facility and make them available for inspection:
   a. Records of all compliance monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, including, if applicable, a copy of the laboratory certification showing the certification number of the laboratory, for at least three years from the date the sample or measurement was taken;
   b. Copies of all reports, other than those required in items a. and b. of this section, required by the permit for at least three years from the date the report was prepared, unless otherwise specified by Department rule;
   c. Records of all data, including reports and documents used to complete the application for the permit for at least three years from the date the application was filed, unless otherwise specified by Department rule;
   d. A copy of the current permit;
   e. A copy of any required record drawings;
   f. Copies of the logs and schedules showing plant operations and equipment maintenance for three years from the date on the logs or schedule

VI. Compliance Schedules and Self-imposed Improvement Schedules

A. Schedule of Compliance

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   a. Attainment of effluent limitations........................Permit issuance

   b. Best Management Practices (BMP3) Plan (See Part VII, Subpart D)

   (1) Update plan...No later than 3 months from the effective date of the permit

   (2) Implement plan...On start of discharge

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by an identified date, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

VII. Other Specific Conditions

A. Specific Conditions Applicable to all permits

1. Drawings, plans, documents or specifications submitted by the permittee, not attached hereto, but retained on file with the Department, are made a part hereof.
2. If significant historical or archaeological artifacts are discovered at any time within the project site, the permittee shall immediately notify the office specified in Condition 5. and the Bureau of Historic Preservation, Division of Archives, History and Records Management, R.A. Gray Building, Tallahassee, Florida 32301.
3. Where required by Chapter 471 (P.E.) or Chapter 492 (P.G.) Florida Statutes, applicable portions of reports to be submitted under this permit, shall be signed and sealed by the professional(s) who prepared them.
4. This permit satisfies industrial wastewater program permitting requirements only and does not authorize operation of this facility prior to obtaining any other permits required by local, state or federal agencies.

B. Duty to Reapply

1. The permittee shall submit an application to renew this permit at least 180 days before the expiration date of this permit.
2. The permittee shall apply on the appropriate form listed in Rule 62-620.910, F.A.C., and in the manner established in Rules 62-620.400 through 62-620.460, F.A.C., including submittal of the appropriate processing fee set forth in Rule 62-4.050, F.A.C.
3. An application filed in accordance with subsections 1. and 2. of this part shall be considered timely. When an application for renewal of a permit is timely and sufficient, the existing permit shall not expire until the Department has taken final action on the application for renewal or until the last day for seeking judicial review of the agency order or a later date fixed by order of the reviewing court.
4. The late submittal of a renewal application shall be considered timely and sufficient for the purpose of extending the effectiveness of the expiring permit only if it is submitted and made complete before the expiration date.

C. Specific Conditions Related to Best Management Practices Condition

1. Best Management Practices Plan:

   In accordance with Rule 62-620.620(1)(n), the permittee shall develop and implement a Best Management Practices plan incorporating pollution prevention measures. References which may be used in developing the plan are "Criteria and Standards for Best Management Practices Authorized Under Section 304(e) of the Act", found at 40 CFR Section 122.44(k), the Storm Water Management Industrial Activities Guidance Manual, EPA/833-R92-002 and other EPA documents relating to Best Management Practice guidance.

2. Definitions:

   a. The term "pollutants" refers to conventional, non-conventional and toxic pollutants, as appropriate for the NPDES storm water program and toxic pollutants.

b. Conventional pollutants are: biochemical oxygen demand (BOD), suspended solids, pH, fecal coliform bacteria and oil & grease.

c. Non-conventional pollutants are those which are not defined as conventional or toxic, such as phosphorus, nitrogen or ammonia. (Ref: 40 CFR Part 122, Appendix D, Table IV)

d. For purposes of this part, Toxic pollutants include, but are not limited to: a) any toxic substance listed in Section 307(a)(1) of the CWA, any hazardous substance listed in Section 311 of the CWA, and b) any substance (that is not also a conventional or non-conventional pollutant) for which EPA has published an acute or chronic toxicity criterion, or that is a pesticide regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

e. "Pollution prevention" refers to the first category of EPA's preferred hazardous waste management strategy - source reduction.

f. "Significant Materials" is defined as raw materials; fuels; materials such as solvents and detergents; hazardous substances designated under Section 101(14) of CERCLA; and any chemical the facility is required to report pursuant to EPCRA, Section 313; fertilizers; pesticides; and waste products such as ashes, slag and sludge.

g. "Source reduction" means any practice which: i) reduces the amount of any pollutant entering a waste stream prior to recycling, treatment or disposal; and ii) reduces the hazards to public health and the environment associated with the release of such pollutant. The term includes equipment or technology modifications, process or procedure modifications, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. It does not include any practice which alters the physical, chemical, or biological characteristics or the volume of a pollutant through a process or activity which itself is not integral to, or previously considered necessary for, the production of a product or the providing of a service.

h. "BMP3" means a Best Management Plan incorporating the requirements of 40 CFR § 125, Subpart K, plus pollution prevention techniques, except where other existing programs are deemed equivalent by the permittee. The permittee shall certify the equivalency of the other referenced programs.

i. "Reportable Quantity (RQ) Discharge" A RQ release occurs when a quantity of a hazardous substance or oil is spilled or released within a 24-hour period of time and exceeds the RQ level assigned to that substance under CERCLA or the Clean Water Act. These levels or quantities are defined in terms of gallons or pounds. Regulations listing these quantities are contained at 40 CFR 302.4, 40 CFR 117.21 and 40 CFR 110.

j. The term "material" refers to chemicals or chemical products used in any plant operation (i.e., caustic soda, hydrazine, degreasing agents, paint solvents, etc.). It does not include lumber, boxes, packing materials, etc.

3. Best Management Practices/Pollution Prevention Plan:

The permittee shall develop and implement a BMP3 plan for the facility which is the source of wastewater and storm water discharges. The plan shall be directed toward reducing those pollutants of concern which discharge, or could discharge, to surface waters to and shall be prepared in accordance with good engineering

and good housekeeping practices. For the purposes of this permit, pollutants of concern shall be limited to toxic pollutants and significant materials, as defined above, known to the discharger. The plan shall address all activities which could or do contribute these pollutants to the surface water discharge, including storm water, water and waste treatment, and plant ancillary activities.

In addition, the BMP3 plan shall include procedures to be implemented by the facility to minimize and monitor losses that may occur during operation of the condenser tube cleaning system. At a minimum, the plan shall include provisions for:

a) Cleaning device losses and recovery for each cleaning event.

b) Replacement of worn cleaning devices.

c) Cleaning device losses shall be reported to NMFS and DEP-BPSM on an annual basis.

The above documentation shall be kept on file at the facility for a minimum of at least three years from the date of preparation pursuant to Section V.B.1.

4. Signatory Authority & Management Responsibilities:

A copy of the BMP3 plan shall be retained at the facility and shall be made available to the permit issuing authority upon request.

The BMP3 plan shall contain a written statement from corporate or plant management indicating management's commitment to the goals of the BMP3 program. The BMP3 plan shall be signed and reviewed by the plant management.

5. BMP3 Plan Requirements:

The following requirements may be incorporated by reference from existing facility procedures:

a. Name and description of facility

b. A site map - At a minimum the site map must include information of the following: discharge points ("outfalls"); drainage patterns; identification of the types of pollutants likely to be discharged from each drainage area; direction of flow; surface water bodies, including any proximate stream, river, lake, or other waterbody receiving storm water discharge from the site; structural control measures (physically constructed features used to control storm water flows); locations of "significant materials" exposed to storm water; locations of industrial activities (such as fueling stations, loading and unloading areas, vehicle or equipment maintenance areas, waste disposal areas, storage areas).

c. A materials inventory including the types of materials that are handled, stored, or processed onsite, particularly significant materials. To complete the materials inventory, the permittee must list materials that have been exposed to storm water in the past 3 years (focus on areas where materials are stored, processed, transported, or transferred and provide a narrative description of methods and location of storage and disposal areas, materials management practices, treatment practices, and any structural/nonstructural control measures.

d. A list of significant spills and leaks of toxic or hazardous materials that have occurred in the past 3 years. "Significant spills" includes releases in excess of reportable quantities.

e. A summary of any existing storm water sampling data and a description of the sample collection procedures used.

f. A site evaluation summary - The Site Evaluation Summary should provide a narrative description of activities with a high potential to contaminate storm water at the site, including those associated with materials loading and unloading, outdoor storage, outdoor manufacturing or processing, onsite disposal, and significant dust or particulate generating activities. The summary should also include a description of any pollutants of concern that may be associated with such activities.

g. A narrative description of the following BMP's:

(i) - <u>Good Housekeeping Practices</u>

(ii) - <u>Preventive Maintenance</u> The permittee must develop a preventive maintenance program that involves inspections and maintenance of storm water management devices and routine inspections of facility operations to detect faulty equipment. Equipment (such as tanks, containers, and drums) should be checked regularly for signs of deterioration.

(iii) - <u>Visual Inspections</u> Regular inspections shall be performed by qualified, trained plant personnel. Reports shall note when inspections were done, the name of the person who conducted the inspection, which areas were inspected, what problems were found, and what steps were taken to correct any problems.

(iv) - <u>Spill Prevention and Responses</u> Areas where spills are likely to occur and their drainage points must be clearly identified in the BMP3 plan. Employees shall be made aware of response

procedures, including material handling and storage requirements, and should have access to appropriate cleanup equipment.

(v) - <u>Sediment and Erosion Control</u> The BMP3 must identify activities that present a potential for significant soil erosion and measures taken to control such erosion.

(vi) - <u>Management of Runoff</u> The permittee must describe existing storm water controls found at the facility and any additional measures that can be implemented to improve the prevention and control of polluted storm water. Examples include: vegetative swales, reuse of collected storm water, infiltration trenches, and detention ponds.

6. Best Management Practices & Pollution Prevention Committee:

A Best Management Practices Committee (Committee) should be established to direct or assist in the implementation of the BMP3 plan. The Committee should be comprised of individuals within the plant organization who are responsible for developing, implementing, monitoring of success, and revision of the BMP3 plan. The activities and responsibilities of the Committee should address all aspects of the facility's BMP3 plan. The scope of responsibilities of the Committee should be described in the plan.

7. Employee Training:

Employee training programs shall inform appropriate personnel of the components & goals of the BMP3 plan and shall describe employee responsibilities for implementing the plan. Training shall address topics such as good housekeeping, materials management, recordkeeping and reporting, spill prevention & response, as well as specific waste reduction practices to be employed. The plan shall identify periodic dates for such training.

8. Plan Development & Implementation:

The BMP3 plan shall be developed or updated 6 months prior to commercial operation and implemented upon commercial operation, unless any later dates are specified by the Department.

9. Plan Review & Modification:

If following review by the Permit Issuing Authority, or authorized representative, the BMP3 plan is determined insufficient, he/she may notify the permittee that the BMP3 plan does not meet one or more of the minimum requirements of this Part. Upon such notification from the Permit Issuing Authority, or authorized representative, the permittee shall amend the plan and shall submit to the Permit Issuing Authority a written certification that the requested changes have been made. Unless otherwise provided by the Permit Issuing Authority, the permittee shall have 30 days after such notification to make the changes necessary.

The permittee shall modify the BMP3 plan whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for the discharge of pollutants to surface waters of the State <u>or</u> if the plan proves to be ineffective in achieving the general objectives of reducing pollutants in wastewater or storm water discharges. Modifications to the plan may be reviewed by Permit Issuing Authority in the same manner as described above.

10. Annual Site Compliance Evaluation:

Qualified personnel must conduct site compliance evaluations at appropriate intervals, but at least once a year. Compliance evaluations shall include:

- inspection of storm water drainage areas for evidence of pollutants entering the drainage system;

- evaluation of the effectiveness of BMP's;

- observations of structural measures, sediment controls, and other storm water BMP's to ensure proper operation;

- revision of the plan as needed within 2 weeks of the inspection, and implementation of any necessary changes within 12 weeks of the inspection; and

- preparation of a report summarizing inspection results and follow-up actions, identifying the date of inspection and personnel who conducted the inspection.

The inspection report shall be signed by the plant environmental engineering staff and plant management and kept with the BMP3 plan.

11. Recordkeeping and Internal Reporting:

For at least one year after the expiration of this permit, the permittee shall record and maintain records of spills, leaks, inspections, and maintenance activities. For spills and leaks, records should include information such as the date and time of the incident, weather conditions, cause, and resulting environmental problems.

D. Specific Conditions Related to Existing Manufacturing, Commercial, Mining, and Silviculture Wastewater Facilities or Activities

1. Existing manufacturing, commercial, mining, and silvicultural wastewater facilities or activities that discharge into surface waters shall notify the Department as soon as they know or have reason to believe: [62-620.624(1)]

(a) That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following levels
(1) One hundred micrograms per liter,
(2) Two hundred micrograms per liter for acrolein and acrylonitrile; five hundred micrograms per liter for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter for antimony, or
(3) Five times the maximum concentration value reported for that pollutant in the permit application.

(b) That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following levels
(1) Five hundred micrograms per liter,
(2) One milligram per liter for antimony, or
(3) Ten times the maximum concentration value reported for that pollutant in the permit application.

VIII. General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit are binding and enforceable pursuant to Chapter 403, Florida Statutes. Any permit noncompliance constitutes a violation of Chapter 403, Florida Statutes, and is grounds for enforcement action, permit termination, permit revocation and reissuance, or permit revision. [62-620.610(1)]

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviations from the approved drawings, exhibits, specifications or conditions of this permit constitutes grounds for revocation and enforcement action by the Department. [62-620.610(2)]

3. As provided in Subsection 403.087(6), F.S., the issuance of this permit does not convey any vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor authorize any infringement of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other Department permit or authorization that may be required for other aspects of the total project which are not addressed in this permit. [62-620.610(3)]

4. This permit conveys no title to land or water, does not constitute state recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title. [62-620.610(4)]

5. This permit does not relieve the permittee from liability and penalties for harm or injury to human health or welfare, animal or plant life, or property caused by the construction or operation of this permitted source; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department. The permittee shall take all reasonable steps to minimize or prevent any discharge, reuse of reclaimed water, or residuals use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. [62-620.610(5)]

6. If the permittee wishes to continue an activity regulated by this permit after its expiration date, the permittee shall apply for and obtain a new permit. [62-620.610(6)]

7. The permittee shall at all times properly operate and maintain the facility and systems of treatment and control, and related appurtenances, that are installed and used by the permittee to achieve compliance with the conditions of this permit. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to maintain or achieve compliance with the conditions of the permit. [62-620.610(7)]

8. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit revision, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition. [62-620.610(8)]

9. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, including an authorized representative of the Department and authorized EPA personnel, when applicable, upon presentation of credentials or other documents as may be required by law, and at reasonable times, depending upon the nature of the concern being investigated, to

   a. Enter upon the permittee's premises where a regulated facility, system, or activity is located or conducted, or where records shall be kept under the conditions of this permit;
   b. Have access to and copy any records that shall be kept under the conditions of this permit;
   c. Inspect the facilities, equipment, practices, or operations regulated or required under this permit; and
   d. Sample or monitor any substances or parameters at any location necessary to assure compliance with this permit or Department rules.
   [62-620.610(9)]

10. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data, and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except as such use is proscribed by Section 403.111, Florida Statutes, or Rule 62-620..302, Florida Administrative Code. Such evidence shall only be used to the extent that it is consistent with the Florida Rules of Civil Procedure and applicable evidentiary rules. [62-620.610(10)]

11. When requested by the Department, the permittee shall within a reasonable time provide any information required by law which is needed to determine whether there is cause for revising, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also provide to the Department upon request copies of records required by this permit to be kept. If the permittee becomes aware of relevant facts that were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be promptly submitted or corrections promptly reported to the Department. [62-620.610(11)]

12. Unless specifically stated otherwise in Department rules, the permittee, in accepting this permit, agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules. A reasonable time for compliance with a new or amended surface water quality standard, other than those standards addressed in Rule 62-302.500, F.A.C., shall include a reasonable time to obtain or be denied a mixing zone for the new or amended standard. [62-620.610(12)]

13. The permittee, in accepting this permit, agrees to pay the applicable regulatory program and surveillance fee in accordance with Rule 62-4.052, F.A.C. [62-620.610(13)]

14. This permit is transferable only upon Department approval in accordance with Rule 62-620.340, F.A.C. The permittee shall be liable for any noncompliance of the permitted activity until the transfer is approved by the Department. [62-620.610(14)]

15. The permittee shall give the Department written notice at least 60 days before inactivation or abandonment of a wastewater facility and shall specify what steps will be taken to safeguard public health and safety during and following inactivation or abandonment. [62-620.610(15)]

PERMITTEE:
Florida Power & Light
St. Lucie Power Plant
Unit 1 & 2
6501 S. Ocean Drive
Jensen Beach, Florida 34957

PERMIT NUMBER: FL0002208
ISSUANCE DATE: January 10, 2000
EXPIRATION DATE: January 9, 2005

16. The permittee shall apply for a revision to the Department permit in accordance with Rules 62-620.300, 62.420 or 62.620.450, F.A.C., as applicable, at least 90 days before construction of any planned substantial modifications to the permitted facility is to commence or with Rule 62-620.300 for minor modifications to the permitted facility. A revised permit shall be obtained before construction begins except as provided in Rule 62-620.300, F.A.C. [62-620.610(16)]

17. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements. The permittee shall be responsible for any and all damages which may result from the changes and may be subject to enforcement action by the Department for penalties or revocation of this permit. The notice shall include the following information:

    a. A description of the anticipated noncompliance;
    b. The period of the anticipated noncompliance, including dates and times; and
    c. Steps being taken to prevent future occurrence of the noncompliance.
    [62-620.610(17)]

18. Sampling and monitoring data shall be collected and analyzed in accordance with Rule 62-4.246, Chapter 62-160 and 62-601, F.A.C., and 40 CFR 136, as appropriate.

    a. Monitoring results shall be reported at the intervals specified elsewhere in this permit and shall be reported on a Discharge Monitoring Report (DMR), DEP Form 62-620.910(10).
    b. If the permittee monitors any contaminate more frequently than required by the permit, using Department approved test procedures, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.
    c. Calculations for all limitations which require averaging of measurements shall use an arithmetic mean unless otherwise specified in this permit.
    d. Any laboratory test required by this permit for domestic wastewater facilities shall be performed by a laboratory that has been certified by the Department of Health and Rehabilitative Services (DHRS) under Chapter 10D41, F.A.C., to perform the test. In domestic wastewater facilities, on-site tests for dissolved oxygen, pH, and total chlorine residual shall be performed by a laboratory certified to test for those parameters or under the direction of an operator certified under Chapter 61E12-41, F.A.C.
    e. Under Chapter 62-160, F.A.C., sample collection shall be performed by following the protocols outlined in "DER Standard Operating Procedures for Laboratory Operations and Sample Collection Activities" (DER-QA-001/92). Alternatively, sample collection may be performed by an organization who has an approved Comprehensive Quality Assurance Plan (CompQAP) on file with the Department. The CompQAP shall be approved for collection of samples from the required matrices and for the required tests.
    [62-620.610(18)]

19. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule detailed elsewhere in this permit shall be submitted no later than 14 days following each schedule date. [62-620.610(19)]

20. The permittee shall report to the Department any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five days of the time the permittee becomes aware of the circumstances. The written submission shall contain: a description of the noncompliance and its cause; the period of noncompliance including exact dates and time, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

a. The following shall be included as information which must be reported within 24 hours under this condition:

(1). Any unanticipated bypass which causes any reclaimed water or the effluent to exceed any permit limitation or results in an unpermitted discharge,
(2). Any upset which causes any reclaimed water or the effluent to exceed any limitation in the permit,

(3). Violation of a maximum daily discharge limitation for any of the pollutants specifically listed in the permit for such notice, and
(4). Any unauthorized discharge to surface or ground waters.

b. If the oral report has been received within 24 hours, the noncompliance has been corrected, and the noncompliance did not endanger health or the environment, the Department shall waive the written report.
[62-620.610(20)]

21. The permittee shall report all instances of noncompliance not reported under Conditions VIII. 18. and 19. of this permit at the time monitoring reports are submitted. This report shall contain the same information required by Condition VIII. 20. of this permit. [62-620.610(21)]

22. Bypass Provisions.

a. Bypass is prohibited, and the Department may take enforcement action against a permittee for bypass, unless the permittee affirmatively demonstrates that:

(1). Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; and
(2). There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
(3). The permittee submitted notices as required under Condition VIII. 22. b. of this permit.

b. If the permittee knows in advance of the need for a bypass, it shall submit prior notice to the Department, if possible at least 10 days before the date of the bypass. The permittee shall submit notice of an unanticipated bypass within 24 hours of learning about the bypass as required in Condition VIII. 20. of this permit. A notice shall include a description of the bypass and its cause; the period of the bypass, including exact dates and times; if the bypass has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent recurrence of the bypass.

c. The Department shall approve an anticipated bypass, after considering its adverse effect, if the permittee demonstrates that it will meet the three conditions listed in Condition VIII. 22. a. 1. through 3. of this permit.

d. A. permittee may allow any bypass to occur which does not cause reclaimed water or effluent limitations to be exceeded if it is for essential maintenance to assure efficient operation. These bypasses are not subject to the provision of Condition VIII. 22. a. through c. of this permit.
[62-620.610(22)]

23. Upset Provisions

a. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed contemporaneous operating logs, or other relevant evidence that:

(1). An upset occurred and that the permittee can identify the cause(s) of the upset;
(2). The permitted facility was at the time being properly operated;

(3). The permittee submitted notice of the upset as required in Condition VIII. 20. of this permit; and
(4). The permittee complied with any remedial measures required under Condition VIII. 5. of this permit.

b. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

c. Before an enforcement proceeding is instituted, no representation made during the Department review of a claim that noncompliance was caused by an upset is final agency action subject to judicial review. [62-620.610(23)]

Executed in Tallahassee, Florida.

STATE OF FLORIDA
DEPARTMENT OF
ENVIRONMENTAL PROTECTION

Mimi Drew

Mimi Drew
Director
Division of Water Resource Management

2600 Blair Stone Road
Tallahassee, FL 32399-2400
(850) 487-1855

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

AMENDMENT TO THE FACT SHEET FOR PERMIT TO DISCHARGE TREATED WASTEWATER TO WATERS OF THE STATE

Permit Number: FL0002208
Permit Writer: Wanda Parker-Garvin

Application Date: April 9, 1996

1. SYNOPSIS OF APPLICATION

A. Name and Address of Applicant

Florida Power & Light Company
6501 S. Ocean Drive
Jensen Beach, Florida 34957

For:

St. Lucie Power Plant
Units 1 and 2
Hutchinson Island
St. Lucie County, Florida

2. EPA Comments

None received.

3. Public Comments

None received.

4. Other Comments Received

Changes made to the draft permit after Notice of Draft Issuance:

a) Section I.A.1.a., page 2: The parameter for biocide was deleted pursuant to supporting documentation provided by the facility which states that FPL no longer intends to discharge biocides other than chlorine. An additional requirement was included in specific condition I.B.11. if any discharges of these biocides occur to "waters of the US" in other than deminimus amounts where as the active ingredient is a detectable level.
b) Section I.A.2., page 4 of the draft permit: Outfall 002 was deleted because the facility provided supporting documentation that FPL no longer intends to discharge low volume wastewater from the neutralization basin to the intake canal. Future discharges from the neutralization basin will be directed to the evaporation/percolation pond system.
c) Section I.A.5., page 6: The sample type for Dimethylamine and Carbohydrazide was changed from grab to calculation. Additional calculations for the aforementioned were added as footnotes.
d) Section I.A.8.d., page 9: A specific requirement was added referencing monitoring applicability for outfall I-008.

e) Section I.B.11., page 12: The language was changed to clarify the specific requirement and amend the changes made in item c) of this fact sheet.
f) Section I.B.12., page 12: The measurement frequency was changed from "the third and fifth year" to the "fourth year".

Changes made to the fact sheet after Notice of Draft Issuance:

a) Additional language was added to the fact sheet referencing the facility's 316(a) and (b) issues.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

FACT SHEET FOR APPLICATION FOR PERMIT TO DISCHARGE TREATED WASTEWATER TO WATERS OF THE STATE

Permit Number: FL0002208
Permit Writer: Wanda Parker-Garvin

Application Date: April 9, 1996
Application No: FL0002208-001-IW1S
Additional Information: April 30, 1999/June 8, 1999
Designation: Major

1. SYNOPSIS OF APPLICATION

A. Name and Address of Applicant

Florida Power & Light Company
6501 S. Ocean Drive
Jensen Beach, Florida 34957

For:

St. Lucie Power Plant
Units 1 and 2
Hutchinson Island
St. Lucie County, Florida

B. Description of Applicant's Operation

The Standard Industrial Classification (SIC) code is 4911 which covers generation, transmission, and distribution of electricity. The St. Lucie plant is located on Hutchinson Island in St. Lucie County, approximately twelve miles north of Stuart, Florida. The plant covers 1,132 acres and is at about midpoint of Hutchinson Island. The plant is a two unit nuclear powered steam electric plant. Each unit is nominally rated at 850 MW. The commercial operation of Unit 1 began in March 1976 and Unit 2 began in May 1983.

C. Design Capacity of Facility

Number of Units - 2
Unit 1 Nameplate Rating - 850 MW
Unit 2 Nameplate Rating - 850 MW

D. Applicant's Receiving Waters: Atlantic Ocean @ D-001 (formerly OSN 001) POD
27° 21' 05" - Latitude 80° 14' 26" - Longitude
Classification: Class III Open Marine Waters
Use Designation: Suitable for Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife.
(For a sketch showing the location of the discharges see Attachment A)

E. Description of Wastewater Treatment Facilities

Once-Through Cooling Water and Auxiliary Cooling Water - D-001
(formerly OSN 001)

The plant utilizes a total of eight circulating water pumps (four per unit) having a nominal total capacity of 968,000 gpm to supply once-through cooling water to Units 1 and 2. The once-through condenser and auxiliary cooling water systems discharge through pipelines into the Atlantic Ocean. Unit 1 discharge pipe utilizes a Y-port diffuser which discharges approximately 1500 feet from shore. Unit 2 utilizes a multi-port diffuser designed with 58 ports, each port being about 16 inches in diameter. The length of the multi-port diffuser is 1,416 feet beginning 1959 feet from shore. The discharge of heated water through the Y-port and multi-port diffusers ensures distribution over a wide area and enables a more rapid and efficient mixing with ambient waters.

Two additional minor effluent streams into the discharge canal are from the steam generators, with monitoring for boron at the point of discharge (POD) and the refueling water storage tank/non-aerated water hold-up tanks. The tanks are normally treated by the liquid radwaste system for further reduction of radioactivity. The refueling water storage tank, whose contents are used for safety injection and refueling water, contains 5000,000 gallons of water with a 2000 ppm boron content. There are four, forty thousand gallon non-aerated water hold-up tanks which hold reactor coolant bleed-off or drain down water. Both of which discharge very infrequently. The once-through cooling water system is presently chlorinated at a maximum of two hours per day per unit for micro- and acrobiofouling control.

As a replacement for the biocide treatment, FPL utilizes mechanical condenser tube cleaning systems on both units. These systems utilize sponge balls that are about 23 mm in diameter, which are forced through the condenser tubes. Approximately 1800 sponge balls are utilized at one time per condenser waterbox. There are four waterboxes per condenser on each unit. The sponge balls scrub the tubes as they pass through and downstream of the condensers, the sponge balls are captured by a ball strainer.

In addition to once-through cooling, up to 58,000 gpm of ocean cooling water is pumped using auxiliary cooling water pumps through the auxiliary equipment heat exchangers. The solution being cooled by these heat exchangers contain 200-500 ppm of sodium molybdate, 200-500 ppm of sodium nitrate and 10-30 ppm of tolytriazole. Low-level chlorination of the auxiliary cooling water is utilized.

Liquid Radwaste System Batch Releases – I-003 (formerly OSN 003)

The flow from the radwaste treatment system is intermittent. The system has been modified to permit a maximum estimated flow of 259 gpm. The waste stream originates from various maintenance and operational activities which take place in the reactor auxiliary building (RAB) and is processed for radioactive reduction by ion exchange resins and low micron filtration systems.

Steam Generator Blowdown – I-005 (formerly OSN 005)

High purity make-up water is routed to the secondary system and steam generators as makeup for the water/steam cycle. Ammonium hydroxide is added for pH control and catalyzed hydrazine (Amerzine) is added for oxygen removal. The blowdown is either recovered or routed to the discharge canal. The concentration of hydrazine in these discharges during plant operation normally ranges from
25 ppb to 2 ppm.

Intake Traveling Screen Wash Water – I-007 (formerly OSN 007)

Two 1060 gpm capacity traveling screen wash pumps located on both Units 1 and 2 at the intake structure withdraw ocean water for traveling screen cleaning. The traveling screens are used to prevent debris from reaching the condensers. One pump is normally in operation on each unit for two hours per day, at an average wash flow of 90 gpm per unit. The wash water is returned to the intake canal through a collection sump and drain system.

Non-equipment Area Storm Water Run-off – I-06B and I-06C (formerly OSN 006B and OSN 006C)

Two non-equipment area stormwater discharges are made to the cooling water intake canal or mangrove impoundments. These streams originate from areas of the plant including roadways, parking lots, and building storm drains.

Evaporation/Percolation Basin – I-008

This new discharge from the Southeast Evaporation/Percolation Basin to the plant intake canal is to be used when local rainfall amounts result in pond levels that impend plant operating equipment. The discharge is to be utilized via a staff gauge located in the basin and opened for discharge when necessary. Historical data indicates the discharge would occur approximately twice a year.

F. Description of Discharges (as reported by the applicant)

D-001 (formerly outfall 001) - Once-through cooling water for Unit 1 & 2

Maximum Daily flow, MGD	1477
pH range, SU	8.09-8.11
Daily Maximum Temp., ° C(Winter)	35.6
Daily Maximum Temp., °C(Summer)	44.4

I-003 (formerly outfall 003) - Liquid radiation waste

Maximum Daily flow, MGD	0.040
pH range, SU	5.73 - 5.73
Daily Maximum Temp., °C (Winter)	21.0

I-005 (formerly outfall 005) - Steam generator blowdown

Maximum Daily flow, MGD	0.509
pH range, SU	7.59 - 10.05
Daily Maximum Temp., °C (Winter)	48.9

2. PROPOSED EFFLUENT LIMITATIONS

A. **Outfall D-001 [formerly (OSN) 001]** - Condenser once through cooling water and auxiliary equipment cooling water

	DISCHARGE LIMITATIONS
EFFLUENT CHARACTERISTIC	Instantaneous Maximum
Flow, MGD	Report
Discharge Temperature, °F	113 [1,2]
Temperature Rise, °F	30 [1,2]
Total Residual Oxidants (TRO), mg/l	0.10 (See item b.)
Time of Condenser Chlorine Addition, minutes/day/unit	120
Free Available Oxidants, mg/l	0.5 (See item b.)
Toxicity (Acute)	(See section I.B.12)

b. Free available oxidants (FAO) shall not exceed an average concentration of 0.2 mg/l and maximum instantaneous concentration of 0.5 mg/l at the outlet corresponding to an individual condenser during any chlorination period. Neither FAO nor total residual oxidants (TRO) may be discharged from either unit condensers for more than two hours in any one day and not more than one unit may discharge FAO or TRO from its condensers at any one time. Additionally, TRO shall not exceed a maximum instantaneous concentration of 0.10 mg/l at any one time as measured at the POD prior to discharge to the Atlantic Ocean. Auxiliary equipment cooling water may receive continuous low-level chlorination.

[1] At the point of discharge, the heated water temperature from the diffusers shall not exceed 113°F or 30°F above ambient at any time except that the maximum discharge temperature shall be limited to 117°F or 32°F above ambient during condenser and/or circulating water pump maintenance, throttling circulating water pumps to minimize use of chlorine, and/or fouling of circulating water system. This temperature may be measured at a point within the discharge canal. (In determining the temperature differential, the time of travel through the plant may be considered). In the event that discharge temperature exceeds 113°F the permittee shall notify the Department within 5 days.

[2] The ambient ocean surface temperature shall not exceed 97°F as an instantaneous maximum at any point.

B. **Outfall I-003 [formerly (OSN) 003] - Liquid radiation waste**

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS	
	Daily Average	Daily Maximum
Flow, MGD	Report	Report
Oil and Grease, mg/l	15.0	20.0
Total Suspended Solids, mg/l	30.0	100.0

D. **Outfall I-005 [formerly (OSN) 005] - Steam generator blowdown**

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS	
	Daily Average	Daily Maximum
Intake Flow, MGD	Report	Report
Oil and Grease, mg/l	15.0	20.0
Total Suspended Solids, mg/l	30.0	100.0
Boron, mg/l	---------	4.0
Hydrazine, mg/l	---------	0.30
Dimethylamine, mg/l	---------	Report
Carbohydrazide, mg/l	---------	Report

E. **Outfall I-06B [formerly (OSN) 006B] – Former Oil storage area**

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS	
	Daily Average	Daily Maximum
Flow, MGD	Report	Report
Total Suspended Solids, mg/l	Report	Report
Oil and Grease, mg/l	Report	Report

F. **Outfall I-06C [formerly (OSN) 006C]** - Non-industrial related storm water

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS	
	Daily Average	Daily Maximum
Flow, MGD	Report	Report
Oil and Grease, mg/l	Report	

G. **Outfall I-007 [formerly (OSN) 007]** - Intake screen wash water

a. Discharge of intake screen wash water is permitted without limitations or monitoring requirements.

b. There shall be no discharge of floating or visible foam or oil sheen in such amounts as to create a nuisance, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).

H. **Outfall I-008 – Evaportation Percolation Ponds** - Industrial related storm water

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS	
	Daily Average	Daily Maximum
Flow, MGD	Report	Report
Total Suspended Solids, mg/l	30.0	100.0
Oil and Grease, mg/l	15.0	20.0

3. BASIS FOR EFFLUENT LIMITATIONS AND PERMIT CONDITIONS

The majority of the effluent limitations and conditions for permitting contained in Part I of the permit are continuations of those provisions in the previous NPDES permit. These conditions were made in accordance with the following regulations and determinations:

A. Federal effluent guidelines for the steam electric power generating point source category (40 CFR Part 423, November 19, 1982, 47 FR[3] 52290), New Source Performance Standards (§ 423.15). A best professional judgment (BPJ) has been made that concentration limitations will be used in lieu of mass limitations in accordance with 40 CFR § 423.15(m). All measurement frequency and sample type requirements are based on BPJ. A limitation on pH range of 6.0 standard units minimum and 9.0 maximum has been proposed in accordance with 40 CFR § 423.15(a), except when limited for direct

[3] FR - Federal Register

discharge. For direct discharge, the pH range is limited to 6.0 to 8.5 in accordance with FAC[4] Section 62-302.560(21).

Where necessary, limitations and monitoring requirements have been established for internal waste streams (e.g., wastes which combine with other contaminated wastes or cooling water prior to discharge) in accordance with 40 CFR §122.45(h). Unless otherwise noted, the reason for designating internal waste streams is that the required pollutant concentration limitations cannot be monitored after combination, due to dilution.

B. Florida Water Quality Standards: The receiving waters are classified as Surface Waters, Class III Waters Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife (FAC Chapters 62-301 and 62-302).

Requirements for toxic pollutants are provided in FAC Sections 62-302.200, 62-302.500, and 62-302.560. "All surface waters of the State shall at all places and at all times be free from domestic, industrial, agricultural, or other man-induced non-thermal components of discharges which, alone or in combination with other substances or in combination with other components of discharges (whether thermal or non-thermal) are acutely toxic [Section 62-302.500(1)(d)]." "Acute Toxicity" is defined in Section 62-302.200(1) as: "the presence of one or more substances or characteristics or components of substances in amounts which: (a) are greater than one-third (1/3) of the amount lethal to 50% of the test organisms in 96 hours (96 hr LC50) where the 96 hr LC50 is the lowest value which has been determined for a species significant to the indigenous aquatic community; or (b) may reasonably be expected, based upon evaluation by generally accepted scientific methods, to produce effects equal to those of the concentration of the substance specified in (a) above." Criteria for specific pollutants are contained in Section 62-302.530.

C. Specific citations of the regulations and other rationale for the limitations and conditions for each outfall authorized by this permit are as follows:

1) Part I.A. Conditions:

<u>D-001 [formerly (OSN) 001] -</u> Condenser once through and auxiliary equipment cooling water

<u>Flow</u>

Monitoring and reporting requirements are based on BPJ, and are consistent with §308(a) of the CWA.

<u>Discharge Temperature</u>

Monitoring and reporting requirements are based on BPJ, supporting historical data and previous thermal studies conducted at the facility.

The thermal component of the discharge is subject to compliance with Florida Water Quality Standards. FAC Section 62-302.520 provides that heated water discharges "shall not increase the temperature of the RBW [receiving body of water] so as to cause substantial damage or harm to the aquatic life or vegetation therein or interfere with the beneficial uses assigned to the RBW."

Section 316(a) Clean Water Act allows the Regional Administrator to impose alternative and less stringent thermal limitations after demonstration that the water quality standards limitations are more stringent than

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[4] FAC - Florida Administrative Code

necessary to assure the protection and propagation of a balanced, indigenous population of the shellfish fish and wildlife in an on the RBW. It was previously determined that the thermal component of this discharge meets Florida Water Quality Standards. (The temperature limitations included in this permit are supported by previous biological studies which can be found in the administrative record.) Therefore, Section 316(a) was determined not to be applicable. At the time of this writing, there have been no reported changes by the permittee, in the operation of the plant or changes in the biotic community of the RBW which would change the previous determinations.

Section 316(b) of the Clean Water Act requires that the location, design, construction, and capacity of a cooling water intake structure reflect the best technology available for minimizing environmental impacts. Through deliberations between FPL and several government agencies, it was determined that the intake structure met the requirements of Section 316 (b). (See the August 15, 1981 and January 29, 1982 Findings of Facts in the administrative file.)

Total Residual Oxidants

Based on FAC Section 62-302.560(19).

Toxicity

Monitoring and reporting requirements are based on toxicity tests and chemical data provided by the facility.

I-003 [formerly (OSN) 003] - Liquid radiation waste

Flow

Monitoring and reporting requirements are based on BPJ, and are consistent with §308(a) of the CWA.

Oil and Grease and Total Suspended Solids

Based on 40 CFR Section 423.12(b)(5) for low volume wastes.

pH

Based on 40 CFR Section 423.12(b)(1).

I-005 [formerly (OSN) 005] - Steam generator blowdown

Flow

Monitoring and reporting requirements are based on BPJ, and are consistent with §308(a) of the CWA.

Oil and Grease and Total Suspended Solids

Based on 40 CFR Section 423.12(b)(5) for low volume wastes.

Boron, Hydrazine, Dimethylamine, and Carbohydrazide

Monitoring and reporting requirements are based on BPJ and current/historical chemical data provided by the facility.

<u>I-06B [formerly (OSN) 006B]</u> – Former Oil storage area

<u>Flow</u>

Monitoring and reporting requirements are based on BPJ, and are consistent with §308(a) of the CWA.

<u>Oil and Grease and Total Suspended Solids</u>

Based on 40 CFR Section 423.12(b)(5) for low volume wastes.

<u>I-06C [formerly (OSN) 006C]</u> - Non-industrial related storm water

<u>Flow</u>

Monitoring and reporting requirements are based on BPJ, and are consistent with §308(a) of the CWA.

<u>Oil and Grease</u>

Based on FAC Section 62-302.530(50)(b).

<u>I-008</u> - industrial related storm water

<u>Flow</u>

Monitoring and reporting requirements are based on BPJ.

<u>Oil and Grease and Total Suspended Solids</u>

2) Part I.B. Conditions:

a) Condition 1. The requirement is based on 62-160, F.A.C.

b) Condition 2. and 3. Reporting requirements are standard for a major industrial discharger.

c) Condition 5. PCB prohibition as required by 40 CFR 423.12(b)(2) and 40 CFR 423.13(a).

d) Condition 6. FIFRA and Toxic Compound prohibitions are based on BPJ and the absence of a request for discharge in the application. These compounds may be highly toxic and any proposed discharge would require assessment and possible inclusion of an effluent limitation to insure that toxicity did not occur.

The remaining conditions are included per best professional judgment of the permit writer, consistency with requirements in the previous NPDES permit, and standard requirements for each NPDES permit.

4. REQUESTED VARIANCES OR ALTERNATIVES TO REQUIRED STANDARDS

The applicant did not make a request.

5. EFFECTIVE DATE OF PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULE

a. Attainment of effluent limitations....................Permit issuance

b. Best Management Practices (BMP3) Plan (See Part VII, Subpart D)

(1) Update plan..No later than 3 months from the effective date of the permit

(2) Implement plan.......................................On start of discharge

6. PRINCIPAL CHANGES FROM THE EXISTING PERMIT TO THE DRAFT PERMIT

The permit incorporates a request by the applicant of the following:

a. Authorization for use of the following new and existing chemical additives at outfall D-001 and I-005: Boron, Hydrazine, Dimethylamine, Carbohydrazide, Glutaraldehyde, Isothiazolin and Polyglycol.

b. Deletion of the limitations and monitoring requirements of copper and iron for outfall I-005 (formerly (OSN) 005). The parameters were deleted pursuant to historical monitoring data and supporting documentation provided by the facility which demonstrated compliance and no adverse affect to the environment.

c. Authorization to add a discharge outfall (outfall I-008) from the Southeast Evaporation/Percolation Basin to the plant intake canal.

The permit incorporates changes made by the permit writer based on historical data provided by the facility and best professional judgment of the following:

a. Deletion of the limitations and monitoring for boron at outfall D-001. The change was made because boron is monitored at the internal outfall I-005 for the same limitation.

b. Deletion of the limitations and monitoring for copper, iron, and phosphorus at outfall I-003. The parameters were deleted pursuant to historical monitoring data and supporting documentation provided by the facility which demonstrated compliance and no adverse affect to the environment.

c. Deletion of outfall 004 because the facility is currently connected to the municipal sewage treatment plant.

d. Deletion of the limitations and monitoring requirements of biocides at outfall D-001. The parameters were deleted pursuant to supporting documentation provided by the facility which states that FPL no longer intends to discharge biocides other than chlorine. An additional requirement was included in specific condition I.B.11. if any discharges of these biocides occur to "waters of the US" in other than deminimus amounts where as the active ingredient is a detectable level.

e. Deletion of outfall 002 because the facility provided supporting documentation that FPL no longer intends to discharge low volume wastewater from the neutralization basin to the intake canal. Future discharges from the neutralization basin will be directed to the evaporation/percolation pond system.

7. FDEP CONTACT

Additional information concerning the permit may be obtained by Wanda Parker-Garvin at the address and during the hours noted in Item 8.

8. ADMINISTRATIVE RECORD

The administrative record including application, draft permit, fact sheet, public notice (after release), documents cited herein, comments received and responses thereto, and other documents contained in the supporting file for the permit, is available by writing FDEP or for review and copying at 2600 Blairstone Road, Tallahassee, Florida 32399-2400 between the hours of 8 A.M. and 5 P.M., Monday through Friday. Copies will be provided at a minimal charge per page.

9. PROPOSED SCHEDULE FOR PERMIT ISSUANCE

Draft Permit to Applicant and EPA..............................July 17, 1999
Applicant to Publish Public Notice (no later than)..............August 16, 1999
Public Comment Period..............................Beginning:......August 19, 1999
Ending:..........October 18, 1999
Final Department Action..November 18, 1999

10. PROCEDURES FOR THE FORMULATION OF FINAL DETERMINATIONS

a. Comment Period

The Florida Department of Environmental Protection proposes to issue an NPDES permit to this applicant subject to the aforementioned effluent limitations and special conditions. These determinations are tentative and open to comment from the public.

Copies of the Draft Permit (including Public Notice and Fact Sheet) will be available for review at the address noted in Item 8 and at the Department's Southeast District office located at 400 North Congress Avenue, West Palm Beach, Florida 33401. Interested persons are invited to submit written comments regarding permit issuance on the proposed permit limitations and conditions to the following address:

Industrial Wastewater Section
Mail Station 3545
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

All comments received within thirty (30) days following the date of public notice will be considered in the formulation of final determinations with regard to proposed permit issuance.

b. Public Meeting

Interested persons may submit to the Department at the above address a request for a public meeting, stating the nature of the issues the person proposes be raised at such meeting. The Department shall hold a public meeting following public notice whenever a significant degree of public interest in this permit is expressed through public comments and requests for a public meeting. If a public meeting is held, any person may submit oral or written statements and data concerning this draft permit. Public notice of such a public meeting will be given at least 30 days before the meeting.

c. Preparation of a Proposed Permit

Following receipt of any public comments in accordance with a. and b. above, the Department will consider all significant comments in revising the draft permit and making a final decision to issue a final permit. If the draft permit is revised based on public comment it will be submitted to the U.S. Environmental Protection Agency as a proposed permit for EPA's concurrence in the Department's decision. Following receipt of any comments or objections from USEPA, the Department will either issue the proposed permit, issue a modified proposed permit, or deny the permit in accordance with the EPA objections.

d. Issuance of a Final Permit

The Department will prepare and send a public notice of the final permit to the applicant for publication in a local newspaper published in the vicinity of the project. That notice will advise the applicant and all affected persons of their right to petition for an administrative hearing pursuant to Chapter 120, Florida Statutes. Substantially affected persons will have 14 days from receipt of public notice to request an administrative hearing. If no administrative hearing is held, the Department will issue a final permit to the applicant.

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME: Florida Power & Light
MAILING ADDRESS: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

FACILITY: St. Lucie Power Plant - Units 1 & 2
LOCATION: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

COUNTY: St. Lucie

PERMIT NUMBER: 0002208
MONITORING PERIOD From:________________ To:________________
LIMIT: Final
CLASS SIZE: Major
DISCHARGE POINT NUMBER: D-001
(formerly OSN 001)
PLANT SIZE/TREATMENT TYPE:
☐-check if no discharge for reporting period

REPORT: Monthly
GROUP: Industrial
DMR Issued:

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. INT-1	Permit Requirement		Report Inst. Maximum	MGD						Hourly	Pump Logs
Discharge Temperature (Normal Operations)	Sample Measurement										
STORET No. 00011 1 Mon. Site No. EFF-2	Permit Requirement						113 Inst. Maximum	°F		Hourly	Recorders
Temperature Rise (Normal Operations)	Sample Measurement										
STORET No. 61576 1 Mon. Site No. EFF-2	Permit Requirement						30 Inst. Maximum	°F		Hourly	Recorders
Discharge Temperature (Maintenance Operations)	Sample Measurement										
STORET No. 00011 Q Mon. Site No. EFF-2	Permit Requirement						117 Inst. Maximum	°F		Hourly	Recorders
Temperature Rise (Maintenance Operations)	Sample Measurement										
STORET No. 61576 Q Mon. Site No. EFF-2	Permit Requirement						32 Inst. Maximum	°F		Hourly	Recorders

NOTE: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

Part A (Continued)

FACILITY NAME: St. Lucie – Units 1 & 2 PERMIT NUMBER: FI0002208 DISCHARGE POINT NUMBER: D-001

Parameter	[redacted]	Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Total Residual Oxidants	Sample Measurement										
STORET No. 34044 1 Mon. Site No. EFF-2	Permit Requirement						0.10 Inst. Maximum	mg/l		Continuous	Recorders
Time of Condenser Chlorine Addition (Unit 1)	Sample Measurement										
STORET No. 50068 R Mon. Site No. EFF-2	Permit Requirement						120 Inst. Maximum	minutes/ day/unit		Daily	Log
Time of Condenser Chlorine Addition (Unit 2)	Sample Measurement										
STORET No. 50068 S Mon. Site No. EFF-2	Permit Requirement						120 Inst. Maximum	minutes/ day/unit		Daily	Log
Free Available Oxidants (Unit 1)	Sample Measurement										
STORET No. 34045 R Mon. Site No. EFF-1	Permit Requirement					0.2 Average	0.5 Inst. Maximum	mg/l		1 / 2 Months	Multiple Grabs
Free Available Oxidants (Unit 2)	Sample Measurement										
STORET No. 34045 S Mon. Site No. EFF-1	Permit Requirement					0.2 Average	0.5 Inst. Maximum	mg/l		1 / 2 Months	Multiple Grabs

Note: If any line not required, enter "NODI = 9".

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Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. Area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME: Florida Power & Light
MAILING ADDRESS: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

FACILITY: St. Lucie Power Plant - Units 1 & 2
LOCATION: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

COUNTY: St. Lucie

PERMIT NUMBER: 0002208
MONITORING PERIOD From:____________ To:____________
LIMIT: Final
CLASS SIZE: Major
DISCHARGE POINT NUMBER: D-001
(formerly OSN 001)
PLANT SIZE/TREATMENT TYPE:
☐-check if no discharge for reporting period

REPORT: Toxicity
GROUP: Industrial
DMR Issued:

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Mysidopsis Bahia 96-hour acute static	Sample Measurement										
STORET No. TAN3E P Mon. Site No. EFF-2	Permit Requirement				100 Daily Minimum			Percent		Annual	Multiple Grab
Mysidopsis Bahia, 96-hour acute static	Sample Measurement										
STORET No. TAN3E Q Mon. Site No. EFF-2	Permit Requirement				100 Daily Minimum			Percent		As Required	Multiple Grab
Menidia Beryllina 96-hour acute static	Sample Measurement										
STORET No. TAN6B P Mon. Site. No. EFF-2	Permit Requirement				100 Daily Minimum			Percent		Annual	Multiple Grab
Menidia Beryllina 96-hour acute static	Sample Measurement										
STORET No. TAN6B Q Mon. Site. No. EFF-2	Permit Requirement				100 Daily Minimum			Percent		As Required	Multiple Grab

Note: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME: Florida Power & Light
MAILING ADDRESS: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

FACILITY: St. Lucie Power Plant - Units 1 & 2
LOCATION: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

COUNTY: St. Lucie

PERMIT NUMBER: 0002208
MONITORING PERIOD From:________________ To:________________
LIMIT: Final
CLASS SIZE: Major
DISCHARGE POINT NUMBER: I-003
(formerly OSN 003)
PLANT SIZE/TREATMENT TYPE:
☐-check if no discharge for reporting period

REPORT: Monthly
GROUP: Industrial
DMR Issued:

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. EFF-3	Permit Requirement	Report Average	Report Maximum	MGD						1/Batch	Calculation
Oil and Grease	Sample Measurement										
STORET No. 00556 1 Mon. Site No. EFF-3	Permit Requirement					15.0 Average	20..0 Maximum	mg/l		Annually	Grab
Total Suspended Solids	Sample Measurement										
STORET No. 00530 1 Mon. Site No. EFF-3	Permit Requirement					30.0 Average	100.0 Maximum	mg/l		1/Batch	Grab

Note: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME:	Florida Power & Light	PERMIT NUMBER: 0002208			
MAILING ADDRESS:	6501 S. Ocean Drive Jensen Beach, Florida 34957	MONITORING PERIOD From:________	To:________		
		LIMIT: Final	REPORT: Monthly		
		CLASS SIZE: Major	GROUP: Industrial		
FACILITY:	St. Lucie Power Plant - Units 1 & 2	DISCHARGE POINT NUMBER: I-005 (formerly OSN 005)	DMR Issued:		
LOCATION:	6501 S. Ocean Drive Jensen Beach, Florida 34957	PLANT SIZE/TREATMENT TYPE:			
COUNTY:	St. Lucie	☐-check if no discharge for reporting period			

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. EFF-5	Permit Requirement	Report Average	Report Maximum	MGD						1/Discharge[1]	Calculation
Oil and Grease	Sample Measurement										
STORET No. 00556 1 Mon. Site No. EFF-5	Permit Requirement					15.0 Average	20..0 Maximum	mg/l		1/Discharge[1]	Grab
Total Suspended Solids	Sample Measurement										
STORET No. 00530 1 Mon. Site No. EFF-5	Permit Requirement					30.0 Average	100.0 Maximum	mg/l		1/Discharge[1]	Grab

Note: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

[1] One per discharge event or one per week which ever is more frequent, unless there is no discharge for that week. Total volume of batch and period of discharge shall be reported.

DEP Form62-620.910(10), Effective November 29, 1994

Part A (Continued)

FACILITY NAME: St. Lucie – Units 1 & 2 PERMIT NUMBER: FI0002208 DISCHARGE POINT NUMBER: I-005

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Boron, Chemical Additive	Sample Measurement										
STORET No. 01020 1 Mon. Site No. EFF-2	Permit Requirement						4.0 Maximum	mg/l		1/Discharge[1,2]	Calculation[3]
Hydrazine, Chemical Additive	Sample Measurement										
STORET No. 81313 1 Mon. Site No. EFF-2	Permit Requirement						0.30 Maximum	mg/l		1/Discharge[1,2]	Calculation[3]
Dimethylamine, Chemical Additive	Sample Measurement										
STORET No. 77003 1 Mon. Site No. EFF-2	Permit Requirement						Report Maximum	mg/l		1/Discharge[1,2]	Calculation[3]
Carbohydrazide, Chemical Additive	Sample Measurement										
STORET No. 61916 1 Mon. Site No. EFF-2	Permit Requirement						Report Maximum	mg/l		1/Discharge[1,2]	Calculation[3]

Note: If any line not required, enter "NODI = 9".

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Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

[1] One per discharge event or one per week which ever is more frequent, unless there is no discharge for that week. Total volume of batch and period of discharge shall be reported.

[2] Boron and hydrazine or carbohydrazide shall be monitored once per batch by a grab sample, during wet lay-up discharges that result from the start-up of a unit following a refueling outage.

[3] A grab sample shall be taken at the discharge of the steam generator to the discharge canal and the following calculations shall be used to determine the concentration from the discharge canal to the Atlantic Ocean [point of discharge (POD)]:

$$\frac{\text{Steam Generator Blowdown Flow x Blowdown Boron Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Boron @ POD}$$

$$\frac{\text{Steam Generator Blowdown Flow x Blowdown Hydrazine Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Hydrazine @ POD}$$

$$\frac{\text{Steam Generator Blowdown Flow x Blowdown DimethylamineConcentration}}{\text{Once Through Cooling Water Flow}} = \text{Dimethylamine @ POD}$$

$$\frac{\text{Steam Generator Blowdown Flow x Blowdown Carbohydrazide Concentration}}{\text{Once Through Cooling Water Flow}} = \text{Carbohydrazide @ POD}$$

DEP Form62-620.910(10), Effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME: Florida Power & Light
MAILING ADDRESS: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

FACILITY: St. Lucie Power Plant - Units 1 & 2
LOCATION: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

COUNTY: St. Lucie

PERMIT NUMBER: 0002208
MONITORING PERIOD From:________________ To:________________
LIMIT: Final
CLASS SIZE: Major
DISCHARGE POINT NUMBER: I-06B
(formerly OSN 006B)
PLANT SIZE/TREATMENT TYPE:
☐-check if no discharge for reporting period

REPORT: Annual
GROUP: Industrial
DMR Issued:

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. EFF-6	Permit Requirement	Report Average	Report Maximum	MGD						Annually	Estimate
Oil and Grease	Sample Measurement										
STORET No. 00556 1 Mon. Site No. EFF-6	Permit Requirement					Report Average	Report Maximum	mg/l		Annually	Grab
Total Suspended Solids	Sample Measurement										
STORET No. 00530 1 Mon. Site No. EFF-6	Permit Requirement					Report Average	Report Maximum	mg/l		Annually	Grab

Note: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME:	Florida Power & Light	PERMIT NUMBER: 0002208	
MAILING ADDRESS:	6501 S. Ocean Drive Jensen Beach, Florida 34957	MONITORING PERIOD From:________ LIMIT: Final CLASS SIZE: Major	To:________ REPORT: Annual GROUP: Industrial
FACILITY:	St. Lucie Power Plant - Units 1 & 2	DISCHARGE POINT NUMBER: I-06C	DMR Issued:
LOCATION:	6501 S. Ocean Drive Jensen Beach, Florida 34957	(formerly OSN 006C) PLANT SIZE/TREATMENT TYPE:	
COUNTY:	St. Lucie	☐-check if no discharge for reporting period	

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. EFF-7	Permit Requirement	Report Average	Report Maximum	MGD						Annually	Estimate
Oil and Grease	Sample Measurement										
STORET No. 00556 1 Mon. Site No. EFF-7	Permit Requirement					Report Average	Report Maximum	mg/l		Annually	Grab

Note: If any line not required, enter "NODI = 9".

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

WHEN COMPLETED MAIL THIS REPORT TO: Department of Environmental Protection, 2600 Blair Stone Rd, Tallahassee FL 32399-2400

PERMITTEE NAME: Florida Power & Light
MAILING ADDRESS: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

FACILITY: St. Lucie Power Plant - Units 1 & 2
LOCATION: 6501 S. Ocean Drive
Jensen Beach, Florida 34957

COUNTY: St. Lucie

PERMIT NUMBER: 0002208
MONITORING PERIOD From:________________ To:________________
LIMIT: Final
CLASS SIZE: Major
DISCHARGE POINT NUMBER: I-008

REPORT: Annual
GROUP: Industrial
DMR Issued: :

PLANT SIZE/TREATMENT TYPE:
☐-check if no discharge for reporting period

Please read instructions before completing this form

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
		Avg.	Max.	Units	Min.	Avg.	Max.	Units			
Flow	Sample Measurement										
STORET No. 50050 1 Mon. Site No. EFF-8	Permit Requirement	Report Average	Report Maximum	MGD						1/Week	Calculation
Oil and Grease	Sample Measurement										
STORET No. 00556 1 Mon. Site No. EFF-8	Permit Requirement					15.0 Average	20..0 Maximum	mg/l		1/Week	Grab
Total Suspended Solids	Sample Measurement										
STORET No. 00530 1 Mon. Site No. EFF-8	Permit Requirement					30.0 Average	100.0 Maximum	mg/l		1/Week	Composite

Note: If any line not required, enter "NODI = 9".

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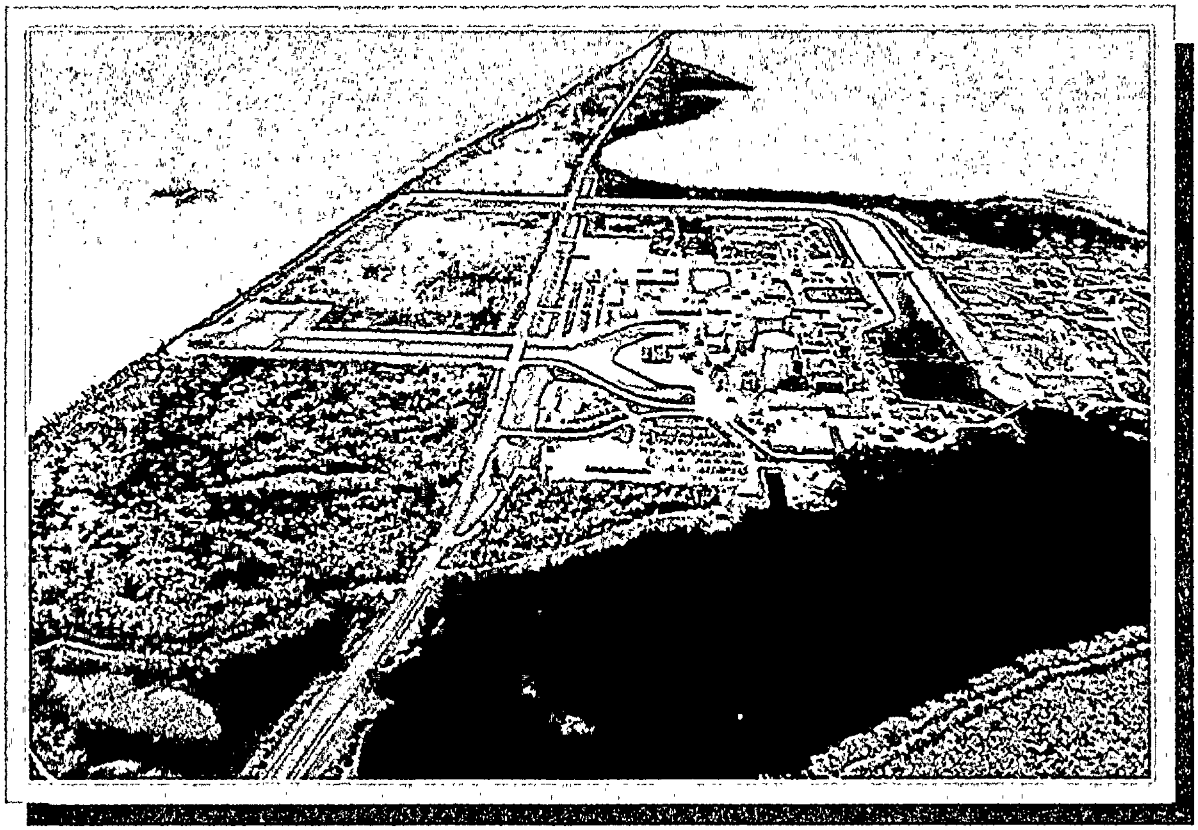
Name/Title of Principal Executive Officer or Authorized Agent (Type or Print)	Signature of Principal Executive officer Or Authorized Agent	Telephone No. (incl. area code)	Date (yy/mm/dd)

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

DEP Form62-620.910(10), Effective November 29, 1994

Physical and Ecological Factors Influencing Sea Turtle Entrainment Levels at the St. Lucie Nuclear Plant: 1976-1998



Prepared for: *Florida Power & Light Company*
St. Lucie Plant
6501 South Ocean Drive
Jensen Beach, Florida 34957

Prepared by: *Ecological Associates, Inc.*
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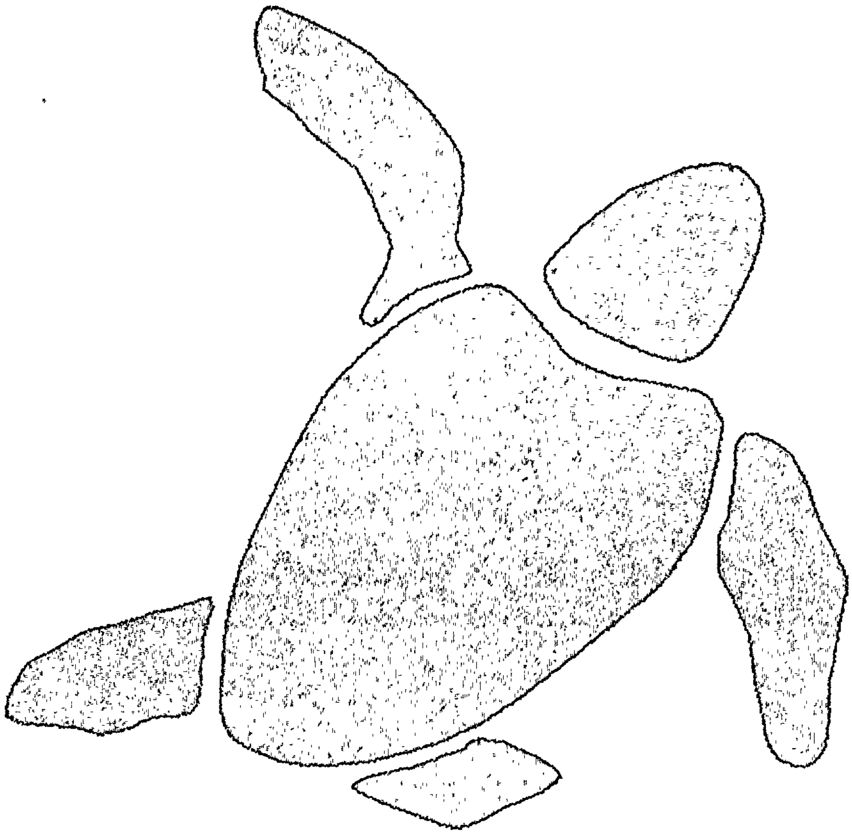
PHYSICAL AND ECOLOGICAL FACTORS INFLUENCING SEA TURTLE ENTRAINMENT AT THE ST. LUCIE NUCLEAR PLANT: 1976-1998



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EXECUTIVE SUMMARY

Florida Power & Light Company operates two nuclear power plants on Hutchinson Island, a barrier island in St. Lucie County, Florida. The adjacent marine environment provides foraging and developmental habitat for juvenile loggerhead and green sea turtles, and the adjacent beaches support high density nesting by adult loggerheads.

The St. Lucie Plant obtains its cooling water through a canal system connected to the Atlantic Ocean by underground pipes. Sea turtles, attracted to the offshore structures housing the intake pipes, are frequently entrained with cooling water. After passing through the large-diameter pipes turtles become entrapped in the intake canal. Since the plant began operating in 1976, an evolving program has been implemented to capture and safely return these turtles to the ocean.

Between 1976 and 1998, a total of 6,086 sea turtle captures were documented at the St. Lucie Plant. Although five species and all post-pelagic life history stages were represented, nearly 99 percent of the captures were comprised of loggerhead and green turtles, most of which (80 percent) were juveniles.

Over the life of the plant, the number of annual captures appeared to be rising, with unprecedented capture rates being documented beginning about 1993. As part of a Section 7 Consultation between the Nuclear Regulatory Commission and the National Marine Fisheries Service, FPL agreed to perform an analysis of sea turtle entrapment data to assess the extent to which changes in capture rates may be related to plant operating characteristics and/or extraneous environmental conditions. This report summarizes the findings of that study.

The offshore intake structures resemble a reef system in many aspects. They offer vertical relief in an area where the seafloor is relatively flat and provide suitable attachment sites for a variety of encrusting organisms and marine algae. They also provide unlimited and uncontested space for refuge. Both loggerhead and green turtles are known to utilize natural reefs for foraging and shelter, and loggerheads have been shown to associate with artificial structures. Additionally, nearby hard bottom and worm reefs support many of the same species known to be preferred food items in the diets of both species. These natural systems probably attract turtles to the vicinity of the structures.

The intake structures were designed so they would not entrain sea turtles and other motile marine life (nekton) into the structures from the surrounding environment. These animals must actively enter the structures before they encounter water velocities

sufficiently strong to affect their entrainment. Once within the intake pipes, velocities prevent most turtles from escaping.

Between 1977 and 1998, there were significant increases in the number of juvenile and adult loggerhead and juvenile green turtle captures at the St. Lucie Plant. Captures of adult loggerheads increased gradually and closely corresponded to increases in nesting on Hutchinson Island. Thus, as more adult turtles were present in the nearshore environment, more individuals of this life history stage were entrained with cooling water. A different pattern emerged with juvenile loggerhead and green turtles. Although the number of captures for both species increased significantly over the life of the plant, the changes were not linear. Nearly all of the increases occurred after 1992.

The addition of a second unit at the St. Lucie Plant in 1983, along with a new and larger intake structure, increased the volume of cooling water drawn from the ocean and altered intake velocities. Although the annualized number of captures prior to Unit 2 startup was less than the number after, the addition of a second unit could not account for the dramatic rise in capture rates during the 1990s. Analysis of data following Unit 2 startup indicated that the volume of water entrained each month was not significantly correlated with green turtle entrapment levels, but it did have a weak influence on the number of juvenile loggerhead turtles captured. However, this influence was temporally limited and could not explain the longer-term patterns that were documented. Repairs to the intake structures, completed in 1992, coincided with a substantial increase in the number of juvenile green turtles captured. However, this was probably more coincidental than causal.

Similar to results for plant operating conditions, water temperatures accounted for some of the seasonal variations in capture rates but could not explain long-term changes. Furthermore, seasonal variation in the numbers of juvenile loggerhead and green turtles captured at the plant may be more closely related to migration patterns than to local environmental conditions. There was no correlation between wind velocities (and by extension ocean turbulence) and either short- or long-term sea turtle capture rates. There were no data to discern whether there had been substantive changes in the composition or relative abundance of plants and animals fed upon by loggerhead and green sea turtles in the vicinity of the St. Lucie Plant. Consequently, it was not possible to correlate changes in entrainment rates with changes in biological conditions adjacent to the plant.

A variety of factors affect the entrainment of turtles at the St. Lucie Plant, some related and some unrelated to plant operating conditions. However, none of the factors evaluated during this study provided a convincing explanation for the dramatic increase in captures of juvenile loggerhead and green turtles observed at the plant since the mid 1990s. Increased nesting on Hutchinson Island by both loggerhead and green turtles and recent unprecedented increases in juvenile green turtle captures in other areas of south central Florida suggest that local sea turtle populations may be increasing. This seems to offer the most logical explanation for increased capture rates at the St. Lucie Plant.

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INTRODUCTION

Florida Power and Light Company (FPL) operates two nuclear power plants (St. Lucie Plant Units 1 and 2) on Hutchinson Island, Florida (Figure 1). Both plants draw cooling water from the nearshore waters of the Atlantic Ocean through submerged intake pipes. Water flows through the intake pipes into a canal system. In 1976, when the first of the two power plants began operation, it was discovered that sea turtles were being entrained into the intake canal with the cooling water. Once in the canal, water velocities in the intake pipes prevented turtles from returning to the ocean.

A sea turtle capture and release program was instituted in 1976 to remove entrapped turtles from the intake canal and release them safely back into the ocean. Data collected from 1976 through 1998 suggested that the number of sea turtles being entrained with cooling water had increased in recent years. In accordance with a Section 7 consultation under the U.S. Endangered Species Act of 1973, FPL was required to assess sea turtle capture trends at the St. Lucie Plant and to identify factors potentially responsible for recent increases. Ecological Associates, Inc. was contracted by FPL to perform that analysis.

OVERVIEW OF ST. LUCIE PLANT DESIGN AND OPERATION

Site Description

The St. Lucie Plant is located on a 437-hectare site on Hutchinson Island, a 36-km-long barrier island on Florida's East Cóast. The island is bounded by the Atlantic Ocean on the east, the Indian River Lagoon on the west, the Ft. Pierce Inlet on the north and the St. Lucie Inlet on the south. The plant is located approximately midway between the two inlets (Figure 1).

The shoreline in the vicinity of the power plant consists of sandy beach with intertidal worm reefs located just south of the intake (Figure 2). Submerged coquinoid rock formations parallel much of the island off the ocean beaches (Gallagher and Hollinger, 1977), though no substantial reef formations have been reported immediately offshore of the plant. The sea bottom adjacent to the power plant is reported to consist of a mixture of sand and shell fragments (Ebasco Servcies, Inc., 1971; Gallagher, 1977).

The continental shelf margin is located approximately 30 km offshore of Hutchinson Island. The Florida Current flows approximately parallel to the margin, but oceanic water associated with the western edge of the current periodically intrudes inshore during the summer (Worth and Hollinger, 1977; Smith, 1982). Seasonal variations in both the Florida Current and coastal winds are apparently responsible for

annually recurring upwelling along Florida's Atlantic coast (Smith, 1982). These upwelling events occur during the summer and result in anomalously low water temperatures. During such events, water temperatures near the power plant may rapidly decrease by as much as 10°C and remain cool for several days to several weeks (ABI, 1977, 1981, 1986, 1990, 1991, 1992; FPL, unpublished data). Ambient water temperatures of the Atlantic Ocean in the vicinity of the power plant range from approximately 14 to 31°C. Water temperatures are typically warmest in September and coolest in January or February.

St. Lucie Plant Description

The St. Lucie Plant consists of two 850 Mwe, nuclear-fueled, electric generating units that draw once-through condenser cooling water from the Atlantic Ocean (Figure 3). Unit 1 went online in May 1976 and Unit 2 went online in June 1983. Three intake structures (one with a 4.9 m diameter opening and two with 3.7 m diameter openings) are located 365 m offshore in approximately 7 m of water. The two smaller intake structures were completed in late-1975 and the larger structure was completed in mid-1983. The configurations of the intake structures are shown in Figures 4 and 5. Each intake structure consists of a large base with a vertical shaft in the center. Numerous columns support a concrete velocity cap approximately two meters above the base of each structure. This configuration was designed to eliminate vertical water entrainment and reduce horizontal intake velocities thereby minimizing incidental entrainment of marine life.

In August 1989, large holes were discovered in the intake structure velocity caps. These holes added a strong vertical component to water entrainment, creating vortices that reached the ocean's surface. In March 1991, a construction project was initiated to repair the damaged caps. A large elevated platform, from which all repairs were conducted, was erected around the three intake structures. The platform remained in place until repairs were completed in February 1992. Repairs resulted in thicker velocity caps and supporting columns with the vertical clearance between the base of the intake structure and the bottom of the velocity cap remaining the same (Figure 6).

Water moves from the vertical shaft of each intake structure to a horizontal intake pipe. Intake pipes pass under the beach and dune system and connect to a 1500 m long intake canal that transports water to the plant. During the history of plant operation several barrier nets have been installed along the intake canal. The locations of these nets are shown in Figure 3. In 1978, a barrier net with a 20.3 cm square mesh was installed across the canal at the Highway A1A bridge. This barrier was intended to keep large debris and sea turtles away from the power plant. Then in January of 1987, an underwater intrusion detection system (UIDS) was installed on the north-south arm of the canal. This security system consists of a 22.9 cm mesh rigid net. And finally, in January 1996, a barrier net with a square mesh of 12.7 cm was installed east of the A1A bridge. This net was intended to better confine turtles to the eastern portion of the intake canal where capture techniques are most effective.

At the power plants, cooling water is drawn from the bottom of the canal into eight separate intake wells (Figures 3 and 7). In the wells, the water first passes through a series of trash racks (vertical bars spaced approximately 7.6 cm apart) and then through a series of traveling screens with a one centimeter mesh. Finally, the water flows through the circulating water pumps and into the plant's condenser system. As the water moves through the plant's condenser system, it gains heat from the condenser and is expelled into the discharge canal.

The discharge canal is 670 m long and leads to two buried discharge pipes at it's eastern terminus (Figure 3). The pipes transport water beneath the beach dune system back into the Atlantic Ocean. One pipe is 3.7 m in diameter, extends approximately 460 m offshore and terminates in a two-port "Y" nozzle. Installation of this discharge pipe was completed in 1975. The other pipe is 4.9 m in diameter and extends 1030 m offshore. Water is discharged into the ocean through a series of 58 ports that rise above the ocean floor along the easternmost 425 m of the pipe. Installation of this structure was completed in 1981.

St. Lucie Plant Intake System Characteristics

From May 1976 through May 1983, St. Lucie Plant Unit 1 drew 32.56 m^3/sec (1150 ft^3/sec) of water through two 3.7-m-diameter intake pipes during normal plant operation. Water velocities at various locations along the intake system are given in the second row of Table 1. When the power plant was shut down for refueling and/or maintenance, the main circulating water pumps were shut down and auxiliary pumps were run. During these periods, velocities due to the auxiliary pumps were approximately three percent of those for periods of normal plant operation (pers. com., N. Whiting). Water velocities along the intake system during periods when only auxiliary pumps were operating are given in the first row of Table 1. Between 1976 and 1983, during periods of normal plant operation, velocities within the 3.7-m intake pipes were between 159 and 178 cm/sec (5.2 – 5.8 ft/sec). Once within the intake canal, water velocities slowed to about 15.2 cm/sec (0.5 ft/sec).

With the addition of Unit 2 and a third (4.9-m-diameter) intake pipe in June 1983, water velocities along the intake system during normal plant operation changed (see the fourth row of Table 1). Velocities within the 4.9-m-diameter intake pipe were greater than those occurring within the 3.7-m-diameter pipes prior to the addition of Unit 2. However, velocities within the 3.7-m-diameter intakes decrease after addition of the larger intake pipe. Between 1983 and 1998, during periods of normal plant operation, velocities within the smaller intake pipes ranged from 127 – 142 cm/sec (4.2 – 4.7 ft/sec) and in the large intake pipe from 180 – 206 cm/sec (5.9 – 6.8 ft/sec). The addition of the second unit doubled current velocities within the intake canal when both units were operational.

The addition of a second power plant also affected velocities along the intake system during maintenance/refueling periods. After June 1983, maintenance and refueling was scheduled such that one plant was always operating while the other was

shut down (with only auxiliary pumps running). So, flow velocities during maintenance/refueling periods were considerably higher after June 1983 than before when only auxiliary pumps were running (see the third row of table 1).

ST. LUCIE PLANT SEA TURTLE CAPTURE PROGRAM

Over the years, most of the turtles entrapped in the St. Lucie Plant were removed by means of large mesh tangle nets. Nets varied in length from 30 to 115 m, were 2.7 to 3.7 m in depth and were usually made of 40.6 cm stretch mesh, multi-strand nylon. Large floats were attached to the surface line and during the first several years the bottom line consisted of hollow braided polypropylene line with lead weights inserted every 61 cm. Since 1982, bottom lines were unweighted. Turtles entangled in the nets generally floated at the water's surface until removed.

Nets were fished at various locations throughout the intake canal, though most netting took place east of the A1A bridge (Figure 3). Throughout the study period, the canal capture program underwent continuous refinement to minimize both entrapment time and any harm to entrained turtles. Prior to April 1990, nets were usually deployed on Monday morning and retrieved Friday afternoon. During deployment, the nets were inspected a minimum of twice per day (once in the morning and again in the afternoon) by biologists. In addition, St. Lucie Plant personnel periodically checked the nets throughout the day and night. Biologists were on call 24 hours per day and were notified immediately if a turtle was observed in the net.

Beginning in April 1990, procedures were revised to decrease response time for removal of entangled turtles from nets and to increase surveillance of the canal for the presence of turtles. Under the new procedures, nets were deployed during daylight hours only (Monday through Friday; approximately eight hours per day) and biologists remained on site during deployment. While on site, biologists were able to assess turtle levels in the canal. Records of daily canal observations were compared with capture data to determine capture efficiencies. Beginning in July 1994, netting effort was increased to seven days per week and 10 to 12 hours per day.

In addition to procedural changes, there were physical changes in the canal that increased the efficiency of the capture program. The A1A barrier net, which was installed in 1978, was constructed to restrict turtles to the easternmost section of the intake canal where netting was most effective. For a number of years after it was installed, the integrity of the barrier net was periodically compromised and turtles were able to move west of A1A. Beginning in January 1987, turtles moving west of A1A were further constrained downstream by the UIDS. Prior to the completion of the UIDS, turtles that breached the A1A barrier net were usually not captured until they reached the power plant's intake wells. The intake wells were inspected throughout the day and night by St. Lucie Plant personnel, and biologists were notified immediately if turtles were observed. Turtles were removed from the intake wells by means of mechanical rakes, dip nets or by hand. Following construction of the UIDS, all but the smallest turtles were

restricted from the intake wells. After improvements were made in 1990, the A1A barrier net was effective in confining all turtles larger than 32.5 cm carapace length (28.7 cm carapace width) to the eastern end of the canal.

In response to a dramatic increase in intake canal captures in 1995, consultation was initiated with FPL, the Nuclear Regulatory Commission (NRC) and the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act. As a result of that consultation, FPL has designed and constructed a small mesh barrier net east of the A1A barrier net. Construction of the net was completed in January 1996. This net was designed to restrict all turtles with a carapace width greater than 18 cm to the extreme eastern portion of the intake canal. Because capture techniques were most efficient in this portion of the canal, residency times of entrained turtles were further reduced after the installation of this net.

Throughout the history of the canal capture program, the entire intake canal was periodically inspected to determine the numbers, locations and species of turtles present. The effort devoted to surveillance of the canal was increased in 1990, and then again in 1994, concurrent with revised netting procedures during those years. Also, surface observations were augmented with periodic underwater inspections, particularly in the vicinity of the barrier nets. These efforts insured that all turtles that were entrapped in the canal were accounted for.

In addition to tangle nets, several other methods were used to remove turtles from the intake canal. Captures at the intake wells were previously discussed. Another technique involved the use of long handled dip nets from boats, canal banks and headwall structures[1] to capture small turtles (carapace lengths of 30 cm or less). This method was moderately effective. Additionally, divers with snorkels or SCUBA entered the canal and hand-captured turtles. Because this latter technique proved to be highly effective in the capture of turtles of all sizes, it was used extensively from 1990 through 1998. This method was particularly effective in removing less active turtles and undoubtedly helped to reduce residency times for entrapped turtles. Between 1994 and 1998, 12 to 18 percent of the captures that occurred east of the A1A bridge were attributable to hand captures.

Regardless of capture method, all live turtles removed from the canal were identified to species, measured, weighed, tagged and examined for overall condition. Healthy turtles were released into the ocean the same day of capture. Sick or injured turtles were treated and, if necessary, held for observation prior to release. Dead turtles were identified to species, measured and assigned an identity number. Beginning in 1982, necropsies were conducted on dead turtles found in fresh condition.

From 1976 through 1998, 6,086 sea turtles were captured in the St. Lucie Plant intake canal (Table 2). Captures included 3,578 loggerhead turtles, 2,432 green turtles, 21 leatherback turtles, 21 hawksbill turtles and 34 Kemp's ridley turtles. Because the vast majority of the captures consisted of loggerhead (58.8 percent) and green (40.0 percent) turtles, this report will deal only with these two species.

[1] Bulkhead and pier-like structures located at the east end of the intake canal (Figure 3).

The earliest estimates of residency times for turtles in the intake canal were derived from data collected from October 1980 through January 1981 (ABI, 1983). Eleven loggerhead turtles were captured, tagged, released back into the canal and recaptured (ABI, 1983). Recapture occurred one to nine times before individual turtles were released back into the ocean. There were 32 recapture events: The average elapsed time between successive captures was 10.3 days (range: 0.25 to 38 days). Twenty-three of the recaptures (72 percent) occurred within 11 days.

The increased surveillance for turtles in the intake canal that began in April 1990 allowed individual turtles to be identified as they were observed in the canal. As turtles were captured, the date of initial observation was compared to the date of capture and residency times were determined. Data collected for 416 loggerhead turtles from April 1990 through December 1993 indicated that the average residency time was 2.7 days (range: 1 to 50 days; ABI, 1994). Ninety-three percent of these loggerheads were captured within one week of first sighting. Data for 252 green turtles collected during the same period indicated an average residency time of 3.8 days (range: 1 to 61 days). Eighty-six percent of these green turtles were captured within one week of first sighting.

Results of residency time analyses provided the basis for establishing time intervals to be used for analysis of trends in turtle entrainment at the St. Lucie Plant. In this report long-term trends in turtle entrainment are analyzed using annual data. Seasonal trends in entrainment and relationships between turtle entrainment and various environmental and power plant factors are analyzed using monthly data. The latter interval seemed appropriate based on average residency times (time lags between entrainment and capture) of three to ten days. It is recognized that not all turtles captured during a particular month were necessarily entrapped that month. However, overall seasonal trends should be fairly accurately portrayed using monthly data.

Prior to analyzing trends in loggerhead and green turtle captures at the St. Lucie Plant, an overview of pertinent biological characteristics of these two species is warranted. This will aid in interpreting the results of the St. Lucie Plant sea turtle capture program.

BIOLOGY OF LOGGERHEAD AND GREEN TURTLES

Loggerhead Turtles

The loggerhead turtle, *Caretta caretta*, inhabits temperate, subtropical and tropical waters of the Atlantic, Pacific, and Indian Oceans. Most nesting occurs on warm temperate and subtropical beaches (Dodd, 1988). Approximately 50,000 to 70,000 loggerhead turtle nests are deposited on Southeastern US beaches annually, ranking this loggerhead turtle rookery the second largest in the world (NMFS and USFWS, 1991a). The beaches in southeast Florida are especially prolific nesting areas, with Hutchinson Island being a critically important nesting beach (Meylan et al., 1995). Between 5,000

and 8,000 loggerhead nests have been deposited annually on Hutchinson Island during the last ten years (Quantum Resources, 1999).

Most nests on Hutchinson Island hatch within sixty days (Ernest and Martin, 1993; Ecological Associates, Inc., unpublished data). Hatchlings emerge from nests primarily at night. Upon entering the surf, the hatchling swims offshore in a "frenzy" to arrive at floating weed and debris lines (Carr, 1986; Salmon and Wyneken, 1994). Once there, loggerhead turtles feed on various insects, hydrozoans, gelatinous animals, barnacles and other material associated with floating mats of *Sargassum* (Richardson and McGillivary, 1991; Witherington, 1994). Post-hatchling loggerhead turtles from the Florida coast enter the currents of the North Atlantic Gyre that encircles the Sargasso Sea and move toward the eastern Atlantic. They may use magnetic cues to keep them from getting off course and floating into waters too cold for survival (Lohmann and Lohmann, 1996). Bolten et al. (1998) conducted a study of mitochondrial DNA from 131 pelagic juvenile loggerheads captured off the Azores and Madeira in the eastern Atlantic. One hundred and twenty-one of the turtles had known nesting beach haplotypes, and of those, approximately 71 percent were from south Florida, 19 percent from north Florida to North Carolina, and 11 percent from Mexico. The curved carapace length of the turtles from the Azores was 9-71 cm, and for the Madeira turtles 20 to 55 cm. From the eastern Atlantic, some pelagic turtles may enter the Mediterranean Sea, but many drift back around to the shallow coastal waters of the western Atlantic (Bowen et al., 1993; Laurent et al., 1998).

When loggerhead turtles reach the size of approximately 40-60cm straight carapace length (SCL), they leave the pelagic environment and move into various inshore estuaries or reef-system habitats (Carr et al., 1978; Carr, 1986). Most western Atlantic loggerheads are estimated to arrive in coastal waters after five to twelve years of a pelagic existence (National Research Council, 1990; Bjorndal and Bolten, 1994). The nearshore regions where juvenile and subadult loggerheads live and forage have been termed developmental habitats. They may reside in these developmental habitats either seasonally or year round until they reach sexual maturity (Carr et al., 1978). This is estimated to occur between 22 to 26 years of age (Frazer and Ehrhart, 1985; Klinger and Musick, 1995). Few mature adults are found in developmental habitats along the east coast of Florida except during mating or nesting season (National Research Council, 1990).

In the United States, developmental habitats for loggerhead turtles are found from Texas to Nova Scotia (Carr, 1952; Turtle Expert Working Group, 1998). Aerial surveys conducted in summer months indicated that 54 percent of the post-pelagic loggerheads in US coastal waters were found off the southeast coast; 29 percent were off the northeast coast; 12 percent were in the eastern Gulf of Mexico; and 5 percent were in the western Gulf of Mexico (Turtle Expert Working Group, 1998).

While immature loggerhead turtles are found in south Florida waters year round, their occurrence in northern estuaries and bays is seasonal. Generally, the northern habitats are only occupied during the late spring, summer, and early fall (Lutcavage and

Musick, 1985; Keinath et al., 1987; Morreale et al., 1992; Epperly et al., 1995). Over 90 percent of the loggerhead turtles that migrate seasonally to northern waters are sexually immature (Rankin-Baransky, 1997; Coles, 1999).

Coles (1999) reported that loggerhead turtles in the Chesapeake Bay have been found in areas with water temperatures ranging from 13 to 29°C. Most juvenile sea turtles enter the bay in the late spring as temperatures approach 20°C, and they leave in the fall after temperatures fall below 20°C. Many of the turtles entering the bay have migrated from areas south of Cape Hatteras. When they arrive, water temperatures in the bay are still rather cool, and thus the turtles spend proportionately more time near the surface and in deeper areas where temperatures are warmest (19-21°C). This behavior keeps the turtles away from their benthic food supply and exposes them to hazards such as boat collisions. Already weakened from their recent migration, these turtles are also less likely to avoid or survive incidental capture in pound nets and other types of fishing gear (Byles, 1988). Consequently, most dead, ill and injured marine turtles are found in the Chesapeake Bay during the spring (usually May). Loggerhead stranding numbers decrease as bottom temperatures heat up (Keinath et al., 1987; Epperly et al., 1995; Coles, 1999). Klinger and Musick (1995) estimated the age of most loggerheads foraging in the Chesapeake Bay to be between six and ten years old.

Often in the fall, temperatures in the shallower bays along the Atlantic seaboard will drop rapidly before some turtles have migrated south. When water temperatures fall below 8°C, the turtles become hypothermic and float to the surface where many die. This is termed a cold-stunning event. Cold-stunning events have been documented from Cape Cod to the Mosquito Lagoon in the northern region of the Indian River Lagoon system (Witherington and Ehrhart, 1989a; Morreale et al., 1992). Witherington and Ehrhart (1989a) pointed out that these events often occur in estuaries where the outlet to deeper, warmer waters lies to the north – a path opposite to the one that a turtle would instinctively follow to reach warmer waters. Cold-stunning events have also been reported in the Laguna Madre of Texas (Shaver, 1990).

Turtles survive the cold winters in Florida waters by residing in the warmer regions or currents, or by burying themselves into the muddy substrate of deep channels (Ogren and McVea, 1982). Loggerhead turtles are often found buried in the muddy substrates of the Cape Canaveral Ship Channel during the winter. Most of these individuals are subadults or juveniles.

Surveys conducted by trawling vessels in the vicinity of Cape Canaveral, Florida captured immature loggerhead turtles throughout the year, but the majority were caught during the winter months (Henwood, 1987; Bolten et al., 1994). In the central Indian River Lagoon, Ehrhart et al. (1996, 1999) also captured immature loggerhead turtles in tangle nets throughout the year. However, unlike the Canaveral Ship Channel, no seasonal trends in catch per unit effort (CPUE) were apparent.

Since 1989, netting has been conducted on the sabellariid worm reefs just south of Sebastian Inlet, Florida by Ehrhart et al. (1996, 1999). Surprisingly, few loggerhead

turtles have been captured on the reef. Ehrhart et al. (1996) found the paucity of loggerheads over the reefs somewhat perplexing in light of the large number of loggerheads occurring in similar habitat near the St. Lucie Plant. However, Ehrhart et al.'s study site was in water depths of less than 3.5 meters and within 150 meters of shore compared to the St. Lucie Plant intake that is in a water depth of approximately 7 meters and is 365 meters from shore. Additionally, netting on the worm reefs was only performed during the summer months.

Nocturnal SCUBA surveys were conducted from 1986 through 1990 on nearshore hardbottom habitat in Broward County. Turtles encountered by divers were captured by hand. During the period of study, only one loggerhead turtle was captured, compared to 134 juvenile green turtles and 5 juvenile hawksbill turtles (Wershoven and Wershoven, 1990). The loggerhead was captured in the most seaward section of one of the study sites.

Genetic studies performed on immature loggerheads entrapped in the St. Lucie Power Plant intake canal indicate that 70 percent were from South Florida nesting populations, 20 percent from Yucatan nesting populations, and 10 percent were from northern Florida to North Carolina nesting populations (Bass, 1999). The results were similar to a mitochondrial DNA (mtDNA) study of stranded turtles from the northeastern US coast, where 58 percent of the loggerheads originated from south Florida nesting stock, 25 percent were from the north Florida to North Carolina stock, and 17 percent were from Mexico (Rankin-Baransky, 1997). Genetic research has also been done on loggerheads from the Chesapeake Bay, Charleston Harbor, and Kings Bay, Georgia. The genetic origin of these populations seems to be split between north Florida/North Carolina stock and South Florida stock (Sears, 1994; Norrgard, 1995; Sears et al., 1995).

Radioimmunoassay (RIA) analysis of testosterone titer levels on blood serum has allowed researchers to determine the sex of immature sea turtles. The pooled sex ratio of immature loggerhead turtles (40-76 cm SCL) captured at the St. Lucie Plant was 2.1 females for each male (n=218; Wibbels et al., 1991). The sex ratios did not vary by season, or by size class, suggesting that the female bias may be a temporally stable phenomenon, at least within the juvenile stage of the life history. These data are consistent with a previous study done by Wibbels et al. (1984) on immature loggerheads from four locations along the Atlantic Coast of the U. S. in which the ratio of females to males was 1.94:1.0 (female:male). Ehrhart et al. (1999) reported that the juvenile loggerhead population in the Indian River Lagoon also had a female bias (1.6:1.0).

Most of the juvenile loggerhead turtles captured in the Indian River Lagoon and other places along the Atlantic seaboard fall within the size range of 50 to 70 cm straight minimum carapace length (SMCL; Lutcavage and Musick, 1985; Standora et al., 1994; Epperly et al., 1995; Provancha, 1997, 1998; Coles, 1999; Ehrhart et al., 1999). The mean straight carapace length (SCL) for the turtles netted in the central Indian River Lagoon was 62.6 cm (range = 42 – 83 cm; Ehrhart et al., 1999). In the waters around the coast of North Carolina, the mean standard curved carapace length of loggerhead turtles was 66 cm (range = 42 to 105 cm; Epperly et al., 1995). Lutcavage and Musick (1985)

reported SCL means of 68.7 cm for the loggerhead turtles occupying the Chesapeake Bay. Mean SCL for stranded, mainly cold stunned, turtles north of Virginia have been reported to range from 48.2 to 54 cm (Morreale et al., 1992; Rankin-Baransky, 1997). These smaller means may result from the greater physiological susceptibility of younger turtles to hypothermia (Witherington and Ehrhart, 1989a; Morreale et al., 1992).

Loggerhead turtles live in the Florida nearshore waters and lagoons until they approach the size of the smallest females nesting on nearby beaches (Ehrhart et al., 1999). It is not known what cues prompt a subadult to leave developmental habitat or at what time of year departure occurs. However, the average size of loggerhead turtles captured in Florida Bay is 80.1 cm SCL (with a range of 48.9 to 98.7 cm). These turtles appear to comprise an intermediate size class that is nearing maturation (Schroeder et al., 1998). Thus, the larger juvenile loggerhead turtles leaving developmental habitats along the eastern U.S. seaboard may reside in Florida Bay for a period before moving on to join the adult population on distant feeding grounds.

While occupying inshore, developmental habitats, juvenile loggerhead turtles primarily feed on decapod crustaceans, mollusks, and fish (Lutcavage and Musick, 1985). They tend to be opportunistic, often exploiting regionally abundant prey items. The preferred food for loggerheads along the mid-Atlantic coast of the United States is reported to be the horseshoe crab, *Limulus polyphemus* (Keinath et al., 1987; Dodd, 1988; Sauls and Thompson, 1988). On the south Texas coast, Plotkin et al. (1993) reported that sea pens (*Virgularia presbytes*; a soft coral) were a major component of the loggerhead diet. Crabs and mollusks were also present in high quantities within loggerhead diet samples from Texas, along with tube worms, sea pansies, whip corals, and sea anemones.

Carr (1952) wrote that loggerhead dietary items consisted of crabs, shellfish (like clams, oysters and conchs), fish, sponges, jellyfish, and sometimes algae. A loggerhead dietary study conducted in the bays around Long Island, New York, concurred with Carr's food list. Burke et al. (1993) found that approximately 90 percent of the juvenile loggerhead turtles they sampled had consumed crabs (spider crabs *Libinia emarginata*, Atlantic rock crab *Cancer irroratus*, and the lady crab *Ovalipes ocellatus*). These loggerheads had also eaten mussels, whelks, and algae (*Sargassum natans*, *Ulva* sp., and *Fucus* sp.). Similar dietary items were reported for turtles stranded off the coast of Virginia by Bellmund et al. (1987) and off of Georgia by Ruckdeschel and Shoop (1988). A comprehensive list of reported food items of the loggerhead turtle is provided by Dodd (1988).

Adult loggerhead turtles nest mainly in the continental United States from North Carolina to the Florida panhandle, with about 90 percent of the nests being deposited on southern Florida beaches (National Research Council, 1990). The average female loggerhead makes reproductive migrations between her foraging grounds and nesting beach every two or three years and deposits about four clutches of eggs during those years that she nests (Richardson and Richardson, 1982; Murphy and Hopkins, 1984).

In the southeastern United States, the first nests begin to appear in late April and the last usually in September. The months of highest loggerhead turtle nesting are in June and July (NMFS and USFWS, 1991a; Meylan et al., 1995; Ernest and Martin, 1999). The mating season begins in early March, prior to the start of nesting season. Mating activity subsides in mid-June, when it is assumed that most males return to their foraging grounds. Stranding reports coincide with the above mentioned seasonal trends. Most of the adult male loggerhead strandings along the Atlantic seaboard occur just prior to and during the beginning of the nesting season (Turtle Expert Working Group, 1998). Far fewer adult loggerhead strandings (especially male) occur outside of the nesting season. Aerial surveys of turtles in coastal waters of Florida are consistent with the stranding data. The fly-over observations have found highest concentrations of adult loggerheads off the coast of primary nesting beaches during spring and summer, with numbers dramatically dropping off in the fall and winter. The numbers of sighted adults are about 15 times higher in the spring and summer than in the fall and winter (Thompson, 1988; National Research Council, 1990). However, some adult loggerhead turtles are found in Florida waters throughout the year.

Surveys conducted by trawling vessels in the vicinity of the Cape Canaveral Ship Channel between 1978 and 1984 resulted in the capture of over 3,000 individuals (Henwood, 1987). Each age class was dominant at different times of year. Adult males were most abundant in April and May. Adult females were most common from May to July, and juvenile and subadults (<83 cm SCL) constituted over 80 percent of the population during the remainder of the year. Adult females did not seem to stay in the area except while nesting. These seasonal patterns were also documented in a later study by Bolten et al. (1994) in Port Canaveral.

Loggerhead turtles that nest on Hutchinson Island are part of a larger, genetically distinct south Florida nesting population (Bowen et al., 1993). The turtles differ genetically from those turtles that nest in north Florida to North Carolina as well as those found in the Mediterranean. This indicates that there is little to no gene flow between rookeries, supporting the predictions of a natal beach homing hypothesis. This hypothesis contends that hatchlings leaving a particular nesting beach will return to that beach to nest as adults. Thus, from a management standpoint, each subpopulation should be treated as unique and vulnerable to extirpation (Turtle Expert Working Group, 1998).

The adult loggerhead foraging grounds for the south Florida nesting population are thought to be in the Bahamas, Cuba, Dominican Republic, eastern seaboard of the United States, Florida Keys, and the Gulf of Mexico (Meylan et al., 1983; Henwood, 1987; Spotila et al., 1997; Rankin-Baransky, 1997). The habitats used as adult foraging grounds are very diverse, ranging from the muddy bayous of the northern Gulf Coast to continental shelves to the clear, shallow waters of the Bahamas (National Research Council, 1990).

In the southeastern United States, adult loggerheads have a mean SCL of 92 cm and a mean body weight of 113 kg. They rarely exceed 122 cm in length (National Research Council, 1990).

The size used to classify individuals as mature adults is somewhat arbitrary, as loggerhead turtles reach maturity at variable sizes. The adult size range is primarily based on the size of females measured on various nesting beaches. Limpus (1991) reported that the average female begins to breed at a size only slightly smaller than the average size of the entire nesting population.

Ernest et al. (1989) used 85 cm SMCL as a breakpoint separating adults from subadults captured at the St. Lucie Plant. Ehrhart et al. (1996) used 83 cm SCL as the cut off point between subadult and adult females based on the range of measurements from 1,207 females nesting on Brevard County beaches; only four percent of nesting turtles in Brevard County were less than 83 cm. Henwood (1987) used the measurement of 83 cm total (or maximum) carapace length (which equates to 81.5 cm SCL) to delineate between subadults and adults in his trawling study at Cape Canaveral.

Adult loggerhead turtles seem to eat the same general prey as juveniles and subadults. However, more dietary research is needed from various adult foraging grounds. Adults are known to eat horseshoe crabs, decapod and cirriped crustaceans, gastropod and pelecypod mollusks, cnidarians, echinoderms, fish, and algae (Lutcavage and Musick, 1985; Dodd, 1988).

Green Turtles

Green turtles are found in tropical seas throughout the world (Hirth, 1997). Off the east coast of the continental United States, green turtles can be found from Texas to Massachusetts, although nesting only occurs on Florida beaches. The number of nests deposited in Florida is relatively small compared to Costa Rica, Aves Island, Ascension Island, and Surinam. However, many juvenile green turtles utilize shallow U.S. coastal waters and bays as developmental habitat (NMFS & USFWS, 1991b).

Similar to the loggerhead turtle, green turtle hatchlings actively swim offshore to oceanic convergence zones after leaving the beach. Pelagic hatchlings from Florida nests are suspected to enter the North Atlantic Gyre system and eventually make their way back to western Atlantic coastal waters (Witham, 1980). During the pelagic phase, green turtles are presumed to be carnivorous, feeding on small animals like ctenophores and tunicates in the plankton (Booth and Peters, 1972; Bustard, 1976; Hirth, 1997). However, further research is needed on this aspect of their biology. Differences in intestinal length proportions between post-hatchlings and adults, suggest a developmental shift from a predominantly carnivorous to a primarily herbivorous diet (Davenport et al., 1989).

When green turtles reach a size of about 20-25 cm SCL, they leave the pelagic habitat and enter benthic feeding grounds (National Research Council, 1990). The juvenile feeding grounds are usually in warm, shallow, protected waters where benthic vegetation is prevalent (Carr et al., 1978). Foraging habitats most commonly consist of sandy bottoms supporting seagrass or algal beds, but small green turtles are also found on coral reefs, sabellariid worm reefs, or rocky substrate where attached algae is present. Some feeding grounds support only a particular size class of green turtles, while other

feeding areas support a full range of sizes from juveniles to breeding adults (National Research Council, 1990; Wershoven and Wershoven, 1990; Coyne, 1994; Redfoot et al., 1996; Ehrhart et al., 1996).

Many juvenile green turtles use the southeast coast of Florida year-round as developmental habitat. Both inshore lagoons and nearshore sabellariid reefs are considered prime developmental habitat (Ehrhart et al, 1996). Large reefs constructed by polychaete worms of the Family Sabellariidae have been reported from Brevard through Dade County, Florida (Kirtley, 1966). These worm reefs run roughly parallel to the shore and are the primary basis for an elaborate marine community of encrusting, boring and shelter-seeking animals as well as abundant marine flora (Kirtley and Tanner, 1968).

Green turtles appear in coastal developmental habitats at a much smaller size class than loggerhead turtles (Musick and Limpus, 1997). Zug and Glor (1998) used skeletochronology to age juvenile green turtles that died from a cold stunning event in the Mosquito and Northern Indian River Lagoon. The juveniles ranged in size from 28 to 74 cm SCL, and the age estimates for these individuals were 3 to 14 years old. Zug and Glor estimated that most of the juveniles were recruited to the developmental habitat at about 5 or 6 years of age, and would stay in this or other developmental habitats for 6 to 8 years. The individuals would thus leave between the ages of 10 to 14 years old. Mean growth rate estimates were 3.0-5.2 cm per year.

Sabellariid worm reefs are a prime developmental habitat for green turtles in south Florida. The reefs, which can extend from the intertidal zone out to a depth of ten meters, are found along the Atlantic shoreline from Cape Canaveral to Biscayne Bay, Florida. The reefs generally run parallel to the shoreline, and juvenile green turtles feed on the many species of red and green benthic marine algae present on the reef (Ehrhart et al., 1996).

In 1989, Ehrhart et al. (1996) began conducting netting during the summer over a sabellariid worm reef near Sebastian Inlet, Florida. More juvenile green turtles were caught per unit effort (CPUE) on the reef than at a site in the Indian River Lagoon south of the inlet. These data suggests that there may be a higher number of turtles inhabiting the reef than the lagoon, at least during the summer. Alternatively, capture rates on the reef may be higher, because the foraging area is more concentrated over the reef and therefore capture techniques are more effective. The turtles on the reef were similar in size and weight to those captured in the lagoon. Much of the algae consumed by the turtles grows in both locations. However, the juveniles rarely seem to migrate between the two habitats even though an inlet is nearby (Ehrhart et al., 1996, 1999; D. Bagley, unpublished data).

Inside the central Indian River Lagoon, more juvenile green turtles were captured in the winter than in the summer (Ehrhart et al., 1996, 1999). Ehrhart et al. (1996) hypothesized that seasonal increases in drift algae within the lagoon and migrants from northern climates may be responsible for the increased capture frequency during the cooler months.

North of Florida, green turtles are found in smaller numbers than juvenile loggerhead turtles, but there is evidence that many do migrate seasonally as far north as Cape Cod Bay (Lazell, 1980; Henwood, 1987; Morreale et al., 1992; Epperly et al., 1995; Provancha et al., 1998). Like the loggerhead turtle, their migrations seem to be water temperature dependent, and they are quite susceptible to cold water stunning events (Morreale et al., 1992; Coyne, 1994; Epperly et al., 1995).

In Florida, major cold stunning events have been documented as far south as the northern Indian River Lagoon system (Mendonca and Ehrhart, 1982; Witherington and Ehrhart, 1989a; Schroeder et al., 1990). Over 90 percent of the turtles affected by these events were juvenile green turtles; the remaining 10 percent were loggerhead turtles. The body size and physiology of juvenile green turtles may make them more susceptible to hypothermia than loggerhead turtles. The relatively large number of individuals involved in cold-stunning events demonstrates the importance of the Indian River Lagoon as a developmental habitat for green turtles (Witherington and Ehrhart, 1989a).

In a study conducted in the Mosquito Lagoon, Mendonca (1983) noted that green turtles occupied deeper water, would not eat, and took to wandering long distances when water temperatures were between 11 and 18°C, suggesting that they were looking for warmer waters. In Texas, Coyne (1994) reported that green turtles left the study area or became inactive when water temperatures fell below 16°C. Conversely, green turtles also are known to actively thermoregulate when water temperatures get too warm. Both Coyne (1994) and Mendonca (1983) noticed increased activities in the warmer months of the year. When temperatures rose above 32°C the turtles moved to deeper and cooler water (Mendonca, 1983). During hot summer days, turtles often fed in the early morning and late afternoon, when waters temperatures were coolest, and moved into deeper waters to rest during the midday hours (Bjorndal, 1980; Mendonca, 1983).

Bass and Witzell (in press) compared the mtDNA of 62 juvenile green turtles captured at the St. Lucie Power Plant and reported that approximately 42 percent of the turtles originated from Florida or Mexico nesting populations. About 53 percent came from rookeries in Costa Rica, and 4 percent were from Aves Island (Venezuela) and Surinam. The juvenile green turtles residing in developmental habitats in the nearby Bahamas were also tested and found to be primarily (80 percent) from Costa Rican nesting populations. Individuals representing Aves Island and Surinam (14 percent), United States and Mexico (5 percent), and Ascension Island and Guinea Bissau (1 percent) populations were represented as well (Bass and Witzell, in press). These results indicate that the juvenile green turtles utilizing a particular developmental habitat are not of homogenous origin. As for loggerheads, molecular studies support the hypothesis of natal beach homing in green turtles (Bowen et al., 1992).

The sex ratio of juvenile green turtles captured on sabellariid worm reefs and in the central Indian River Lagoon was studied by Ehrhart et al. (1999). Similar to the loggerhead, the green turtle sex ratio was strongly female biased at 2.9:1.0 (female:male). Redfoot et al. (1996) also measured testosterone levels on small green turtles occupying the Trident submarine basin at Cape Canaveral and found the sex ratio to be highly

skewed toward females (10.9:1.0). In the Mosquito Lagoon, the sex ratio of cold stunned green turtles was 1.75:1.0 (Schroeder and Owens, 1994). Only fourteen juvenile green turtles captured in the St. Lucie Plant intake canal have been sexed through blood work. Twelve were females, and two were males, resulting in a 6.0:1.0 ratio (ABI, 1994).

The average size of green turtles netted in the Indian River Lagoon and on the sabellariid worm reef near Sebastian Inlet were 40.7 cm SCL (range = 24 to 72 cm) and 41.1 cm (range = 25 to 67 cm), respectively (Ehrhart et al., 1996). Hand caught green turtles on reefs in Broward County, Florida were similar in size at 43.5 cm mean curved carapace length (CCL; range = 27 to 60 cm; Wershoven and Wershoven, 1990). The mean length of green turtles captured in Florida Bay was recently reported as 46.2 cm SCL (range = 26 to 63 cm; Schroeder et al., 1998). Slightly larger (mean = 52.3 cm SCL; range = 27 to77 cm) turtles were retrieved from the Mosquito Lagoon (northern Indian River Lagoon system) in the cold-stunning event of 1989 (Schroeder et al., 1990). Green turtles netted in the Indian River Lagoon near the Fort Pierce Inlet were of similar size at 53.1cm mean SCL (range = 37 to 75 cm; Bresette et al., 1999). Turtles netted in the Trident Submarine Basin were somewhat smaller averaging about 32.9 cm SCL (range 23 to 48 cm; Redfoot et al., 1996). This was similar to the average size of green turtles (33.8 cm TSCL; range 24 to 68 cm) captured by trawling in the Port Canaveral ship channel (Henwood and Ogren, 1987).

Differences in mean size among study areas may reflect the quantity and quality of food resources available in the habitat. There are some habitats that cannot sustain large individuals because of inadequate food availability (Coyne, 1994; Redfoot et al., 1996). Size class distributions may also be affected by capture methods (Ehrhart et al., 1996). Netting, for example, may undersample very small or large size classes because of mesh size limitations. Net placement at different depths and locations may also influence capture statistics (Ehrhart et al., 1999). Cold stunning may be a very efficient method of sampling turtles. However, as mentioned before, some size groups may be more physiologically susceptible to cooler temperatures than others (Witherington and Ehrhart, 1989a; Morreale et al., 1992).

An extensive list of juvenile and adult green turtle food items from around the globe can be found in Hirth (1997). In many habitats, green turtles are known to exhibit dietary preferences for either algae or seagrass. There are a few places that have populations of turtles that forage primarily on seagrasses within a few kilometers of those that feed primarily on algae (Bjorndal, 1980; Mortimer, 1981a; Coyne, 1994).

Mendonca (1983) found that *Syringodium filiforme* (manatee grass) *and Halodule wrightii* (shoal grass) were the primary food items in the stomachs of juvenile green turtles in the Mosquito Lagoon. These two species of seagrass were also the dominant rooted macrophytes in the lagoon. Although red alga was also abundant, it made up only a small percentage (about 8 percent) of stomach contents. Bjorndal (1980) suggested that switching between a diet high in seagrass to a diet high in algae, or eating both simultaneously, may lead to digestive inefficiency as different fermentative gut microflora are needed to adequately digest each.

The Trident submarine basin at Port Canaveral is about 40km south of the Mosquito Lagoon. Redfoot et al. (1996) studied the diets of juvenile green turtles that inhabited the rock-lined basin. All captured turtles were small (mean = 32.9 SCL), and most of the turtles (58 out of 67) had only algae in their stomachs. Algae and jellyfish were found in 5 of the 67 stomach samples, one sample contained algae and unidentified animal tissue, two samples contained only jellyfish, and one contained only fish. The algae consumed by the turtles were the same species that grew on the rocks in the basin. The researchers suggested that the absence of larger juvenile green turtles (>50cm) was due to limited biomass of the algae growing on the rocks.

In the central portion of the Indian River Lagoon, Ehrhart et al. (1996) found that green turtles were feeding almost exclusively on drift algae instead of nearby seagrasses. The drift algae were comprised of *Gracilaria* spp., *Acanthophora spicifera*, *Bryothamnion seaforthii*, *Hypnea* spp., and *Solieria filiformis*. Ehrhart et al. (1996) also captured turtles on sabellariid worm reefs in the ocean south of Sebastian Inlet. The reefs supported a diverse flora of green, brown, and red algae upon which the turtles foraged. The algae species *Caulerpa prolifera, Ulva lactuca, Bryocladia cuspida, Bryothamnion seaforthii, Gelidium americana, Gigartina acicularis, Hypnea musciformis, Rhodymenia pseudopalmata*, and *Solieria filiformis* were documented on the reef.

In the waters around South Padre Island, Texas, Coyne (1994) studied two populations of juvenile green turtles. The smaller sized turtles (<40 cm SCL) resided near and fed on the algae growing on the large boulders along Brazos Santiago Pass. The larger turtles (>30 cm SCL) were found over the grassbeds of South Bay/Mexiquita Flats. The turtles living near the grassbeds generally fed on *Halodule wrightii*, which was one of the less abundant seagrass species present, indicating that they were selective feeders. Coyne suggested that the algal biomass contained on the boulders in the pass was insufficient to sustain the larger turtles. The study did not determine if the smaller, algae-eating turtles were moving to the grassbeds after leaving the rocky Brazos Santiago Pass.

As noted earlier, green turtles end their pelagic existence and enter shallow coastal waters at an smaller size than loggerhead juveniles. They also leave their developmental habitat at an earlier stage. Unlike loggerhead turtles, green turtles leaving continental US waters are still far from sexual maturity. This is apparent from size range distributions along the coast. The size of most juveniles captured in Florida is between 20 and 65 cm SMCL, while the size of the smallest nesting females on nearby beaches is 83.2 cm SCL (Witherington et al., 1989b).

It has been estimated that juvenile green turtles leave their developmental habitat when they are between 10 and 14 years of age (Zug and Glor, 1998). Estimated age at sexual maturity in Atlantic green turtle populations ranges from 19 to 33 years (Mendonca, 1983; Frazer and Ehrhart, 1985; Frazer and Ladner, 1986; Ehrhardt and Witham, 1992). Thus, there is a period of several years before the juveniles leaving Florida's developmental habitats become part of the adult nesting population. The location and types of habitat supporting subadult green turtles is largely unknown. The Caribbean is one possibility. For example, Ehrhart et al. (1996) had eight remote tag

recoveries from green turtles tagged and released in the central Indian River Lagoon. Four of the tags were recovered from Nicaragua, three were from Cuba and one was from Belize. Nicaragua is known to be a prime subadult and adult foraging ground for green turtles that nest in Costa Rica (Mortimer, 1981a). Thus, many of the green turtles that spend their juvenile days on the east coast of Florida may eventually migrate to the Caribbean to spend the subadult phase of their lives.

Adult green turtles occur relatively infrequently in continental United States coastal waters and nest in relatively low numbers along the Florida coast although the numbers appear to be increasing (Dodd, 1981; NMFS and USFWS, 1991b; Meylan et al., 1995). Green turtle nests have been deposited in Florida from Nassau to Okaloosa Counties, but most are deposited in Brevard, Martin, and Palm Beach Counties.

Witherington and Ehrhart (1989b) measured nesting green turtles on Atlantic beaches in central Florida. The mean carapace length was 101.5 cm SCL and ranged from 83 to 117 cm. At Melbourne Beach, Florida, female green turtles generally deposit 3 to 4 clutches of eggs per season with an average internesting interval of about 12.9 days (Johnson, 1994). The mean distance between consecutive nesting sites was 1.8 miles. Females returned to Melbourne Beach after 2 to 6 years; however, a remigration interval of two years seemed to predominate, and no females were found to nest every nesting season.

The location of foraging grounds used by adult green turtles that nest in Florida has not yet been identified (NMFS and USFWS, 1991b; Johnson, 1994). However, satellite transmitters placed on two females that nested on the central east coast of Florida revealed interesting short term trends. After leaving the vicinity of the nesting beach, these females moved south along the Florida coastline and proceeded west along the Florida Keys, possibly to feed and reside in extensive seagrass meadows and coral reefs surrounding the islands (Schroeder et al., 1996).

Because the exact location of foraging grounds used by adult green turtles nesting in Florida has not been firmly established, the primary food item in the adult turtle's diet is also unidentified. Mortimer (1981b) suggested that adult green turtles graze on seagrass throughout most of their range, but in areas where seagrasses are lacking, algae is the primary dietary component. Also, Mortimer (1981a) suggested that turtles migrating from their foraging ground to their nesting habitat may be more opportunistic feeders than when they remain on their foraging grounds. Adult foraging grounds are typically in quiet, sheltered waters containing lush submarine vegetation. The nesting beaches, however, are typically in high energy surf, which may be devoid of food. During their migration from Nicaraguan foraging grounds to Costa Rican nesting beaches, green turtles stay relatively close to shore and feed on *Syringodium* and red algae. However, on their foraging grounds in Nicaragua, the turtle's diet consists primarily (90 percent) of turtle grass (*Thalassia testudinum*), which is the dominant rooted macrophyte.

Stomach contents from three stranded adult green turtles near Fort Lauderdale consisted of the algae *Sargassum natans, Gracilaria cylindrica,* and the hydroid *Bourainvilla carolinensis* (Wershoven and Wershoven, 1990). It is assumed that these turtles were not permanent residents, but rather part of the east coast nesting population.

NEARSHORE ENVIRONMENT AS DEVELOPMENTAL/FORAGING HABITAT

A variety of factors may account for the presence of sea turtles in the vicinity of the St. Lucie Plant. For one, the continental shelf adjacent to the plant is relatively narrow. It decreases in width from about 40 km at the Fort Pierce Inlet, north of the plant, to about 26 km at the St. Lucie Inlet south of the plant (Gallagher and Hollinger, 1977). Aerial surveys have shown that turtle densities are much higher in water depths less than 50 meters (National Research Council, 1990). Thus, a narrow continental shelf would tend to concentrate turtles. Furthermore, Mortimer (1981a) reported that green turtles often stay nearshore when they migrate to nesting areas. Nearshore movements increase the probability of turtles encountering one of the plant's intake structures.

A system of hard bottom substrates and sabellariid worm reefs parallel the shoreline between the Fort Pierce and St. Lucie Inlets. These habitats provide potential foraging and resting areas for turtles moving along the coast. Although the system is not continuous, it does provide intermittent refugia on an otherwise featureless seafloor. Turtles that utilize these natural reefs may be brought into close proximity with the intake structures. The closest sabellariid worm reef is located approximately 450 m southwest of the intake structures.

Documented dietary items of loggerhead turtles were compared to fauna collected during environmental sampling conducted in the vicinity of the St. Lucie power plant by the Florida Department of Natural Resources and Applied Biology, Inc. during the 1970s and early 1980s. Sampling was mostly conducted by trawl or benthic grab.

Crabs are a prevalent item found in most loggerhead dietary studies. Various crabs reportedly consumed by loggerheads have also been collected in the nearshore waters of Hutchinson Island. For example, blue crabs (*Callinectes sapidus*), swimming crabs (*Portunus* spp.), spider crabs (*Libinia* spp.), calico crabs (*Hepatus epheliticus*), speckled crabs (*Arenaeus cribrarius*), purse crabs (*Persephona mediterranea*), box crabs (*Calappa* spp.) and hermit crabs (*Pagurus spp.*) have all been documented as loggerhead turtle food (Mortimer, 1981b; Bellmund et al., 1987; Ruckdeschel and Shoop, 1988; Plotkin et al., 1993; Burke et al., 1993; Godley et al., 1997). Each of these species occurs on the sandy bottoms or sabellariid worm reefs in the vicinity of the power plant (Camp et al., 1977; ABI, 1979). Plotkin et al. (1993) and Ruckdeschel and Shoop (1988) also found barnacles in loggerhead digestive tracts. Several species of barnacles (*Balanus* spp.) have been documented by Camp et al. (1977) and ABI (1981) in the nearshore environment.

Mollusks are a prevalent staple for loggerhead turtles. Mollusks previously documented as food items and found near the St. Lucie Plant include: whelks (*Busycon* spp.; Ruckdeschel and Shoop, 1988; Lyons, 1989; Burke et al., 1993), ceriths (*Cerithium* spp.; Lyons, 1989; Godley et al., 1997), slipper shells (*Crepidula* spp.; ABI, 1981; Lyons, 1989; Burke et al., 1993), tulip shells (*Fasciolaria* spp.; Lyons, 1989; Godley et al., 1997), conchs (*Plueroploca* spp. and *Strombus* spp.; Carr, 1952; Lyons, 1989; Burke et al., 1993; Godley et al., 1997), bonnets (*Phalium* spp.; Lyons, 1989; Godley et al., 1997), and mussels (*Mulinia* spp. and *Mytilus* spp.; ABI, 1981; Lyons, 1989; Burke et al., 1993).

Jellyfish are usually found in low percentages in loggerhead dietary samples, but are probably underrepresented because they are digested so quickly (Plotkin et al., 1993). Jellyfish are often entrained into the St. Lucie Plant intake canal and can become so thick that they clog the plant's cooling system. On occasion the plant has had to reduce power for brief periods because of the massive amounts of jellyfish that were entrained with cooling water (Applied Biology, Inc., unpublished data).

The nearshore environment near the St. Lucie Plant was also evaluated with respect to its suitability as foraging habitat for green turtles. The high-energy environment of the ocean around the St. Lucie Plant precludes the extensive growth of seagrasses. However, both drift and benthic algae are known to occur in the area (Moffler and Van Breedveld, 1979; Bresette et al., 1998).

Gracilaria sp. and *Bryothamnion seaforthii* were the two most abundant food items in immature green turtle dietary samples taken in the summer and fall in the central Indian River Lagoon (Ehrhart et al., 1996). Preliminary observations from a dietary study done on the sabellariid worm reef near the Sebastian Inlet show that immature green turtles feed primarily on algae of the following genera: *Bryothamnion, Gracilaria, Acanthophora, Botryocladia,* and *Solieria* (K. Holloway, pers. com.). All of these genera were included on the list of 119 taxa found in the nearshore area around the St. Lucie Plant (Moffler and Van Breedveld, 1979). Although the sandy-shell hash sediments of the nearshore environment do not support the attachment of larger species of macroscopic algae, a variety of drift algae can often be found near the plant. Additionally, the sabellariid worm reefs along the shoreline support macroscopic algal growth. Moffler and Van Breedveld (1979) estimated that these nearby reefs were the probable source for at least 57 percent of the drift algae species. All of the taxa listed above have been found growing on the sabellariid worm reefs near the St. Lucie Plant.

THE INTAKE STRUCTURES AS TURTLE SHELTER/FORAGING AREAS

In the nearshore environment adjacent to the St. Lucie Plant, where much of the ocean bottom is flat and sandy (Lackey, 1970), the intake and discharge structures provide vertical relief. Both natural and artificial structures attract a variety of marine life, including turtles. For example, divers, NMFS observers, and aerial surveyors have reported that turtles commonly associate with offshore oil platforms in the Gulf of Mexico (National Research Council, 1990). Resting loggerhead turtles are often seen

with their heads, or other body parts tucked under rocky ledges offshore (J. Gorham and E. Martin, pers. com.; Wershoven and Wershoven, 1990). Green turtles have also been documented resting under coral heads and rocky outcroppings at night and during the hottest part of the day (Bjorndal, 1980; Mendonca, 1983; Ogden et al., 1983; Wershoven and Wershoven, 1990; Balazs, 1995). The large opening between the velocity caps and the base of the intake structures may very much resemble a reef ledge and appear to offer an ideal resting site to turtles.

Both Mortimer (1981a) and Mendonca (1983) noted that green turtles seem to occupy a home range while residing on their foraging grounds and may return to the same sleeping place on consecutive nights. Coyne (1994) found that juvenile green turtles living in Brazos Santiago Pass spend more time in and exhibit greater site fidelity to rocky/jetty environments relative to other surrounding habitats. Smaller turtles may also use structure as a refuge from predators (Musick and Limpus, 1997).

In a study conducted at the Miami Seaquarium wooden boxes simulating intake structures were placed in a large tank. Loggerhead and green turtles introduced to the tank readily sought out and utilized these boxes during resting periods (ABI, 1980). One apparent reason for seeking out and wedging themselves within the boxes was to maintain a stationary position while resting instead of being moved by the currents. Often, aggressive interactions would occur between turtles at the boxes indicating competition for available space. Turtles were also observed chasing other turtles away from the boxes or hiding inside as an attack avoidance maneuver.

The St. Lucie Plant intake structures closely resemble large reef outcroppings with one notable exception. They provide practically unlimited habitat. When turtles use the structures as shelter they may be rapidly drawn into the intake pipes. Thus, the shelter effectively remains unoccupied and available to other turtles. Competitive interactions are thereby eliminated.

Another plausible reason for the entrainment of sea turtles at the St. Lucie Plant is that the food supply for both loggerhead and green turtles might be greater on the intake structures than on surrounding sandy areas. Bresette et al. (1998) reported that the intake structures are covered by much of the same green, brown and red algae that Ehrhart (1992) found growing on worm-rock reefs in Indian River County. Based on underwater photographs and videos, the growth on the intake structures resembles that of nearby reefs. All of the surface area is covered with epibiota. Epibiota appear to include hydroids, encrusting sponges, large barnacles, bryozoans, algae (primarily on top of the caps), anemones, and some gorgonian coral. Various species of fish were also observed around the structure. Many of these items were previously shown to be components of loggerhead and green turtle diets.

TRENDS IN LOGGERHEAD CAPTURES AT THE ST. LUCIE PLANT

Size Distribution

When the canal capture program was initiated in May 1976, the sizes of captured turtles were estimated. Beginning in July 1976 the straight minimum carapace length[2] (SMCL) and straight carapace width (SCW) of each turtle was measured with calipers. Weights of captured turtles were recorded beginning in November 1976. Measurement of curved standard carapace length (CSCL) and straight standard carapace length (SSCL) began in April 1981 and November 1987, respectively.

In some cases all measurements could not be taken because gear was not available. In other cases, certain measurements could not be accurately determined due to damage to a turtle's carapace.

Because SMCL measurements were available for more turtles than any other measurement and because it is the recommended length measurement (Bjorndal and Bolten, 1989; Bolten, 1999), it was used for all analyses in this report.

Between 1976 and 1998, SMCL measurements were obtained for 3,479 loggerhead turtle captures at the St. Lucie Plant. The mean size of these turtles was 67.0 cm and sizes ranged from 38.6 to 112.0 cm. This is similar to the size range reported for loggerhead turtles in the central and northern regions of the Indian River Lagoon (Ehrhart, 1983; Ehrhart et al., 1999) and in the Canaveral Ship Channel (Henwood, 1987; Bolten et al., 1994)

The size distribution of loggerhead turtles captured at the St. Lucie Plant is presented in Figure 8. There are several important aspects of this distribution. First, most of the individuals captured were less than 70 cm SMCL. Second, there was a paucity of loggerheads between 70 and 85 cm. And third, a secondary accumulation of adults gives the distribution a bimodal appearance. This distribution is similar to that presented by Ehrhart et al. (1999) for the central Indian River Lagoon and Bolten et al. (1994) for the Canaveral Ship Channel.

The Turtle Expert Working Group (1998) referred to loggerhead turtles less than 70 cm as small benthic immature turtles and those between 70 and 91 cm as large benthic immature turtles. Loggerheads ≥ 92 cm were considered adults. Ehrhart et al. (1996), however, used 83 cm SSCL[3] as the minimum size for adult loggerheads captured in the central Indian River Lagoon.

For the purposes of this report, loggerheads with SMCLs less than 70.0 cm are referred to as juveniles, those between 70.0 and 84.9 cm are considered subadults and those ≥ 85.0 cm are designated adults. These criteria follow the general format used by

[2] See Bolten (1999) for definitions of carapace measurements.

[3] 83 cm SSCL is equivalent to approximately 81.7 cm SMCL based on regression analysis of SMCLs and SSCLs obtained from over 2,000 St. Lucie Plant loggerheads.

Ernest et al. (1989) and ABI (1994) to define size classes/life history stages of loggerhead turtles. Based on the reported sizes of nesting loggerheads, no mature animals should be included in the juvenile size class and few immature animals should be included in the adult size class. The subadult size class, however, undoubtedly contains some small mature animals along with the large immature turtles.

Since most of the analyses in this report were segregated by life history stage, it was important to assign as many turtles as possible to one of the three stages. For this reason, turtles lacking SMCLs were placed in one of the stages based on conversion of other available measurements to SMCL. Equations used to make these conversions are presented in Table 3. After conversions, over 98 percent of the loggerhead turtles captured could be assigned to a life history stage.

The size distribution of loggerhead turtles from the St. Lucie Plant suggests that juvenile loggerheads are using the nearshore waters off Hutchinson Island for developmental habitat but begin to leave the area as subadults. Schroeder et al. (1998) hypothesized that Florida Bay may represent another developmental habitat for turtles nearing maturation (75-85 cm). It may very well be that subadult loggerheads from the Florida East Coast move to Florida Bay to complete maturation. Adult turtles then return to the east coast to mate and nest.

Annual changes in the mean sizes of loggerhead turtles captured at the St. Lucie Plant are illustrated in Figure 9. Linear regression analysis[4] (Zar, 1996) of these data indicated a significant ($r^2 = 0.28$, $P < 0.01$, $n = 23$) increase in the mean size of loggerhead turtles between 1976 and 1998. To further investigate this trend, annual size distributions for loggerhead turtles captured at the St. Lucie Plant were plotted (Figures 10-14). Annual size distributions indicate some year to year fluctuations in the proportion of turtles in each size class. In general, the proportion of adults was relatively low between 1976 and 1983, relatively high during 1989 and 1990, and intermediate during other years. This is more clearly illustrated by examining the annual percentage of captures consisting of adults (Figure 15). These data indicate a significant ($r^2 = 0.48$, $P < 0.001$, $n = 23$) increase in the proportion of adults captured between 1976 and 1998. It appears that the increase in mean size of loggerhead captures at the St. Lucie Plant was a result of an increase in the proportion of adults captured. This is substantiated by the fact that there was no significant trend in the mean size of immature (juvenile + subadult) loggerheads (Figure 16).

[4] Regression analysis is a statistical method for evaluating the relationship of two variables. In a linear regression analysis this relationship is described in terms of variation about a straight line. The extent to which the two variables, x and y, are related to one another is described by the equation $y = bx + a$, where b is the slope of the line (amount of change in y when x increases by one unit) and a is the y intercept (value of y corresponding to $x = 0$). The amount of variation about the line is expressed as the coefficient of determination (r^2). It can range from -1 to $+1$. A negative value indicates that one variable increases as the other decreases, while a positive value indicates that the two variables increase and decrease in unison. Values of r^2 approaching -1 or +1 indicate a strong relationship. The relationship becomes weaker as values approach 0.

Seasonal Distribution of Juveniles

The seasonal distribution of juvenile loggerhead captures at the St. Lucie Plant is presented in Figure 17. Juvenile loggerheads were captured throughout the year, but, overall, tended to be most abundant from January through April. Juvenile loggerheads were also reported to be present throughout the year in the Canaveral Ship Channel (Henwood, 1987; Bolten et al., 1994) and in the central region of the Indian River Lagoon (Ehrhart et al., 1996, 1999). No seasonal trend was observed in the Indian River Lagoon. However, in the Canaveral Ship Channel the largest concentrations of juvenile loggerheads occurred from October through March.

Bolten et al. (1994) suggested that a sharp increase in juveniles in the Channel in January 1993, probably represented a group of juveniles migrating south away from cooler northern temperatures. These researchers also suggested that the appearance of these migrating loggerheads is determined more by water temperature than by absolute time of year so that peaks may occur in almost any month from late fall to early spring. Other authors have also indicated that temperature was an important factor in regulating the movements of loggerhead turtles (Mendonca, 1983; Keinath et al., 1987; Coles, 1999). Likewise, the seasonal distribution of juvenile loggerheads at the St. Lucie Plant may be influenced by influxes of turtles from northern areas as waters cool.

Examination of seasonal distributions for each year from 1977 through 1998 (Figures 18-22) reveals considerable fluctuation from year to year. These annual fluctuations may in part be explained by variations in water temperatures both in northern areas and locally. No long-term change in the seasonal distribution of juvenile loggerheads is indicated.

Long-term Trends in Juvenile Captures

The number of juvenile loggerhead turtles captured each year from 1977[5] through 1998 at the St. Lucie Plant is presented in Figure 23. Linear regression analysis indicated that there was a significant ($r^2 = 0.33$, $P < 0.01$, $n = 22$) increase in the annual number of juvenile loggerhead captures over that period. However, these data include recaptures (turtles that were captured in the canal, released into the ocean then recaptured in the canal). Analysis of recapture data (Figure 24) indicates that there was also a significant ($r^2 = 0.56$, $P < 0.001$, $n = 22$) increase in recaptures during the same period.

To rule out the possibility that the observed increase in juvenile loggerhead captures was simply due to an increase in the number of individuals captured multiple times, data were reanalyzed with recaptures excluded (Figure 25). Analysis of these data indicated that, even when recaptures were excluded, there was still a significant ($r^2 = 0.28$, $P < 0.05$, $n = 22$) increase in juvenile loggerhead captures from 1977 through 1998. However, most of that increase occurred between 1995 and 1998. In fact, when regression analysis was applied to data from 1977 through 1994, no significant trend was

[5] Data for 1976 are excluded because the power plant did not begin operation until May of that year. A total of 20 juvenile loggerheads were captured in 1976.

indicated. Thus, rather than experiencing a gradual increase in captures over the life of the plant, there was an exponential increase after 1994.

Site Fidelity of Juveniles

The fact that some turtles were captured in the intake canal on more than one occasion is an indication that at least some turtles either remained in the vicinity of the power plant or returned to the plant after moving to other areas. The ability of sea turtles to return to a specific site has been referred to as site fixity, site tenacity and site fidelity. These terms usually refer to a female turtle's tendency to return to a specific nesting beach with a high degree of accuracy (Carr, 1975; Bjorndal et al., 1983; Miller, 1997). The term site fidelity will be used here to describe a turtle's tendency to return to the intake structure (as demonstrated by its recapture in the intake canal).

Approximately five percent of the juvenile loggerhead turtles that were captured in the intake canal were documented returning. However, the extent to which turtles may learn to avoid being entrained while remaining in the vicinity of the intake structures is unknown. Thus, this figure may be conservative. Furthermore, the ability to identify a turtle as a recapture was dependent on the turtle's tag remaining intact. Poor retention of tags has been documented in sea turtles by various authors (Balazs, 1982; Henwood, 1986; Gorham et al., 1998). Considering these factors, it is safe to say that at least five percent of the juvenile loggerhead turtles captured in the canal showed site fidelity to the intake structure.

Some juvenile loggerheads returned to the canal only once while others returned repeatedly (23 times in one case). The time interval between a turtle's first and last capture is an indication of how long a turtle shows site fidelity to the area around the power plant. In some cases a turtle may have remained in the vicinity of the plant between captures, while in others it may have traveled to other areas between captures. In either case, the turtle demonstrated site fidelity to the intake structures. The percentage of recaptures that occurred within each of the various time intervals is presented in Figure 26. Based on these data, approximately 76 percent of the juvenile loggerheads that exhibited site fidelity did so for less than one year. Conversely, only 24 percent of the recaptures showed site fidelity for more than a year. When expressed as a percentage of all juvenile loggerheads entrained, this equates to only 1.2 percent of the juvenile loggerheads captured in the canal returning after one year. Though some juvenile loggerheads returned to the canal over periods of more than seven years, only 0.5 percent returned after two years.

Seasonal Distribution of Subadults

The seasonal distribution of subadult loggerhead turtles at the St. Lucie Plant is presented in Figure 27. As with juveniles, subadults were captured throughout the year. In contrast to the seasonal pattern for juveniles, however, subadults were most abundant during June, July and August. The loggerhead nesting season on Hutchinson Island typically extends from mid-April through mid-September with most nesting usually

occurring in June and July (ABI, 1987, 1994). Therefore, the higher number of subadult captures between June and August suggests that some adults have been included in the subadult life history stage and/or some subadults follow adults to their nesting/mating areas.

Seasonal distributions of subadult loggerheads at the St. Lucie Plant are presented on an annual basis in Figures 28-32. As with juveniles, there were considerable year-to-year fluctuations in seasonal patterns of abundance. In general though, the percentage of subadults captured in June and July was higher during the last ten years than during the previous twelve years. The increase in the proportion of subadults occurring during these two months coincided with a general increase in the mean size of subadults that began in 1989 (Figure 33). This apparent relationship may be accounted for by one or both of the following: 1) as the mean size of subadults increases it becomes more likely that mature animals are included in this size class, and/or 2) as subadults approach adult size they may be more likely than smaller individuals to join with adults in nesting/mating migrations.

Long-term Trends in Subadult Captures

The number of subadult loggerheads captured each year from 1977 through 1998 at the St. Lucie Plant is presented in Figure 34. The long-term trend was not significant. Because so few subadults were recaptured and because there was no significant long-term trend in recapture rates, the annual capture pattern changed little after recaptures were excluded (Figure 35).

Site Fidelity of Subadults

Nine of the loggerhead turtles that were classified as subadults on initial capture were recaptured in the intake canal. Eight were still within the subadult size class when recaptured, but one had grown to adult size prior to recapture. Intervals between first and last capture ranged from nine days to almost seven and a half years (Figure 36). When expressed as a percentage of all subadult loggerheads entrained, approximately two percent of the subadult loggerheads captured in the intake canal were documented returning. Only five (1.1 percent) returned after one year.

Seasonal Distribution of Adults

Adult loggerhead turtles, like juveniles and subadults, were captured in the St. Lucie Plant intake canal throughout the year (Figure 37). However, the most conspicuous aspect of the seasonal distribution of adult loggerhead captures is that it closely corresponded to the seasonal distribution of nesting on Hutchinson Island. Nesting usually begins in mid-April, increases through May, is highest in June and July, decreases in August, and ends in mid-September (ABI, 1987, 1994). Adult loggerhead captures in the intake canal followed this same pattern.

Of the 649 adult loggerhead capture events in the canal, the sex of the turtle was determined in 637 cases. Determination of sex was based on tail length (Wibbels, 1999). A total of 562 of the adult loggerheads were females and 75 were males. Though both sexes were captured during every month of the year, the seasonal distributions of males and females were different (Figure 38). Females were most abundant from May through August while males were most abundant from February through June. Henwood (1987) found a similar pattern in the Canaveral Ship Channel. He suggested that most breeding occurs in April and May with males leaving the area in June while females remain in the area throughout the nesting season (May – August). This probably explains the seasonal patterns documented for the St. Lucie Plant.

As with the other life history stages of loggerhead turtles, adults exhibited considerable year to year fluctuation in seasonal patterns (Figures 39-43). It should be noted, however, that the number of annual captures from 1977 through 1983 was very low. Larger numbers of adults were captured from 1984 through 1998, and during this period seasonal patterns tended to be more consistent (i.e., most adults were captured during the nesting season). This undoubtedly reflects the fact that over 85 percent of the adult captures were females and probably in the area for the purpose of nesting.

Long-term Trends in Adult Captures

The number of adult loggerhead turtles captured each year at the St. Lucie Plant is presented in Figure 44. As with subadults, few adults were recaptured and no significant increase or decrease in recaptures occurred over the period of study. For those reasons, the annual capture pattern changed little after recaptures were excluded (Figure 45). In contrast to subadults, there was a significant increase in the number of adult loggerheads captured between 1977 and 1998 whether recaptures are included or excluded ($r^2 = 0.60$, $P < 0.001$, $n = 22$).

Since the sexes of most adults were determined, long-term trends were reanalyzed for each sex separately. Because the trends including and excluding recaptures are essentially identical, only trends exclusive of recaptures are presented. The numbers of adult female loggerheads captured each year are presented in Figure 46. Since females comprised over 85 percent of the adult captures, it is not surprising that the trend in female captures was very similar to the trend for all adult captures. As for all adults, female captures significantly ($r^2 = 0.61$, $P < 0.001$, $n = 22$) increased from 1977 through 1998.

The fact that seasonal trends in adult captures coincided with seasonal trends in nesting suggests that many of the females captured at the St. Lucie Plant intake may have migrated to the area for the purpose of nesting. To further investigate this possibility, the long-term trend in female captures was compared to the long-term trend in loggerhead nesting on Hutchinson Island (Figure 47). When analyzed, a significant ($r^2 = 0.54$, $P < 0.001$, $n = 18$) positive relationship between capture rates and nesting was indicated (Figure 48). As nesting has increased on Hutchinson Island, so too have the number of adult females entrained into the St. Lucie Plant intake canal. Female turtles may use reef

areas for feeding and/or shelter between nesting episodes and the intake structure may appear to be suitable habitat.

The annual numbers of adult male loggerhead captures are presented in Figure 49. Compared to adult females, the numbers of adult males captured annually were relatively small. However, like females, males exhibited a significant ($r^2 = 0.25$, $P < 0.05$, $n = 22$) increase in numbers from 1977 through 1998.

Site Fidelity of Adults

Seven (six females and one male) of the loggerhead turtles that were classified as adults on initial capture were recaptured in the intake canal. Intervals between first and last capture ranged from three days to over nine years (Figure 50). The male was recaptured 43 days after its initial capture.

When expressed as a percentage of all adult loggerheads entrained, 1.1 percent of the adult loggerheads captured in the intake canal were documented returning. Only four (0.6 percent) returned after one year.

TRENDS IN GREEN TURTLE CAPTURES AT THE ST. LUCIE PLANT

Size Distribution

Between 1976 and 1998, SMCL measurements were obtained for 2,417 green turtle captures at the St. Lucie Plant. The mean size of these turtles was 38.7 cm (range: 20.0 – 108.0 cm). The size distribution of green turtles from the intake canal is presented in Figure 51. Green turtle captures were dominated by juveniles as has been reported on nearshore reefs in Indian River and Broward Counties and in the Indian River and Mosquito Lagoons (Mendonca and Ehrhart, 1982; Wershoven and Wershoven, 1990; Schroeder et al., 1990; Ehrhart et al., 1996, 1999).

Though the mean size of green turtles from the intake canal was similar to that reported by Ehrhart et al. (1996) for green turtles from the central region of the Indian River Lagoon, there was a much higher proportion of very small (< 30 cm) turtles in the intake canal. Only 5.4 percent of the lagoon green turtles, compared to 22.3 percent of those in the intake canal, were less than 30 cm. Though Ehrhart et al. captured a higher proportion (10.0 percent) of these very small turtles at their reef site, the proportion was still less than half of that for the intake canal. These researchers offered two possible explanations for size differences between green turtles captured in the St. Lucie Plant intake canal and those they captured in tangle nets. It was suggested that smaller green turtles could be more susceptible than larger individuals to entrainment by the plant's cooling water system and/or the large mesh of the tangle nets used in their study allowed smaller turtles to escape.

Though differences in capture techniques may contribute to the observed difference in size frequencies, real differences in size structure may exist between green turtles in the nearshore Atlantic and those in the lagoon (Ernest et al., 1988, 1989). This is suggested by the fact that Ehrhart et al. (1996) found a higher proportion of very small green turtles at the reef site versus the lagoon site. This is also suggested by the sizes of green turtles captured in the Canaveral Ship Channel (Henwood and Ogren, 1987) and in the Trident Submarine Basin (Redfoot et al., 1996). The mean sizes of green turtles at these two sites were 33.8 and 32.9 cm, respectively. This is considerably smaller than the mean sizes reported for green turtles in the Indian River Lagoon.

The relatively high proportion of individuals between 20 and 30 cm and the paucity of turtles greater than 50 cm in the St. Lucie Plant intake canal suggests that nearshore coastal waters may be an intermediate developmental habitat for green turtles moving from the pelagic environment to lagoons and estuaries. It has been suggested that the algae available in coastal waters are insufficient to sustain green turtles larger than 50 cm (Coyne, 1994; Redfoot et al., 1996). So, as green turtles in the vicinity of the intake approach this size they may begin to migrate out of coastal waters and into lagoons where algae and seagrasses are more abundant.

Annual changes in mean sizes of green turtles captured at the St. Lucie Plant are shown in Figure 52. Considerable fluctuations in mean sizes exhibited during the early years of the program primarily reflect small sample sizes. After eliminating years in which less than 20 individuals were captured, only two years (1981 and 1988) had means outside of the range of 35 to 41 cm. Consequently, over the period of study, there was no significant increase or decrease in the mean size of green turtles captured in the intake canal. Annual size distributions for green turtles at the St. Lucie Plant are presented in Figures 53-57.

For the purpose of this report, the same size classes/life history stages used for loggerheads were also used for green turtles. Measurements were available for over 99 percent of the green turtle captures, so almost all green turtles could be assigned to a life history stage. Because there were so few green turtles in the subadult and adult life history stages (29 and 28, respectively), subsequent analyses of green turtle captures are limited to juveniles.

Seasonal Distribution of Juveniles

The seasonal distribution of juvenile green turtle captures at the St. Lucie Plant is presented in Figure 58. Though juvenile green turtles were captured during all months of the year, they were most abundant from January through March. Likewise, Ehrhart et al. (1996, 1999) captured more juvenile green turtles in the central Indian River Lagoon in the winter than in the summer. Ehrhart et al. (1996) suggested that increased captures during cooler months may be due to an increase in drift algae in the lagoon and an influx of green turtles from northern climates. No data are available concerning seasonal changes in algae abundance in the vicinity of the intake, so it is unknown whether this factor may affect capture rates. However, it seems likely that higher capture rates during

January through March could be due to seasonal movements of juvenile green turtles from northern areas into the nearshore waters of southeast Florida.

Between 1977 and 1994, the seasonal distribution of juvenile green turtle captures at the St. Lucie Plant exhibited some annual variation, but during most years, captures were greatest during the coolest months (December-March; Figures 59-62). However, beginning in 1995, juvenile green turtle captures tended to be more evenly distributed throughout the year (Figures 62-63). This change in seasonal distribution coincided with an unprecedented increase in juvenile green turtle captures at the St. Lucie Plant.

Prior to 1995, juvenile green turtle captures at the plant were apparently dominated by animals that moved into the area as water temperatures cooled then moved out of the area as water temperatures warmed. These seasonal migrants appeared to make a smaller contribution to annual captures beginning in 1995.

Long-term Trends in Juvenile Captures

The numbers of juvenile green turtles captured annually from 1977 through 1998 at the St. Lucie Plant are presented in Figure 64. Annual captures were relatively low from 1977 through 1992, but increased considerably after 1992. Extraordinarily high numbers of green turtles were captured in 1995 and 1996. Linear regression analysis indicated a significant ($r^2 = 0.43$, $P < 0.001$, $n = 22$) increase in juvenile green turtle captures over the entire period of study. However, analysis of recapture data indicates a similar increase in recaptures during the same period (Figure 65). Likewise, juvenile green turtle recaptures were found to significantly ($r^2 = 0.44$, $P < 0.001$, $n = 22$) increase over the study period.

In order to rule out the possibility that the increase in juvenile green turtle captures was due to an increase in recapture rates, data were reanalyzed after excluding recaptures (Figure 66). Even after recaptures were excluded, juvenile green turtle captures were found to significantly ($r^2 = 0.39$, $P < 0.01$, $n = 22$) increase from 1977 through 1998. However, as with juvenile loggerheads, the increase in captures did not occur gradually over the period of study but rather was limited to the 1990s. A regression analysis indicated no significant trend when applied to data through 1992.

Site Fidelity of Juveniles

Over the period of study, 13.1 percent of the juvenile green turtles that were captured in the intake canal returned. Like juvenile loggerheads, some juvenile green turtles returned on only one occasion while others returned repeatedly (as many as 14 times). Intervals between first and last capture varied from one day to over four years. The percentage of recaptures that occurred within each interval is presented in Figure 67. Based on these data, approximately 67 percent of the juvenile green turtles that exhibited site fidelity, did so for less than one year. Conversely, only 33 percent did so for more than one year. Expressed as a percentage of all juvenile green turtles entrained, this equates to 4.3 percent returning after one year.

Green turtles exhibited a higher incidence of site fidelity than loggerheads. This is consistent with the findings of Mendonca and Ehrhart (1982) in the Mosquito Lagoon. They also found that green turtle recapture rates were higher than those for loggerheads.

Though a higher percentage of juvenile green turtles (4.3 percent) than juvenile loggerheads (1.2 percent) returned to the canal after one year, the longest periods of site fidelity were exhibited by loggerheads. This may be explained by the disproportionately higher percentage of green turtles that were captured, tagged and released during the last five years of the study period. Only 28 percent of the juvenile green turtles captured in the canal had been at large for more than five years at the end of 1998, compared to 63 percent of the juvenile loggerhead turtles.

FACTORS THAT MAY INFLUENCE TURTLE ENTRAINMENT PATTERNS

Power Plant Design and Operating Characteristics

There have been a number of changes to the design of the St. Lucie Plant that may have influenced turtle entrainment. Several changes occurred with the addition of Unit 2 in June 1983. First, another intake structure was installed. This increased the spatial extent of physical structures on the seafloor and may have attracted additional turtles. Second, the addition of another power plant changed flow patterns around the intake structures and within the intake pipes. This may have affected a turtle's likelihood of being entrained when it entered the intake structure. Third, the addition of the second discharge pipe with its 58 ports rising above the ocean surface increased the area of structure just north of the intakes. This may have attracted additional turtles into the general area and eventually resulted in more turtles encountering and entering the intake structures. The second discharge pipe in combination with the second power plant would also be expected to increase the thermal plume in the general area of the intake structures. This might act as an attractant to sea turtles during cooler periods thus increasing the probability of entrainment.

In order to identify changes in entrainment associated with the addition of Unit 2, average annual capture rates for the five-year period prior to construction of the third intake structure (1977-1981) were compared to those for a five-year period after Unit 2 began operating (1984-1988; Table 4). For all loggerhead and green turtle life history stages examined, average capture rates increased after Unit 2 began operation. Juvenile and subadult loggerhead captures increased by 25 and 48 percent, respectively. Average annual captures of juvenile green turtles and adult loggerheads more than tripled. However, when tested with a Mann-Whitney test[6] (Zar, 1996), only the increases for juvenile green turtles and adult loggerheads were statistically significant ($P = 0.05$). Though an increase in entrainment rates was indicated after the addition of the second power plant, this does not necessarily demonstrate that the increase was due to the second

[6] A Mann-Whitney test is a statistical method for determining if two samples have been drawn from the same population. It is used for testing means when the assumptions of the more rigorous t-statistic cannot be met or when sample sizes are relatively small.

plant. For example, the increase in captures of adult loggerheads coincided with a similar increase in loggerhead nesting on Hutchinson Island. So the observed increase in adult loggerhead capture rates may have resulted more from an increase in nesting females in the area than from the addition of the second power plant. Though significantly more juvenile green turtles were captured in the five-year period before, than the five-year period after, Unit 2 went on-line, no significant trend in captures were indicated when all data between 1977 and 1992 were analyzed (see Green Turtles - Long Term Trends in Juvenile Captures and Figure 64). Thus, although the addition of the second unit may have affected capture rates to some extent, it is not clear that this change was responsible for the long-term upward trends in captures of juvenile and adult loggerhead turtles or juvenile green turtles.

Repairs to the velocity caps on the three intake structures also may have affected entrainment rates. The thicker columns and caps may have changed the attractiveness of the structures to turtles and may have affected flow patterns underneath the caps. Since damage to the caps was first observed in August 1989, the period from 1984 through 1988 was used to characterize capture rates for the original three-intake system. Because repairs were completed in February 1992, the period from 1992 through 1996 was used to characterize rates for the modified three-intake system. Average capture rates for each of these five-year periods is presented in Table 5. Though mean capture rates for subadult loggerheads decreased by 21 percent after velocity cap repairs, rates increased for the other groups. Average annual capture rates increased by 31 percent for juvenile loggerheads, 67 percent for adult loggerheads and 851 percent for juvenile green turtles. However, based on a Mann-Whitney test (Zar, 1996) only the change in juvenile green turtle captures was significant ($P = 0.05$).

Whether the increases in juvenile green turtle capture rates were caused by, or simply coincident with, velocity cap repairs is unknown. However, as discussed later, other researchers reported similar increases in the number of juvenile green turtles residing in developmental habitats elsewhere on the east coast of Florida during the 1990s. This would suggest that increases seen at the St. Lucie Plant were part of a larger pattern unrelated to changes in the intake structure.

In addition to changes in power plant design, changes in power plant operations may also affect sea turtle entrainment. In particular, when a power plant is shut down for maintenance or refueling, the circulating-water pumps are also shut down. Though auxiliary pumps are run during these periods, the flow of water through the intake system is considerably reduced. This results in a major reduction in water velocities at the intake structures and within the intake pipes (Table 1). Changes in velocity may affect the probability that a turtle will be entrained into the canal after entering the intake structure. How turtles behave after they enter the structure is unknown, but if they attempt to escape after entering the intake pipe, lower velocities might increase their probability of escape.

Information on maximum swimming speeds of green and loggerhead turtles of the sizes encountered in the canal is fragmentary. However, observations by Ogren et al. (1977) of two adult loggerhead turtles encountering shrimp trawls provides some

pertinent information. In both cases the trawls were towed at about 2.5 knots (129 cm/sec). The first loggerhead was observed swimming leisurely in the same direction that the trawl was being towed. As the trawl began to overtake it, the turtle increased its swimming speed until it equaled that of the trawl. The turtle increased its speed further and was able to outdistance and veer away from the trawl. The encounter lasted approximately two to three minutes. So this turtle was able to maintain and exceed a speed of 129 cm/sec for at least two minutes. A second loggerhead, swimming in the same direction as the tow, kept just ahead or even with the net headrope for two to three minutes then slowed its swimming speed. As the headrope passed over the turtle, it increased its swimming speed, swam 2-3 meters to the headrope then rested momentarily and was overtaken by the net. This pattern of swimming was repeated for 8-10 minutes until the turtle was finally swept further back into the net and ceased swimming. This turtle, then, was able to maintain and occasionally exceed a speed 129 cm/sec for at least ten minutes.

J. Mitchel (pers. com.) also made observations of loggerhead turtles encountering trawls. In this case, two-year-old, captive-reared loggerheads were used to test turtle excluder devices in shrimp trawls. Turtles were placed ahead of trawl nets being towed at 2.5-3.0 knots (129-154 cm/sec). Turtles usually kept swimming at those speeds for the first minute then would slow down.

Additional observations of swimming speeds in sea turtles were made on adult females during the nesting season. Using radio telemetry, Tucker et al. (1996) recorded the internesting movements of female loggerhead turtles in Australia. The maximum swimming rate recorded for these turtles was 3.01 km/hr (84 cm/sec). However, these speeds probably do not reflect the maximum speed that these turtles are capable of. Carr et al. (1974) suggested that adult female green turtles in longshore travel maintain a speed of about 1.5 km/hr (42 cm/sec) for several hours at a time and are capable of brief bursts of 4-7 km/hr (111-194 cm/sec).

Based on these swimming speeds, turtles would be expected to easily escape velocities encountered at the velocity caps of all three intakes and in the vertical sections of the 3.7-m intake structures during any operating condition (Table 1). Though turtles should also be able to escape velocities in the vertical section of the 4.9-m intake when one unit is operating, they may not be capable of escaping when two units are running. During the period when there was only one power plant and two intake structures, turtles would not be expected to be entrained when the plant was shut down. However, when the plant was operating turtles would probably have difficulty swimming against the velocities (159-178 cm/sec) within the intake pipes. The addition of the second power plant and third intake structure changed conditions. With only one plant operating, velocities in the 3.7-m pipes are only 66-73 cm/sec. Turtles should be able to easily escape from the pipes at these velocities. Under the same conditions, velocities in the 4.9-m pipe are 93-106 cm/sec. Turtles should be able to escape at these velocities if they begin swimming against the current shortly after they enter the pipe. However, if they drift with the current for several minutes before beginning to swim against it, then they may have difficulty escaping. With both plants running, velocities in the 3.7-m and 4.9-

m pipes increase to 127-142 cm/sec and 180-206 cm/sec, respectively. At these velocities, turtles entering the pipe would be expected to have difficulty escaping and would likely be entrained into the canal.

In order to determine if the operating status of the power plants affected sea turtle entrainment, capture records were examined on a monthly basis. Only the juvenile stages of the two species provided sufficient numbers to allow meaningful interpretation. The monthly operating status of the power plants was based on available information for periods when each of the plants was shut down for refueling and/or maintenance. Only data for major plant outages were available for the entire study period. So some short periods when a plant (and its circulating pumps) may have been shut down or operating at less than capacity, were not taken into account. For the purpose of this comparison it is assumed that the circulating water pumps for each plant continue to run for two days after the plant is shut down and begin pumping two days before the plant goes back on-line. This is the usual operating procedure (N. Whiting, pers. com.). The monthly operating status of the plant is expressed as days per month that the circulating water pumps for each plant were operating.

The operating status of each plant is compared to monthly captures of juvenile loggerhead turtles in Figures 68-75. It is apparent from these figures that there are considerable fluctuations in monthly capture rates even when the operating status of the plants remains constant. These fluctuations probably reflect natural variation in juvenile loggerhead numbers in the vicinity of the intake structures. Such fluctuations make it difficult to interpret the effects of plant operating status on entrainment. However, there are numerous periods in which fluctuations in capture rates appear to correspond to changes in plant status (February - June 1980, January – June 1983, January - April 1987, September – December 1987, June – September 1988, January - April 1989, January - May 1994 and April - July 1996). In some cases there appears to be a one-month delay in the effect (March – July 1979, August – December 1981, September 1990 – January 1991 and October 1991 – January 1992) which may reflect a delay between entrainment and capture. It appears that the operating status of the power plant often affected entrainment of juvenile loggerhead turtles with captures decreasing during periods of plant outages both before and after Unit 2 went on-line.

Juvenile green turtle captures are compared to power plant operating status in Figures 76-83. As with loggerheads, green turtle captures varied considerably from month to month even when there was no change in the operating status of the power plants. Decreases in captures did coincide with plant outages prior to Unit 2 going on-line, however, these results are difficult to interpret because capture rates were often very low even when the plant was operating. During the first nine years after Unit 2 went on-line, there were few indications that outages affected entrainment rates. In particular, the observed peak in captures during January 1984 (during the March 1983 - April 1984 outage of Unit 1) indicates that seasonal fluctuations in juvenile green turtle numbers around the intake structures had more of an effect on entrainment patterns than plant operational status. However, capture rates generally remained low during this nine-year period. Relatively large numbers of juvenile green turtles were not consistently captured

until after September 1992. From October 1992 through December 1998, there were eight outages. In three cases fluctuations in capture rates appear to correspond to changes in plant status (September 1995 - January 1996, April - July 1996, April - June 1997). There were another four cases in which outages may have contributed to lower capture rates, but the relationship was not as clear (March - June 1993, January - May 1994, October 1997 - January 1998, and October - December 1998). There was one case in which an outage appeared to have no effect on capture rates (September - December 1994). Observed reductions in capture rates during several outages suggests that entrainment of juvenile green turtles was, at least occasionally, affected by power plant operating status.

In an attempt to quantify results of the qualitative analysis presented above, monthly capture data were segregated into periods when only one unit was on line and periods when both units were on line. Only data collected after Unit 2 went on line (June 1993) were used in the analysis so the number of intake structures remained constant. To segregate seasonal effects, two different periods were evaluated: spring (March, April, and May) and fall (October and November). During the spring period, water temperatures in the vicinity of the plant were typically rising following seasonal lows in January or February (Figure 95). During the fall period, temperatures were generally in decline following seasonal highs in September. Spring and fall also represent the periods when most routine plant outages occurred (Table 6).

During the spring between 1994 and 1998, there were 19 months when only one unit was operating and 26 months when both were operating. A t-test[7] applied to these data indicated that the capture of juvenile loggerheads was significantly higher ($t_{0.05(2)(43)} = 3.30$, $P < 0.002$) during months when two units were operating (mean = 18.7/mo ± 13.58/mo) than during months when only one unit was on line (mean = 7.7/mo ± 5.71/mo). Similar results were obtained for juvenile green turtles ($t_{0.05(2)(43)} = 2.08$, $P < 0.05$; mean for 2 units = 23.8/mo ± 36.75/mo; mean for 1 unit = 5.9/mo ± 7.91/mo). During the fall, there were 17 months when one unit was on line and 15 months when both were operational. The average number of captures for loggerheads during months when only one unit was operating was 5.9/mo (± 4.91/mo). That was only slightly higher than the number of monthly captures when both units were on line (mean = 4.7/mo ± 2.98/mo). Similarly, the capture of juvenile green turtles during the fall was only slightly higher when two units were on line (mean = 12.3/mo ± 14.99/mo) than when a single unit was operating (mean = 8.7/mo ± 13.35/mo). Differences in fall capture rates between the two plant operating modes were not statistically significant for either species. Thus, while the number of units on line may affect capture rates during some seasons, the effect is not universal. Furthermore, plant outages have been a regular occurrence over the life of the plant, and there were no trends in outages to explain the long-term increases in the capture of juvenile loggerhead and green sea turtles.

[7] A t-test is a statistical method for comparing two sets of samples to infer whether differences exist between the two populations sampled. Sample size and variation of individual values about the mean for each sample are factored into the comparison. A significant t value indicates that the samples were derived from different populations and that the mean values differ because of factors other than random variation.

In a separate analysis of long-term power plant operating trends, the operating status of the plant was determined by calculating the number of days each year that at least one unit was on line (Figure 84). Regression analysis indicated that, over the entire period of study, there was a significant ($r^2 = 0.32$, $P < 0.01$, $n = 22$) increase in the number of days that at least one unit was operating. However, using this criterion, there was no significant trend in the operational status of the plant during the last fifteen years of the study period (1984 – 1998). This was due to the fact that, after Unit 2 went on-line, outages were scheduled so that there was always one unit operating. Thus, the overall trend in operating status was due to the addition of Unit 2 rather than to a gradual increase in plant operating capacity over the period of study.

Because velocities in the intake pipes are proportional to the number of units operating, it was also important to examine periods when both units were on-line. From 1984 through 1998, there was some variation from year to year, but there was no significant long-term trend in the number of days per year that both units were on-line (Figure 85).

Because the operational status of the power plant exhibited no long-term trend between 1984 and 1998, it would not be expected to have been responsible for any increases in turtle entrainment within that period. However, when the entire study period is evaluated it is clear that there was a shift in the operational status of the power plant related to the addition of Unit 2. This shift may have contributed to higher capture rates after Unit 2 went on-line, but if the effect were due strictly to the addition of a second unit, it would be expected to remain constant after 1984. So, for instance, the substantial increases in juvenile loggerhead and green turtle captures that occurred during the 1990s can not be attributed to changes in power plant operating status.

In addition to the duration of outages, the timing of outages could also affect capture rates. Outages would be expected to have a greater effect on annual capture rates if they occurred during months when turtles were more abundant. So a shift in the timing of outages could affect long-term trends in captures. Outage periods for each year are given in Table 6. Throughout the study period, most outages occurred during spring and fall and no long-term shift in timing was indicated. Therefore, the observed increases in loggerhead and green turtle captures can not be attributed to a change in the timing of outages.

More detailed information concerning the operational status of the power plant is available for the period from January 1988 through December 1998. For this eleven-year period actual monthly flow rates are available. These flow rates reflect even short-term outages and periods when circulating water pumps were run at less than capacity. When flow rates were compared to juvenile loggerhead capture rates (Figures 86-87), decreases in capture rates often coincided with decreases in flow rates. The relationship of monthly flow rates to monthly capture rates is shown in Figure 88. Regression analysis indicated a weak but significant ($r^2 = 0.06$, $P < 0.01$, $n = 132$) positive relationship between the two.

When flow rates were compared to monthly juvenile green turtle captures (Figures 89-90), some changes in capture rates seem to coincide with changes in flow rates, but overall there did not appear to be a very strong relationship between the two. This was also indicated when flow rates were plotted against capture rates (Figure 91). Regression analysis indicated no significant relationship between monthly juvenile green turtle captures and monthly flow rates.

These results indicate that flow rates from 1988 through 1998 had a significant but weak effect on juvenile loggerhead entrainment, but no effect on juvenile green turtle entrainment. This may reflect differences in how each species reacts to currents encountered in the intake structures and/or differences in their abilities to escape the velocities encountered.

Regardless of the apparent significant relationship between monthly flow rates and juvenile loggerhead entrainment, flow rates did not appear to be responsible for the considerable increase in juvenile loggerhead captures after 1994. This is indicated by the fact that there was no significant trend in annual flow rates during the period from 1988 to 1998 (Figure 92). When annual juvenile loggerhead captures were compared to annual flow rates during that period (Figure 93), no significant relationship was indicated. Likewise, there was no significant relationship indicated between annual captures of juvenile green turtles and annual flow rates between 1988 and 1998 (Figure 94).

Characteristics of the Nearshore Environment Adjacent to the St. Lucie Plant

Changes in several aspects of the nearshore environment occurring in the vicinity of the St. Lucie Plant during the period that the plant has been operating might affect the numbers of green and loggerhead turtles inhabiting the area. Presumably an increase in the number of turtles near the plant would result in an increase in entrainment rates. For example, changes in the size and structure of nearby worm reefs and coquinoid rock formations might affect the tendency of turtles to utilize these areas. The only data available concerning changes in the dimensions and relief of worm reefs near the St. Lucie Plant were obtained from a study conducted by ABI (1979). Though this study was only conducted between April 1976 and April 1979, the dynamic nature of reef structures was documented. During this study, there was a trend in increasing reef size during the summer with deterioration of the colonies during the winter. Deterioration of the colonies was speculated to be due to increased wave action in fall or natural worm mortality. Major larval settlement resulting in new worm colonies occurred in late fall or early winter. Other rock formations devoid of reef building worms tend to be less dynamic in nature, though some change in relief may occur due to changes in sand levels around the formations.

Changes in the abundance of loggerhead and green turtle food items in the vicinity of the intakes might also affect the abundance of these two species in the area of the intake structures. Changes in the abundance of invertebrates and algae might occur if there were changes in the structure of the nearshore reefs and rock formations or changes

in local environmental conditions. However, there were insufficient data available to assess long-term trends.

One factor for which considerable quantitative data were available was water temperature. Mean monthly water temperatures based on daily temperatures recorded at the power plant's circulating water pumps were available for the period from January 1989 through December 1996. Since water temperatures have been shown to affect loggerhead and green turtle movements and behavior (Mendonca, 1983; Keinath et al., 1987; Coyne, 1994; Epperly et al., 1995; Coles, 1999), the potential effect of water temperature on capture rates was investigated.

Monthly juvenile loggerhead captures are compared to mean monthly water temperatures in Figure 95. In general, peaks in captures coincided with cooler water temperatures. When monthly captures were plotted against mean monthly water temperatures, a negative relationship was indicated (Figure 96). This relationship was found to be statistically significant ($r^2 = 0.23$, $P < 0.001$, $n = 96$).

When monthly juvenile green turtle captures were compared to mean monthly water temperatures a similar relationship was indicated (Figures 97 and 98). Likewise this relationship was found to be statistically significant ($r^2 = 0.06$, $P < 0.05$, $n = 96$).

These results are consistent with suggestions by several authors that increases in juvenile loggerhead and green turtles along the east coast of Florida were associated with decreases in water temperatures (Henwood, 1987; Bolten et al., 1994; Ehrhart et al., 1996). It seems likely that water temperatures influenced seasonal trends in juvenile and loggerhead captures at the St. Lucie Plant.

In order to determine if there was a relationship between long-term trends in turtle captures and water temperatures, average annual water temperatures were compared to annual capture rates of juvenile loggerhead and green turtles (Figures 99 and 100). Though there were differences in average water temperatures among years, correlation analysis indicated no significant relationship between average annual water temperature and annual capture rates of either species.

In addition to differences in average annual water temperatures, there were also differences in the seasonal patterns of water temperature among years. For example, the timing and intensity of cool water intrusions (evidenced by temperature decreases during summer months) varied from year to year. However, no patterns could be detected that would explain long-term trends in turtle captures.

The possibility remains that water temperature may have affected long-term trends in turtle entrainment, but additional data may be necessary to detect the relationship. Increases in turtle numbers along the east coast of Florida during the winter have been partially attributed to seasonal migrants from northern climates. Therefore, water temperature patterns in these northern areas may be just as important as local temperatures in influencing trends in turtle abundance in the vicinity of the St. Lucie

Plant. Investigation of temperature patterns in these northern areas was beyond the scope of the present study.

Another characteristic of the nearshore environment that was investigated related to meteorological conditions (i.e., storms/high winds). The wave action that is often associated with high winds might affect a turtle's tendency to enter the intake structures. For example, turtles might seek refuge in the structures from the turbulence created by increased wave action. Conversely, turtles may leave the area around the intake and move to offshore areas to escape the turbulence.

High wind conditions associated with storms often increase wave activity near shore. This is particularly true if the wind is directed towards the coastline. Since no quantitative data on wave conditions near the St. Lucie Plant were available, wind conditions were used as a gauge of wave activity. Data on wind velocity and direction at the St. Lucie Plant were available for the period from January 1995 through December 1998. Wind data were collected hourly at a height of 10 meters just north of the plant's discharge canal. For the purpose of this analysis, winds with bearings of 0-140° and velocities greater than or equal to 10 mph (16.1 km/hr) were considered to be wave generating. In order to compare wind/wave conditions to monthly capture rates, the percentage of wind readings meeting the above criteria was calculated for each month. Occasionally instruments malfunctioned and readings could not be recorded for a period of time. If more than 24 readings (the equivalent of one day's readings) were missing during a month, then that month was excluded from analysis.

Monthly juvenile loggerhead captures are compared to wind conditions in Figure 101. No consistent relationship between captures and wind conditions were apparent. When capture rates were plotted against wind conditions, there did not appear to be a correlation between the two (Figure 102). Likewise, correlation analysis indicated no significant relationship between wind conditions and juvenile loggerhead captures. As with loggerheads, juvenile green turtle captures did not appear to be influenced by wind conditions (Figures 103 and 104). Again, correlation analysis indicated no significant relationship between wind conditions and juvenile green turtle captures. Based on the lack of any relationship between monthly wind conditions and turtle capture rates, it is unlikely that storms influenced long-term trends in loggerhead or green turtle entrainment at the St. Lucie Plant.

Population Trends

One possible explanation for the observed long-term increases in captures of loggerheads and green turtles at the St. Lucie Plant is that the populations of these two species have increased during the study period. Unfortunately, due to their wide and unpredictable distribution among various developmental and foraging habitats, sea turtle populations are particularly difficult to census (Meylan, 1982).

In fact, the Turtle Expert Working Group (1998) stated that results of studies conducted at the St. Lucie Plant provided one of the very few unbiased indices of

abundance for benthic immature and adult loggerheads. The only other in-water studies that provide long-term trends in the abundance of loggerhead turtles along the east coast of Florida were conducted in the Indian River Lagoon system.

Ehrhart et al. (1999) analyzed trends in loggerhead population density in the central region of the Indian River Lagoon. They analyzed June and July CPUE (catch per unit effort) data for the years 1983-85, 1988-90, 1993-95 and 1998. The results indicated that loggerhead population density had not changed over the 15-year span of the study.

Provancha et al. (1998) evaluated the relative abundance of loggerhead turtles in the Mosquito Lagoon. Data that they collected in 1994-1996 were compared to data collected in 1977-1979 by Mendonca and Ehrhart (1982). Provancha et al. found that loggerhead CPUE declined from 0.16 to 0.06 between the two periods. Additional studies were conducted during 1997 and 1998 (Provancha, 1997, 1998). Loggerhead CPUEs for these two years (0.09 and 0.12) remained below the 0.16 CPUE for 1977-1979.

Differences among trends in the central Indian River Lagoon (no trend), the Mosquito Lagoon (negative trend), and the St. Lucie Plant (positive trend) may be due to differences in local environmental conditions. Conditions may be quite different between the lagoonal habitats and the coastal habitat near the St. Lucie Plant. Local availability of food items may also affect turtle abundance. Provancha et al. (1998) found the decline in loggerhead numbers coincided with a decline in horseshoe crabs in the Mosquito Lagoon.

Because of the limited number of studies that provide information on population trends for immature sea turtles, indices of population size and stability often rely on estimates of nesting females (see Meylan, 1982; NMFS and USFWS, 1991a). The Turtle Expert Working Group (1998) found that nesting data collected on index nesting beaches represented the best dataset available to index the population size of loggerhead sea turtles. This group also found that annual nesting from Hutchinson Island predicted annual nesting on all Florida index beaches well and may accurately reflect nesting trends for the total South Florida Subpopulation.

The National Research Council (1990) found a possible rising trend in numbers of loggerhead nests on Hutchinson Island from 1973 through 1989. They concluded that there was no decline or a possible increase in the loggerhead assemblage nesting south of Cape Canaveral. The Turtle Expert Working Group (1998) found a significant increase on Hutchinson Island during the period 1971-1994 as well as a significant increase for a composite of eight Florida beaches from 1983 through 1994. Witherington and Koeppel (in press) analyzed loggerhead nesting for the thirty index beach sites throughout Florida and concluded that loggerhead nesting appeared to be stable or increasing between 1989 and 1998.

When loggerhead nesting data for Hutchinson Island were analyzed for the period from 1981 through 1998, a significant increase in nesting was indicated ($r^2 = 0.75$, $P < 0.001$, $n = 18$; Figure 105). It has already been shown that there was a significant

positive correlation between adult female loggerhead captures in the St. Lucie Plant intake canal and nesting on Hutchinson Island. However, based on estimates of time spent in the pelagic stage, increases in nesting would not be expected to begin affecting juvenile loggerhead captures for five to twelve years. Consequently, it is difficult to directly correlate changes in juvenile captures with changes in the adult population.

If trends in loggerhead nesting on Hutchinson Island do accurately reflect nesting trends for the total South Florida Subpopulation, then nesting for that subpopulation apparently increased from 1981 through 1998. Based on results of genetic analysis by Bass (1999), the majority (70 percent) of juvenile loggerhead captures from the St. Lucie Plant originated from the south Florida nesting population. So it would be reasonable to conclude that the increase in juvenile loggerhead captures at the plant reflects the increase in this population.

Like loggerheads, in-water studies of green turtles along the Atlantic coast of Florida are limited. The only studies that provide information on long-term trends in abundance were conducted in the Indian River Lagoon system and on worm reefs just south of the Sebastian Inlet.

Ehrhart et al. (1999) analyzed trends in green turtle population density in the central region of the Indian River Lagoon. They analyzed June and July CPUE data for the years 1983-85, 1988-90, 1993-95 and 1998 and found that the 1998 CPUE was significantly greater than CPUE for the other three time periods. These results supported speculation by Ehrhart et al. (1996) that the extraordinary increase in green turtle CPUE that occurred in the winter and spring of 1995-96 may have been an indication of a stepwise increase in the relative population density of the lagoonal green turtle population. Ehrhart et al. (1996) also found that green turtle CPUE during the periods 1988-90 and 1993-95 were significantly greater than the CPUE during 1983-1985.

Ehrhart et al. (1999) also studied green turtles on worm reefs just south of the Sebastian Inlet from 1989 through 1998. Though statistical differences in CPUE were found between years, the fluctuations did not follow any discernible pattern. The researchers suggested that differences among years might reflect changes in surf conditions and water clarity, which affect netting success, or fluctuations in the availability of algae utilized by green turtles as food.

Provancha et al. (1998) evaluated the relative abundance of green turtles in the Mosquito Lagoon. Data that they collected in 1994-1996 were compared to data collected in 1977-1979 by Mendonca and Ehrhart (1982). Provancha et al. found that green turtle CPUE increased from 0.21 to 0.36 between the two periods. Additional studies were conducted during 1997 and 1998 (Provancha, 1997, 1998). Green turtle CPUEs for these two years (0.28 and 0.32) remained above the 0.21 CPUE for 1977-1979.

Recent evidence that a large portion (53 percent) of the juvenile green turtles from the St. Lucie Plant originate from Costa Rican nesting populations (Bass and Witzell, in

press) complicates the use of nesting data as an index of overall population status. Trends in the abundance of juvenile green turtles near the plant may be affected by trends in nesting in Costa Rica as well as Florida (42 percent of the juveniles are from the Florida/Mexico nesting population).

Bjorndal et al. (1999) analyzed nesting data for Tortuguero, Costa Rica, during the period from 1971 through 1996. The green turtle population that nests at Tortuguero is the largest in the Atlantic by at least an order of magnitude. Evaluation of the trend in nesting indicated a relatively consistent increase from 1971 to the mid-1980s, constant or decreasing nesting during the late 1980s, and then continuation of an upward trend in the 1990s. Overall, for the entire period, the trend was upward.

Dodd (1981) reviewed available records of green turtle nesting in Florida from 1959 through 1981 and speculated that the nesting population of green turtles in Florida was increasing. Dodd did point out, though, that better surveillance undoubtedly accounted for some of the increase in reported nests.

The National Research Council (1990) reported that the numbers of green turtle nests increased on Hutchinson Island over the period 1971-1989. Considerable nesting was reported to occur on Melbourne Beach, Florida, but nesting surveys had not been conducted for a long enough period to confirm a trend. Wide year to year fluctuations in numbers of nesting green turtles made statistical analysis of trends for this species particularly difficult.

NMFS and USFWS (1991b) reported that the number of green turtle nests in Florida appeared to be increasing. However, it was uncertain whether the upward trend was due to an increase in the number of nests or a result of more thorough monitoring of nesting beaches.

Meylan et al. (1995) reviewed green turtle nesting data throughout Florida from 1979 through 1992 and found an overall upward trend in nesting. These researchers, like others, cautioned that increased survey effort was partially responsible for the observed increase in numbers of nests.

Witherington and Koeppel (in press) evaluated green turtle nesting from 1989 through 1998 on thirty beach sites that are part of the Florida Index Nesting Beach program. They concluded that, over the ten-year period of study, green turtle nesting in Florida appears to be stable or increasing.

Changes in the annual numbers of green turtle nests on Hutchinson Island from 1981 through 1998 are shown in Figure 106. The drastic year-to-year fluctuations in nests numbers observed on Hutchinson Island have been documented at other green turtle nesting beaches and make analysis of trends difficult. However, regression analysis indicated a significant increase in nesting during this period ($r^2 = 0.28$, $P < 0.05$, $n = 18$).

There appears to be evidence that the green turtle nesting populations in Costa Rica and Florida increased between the 1970s and the 1990s. It seems reasonable to conclude that such an increase would result in an increase in juvenile green turtles in the vicinity of the St. Lucie Plant.

CONCLUSIONS

Immature loggerhead and green turtles apparently use the nearshore ocean environment in the vicinity of the St. Lucie Plant as developmental/foraging habitat. This appears to be related to the water depth in the area, the presence of hard bottom substrates and worm reefs, and the occurrence of preferred food items. Based on recapture data it appears that some turtles reside in the area throughout the year, while others transmigrate seasonally. The area is apparently also used as internesting habitat by large numbers of female loggerhead turtles that nest on Hutchinson Island every year.

Turtles migrating along the coast and/or utilizing hardbottom substrates and worm reefs in the vicinity of the plant would be brought into close proximity with the plant's intake structures. Turtles may enter the intake structures to rest or avoid attack from predators and/or competition from other turtles. Green and loggerhead turtles may also be attracted to the intakes for the purpose of foraging, since the structures resemble reefs, important foraging habitat for both species.

The majority of the loggerhead and green turtles entrained into the St. Lucie Plant intake canal between 1977 and 1998 were juveniles. However, loggerhead captures included a higher proportion of subadults and adults than green turtle captures. This probably reflects the fact that the loggerhead nesting population is considerably larger than the green turtle nesting population in the Hutchinson Island area.

There were significant increases in the numbers of juvenile and adult loggerhead captures and juvenile green turtle captures at the St. Lucie Plant from 1977 through 1998. The increase in adult loggerhead captures was more or less continuous and was significantly correlated with increases in nesting on Hutchinson Island. The upward trends in juvenile loggerhead and green turtle captures were primarily due to increases that occurred in the 1990s.

On average, more turtles were captured each year after Unit 2 was placed on line than before, suggesting that the addition of a second unit affected capture rates to some extent. However, this change could not account for the dramatic increases in capture rates of juvenile loggerhead and green turtles that only occurred after Unit 2 had been operating for ten years.

Changes in the physical appearance of the intake structure velocity caps following their repair coincided with substantial increases in juvenile green turtle captures at the plant. However, the extent to which the two are causally related is unclear.

Power plant outages over the life of the plant, at times, appeared to affect short-term trends in juvenile loggerhead and green turtle captures. However, plant outages could not explain the substantial increases in captures of either species that occurred during the 1990s. Flow rates from 1988 through 1998 appeared to have a weak but significant affect on short-term juvenile loggerhead entrainment rates. Again, however, flow rates were not responsible for the long-term increases in juvenile loggerhead captures occurring during this period. Flow rates had no affect on either short- or long-term captures of juvenile green turtles.

Changes in the nearshore environment near the St. Lucie Plant might be expected to affect long-term trends in turtle entrainment. Unfortunately, data relating to the relative size and relief of nearby worm reefs and hard bottom or to changes in the abundance of food items in the area were lacking. One environmental factor that was shown to be significantly correlated with monthly captures of juvenile green and loggerhead turtles was water temperature. However, no relationship between local water temperatures and long-term trends in capture rates could be demonstrated. The frequency of high, wave-producing winds also did not appear to affect entrainment of turtles. Seasonal increases in the number of juvenile loggerhead and green turtles in the vicinity of the plant may be more closely related to the migration patterns of turtles from more northern areas than to local conditions.

There is evidence (mainly from nesting beach surveys) that the adult populations of both green and loggerhead turtles that provide juveniles to the Hutchinson Island area increased during the study period. It would logically follow that the juvenile component of those populations also increased. The number of juvenile green turtles captured at the St. Lucie Plant increased dramatically in the 1990s. A similar increase was documented in the central Indian River Lagoon in an area well beyond the influence of the St. Lucie Plant. Unfortunately, there are relatively few other study sites for which long-term quantitative data are available for juvenile loggerheads. However, the strong correlation between adult loggerhead captures at the St. Lucie Plant and nesting on Hutchinson Island elucidates the relationship between canal capture rates and the relative numbers of individuals in the nearshore environment.

Even though changes in physical plant design and operating characteristics have occurred over the life of the plant, these changes do not appear to be responsible for the long-term increases in the numbers of juvenile and adult loggerhead and juvenile green turtles captured at the St. Lucie Plant. The most logical explanation for these increases is that there are more individuals of these life history stages present in the vicinity of the plant.

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Table 1. Calculated flow velocities along the intake system. Values for two power plants operating with three intakes are from Bellmund, 1982 (see Table 3). All other values were based on these values and the assumption that changes in velocities are proportional to changes in flow rates and the assumption that the 4.9-m pipe conveys 60 percent of the total flow (see p. 36, Bellmund et al., 1982).

Time Period	Number of power plants operating	Number of Intakes	Velocity Cap Flow Velocity (cm/sec)		Vertical Section Flow Velocity (cm/sec)		Pipe Flow Velocity (cm/sec)		Canal Flow Velocity (cm/sec)
			3.7-m	4.9-m	3.7-m	4.9-m	3.7-m	4.9-m	
May76-May83	None[1]	Two	0.4-0.5		1.3-1.5		4.8-5.3		0.46
May76-May83	One[2]	Two	14.0-15.8		44.9-50.2		159-178		15.24
Jun83-Dec98	One[3]	Three	5.8-6.5	14.4-15.7	18.5-20.7	97-106	66-73	93-106	15.70
Jun83-Dec98	Two[4]	Three	11.2-12.6	27.9-30.5	35.9-40.2	188-206	127-142	180-206	30.48

[1] Only auxiliary pumps for one unit operating
[2] Main pumps for one unit operating
[3] Main pumps for one unit and auxiliary pumps for the other unit operating
[4] Main pumps for both units operating

Table 2. Annual numbers of turtle captures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

Year	Loggerhead	Green Turtle	Leatherback	Hawksbill	Kemp's Ridley	Total
1976	33	0	0	0	0	33
1977	80	5	1	0	0	86
1978	138	6	3	1	0	148
1979	172	3	0	0	0	175
1980	116	10	0	0	0	126
1981	62	32	2	0	1	97
1982	101	8	1	0	0	110
1983	119	23	0	0	0	142
1984	148	69	0	1	2	220
1985	157	14	0	1	0	172
1986	195	22	1	1	1	220
1987	175	35	0	2	6	218
1988	134	42	0	0	5	181
1989	111	17	1	2	2	133
1990	112	20	0	0	0	132
1991	107	12	0	1	1	121
1992	123	61	1	2	0	187
1993	147	179	5	2	4	337
1994	164	193	2	0	2	361
1995	254	673	1	0	5	933
1996	349	549	0	5	3	906
1997	188	191	2	1	0	382
1998	393	268	1	2	2	666
Total	3578	2432	21	21	34	6086
Annual Mean[1]	162.6	110.5	1.0	1.0	1.5	275.1

[1] Data from 1976 are excluded since the power plant did not begin operation until May of that year.

Table 3. Equations used to convert straight standard carapace length (SSCL) and curved standard carapace length (CSCL) to straight minimum carapace length (SMCL) for loggerhead turtles.

Conversion	Equation	R^2	P	SE	N
SSCL to SMCL	$y = 0.9923x - 0.6948$	0.9986	<0.001	0.57	2061
CSCL to SMCL	$y = 0.9363x - 1.7437$	0.9925	<0.001	1.28	2901

Table 4. Average annual numbers of sea turtle captures for a five-year period before construction of the third intake (1977-1981) and for a five-year period after Unit II began operation (1984-1988), St. Lucie Plant intake canal, Hutchinson Island, Florida.

Species	Life History Stage	Mean Annual Capture Rate	
		1977-1981	1984-1988
Loggerhead Turtle	Juvenile	84.8	105.8
Loggerhead Turtle	Subadult	17.4	25.8
Loggerhead Turtle	Adult	7.8	29.0
Green Turtle	Juvenile	10.2	34.2

Table 5. Average annual numbers of sea turtle captures for a five-year period before velocity caps were damaged (1984-1988) and a five-year period after velocity caps were repaired (1992-1996), St. Lucie Plant intake canal, Hutchinson Island, Florida.

Species	Life History Stage	Mean Annual Capture Rate	
		1984-1988	1992-1996
Loggerhead Turtle	Juvenile	105.8	138.4
Loggerhead Turtle	Subadult	25.8	20.4
Loggerhead Turtle	Adult	29.0	48.4
Green Turtle	Juvenile	34.2	325.2

Table 6. Maintenance/refueling outage periods for each of the St. Lucie Plant units. Unit I outages are designated by vertical shading and Unit II outages are designated by black areas. Outages were assigned to months in which circulating water pumps operated for less than 25 days. The asterisks indicate the month (June 1983) in which Unit II went on-line.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977												
1978												
1979												
1980												
1981												
1982												
1983						******						
1984												
1985												
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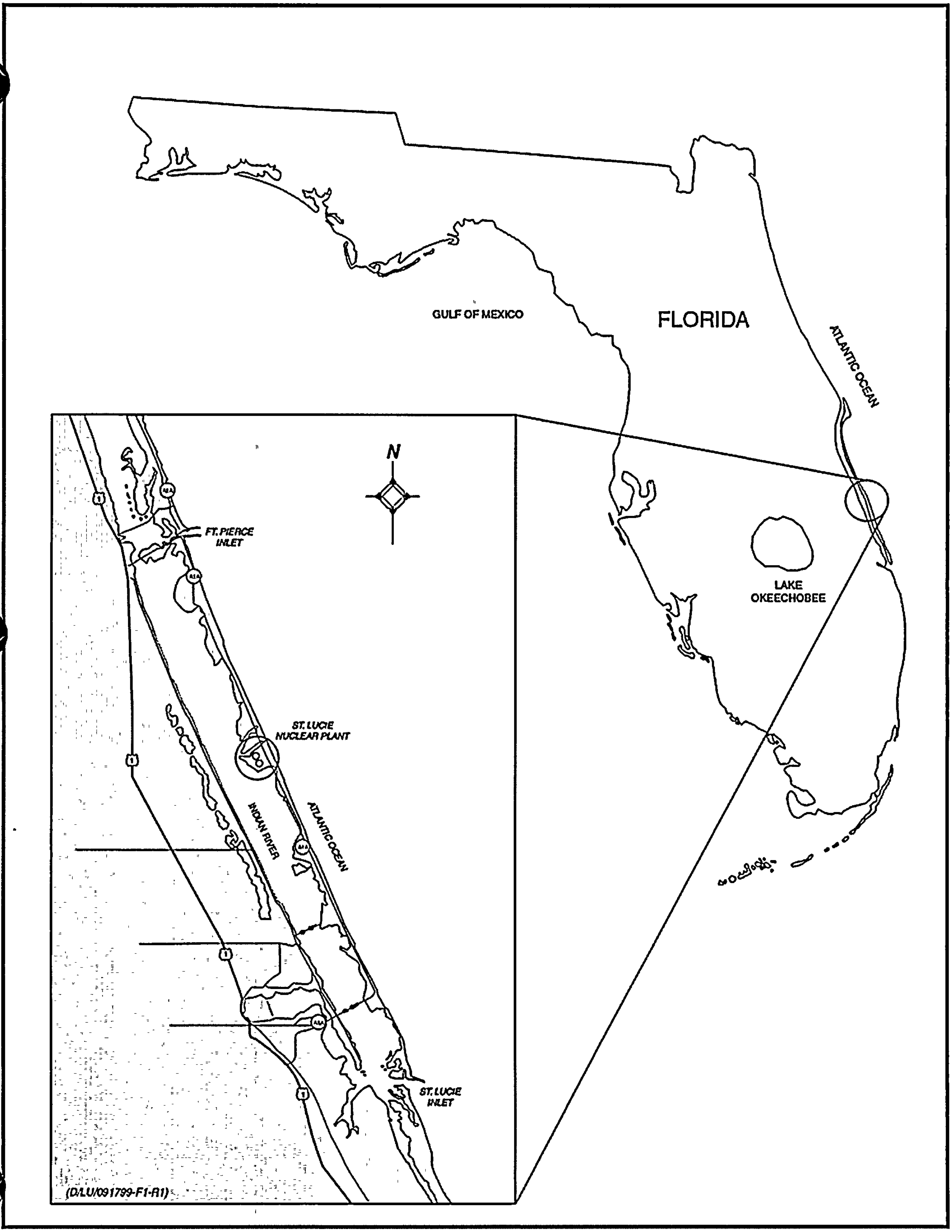

Figure 1. Location of St. Lucie Plant, Hutchinson Island, Florida.

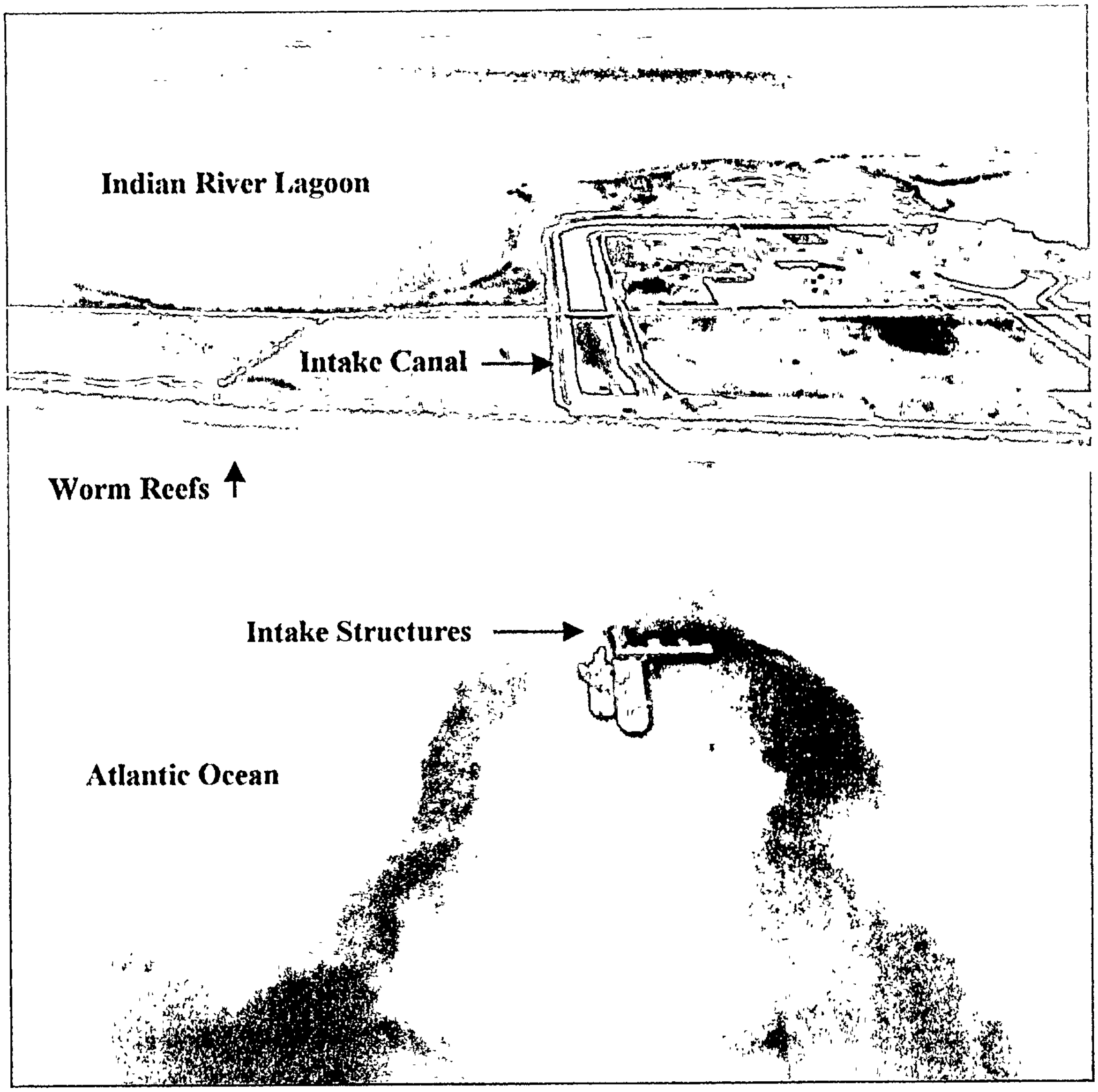

Figure 2. Aerial view of the St. Lucie Plant, Hutchinson Island, Florida. The above-water structures and barges in the vicinity of the intake structures were only present during velocity cap repairs during 1991 and 1992.

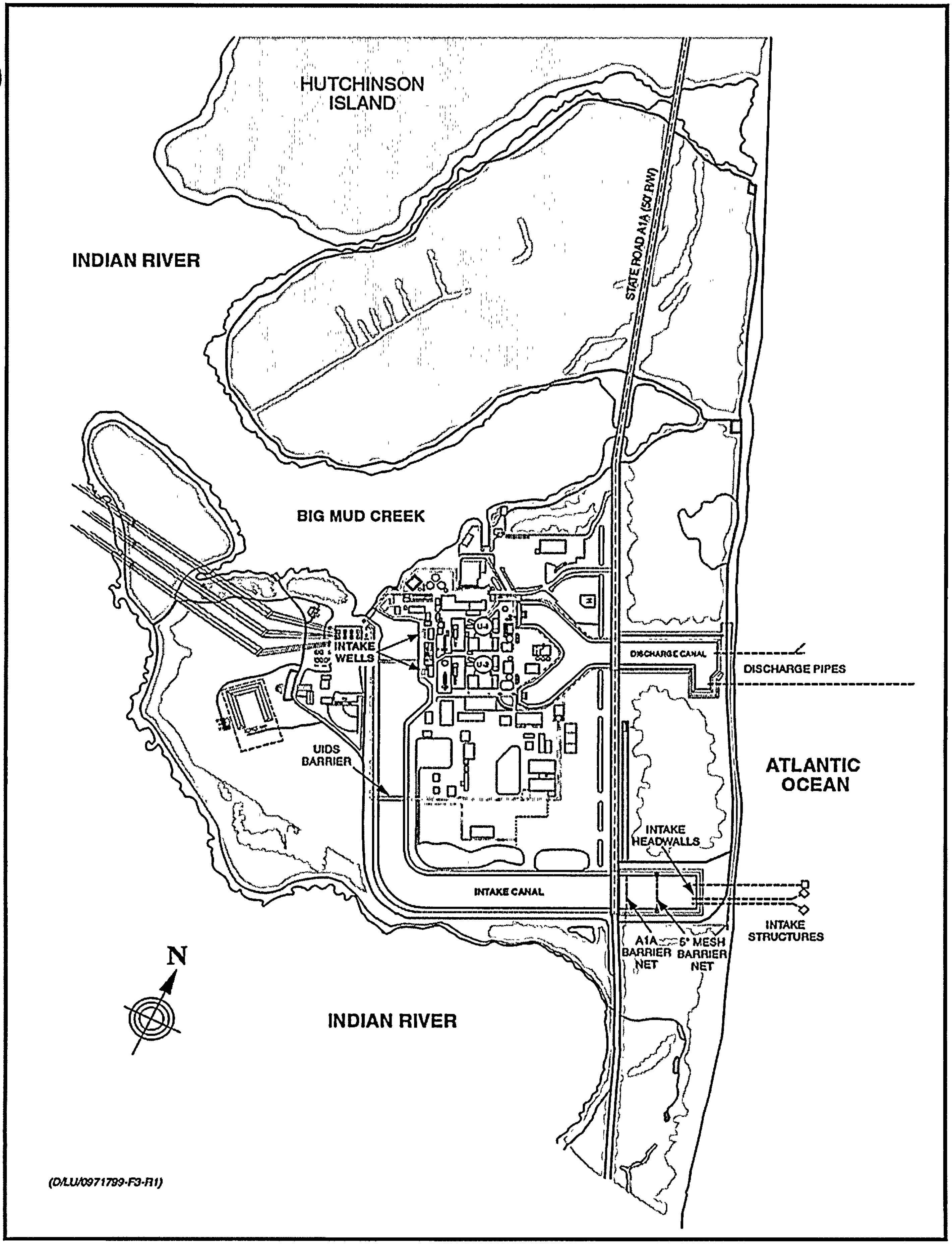

Figure 3. St. Lucie Plant cooling water intake and discharge system.

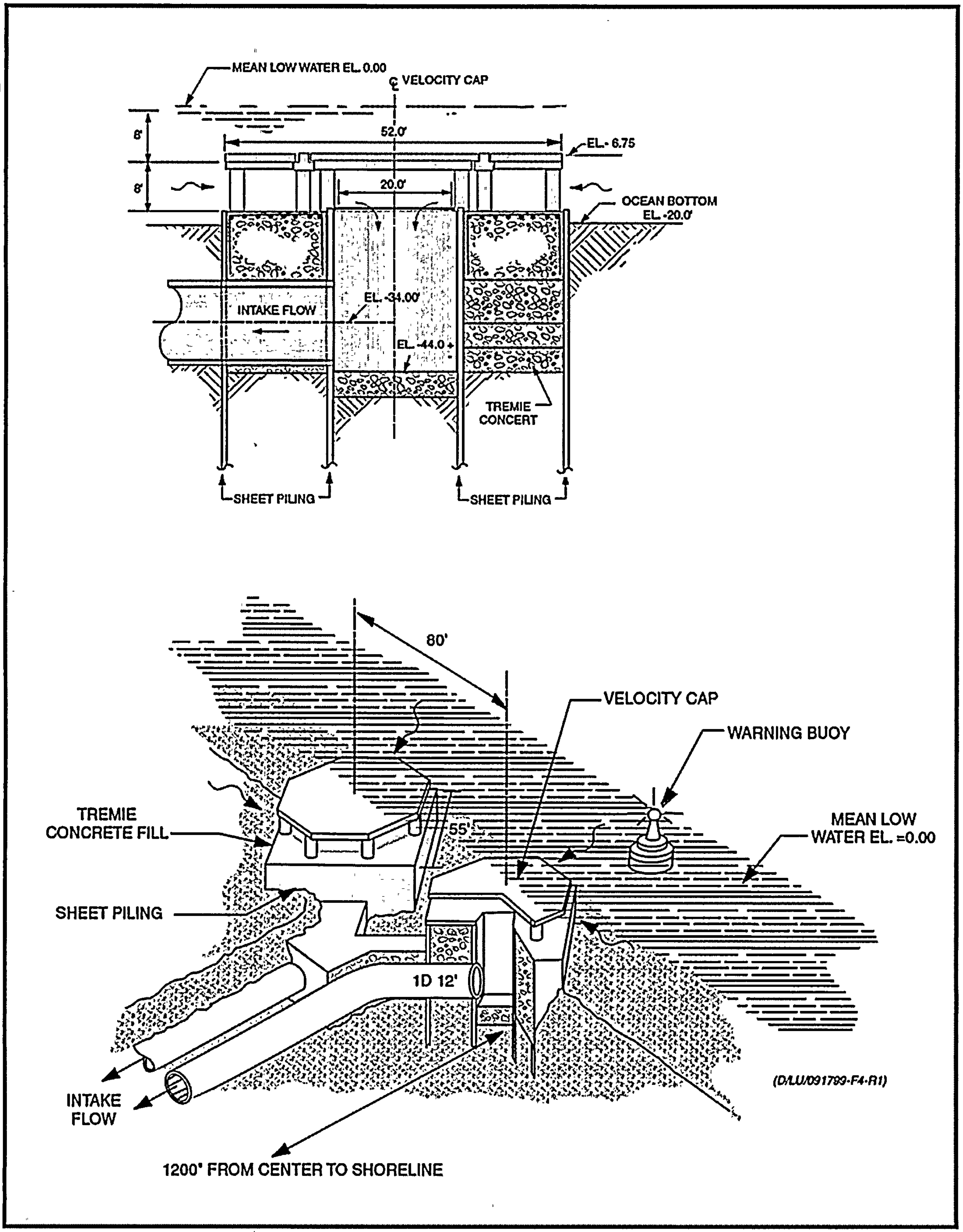

Figure 4. Configuration of the two 3.7-meter-diameter intake structures, St. Lucie Plant, Hutchinson Island, Florida.

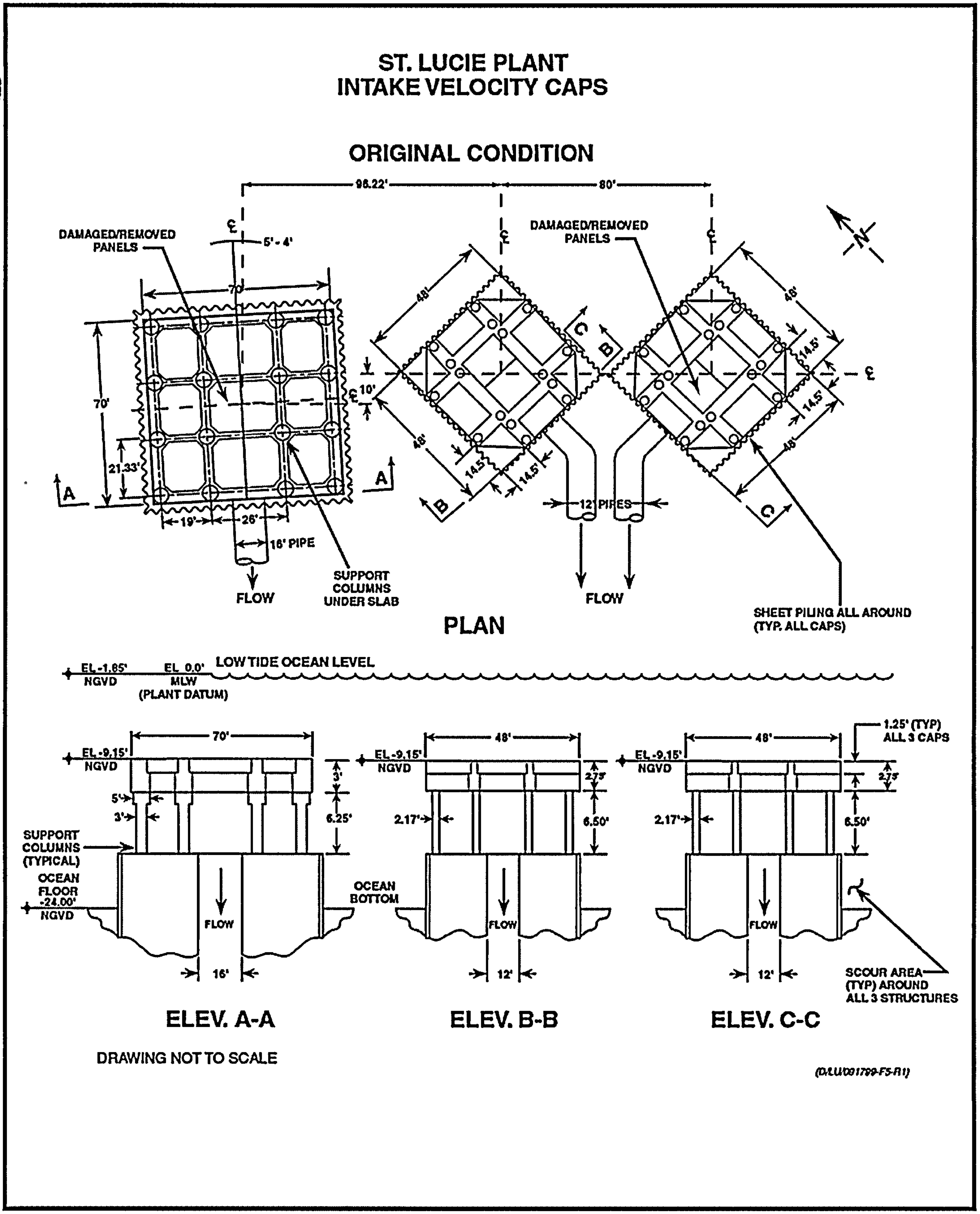

Figure 5. Diagram of the three intake structures located 1200 feet (365 m) offshore of the shoreline at the St. Lucie Plant, Hutchinson Island, Florida. Dimensions represent conditions prior to velocity cap repairs completed in February 1992.

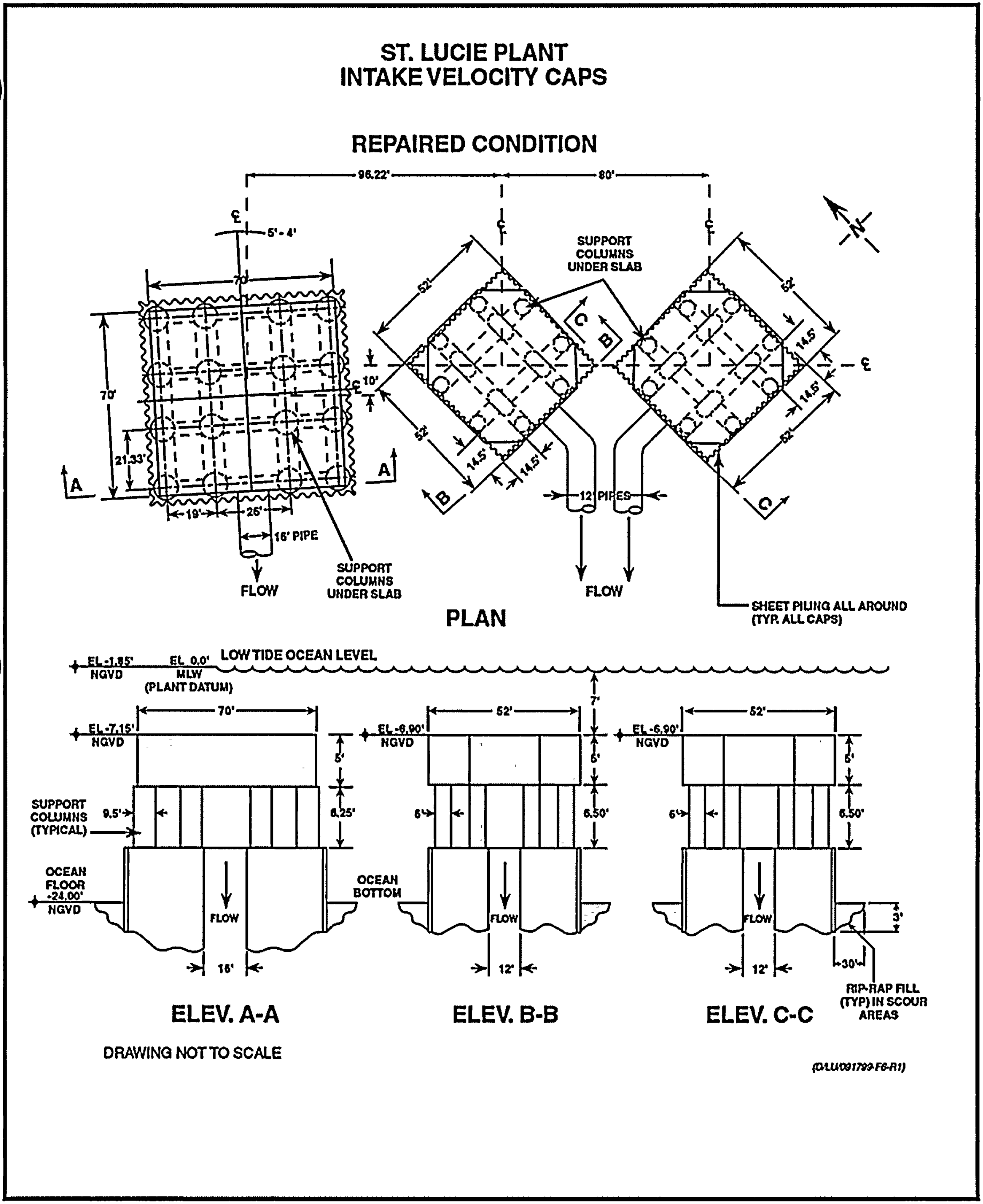

Figure 6. Diagram of the three intake structures located 1200 feet (365 m) offshore of the shoreline at the St. Lucie Plant, Hutchinson Island, Florida. Dimensions represent conditions after velocity cap repairs completed in February 1992.

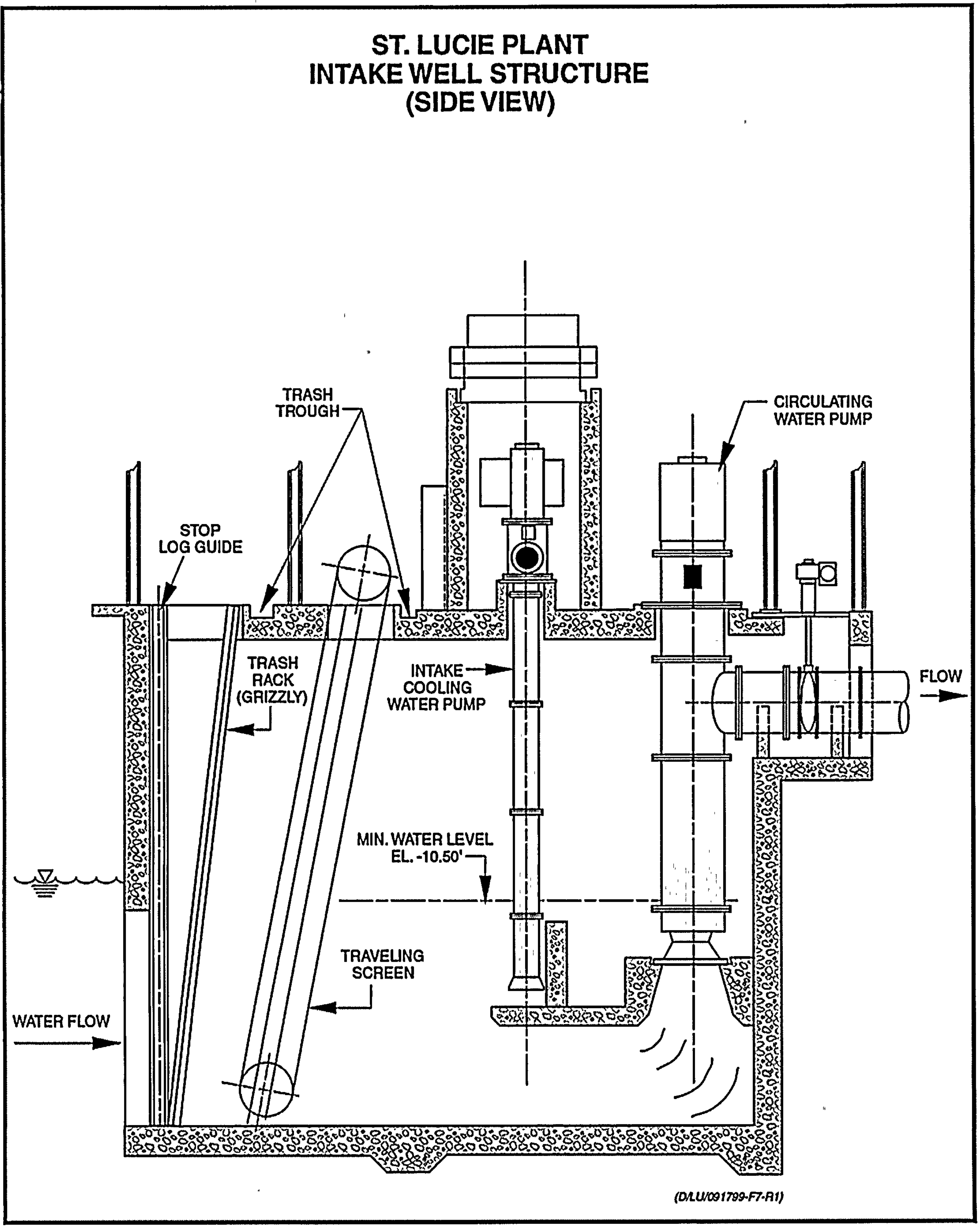

Figure 7. Diagram of an intake well at the St. Lucie Plant, Hutchinson Island, Florida.

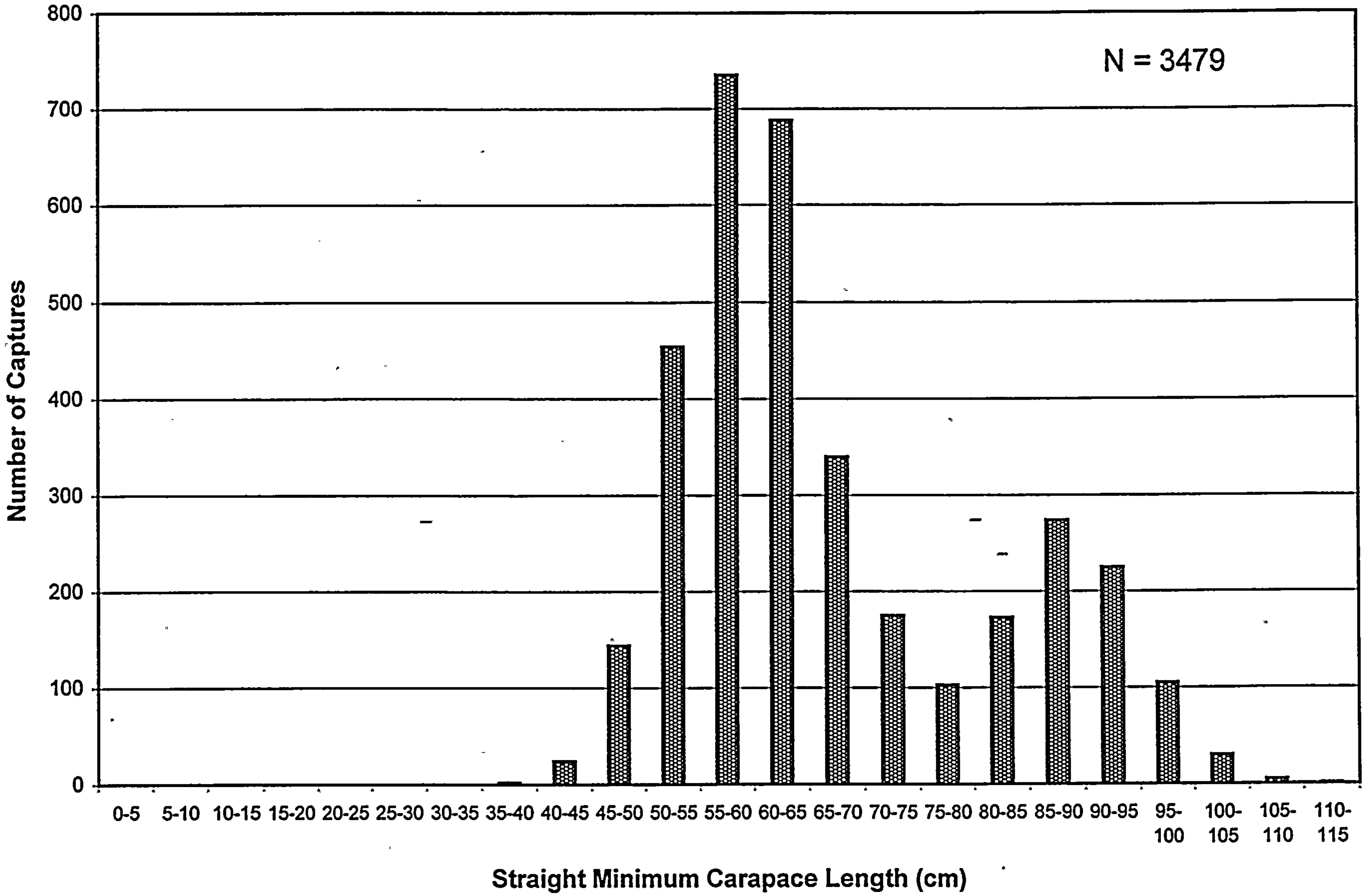

Figure 8. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

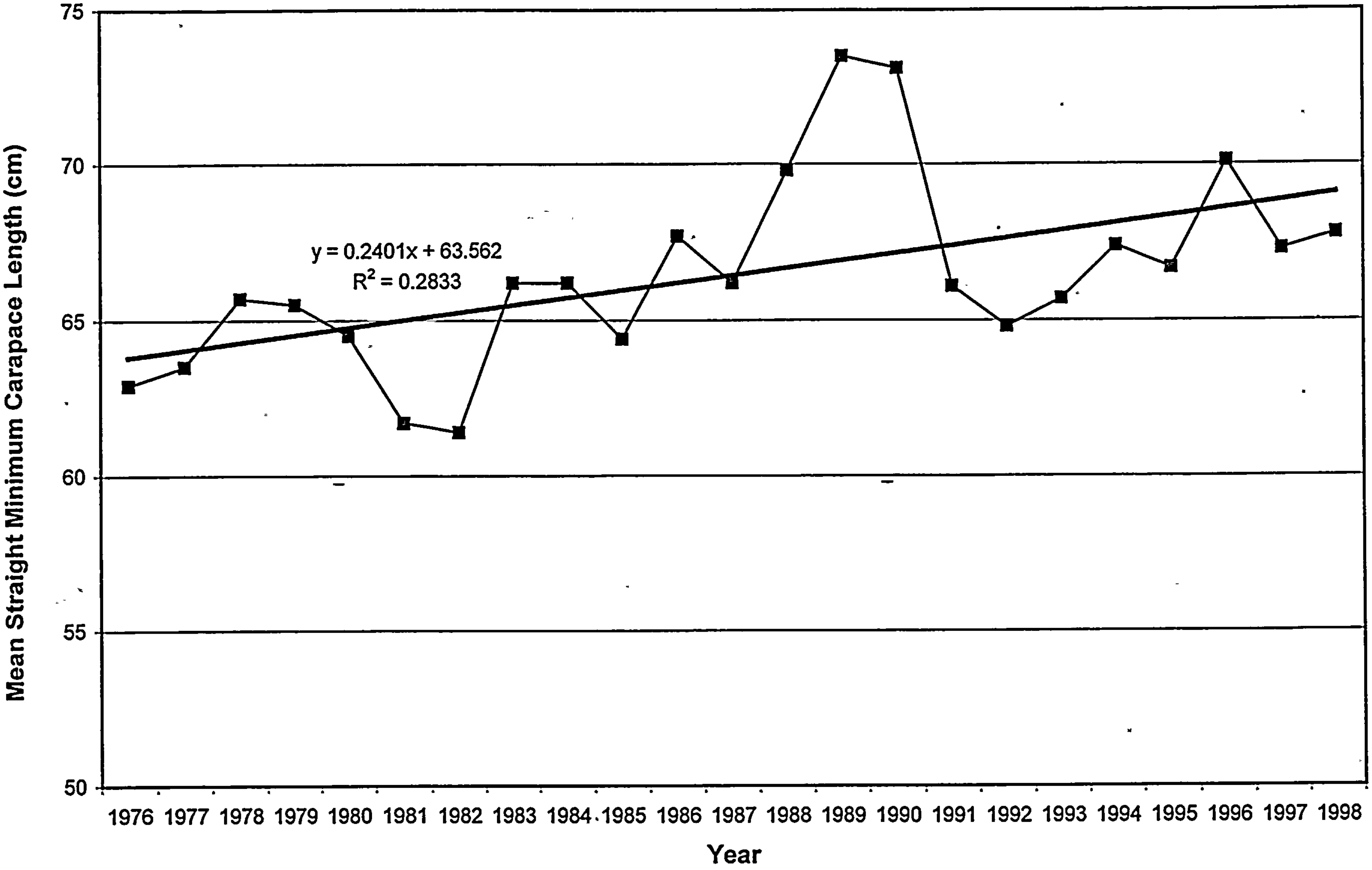

Figure 9. Mean size (straight minimum carapace length) of all loggerhead turtles captured each year in the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

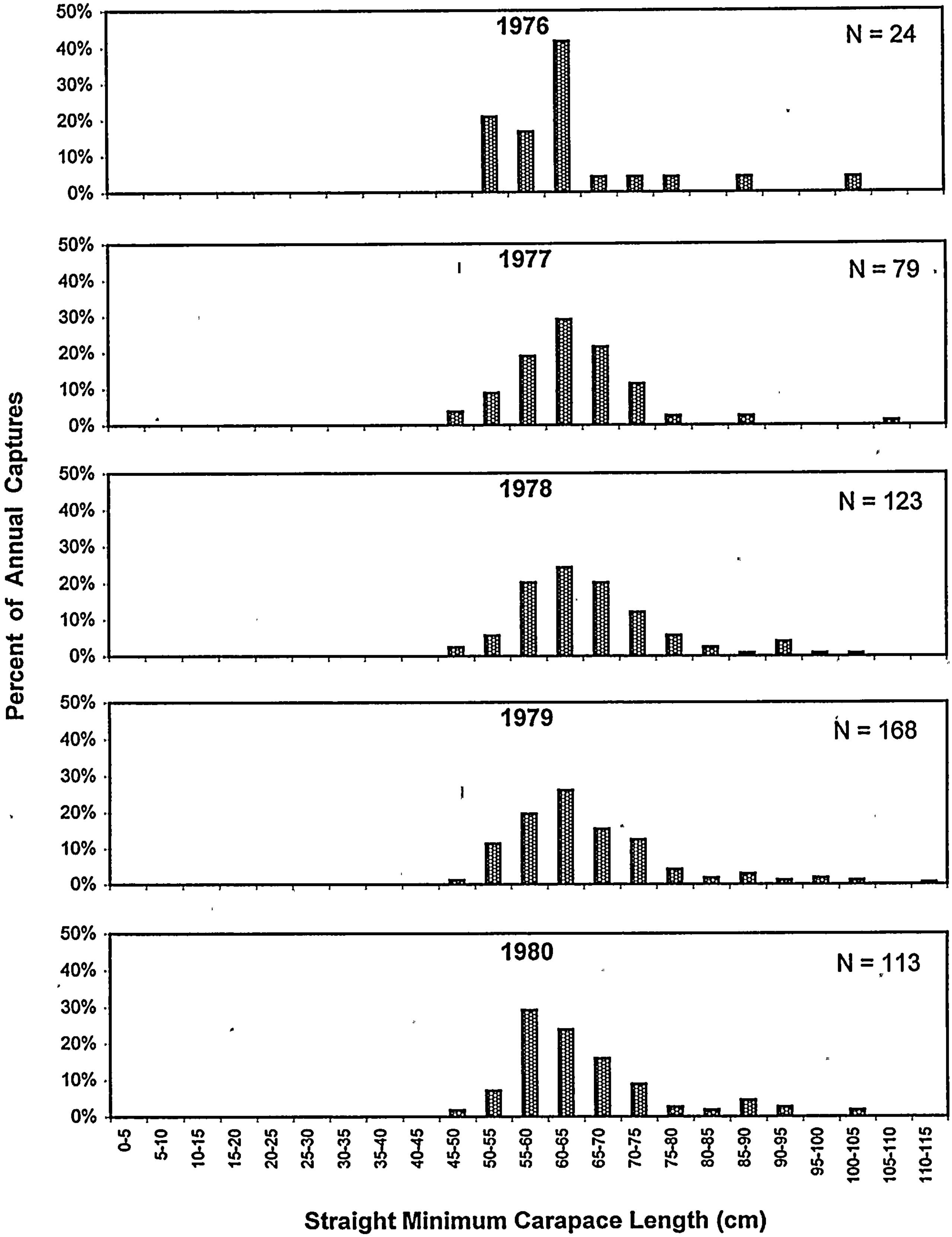

Figure 10. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1980.

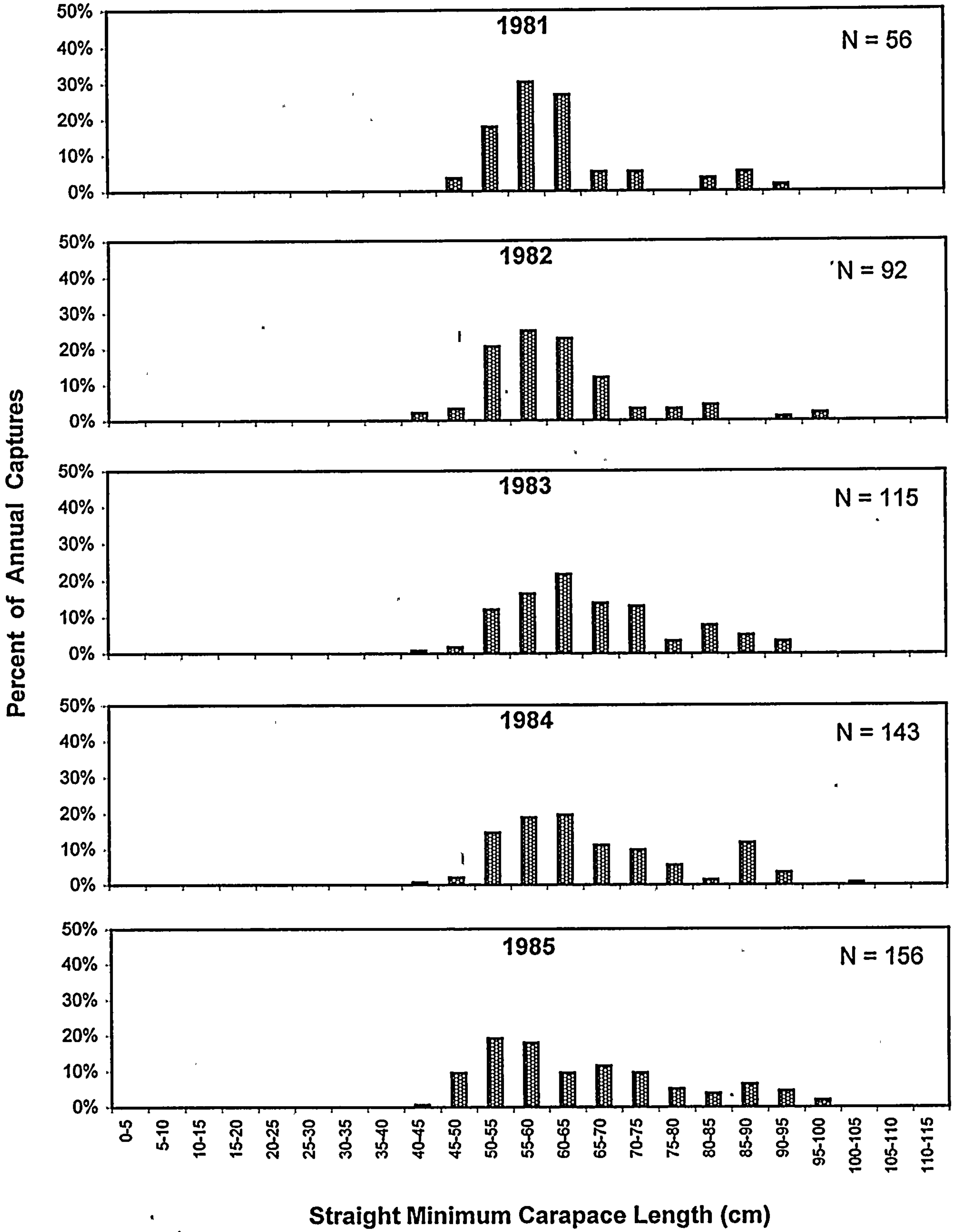

Figure 11. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1981-1985.

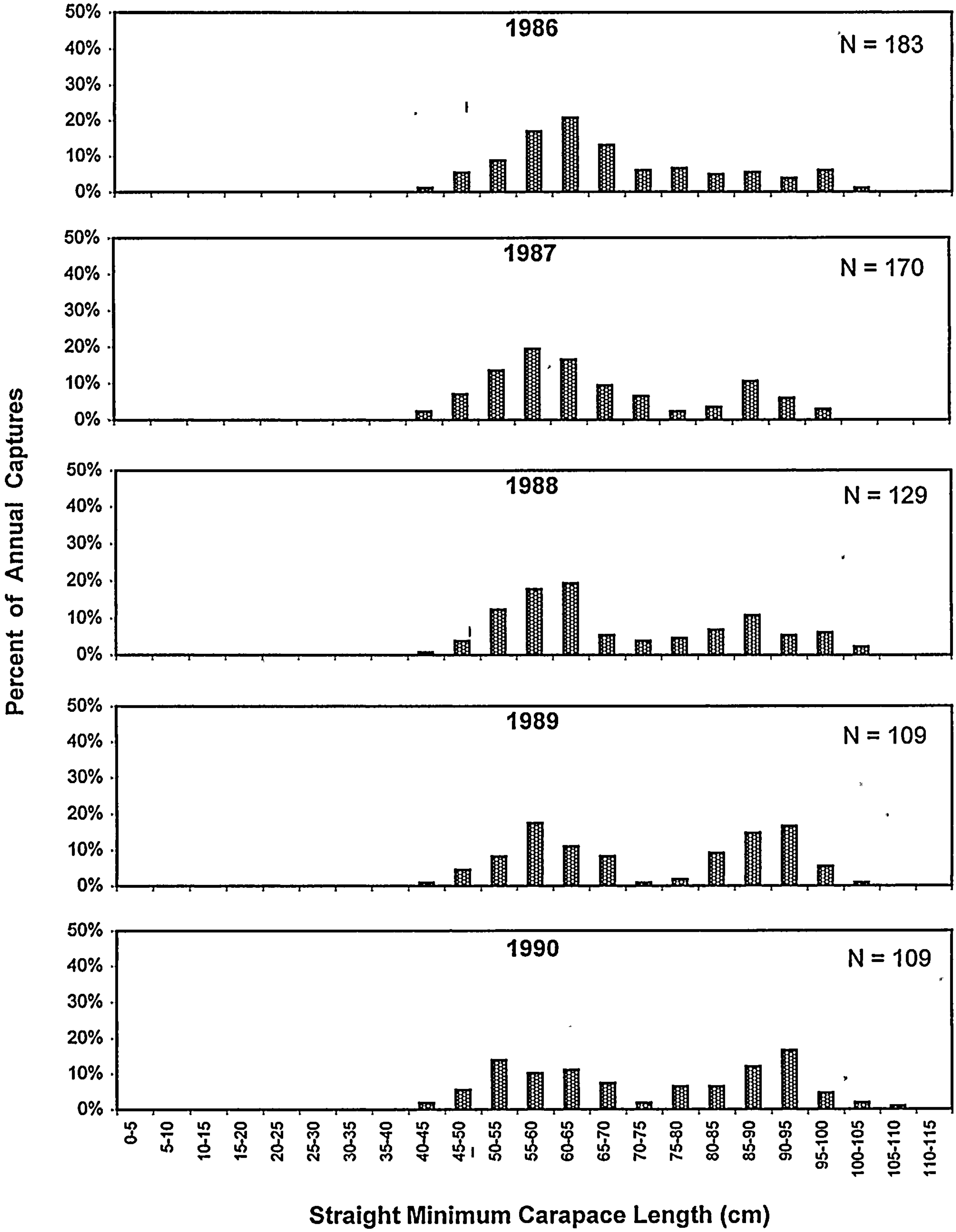

Figure 12. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1986-1990.

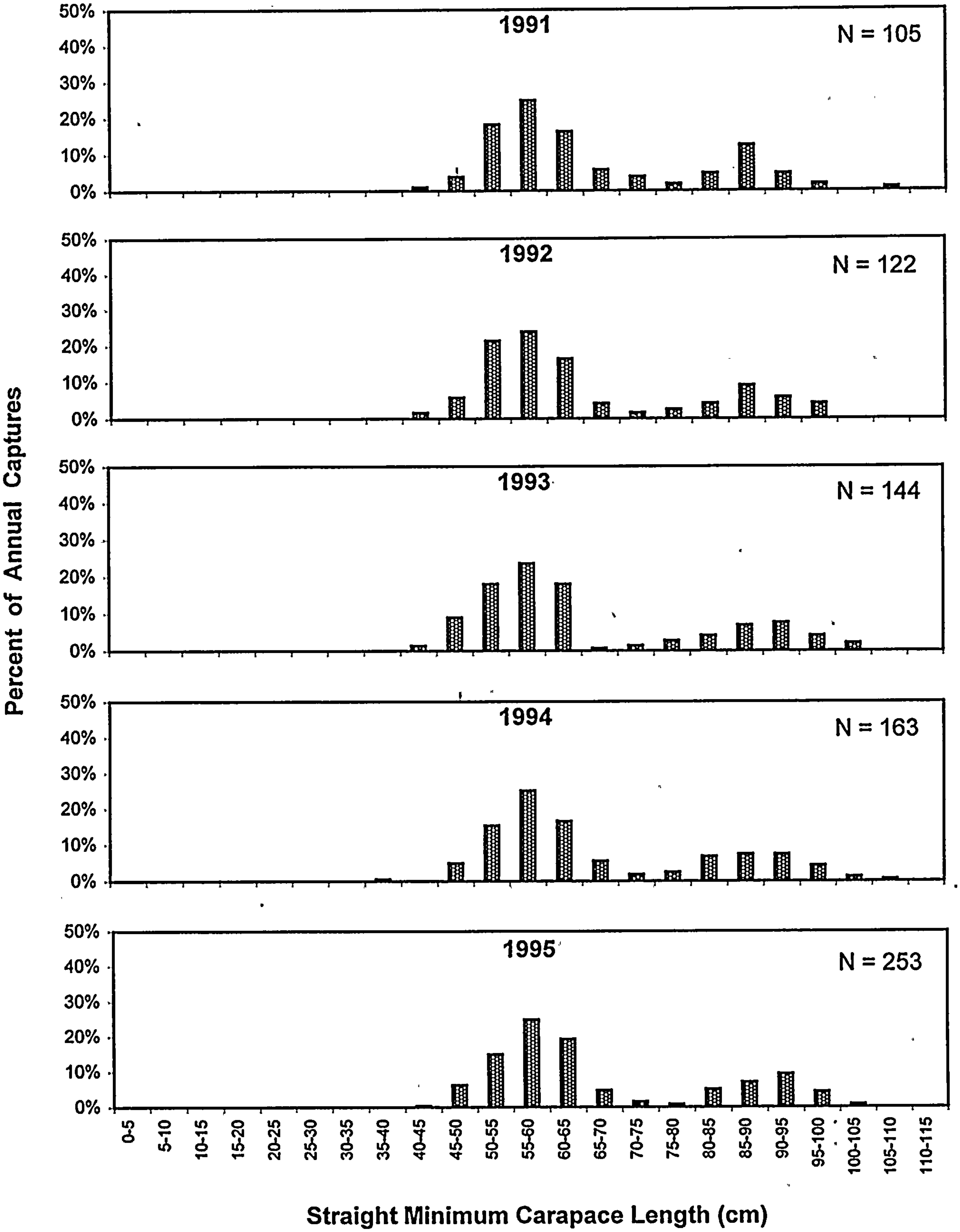

Figure 13. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1991-1995.

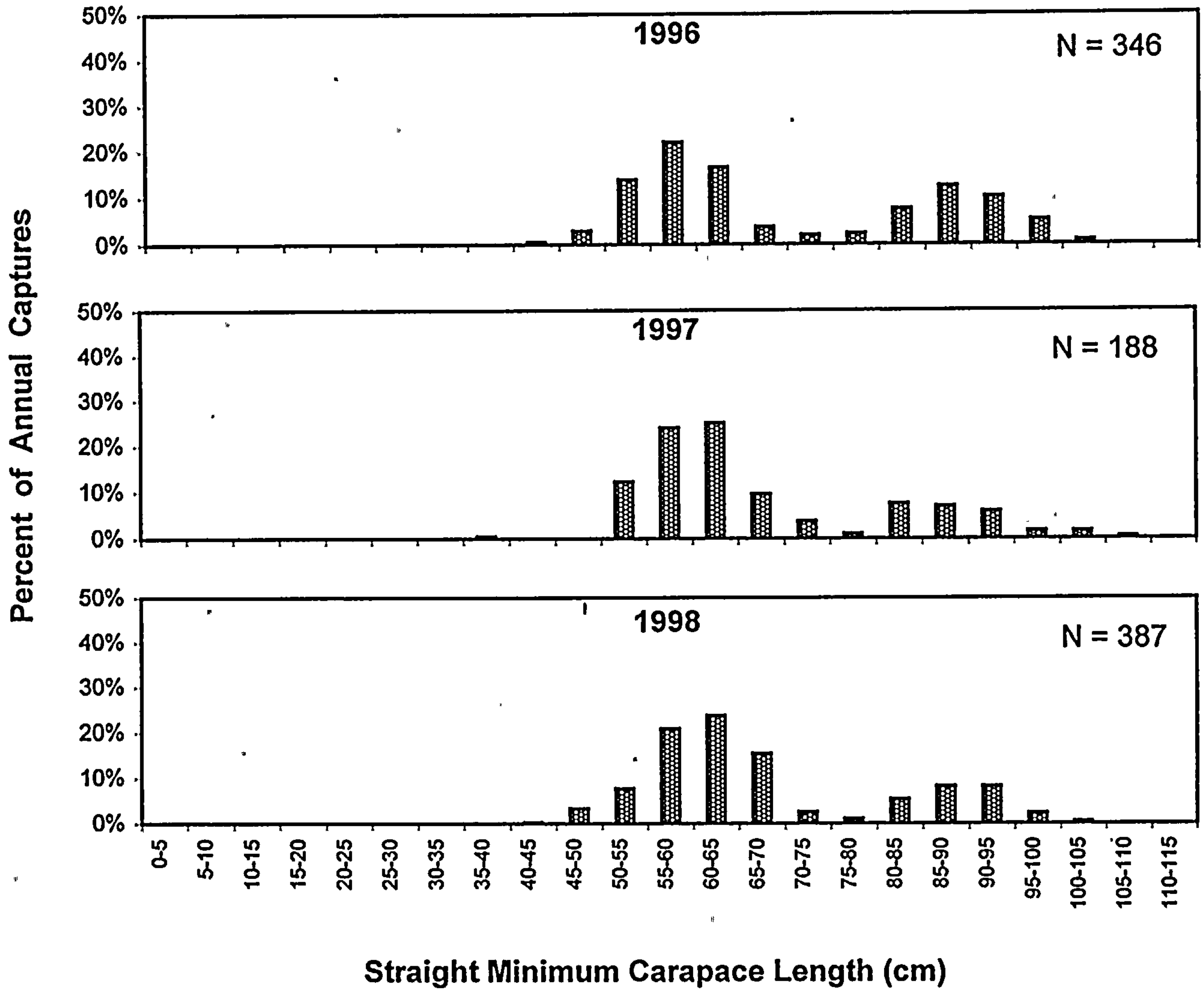

Figure 14. Distribution of straight minimum carapace length measurements for loggerhead turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1996-1998.

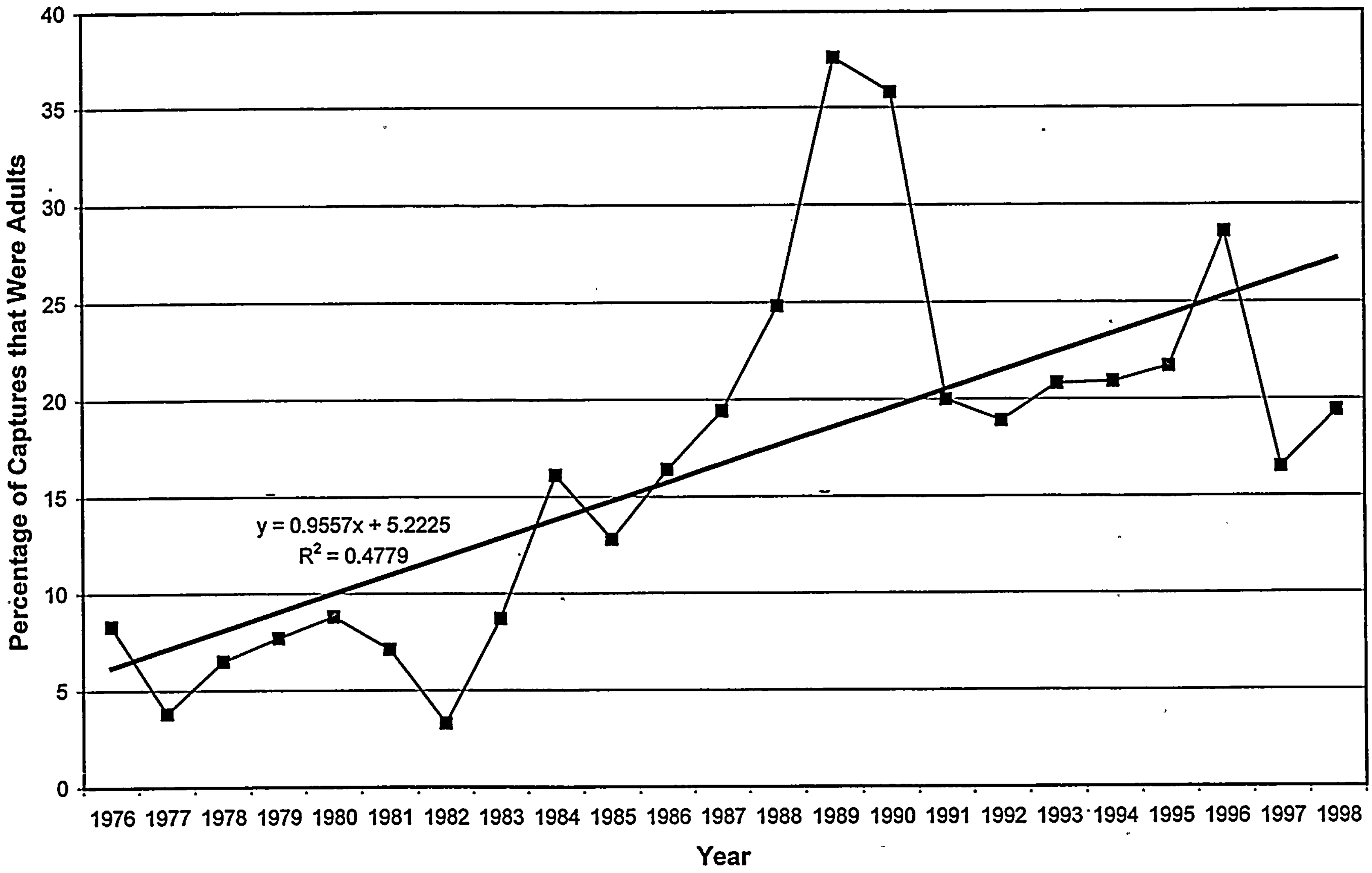

Figure 15. Percentage of annual loggerhead captures that were adults, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

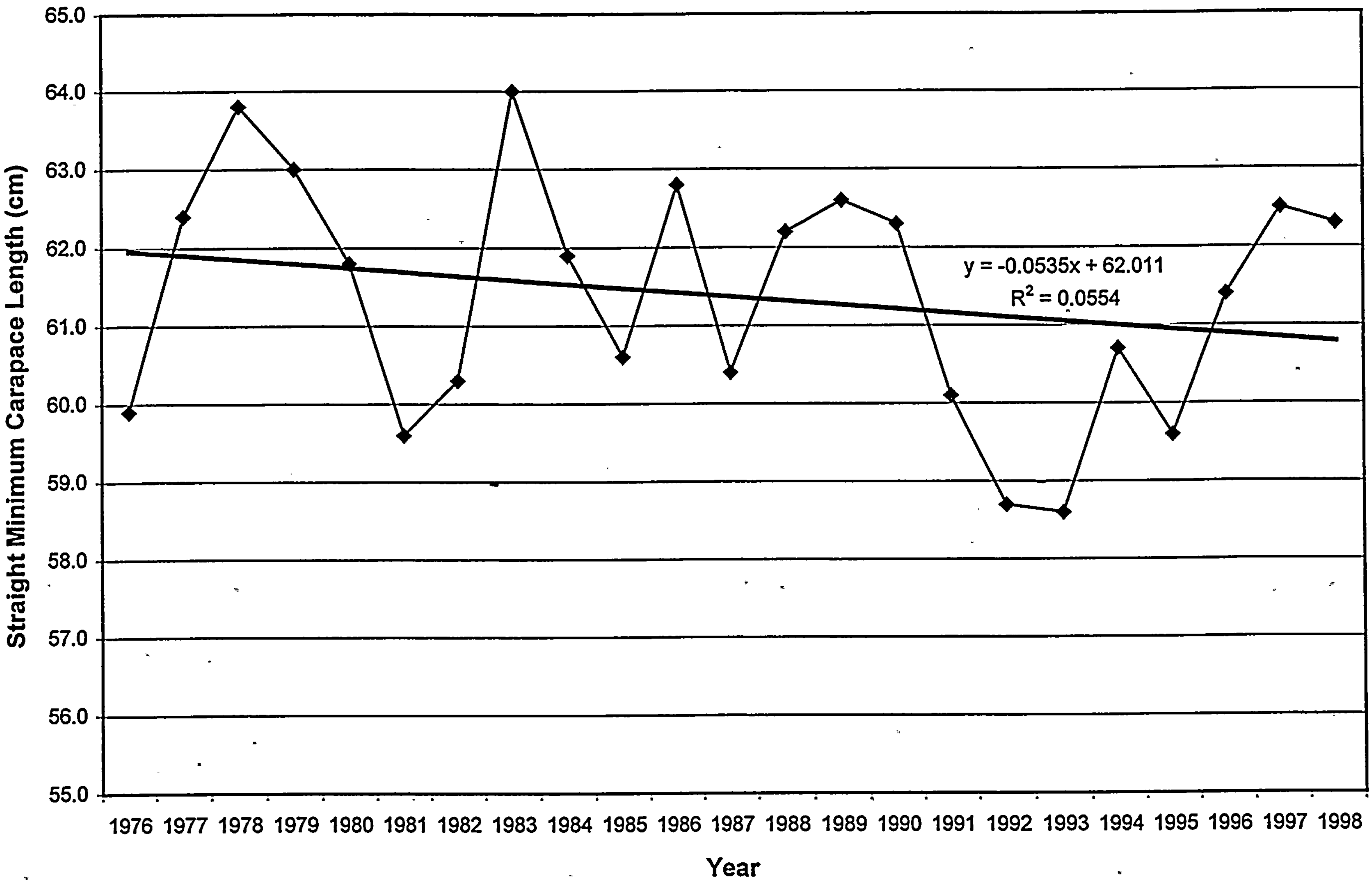

Figure 16. Mean size (straight minimum carapace length) of immature loggerhead turtles captured each year in the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

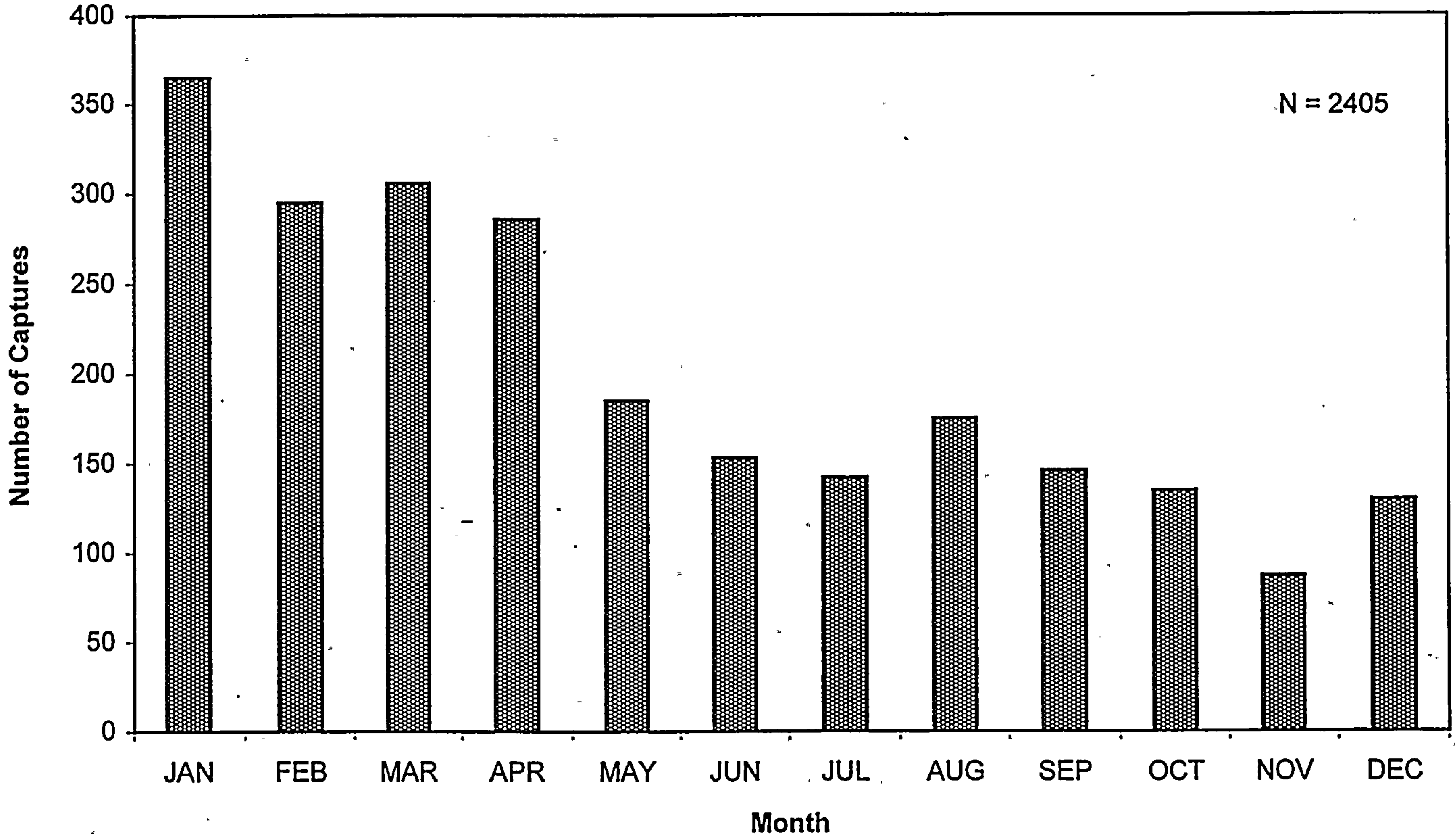

Figure 17. Number of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

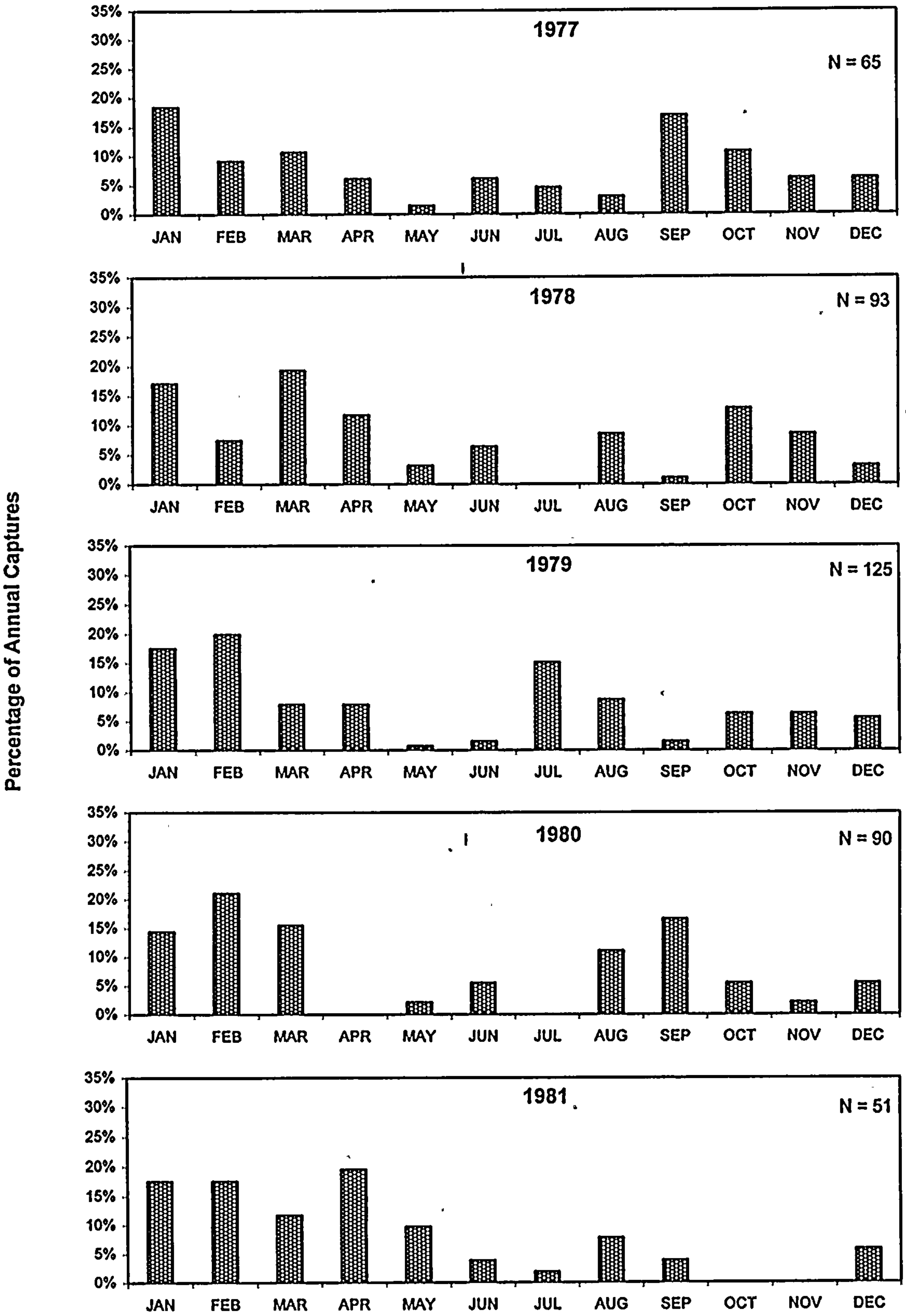

Figure 18. Percentage of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1981. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

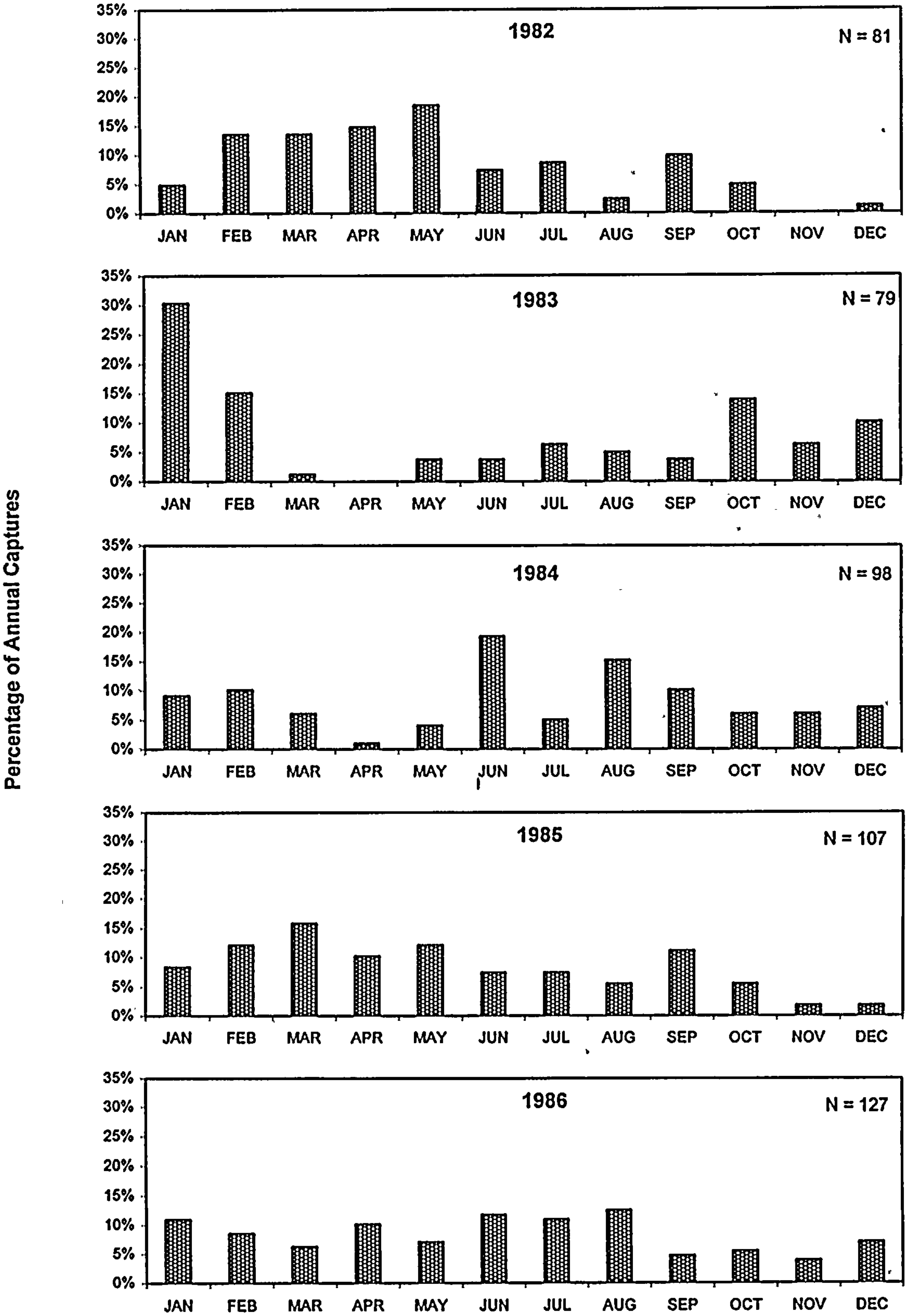

Figure 19. Percentage of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1982-1986.

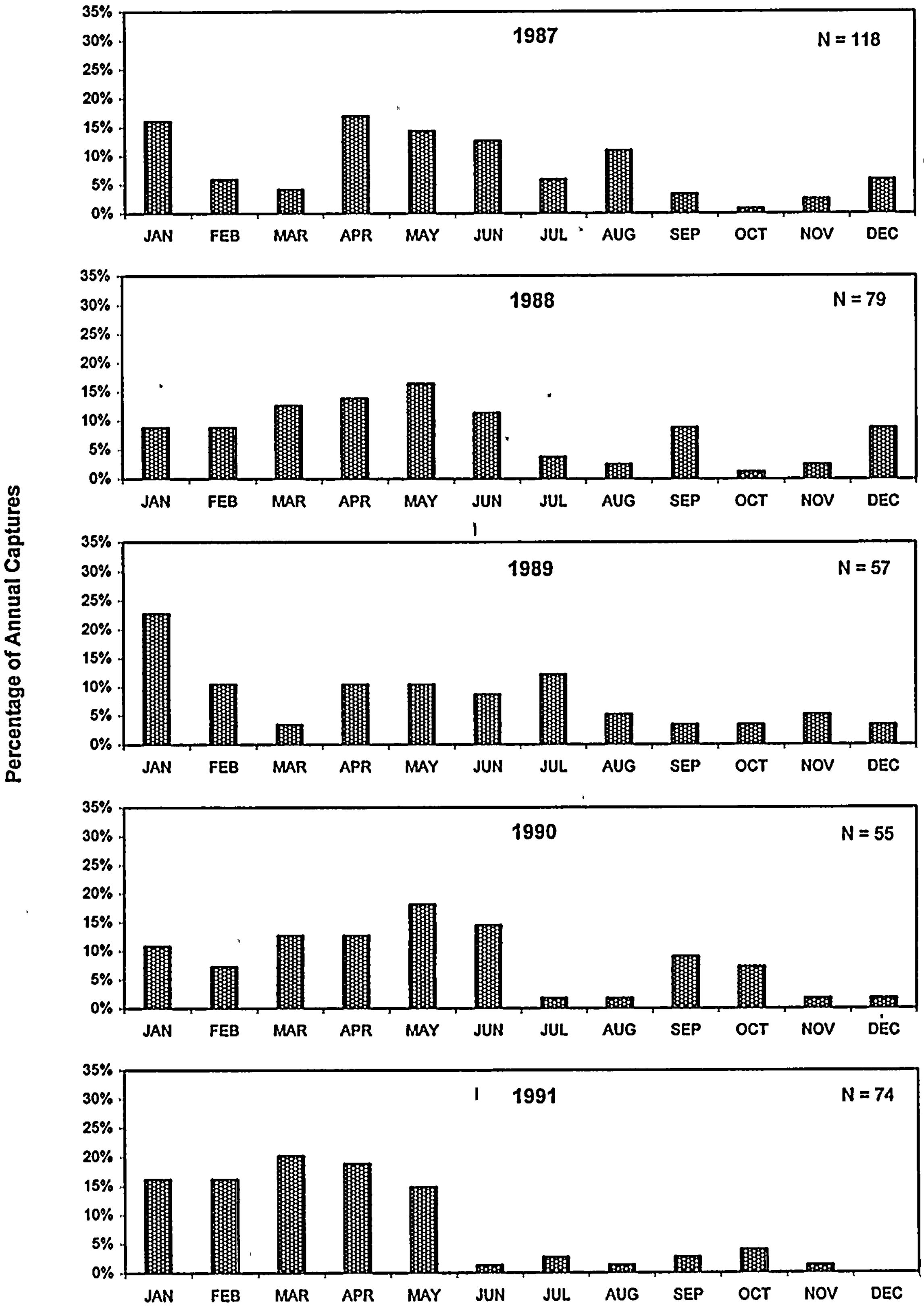

Figure 20. Percentage of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1987-1991.

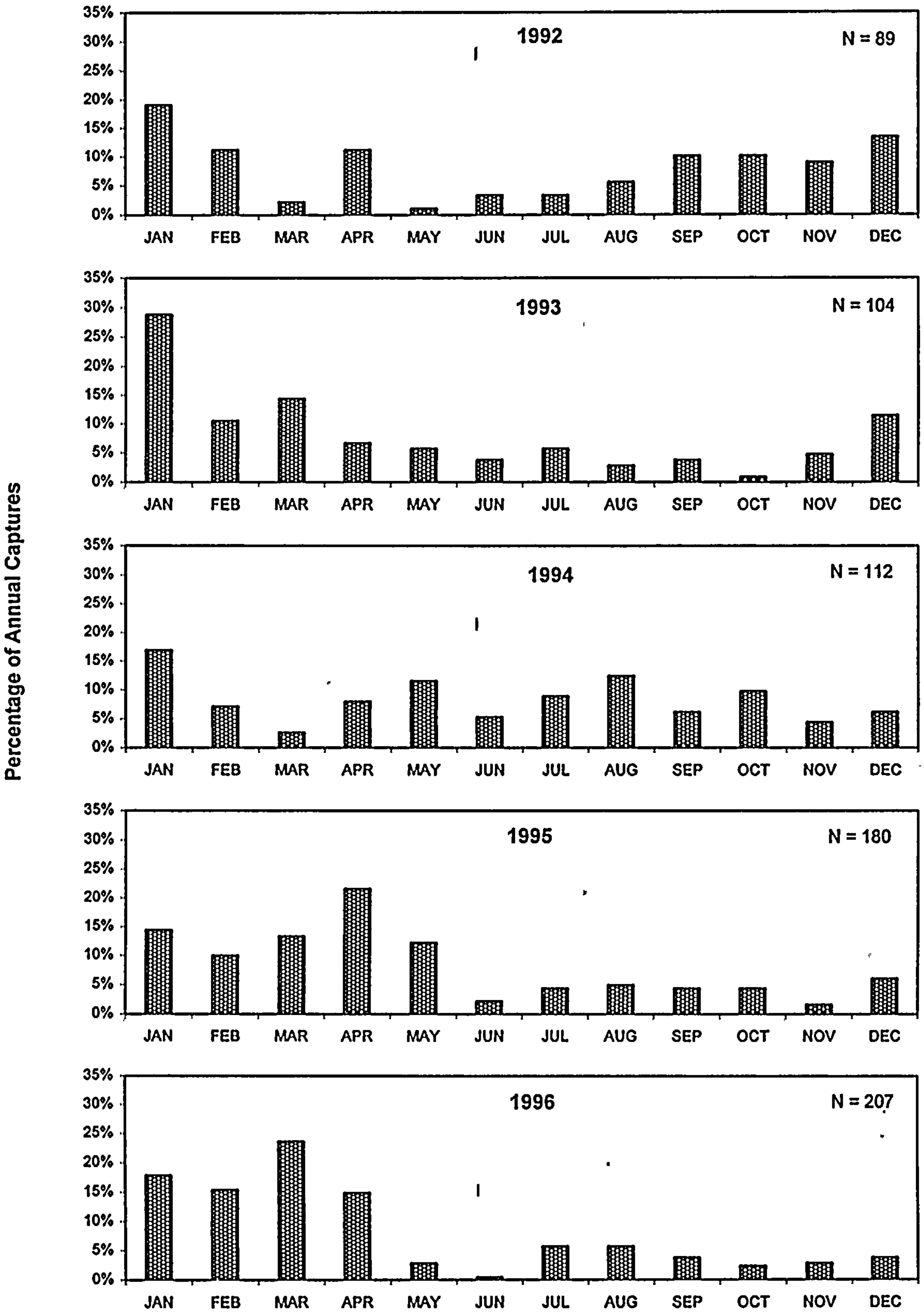

Figure 21. Percentage of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1992-1996.

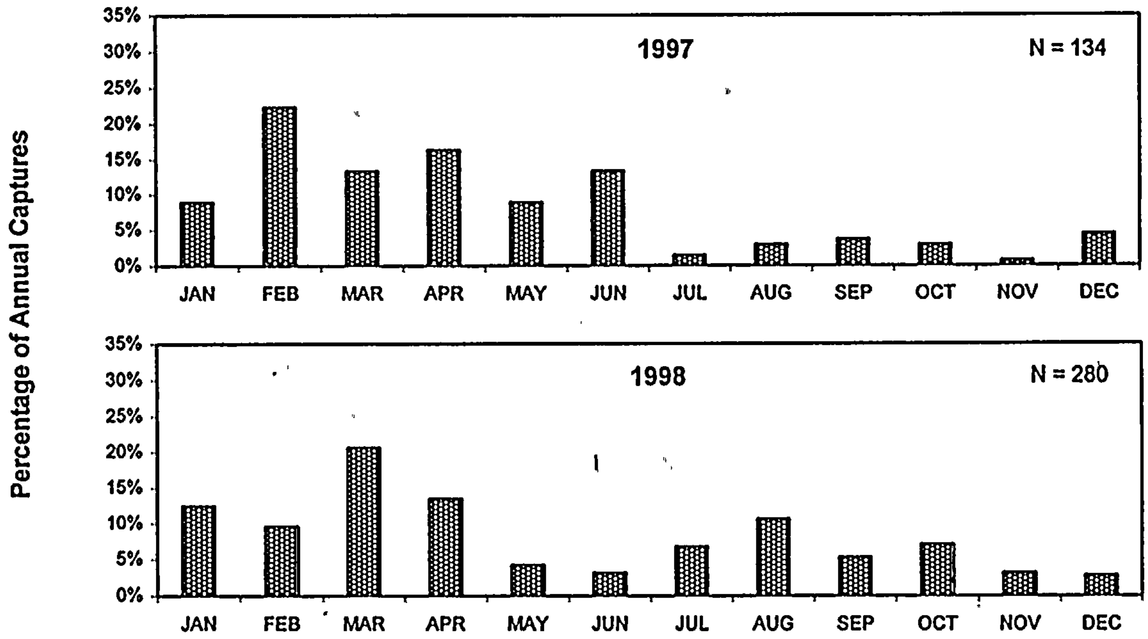

Figure 22. Percentage of juvenile loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1997-1998.

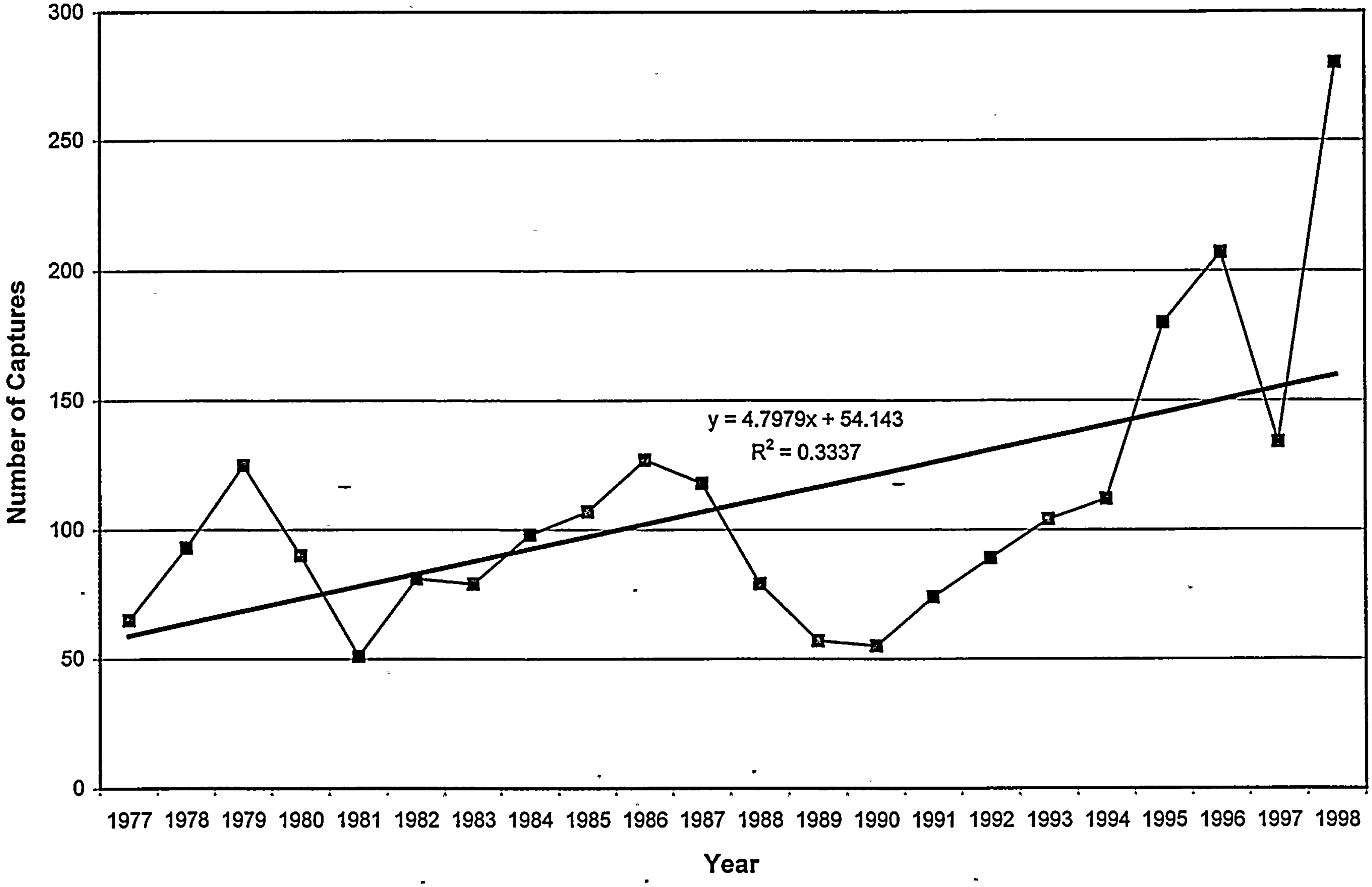

Figure 23. Annual number of juvenile loggerhead captures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

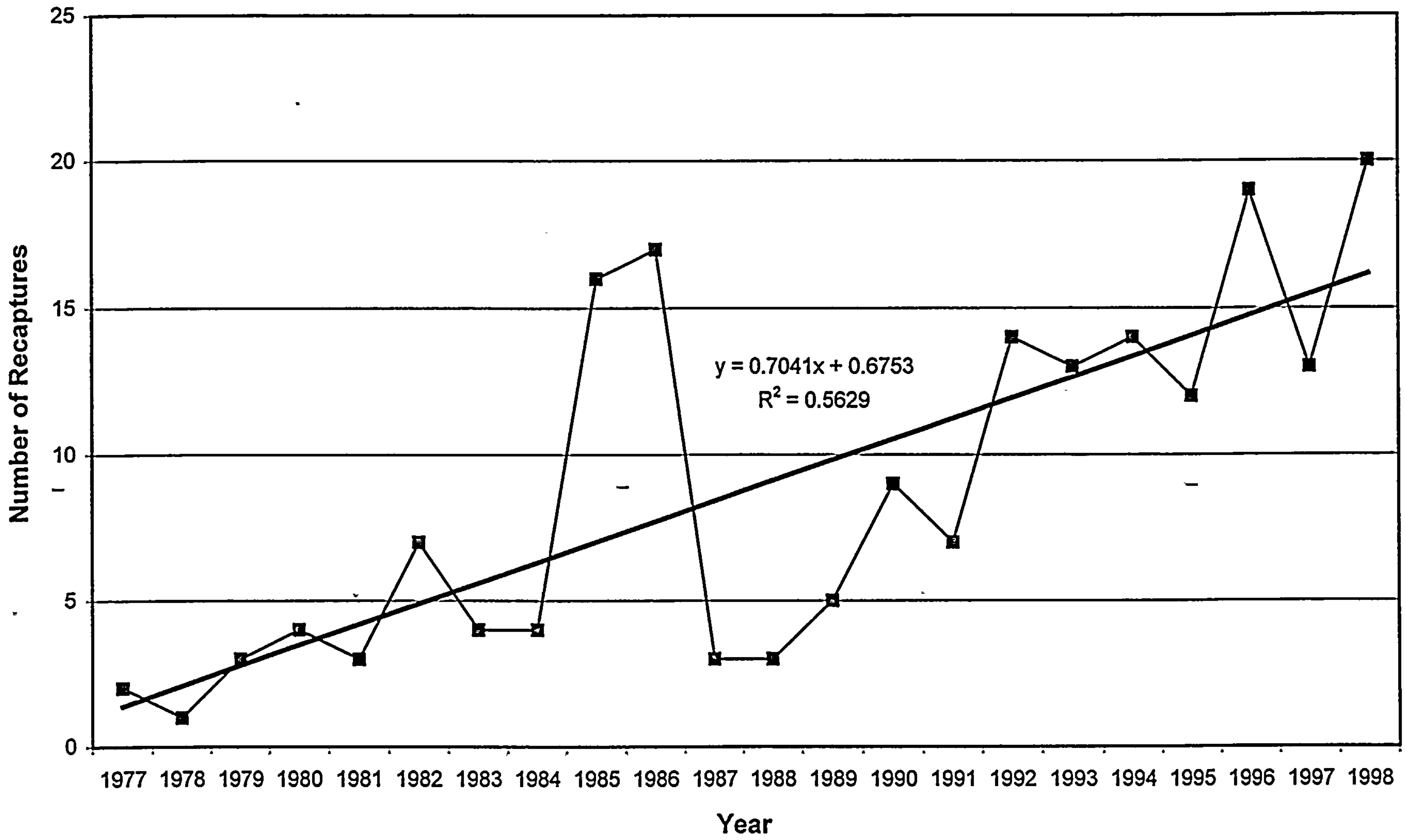

Figure 24. Annual number of juvenile loggerhead recaptures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

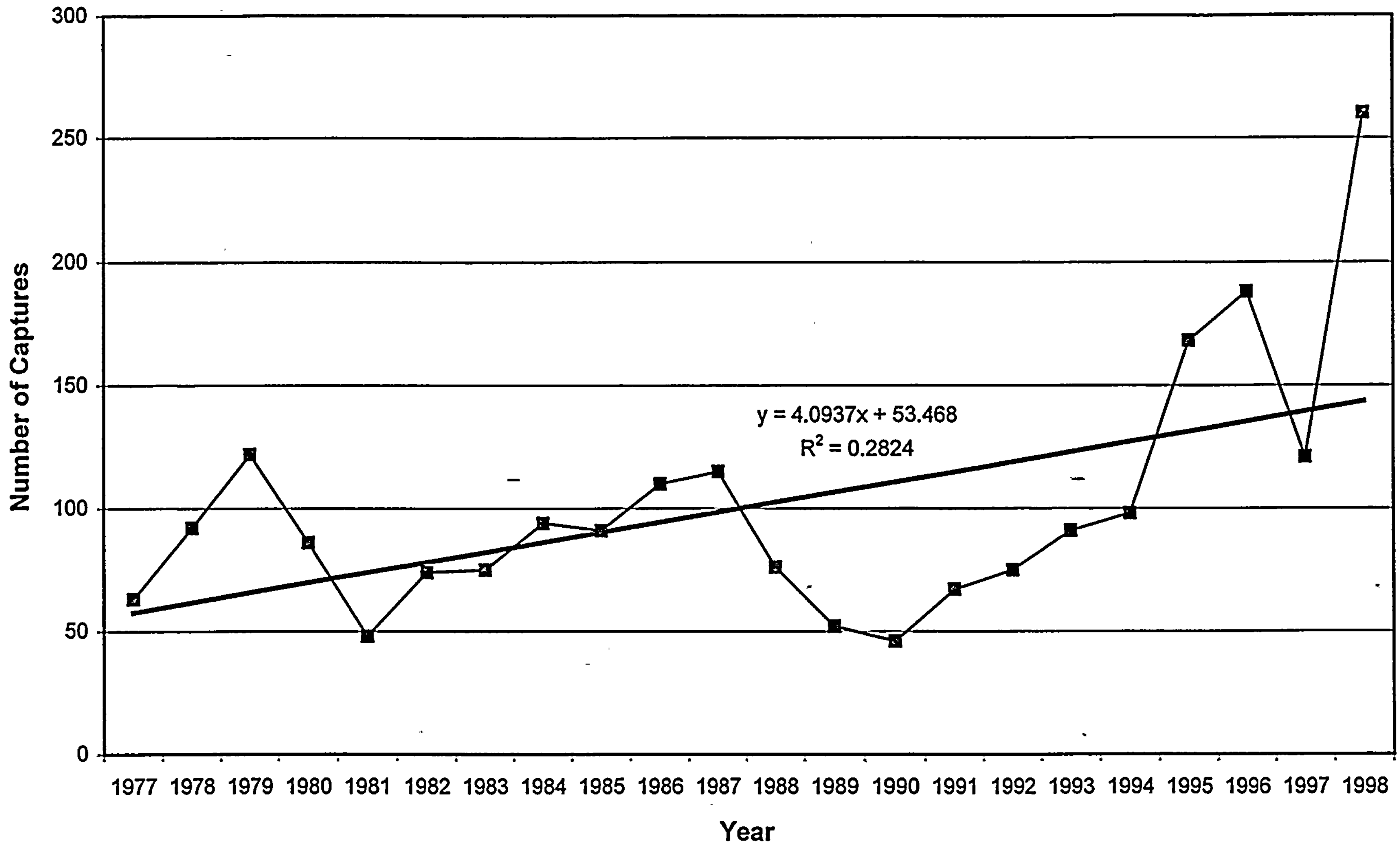

Figure 25. Annual number of juvenile loggerhead captures excluding recaptures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

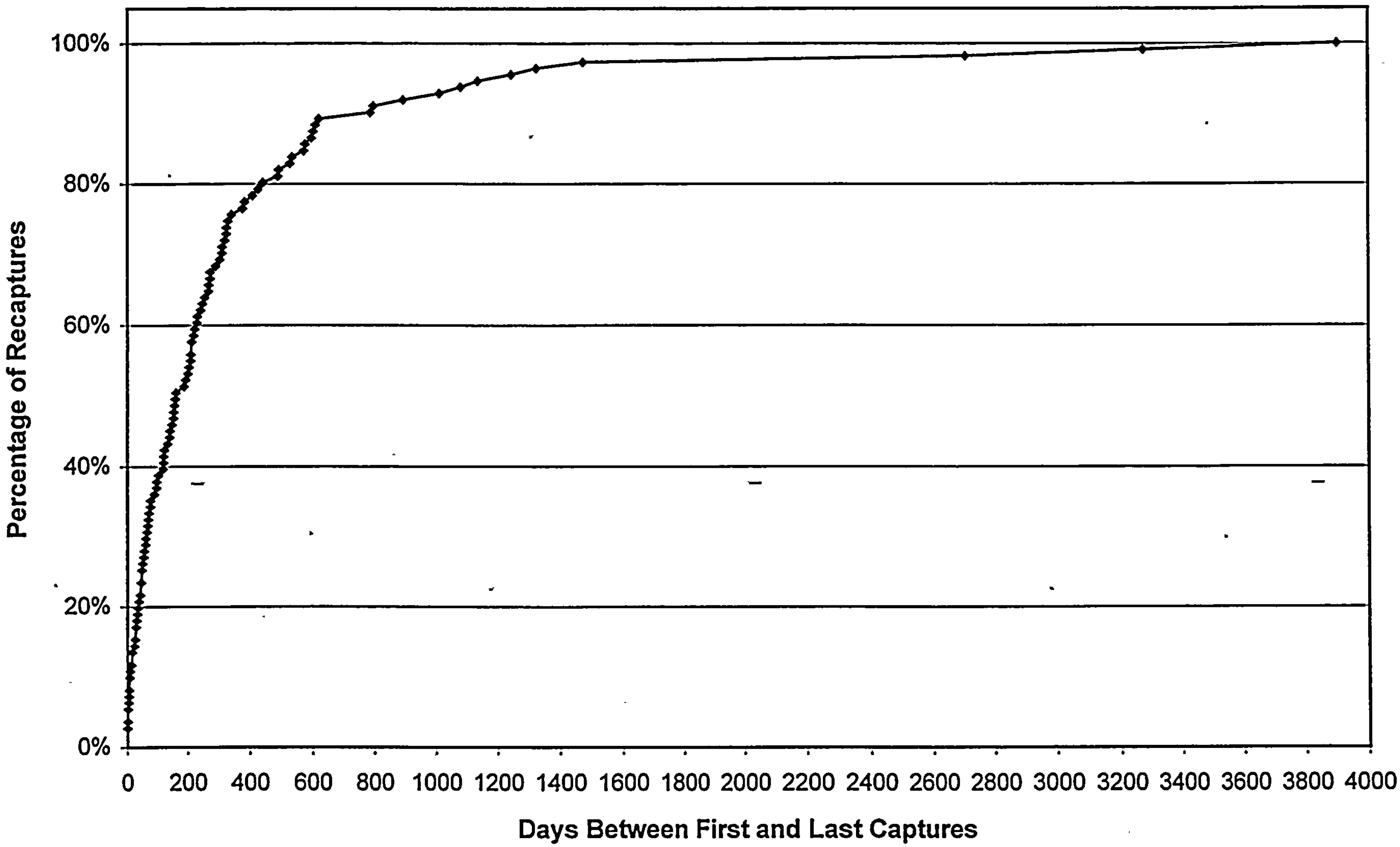

Figure 26. The percentage of juvenile loggerhead recaptures that occurred within each time interval between first and last capture, St. Lucie Plant intake canal, Hutchinson Island, Florida.

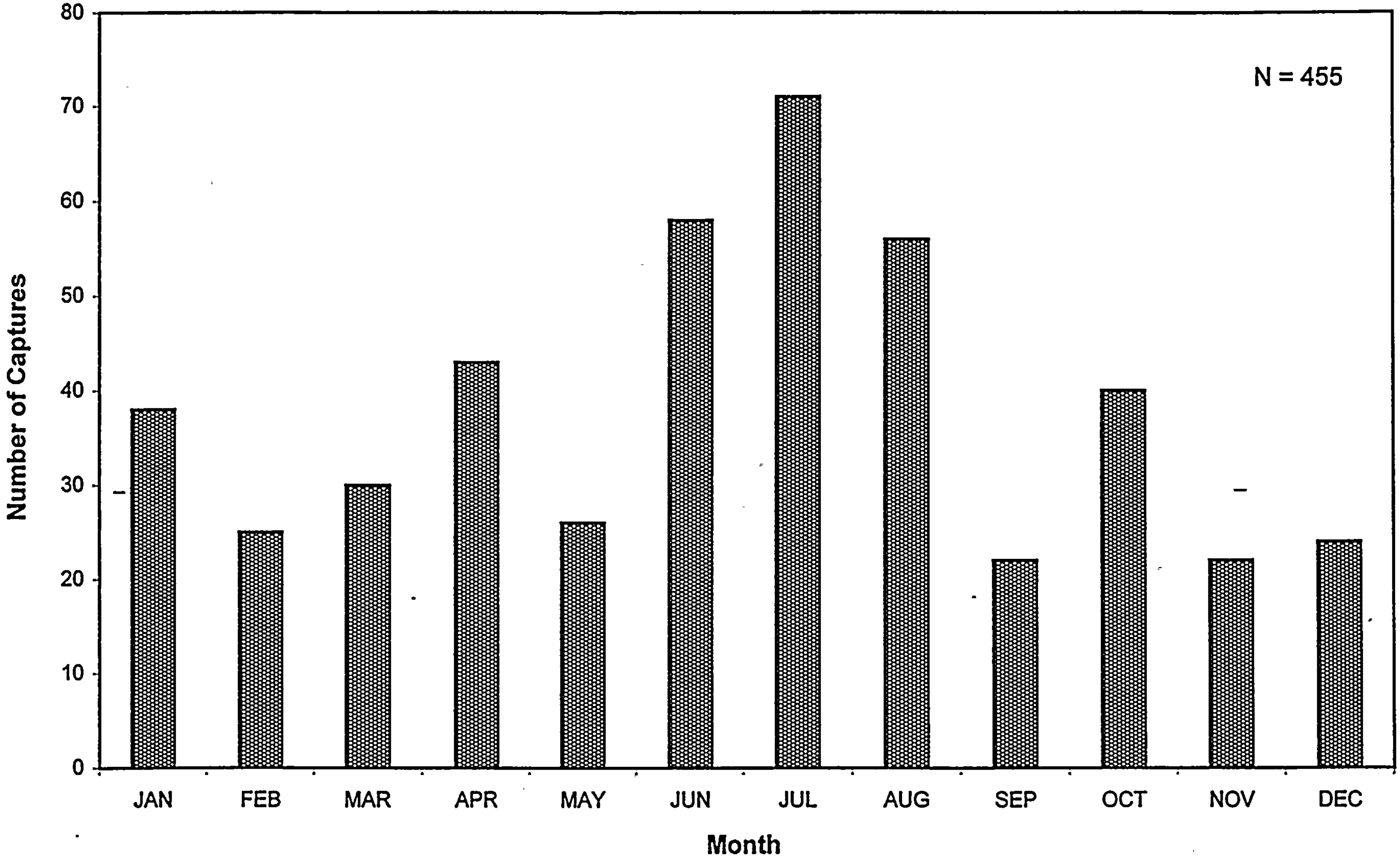

Figure 27. Number of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

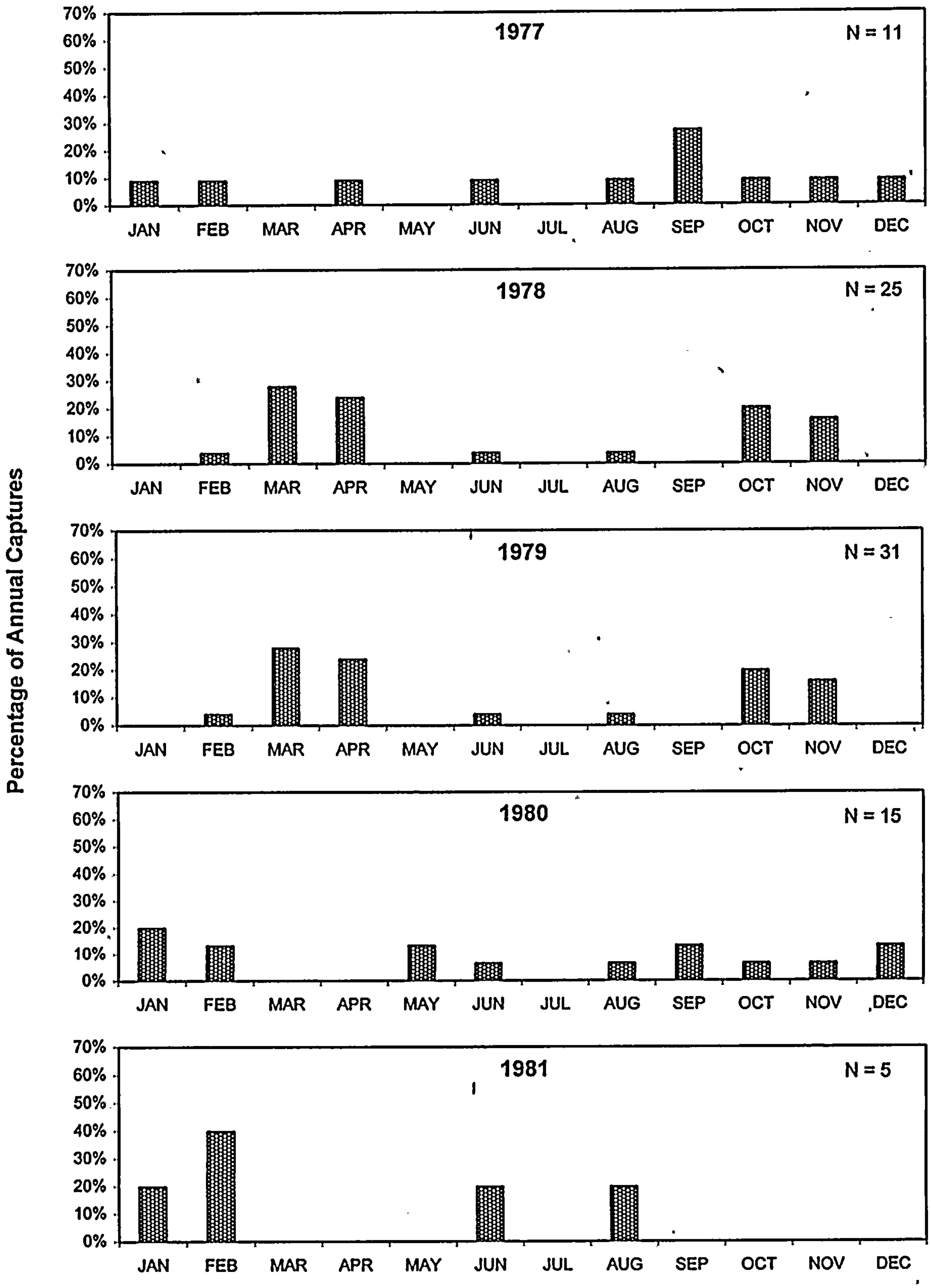

Figure 28. Percentage of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1981. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

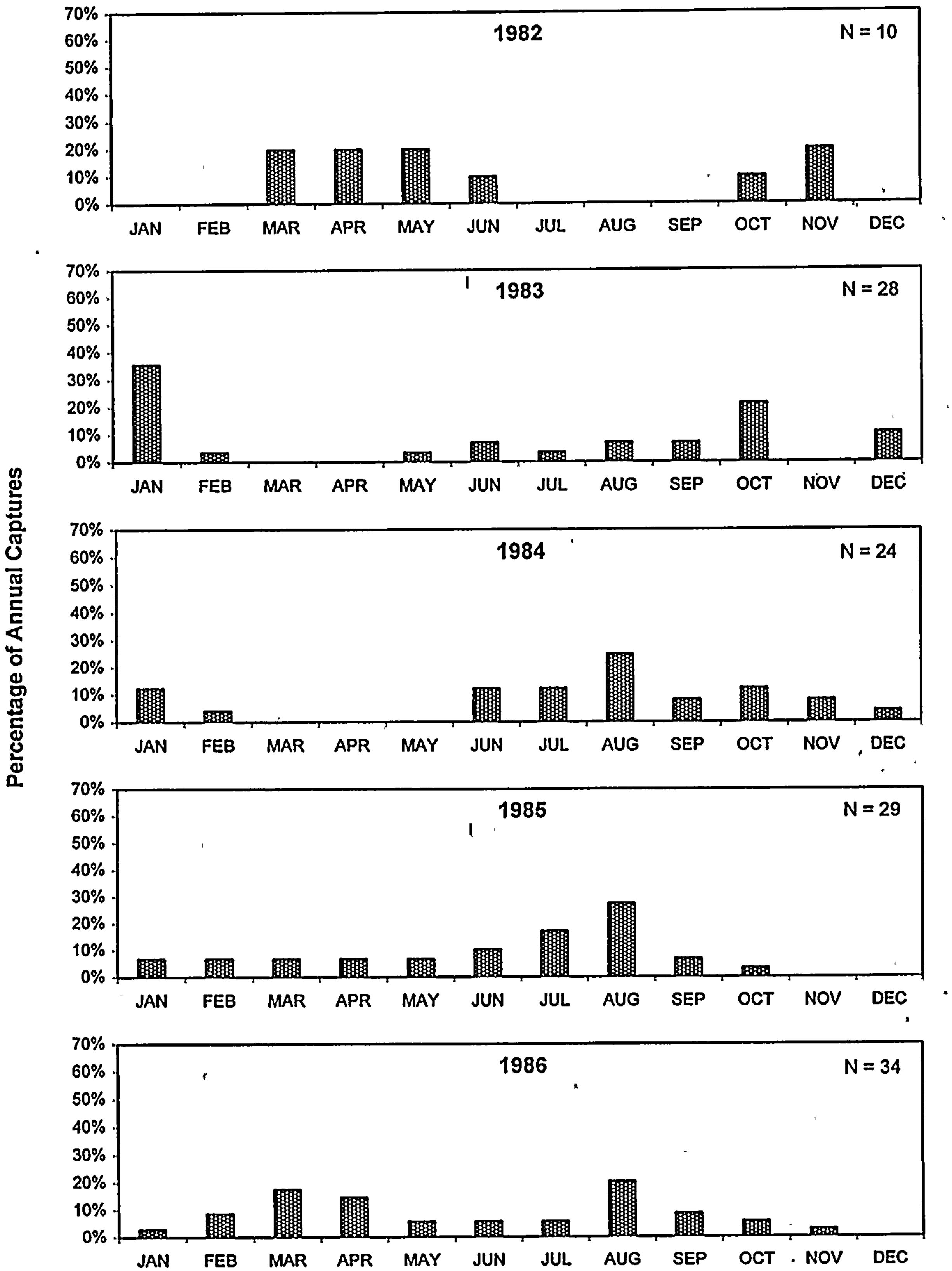

Figure 29. Percentage of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1982+1986.

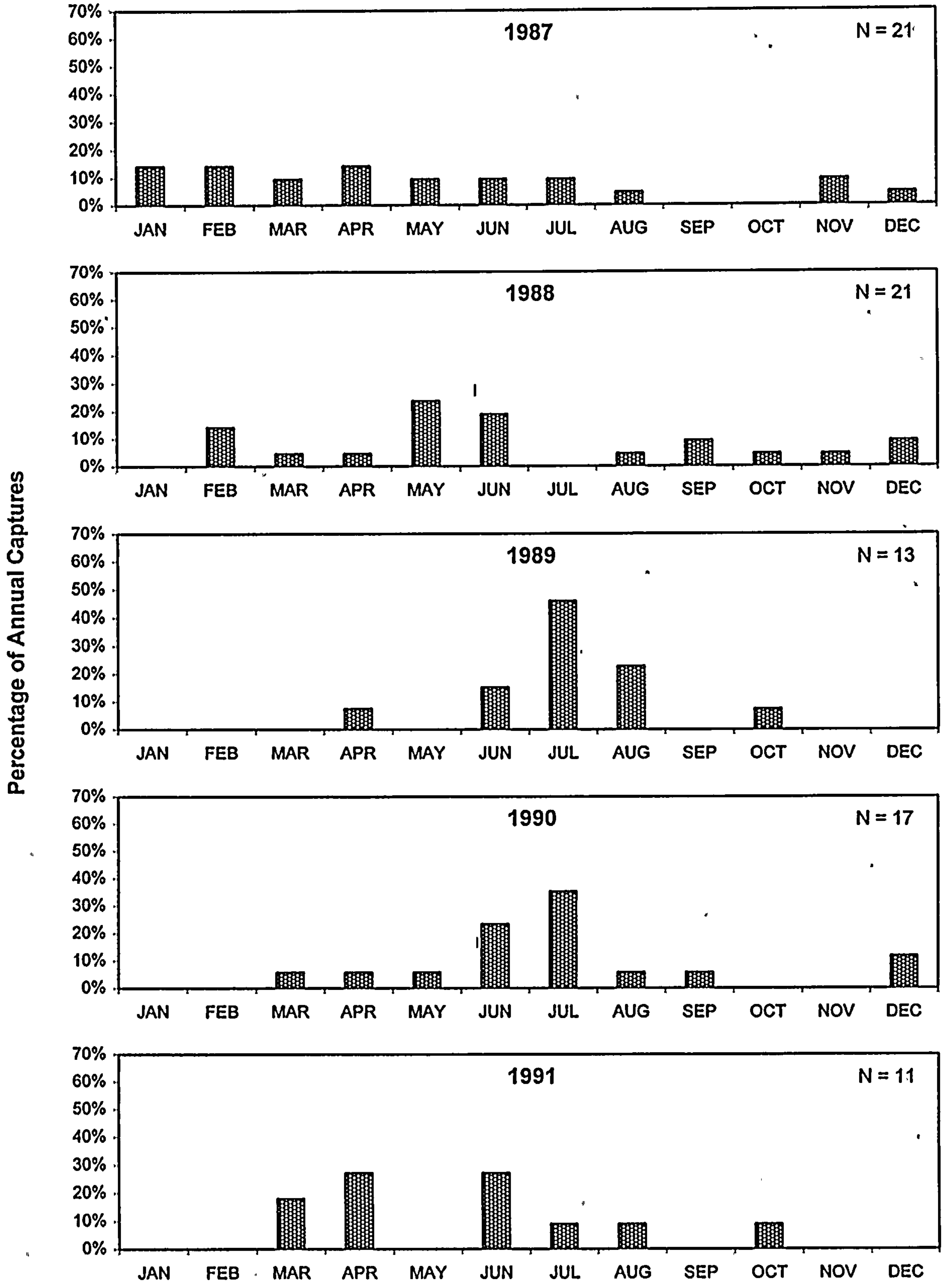

Figure 30. Percentage of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1987-1991.

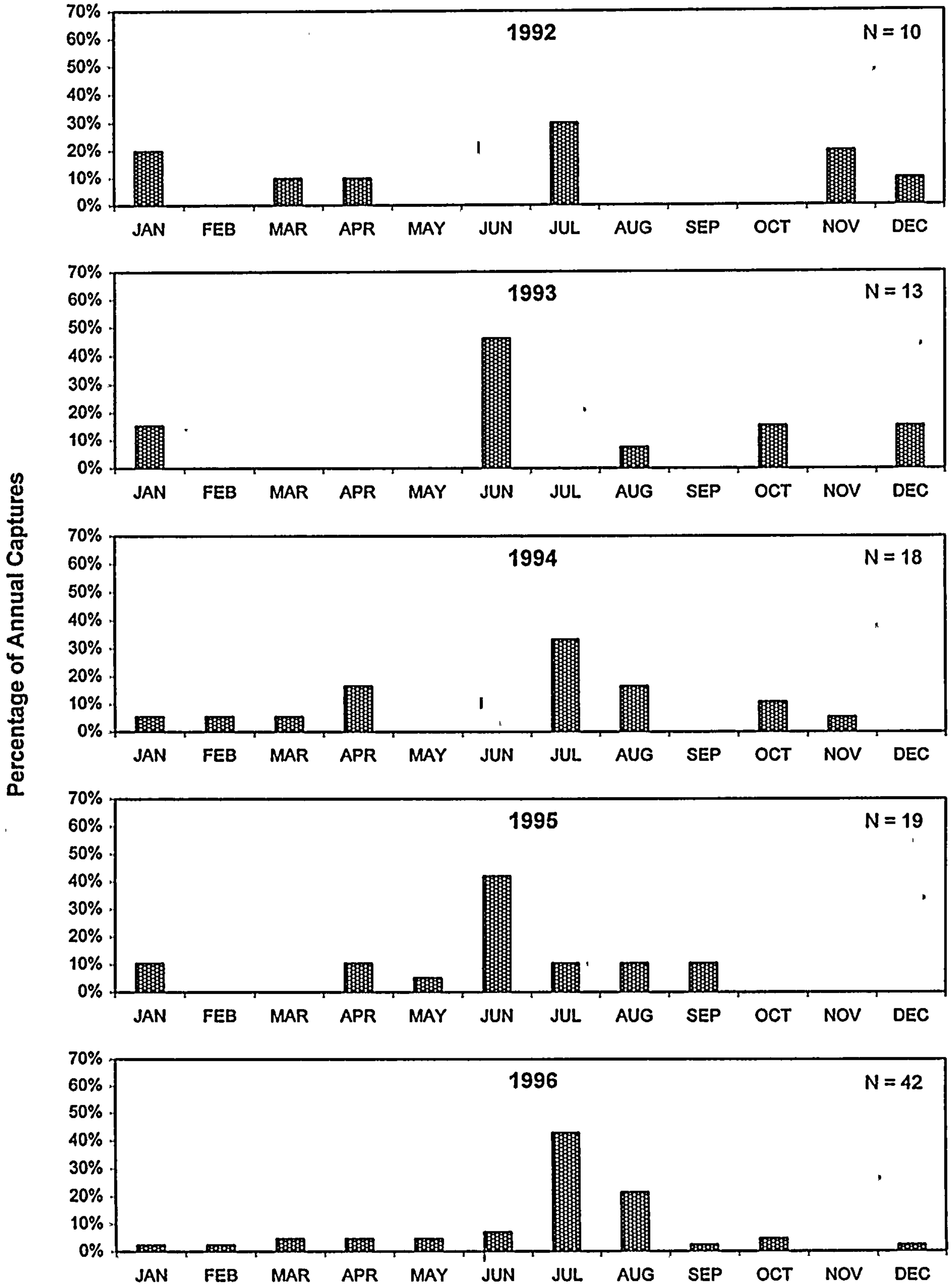

Figure 31. Percentage of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1992-1996.

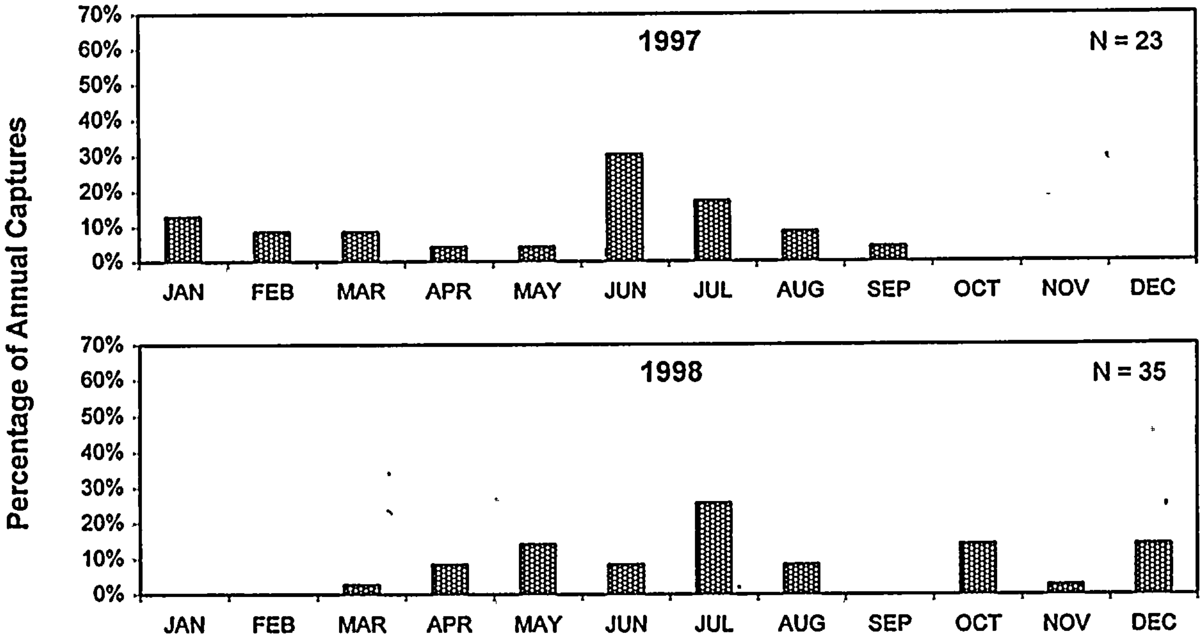

Figure 32. Percentage of subadult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1997-1998.

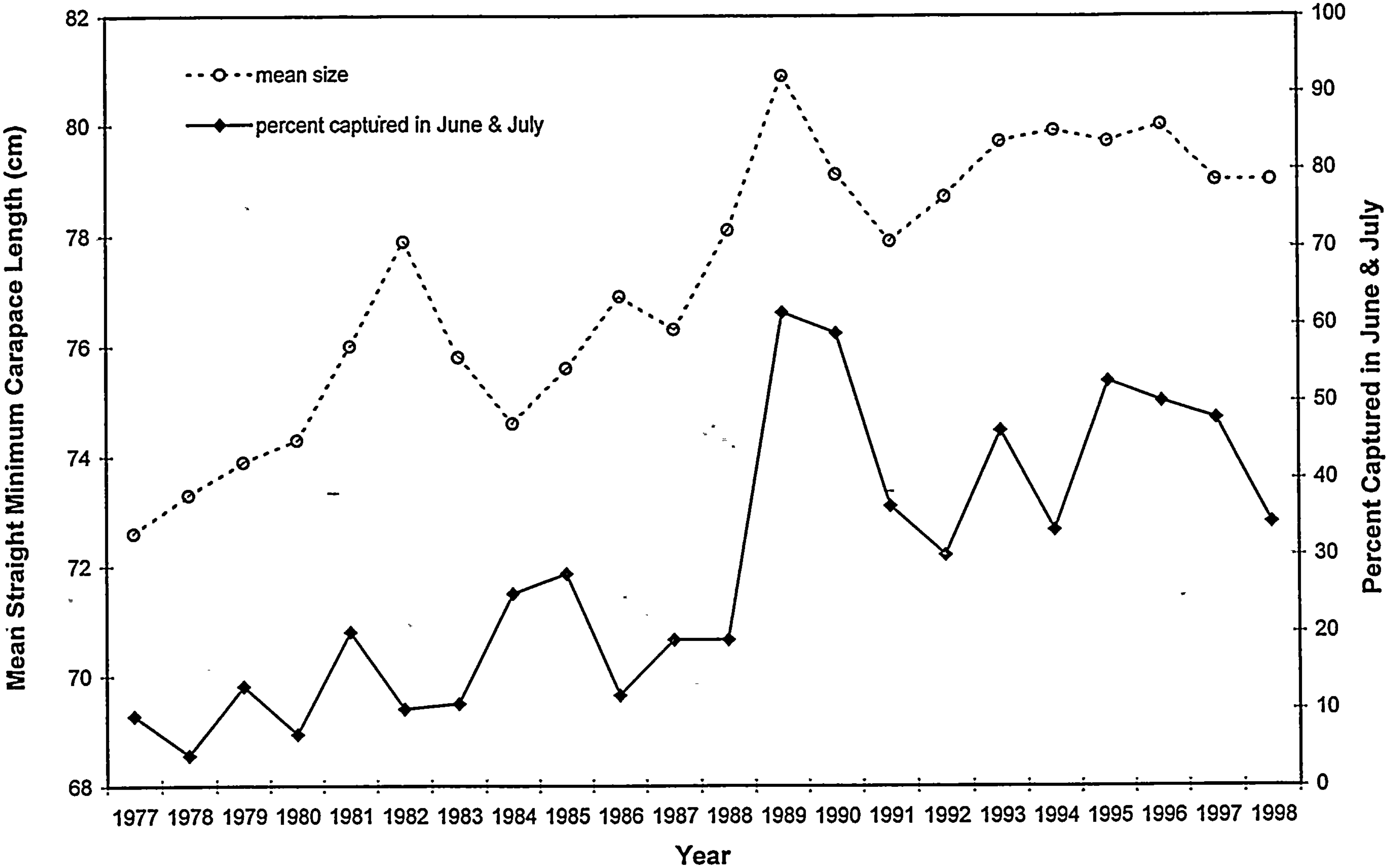

Figure 33. Mean size (straight minimum carapace length) of subadult loggerhead turtles compared to the percentage of annual subadult loggerhead captures that occurred during the months of June and July each year, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998.

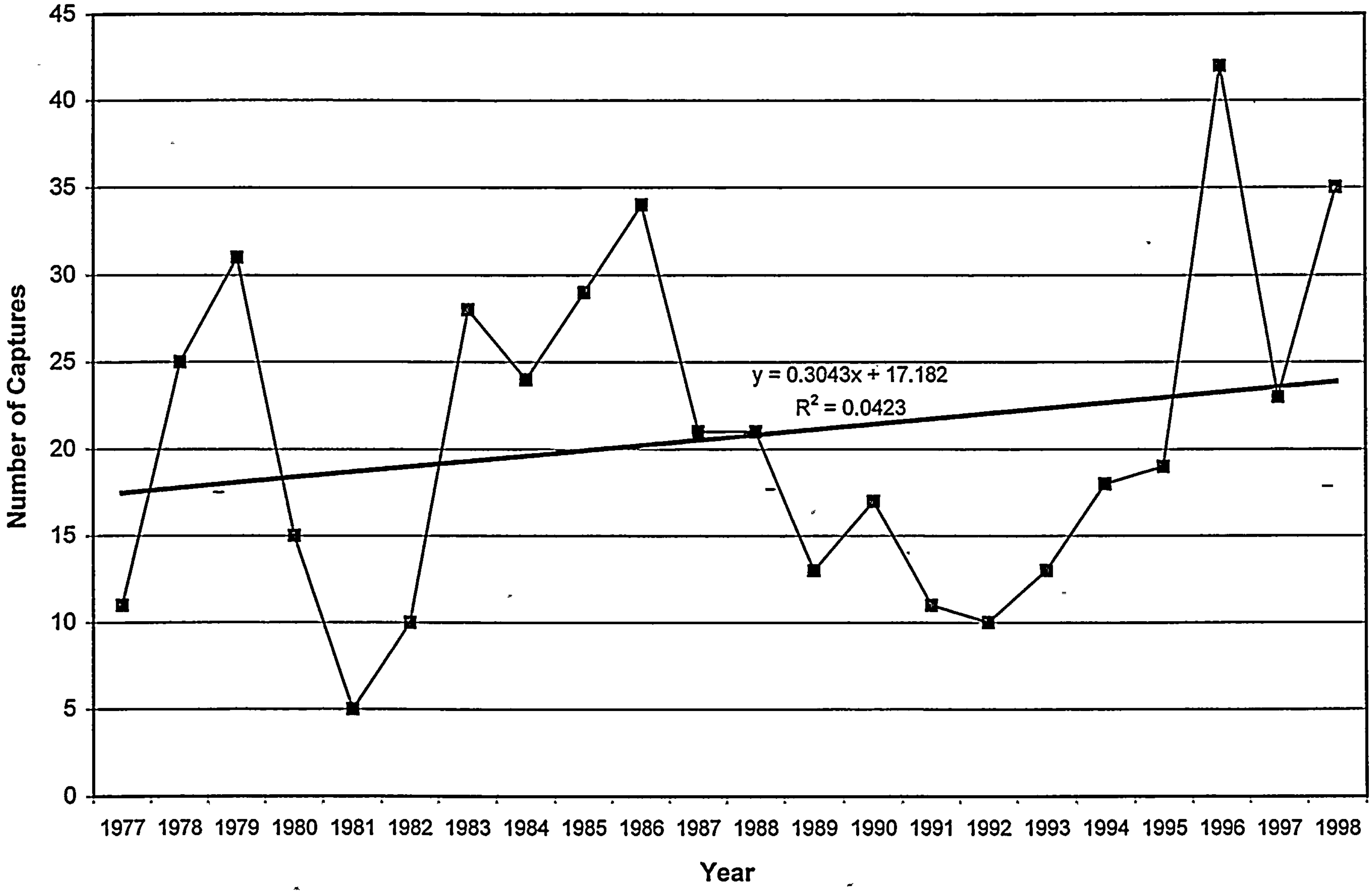

Figure 34. Annual number of subadult loggerhead captures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

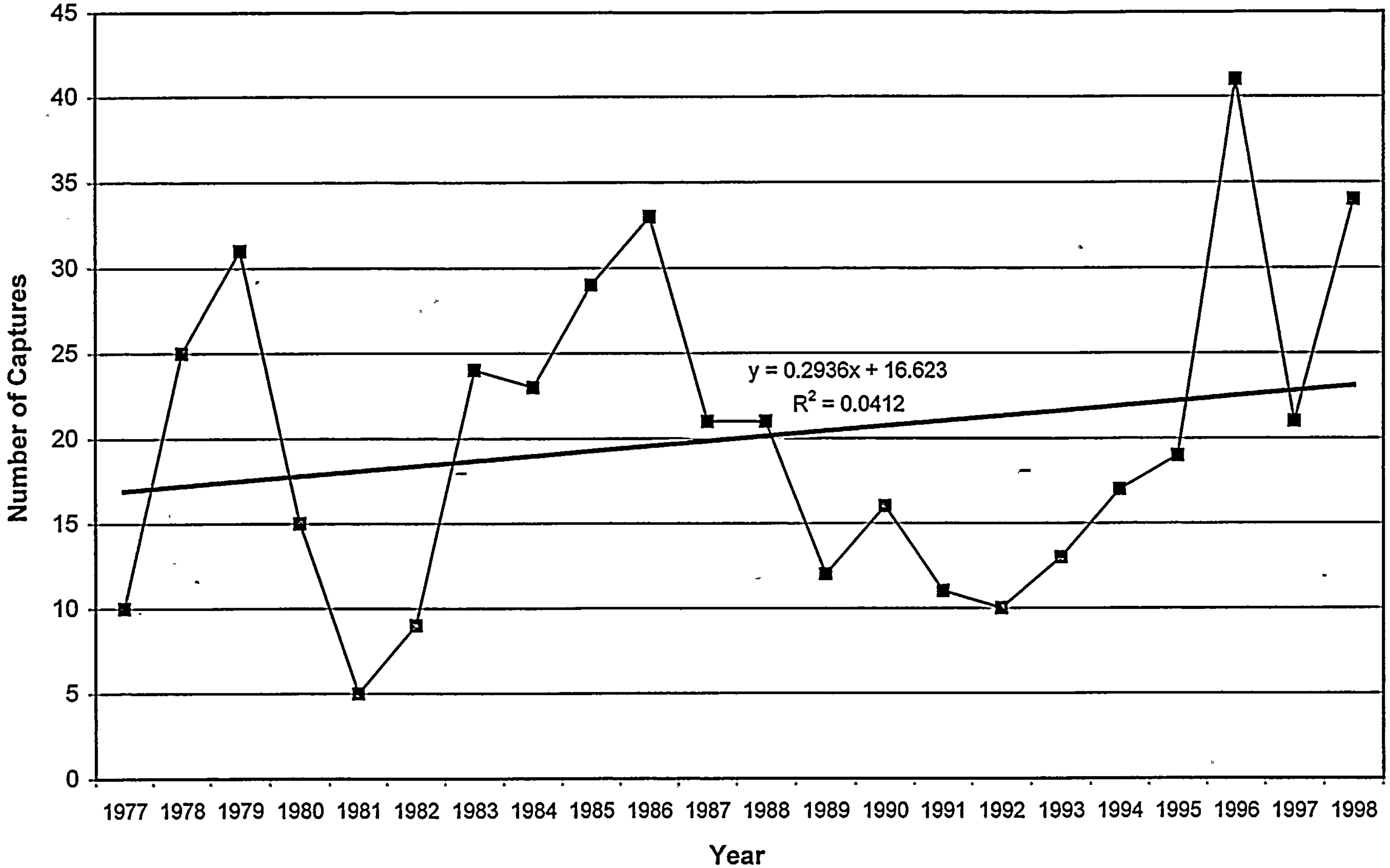

Figure 35. Annual number of subadult loggerhead captures (excluding recaptures), St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

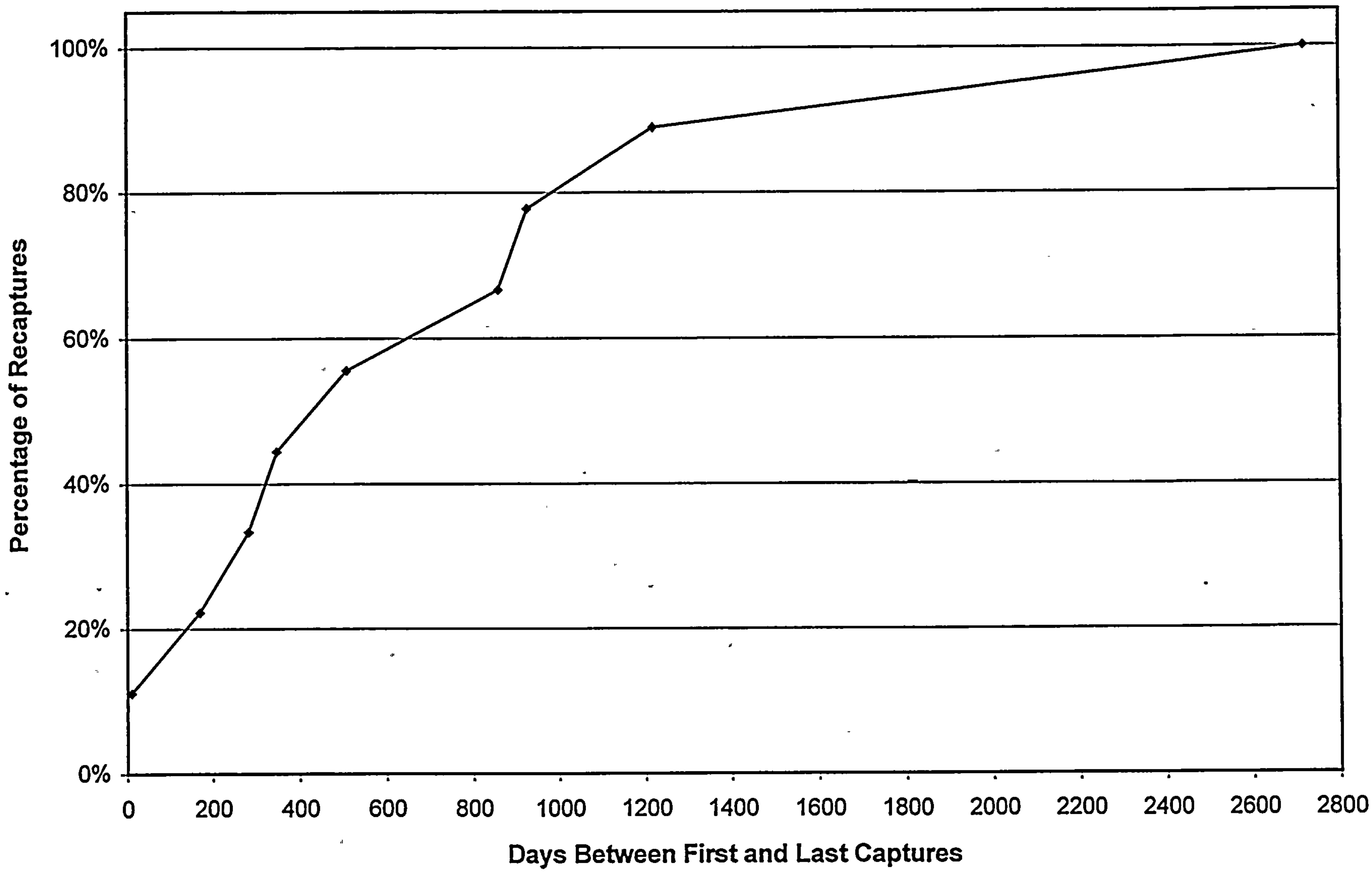

Figure 36. The percentage of subadult loggerhead recaptures that occurred within each time interval between first and last capture, St. Lucie Plant intake canal, Hutchinson Island, Florida.

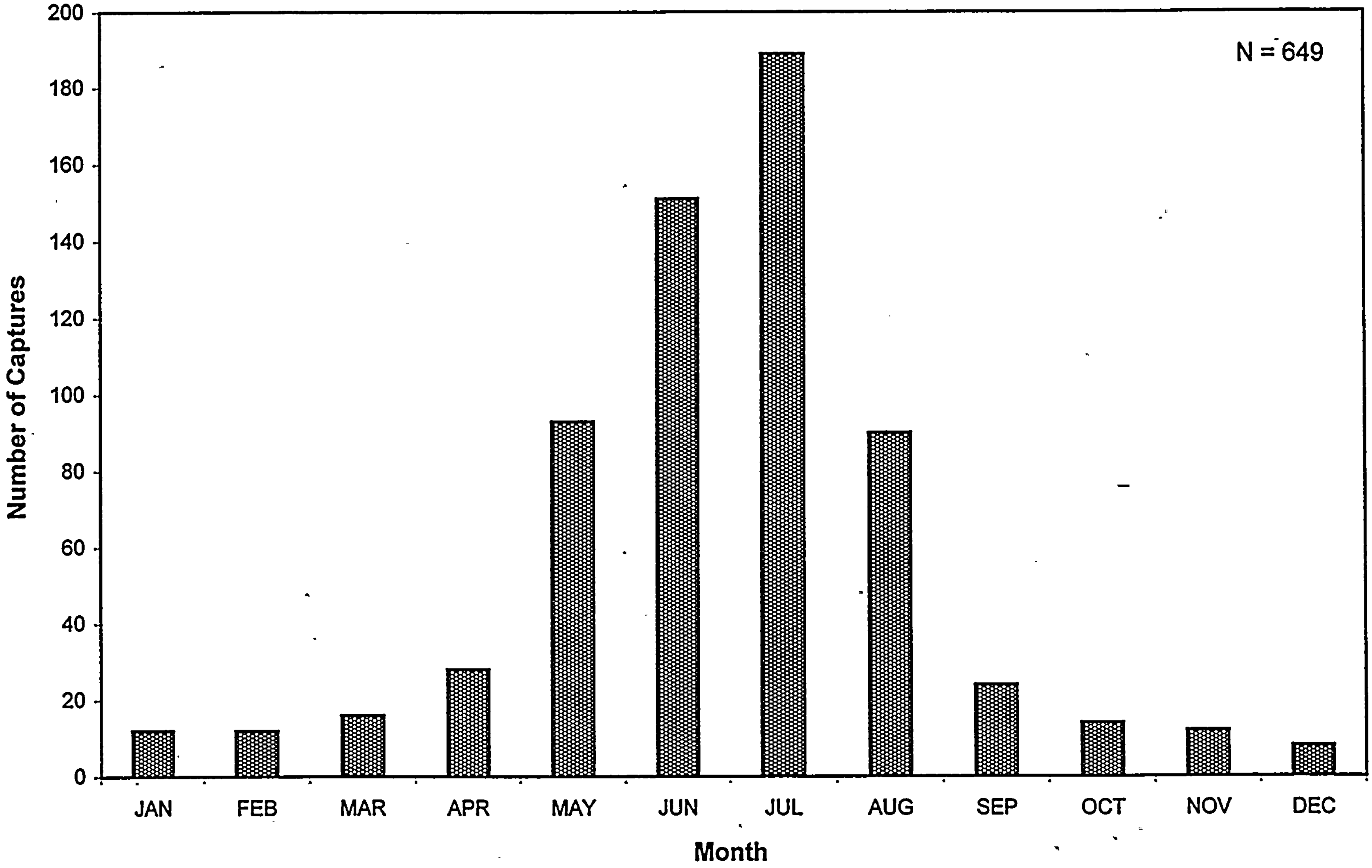

Figure 37. Number of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. The data set includes 562 females, 75 males and 12 adults for which sex was not recorded. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

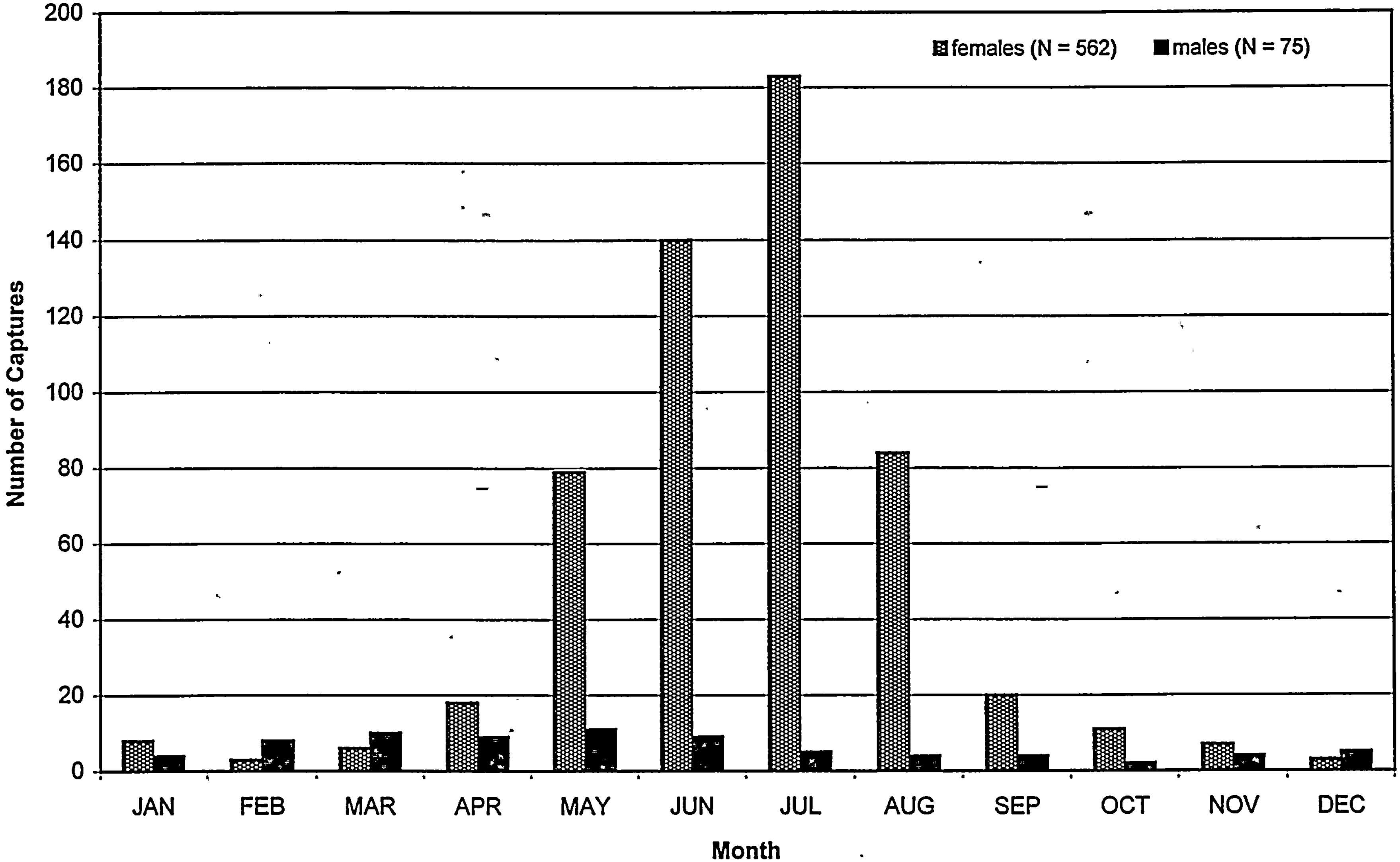

Figure 38. Number of adult male and female loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

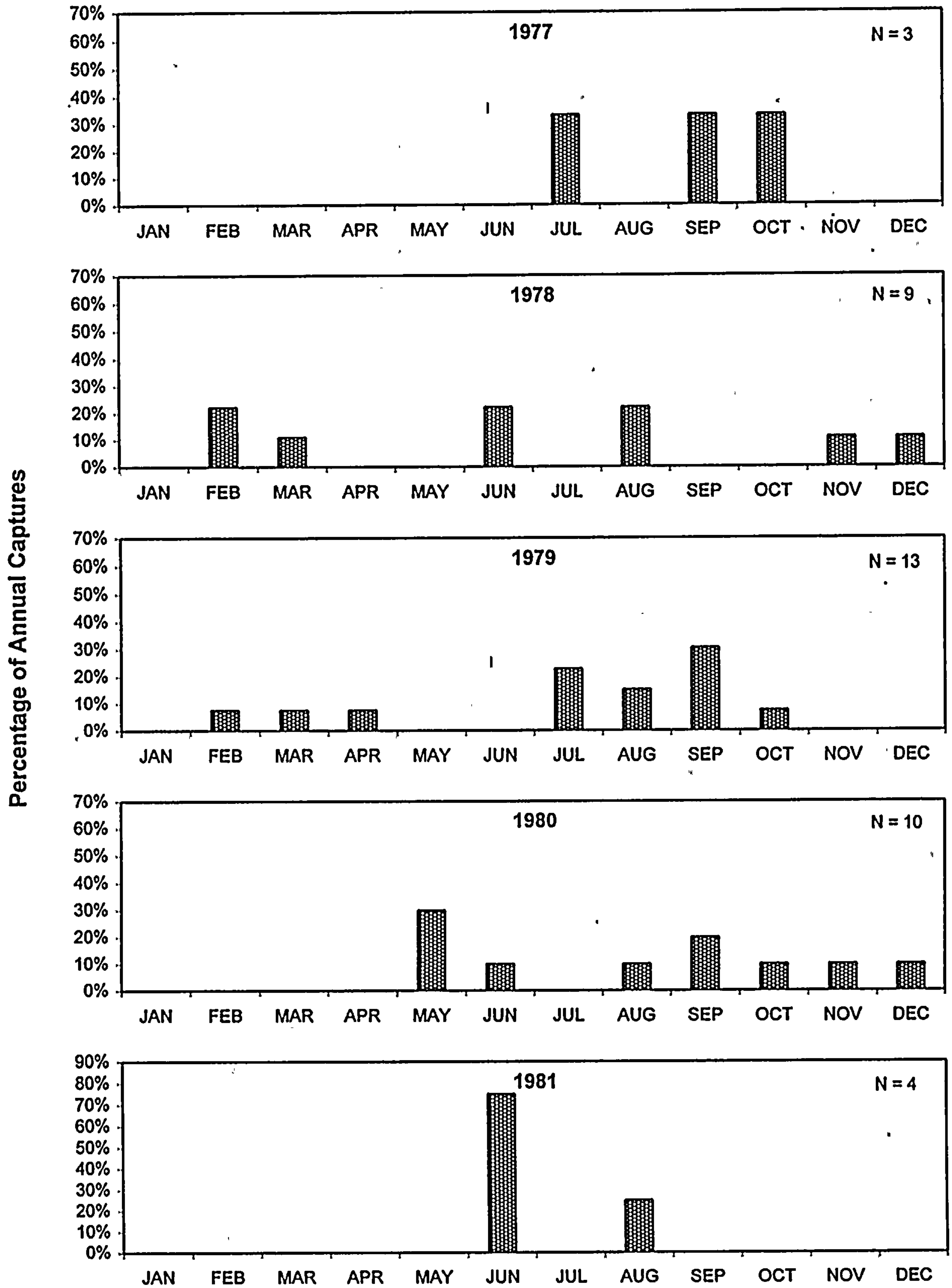

Figure 39. Percentage of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1981. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

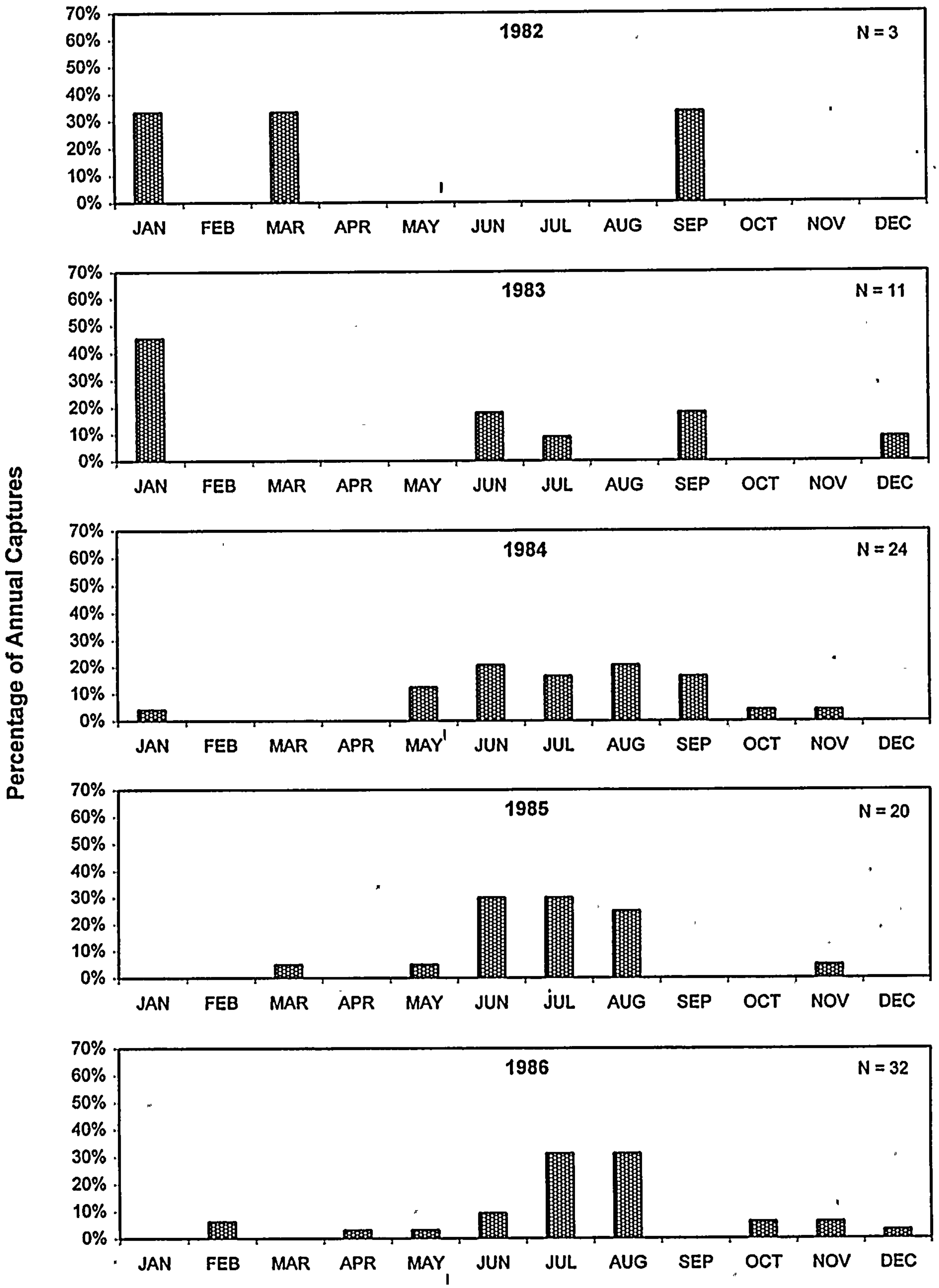

Figure 40. Percentage of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1982-1986.

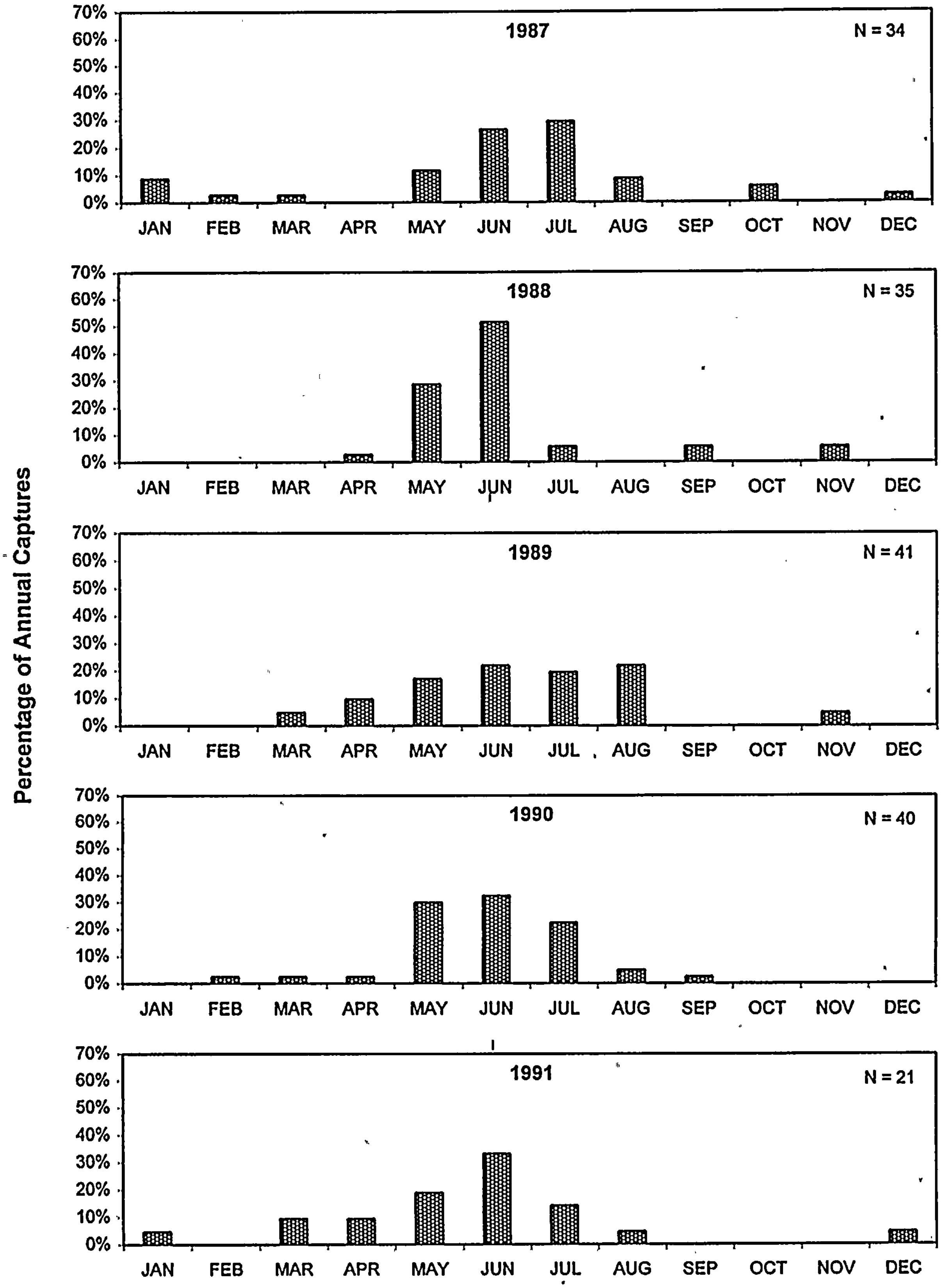

Figure 41. Percentage of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1987-1991.

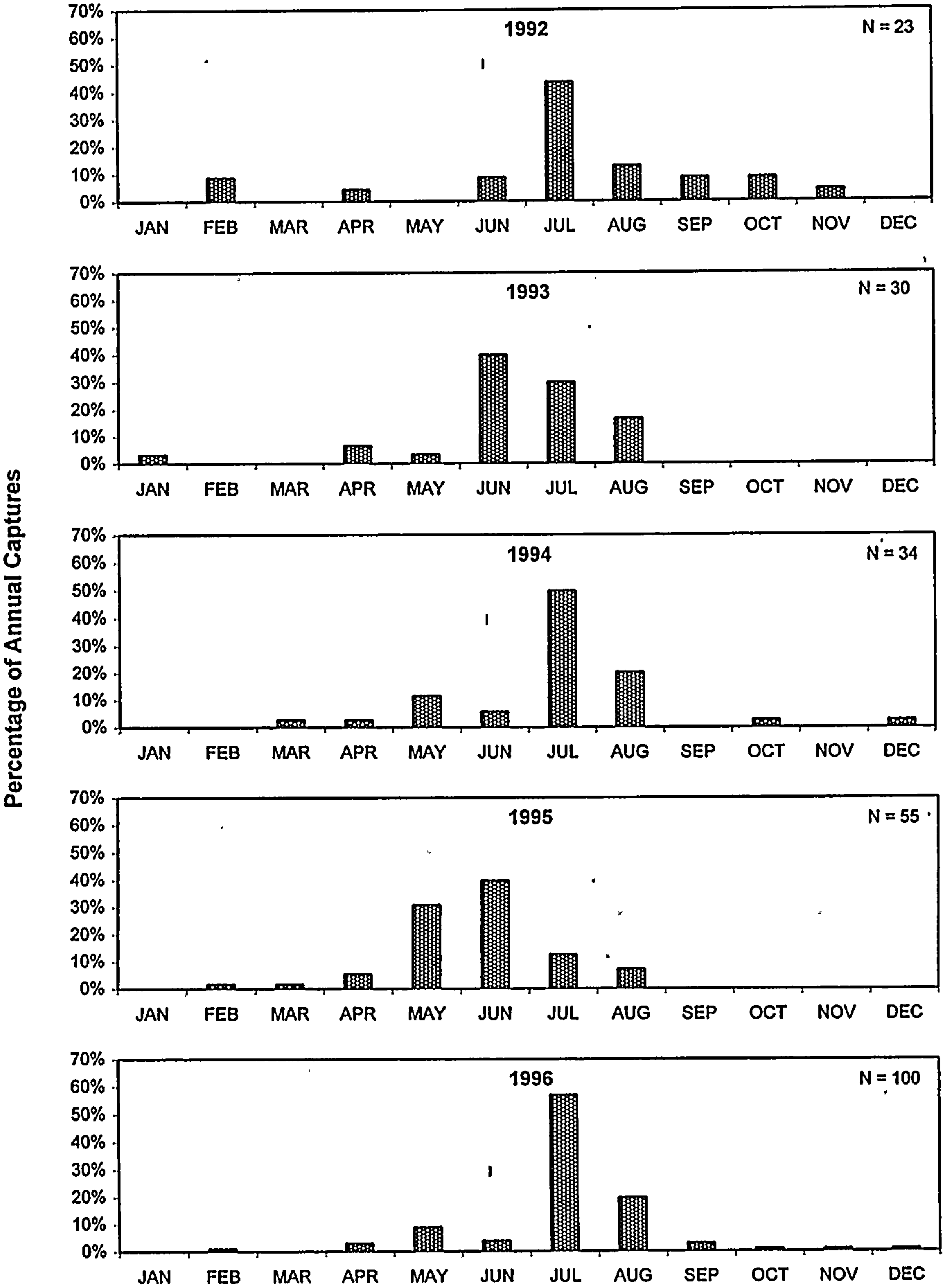

Figure 42. Percentage of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1992-1996.

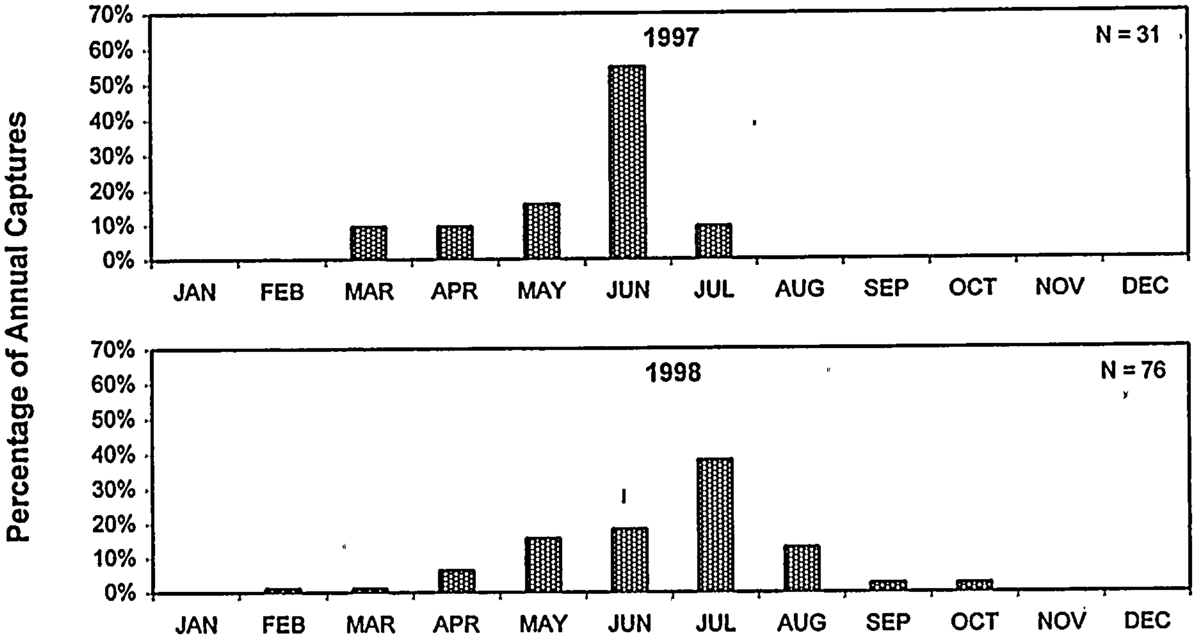

Figure 43. Percentage of adult loggerhead turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1997-1998.

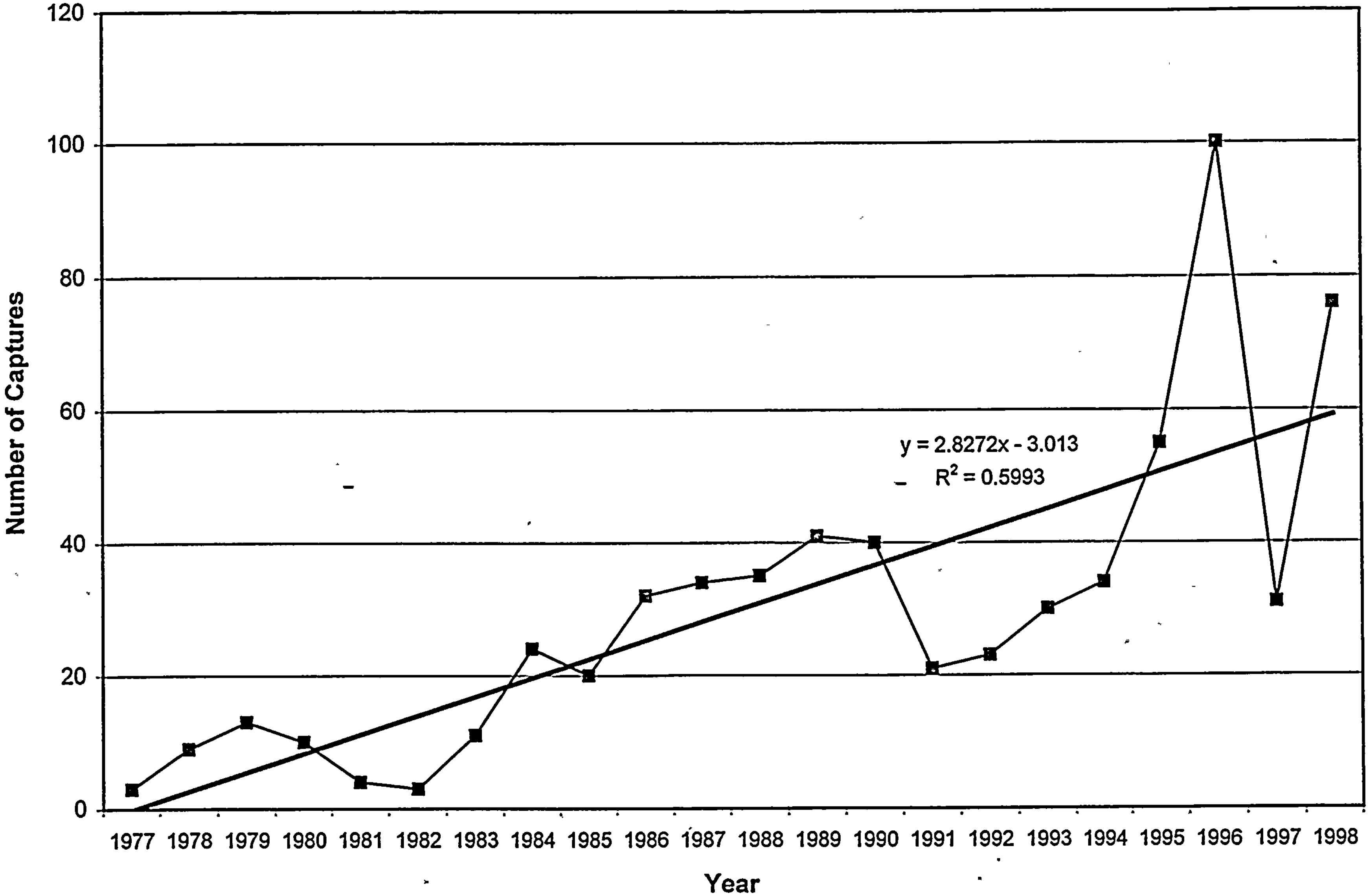

Figure 44. Annual number of adult loggerhead captures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

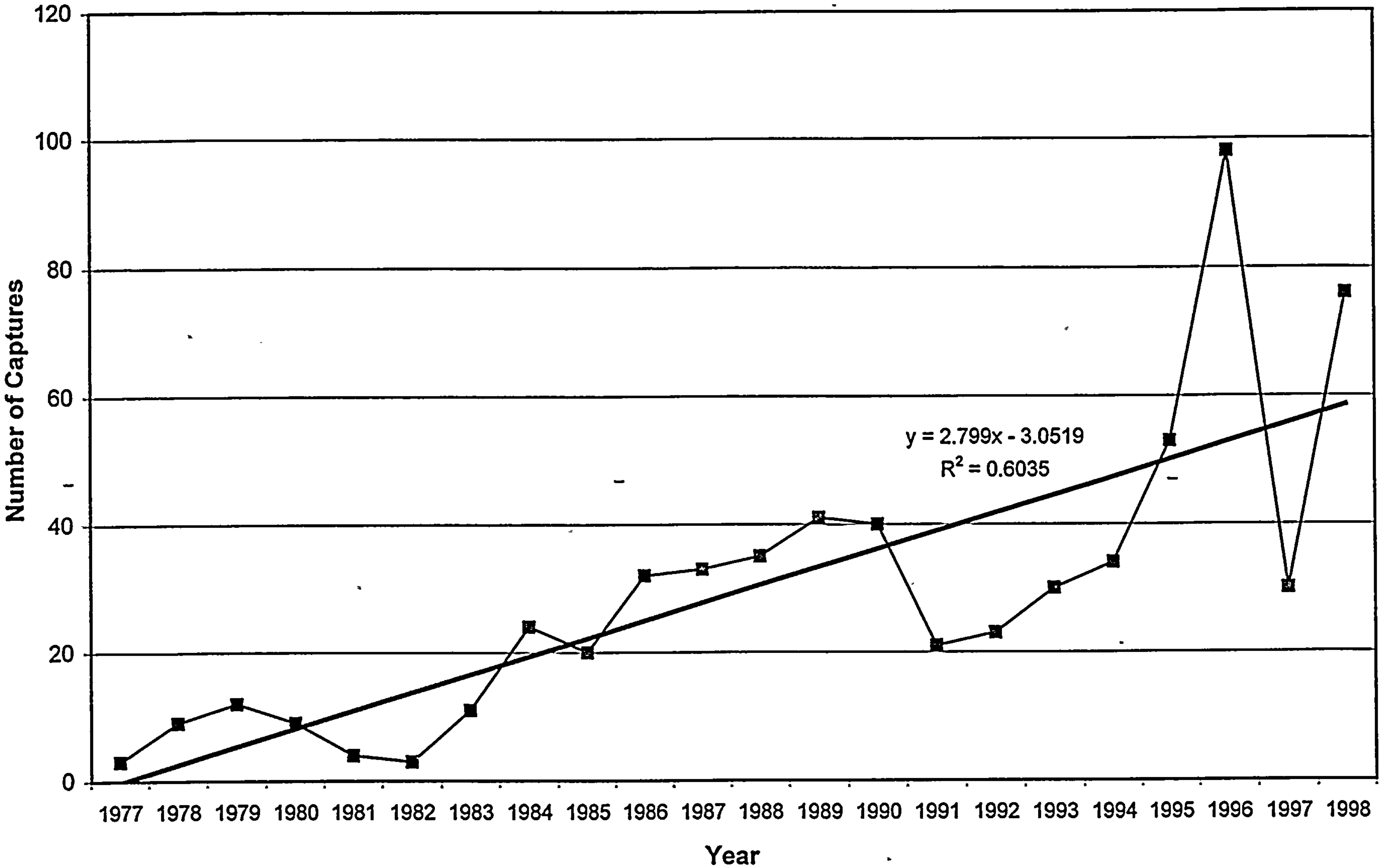

Figure 45. Annual number of adult loggerhead captures (excluding recaptures), St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

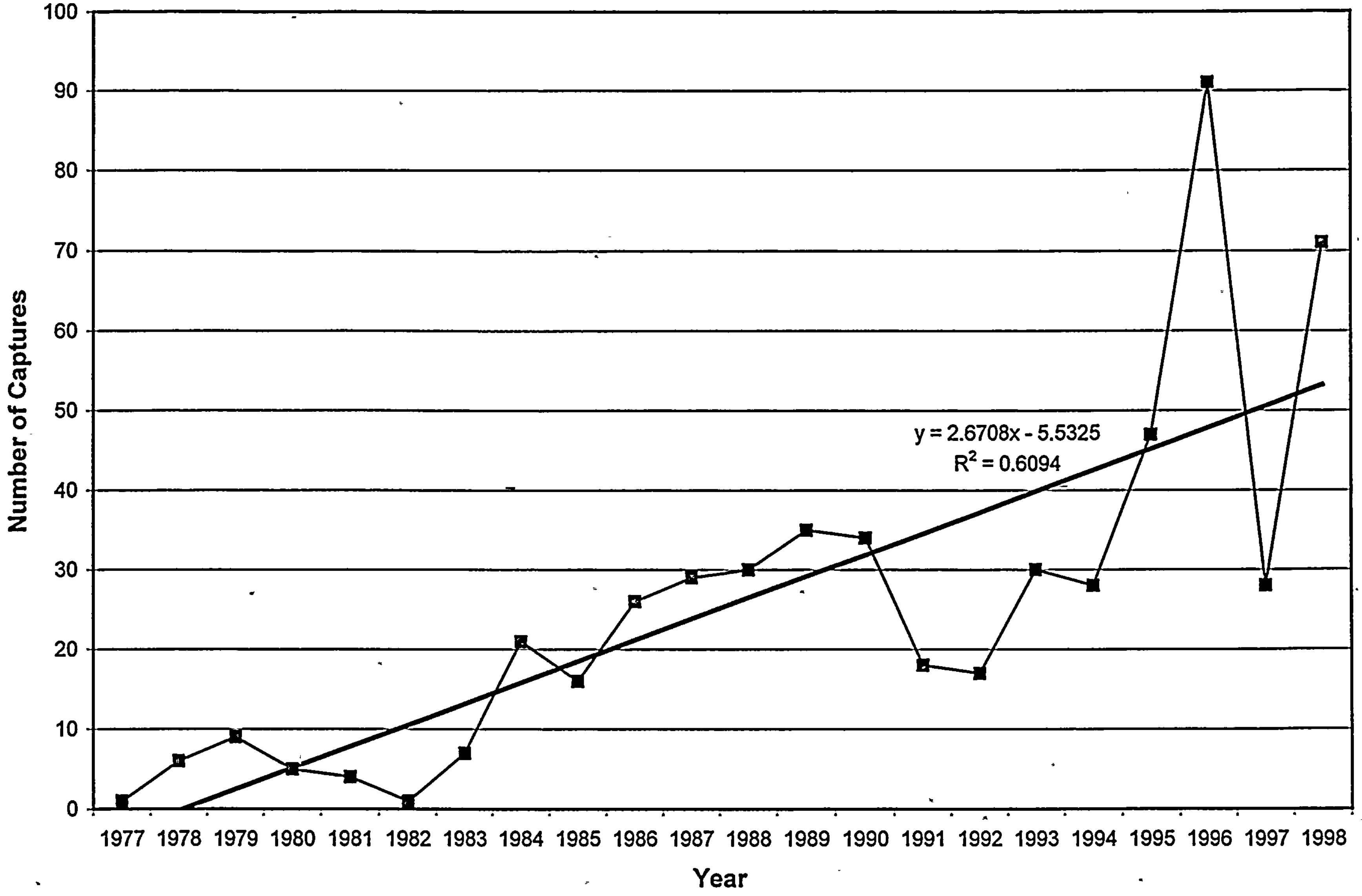

Figure 46. Annual number of adult female loggerhead captures excluding recaptures, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

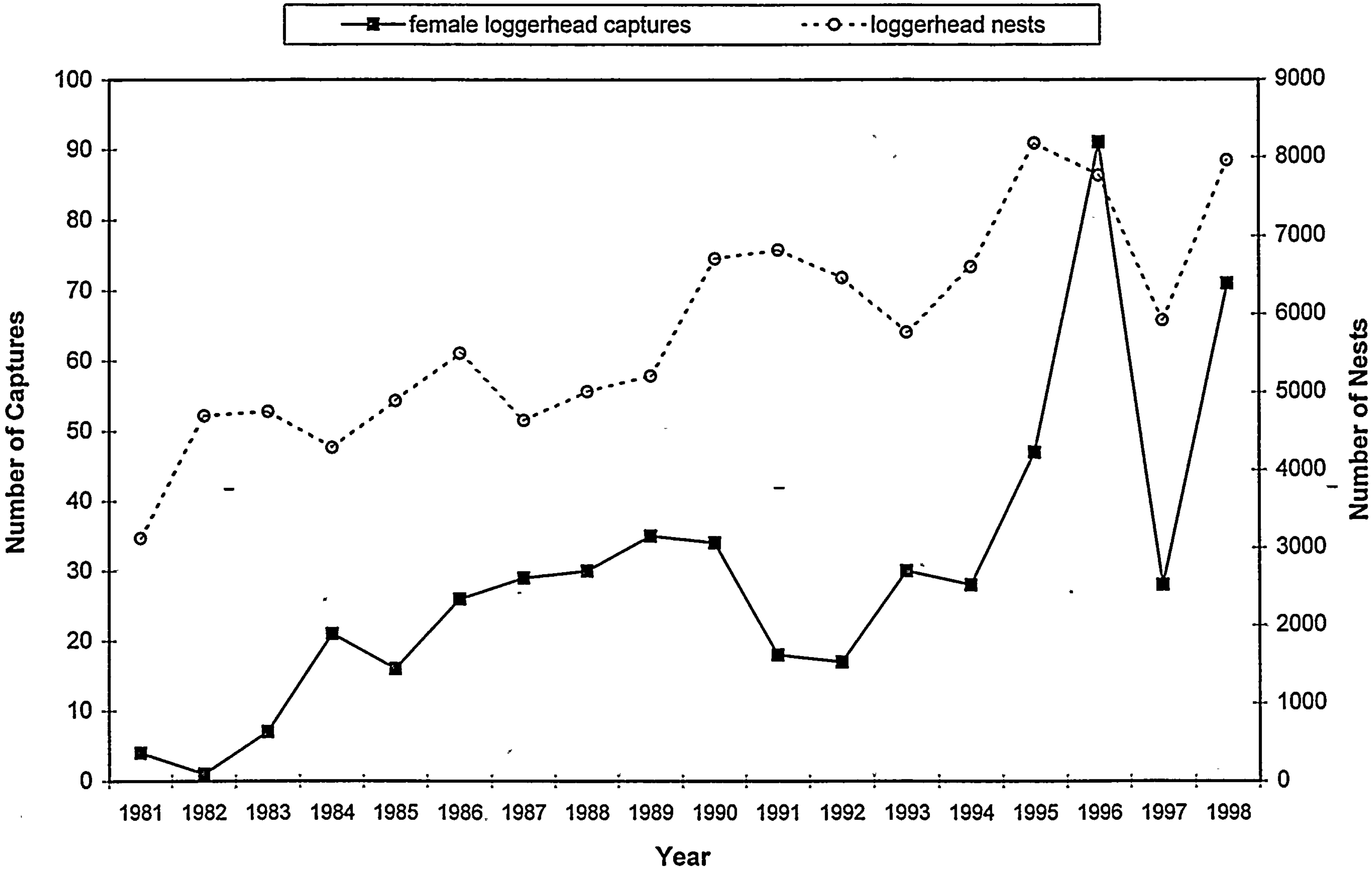

Figure 47. Annual numbers of adult female loggerhead captures at the St. Lucie Plant compared to the annual number of loggerhead nests on Hutchinson Island, Florida, 1981-1998. Annual nesting data are not available prior to 1981.

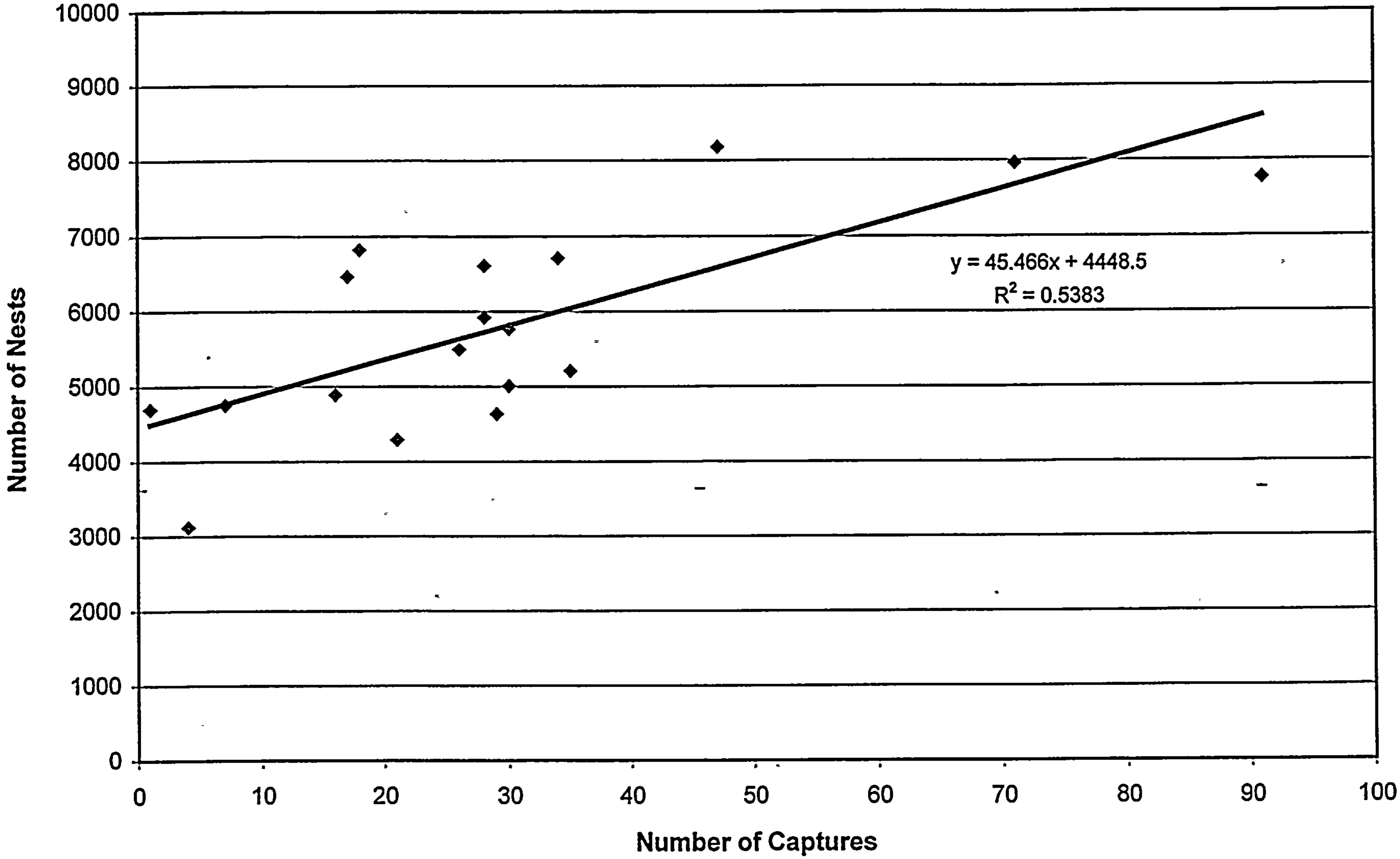

Figure 48. Relationship of annual numbers of adult female loggerhead captures at the St. Lucie Plant to the annual numbers of loggerhead nests on Hutchinson Island, Florida, 1981-1998. Annual nesting data are not available prior to 1981.

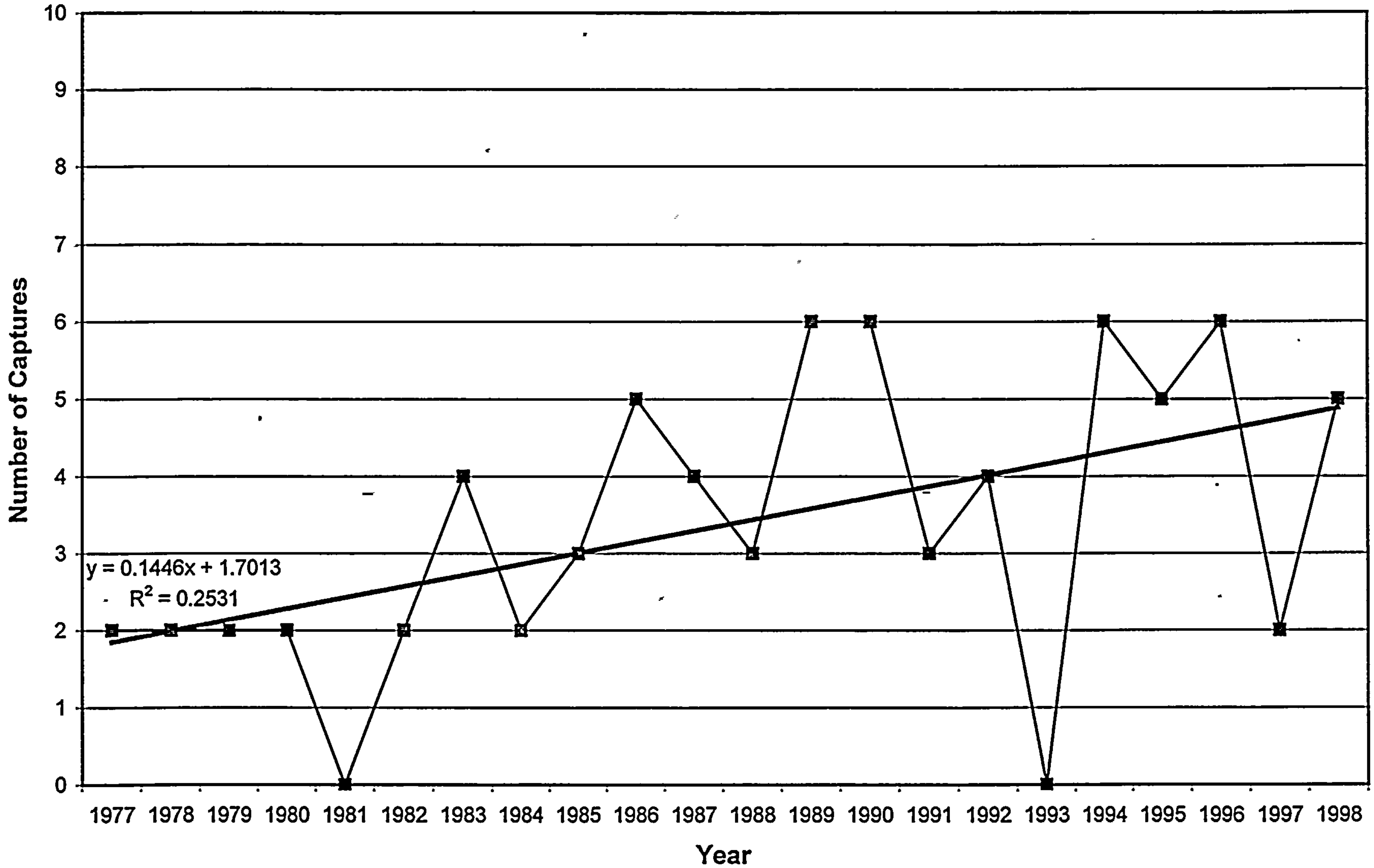

Figure 49. Annual number of adult male loggerhead captures excluding recaptures, St. Lucie Plant, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

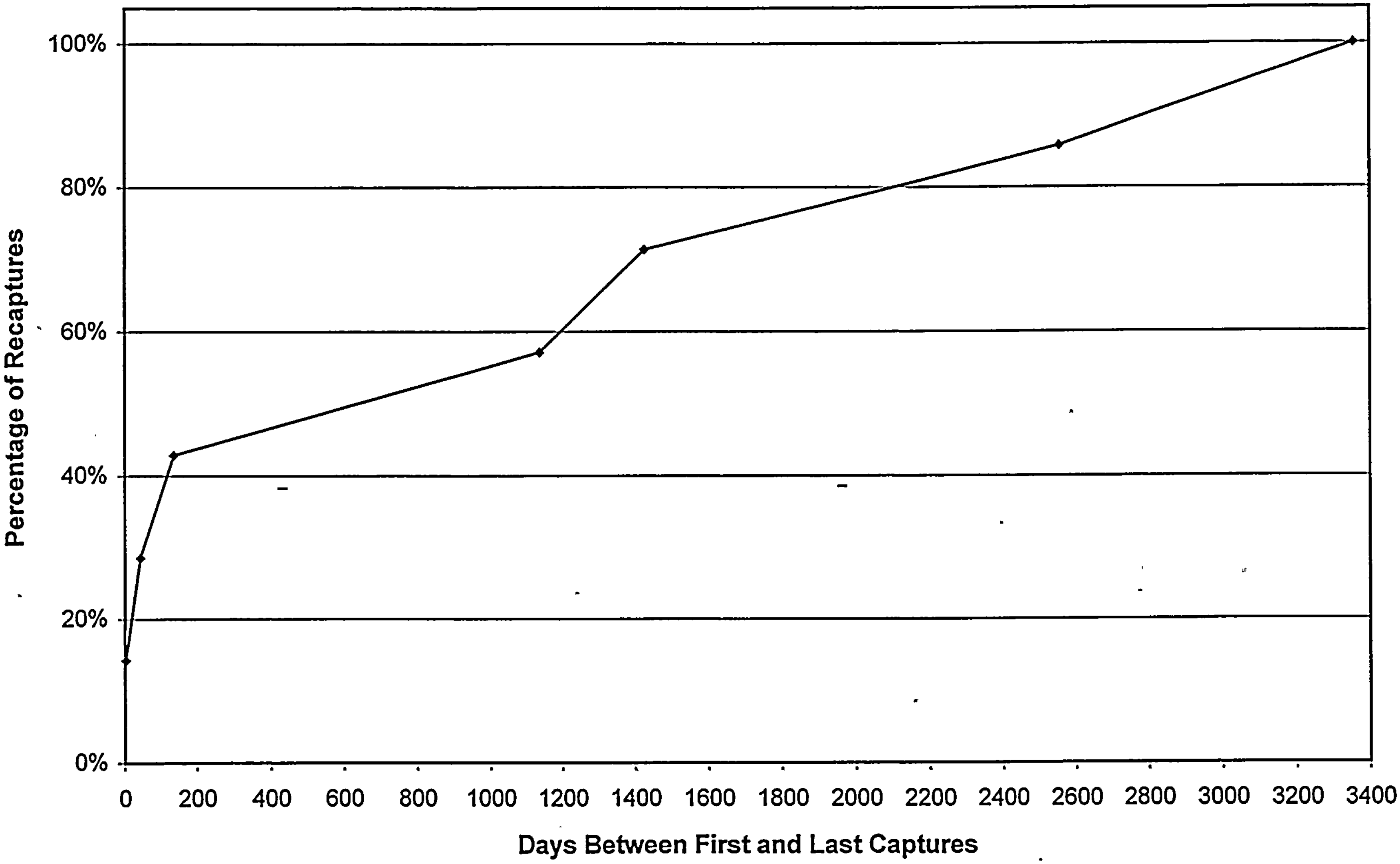

Figure 50. The percentage of adult loggerhead captures that occurred within each time interval between first and last capture, St. Lucie Plant intake canal, Hutchinson Island, Florida.

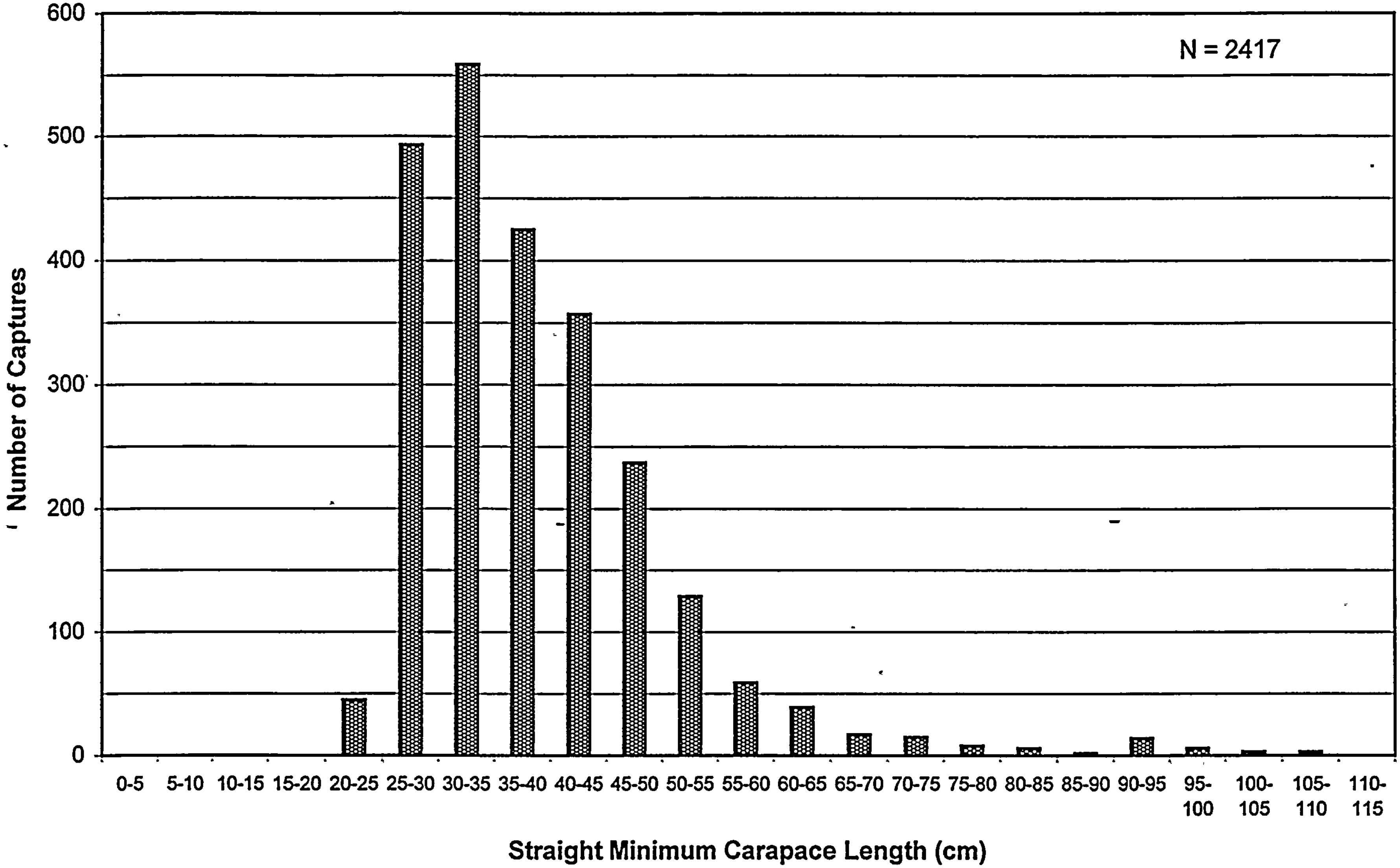

Figure 51. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1976-1998.

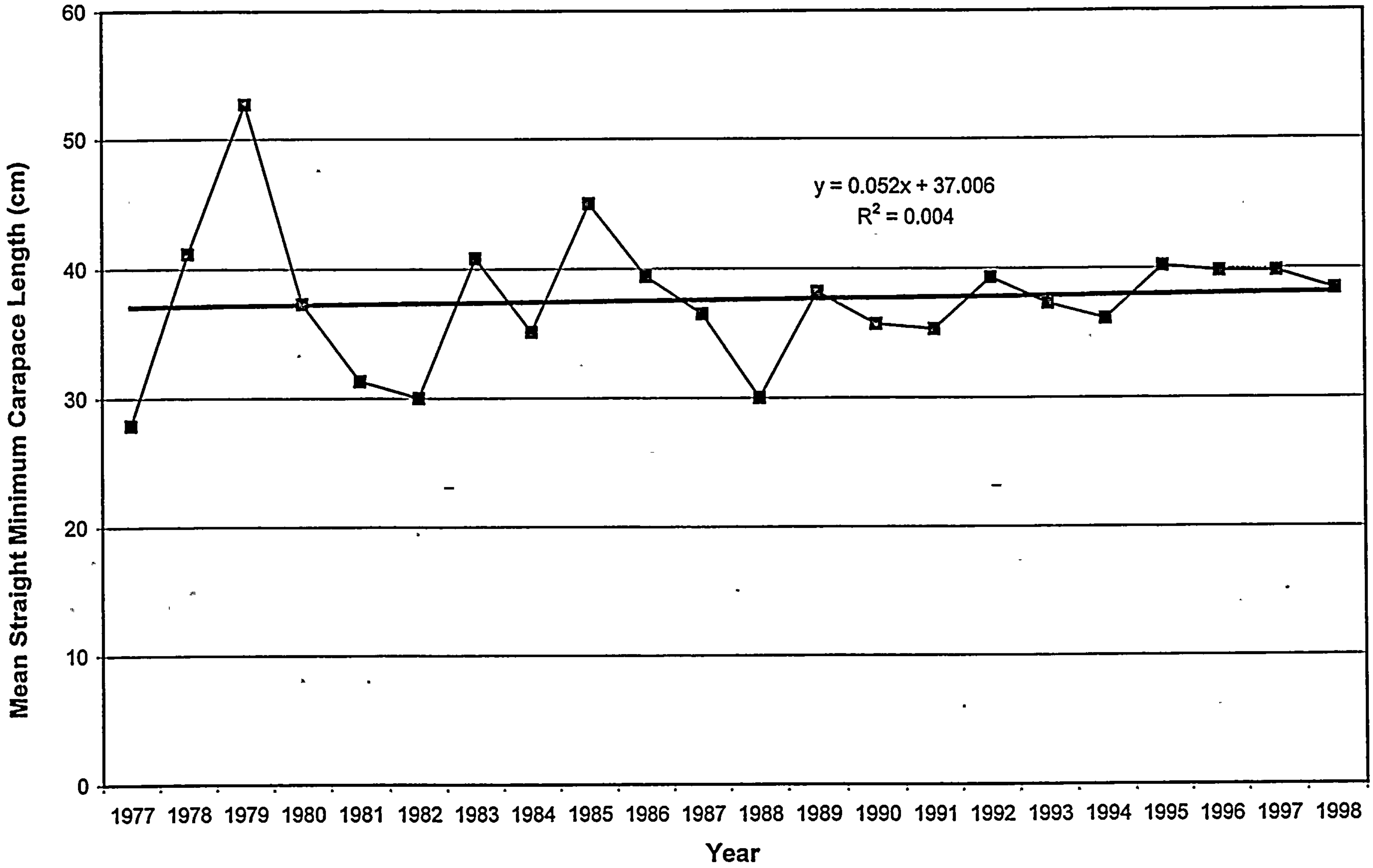

Figure 52. Mean size (straight minimum carapace length) of all green turtles captured each year in the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Note: no green turtles were captured during 1996.

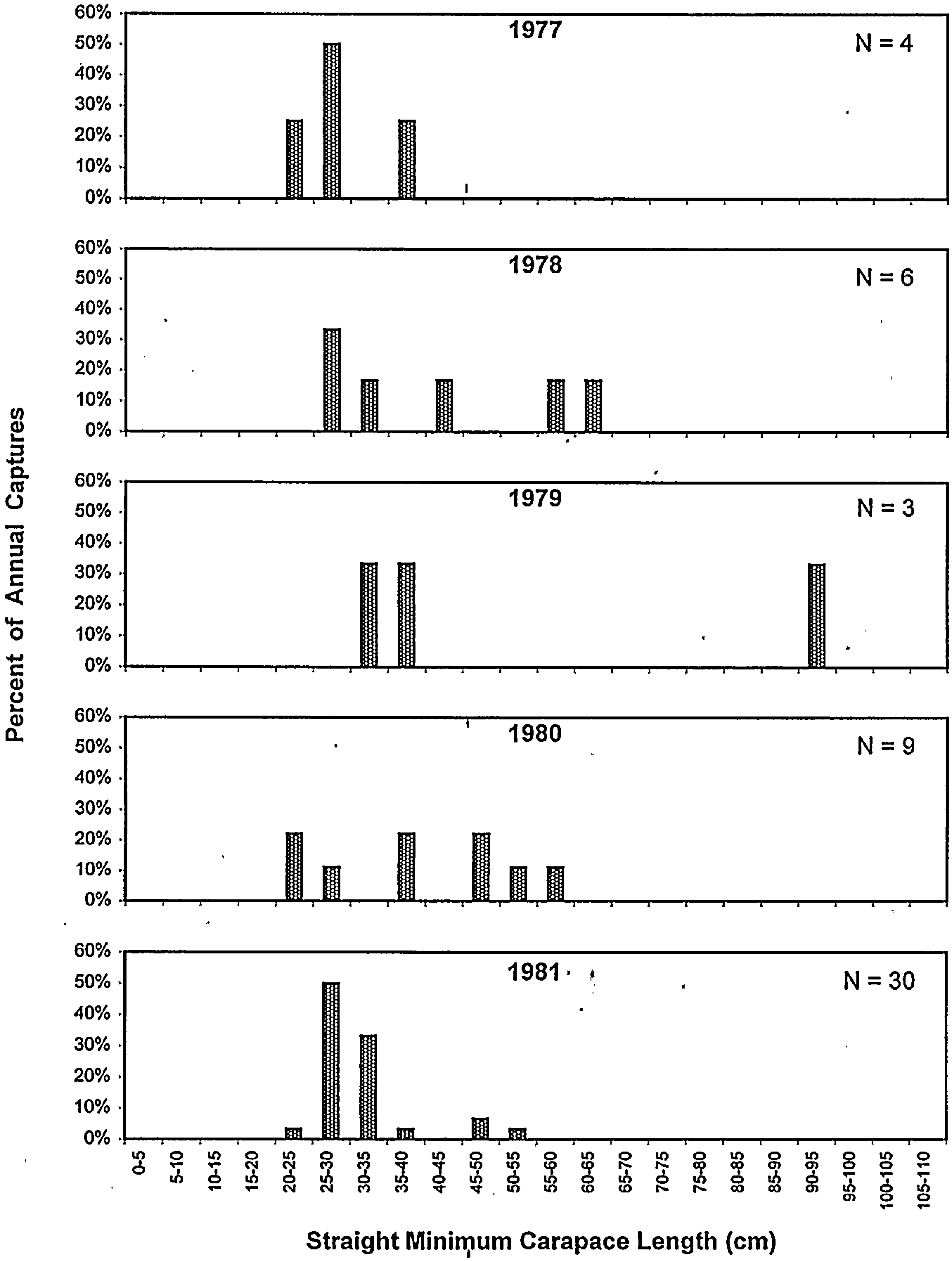

Figure 53. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1981. Note: no green turtles were captured during 1976.

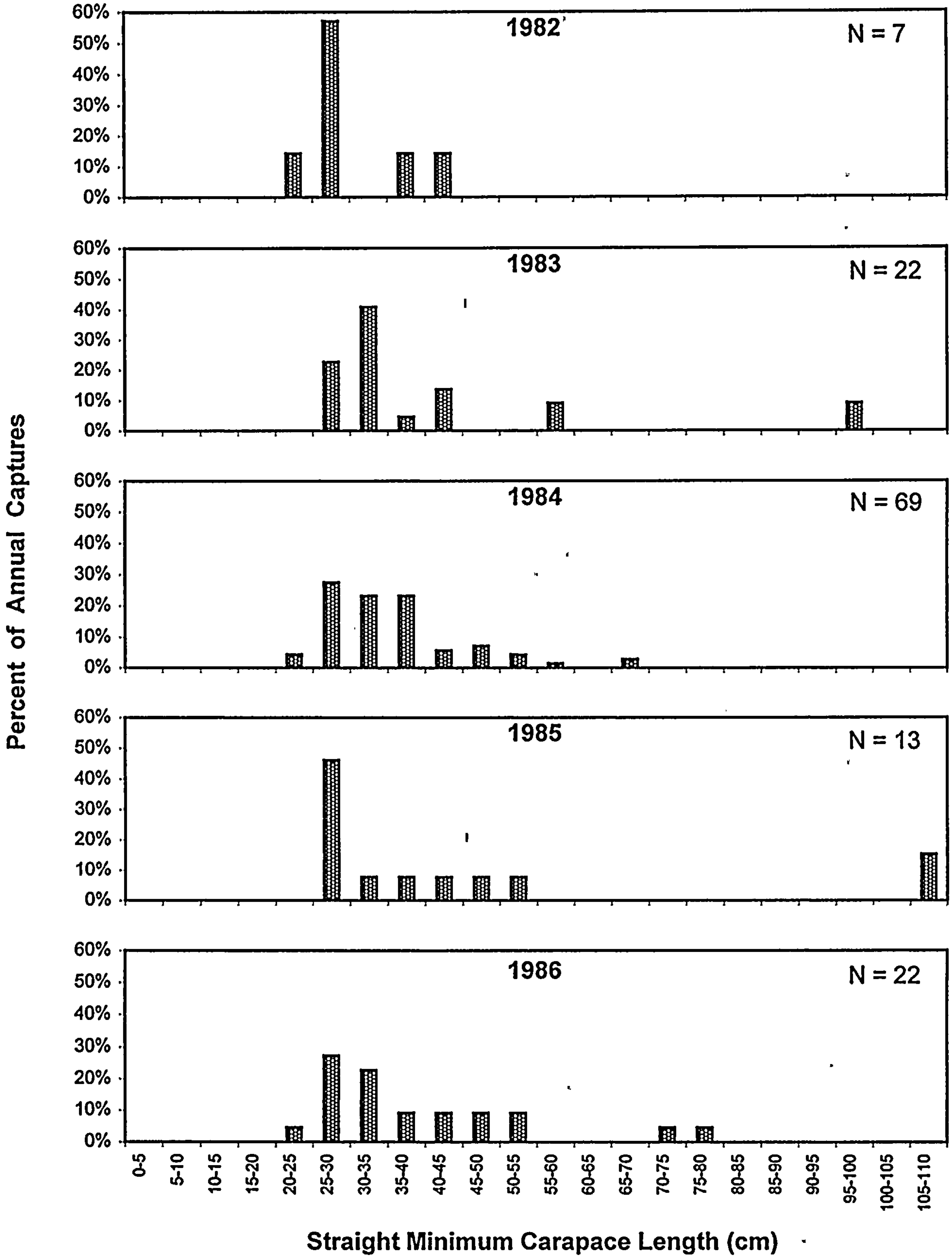

Figure 54. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1982-1986.

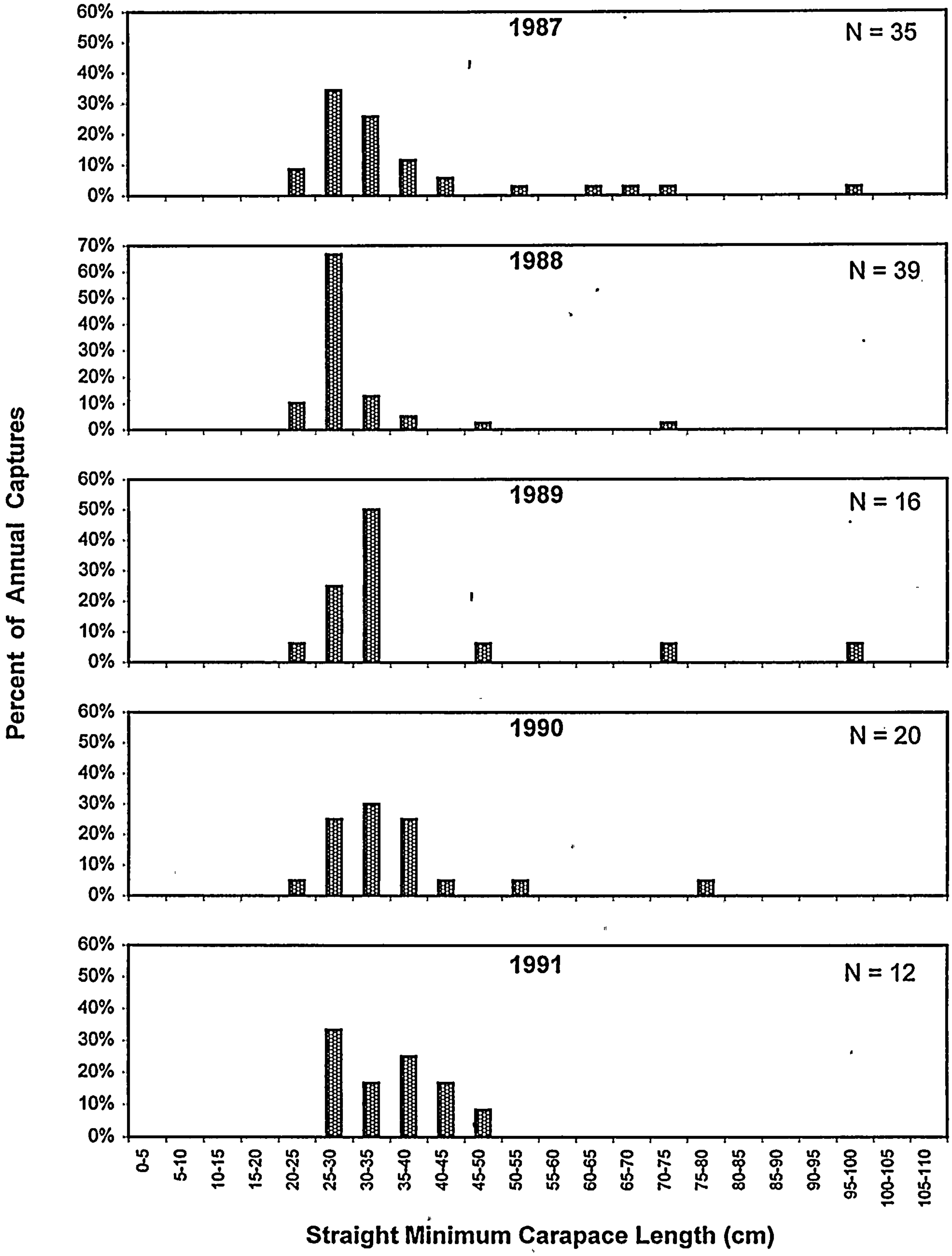

Figure 55. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1987-1991.

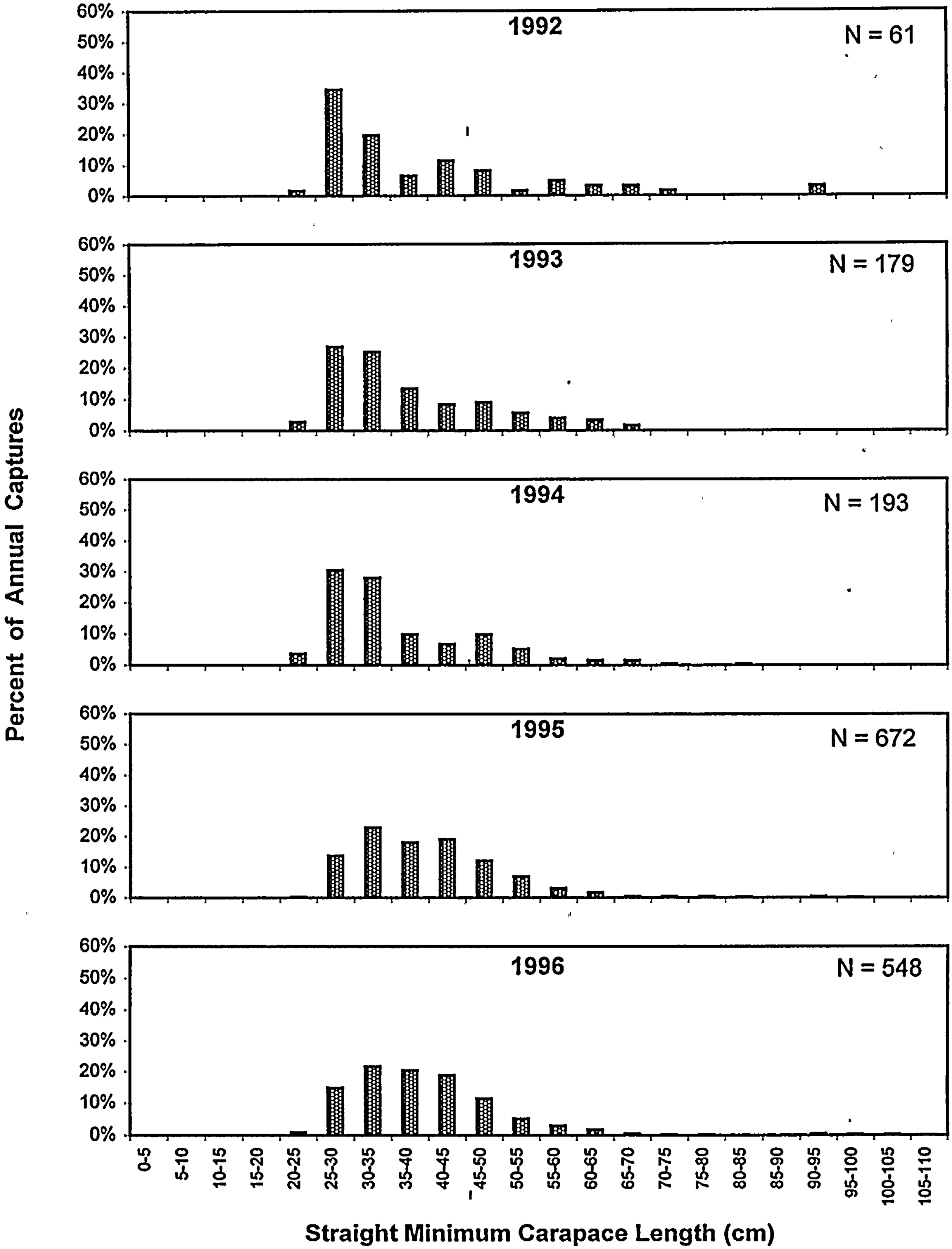

Figure 56. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1992-1996.

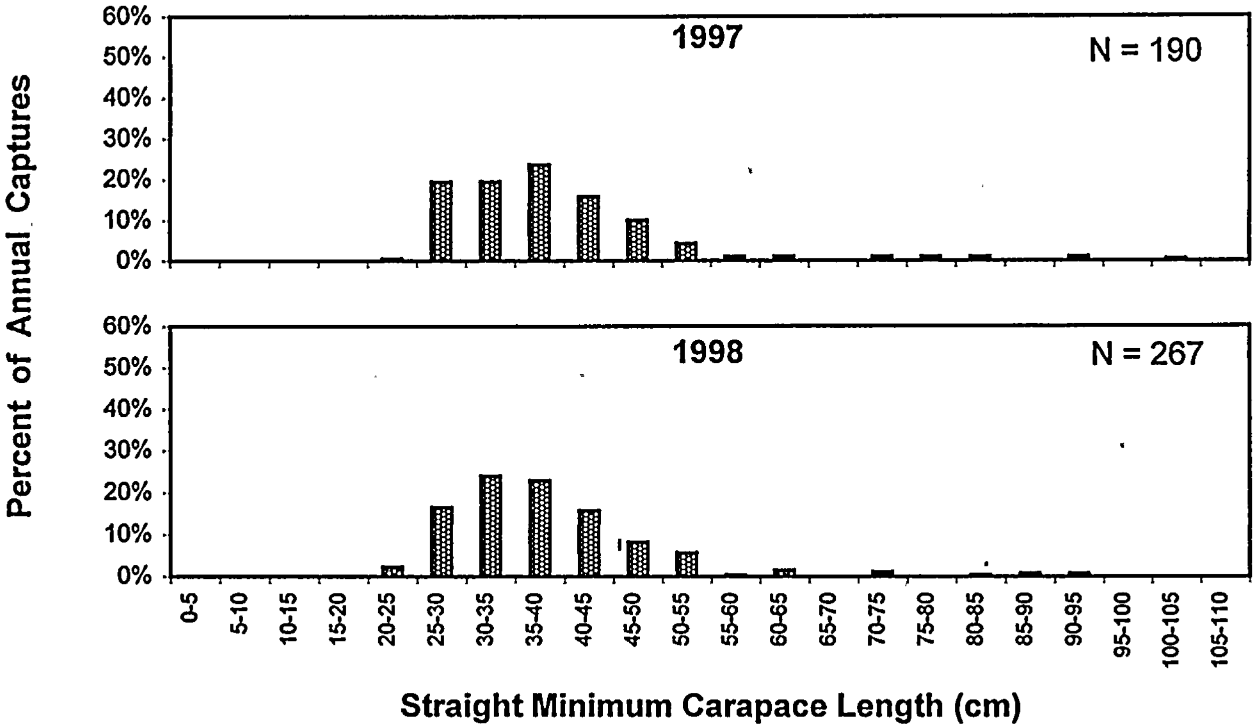

Figure 57. Distribution of straight minimum carapace length measurements for green turtles removed from the St. Lucie Plant intake canal, Hutchinson Island, Florida, 1997-1998.

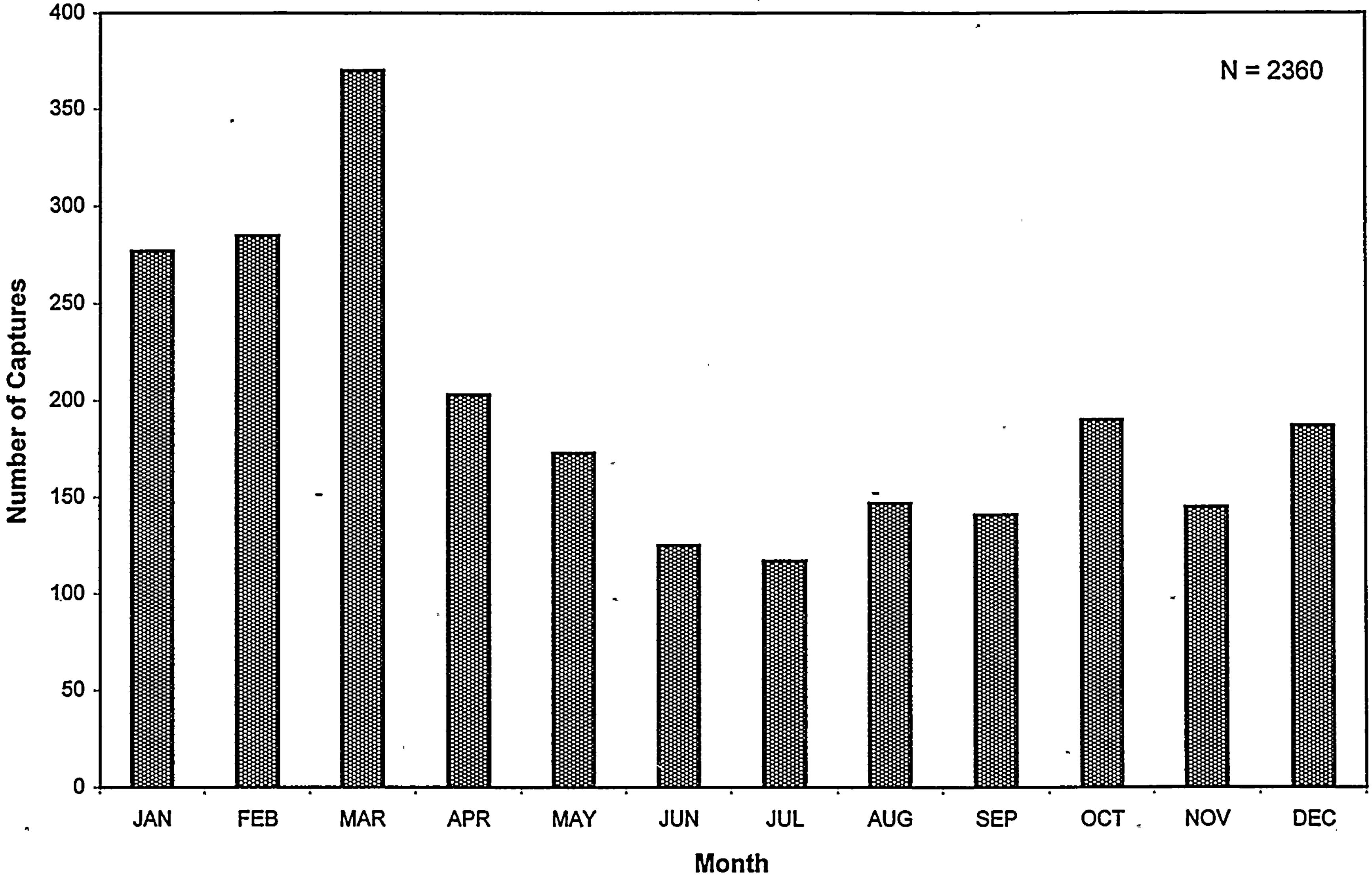

Figure 58. Number of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Note: no green turtles were captured during 1976.

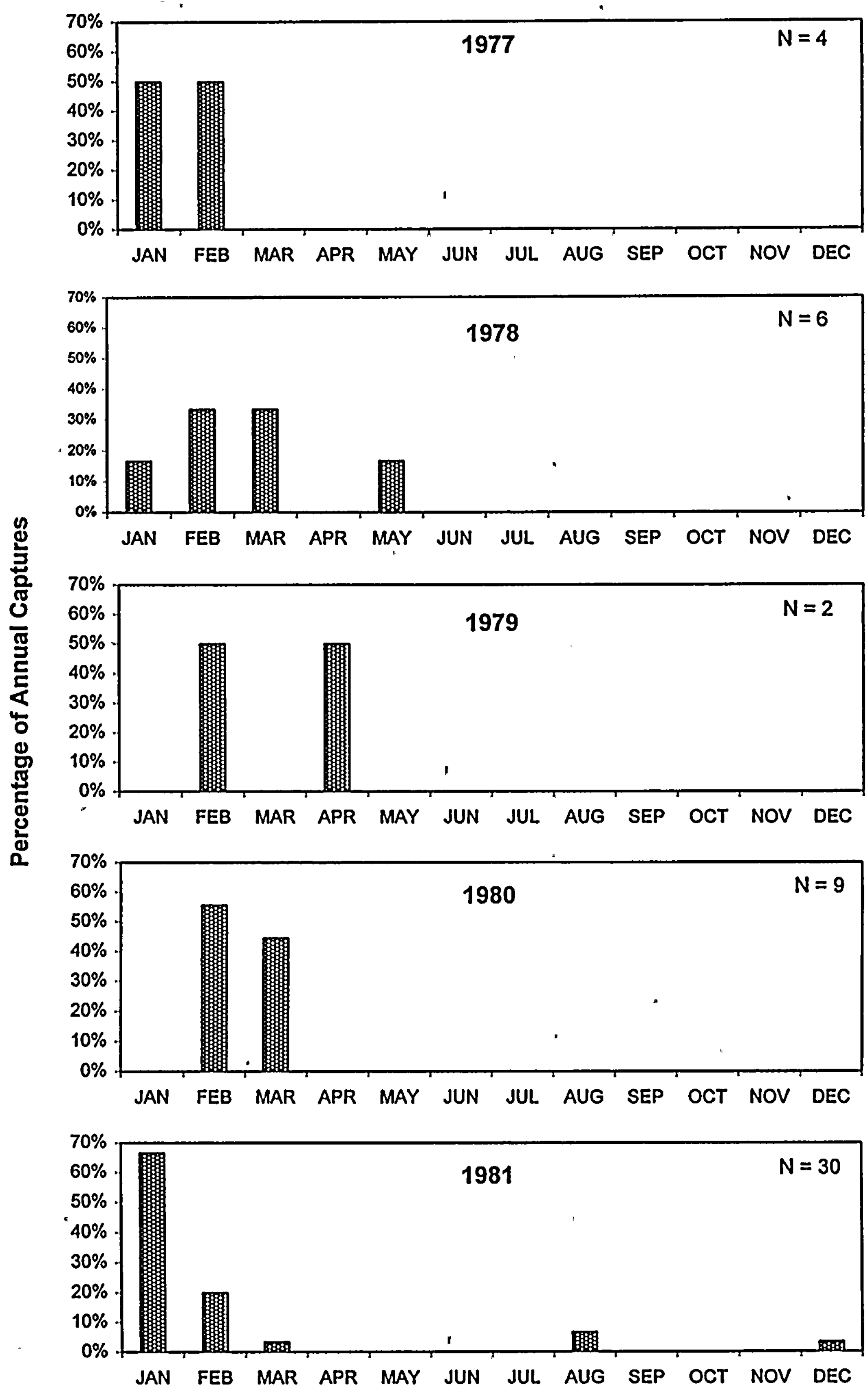

Figure 59. Percentage of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1981. Note: no green turtles were captured during 1976.

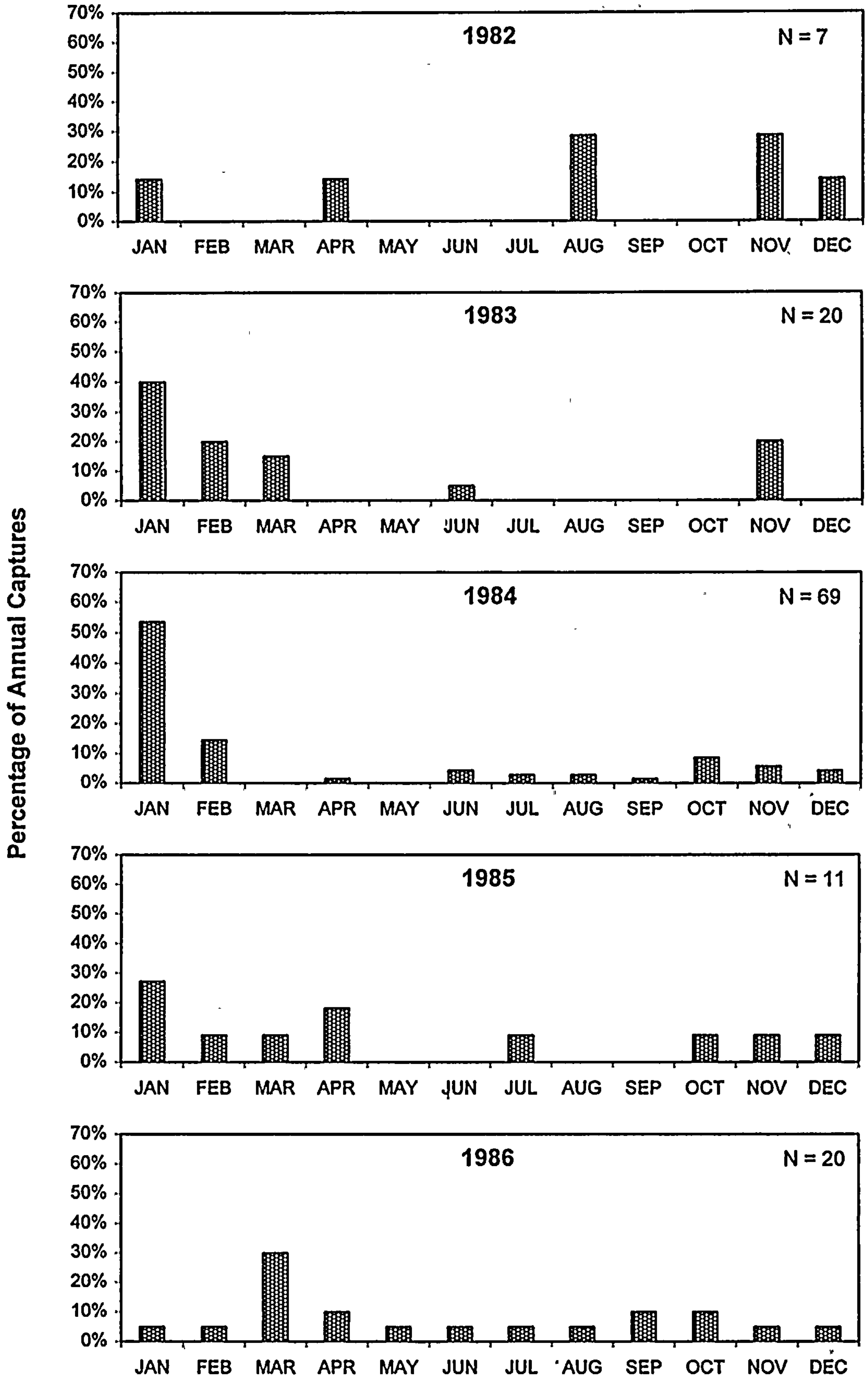

Figure 60. Percentage of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1982-1986.

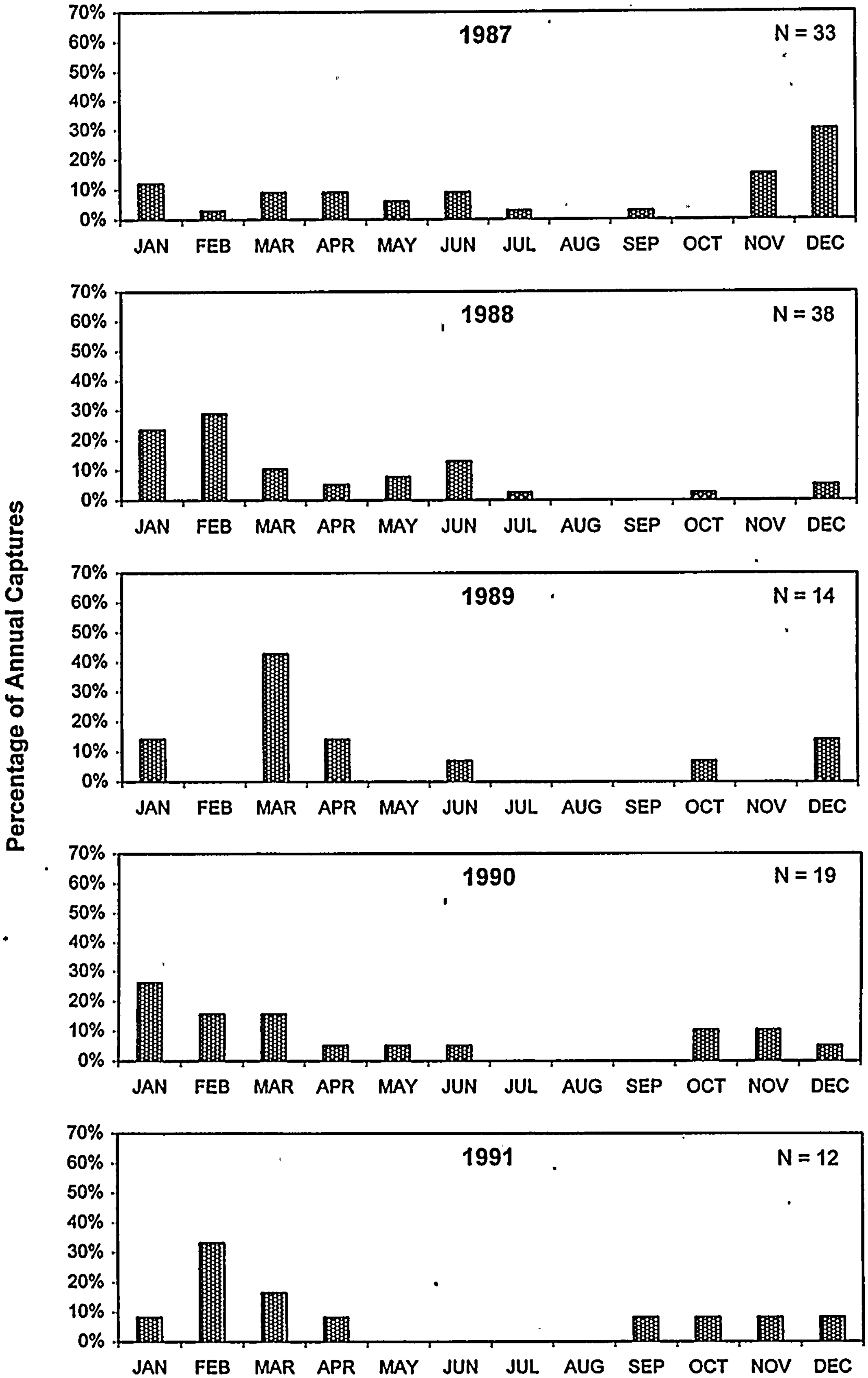

Figure 61. Percentage of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1987-1991.

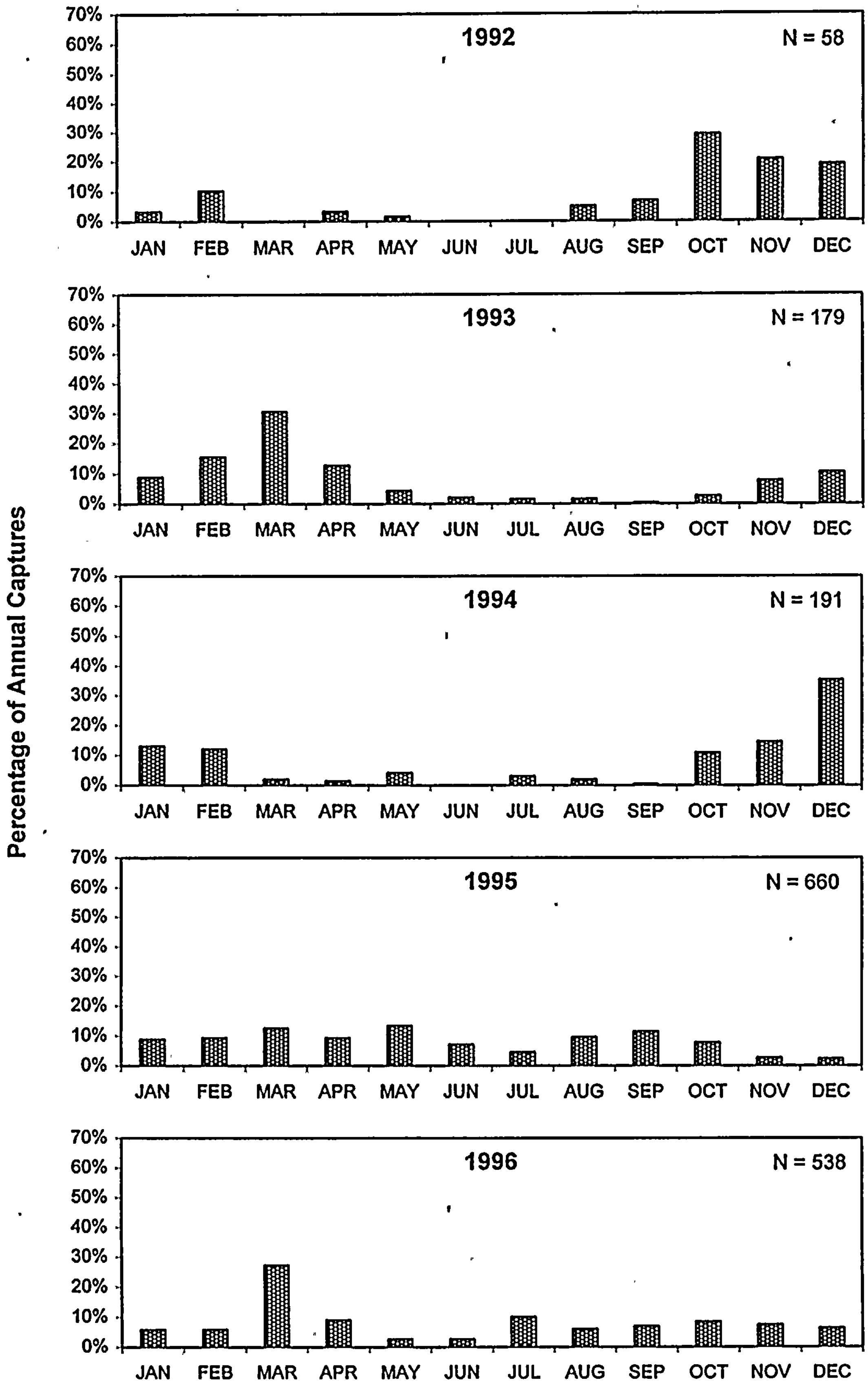

Figure 62. Percentage of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1992-1996.

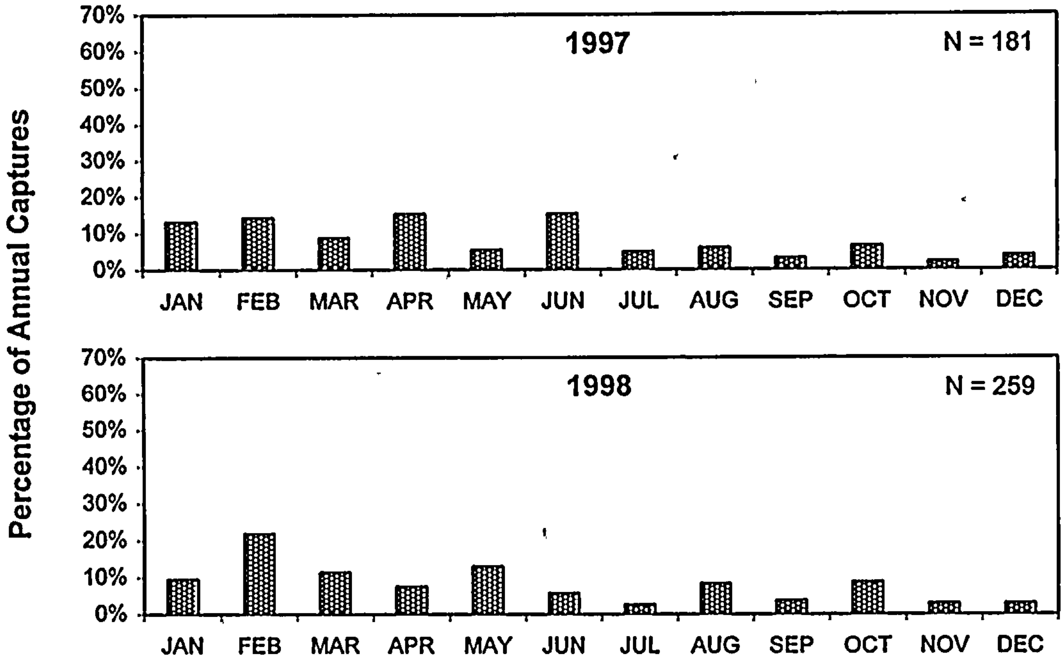

Figure 63. Percentage of juvenile green turtles captured each month, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1997-1998.

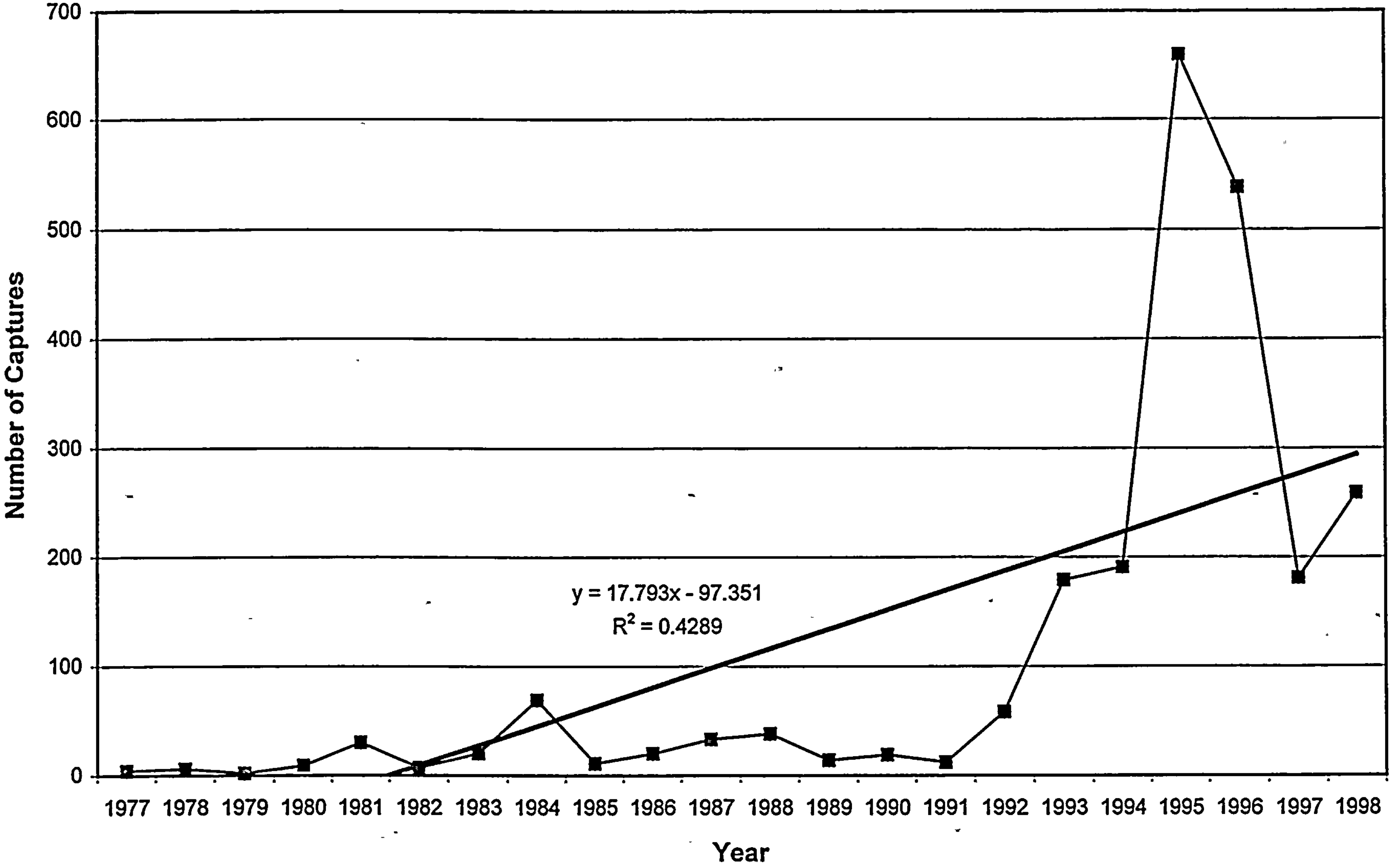

Figure 64. Annual number of juvenile green turtle captures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1996 were excluded since the power plant did not begin operation until May of that year.

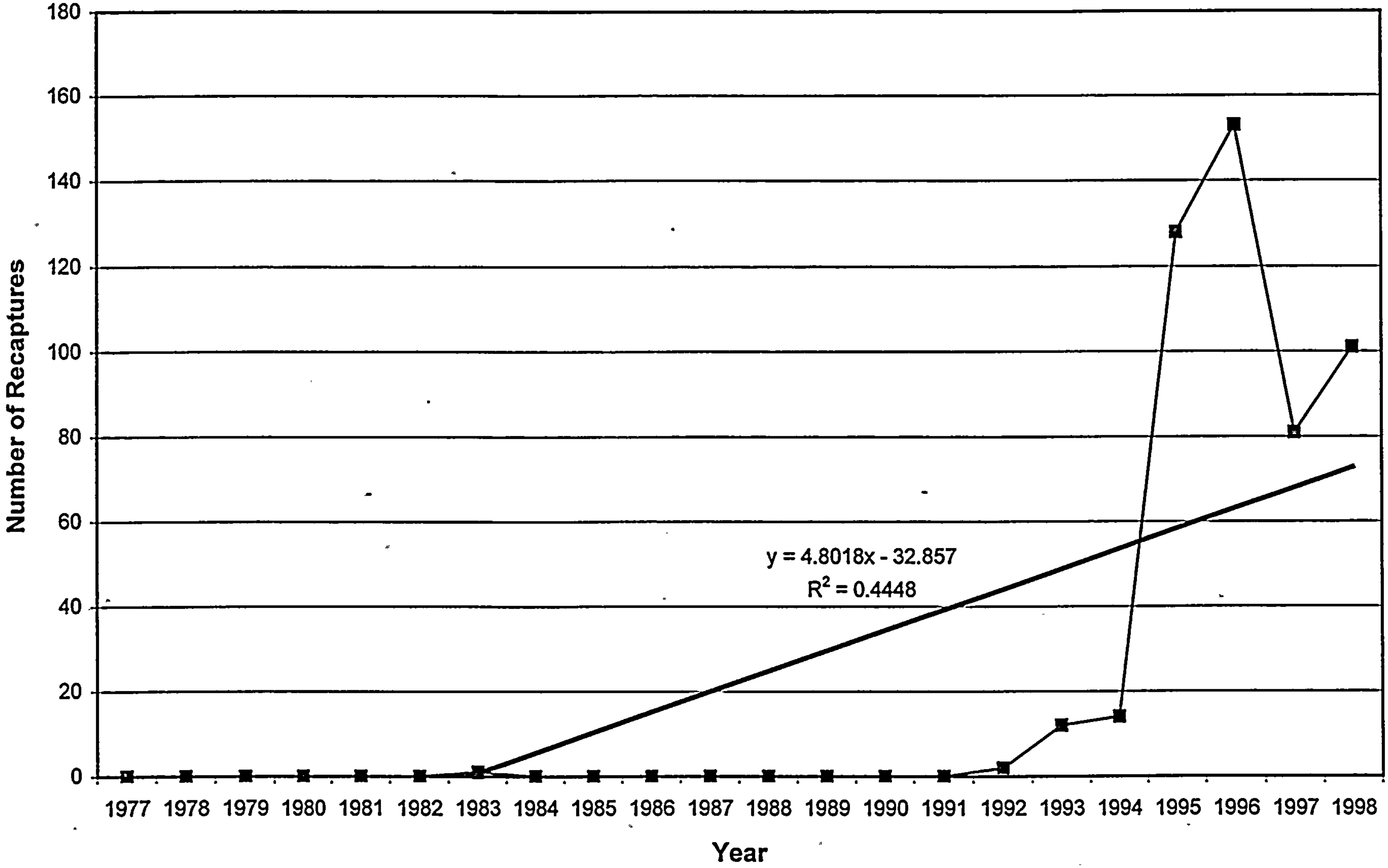

Figure 65. Annual number of juvenile green turtle recaptures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977 1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

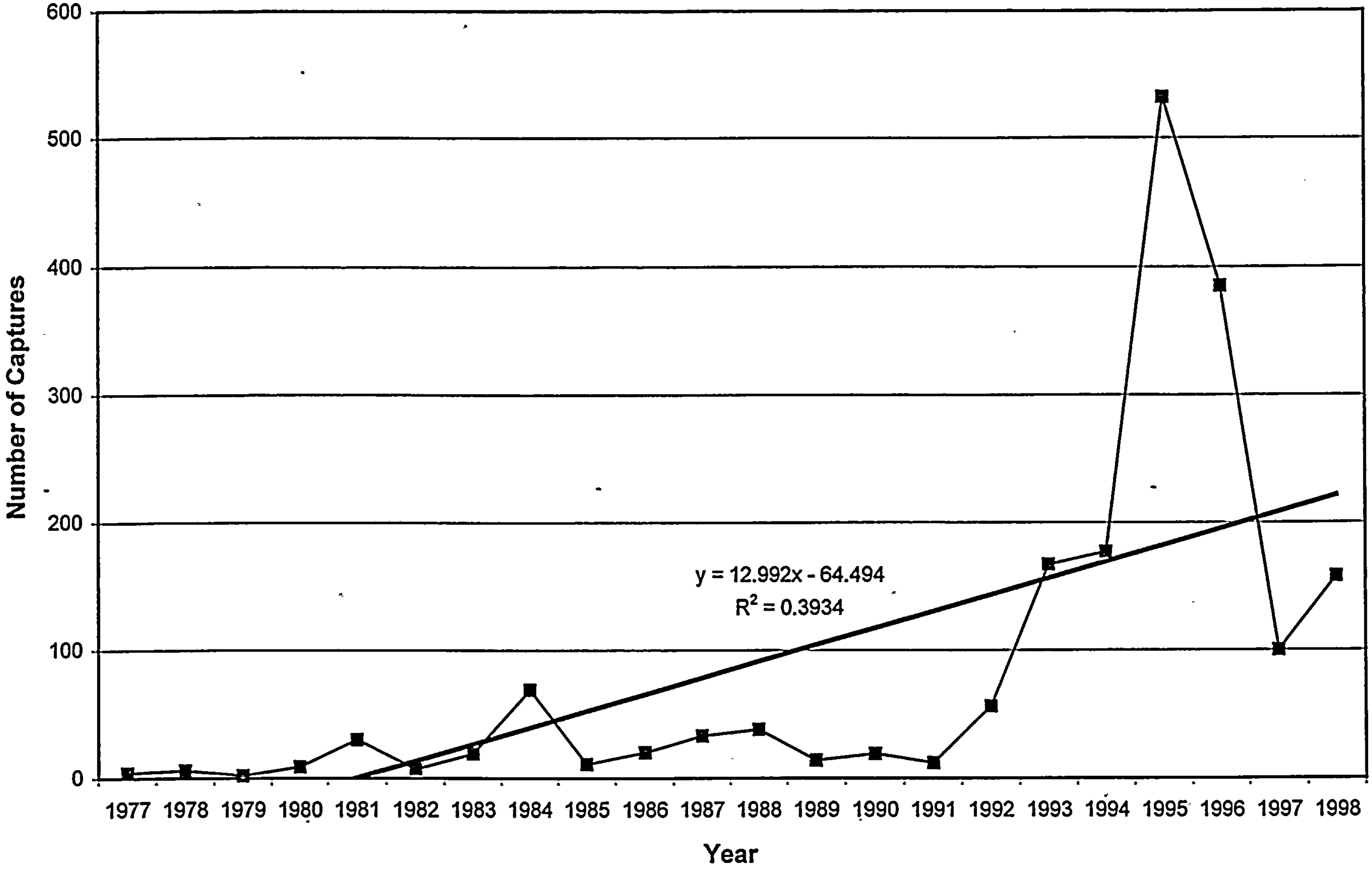

Figure 66. Annual number of juvenile green turtle captures excluding recaptures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1977-1998. Data for 1976 were excluded since the power plant did not begin operation until May of that year.

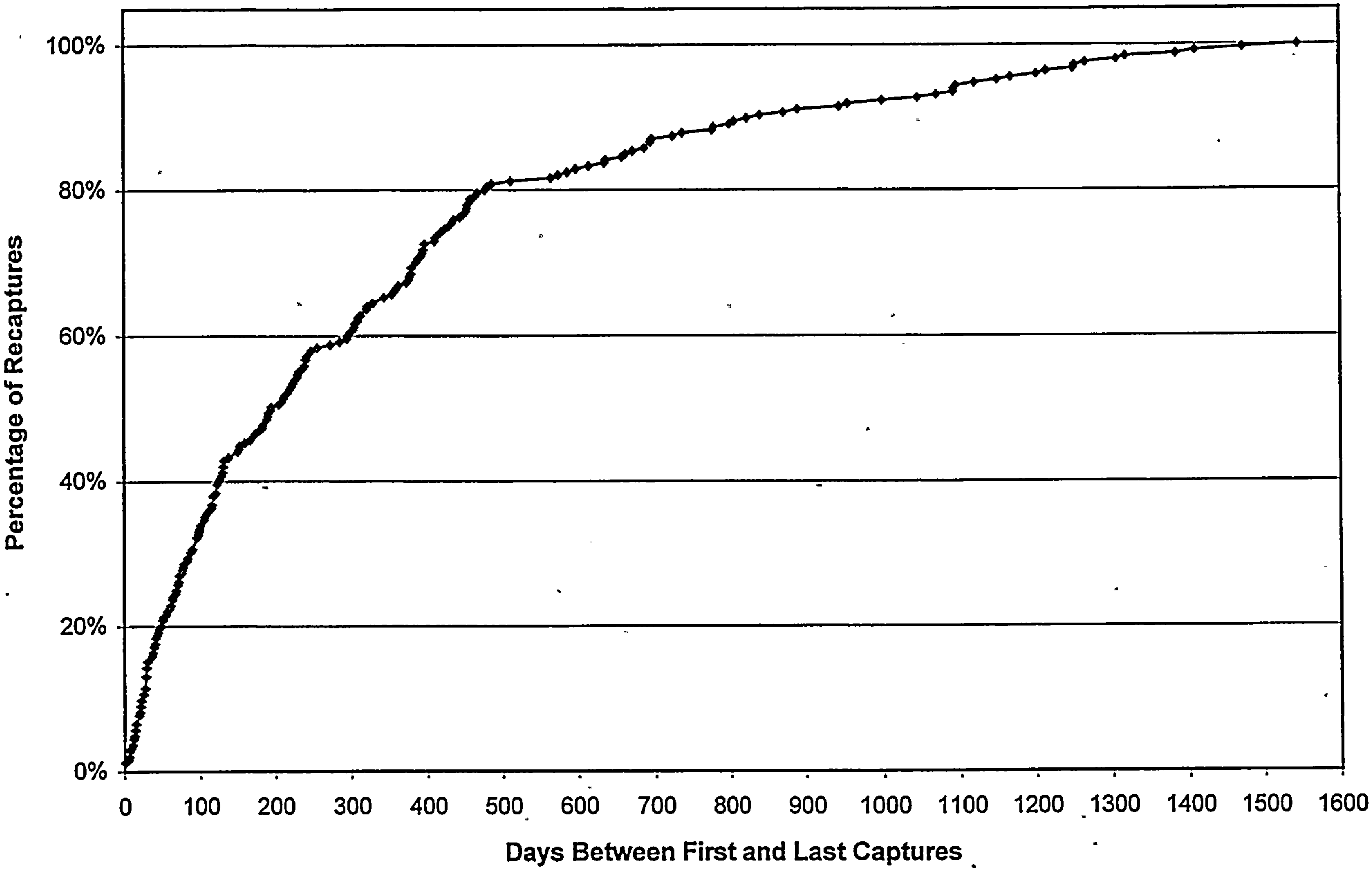

Figure 67. The percentage of juvenile green turtle recaptures that occurred within each time interval between first and last capture, St. Lucie Plant intake canal, Hutchinson Island, Florida.

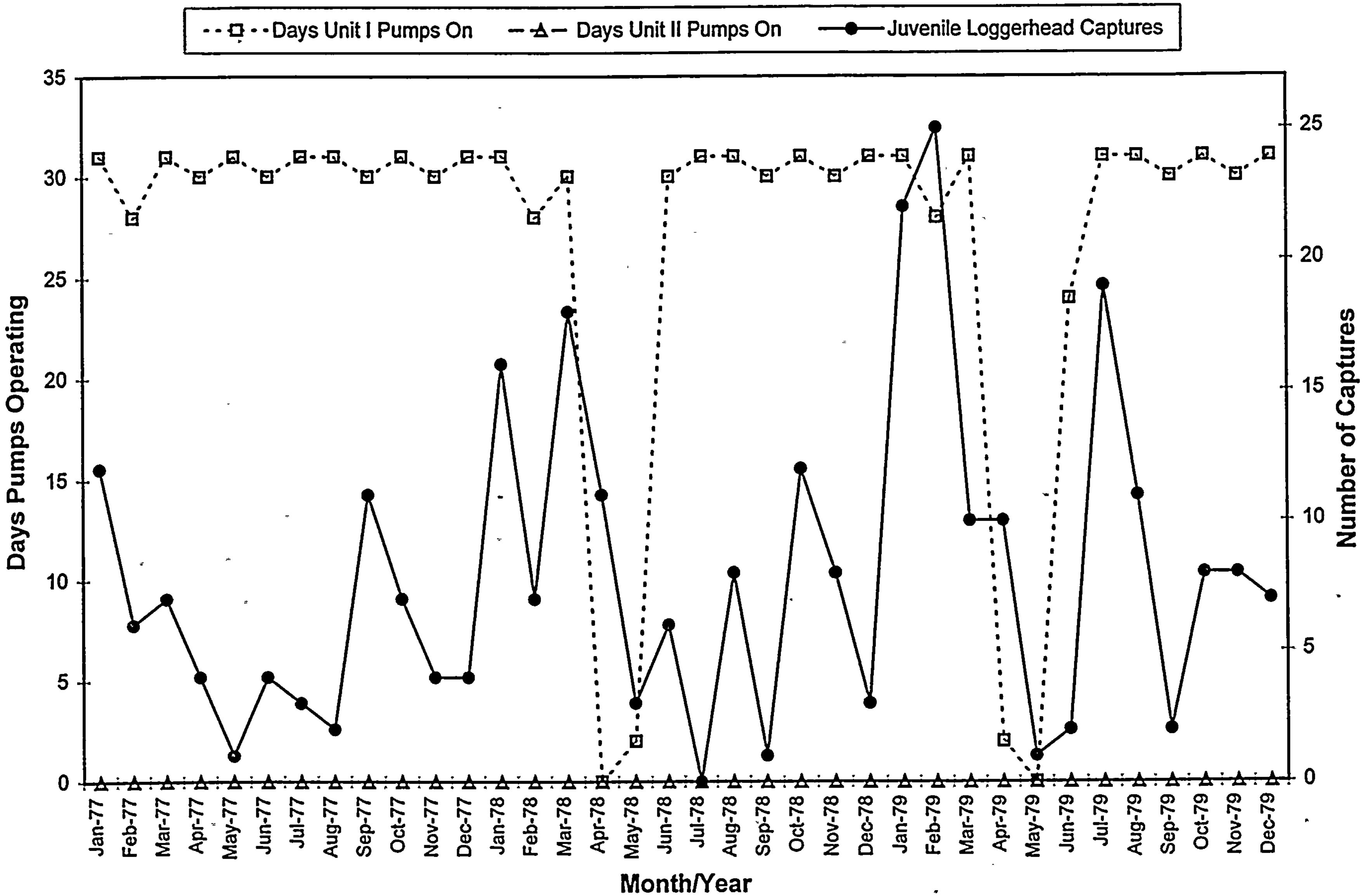

Figure 68. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1977 - December 1979.

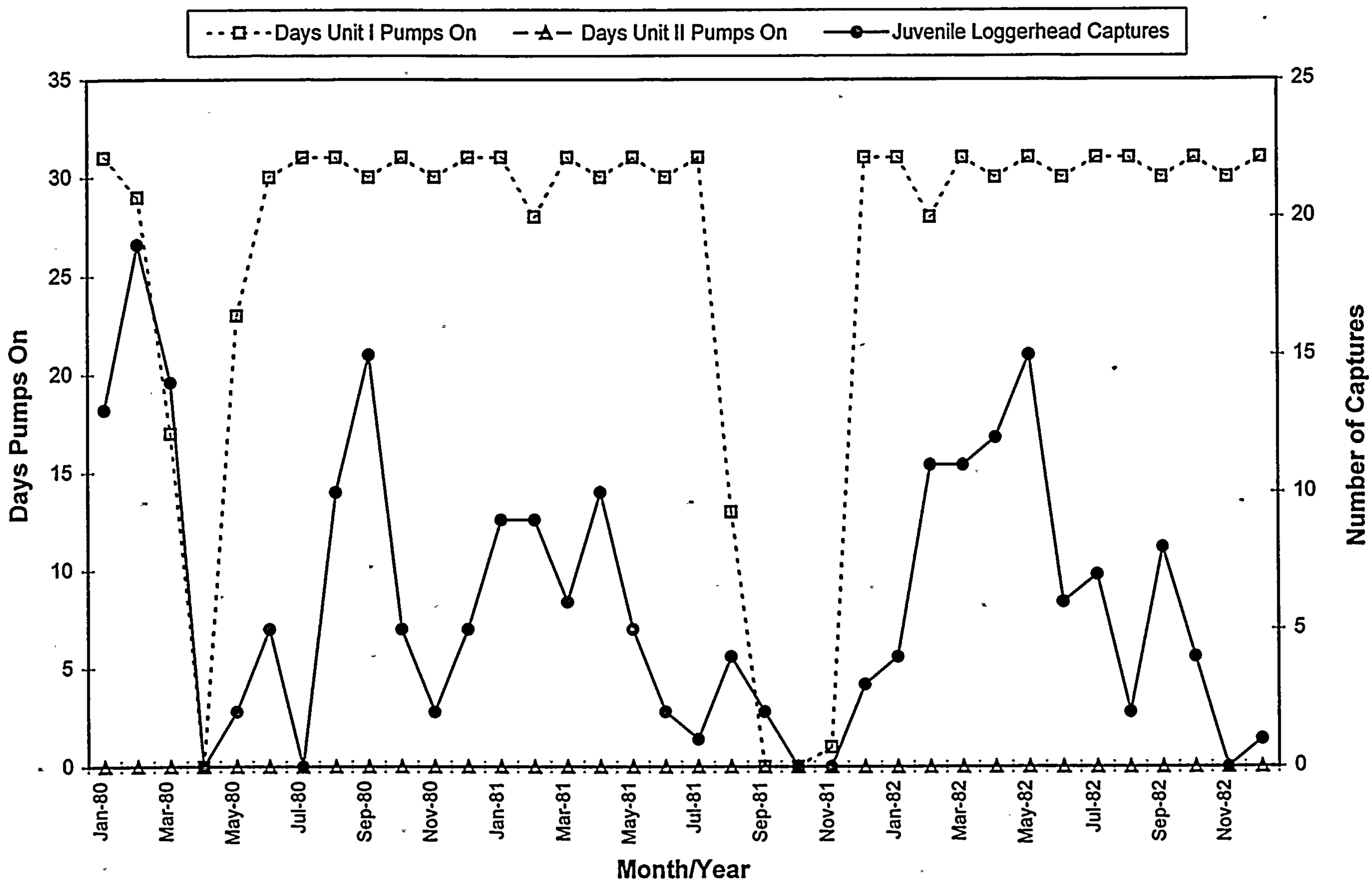

Figure 69. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1980 - December 1982.

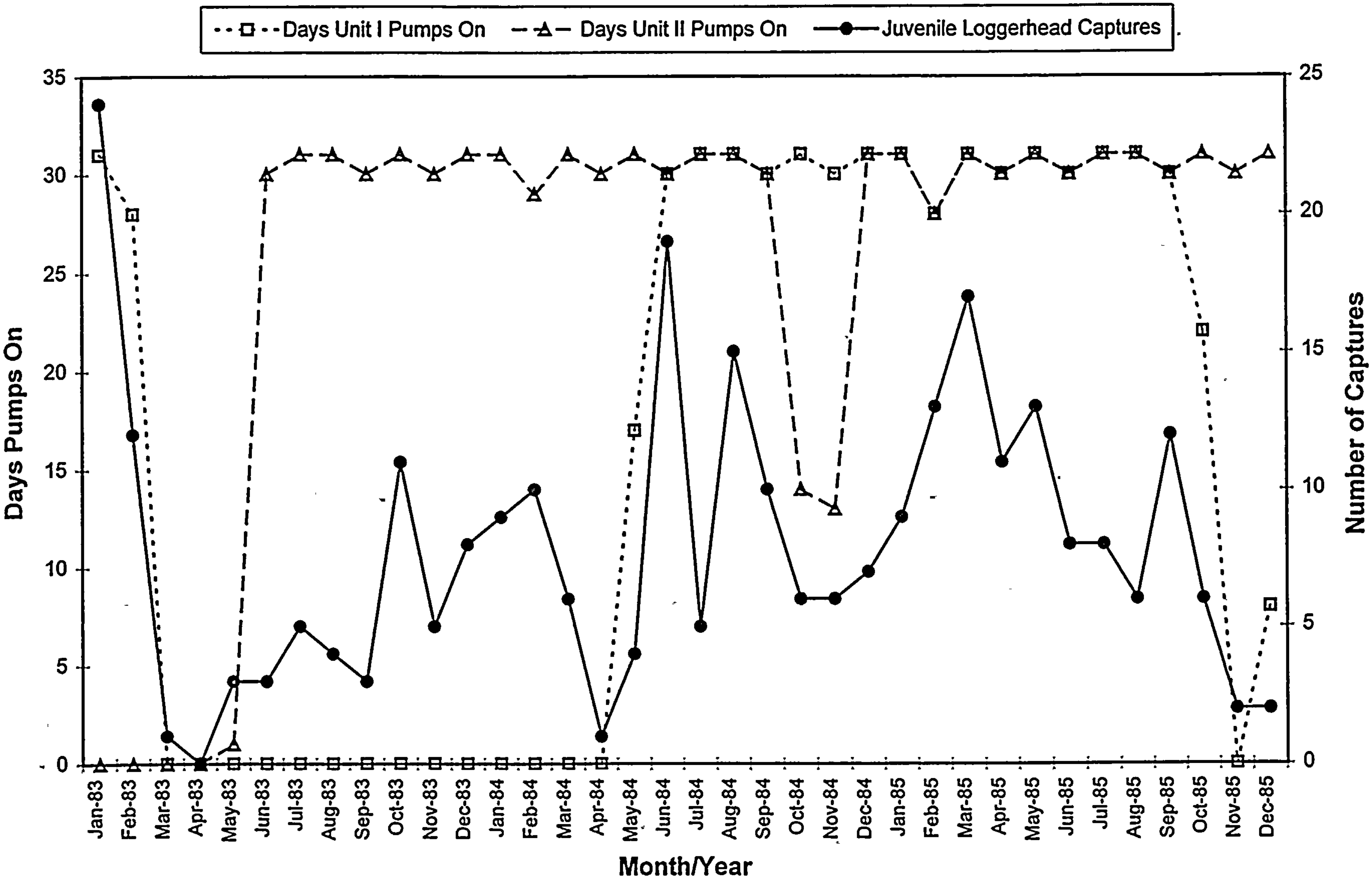

Figure 70. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1983 - December 1985.

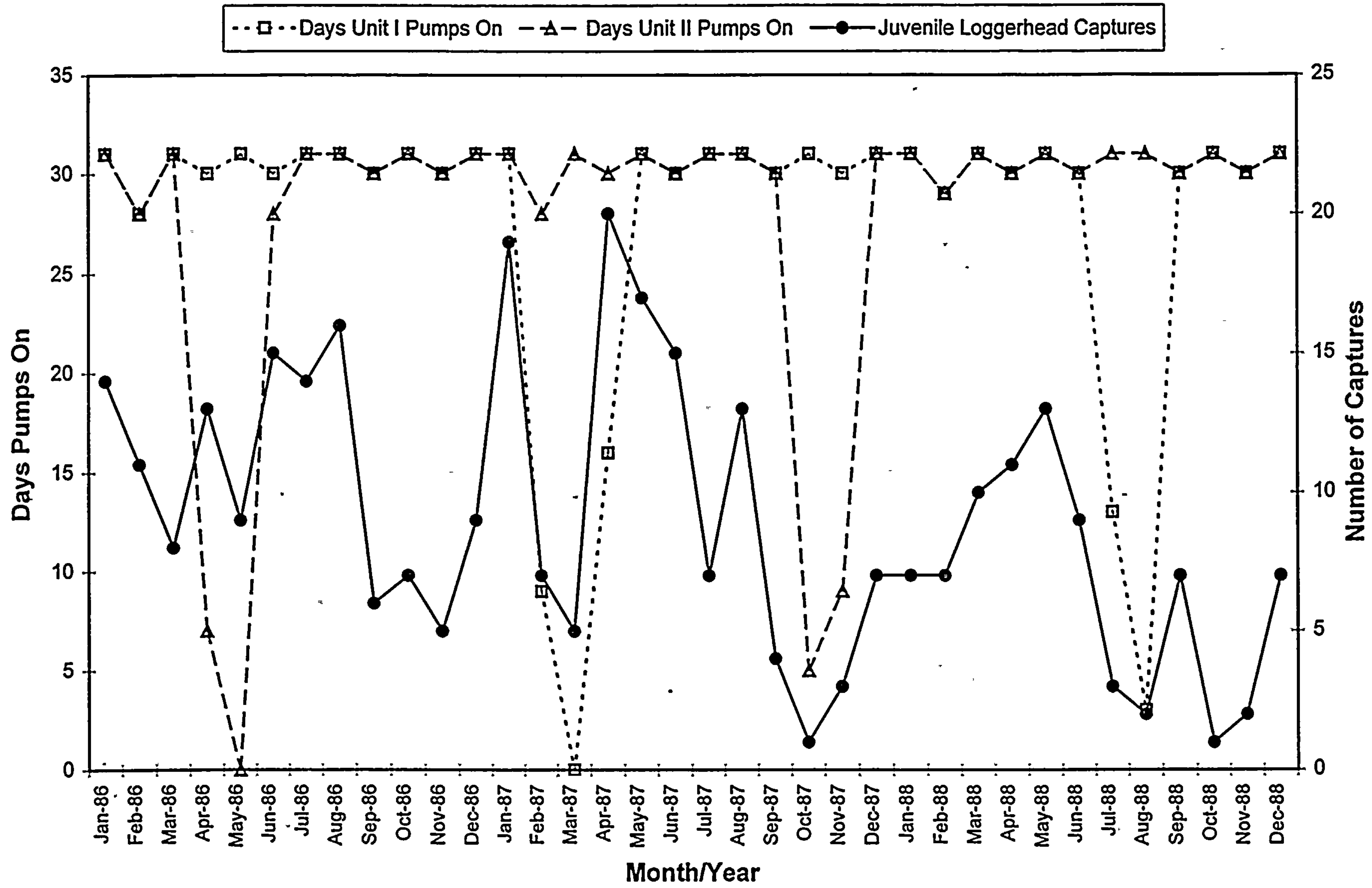

Figure 71. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1986 - December 1988.

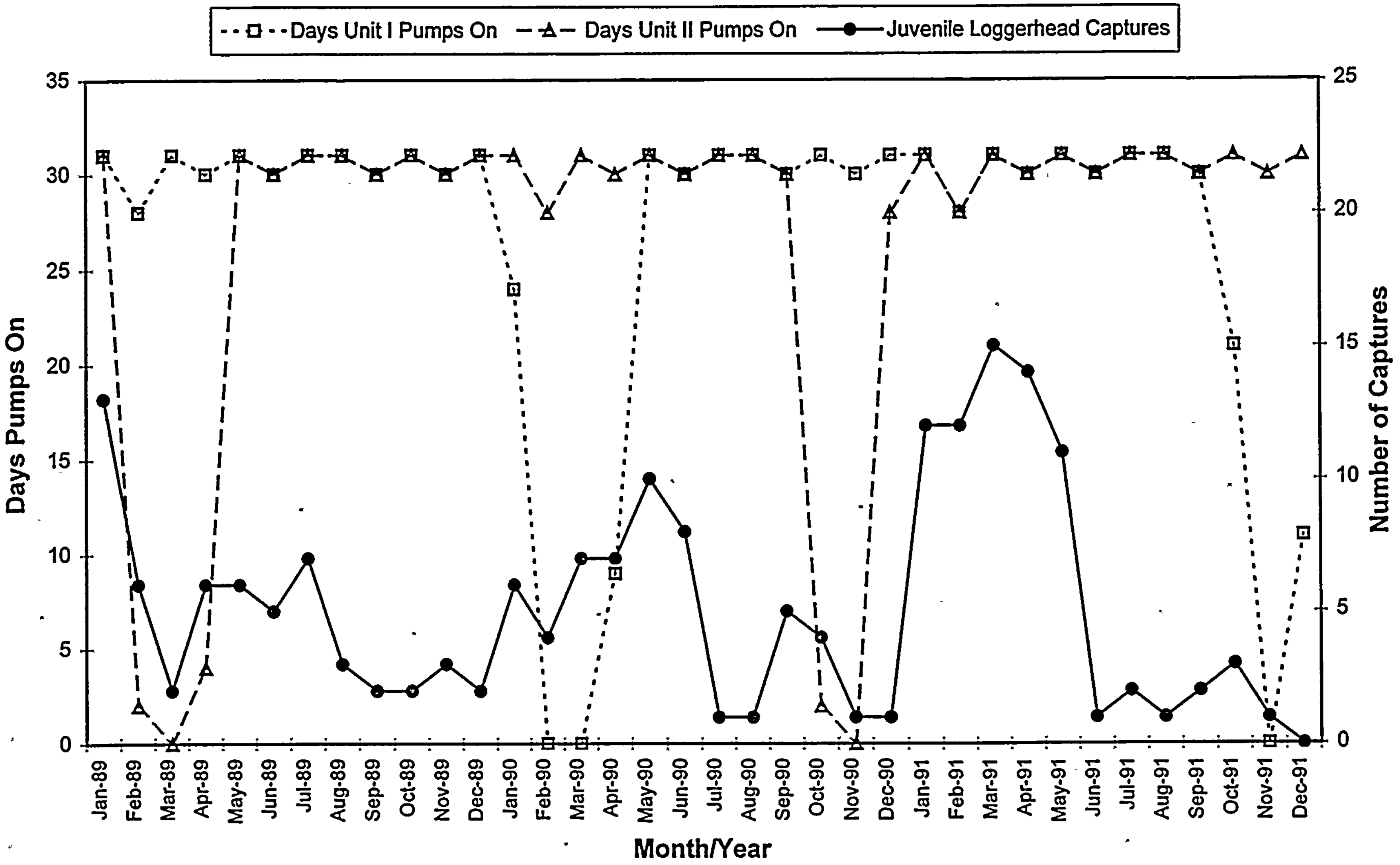

Figure 72. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1989 - December 1991.

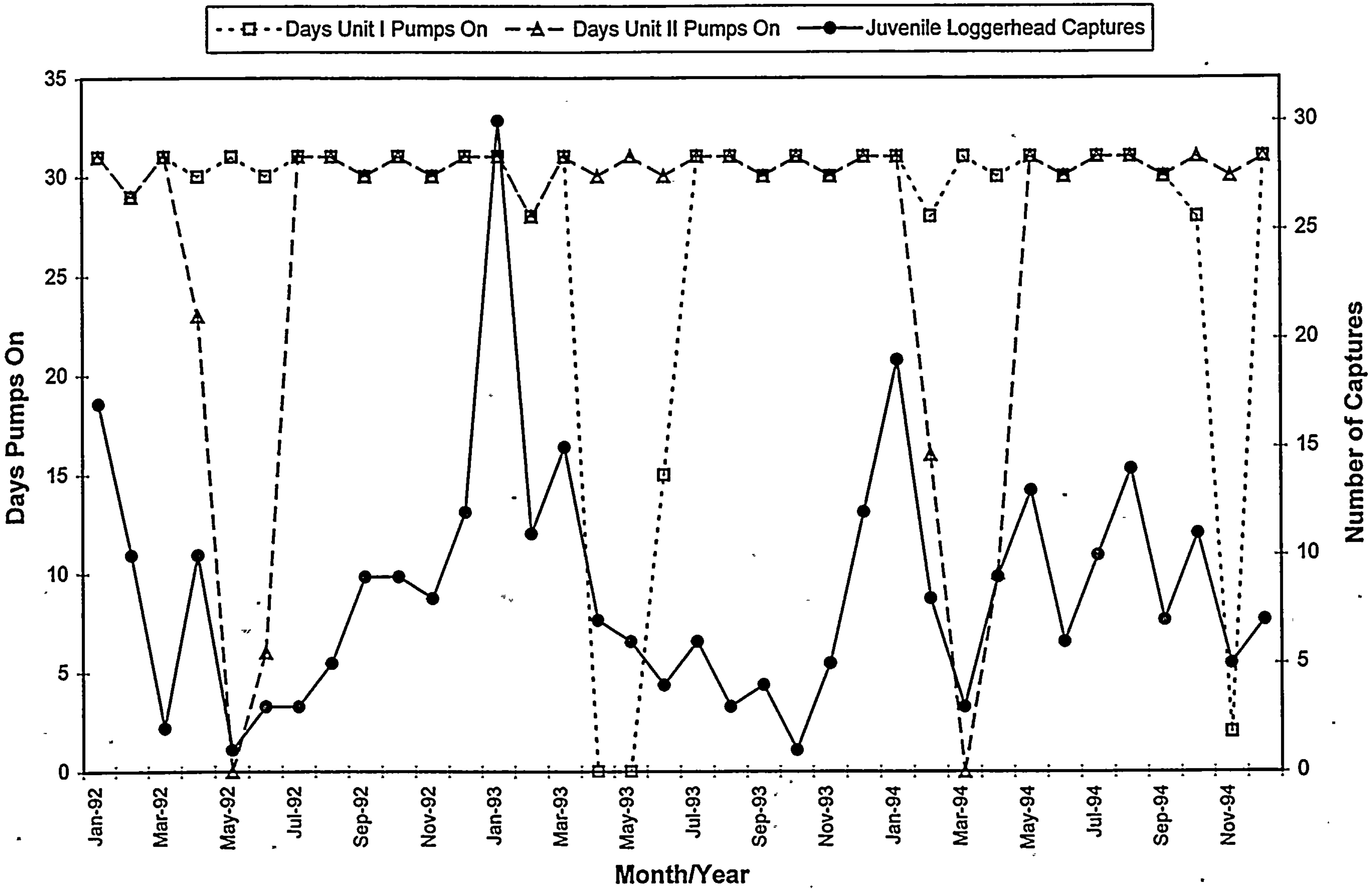

Figure 73. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1992 - December 1994.

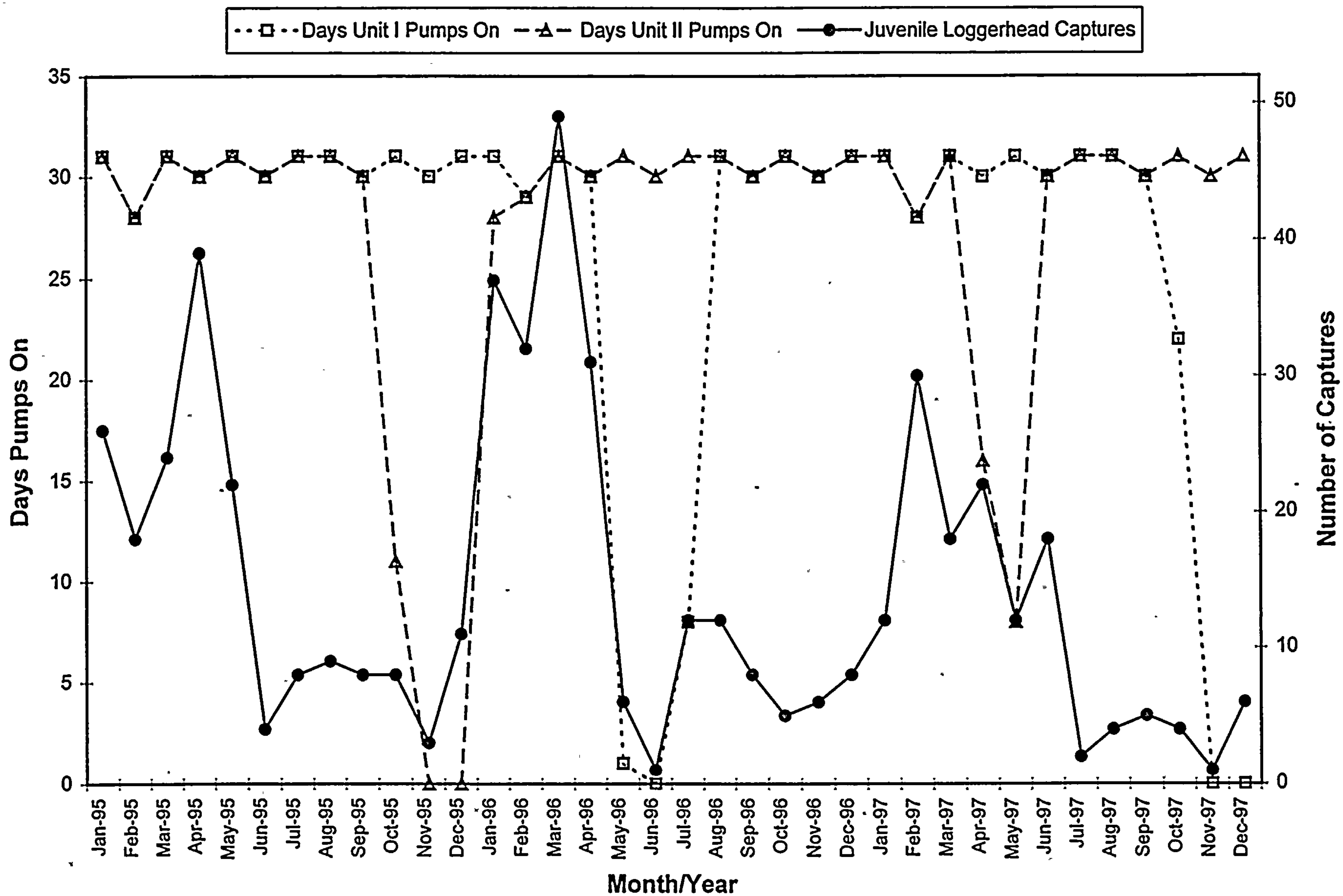

Figure 74. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1995 - December 1997.

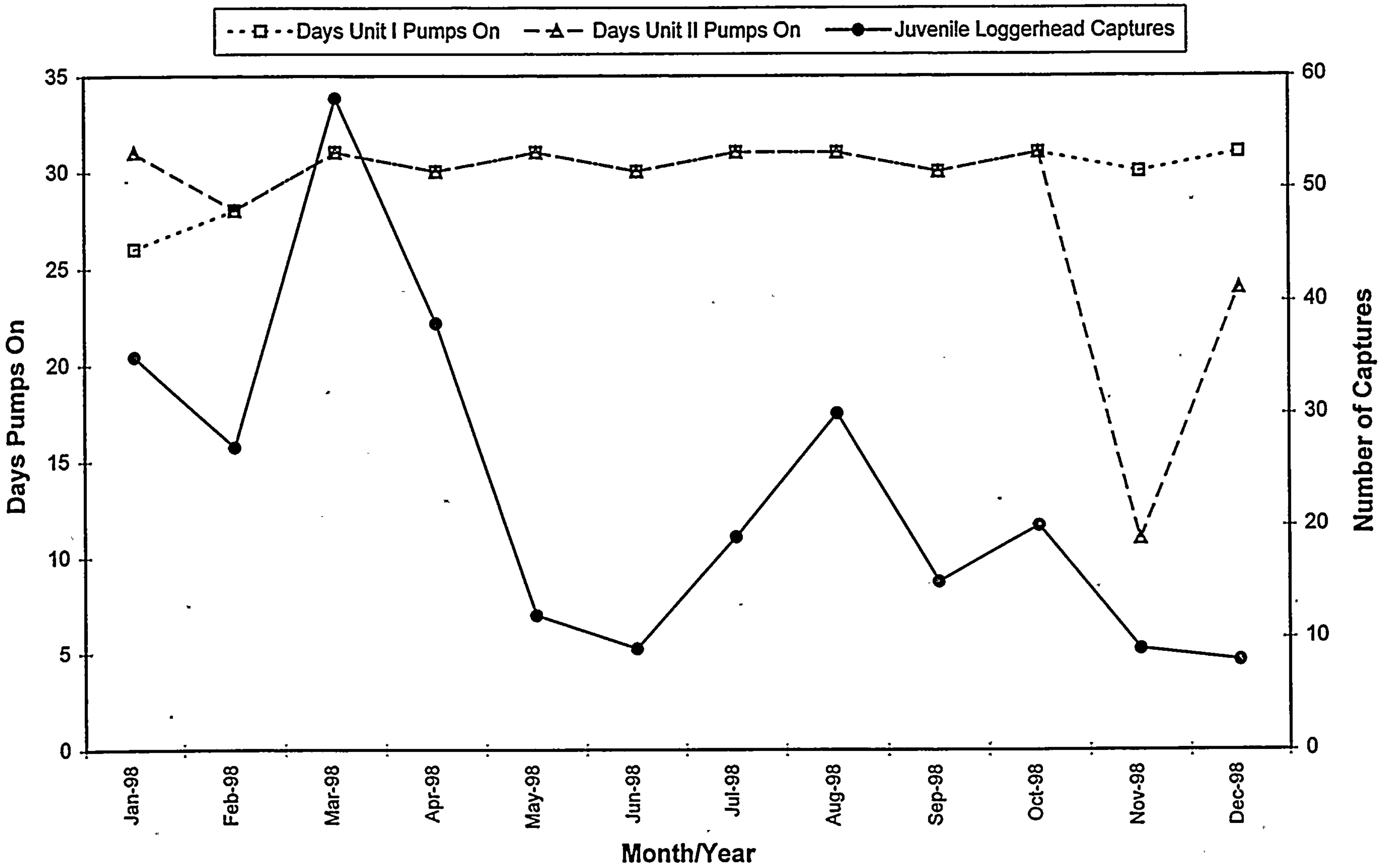

Figure 75. Monthly juvenile loggerhead captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1998 - December 1998.

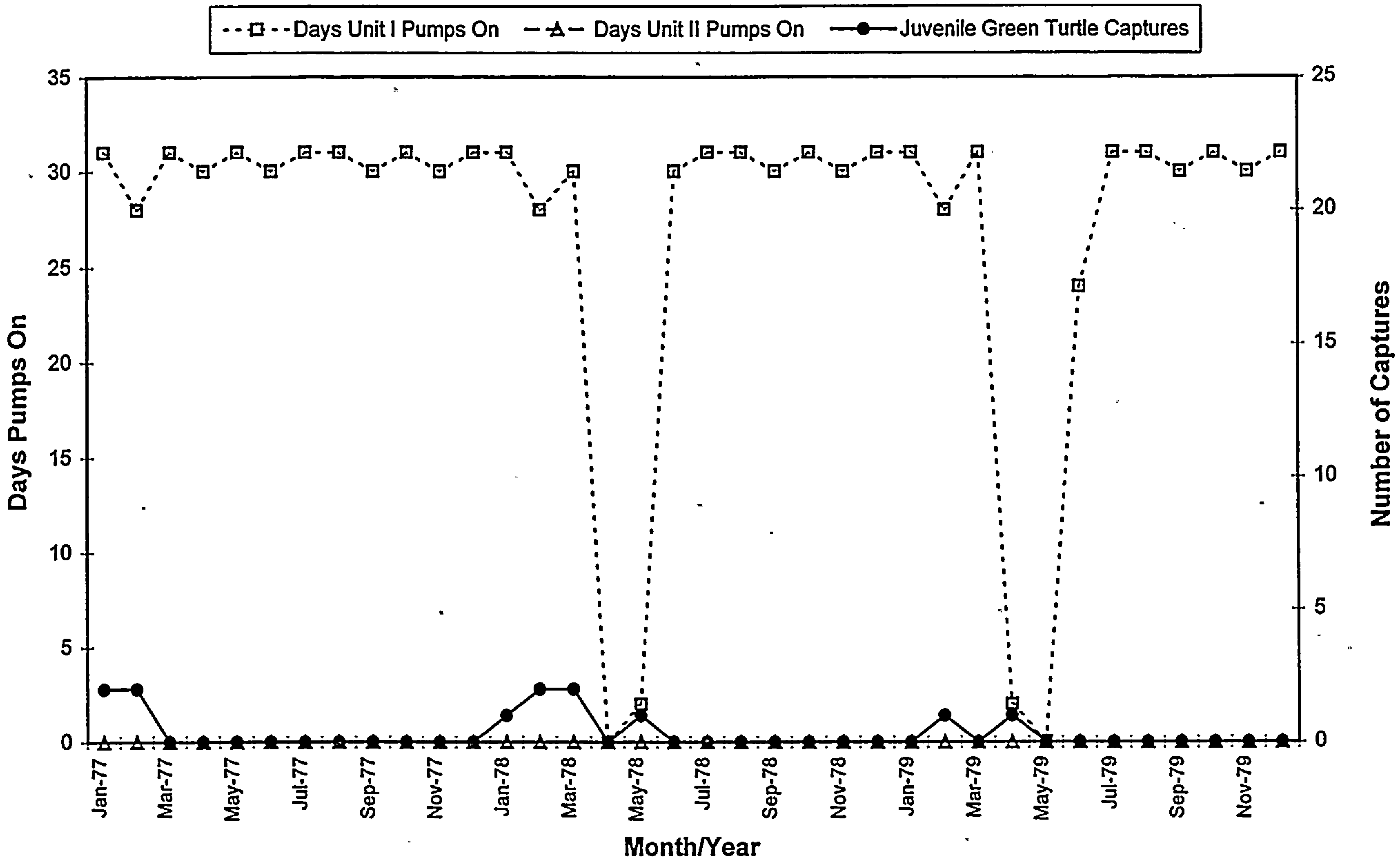

Figure 76. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1977 - December 1979.

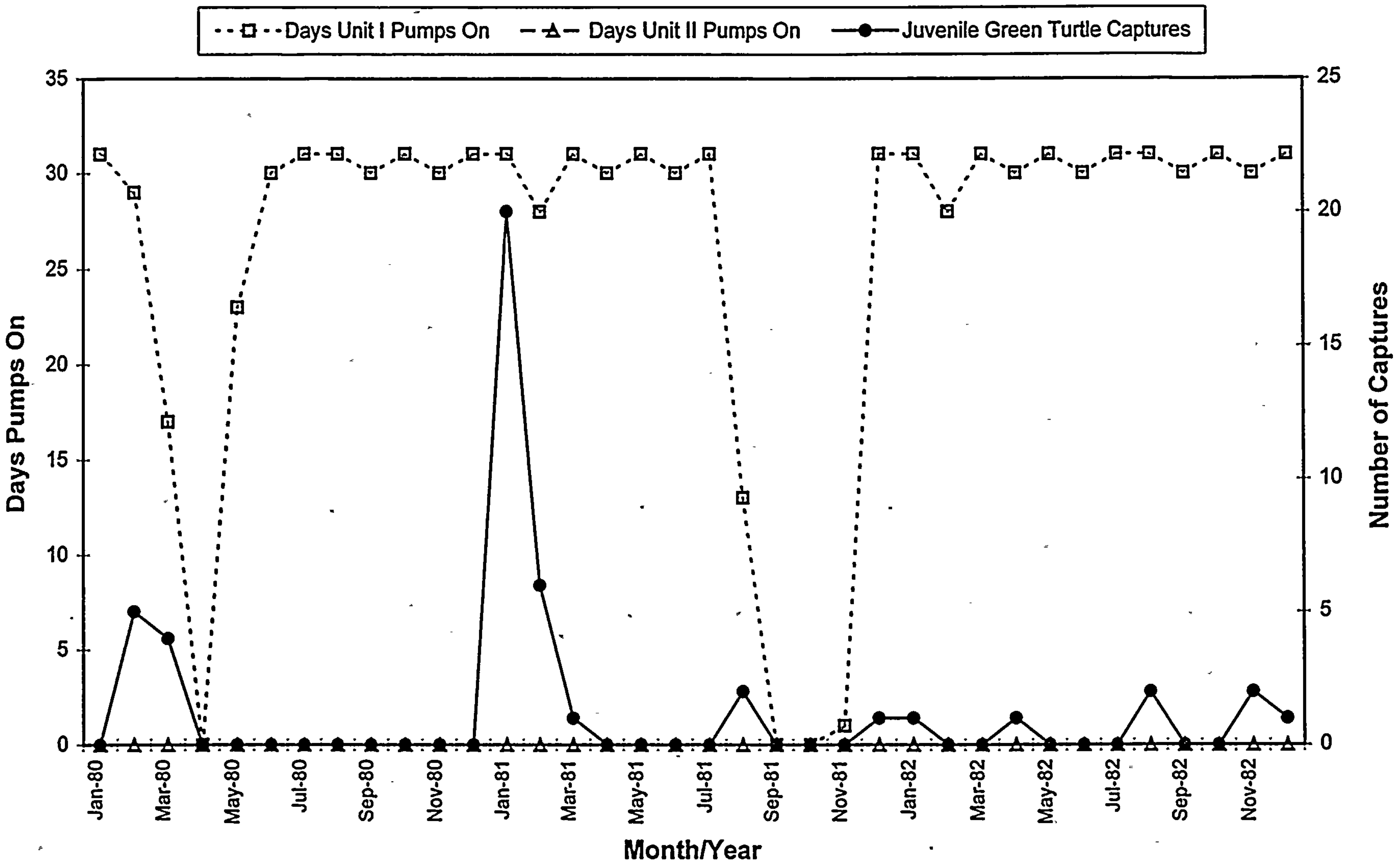

Figure 77. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1980 - December 1982.

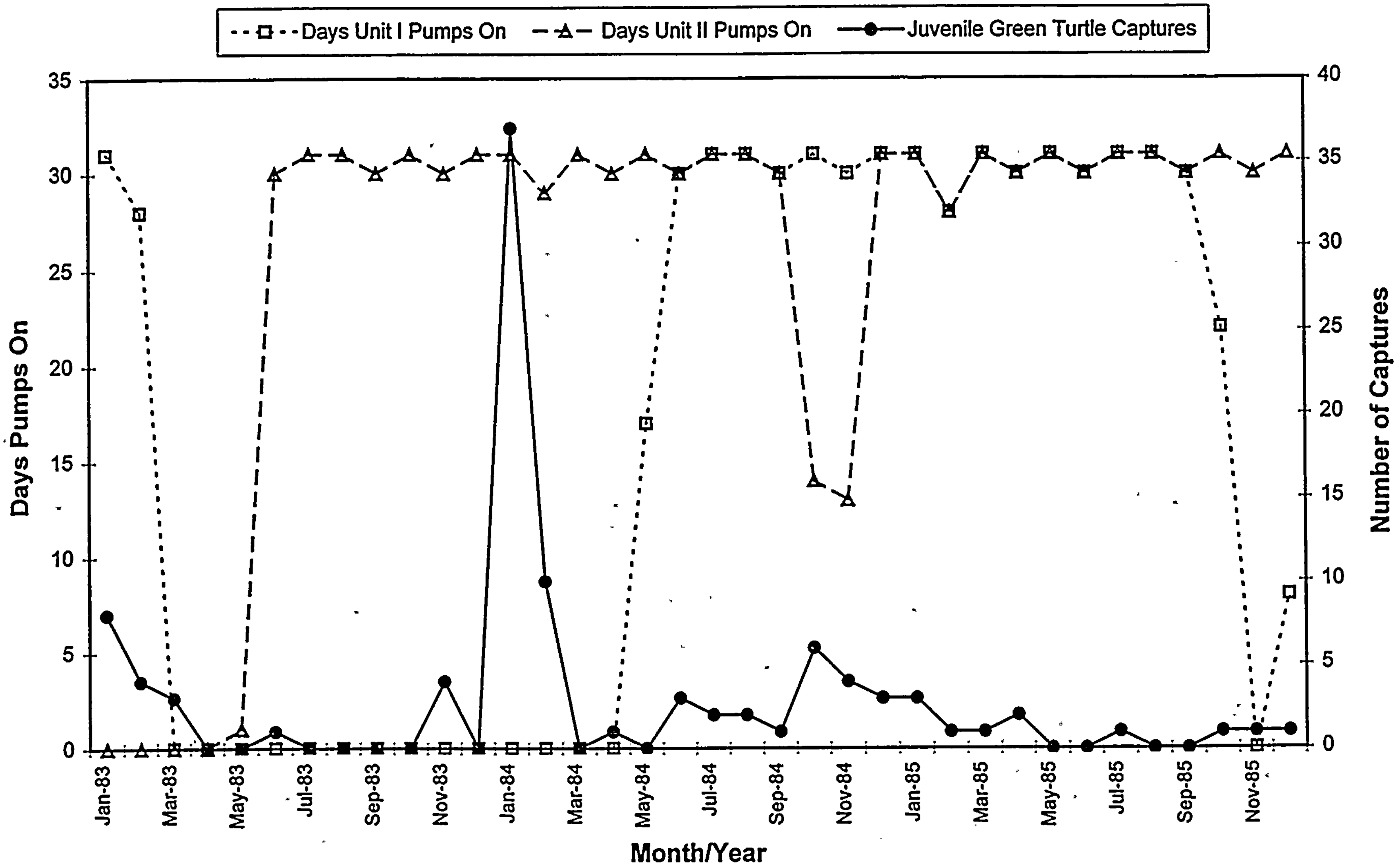

Figure 78. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1983 - December 1985.

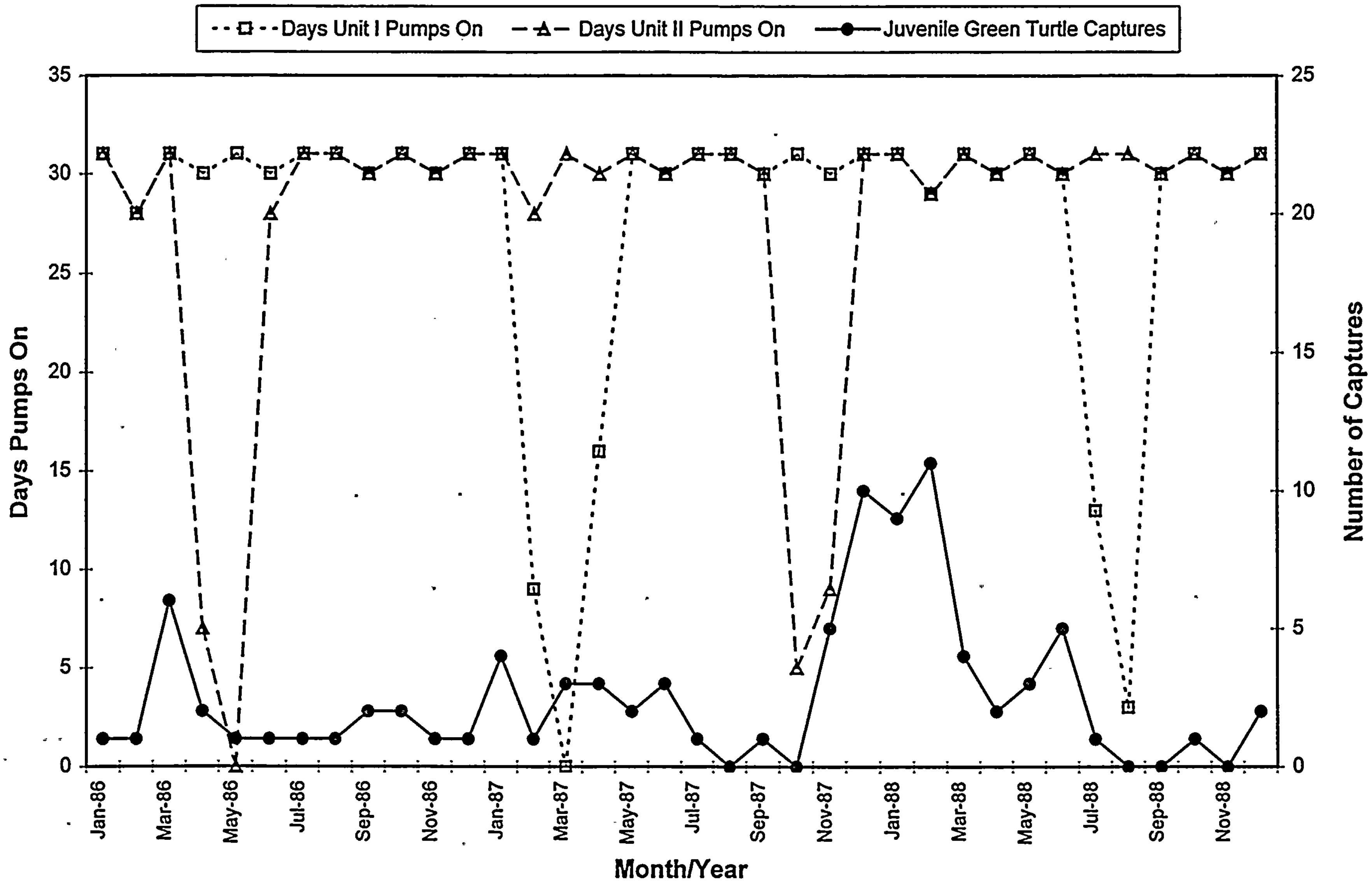

Figure 79. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1986 - December 1988.

[illegible]

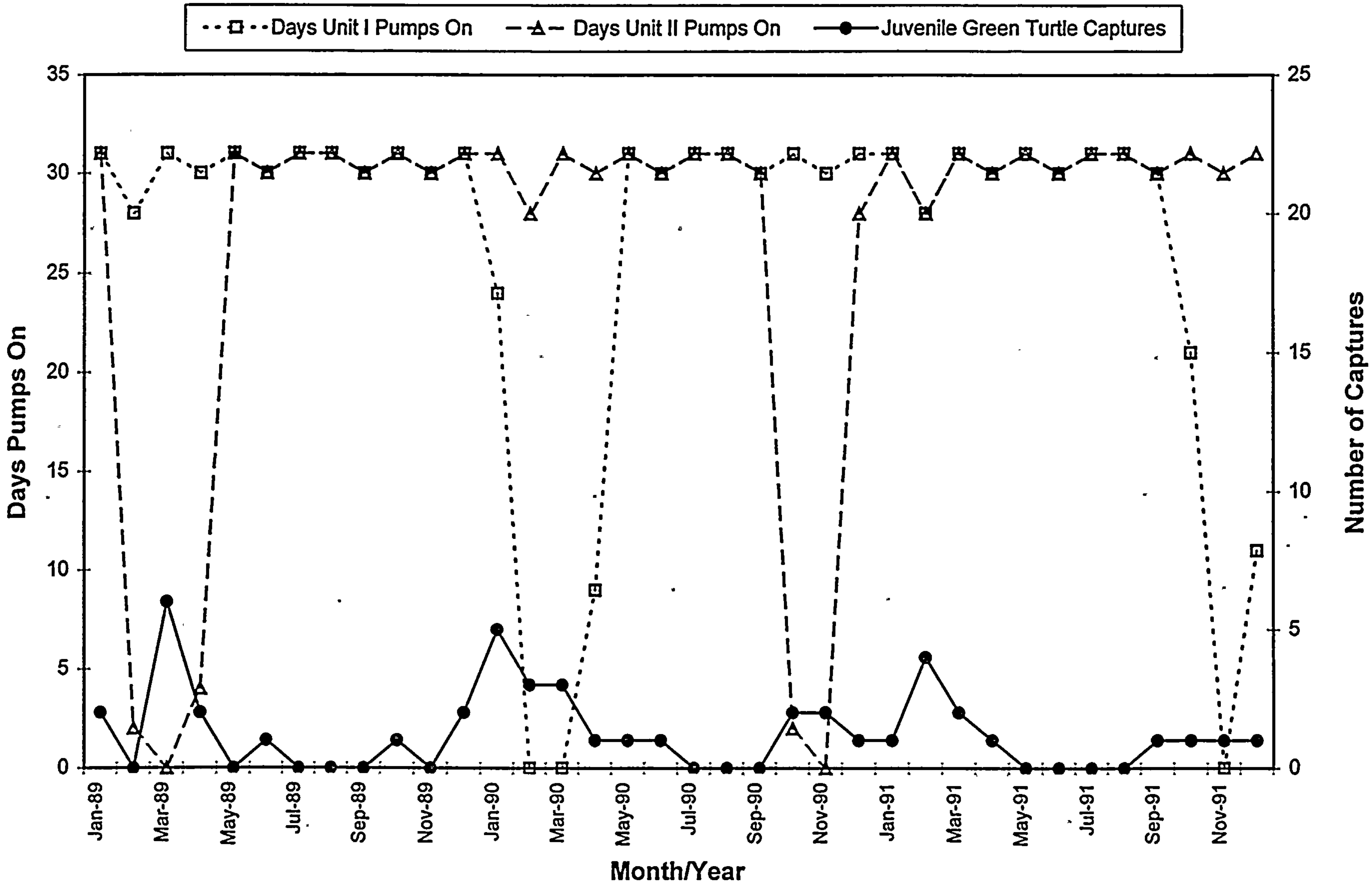

Figure 80. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1989 - December 1991.

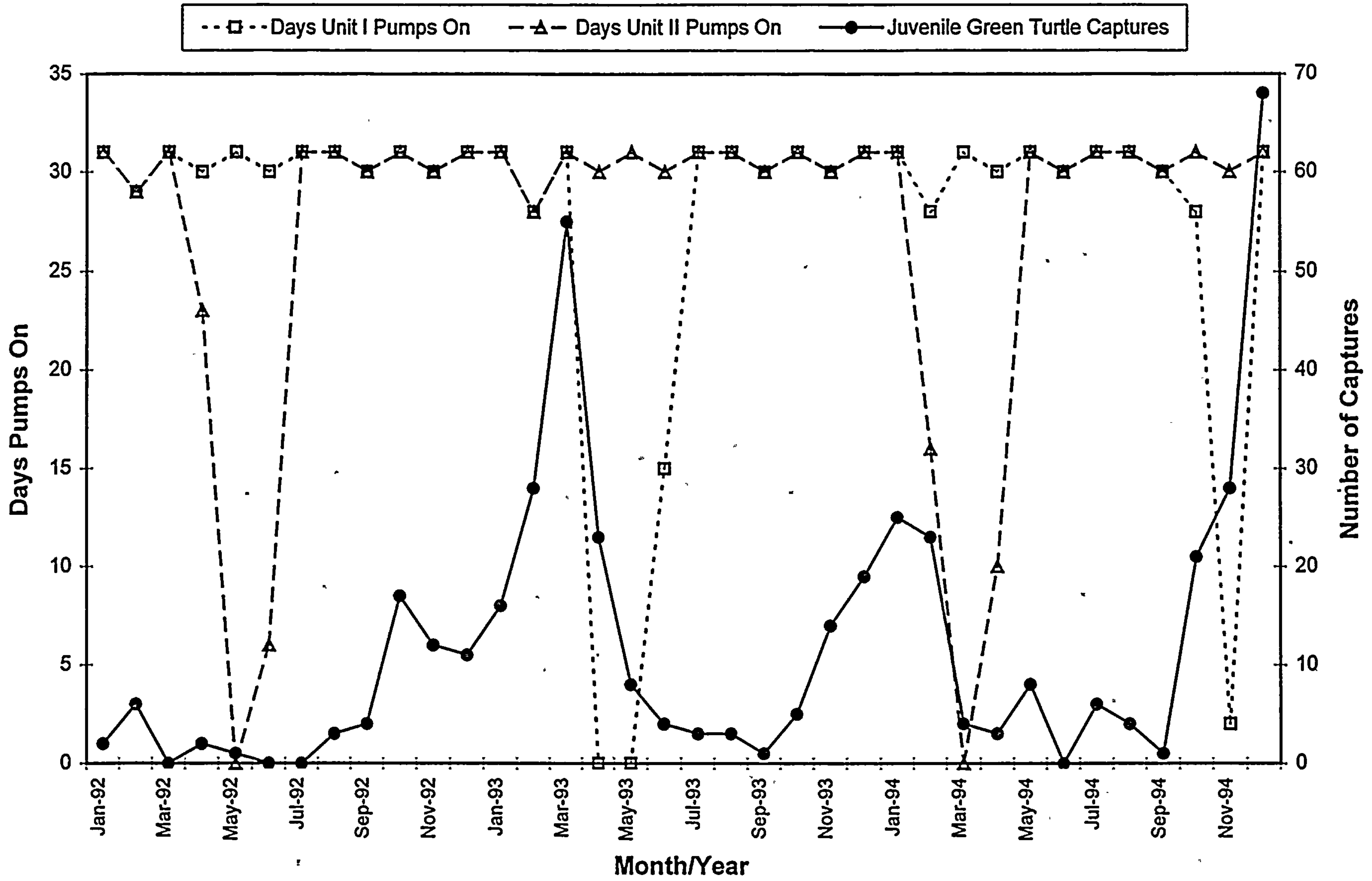

Figure 81. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1992 - December 1994.

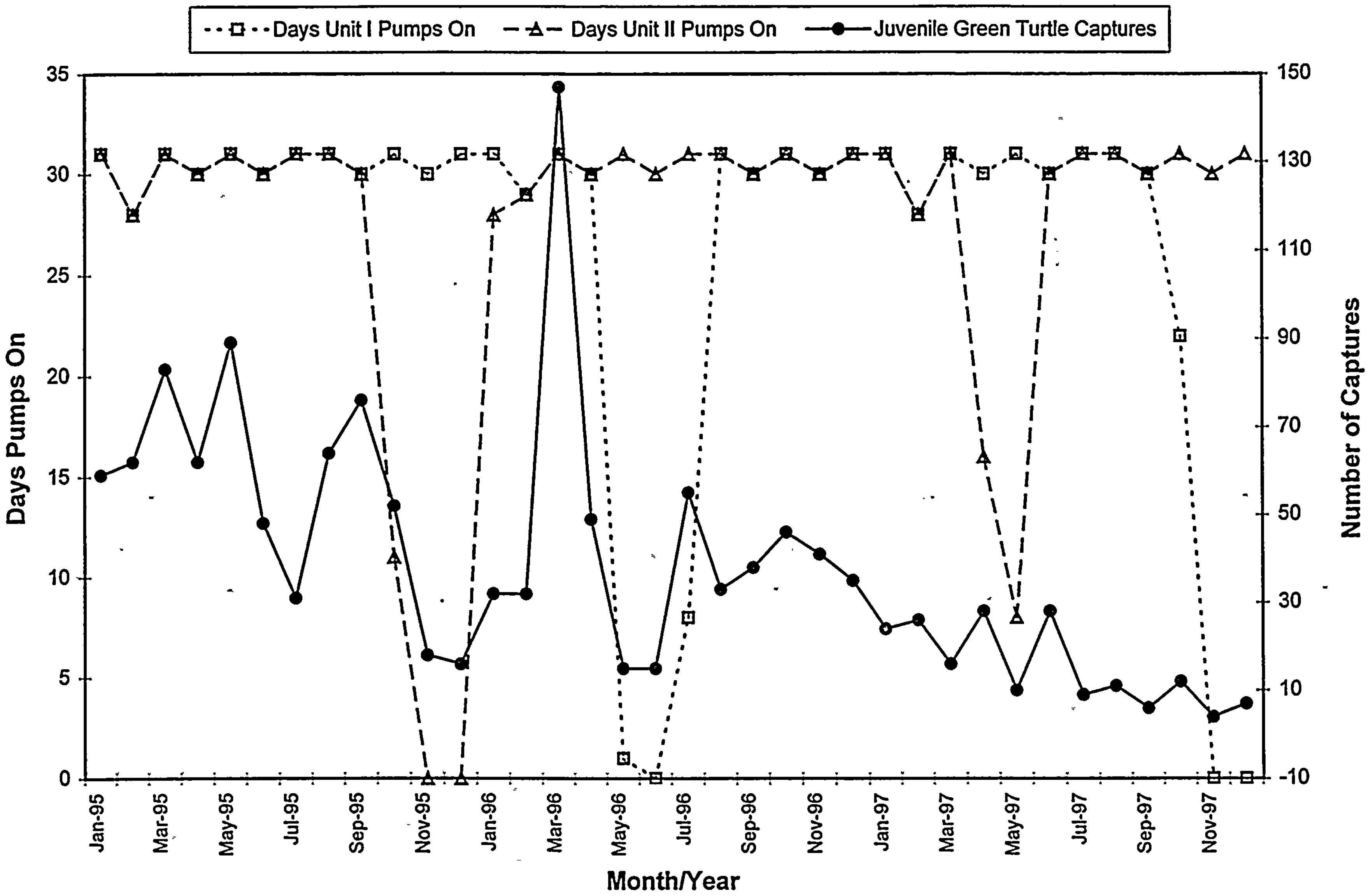

Figure 82. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1995 - December 1997.

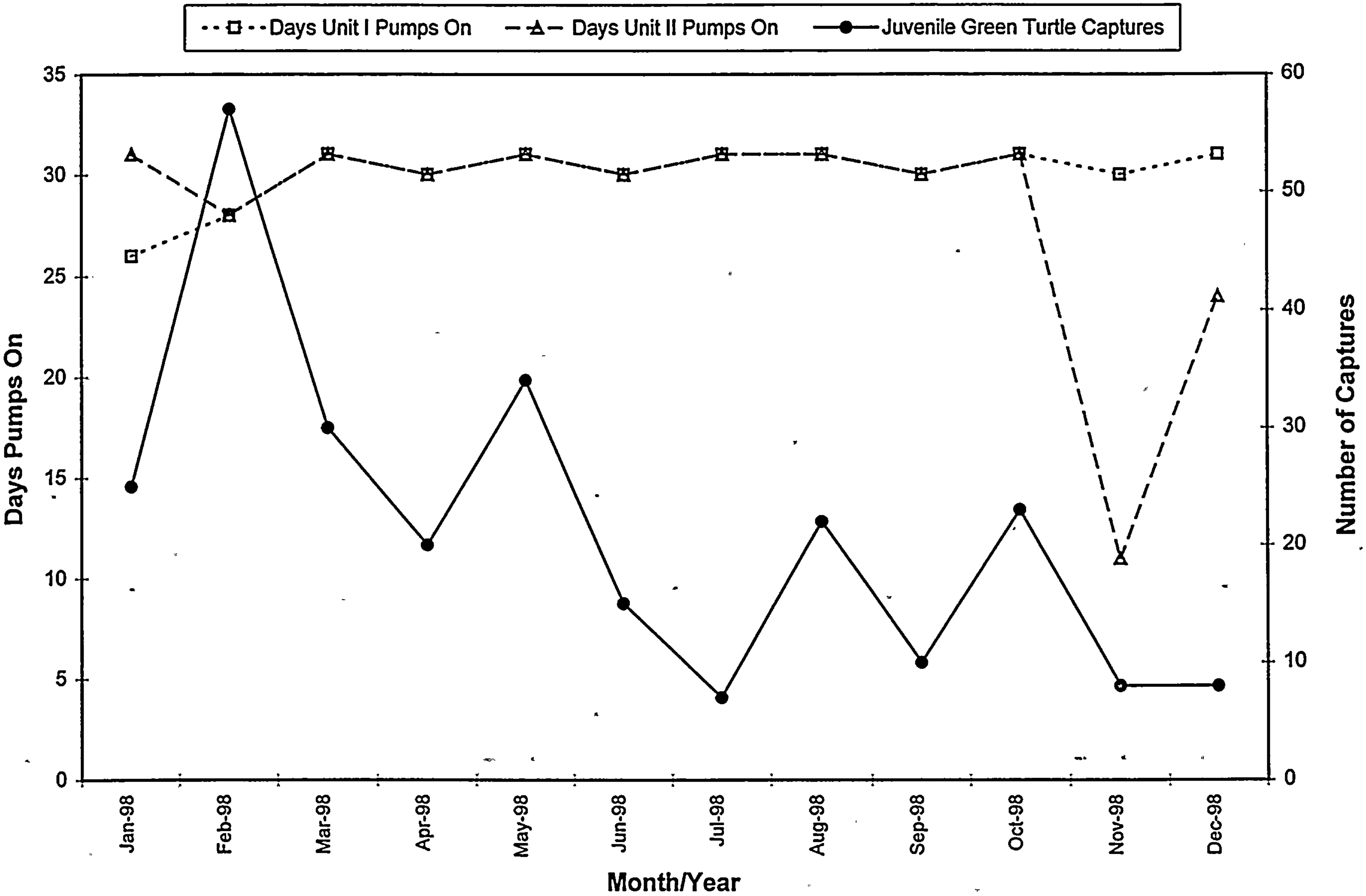

Figure 83. Monthly juvenile green turtle captures compared to St. Lucie Plant operating status (the approximate number of days per month that each unit's circulating water pumps were operating), January 1998 - December 1998.

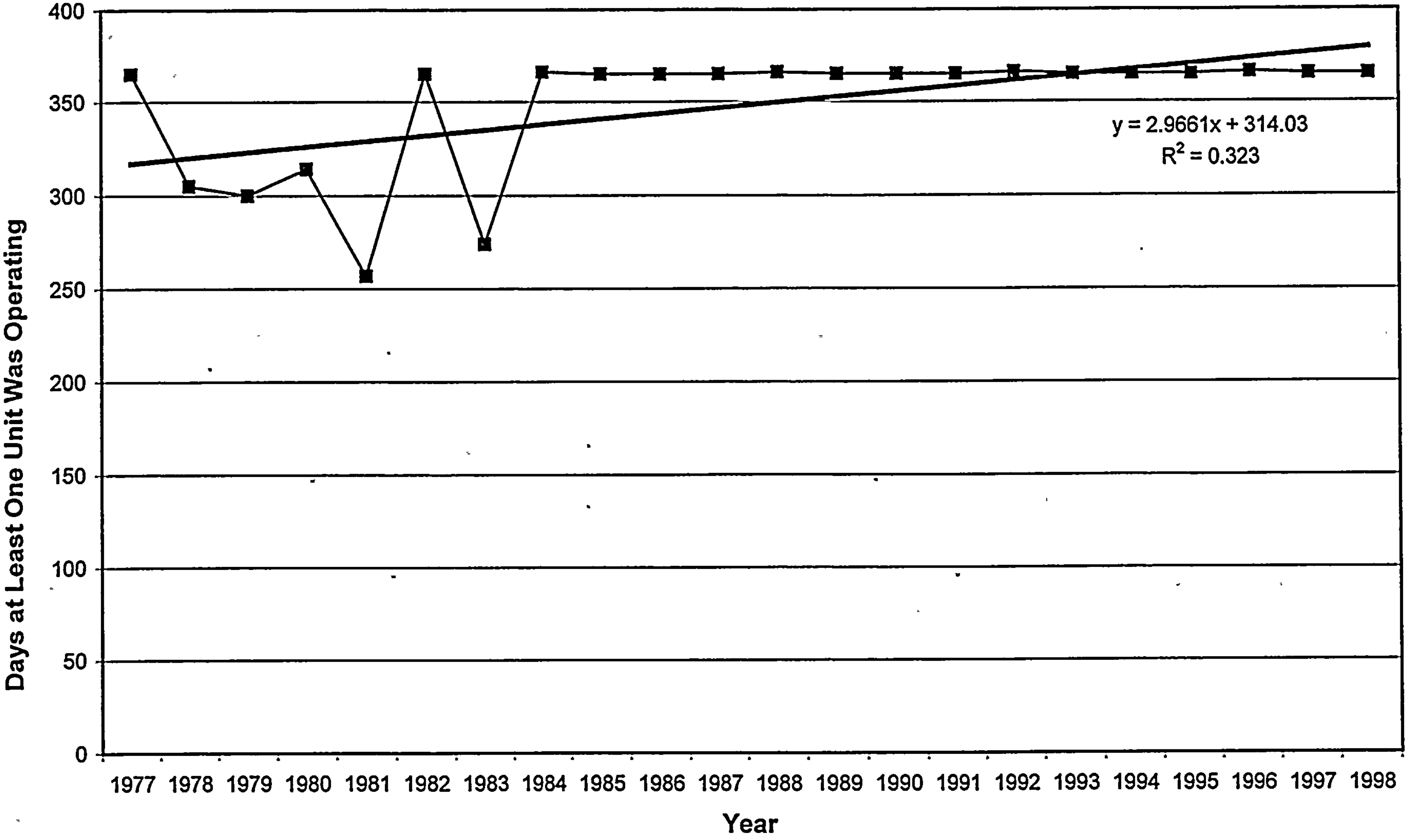

Figure 84. St. Lucie Plant operating status (the approximate number of days per year that at least one unit's circulating water pumps were operating), 1977-1998.

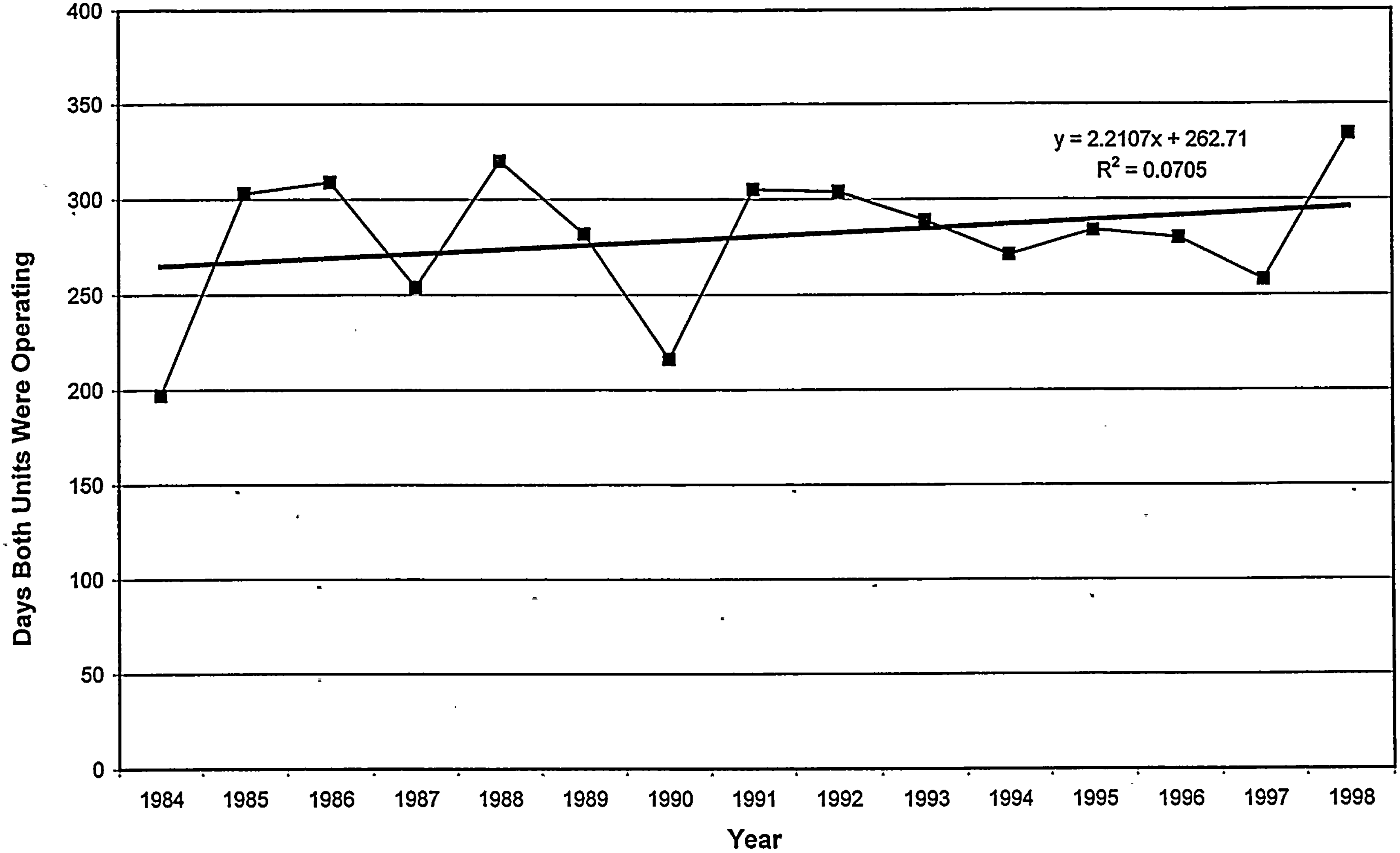

Figure 85. St. Lucie Plant operating status (the approximate number of days per year that circulating water pumps at both units were operating), 1984-1998.

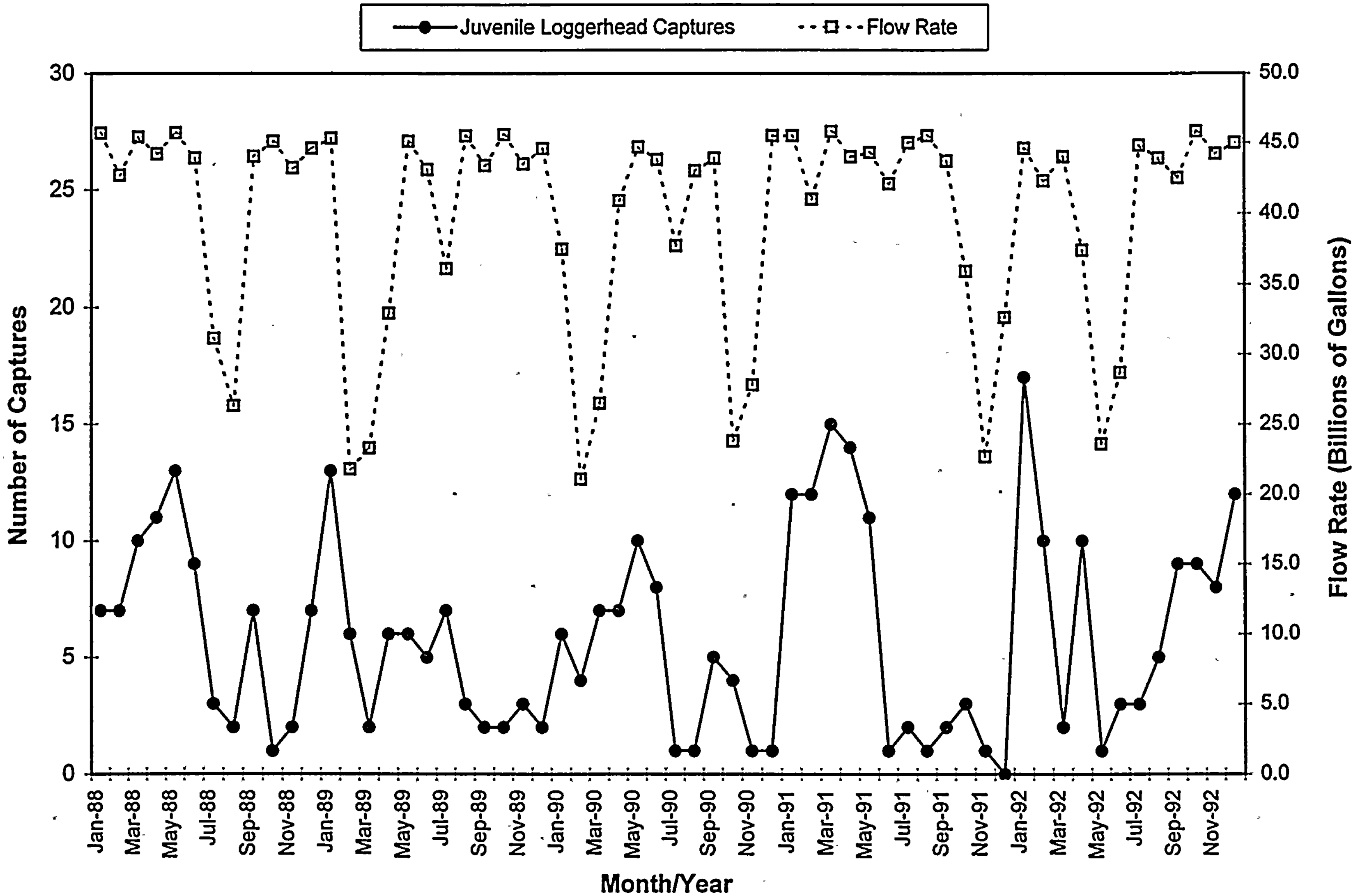

Figure 86. Monthly juvenile loggerhead captures compared to monthly flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1988 - December 1992.

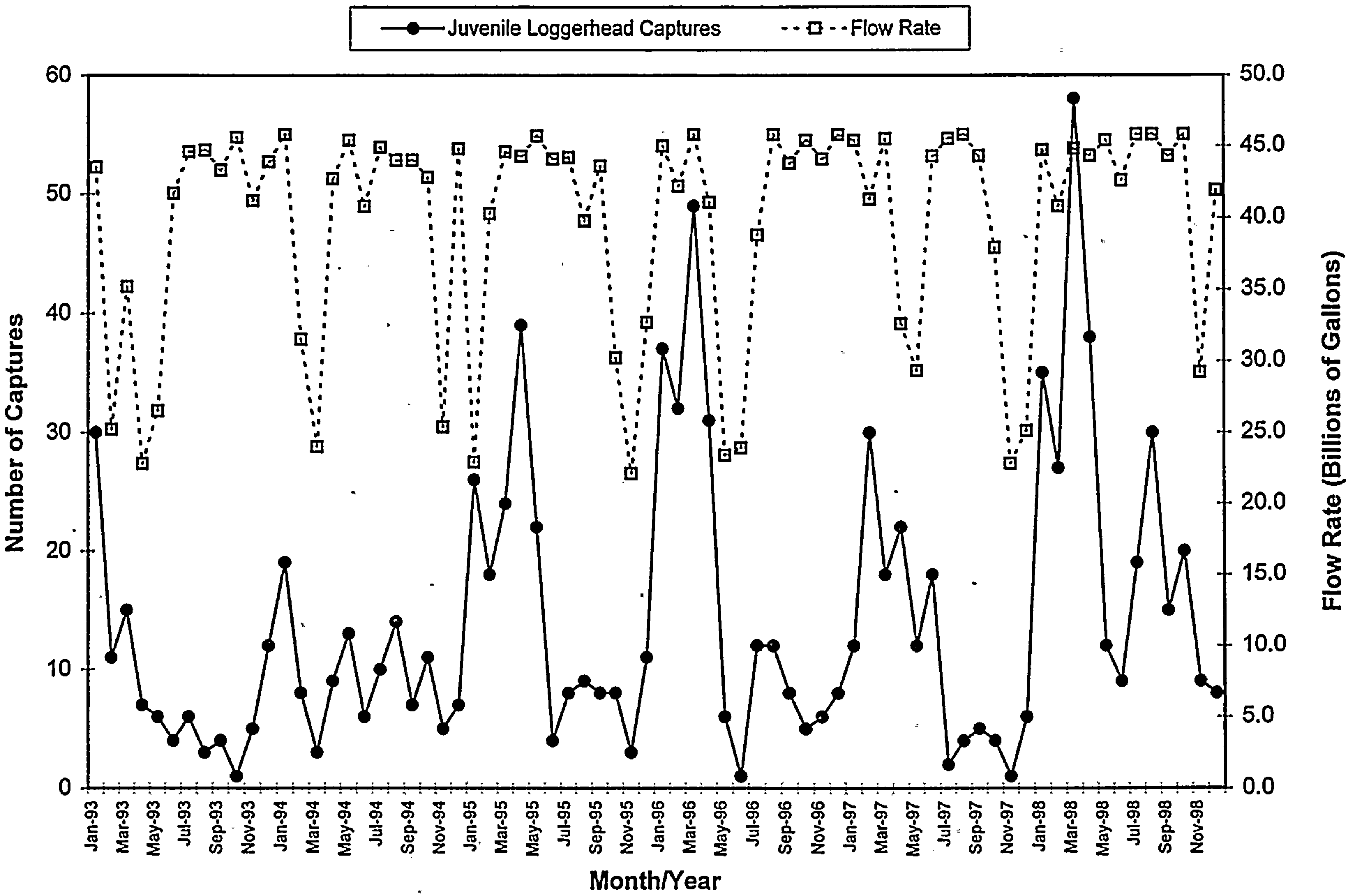

Figure 87. Monthly juvenile loggerhead captures compared to monthly flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1993 - December 1998.

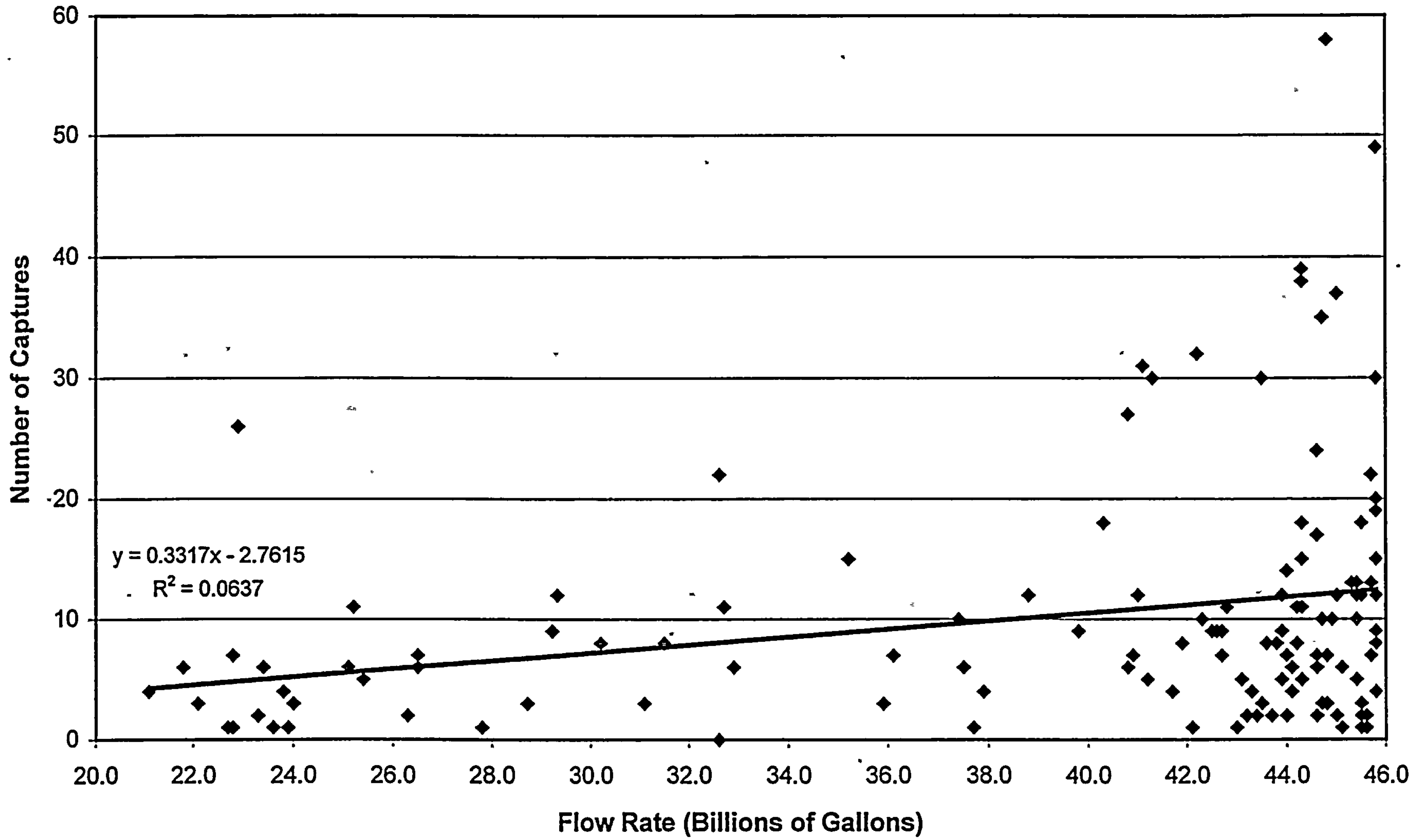

Figure 88. Monthly numbers of juvenile loggerhead captures versus monthly flow rates through circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1988 - December 1998.

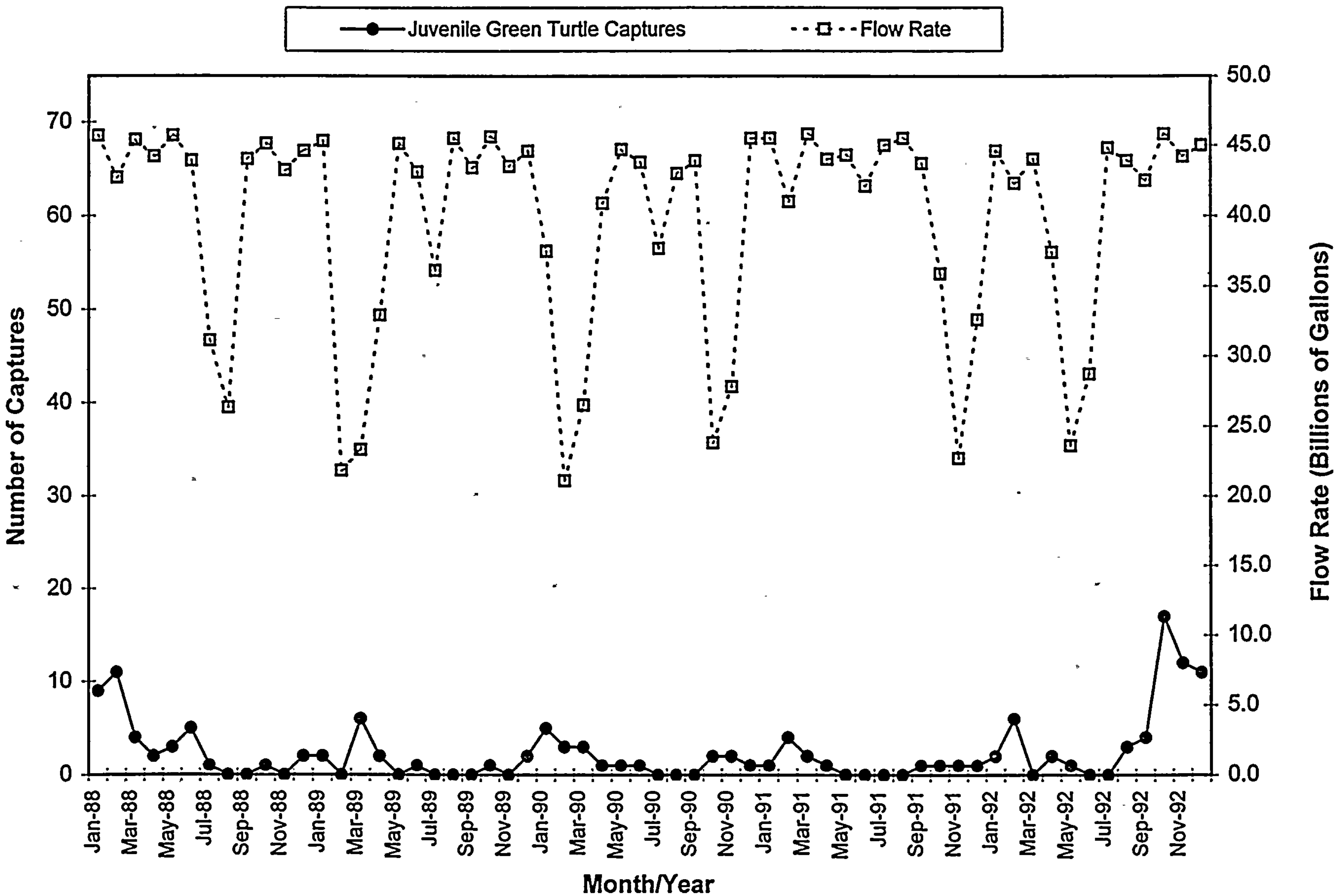

Figure 89. Monthly juvenile green turtle captures compared to monthly flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1988 - December 1992.

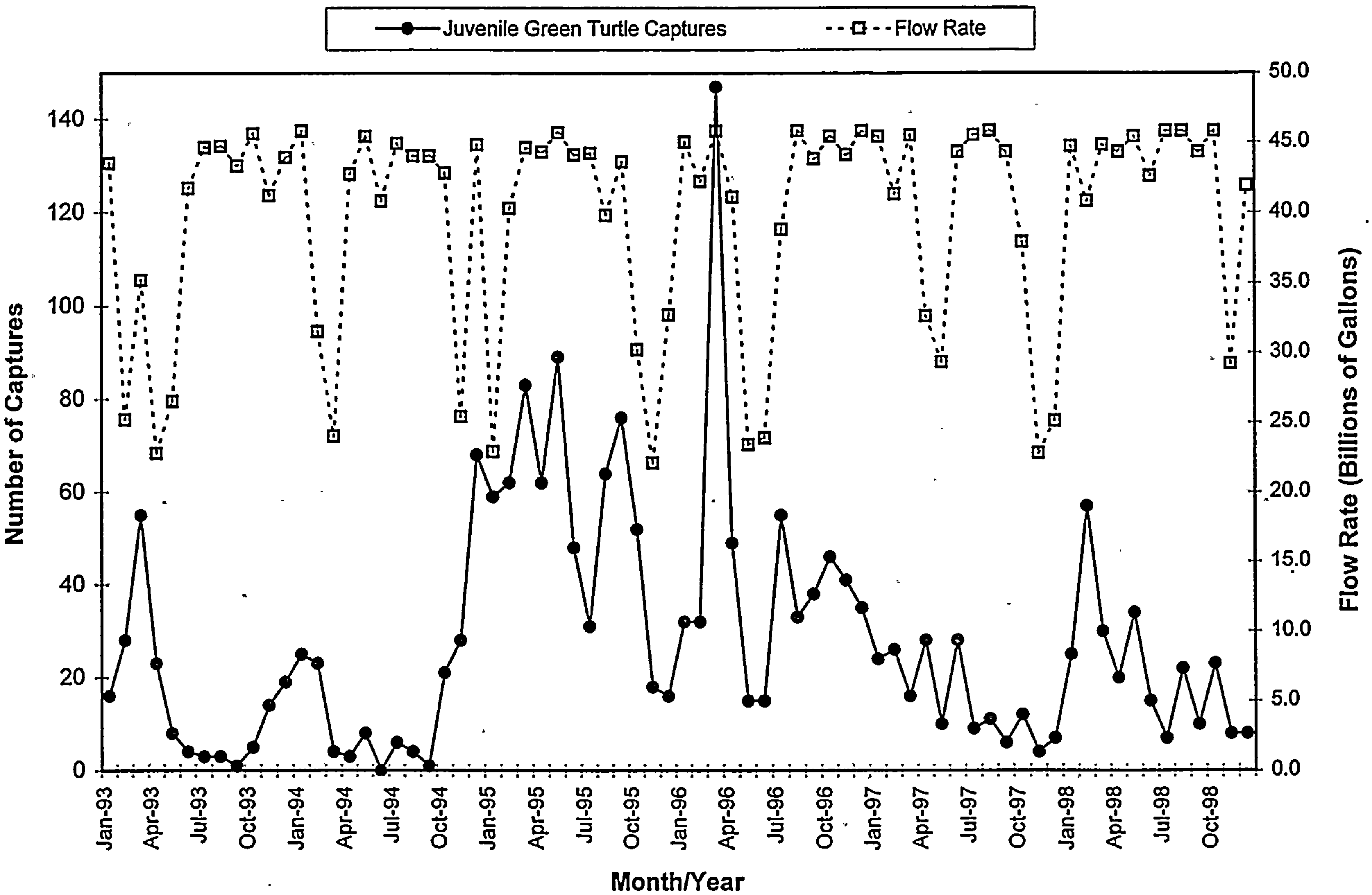

Figure 90. Monthly juvenile green turtle captures compared to monthly flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1993 - December 1998.

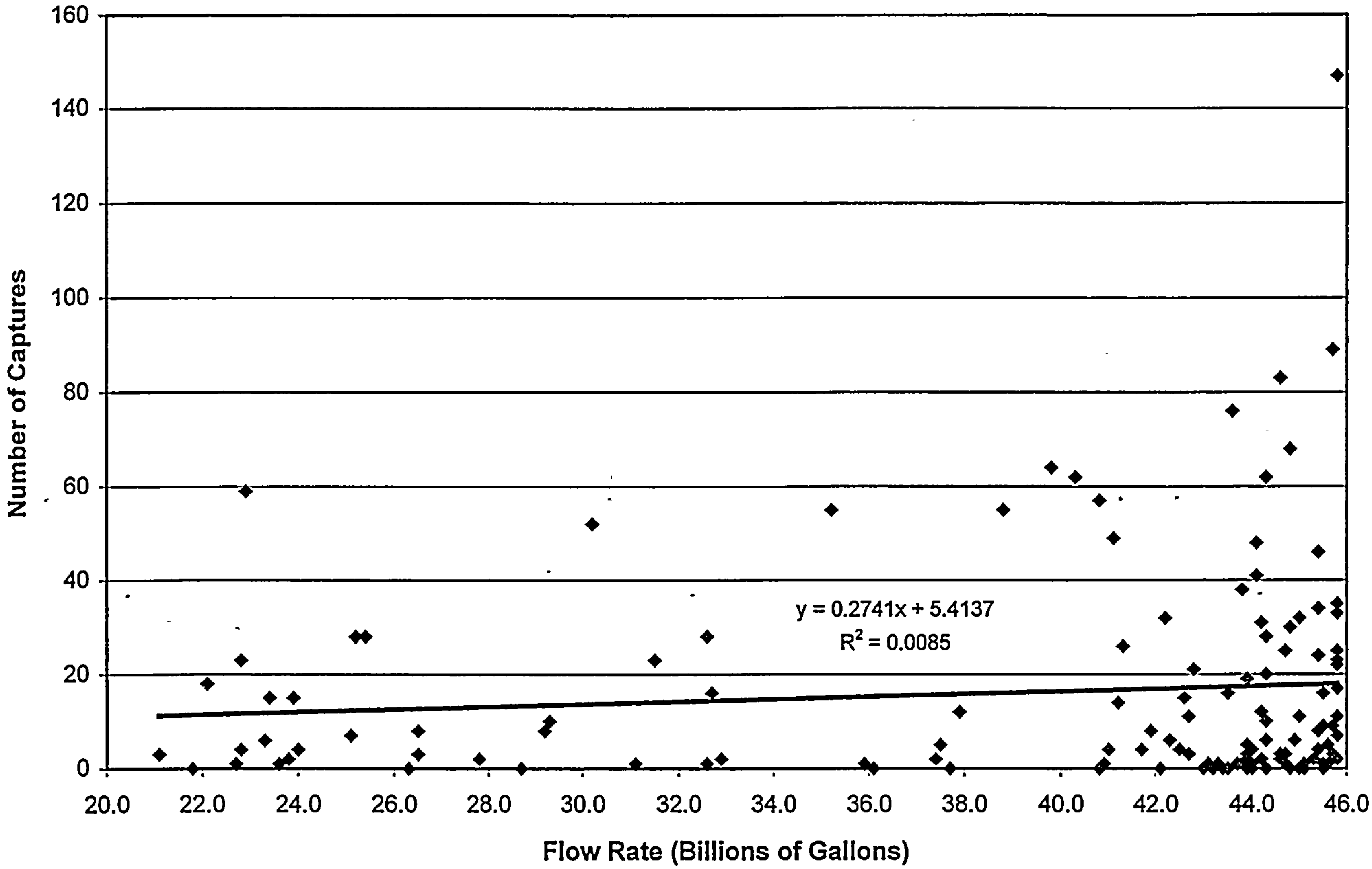

Figure 91. Monthly numbers of juvenile green turtle captures versus monthly flow rates through circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, January 1988 - December 1998.

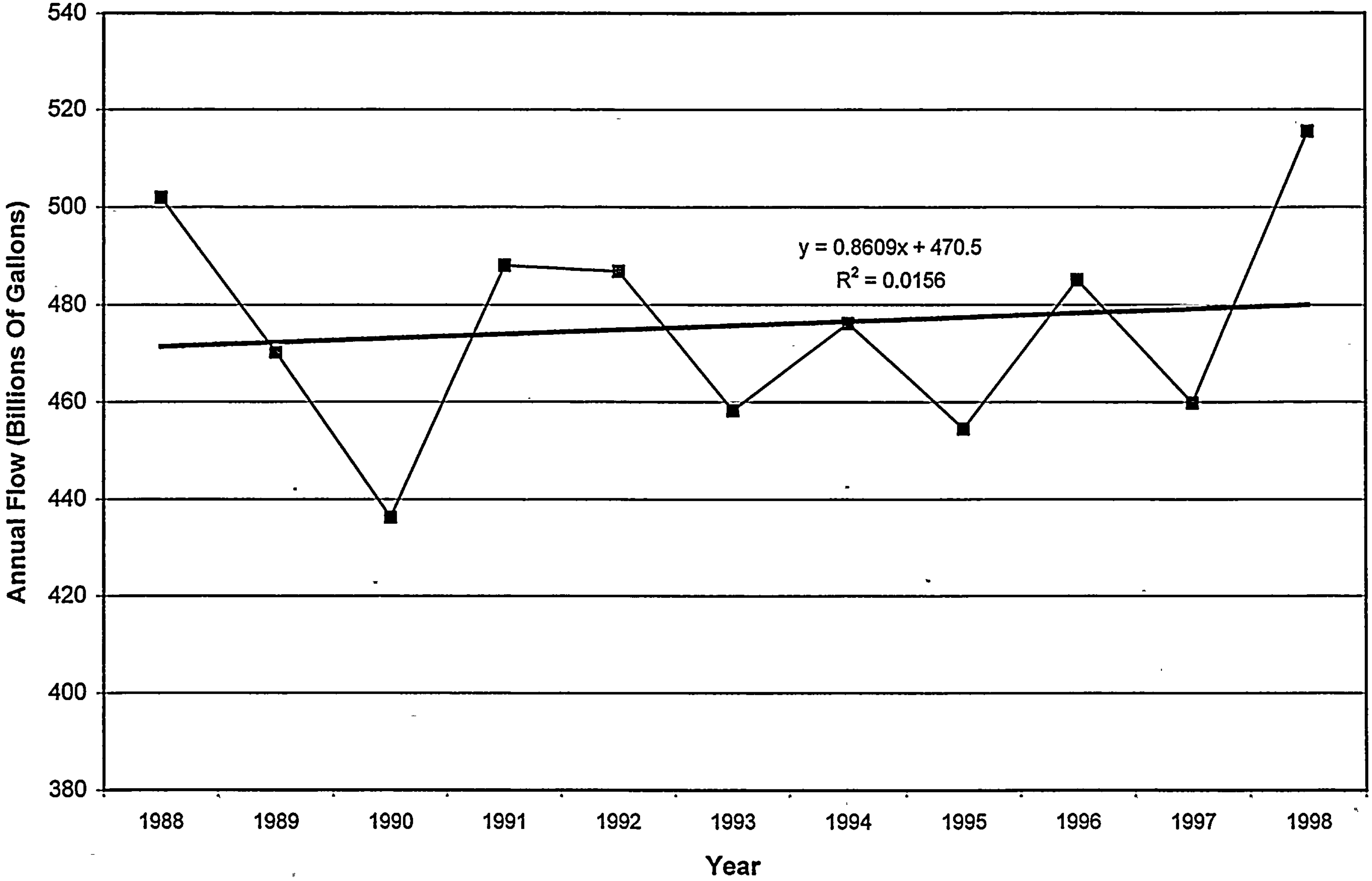

Figure 92. Annual flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, 1988-1998.

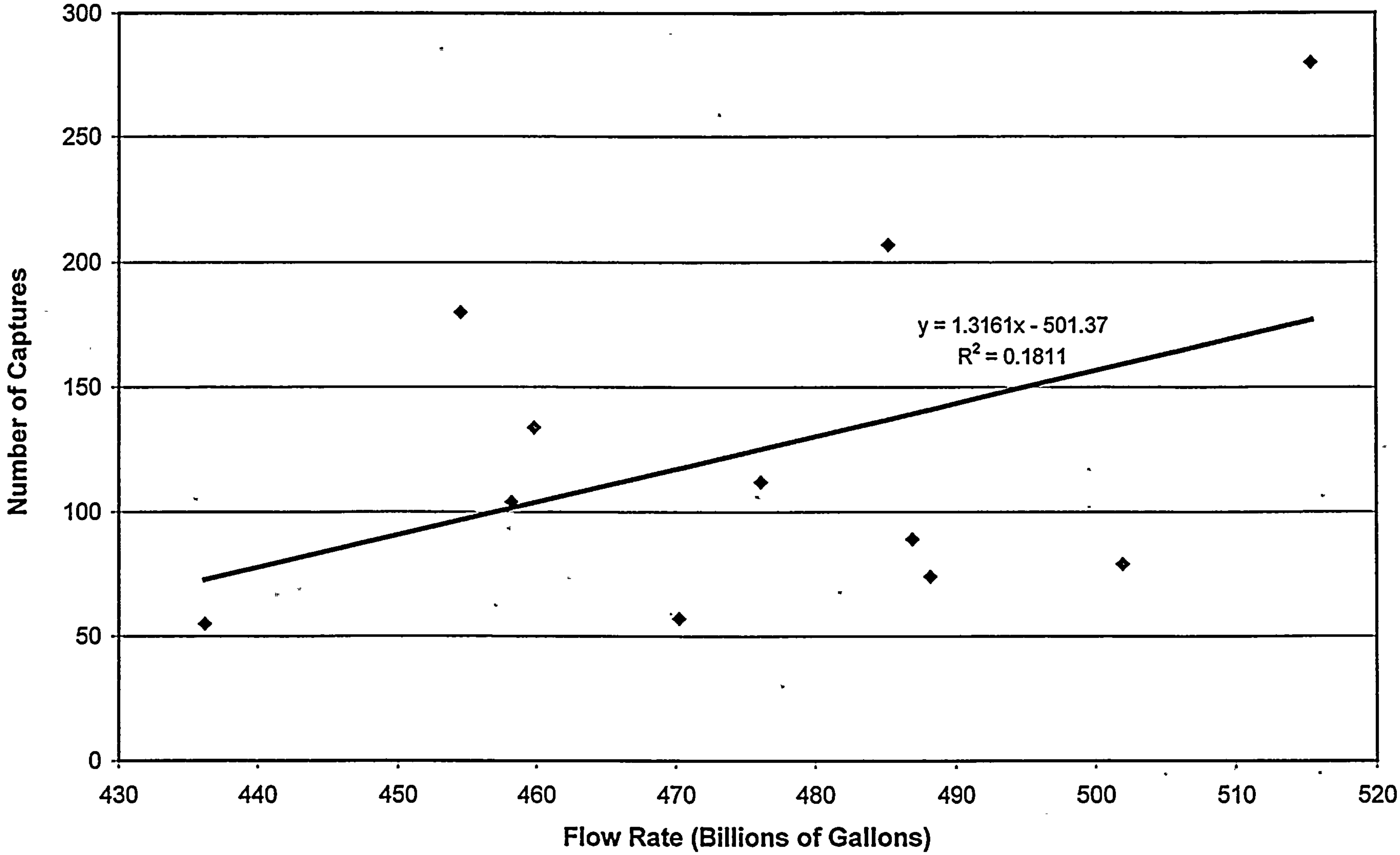

Figure 93. Annual juvenile loggerhead captures versus annual flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, 1988-1998.

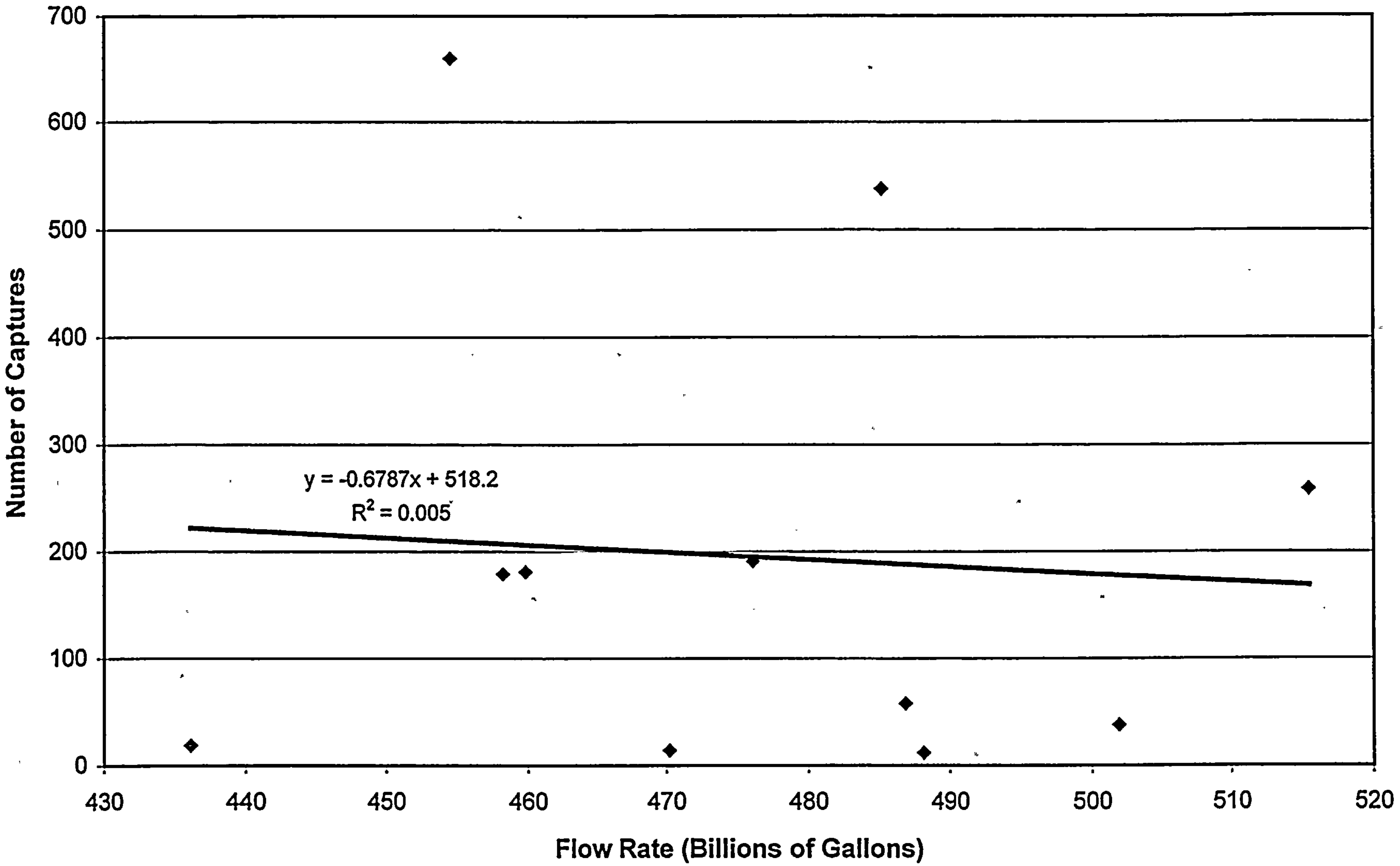

Figure 94. Annual juvenile green turtle captures versus annual flow rates through the circulating water pumps, St. Lucie Plant, Hutchinson Island, Florida, 1988-1998.

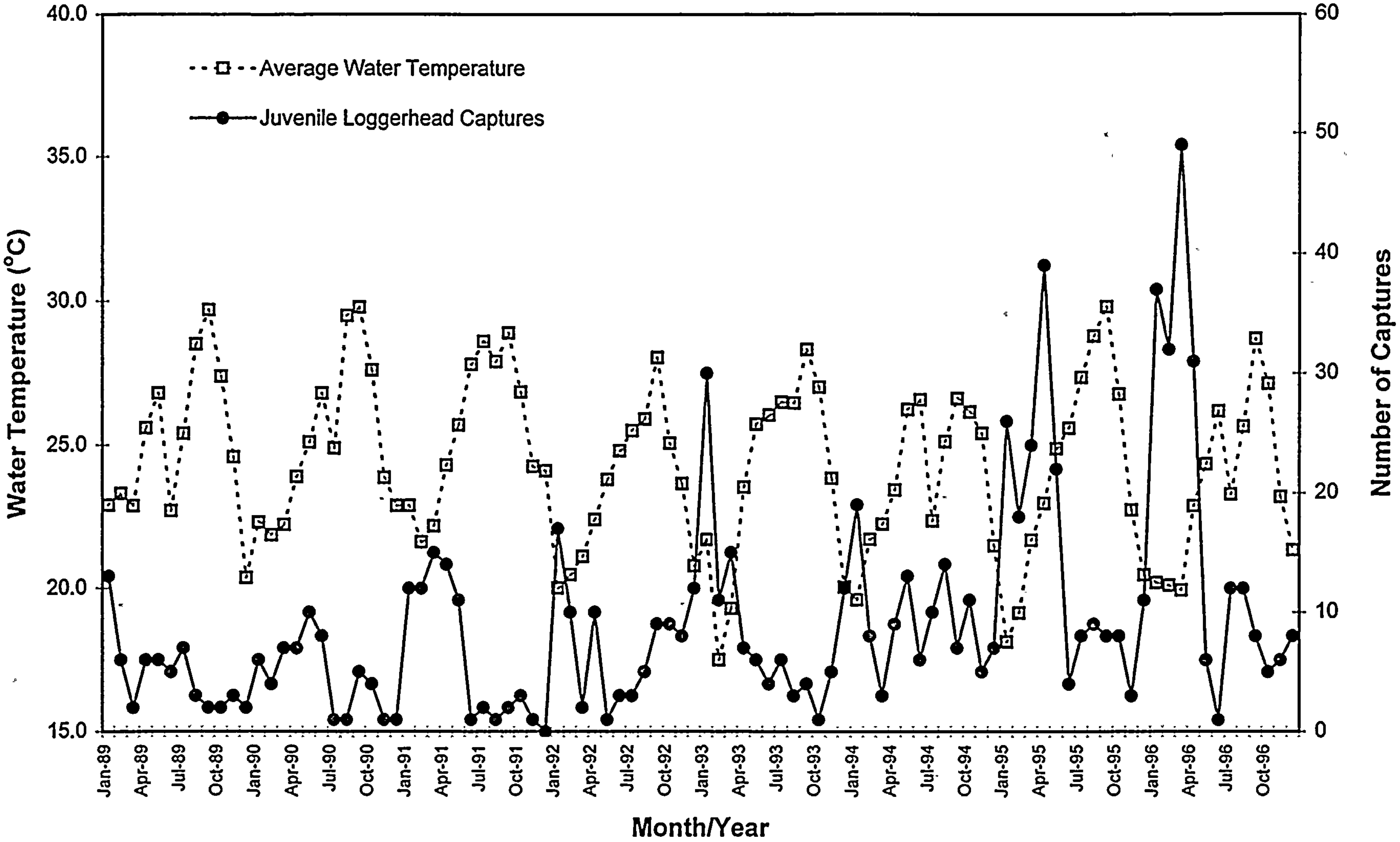

Figure 95. Monthly juvenile loggerhead captures compared to mean monthly water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, January 1989 - December 1996. Mean monthly water temperatures were based on daily water temperatures recorded at the power plant's circulating water pumps.

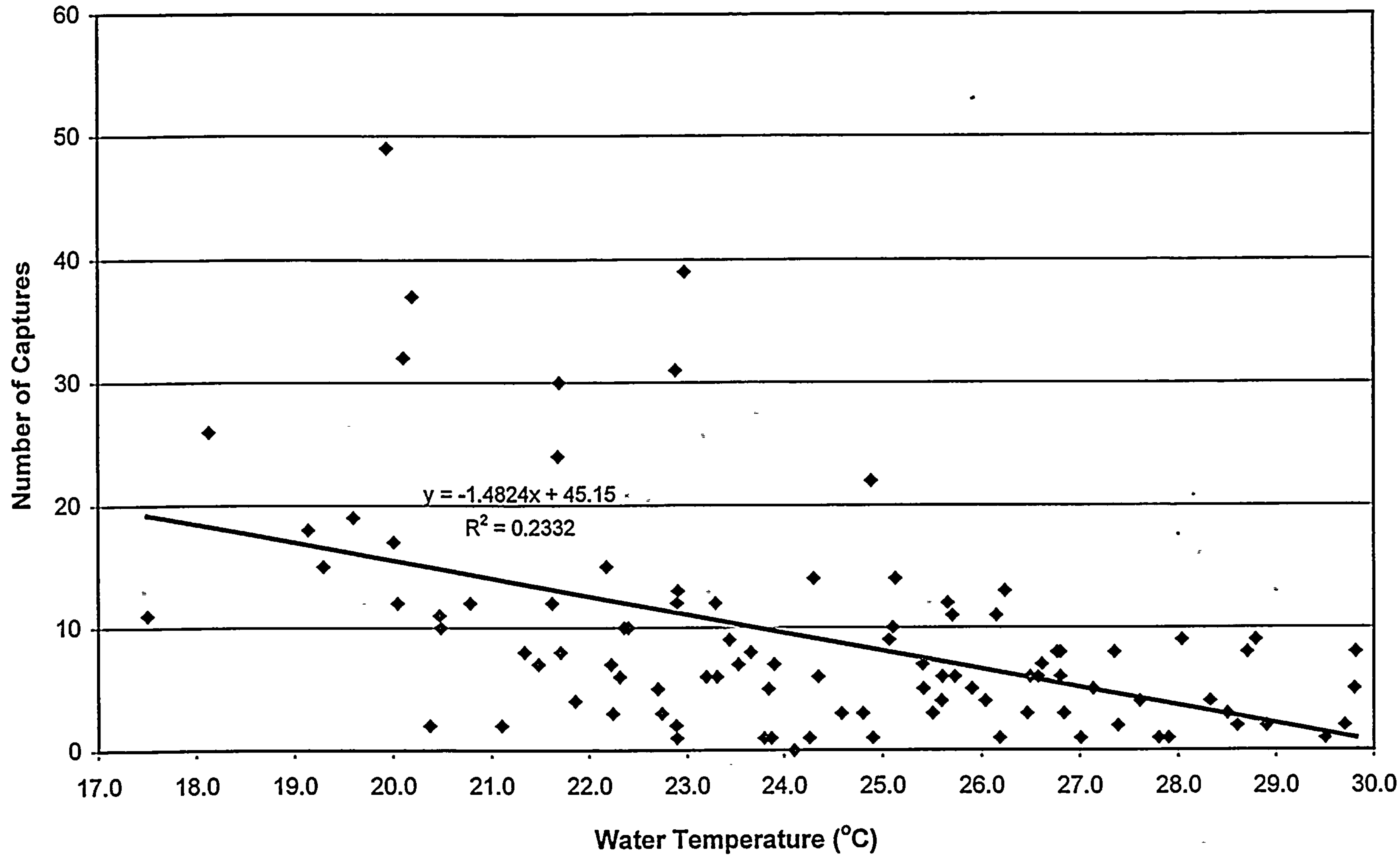

Figure 96. Monthly juvenile loggerhead captures versus mean monthly water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, January 1989 - December 1996. Mean monthly water temperatures were based on daily water temperatures recorded at the power plant's circulating water pumps.

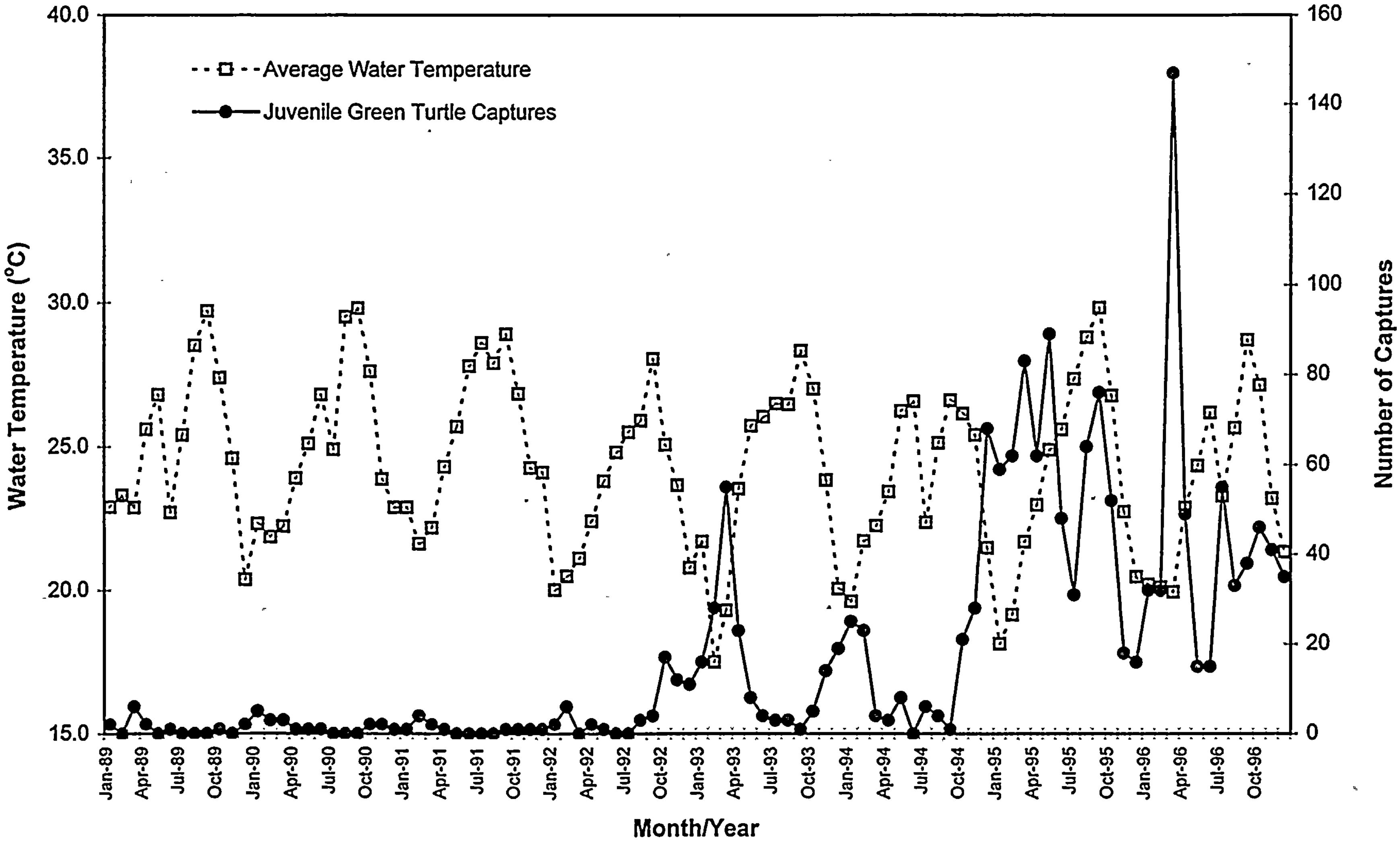

Figure 97. Monthly juvenile green turtle captures compared to mean monthly water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, January 1989 - December 1996. Mean monthly water temperatures were based on daily water temperatures recorded at the power plant's circulating water pumps.

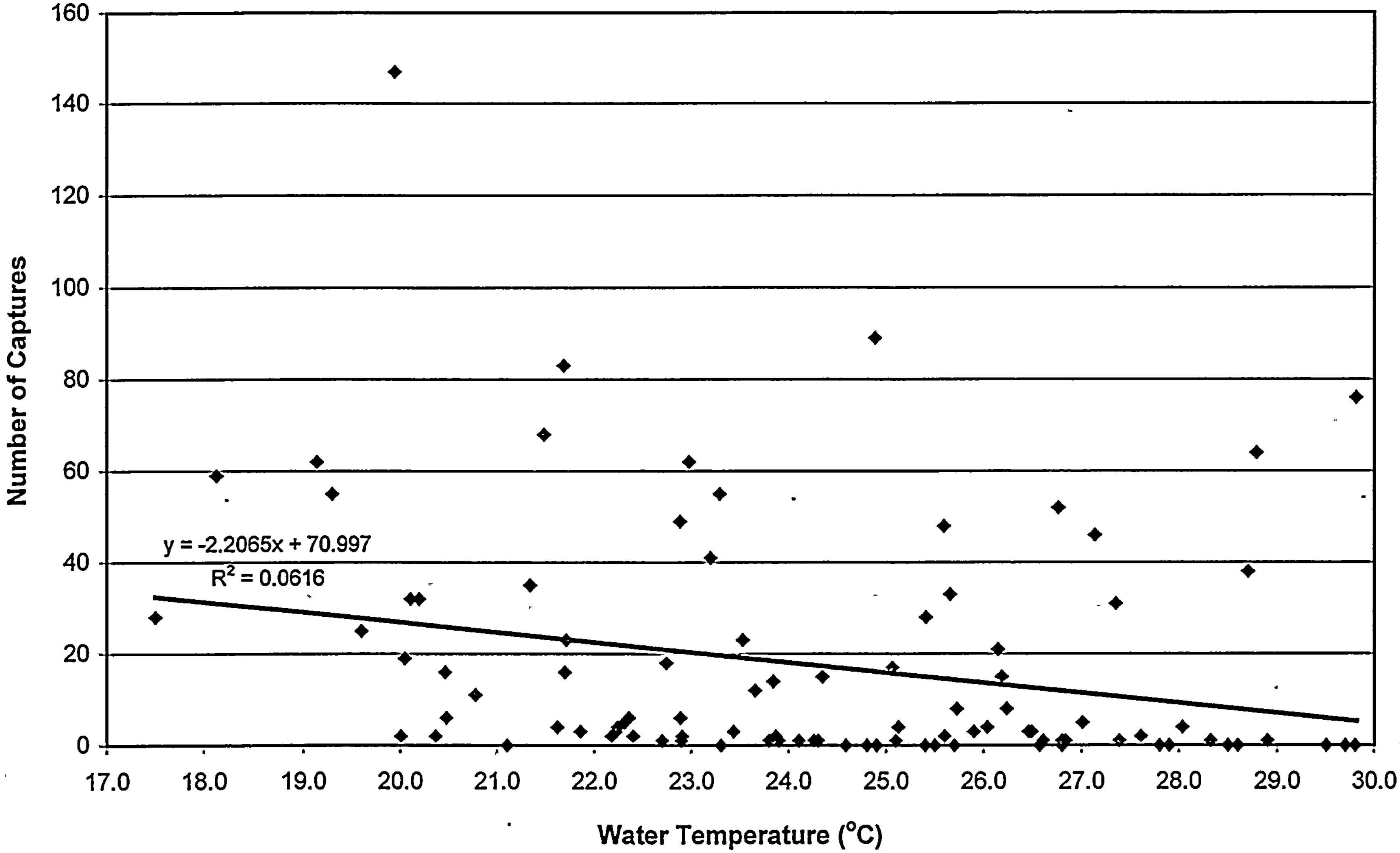

Figure 98. Monthly juvenile green turtle captures versus mean monthly water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, January 1989 - December 1996. Mean monthly water temperatures were based on daily water temperatures recorded at the power plant's circulating water pumps.

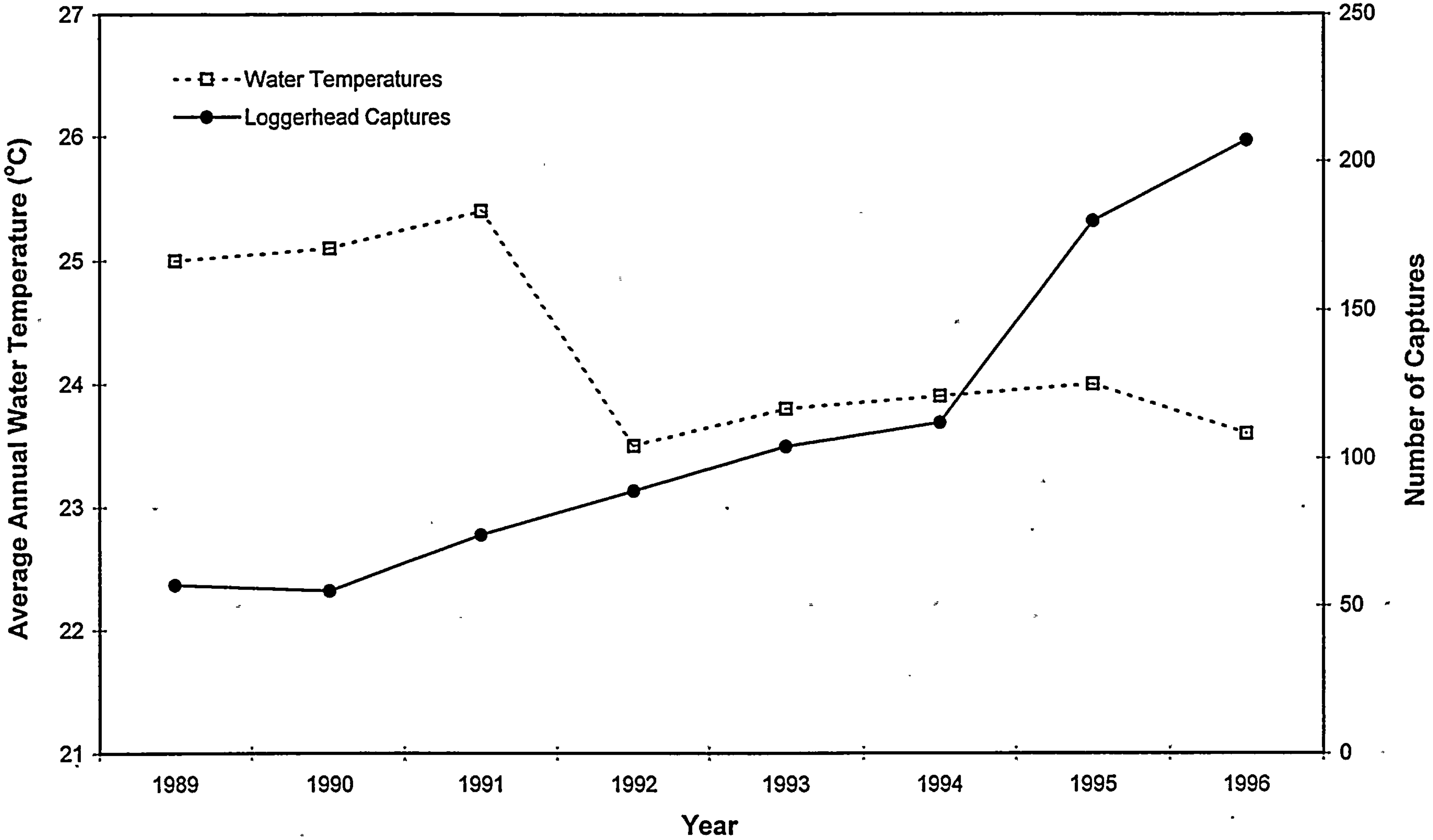

Figure 99. Annual number of juvenile loggerhead captures compared to average annual water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1989-1996.

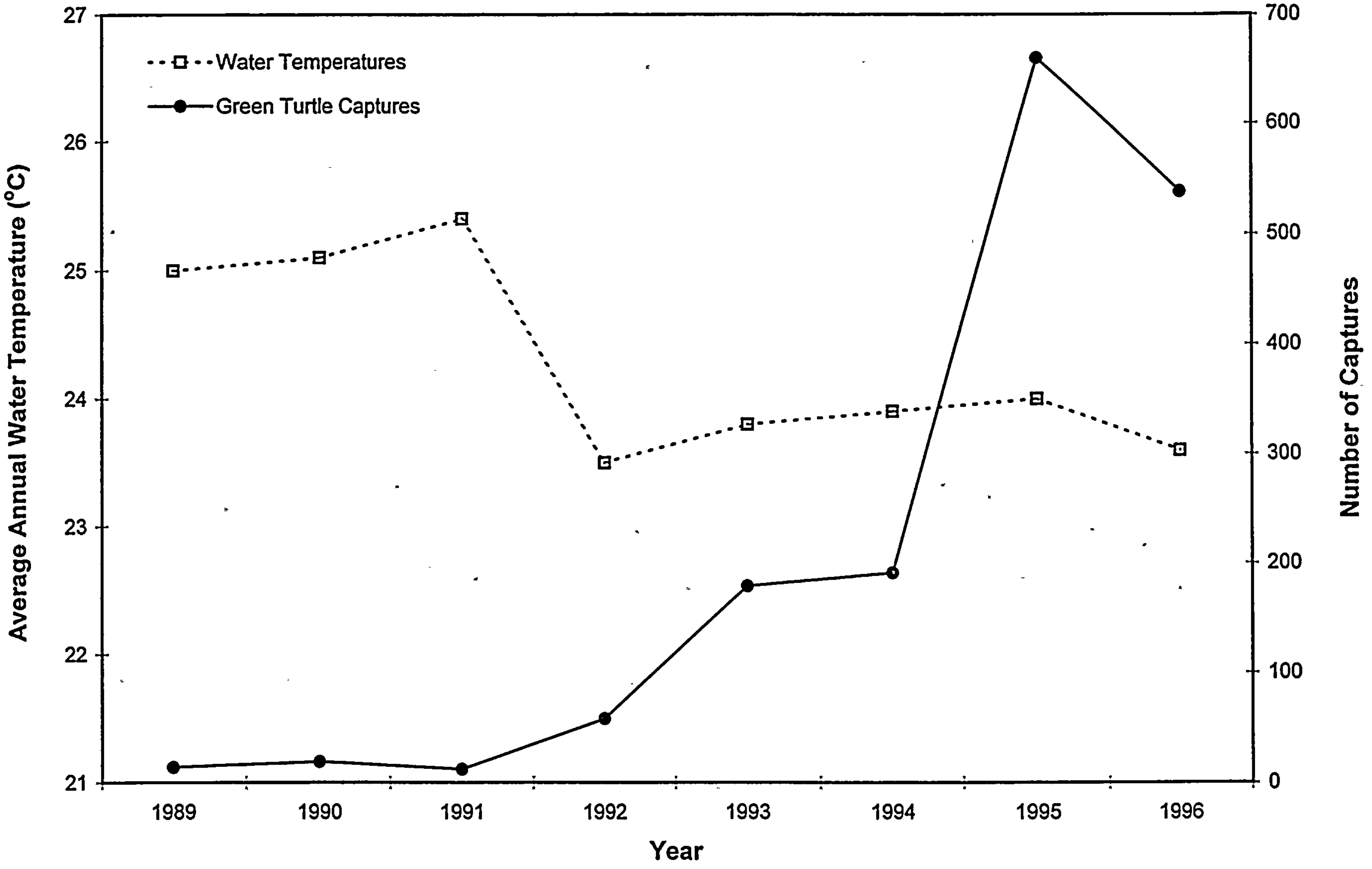

Figure 100. Annual number of juvenile green turtle captures compared to average annual water temperatures, St. Lucie Plant intake canal, Hutchinson Island, Florida, 1989-1996.

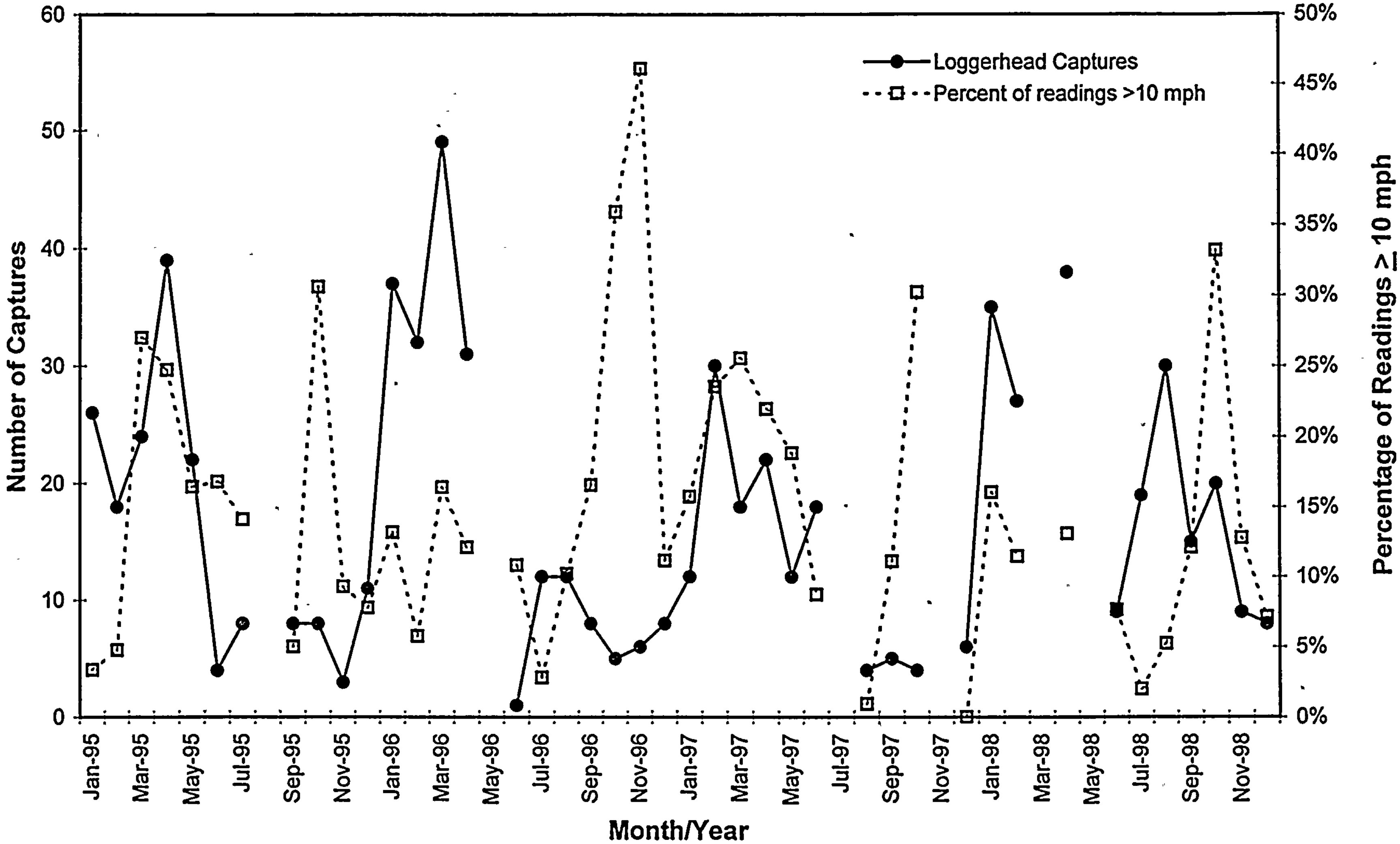

Figure 101. Monthly juvenile loggerhead captures compared to percentage of each month's wind readings with bearings between 0 and 140 degrees and velocities greater than or equal to 10 miles per hour, St. Lucie Plant, Hutchinson Island, Florida, January 1995 - December 1998. Wind direction and velocity were measured hourly at a height of 10 m just north of the discharge canal. Months missing more than 24 hourly wind readings were excluded.

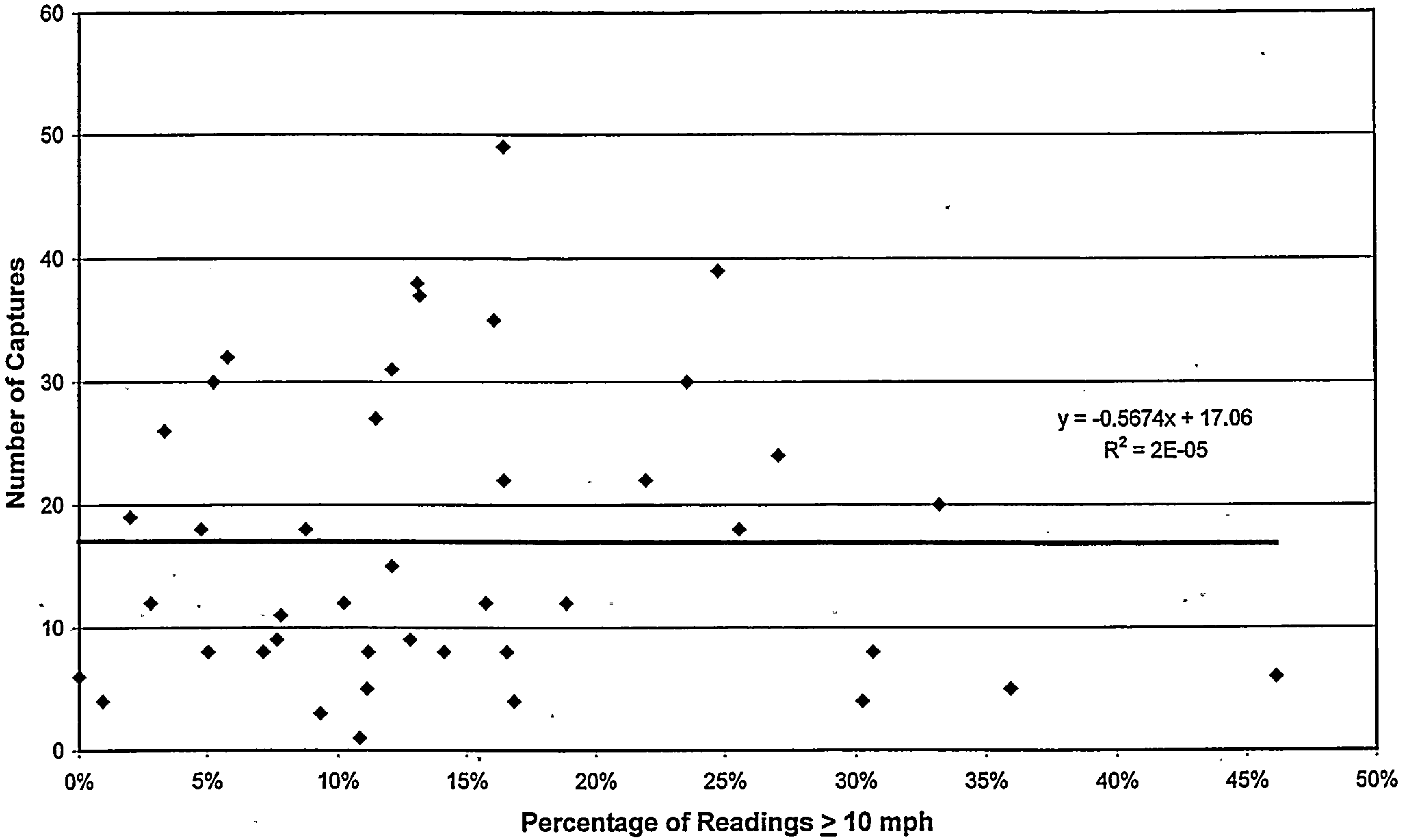

Figure 102. Monthly juvenile loggerhead captures versus percentage of each month's wind readings with bearings between 0 and 140 degrees and velocities greater than or equal to 10 miles per hour, St. Lucie Plant, Hutchinson Island, Florida, January 1995 - December 1998. Wind direction and velocity were measured hourly at a height of 10 m just north of the discharge canal. Months missing more than 24 hourly wind readings were excluded.

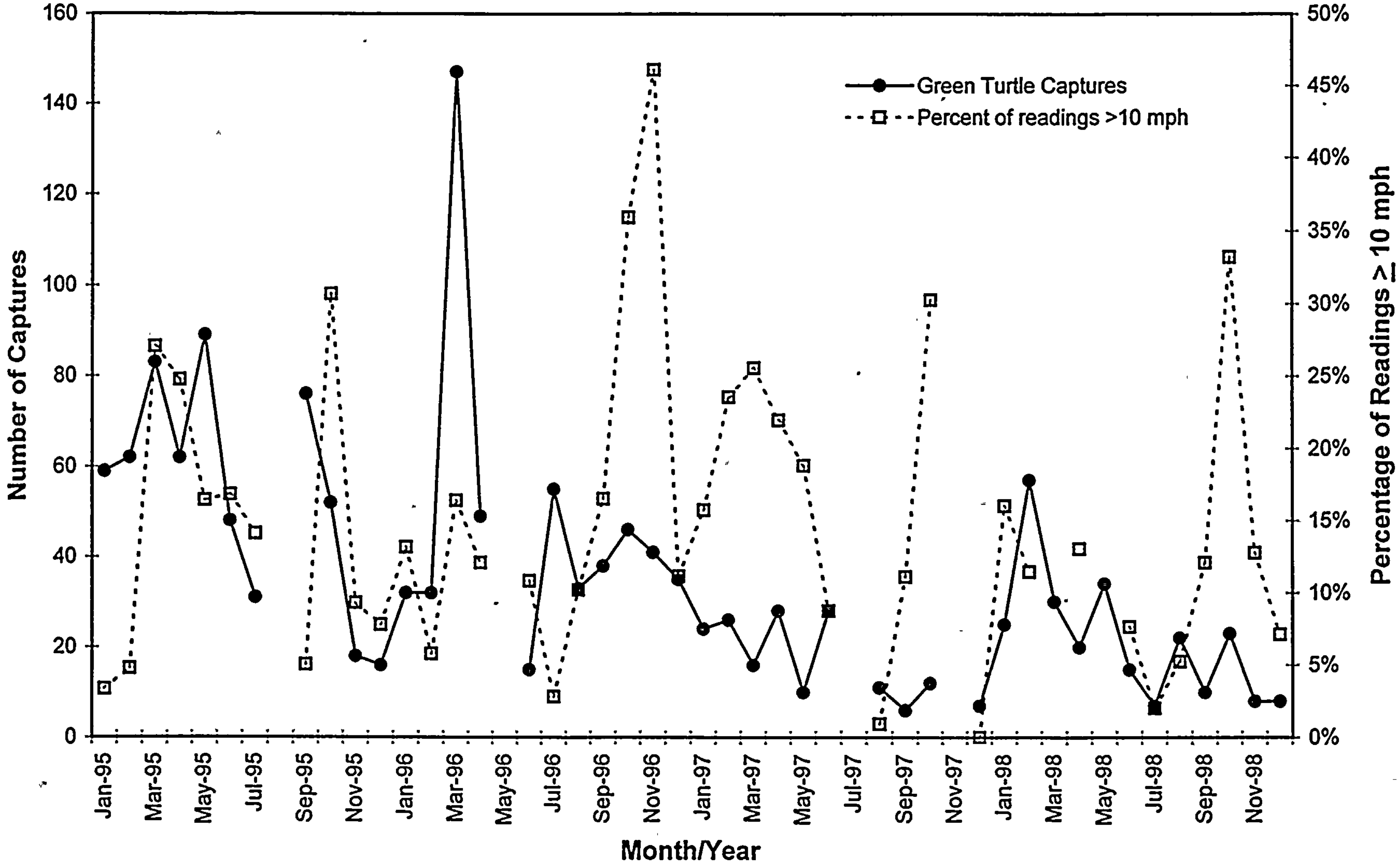

Figure 103. Monthly juvenile green turtle captures compared to percentage of each month's wind readings with bearings between 0 and 140 degrees and velocities greater than or equal to 10 miles per hour, St. Lucie Plant, Hutchinson Island, Florida, January 1995 - December 1998. Wind direction and velocity were measured hourly at a height of 10 m just north of the discharge canal. Months missing more than 24 hourly wind readings were excluded.

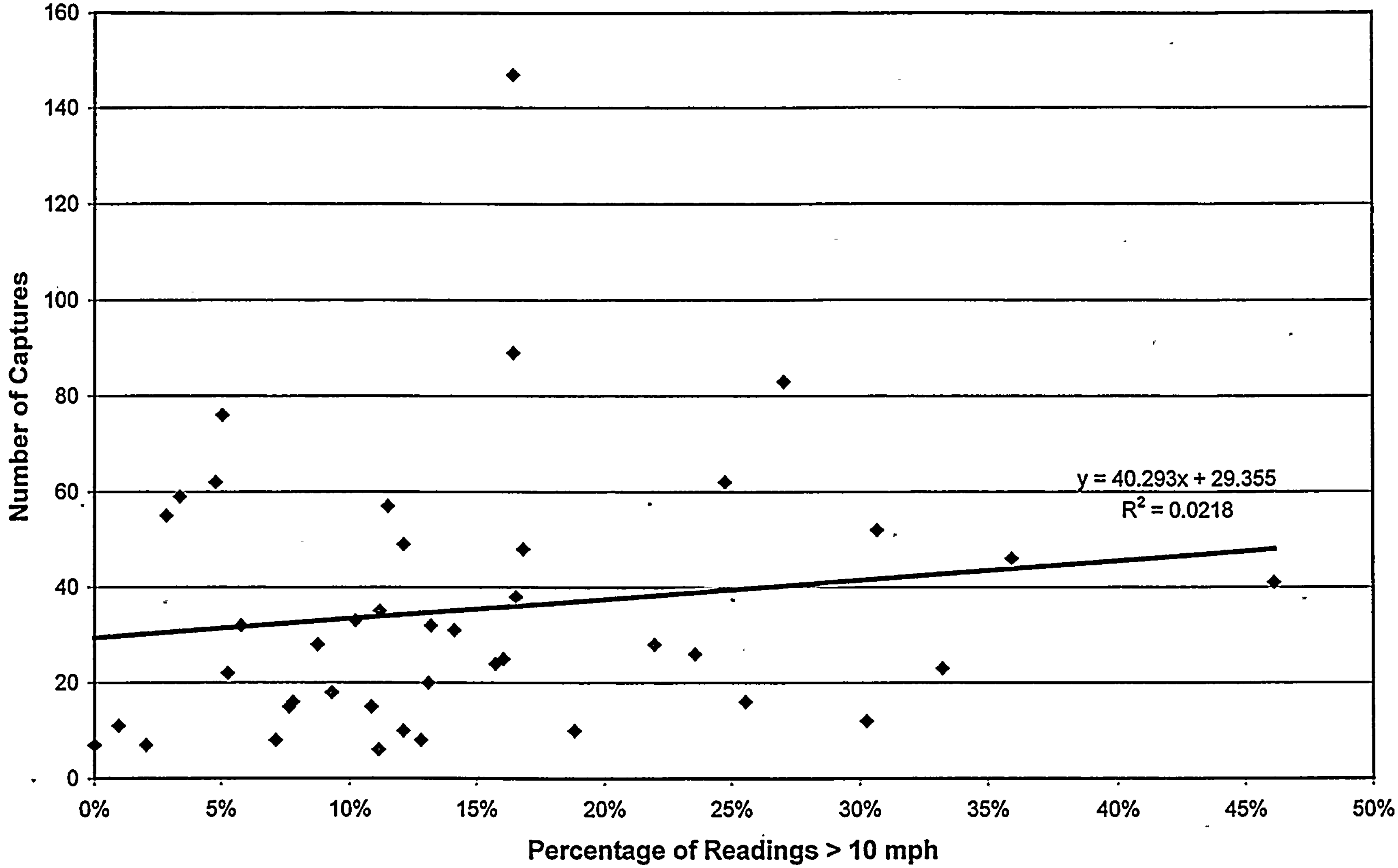

Figure 104. Monthly juvenile green turtle captures versus percentage of each month's wind readings with bearings between 0 and 140 degrees and velocities greater than or equal to 10 miles per hour, St. Lucie Plant, Hutchinson Island, Florida, January 1995 - December 1998. Wind direction and velocity were measured hourly at a height of 10 m just north of the discharge canal. Months missing more than 24 hourly wind readings were excluded.

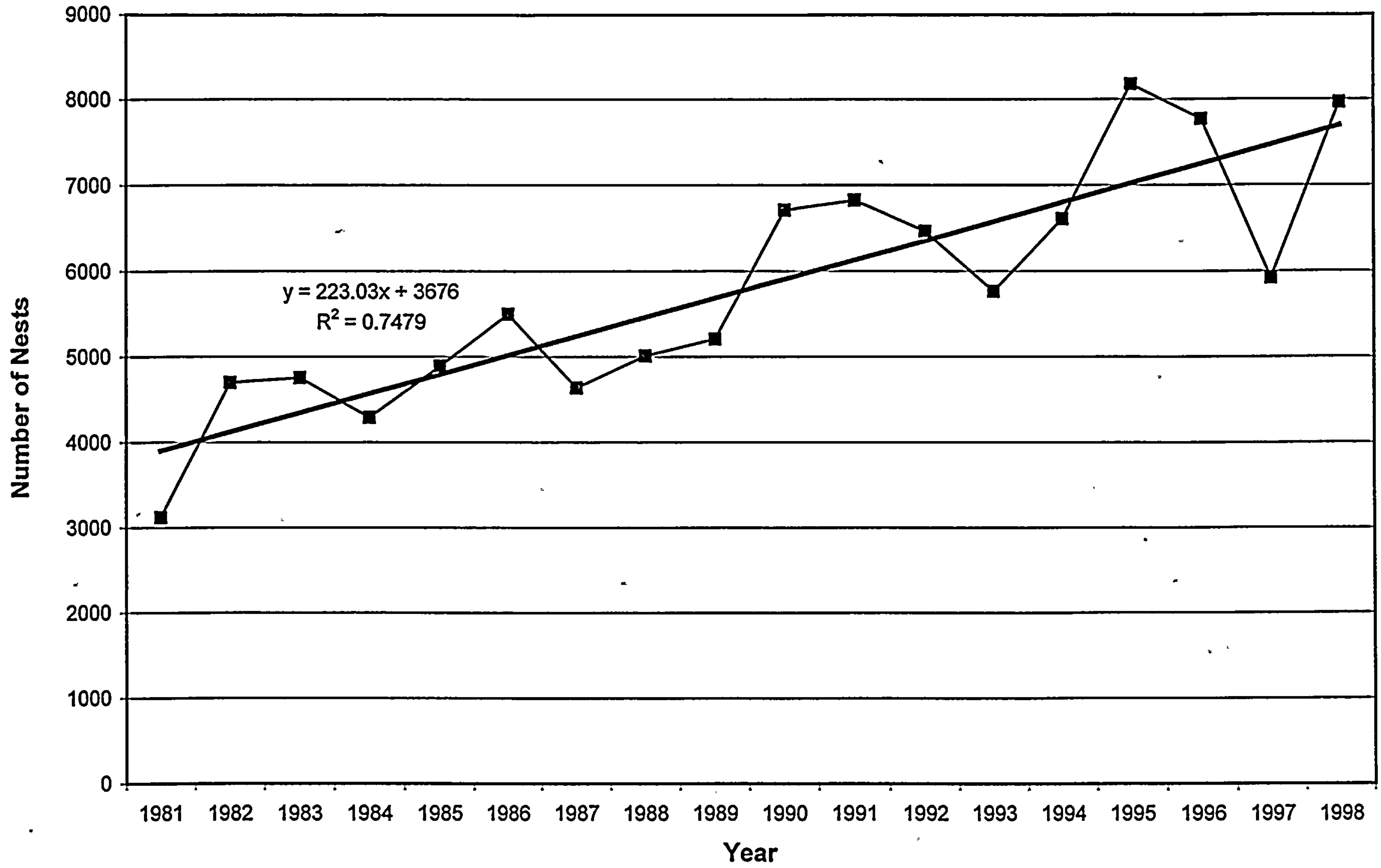

Figure 105. Annual numbers of loggerhead turtle nests recorded on Hutchinson Island, Florida 1981-1998.

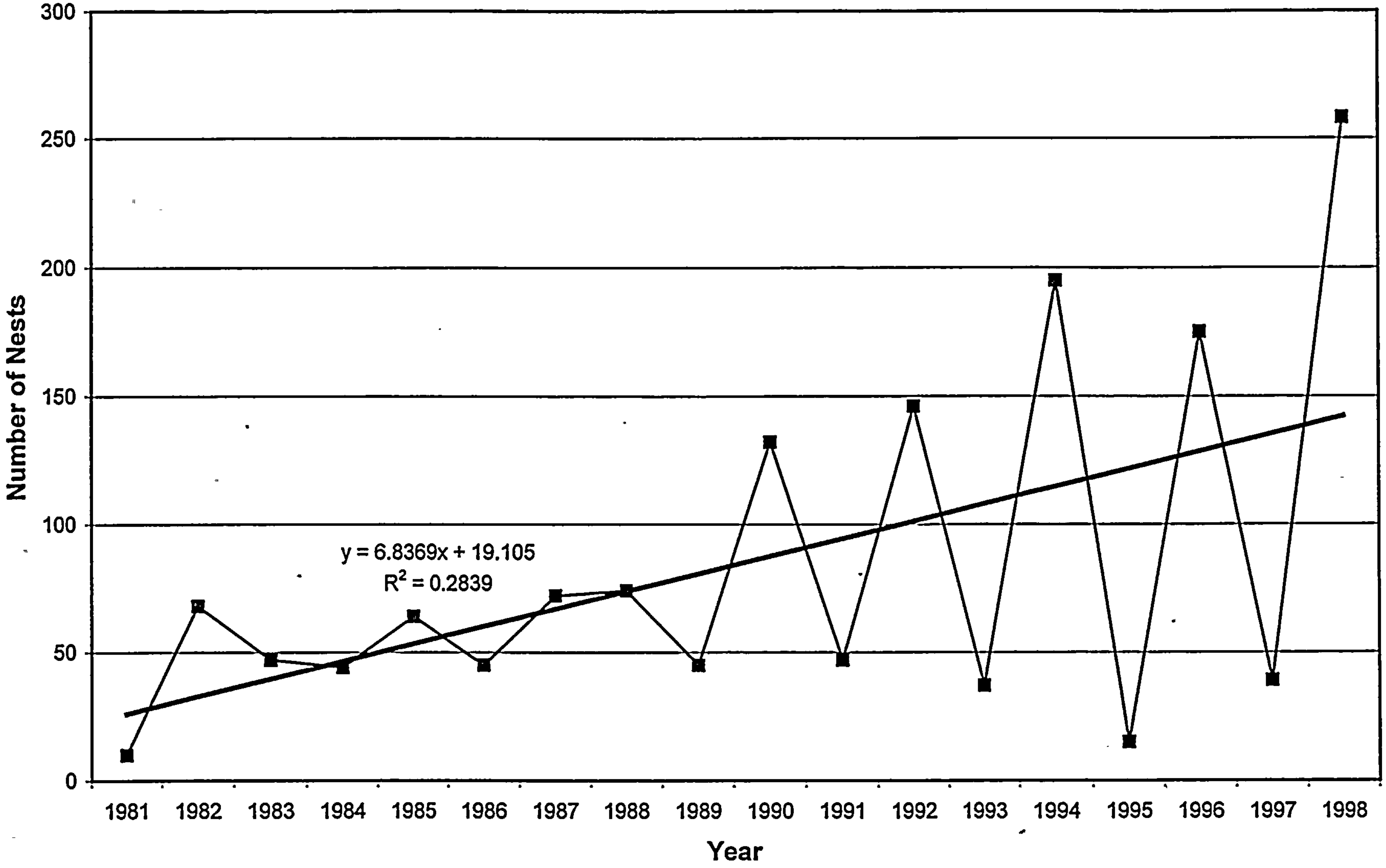

Figure 106. Annual numbers of green turtle nests recorded on Hutchinson Island, Florida, 1981-1998.

50-335 ST. LUCIE 1 FP&LCO

COMBINED ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT FOR THE PERIOD JANUARY 1, 1999 THRU DECEMBER 31, 1999

REC'D W/LTR DTD 2/29/2000...003688851

50-335 003688851 2/29/2000

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT NOS. 1 & 2

LICENSE NUMBERS DPR-67 & NPF-16

COMBINED ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

FOR THE PERIOD

JANUARY 1, 1999 THROUGH DECEMBER 31, 1999

TABLE OF CONTENTS

EFFLUENT AND WASTE DISPOSAL SUPPLEMENTAL INFORMATION

1. Regulatory Limits

1.1 For Liquid Waste Effluents

A. The concentration of radioactive material released from the site shall be limited to ten times the concentrations specified in 10 CFR Part 20 Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2E-4 micro-Curies/ml total activity.

B. The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive material in liquid effluents released, from each reactor unit, to UNRESTRICTED AREAS shall be limited to:
During any calendar quarter to <= 1.5 mrems to the Total Body and
to <= 5 mrems to any organ, and
During any calendar year to <= 3 mrems to the Total Body and
to <= 10 mrems to any organ.

1.2 For Gaseous Waste Effluents:

A. The dose rate in UNRESTRICTED AREAS due to radioactive materials released in gaseous effluents from the site shall be limited to:
For Noble Gases: <= 500 mrems/yr to the total body and
<= 3000 mrems/yr to the skin, and
For Iodine-131, Iodine-133, Tritium, and all radionuclides in particulate form with half-lives greater than 8 days:
<= 1500 mrems/yr to any organ.

*B. The air dose due to noble gases released in gaseous effluents from each unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:
During any calendar quarter, to <= 5 mrads for gamma radiation, and
<= 10 mrads for beta radiation and,
during any calendar year, to <= 10 mrads for gamma radiation and
<= 20 mrads for beta radiation.

*C. The dose to a MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, Tritium, and all radionuclides in particulate form, with half-lives > 8 days in gaseous effluents released, from each unit to areas at and beyond the site boundary, shall be limited to the following:
During any calendar quarter to <= 7.5 mrem to any organ, and
During any calendar year to <= 15 mrem to any organ.

* The calculated doses contained in an annual report shall not apply to any ODCM Control. The reported values are based on actual release conditions instead of historical conditions that the ODCM Control dose calculations are based on. The ODCM Control dose limits are therefore included in Item 1 of the report, for information only.

EFFLUENT AND WASTE DISPOSAL SUPPLEMENTAL INFORMATION (Continued)

2. Effluent Concentration Limits (ECL)
   Water: Ten times the 10 CFR Part 20, Appendix B, Table 2, Column 2, except for entrained or dissolved noble gases as described in 1.1.A of this report.

   Air: Release concentrations are limited to dose rate limits described in 1.2.A. of this report.
3. Average energy of fission and activation gases in gaseous effluents is not applicable.

4. Measurements and approximations of total radioactivity

   Where alpha, tritium, and listed nuclides are shown as zero Curies released, this should be interpreted as "no activity was detected on the samples using the ODCM Control analyses techniques to achieve required Lower Limit of Detection (LLD) sensitivity for radioactive effluents."

   A summary of liquid effluent accounting methods is described in Table 3.1.

   A summary of gaseous effluent accounting methods is described in Table 3.2.

   4.1 Estimate of Errors

	LIQUID		GASEOUS	
Error Topic	Avg %	Max %	Avg %	Max %
Release Point Mixing	2	5	NA	NA
Sampling	1	5	2	5
Sample Preparation	1	5	1	5
Sample Analysis	3	10	3	10
Release Volume	2	5	4	15
Total Percent	9	30	10	35

The predictability of error for radioactive releases can only be applied to nuclides that are predominant in sample spectrums. Nuclides that are near background relative to the predominant nuclides in a given sample could easily have errors greater than the above listed maximums.

EFFLUENT AND WASTE DISPOSAL SUPPLEMENTAL INFORMATION (Continued)

4. Measurements and Approximations of Total Radioactivity (Cont.)

4.2 Methods of Analyses

TABLE 3.1

RADIOACTIVE LIQUID EFFLUENT SAMPLING AND ANALYSIS

Liquid Source	Sampling Frequency	Type of Analysis	Method of Analysis
Monitor Tank Releases	Each Batch	Principal Gamma Emitters	p.h.a.
	Monthly Composite	Tritium Gross Alpha	L.S. G.F.P.
	Quarterly Composite	Sr-89, Sr-90, & Fe-55	C.S.
Continuous Releases	Daily Grab Samples	Principal Gamma Emitters & I-131 for 4/M Composite Analysis	p.h.a.
		Dissolved & Entrained Gases One Batch/ Month	p.h.a.
		Tritium Composite Monthly	L.S.
		Alpha Composite Monthly	G.F.P.
		Sr-89, Sr-90, & Fe-55 Composite Quarterly	C.S.

p.h.a.- Gamma Spectrum Pulse Height Analysis using Germanium Detectors. All peaks are identified and quantified.
L.S.- Liquid Scintillation Counting
C.S.- Chemical Separation
G.F.P.- Gas Flow Proportional Counting
4/M - Four per Month

4. Measurements and Approximations of Total Radioactivity (Continued)

4.2 Methods of Analyses(Continued)

TABLE 3.2

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS

Gaseous Source	Sampling Frequency	Type of Analysis	Method of Analysis
Waste Gas Decay Tank Releases	Each Batch	Principal Gamma Emitters	p.h.a.
Containment Purge Releases	Each Purge	Principal Gamma Emitters Tritium	p.h.a L.S.
Plant Vent	4/M	Principal Gamma Emitters Tritium	p.h.a. L.S.
	Monthly Composite	Particulate Gross Alpha	G.F.P.
	Quarterly Composite	Particulate Sr-89 & Sr-90	C.S.

p.h.a.- Gamma Spectrum Pulse Height Analysis using Germanium Detectors. All peaks are identified and quantified.
L.S.- Liquid Scintillation Counting
C.S.- Chemical Separation
G.F.P.- Gas Flow Proportional Counting
4/M - Four per Month

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EFFLUENT AND WASTE DISPOSAL SUPPLEMENTAL INFORMATION (Continued)

5. Batch Releases

A. Liquid	Unit 1	Unit 2	Eng. Unit
1. Number of batch releases	29	28	
2. Total time period for batch releases	21,852	21,010	minutes
3. Maximum time period for a batch release	1,274	1,274	minutes
4. Average time period for a batch release	753	750	minutes
5. Minimum time period for a batch release	315	315	minutes
6. Average dilution stream flow during the period	985,106	985,106	gpm

All liquid releases are summarized in Tables

B. Gaseous	Unit 1	Unit 2	Eng. Unit
1. Number of batch releases	13	112	
2. Total time period for batch releases	3,347	7,660	minutes
3. Maximum time period for a batch release	1,101	435	minutes
4. Average time period for a batch release	257	68	minutes
5. Minimum time period for a batch release	38	12	minutes

All gaseous waste releases are summarized in Tables

6. Unplanned Releases

A. Liquid	Unit 1	Unit 2	Eng. Unit
1. Number of releases	0	0	
2. Total activity of releases	0.00E+00	0.00E+00	Curies

B. Gaseous	Unit 1	Unit 2	Eng. Unit
1. Number of releases	0	0	
2. Total activity of releases	0.00E+00	0.00E+00	Curies

C. see attachments (if applicable) for:
   1. A description of the event and equipment involved.
   2. Cause(s) for the unplanned release.
   3. Actions taken to prevent a recurrence.
   4. Consequences of the unplanned release.

7. Assessment of radiation dose from radioactive effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY assumes the VISITOR onsite for 6 hours per day for 312 days per year at a distance of 1.6 kilometers in the South East Sector. The VISITOR received exposure from each of the two reactors on the Site.

   VISITOR DOSE RESULTS FOR CALENDAR YEAR 1999 were:

NOBLE GAS	DOSE mrad	Gas Particulate & Iodine Dose	Dose mrem
Gamma Air Dose	3.15E-04	Bone	2.15E-06
Beta Air Dose	1.22E-03	Liver	4.89E-04
		Thyroid	6.78E-04
		Kidney	2.14E-04
		Lung	4.91E-04
		GI-LLI	4.88E-04
		Total Body	4.93E-04

8. Offsite Dose Calculation Manual(ODCM) Revision(s):

   Revision 21 to the ODCM was implemented on September 30, 1999. A complete copy of the ODCM is included as **Attachment - A** to this report.
   The following is a brief description of significant changes:

   DEFINITION of DOSE EQUIVALENT IODINE for Unit 1 now uses ICRP-30 iodine dose conversion factors instead of TID-14844.

   A new liquid pathway was inserted in Table 4.11-1 Radioactive Liquid Waste Sampling and Analysis Program per Liquid Release Type D. Settling Basin as a Batch Release. The inclusion of this pathway is to check the Basin water for potential contamination prior to lowering the level for severe weather preparation. There is no source term into this basin at this time. This pathway is now an EPA permitted pathway.

   The INTERLABORATORY COMPARISON PROGRAM was modified to now include cross-checks for Gross Beta on an air filter and Tritium in water. If milk samples are being obtained from animals within five miles of the site, then Sr-89 and Sr-90 in water medium cross checks are to be performed.

9. Solid Waste and Irradiated Fuel Shipments:
   No irradiated fuel shipments were made from the site.

   Common Solid waste from St. Lucie Units 1 and 2 were shipped jointly.
   A tabulated summation of these shipments is provided in this report as Table 3.9.

10. Process Control Program (PCP) Revisions:

    Administrative Procedure 0520025, "Process Control Program", Revision 13, was accepted by the Facility Review Group and approved by the Plant General Manager during the reporting period. The changes were editorial in nature and did not constitute a change to the procedures, systems, structures or components as described in the Unit 1 or Unit 2 Updated Final Safety Analysis Reports. These editorial changes did not constitute a test or experiment described by the Unit 1 or Unit 2 Updated Final Safety Analysis Reports

11. Major Changes to Radioactive Liquid, Gaseous and Solid Waste Treatment Systems:

    The changes to the Liquid and Gaseous (Flash Tank Operations) Waste Management Systems are detailed in the annual FSAR update. An abstract of these changes is provided in Attachment - B.

TABLE 3.3-1 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR#1	QTR#2
A. Fission and Activation Products			
1. Total Release - (Not including Tritium, Gases, and Alpha)	Ci	1.23E-02	5.23E-03
2. Average Diluted Concentration During Period	uCi/ml	2.44E-11	1.03E-11
B. Tritium			
1. Total Release	Ci	2.27E+01	1.05E+02
2. Average Diluted Concentration During Period	uCi/ml	4.51E-08	2.08E-07
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.01E-03	3.71E-02
2. Average Diluted Concentration During Period	uCi/ml	2.00E-12	7.31E-11
D. Gross Alpha Radioactivity			
1. Total Release	Ci	5.84E-07	0.00E+00
E. Volume of Waste Released (Prior to Dilution)	Liters	4.09E+05	5.66E+05
F. Volume of Dilution Water Used During Period	Liters	5.03E+11	5.07E+11

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ABLE 3.3-1 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES(Continued)

	UNIT	QTR#3	QTR#4
A. Fission and Activation Products			
1. Total Release - (Not including Tritium, Gases, and Alpha)	Ci	5.06E-03	2.39E-02
2. Average Diluted Concentration During Period	uCi/ml	1.08E-11	5.01E-11
B. Tritium			
1. Total Release	Ci	1.10E+02	6.07E+01
2. Average Diluted Concentration During Period	uCi/ml	2.35E-07	1.27E-07
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.86E+00	5.90E-02
2. Average Diluted Concentration During Period	uCi/ml	3.96E-09	1.24E-10
D. Gross Alpha Radioactivity			
1. Total Release	Ci	0.00E+00	6.59E-07
E. Volume of Waste Released (Prior to Dilution)	Liters	1.19E+06	9.68E+05
F. Volume of Dilution Water Used During Period	Liters	4.69E+11	4.77E+11

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TABLE 3.3-2 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR#1	QTR#2
A. Fission and Activation Products			
1. Total Release - (Not including Tritium, Gases, and Alpha)	Ci	1.23E-02	5.23E-03
2. Average Diluted Concentration During Period	uCi/ml	2.44E-11	1.03E-11
B. Tritium			
1. Total Release	Ci	2.27E+01	1.05E+02
2. Average Diluted Concentration During Period	uCi/ml	4.51E-08	2.08E-07
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.01E-03	3.71E-02
2. Average Diluted Concentration During Period	uCi/ml	2.00E-12	7.31E-11
D. Gross Alpha Radioactivity			
1. Total Release	Ci	5.84E-07	0.00E+00
E. Volume of Waste Released (Prior to Dilution)	Liters	4.09E+05	5.66E+05
F. Volume of Dilution Water Used During Period	Liters	5.03E+11	5.07E+11

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ABLE 3.3-2 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES(Continued)

	UNIT	QTR#3	QTR#4
A. Fission and Activation Products			
1. Total Release - (Not including Tritium, Gases, and Alpha)	Ci	5.06E-03	2.39E-02
2. Average Diluted Concentration During Period	uCi/ml	1.08E-11	5.01E-11
B. Tritium			
1. Total Release	Ci	1.10E+02	6.07E+01
2. Average Diluted Concentration During Period	uCi/ml	2.35E-07	1.27E-07
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.86E+00	5.90E-02
2. Average Diluted Concentration During Period	uCi/ml	3.96E-09	1.24E-10
D. Gross Alpha Radioactivity			
1. Total Release	Ci	0.00E+00	6.59E-07
E. Volume of Waste Released (Prior to Dilution)	Liters	1.19E+06	9.68E+05
F. Volume of Dilution Water Used During Period	Liters	4.69E+11	4.77E+11

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TABLE 3.4-1 LIQUID EFFLUENTS

NUCLIDES RELEASED	UNIT	Continuous Mode QTR#1	Continuous Mode QTR#2	Batch Mode QTR#1	Batch Mode QTR#2
Na-24	Ci	0.00E 00	0.00E 00	2.14E-05	0.00E 00
Cr-51	Ci	0.00E 00	0.00E 00	2.99E-04	1.33E-04
Mn-54	Ci	0.00E 00	0.00E 00	1.24E-04	7.09E-05
Fe-55	Ci	0.00E 00	0.00E 00	1.83E-03	2.02E-03
Mn-56	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Co-57	Ci	0.00E 00	0.00E 00	6.50E-06	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00	1.58E-03	5.66E-04
Fe-59	Ci	0.00E 00	0.00E 00	0.00E 00	3.55E-05
Co-60	Ci	0.00E 00	0.00E 00	1.61E-03	9.26E-04
Zn-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ni-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00	1.44E-06	2.49E-05
Sr-90	Ci	0.00E 00	0.00E 00	0.00E 00	7.35E-06
Y-90	Ci	0.00E 00	0.00E 00	0.00E 00	7.35E-06
Sr-91	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Zr-95	Ci	0.00E 00	0.00E 00	8.44E-05	2.05E-05
Nb-95	Ci	0.00E 00	0.00E 00	1.02E-04	3.74E-05
Zr-97	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Nb-97	Ci	0.00E 00	0.00E 00	3.02E-05	1.29E-05
Tc-99m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ru-103	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ag-110	Ci	0.00E 00	0.00E 00	1.62E-04	1.08E-04
Sn-113	Ci	0.00E 00	0.00E 00	1.41E-05	0.00E 00
Sb-122	Ci	0.00E 00	0.00E 00	4.65E-06	0.00E 00
Sb-124	Ci	0.00E 00	0.00E 00	1.95E-03	7.10E-05
Sb-125	Ci	0.00E 00	0.00E 00	3.40E-03	1.05E-03

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TABLE 3.4-1 LIQUID EFFLUENTS(Continued)

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#1	QTR#2	QTR#1	QTR#2
Te-129	Ci	0.00E 00	0.00E 00	1.77E-04	5.36E-05
Te-129m	Ci	0.00E 00	0.00E 00	6.52E-04	0.00E 00
I-131	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Te-132	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
I-132	Ci	0.00E 00	0.00E 00	3.01E-05	0.00E 00
I-133	Ci	0.00E 00	0.00E 00	0.00E 00	2.65E-06
I-134	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00	3.38E-05	0.00E+00
I-135	Ci	0.00E 00	0.00E 00	0.00E 00	7.50E-06
Cs-136	Ci	0.00E 00	0.00E 00	6.37E-05	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00	1.12E-04	6.84E-05
Cs-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ba-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Pr-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Np-239	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
TOTAL FOR PERIOD	Ci	0.00E+00	0.00E+00	1.23E-02	5.23E-03
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	0.00E 00	1.62E-02
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	1.46E-04	9.00E-04
Xe-133m	Ci	0.00E 00	0.00E 00	0.00E 00	1.21E-04
Xe-133	Ci	0.00E 00	0.00E 00	8.54E-04	1.98E-02
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00	6.40E-06	0.00E 00

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TABLE 3.4-1 LIQUID EFFLUENTS(Continued)

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#3	QTR#4	QTR#3	QTR#4
Na-24	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E+00
Cr-51	Ci	0.00E 00	0.00E 00	0.00E 00	3.84E-03
Mn-54	Ci	0.00E 00	0.00E 00	5.82E-05	3.30E-04
Fe-55	Ci	0.00E 00	0.00E 00	1.37E-03	1.47E-03
Mn-56	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Co-57	Ci	0.00E 00	0.00E 00	0.00E 00	3.76E-05
Co-58	Ci	0.00E 00	0.00E 00	4.13E-04	6.75E-03
Fe-59	Ci	0.00E 00	0.00E 00	0.00E 00	7.05E-04
Co-60	Ci	0.00E 00	0.00E 00	1.82E-03	2.89E-03
Zn-65	Ci	0.00E 00	0.00E 00	0.00E 00	5.95E-05
Ni-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00	4.77E-06	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00	7.16E-06	1.65E-06
Y-90	Ci	0.00E 00	0.00E 00	7.16E-06	1.65E-06
Sr-91	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00	1.96E-05	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Zr-95	Ci	0.00E 00	0.00E 00	0.00E 00	7.11E-04
Nb-95	Ci	0.00E 00	0.00E 00	4.50E-05	8.85E-04
Zr-97	Ci	0.00E 00	0.00E 00	0.00E 00	2.30E-04
Nb-97	Ci	0.00E 00	0.00E 00	1.78E-05	1.36E-05
Tc-99m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00	0.00E 00	1.04E-04
Ru-103	Ci	0.00E 00	0.00E 00	0.00E 00	4.98E-06
Ag-110	Ci	0.00E 00	0.00E 00	2.27E-04	5.51E-05
Sn-113	Ci	0.00E 00	0.00E 00	0.00E 00	1.34E-04
Sb-122	Ci	0.00E 00	0.00E 00	0.00E 00	1.50E-04
Sb-124	Ci	0.00E 00	0.00E 00	0.00E 00	1.98E-05
Sb-125	Ci	0.00E 00	0.00E 00	6.43E-04	1.16E-03

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TABLE 3.4-1 LIQUID EFFLUENTS (continued)

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#3	QTR#4	QTR#3	QTR#4
Te-129	Ci	0.00E 00	0.00E 00	0.00E 00	1.71E-04
Te-129m	Ci	0.00E 00	0.00E 00	1.82E-04	0.00E 00
I-130	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	0.00E 00	1.04E-05	4.52E-05
Te-132	Ci	0.00E 00	0.00E 00	1.67E-05	1.64E-05
I-132	Ci	0.00E 00	0.00E 00	4.65E-05	1.60E-05
I-133	Ci	0.00E 00	0.00E 00	2.99E-06	1.60E-05
I-134	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00	3.44E-05	1.85E-03
I-135	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-136	Ci	0.00E 00	0.00E 00	0.00E 00	4.42E-05
Cs-137	Ci	0.00E 00	0.00E 00	1.42E-04	2.00E-03
Cs-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ba-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00	0.00E 00	1.48E-04
Pr-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00	0.00E 00	2.89E-05
Np-239	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
TOTAL FOR PERIOD	Ci	0.00E+00	0.00E+00	5.06E-03	2.39E-02
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	7.15E-06
Kr-85m	Ci	0.00E 00	0.00E 00	1.73E-06	2.08E-05
Kr-85	Ci	0.00E 00	0.00E 00	3.13E-01	4.91E-02
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	2.83E-02	1.98E-03
Xe-133m	Ci	0.00E 00	0.00E 00	1.51E-02	0.00E 00
Xe-133	Ci	0.00E 00	0.00E 00	1.50E+00	7.94E-03
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	9.10E-06
Xe-135	Ci	0.00E 00	0.00E 00	2.30E-03	7.25E-06
Xe-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00

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TABLE 3.4-2 LIQUID EFFLUENTS

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#1	QTR#2	QTR#1	QTR#2
Na-24	Ci	0.00E 00	0.00E 00	2.14E-05	0.00E 00
Cr-51	Ci	0.00E 00	0.00E 00	2.99E-04	1.33E-04
Mn-54	Ci	0.00E 00	0.00E 00	1.24E-04	7.09E-05
Fe-55	Ci	0.00E 00	0.00E 00	1.83E-03	2.02E-03
Mn-56	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Co-57	Ci	0.00E 00	0.00E 00	6.50E-06	0.00E 00
Co-58	Ci	0.00E 00	0.00E 00	1.58E-03	5.66E-04
Fe-59	Ci	0.00E 00	0.00E 00	0.00E 00	3.55E-05
Co-60	Ci	0.00E 00	0.00E 00	1.61E-03	9.26E-04
Zn-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ni-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00	1.43E-06	2.49E-05
Sr-90	Ci	0.00E 00	0.00E 00	0.00E 00	7.35E-06
Y-90	Ci	0.00E 00	0.00E 00	0.00E 00	7.35E-06
Sr-91	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Zr-95	Ci	0.00E 00	0.00E 00	8.44E-05	2.05E-05
Nb-95	Ci	0.00E 00	0.00E 00	1.02E-04	3.74E-05
Zr-97	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Nb-97	Ci	0.00E 00	0.00E 00	3.02E-05	1.29E-05
Tc-99m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ru-103	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ag-110	Ci	0.00E 00	0.00E 00	1.62E-04	1.08E-04
Sn-113	Ci	0.00E 00	0.00E 00	1.41E-05	0.00E 00
Sb-122	Ci	0.00E 00	0.00E 00	4.65E-06	0.00E 00
Sb-124	Ci	0.00E 00	0.00E 00	1.95E-03	7.10E-05
Sb-125	Ci	0.00E 00	0.00E 00	3.40E-03	1.05E-03

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TABLE 3.4-2 LIQUID EFFLUENTS(Continued)

NUCLIDES RELEASED	UNIT	Continuous Mode QTR#1	Continuous Mode QTR#2	Batch Mode QTR#1	Batch Mode QTR#2
Te-129	Ci	0.00E 00	0.00E 00	1.77E-04	5.36E-05
Te-129m	Ci	0.00E 00	0.00E 00	6.52E-04	0.00E 00
I-131	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Te-132	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
I-132	Ci	0.00E 00	0.00E 00	3.01E-05	0.00E 00
I-133	Ci	0.00E 00	0.00E 00	0.00E 00	2.65E-06
I-134	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00	3.38E-05	0.00E+00
I-135	Ci	0.00E 00	0.00E 00	0.00E 00	7.50E-06
Cs-136	Ci	0.00E 00	0.00E 00	6.37E-05	0.00E 00
Cs-137	Ci	0.00E 00	0.00E 00	1.12E-04	6.84E-05
Cs-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ba-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Pr-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Np-239	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
TOTAL FOR PERIOD	Ci	0.00E+00	0.00E+00	1.23E-02	5.23E-03
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	0.00E 00	1.62E-02
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	1.46E-04	9.00E-04
Xe-133m	Ci	0.00E 00	0.00E 00	0.00E 00	1.21E-04
Xe-133	Ci	0.00E 00	0.00E 00	8.54E-04	1.98E-02
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00	6.40E-06	0.00E 00

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TABLE 3.4-2 LIQUID EFFLUENTS(Continued)

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#3	QTR#4	QTR#3	QTR#4
Na-24	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E+00
Cr-51	Ci	0.00E 00	0.00E 00	0.00E 00	3.84E-03
Mn-54	Ci	0.00E 00	0.00E 00	5.82E-05	3.30E-04
Fe-55	Ci	0.00E 00	0.00E 00	1.37E-03	1.47E-03
Mn-56	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Co-57	Ci	0.00E 00	0.00E 00	0.00E 00	3.76E-05
Co-58	Ci	0.00E 00	0.00E 00	4.13E-04	6.75E-03
Fe-59	Ci	0.00E 00	0.00E 00	0.00E 00	7.05E-04
Co-60	Ci	0.00E 00	0.00E 00	1.82E-03	2.89E-03
Zn-65	Ci	0.00E 00	0.00E 00	0.00E 00	5.95E-05
Ni-65	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-89	Ci	0.00E 00	0.00E 00	4.77E-06	0.00E 00
Sr-90	Ci	0.00E 00	0.00E 00	7.16E-06	1.65E-06
Y-90	Ci	0.00E 00	0.00E 00	7.16E-06	1.65E-06
Sr-91	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00	1.96E-05	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Zr-95	Ci	0.00E 00	0.00E 00	0.00E 00	7.11E-04
Nb-95	Ci	0.00E 00	0.00E 00	4.50E-05	8.85E-04
Zr-97	Ci	0.00E 00	0.00E 00	0.00E 00	2.30E-04
Nb-97	Ci	0.00E 00	0.00E 00	1.78E-05	1.36E-05
Tc-99m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00	0.00E 00	1.04E-04
Ru-103	Ci	0.00E 00	0.00E 00	0.00E 00	4.98E-06
Ag-110	Ci	0.00E 00	0.00E 00	2.27E-04	5.51E-05
Sn-113	Ci	0.00E 00	0.00E 00	0.00E 00	1.34E-04
Sb-122	Ci	0.00E 00	0.00E 00	0.00E 00	1.50E-04
Sb-124	Ci	0.00E 00	0.00E 00	0.00E 00	1.98E-05
Sb-125	Ci	0.00E 00	0.00E 00	6.43E-04	1.16E-03

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TABLE 3.4-2 LIQUID EFFLUENTS(Continued)

NUCLIDES		Continuous Mode		Batch Mode	
RELEASED	UNIT	QTR#3	QTR#4	QTR#3	QTR#4
Te-129	Ci	0.00E 00	0.00E 00	0.00E 00	1.71E-04
Te-129m	Ci	0.00E 00	0.00E 00	1.82E-04	0.00E 00
I-130	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
I-131	Ci	0.00E 00	0.00E 00	1.04E-05	4.52E-05
Te-132	Ci	0.00E 00	0.00E 00	1.67E-05	1.64E-05
I-132	Ci	0.00E 00	0.00E 00	4.65E-05	1.60E-05
I-133	Ci	0.00E 00	0.00E 00	2.99E-06	1.60E-05
I-134	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00	3.44E-05	1.85E-03
I-135	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Cs-136	Ci	0.00E 00	0.00E 00	0.00E 00	4.42E-05
Cs-137	Ci	0.00E 00	0.00E 00	1.42E-04	2.00E-03
Cs-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ba-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00	0.00E 00	1.48E-04
Pr-144	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00	0.00E 00	2.89E-05
Np-239	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
TOTAL FOR PERIOD	Ci	0.00E+00	0.00E+00	5.06E-03	2.39E-02
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	7.15E-06
Kr-85m	Ci	0.00E 00	0.00E 00	1.73E-06	2.08E-05
Kr-85	Ci	0.00E 00	0.00E 00	3.13E-01	4.91E-02
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	2.83E-02	1.98E-03
Xe-133m	Ci	0.00E 00	0.00E 00	1.51E-02	0.00E 00
Xe-133	Ci	0.00E 00	0.00E 00	1.50E+00	7.94E-03
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	9.10E-06
Xe-135	Ci	0.00E 00	0.00E 00	2.30E-03	7.25E-06
Xe-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00

TABLE 3.5-1
LIQUID EFFLUENTS - DOSE SUMMATION

AGE GROUP: ADULT LOCATION: ANY ADULT

FISH AND SHELLFISH

ORGAN	DOSE mrem
Bone	3.93E-03
Liver	1.72E-02
Thyroid	5.12E-04
Kidney	6.90E-04
Lung	1.93E-02
GI-LLI	1.94E-02
Total Body	5.24E-03

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TABLE 3.5-2
LIQUID EFFLUENTS - DOSE SUMMATION

AGE GROUP: ADULT LOCATION: ANY ADULT

FISH AND SHELLFISH

ORGAN	DOSE mrem
Bone	3.93E-03
Liver	1.72E-02
Thyroid	5.12E-04
Kidney	6.90E-04
Lung	1.93E-02
GI-LLI	1.94E-02
Total Body	5.24E-03

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TABLE 3.6-1 GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR#1	QTR#2
A. Fission and Activation Gases			
1. Total Release	Ci	0.00E+00	1.55E+01
2. Average Release Rate For Period	uCi/sec	0.00E+00	1.97E+00
B. Iodines			
1. Total Iodine-131	Ci	0.00E 00	0.00E 00
2. Average Release Rate For Period	uCi/sec	0.00E+00	0.00E+00
C. Particulates			
1. Particulates (Half Life > 8 days)	Ci	7.01E-07	2.11E-06
2. Average Release Rate For Period	uCi/sec	8.92E-08	2.68E-07
3. Gross Alpha Radioactivity	Ci	1.76E-08	1.24E-08
D. Tritium			
1. Total Release	Ci	6.58E+00	2.52E+01
2. Average Release Rate For Period	uCi/sec	8.37E-01	3.21E+00

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.TABLE 3.6-1 GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES(Continued)

	UNIT	QTR#3	QTR#4
A. Fission and Activation Gases			
1. Total Release	Ci	6.02E+01	6.57E+00
2. Average Release Rate For Period	uCi/sec	7.66E+00	8.36E-01
B. Iodines			
1. Total Iodine-131	Ci	7.46E-04	7.31E-05
2. Average Release Rate For Period	uCi/sec	9.49E-05	9.30E-06
C. Particulates			
1. Particulates (Half Life > 8 days)	Ci	1.99E-06	9.57E-07
2. Average Release Rate For Period	uCi/sec	2.53E-07	1.22E-07
3. Gross Alpha Radioactivity	Ci	6.62E-08	3.33E-08
D. Tritium			
1. Total Release	Ci	3.36E+00	1.20E+00
2. Average Release Rate For Period	uCi/sec	4.28E-01	1.53E-01

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TABLE 3.6-2 GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QTR#1	QTR#2
A. Fission and Activation Gases			
1. Total Release	Ci	6.00E-01	4.12E-01
2. Average Release Rate For Period	uCi/sec	7.63E-02	5.24E-02
B. Iodines			
1. Total Iodine-131	Ci	2.96E-05	8.33E-06
2. Average Release Rate For Period	uCi/sec	3.76E-06	1.06E-06
C. Particulates			
1. Particulates (Half Life > 8 days)	Ci	1.39E-05	1.59E-05
2. Average Release Rate For Period	uCi/sec	1.77E-06	2.02E-06
3. Gross Alpha Radioactivity	Ci	2.74E-08	3.12E-08
D. Tritium			
1. Total Release	Ci	7.64E+00	2.23E+01
2. Average Release Rate For Period	uCi/sec	9.72E-01	2.84E+00

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TABLE 3.6-2 GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES(Continued)

	UNIT	QTR#3	QTR#4
A. Fission and Activation Gases			
1. Total Release	Ci	1.76E+00	5.36E-01
2. Average Release Rate For Period	uCi/sec	2.23E-01	6.82E-02
B. Iodines			
1. Total Iodine-131	Ci	0.00E 00	0.00E 00
2. Average Release Rate For Period	uCi/sec	0.00E+00	0.00E+00
C. Particulates			
1. Particulates (Half Life > 8 days)	Ci	9.60E-06	4.98E-06
2. Average Release Rate For Period	uCi/sec	1.22E-06	6.33E-07
3. Gross Alpha Radioactivity	Ci	1.62E-07	7.05E-08
D. Tritium			
1. Total Release	Ci	6.51E+01	1.82E+00
2. Average Release Rate For Period	uCi/sec	8.28E+00	2.31E-01

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TABLE 3.7-1 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

Nuclides Released	Unit	Continuous Mode QTR#1	Continuous Mode QTR#2	Batch Mode QTR#1	Batch Mode QTR#2
1. Fission Gases					
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	0.00E 00	3.13E+00
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-89	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-90	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-127	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-133m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-133	Ci	0.00E 00	1.21E+01	0.00E 00	4.36E-04
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	2.31E-01	0.00E 00	0.00E 00
Xe-137	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Total for Period	Ci	0.00E+00	1.23E+01	0.00E+00	3.13E+00
2. Iodines					
I-131	Ci	0.00E 00	0.00E 00		
I-132	Ci	0.00E 00	0.00E 00		
I-133	Ci	6.50E-06	9.20E-05		
I-134	Ci	0.00E 00	0.00E 00		
I-135	Ci	0.00E 00	0.00E 00		
Total for Period	Ci	6.50E-06	9.20E-05		
3. Particulates (> 8 Days)					
Cr-51	Ci	0.00E 00	0.00E 00		
Mn-54	Ci	0.00E 00	0.00E 00		
Fe-55	Ci	0.00E 00	0.00E 00		
Co-57	Ci	0.00E 00	0.00E 00		
Co-58	Ci	0.00E 00	0.00E 00		
Fe-59	Ci	0.00E 00	,0.00E 00		
Co-60	Ci	0.00E 00	0.00E 00		
Zn-65	Ci	0.00E 00	0.00E 00		
Zr-95	Ci	0.00E 00	0.00E 00		
Nb-95	Ci	0.00E 00	0.00E 00		

TABLE 3.7-1 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

			Continuous Mode	
	Nuclides Released	Unit	QTR#1	QTR#2
3. Particulates (> 8 Days) (continued)				
	Sr-89	Ci	0.00E 00	0.00E 00
	Sr-90	Ci	0.00E 00	0.00E 00
	Y-90	Ci	0.00E 00	0.00E 00
	Ru-103	Ci	0.00E 00	0.00E 00
	Ag-110	Ci	0.00E 00	0.00E 00
	Sn-113	Ci	0.00E 00	0.00E 00
	Sb-124	Ci	0.00E 00	0.00E 00
	Sb-125	Ci	4.43E-07	0.00E 00
	Te-129m	Ci	0.00E 00	0.00E 00
	Cs-134	Ci	0.00E 00	0.00E 00
	Cs-136	Ci	0.00E 00	0.00E 00
	Cs-137	Ci	2.58E-07	2.11E-06
	Ba-140	Ci	0.00E 00	0.00E 00
	Ce-141	Ci	0.00E 00	0.00E 00
	Ce-144	Ci	0.00E 00	0.00E 00
Total for Period		Ci	7.01E-07	2.11E-06
4. Particulates (< 8 Days)				
	Mn-56	Ci	0.00E 00	0.00E 00
	Ni-65	Ci	0.00E 00	0.00E 00
	Br-82	Ci	0.00E 00	0.00E 00
	Rb-88	Ci	0.00E 00	0.00E 00
	Rb-89	Ci	0.00E 00	0.00E 00
	Sr-91	Ci	0.00E 00	0.00E 00
	Sr-92	Ci	0.00E 00	0.00E 00
	Y-92	Ci	0.00E 00	0.00E 00
	Zr-97	Ci	0.00E 00	0.00E 00
	Nb-97	Ci	0.00E 00	0.00E 00
	Tc-99m	Ci	0.00E 00	0.00E 00
	Mo-99	Ci	0.00E 00	0.00E 00
	Sb-122	Ci	0.00E 00	0.00E 00
	Te-129	Ci	0.00E 00	0.00E 00
	Te-132	Ci	0.00E 00	0.00E 00
	Cs-138	Ci	0.00E 00	0.00E 00
	La-140	Ci	0.00E 00	0.00E 00
	Pr-144	Ci	0.00E 00	0.00E 00
	W-187	Ci	0.00E 00	0.00E 00
	Np-239	Ci	0.00E 00	0.00E 00
Total for Period		Ci	0.00E+00	0.00E+00

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TABLE 3.7-1 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

Nuclides Released	Unit	Continuous Mode QTR#3	Continuous Mode QTR#4	Batch Mode QTR#3	Batch Mode QTR#4
1. Fission Gases					
Ar-41	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	2.45E+01	5.23E+00
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-89	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-90	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-127	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	2.31E-01	8.41E-02
Xe-133m	Ci	0.00E 00	0.00E 00	1.34E-01	0.00E 00
Xe-133	Ci	2.19E+01	0.00E 00	1.12E+01	1.26E+00
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	2.20E+00	0.00E 00	6.66E-02	0.00E 00
Xe-137	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Total for Period	Ci	2.41E+01	0.00E+00	3.62E+01	6.57E+00
2. Iodines					
I-131	Ci	7.46E-04	7.31E-05		
I-132	Ci	0.00E 00	0.00E 00		
I-133	Ci	4.37E-05	0.00E 00		
I-134	Ci	0.00E 00	0.00E 00		
I-135	Ci	0.00E 00	0.00E 00		
Total for Period	Ci	7.90E-04	7.31E-05		
3. Particulates (> 8 Days)					
Cr-51	Ci	0.00E 00	0.00E 00		
Mn-54	Ci	0.00E 00	0.00E 00		
Fe-55	Ci	0.00E 00	0.00E 00		
Co-57	Ci	0.00E 00	0.00E 00		
Co-58	Ci	0.00E 00	0.00E 00		
Fe-59	Ci	0.00E 00	0.00E 00		
Co-60	Ci	0.00E 00	0.00E 00		
Zn-65	Ci	0.00E 00	0.00E 00		
Zr-95	Ci	0.00E 00	0.00E 00		
Nb-95	Ci	0.00E 00	0.00E 00		

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TABLE 3.7-1 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

Nuclides Released	Unit	Continuous Mode QTR#3	Continuous Mode QTR#4
3. Particulates (> 8 Days) (continued)			
Sr-89	Ci	0.00E 00	1.15E-07
Sr-90	Ci	7.56E-07	0.00E 00
Y-90	Ci	7.56E-07	0.00E 00
Ru-103	Ci	0.00E 00	0.00E 00
Ag-110	Ci	0.00E 00	0.00E 00
Sn-113	Ci	0.00E 00	0.00E 00
Sb-124	Ci	0.00E 00	0.00E 00
Sb-125	Ci	0.00E 00	0.00E 00
Te-129m	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
Cs-136	Ci	0.00E 00	0.00E 00
Cs-137	Ci	4.79E-07	8.42E-07
Ba-140	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Total for Period	Ci	1.99E-06	9.57E-07
4. Particulates (< 8 Days)			
Mn-56	Ci	0.00E 00	0.00E 00
Ni-65	Ci	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00
Rb-89	Ci	0.00E 00	0.00E 00
Sr-91	Ci	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00
Zr-97	Ci	0.00E 00	0.00E 00
Nb-97	Ci	0.00E 00	0.00E 00
Tc-99m	Ci	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00
Sb-122	Ci	0.00E 00	0.00E 00
Te-129	Ci	0.00E 00	0.00E 00
Te-132	Ci	0.00E 00	0.00E 00
Cs-138	Ci	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00
Pr-144	Ci	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00
Np-239	Ci	0.00E 00	0.00E 00
Total for Period	Ci	0.00E+00	0.00E+00

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TABLE 3.7-2 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

Nuclides Released	Unit	Continuous Mode QTR#1	Continuous Mode QTR#2	Batch Mode QTR#1	Batch Mode QTR#2
1. Fission Gases					
Ar-41	Ci	0.00E 00	0.00E 00	2.47E-01	2.44E-01
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	3.88E-02	1.12E-02
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-89	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-90	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-127	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-133m	Ci	0.00E 00	0.00E 00	9.65E-04	8.90E-04
Xe-133	Ci	0.00E 00	0.00E 00	2.95E-01	1.52E-01
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00	1.72E-02	3.90E-03
Xe-137	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00	1.06E-03	0.00E 00
Total for Period	Ci	0.00E+00	0.00E+00	6.00E-01	4.12E-01
2. Iodines					
I-131	Ci	2.96E-05	8.33E-06		
I-132	Ci	0.00E 00	0.00E 00		
I-133	Ci	7.88E-04	1.19E-03		
I-134	Ci	0.00E 00	0.00E 00		
I-135	Ci	0.00E 00	0.00E 00		
Total for Period	Ci	8.18E-04	1.20E-03		
3. Particulates (> 8 Days)					
Cr-51	Ci	0.00E 00	0.00E 00		
Mn-54	Ci	0.00E 00	0.00E 00		
Fe-55	Ci	0.00E 00	0.00E 00		
Co-57	Ci	0.00E 00	0.00E 00		
Co-58	Ci	0.00E 00	0.00E 00		
Fe-59	Ci	0.00E 00	0.00E 00		
Co-60	Ci	0.00E 00	0.00E 00		
Zn-65	Ci	0.00E 00	0.00E 00		
Zr-95	Ci	0.00E 00	0.00E 00		
Nb-95	Ci	0.00E 00	0.00E 00		

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TABLE 3.7-2 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

Nuclides Released	Unit	Continuous Mode QTR#1	Continuous Mode QTR#2
3. Particulates (> 8 Days) (continued)			
Sr-89	Ci	0.00E 00	7.96E-06
Sr-90	Ci	6.89E-06	3.79E-06
Y-90	Ci	6.89E-06	3.79E-06
Ru-103	Ci	0.00E 00	0.00E 00
Ag-110	Ci	0.00E 00	0.00E 00
Sn-113	Ci	0.00E 00	0.00E 00
Sb-124	Ci	0.00E 00	0.00E 00
Sb-125	Ci	0.00E 00	0.00E 00
Te-129m	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
Cs-136	Ci	0.00E 00	0.00E 00
Cs-137	Ci	1.39E-07	3.66E-07
Ba-140	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Total for Period	Ci	1.39E-05	1.59E-05
4. Particulates (< 8 Days)			
Mn-56	Ci	0.00E 00	0.00E 00
Ni-65	Ci	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00
Rb-89	Ci	0.00E 00	0.00E 00
Sr-91	Ci	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00
Zr-97	Ci	0.00E 00	0.00E 00
Nb-97	Ci	0.00E 00	0.00E 00
Tc-99m	Ci	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00
Sb-122	Ci	0.00E 00	0.00E 00
Te-129	Ci	0.00E 00	0.00E 00
Te-132	Ci	0.00E 00	0.00E 00
Cs-138	Ci	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00
Pr-144	Ci	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00
Np-239	Ci	0.00E 00	0.00E 00
Total for Period	Ci	0.00E+00	0.00E+00

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TABLE 3.7-2 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

Nuclides Released	Unit	Continuous Mode QTR#3	Continuous Mode QTR#4	Batch Mode QTR#3	Batch Mode QTR#4
1. Fission Gases					
Ar-41	Ci	0.00E 00	0.00E 00	2.72E-01	2.78E-01
Kr-85m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-85	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-87	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-88	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-89	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Kr-90	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-127	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-131m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-133m	Ci	0.00E 00	0.00E 00	4.44E-03	0.00E 00
Xe-133	Ci	1.13E+00	2.53E-01	3.50E-01	4.43E-03
Xe-135m	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-135	Ci	0.00E 00	0.00E 00	8.74E-04	7.52E-04
Xe-137	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Xe-138	Ci	0.00E 00	0.00E 00	0.00E 00	0.00E 00
Total for Period	Ci	1.13E+00	2.53E-01	6.27E-01	2.83E-01
2. Iodines					
I-131	Ci	0.00E 00	0.00E 00		
I-132	Ci	0.00E 00	0.00E 00		
I-133	Ci	3.46E-05	3.66E-05		
I-134	Ci	0.00E 00	0.00E 00		
I-135	Ci	0.00E 00	0.00E 00		
Total for Period	Ci	3.46E-05	3.66E-05		
3. Particulates (> 8 Days)					
Cr-51	Ci	0.00E 00	0.00E 00		
Mn-54	Ci	0.00E 00	0.00E 00		
Fe-55	Ci	0.00E 00	0.00E 00		
Co-57	Ci	0.00E 00	0.00E 00		
Co-58	Ci	0.00E 00	0.00E 00		
Fe-59	Ci	0.00E 00	0.00E 00		
Co-60	Ci	0.00E 00	0.00E 00		
Zn-65	Ci	0.00E 00	0.00E 00		
Zr-95	Ci	0.00E 00	0.00E 00		
Nb-95	Ci	0.00E 00	0.00E 00		

TABLE 3.7-2 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES(Continued)

Nuclides Released	Unit	Continuous Mode QTR#3	Continuous Mode QTR#4
3. Particulates (> 8 Days) (continued)			
Sr-89	Ci	3.58E-06	3.31E-06
Sr-90	Ci	2.74E-06	0.00E 00
Y-90	Ci	2.74E-06	0.00E 00
Ru-103	Ci	0.00E 00	0.00E 00
Ag-110	Ci	0.00E 00	0.00E 00
Sn-113	Ci	0.00E 00	0.00E 00
Sb-124	Ci	0.00E 00	0.00E 00
Sb-125	Ci	0.00E 00	0.00E 00
Te-129m	Ci	0.00E 00	0.00E 00
Cs-134	Ci	0.00E 00	0.00E 00
Cs-136	Ci	0.00E 00	0.00E 00
Cs-137	Ci	5.42E-07	1.67E-06
Ba-140	Ci	0.00E 00	0.00E 00
Ce-141	Ci	0.00E 00	0.00E 00
Ce-144	Ci	0.00E 00	0.00E 00
Total for Period	Ci	9.60E-06	4.98E-06
4. Particulates (< 8 Days)			
Mn-56	Ci	0.00E 00	0.00E 00
Ni-65	Ci	0.00E 00	0.00E 00
Br-82	Ci	0.00E 00	0.00E 00
Rb-88	Ci	0.00E 00	0.00E 00
Rb-89	Ci	0.00E 00	0.00E 00
Sr-91	Ci	0.00E 00	0.00E 00
Sr-92	Ci	0.00E 00	0.00E 00
Y-92	Ci	0.00E 00	0.00E 00
Zr-97	Ci	0.00E 00	0.00E 00
Nb-97	Ci	0.00E 00	0.00E 00
Tc-99m	Ci	0.00E 00	0.00E 00
Mo-99	Ci	0.00E 00	0.00E 00
Sb-122	Ci	0.00E 00	0.00E 00
Te-129	Ci	0.00E 00	0.00E 00
Te-132	Ci	0.00E 00	0.00E 00
Cs-138	Ci	0.00E 00	0.00E 00
La-140	Ci	0.00E 00	0.00E 00
Pr-144	Ci	0.00E 00	0.00E 00
W-187	Ci	0.00E 00	0.00E 00
Np-239	Ci	0.00E 00	0.00E 00
Total for Period	Ci	0.00E+00	0.00E+00

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TABLE 3.8-1
GASEOUS EFFLUENTS - DOSE SUMMATION

AGE GROUP: INFANT

Pathway	Bone mrem	Liver mrem	Thyroid mrem	Kidney mrem
Ground Plane(a)				
Cow - Milk (b)	4.06E-05	1.88E-04	1.34E-02	7.29E-05
Inhalation (a)	8.24E-07	2.93E-04	5.21E-04	1.28E-04
Total	4.14E-05	4.81E-04	1.39E-02	2.01E-04

Pathway	Lung mrem	GI-LLI mrem	T. Body mrem
Ground Plane (a)			5.14E-06
Cow - Milk (b)	1.43E-04	1.44E-04	1.67E-04
Inhalation (a)	2.93E-04	2.93E-04	2.93E-04
Total	4.36E-04	4.37E-04	4.65E-04

(a) Sector : SE Range: 1.50 miles
(b) Sector : W Range: 4.25 miles(default milk animal)

Noble Gases	mrad
Gamma Air Dose	4.83E-04
Beta Air Dose	2.65E-03

Sector: SE Range: 1.5 miles

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TABLE 3.8-2
GASEOUS EFFLUENTS - DOSE SUMMATION

AGE GROUP: INFANT

Pathway	Bone mrem	Liver mrem	Thyroid mrem	Kidney mrem
Ground Plane(a)				
Cow - Milk (b)	4.54E-05	3.85E-04	1.43E-03	1.67E-04
Inhalation (a)	3.90E-06	7.80E-04	9.68E-04	3.41E-04
Total	4.93E-05	1.17E-03	2.40E-03	5.08E-04

Pathway	Lung mrem	GI-LLI mrem	T. Body mrem
Ground Plane(a)			3.21E-06
Cow - Milk (b)	3.78E-04	3.79E-04	3.89E-04
Inhalation (a)	7.84E-04	7.79E-04	7.80E-04
Total	1.16E-03	1.16E-03	1.17E-03

(a) Sector : SE Range: 1.50 miles
(b) Sector : W Range: 4.25 miles(default)

Noble Gases	mrad
Gamma Air Dose	2.33E-04
Beta Air Dose	1.30E-04

Sector: SE Range: 1.5 miles

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UNITS 1 AND 2, TABLE 3.9

A. Solid Waste Shipped Off-Site for Burial or Disposal

1. Type of Waste	Unit	12 Mo. Period	Error %
a. Spent Resin,	M3	3.75 E+0	
Process Filters	Ci	9.02 E+1	2.00E+01
b. Dry Compressible	M3	5.75E+01	
Waste (Note 5)	Ci	1.55E+01	2.00E+01
c. Irradiated	M3	0	
Components	Ci	0	N/A *
d. Other (Note 6)			
1. Metal ingot,	M3	2.42E-01	
of processed resins	Ci	7.78E+00	2.00E+01

2. Estimate of Major Nuclide Composition (By Waste Type)

Category	Nuclide	%
a.	Fe55	2.90E+01
	Ni63	2.68E+01
	Co60	1.88E+01
	Cs137	1.17E+01
	Cs134	5.10E+00
	Mn54	3.54E+00
	Co58	2.97E+00
	Sb125	1.07E+00
	C14	5.20E-01
b.	Ni63	3.29E+01
	Co60	2.39E+01
	Fe55	2.27E+01
	Co58	8.23E+00
	Cs137	8.15E+00
	Mn54	1.13E+00
	Cr51	6.90E-01
	Sb125	5.00E-01
	Nb95	4.40E-01
	Zr95	4.30E-01
c.	N/A*	N/A*

UNITS 1 AND 2, TABLE 3.9(Continued)

2. Estimate of major nuclide composition (Continued)

Category	Nuclide	%
d.1	Fe55	2.01E+01
	Co58	1.95E+01
	Ni63	1.86E+01
	Co60	1.81E+01
	Sb125	7.58E+00
	Cs137	7.32E+00
	Cs134	3.62E+00
	Be7	2.32E+00
	Mn54	2.10E+00
	Sb124	3.66E-01

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
4	Sole Use Truck	Barnwell, SC
13	Sole Use Truck	GTSD, Oak Ridge, TN
2	Sole Use Truck	ATG, Oak Ridge, TN

B. Irradiated Fuel Shipments

Number of Shipments	Mode of Transportation	Destination
0	N/A*	N/A*

*N/A = Not Applicable

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UNITS 1 AND 2, TABLE 3.9 (CONTINUED)

Waste Class	Total Volume Cubic Ft.	Total Curies (Note 1)	Principal Radionuclides (Notes 1 & 2)	Type of Waste (Note 3)	Category Reg. Guide 1.21	Type of Container (Note 4)	Solidification Agent
Class A	1561.95	1.61	N/A	PWR Compactible trash (Note 5)	1.b.	Non-Specification Strong Tight Package	None
Class A	202.1	7.78	Ni63, Cs137	PWR Compactible trash	1.b.	NRC Certified LSA Type A	None
Class A	264.8	6.14	Ni63, Cs137, Sr90	PWR Compactible Trash	1.b.	NRC Certified Type B	None
Class B	132.4	90.2	Co60, Ni63, Sr90, Cs137, C14, TRU SUM Nuclides T1/2 < 5yrs	PWR Ion Exchange Resins	1.a.	NRC Certified Type B	None
Class B	8.56	7.78	Ni63, Cs137 Sr90	Metal Ingot (Note 6)	1.d.1	US DOT 7A Type A	None

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UNITS 1 AND 2, TABLE 3.9 (CONTINUED)

SOLID WASTE SUPPLEMENT

NOTE 1: The total radionuclide activity and composition of solid waste shipped from the St. Lucie Plant Units 1 and 2 are determined using a combination of qualitative techniques. In general, the St. Lucie Plant follows the quidelines outlined in the Low Level Waste Branch Technical Position (BTP) on Radioactive Waste Classification (5/11/83) for these determinations. The most frequently used techniques for determining the total activity in a package are the "Dose-to-Curie" method and "Concentration Times Volume or Mass" calculations. Where appropriate, engineering type activation analyses may be applied. Since each of the above methodologies involve, to some extent, qualitative parameters, the total activity is considered to be an estimate.

The composition of radionuclides in the waste is determined by both on-site analyses for principal gamma emitters and periodic off-site analyses for other radionuclides. The onsite analyses are performed either on a batch basis or on a routine basis using reasonably representative samples as appropriate for the waste type. Off-site analyses are used to establish scaling factors or other estimates for radionuclides such as H3, C14, Fe55, Sr90, Tc99, I129, Pu238, Pu239/240, Pu241, Am241, Cm242, and Cm243/244.

NOTE 2: "Principal Radionuclides" refer to those radionuclides contained in the waste in concentrations greater than 0.01 times the concentration of nuclides listed in Table 1 or 0.01 times the smallest concentration of nuclides listed in Table 2 of 10 CFR 61.

NOTE 3: "Type of Waste" is generally specified as described in NUREG-0782, Draft Environmental Impact Statement on 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

NOTE 4: "Type of Container" refers to the transport package.

NOTE 5: The volume and activity listed for Dry Compressible Waste represent the quantity of material that during the reporting period was sent to the licensed disposal facilities. Some of this material was shipped to contract vendors for volume reduction or recycle prior to final disposal at the licensed disposal facilities. During the reporting period, thirteen (13) shipments of dry compactible waste, non-compactible waste, and resins (15500 Cubic Feet, 7.3E-1 Curies) were made from the St. Lucie Plant to the volume reduction facilities. These materials were shipped via "Sole Use Truck" in non-specification, strong tight containers.

NOTE 6: The volume and activity listed for the Metal Ingot represent the quantity of material that during the reporting period was sent to the licensed disposal facility. This material was shipped to a contract vendor in bead resin form for volume reduction prior to final disposal at the licensed disposal facility. During the reporting period, two shipments of bead resin were made from the St. Lucie Plant to the contract vendor (294 Cubic Feet, 15.45 Curies) for volume reduction treatment and disposal.

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Attachment - A
Assumption used for ODCM Table 4.11-2 "Batch" Sample Analysis

Description of the Event:
On March 14, 1999, a Containment gaseous activity sample was obtained prior to performing a containment mini-purge to slightly reduce Unit 2 containment building pressure to maintain Technical Specification pressure limits. The reactor was operating at power.
A 4600 cubic centimeter(cc) gas sample results indicated no noble gas activity and a tritium analysis indicated 5.5E-08 uCi/cc. The technician processed the results and issued the admininistrative release permit to operations to perform the release for a maximum duration of one hour at 2550 cubic feet per minute release rate. The release was performed for a duration of 58 minutes.

The area supervisor reviewed the results after the release and noted that the release's gas activity analyses results were well below LLD, but were lower than usual for this release pathway. There were no deviations noted in the completed sampling procedure. There was no increase in the continuous monitor gas activity channel during the actual release (none would be expected).

Assumptions used to determine specific activity for the March 14, 1999 release:
To conservatively estimate the probable radioactivity for the March 14, 1999, release, an average of the releases before and after was calculated for the below nuclides:

Permit Number	Date of release	Xe-133 uCi/cc	Xe-135 uCi/cc	Ar-41 uCi/cc	Tritium uCi/cc
21	3/10/99	2.80E-06	1.50E-07	2.30E-06	3.20E-06
23	3/19/99	3.20E-06	1.60E-07	2.40E-06	1.60E-06
	Average concentration	3.00E-06	1.55E-07	2.35E-06	2.40E-06

ODCM required LLD's are = (LLD = Lower Limit of Detection)	1.00E-04	1.00E-04	1.00E-04	1.00E-06
Calculated Curies released on March 14, 1999 =	1.26E-02	6.44E-04	9.81E-03	1.01E-02

The average activity of the gas release source was a factor of 33 below the required analysis LLD and the tritium was 2.4 times greater than it's ODCM LLD activity.
The averaging was performed to more accurately report the activity that was released on March 14, 1999, rather than assume zero noble gas activity and lower than average tritium.

Reference

ODCM Radioactive Effluents **3/4.11.6 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT TO THE COMMISSION**
ODCM **Control 3.11.2.6 b.** states " All assumptions used in making assessments, i.e., specific activity, exposure time and location shall be included in these reports,"

The inclusion of this Attachment in the Annual Report fulfills the ODCM requirement.

Attachment - B

Major changes to Radioactive Liquid, Gaseous and Solid Waste Treatment Systems

FLASH TANK OPERATION (UNITS 1 & 2)

Safety Evaluation PSL-ENG-SENS-98-085 Summary:

The 1996 UFSAR review process identified two discrepancies related to the current operation of the flash tank applicable to both units. According to the findings, the flash tank is bypassed to the holdup tanks in each unit during normal plant operations, which is contrary to the operation described in the UFSAR.

This evaluation provided the necessary Unit 1 and 2 UFSAR change packages and justified current operating practices. The option for flash tank use will be kept in the UFSAR for plant operations whenever a minimum amount of fuel failures is experienced or whenever hydrogen or fission gas stripping is required.

LIQUID WASTE MANAGEMENT SYSTEM (UNIT 2)

Safety Evaluation PSL-ENG-SENS-98-068 Summary:

The 1996 UFSAR review effort identified a number of discrepancies related to Liquid Waste Management System (LWMS) operations, described in UFSAR Section 11.2. Specifically, the operation of the boric acid concentrators, waste concentrator and associated components is not performed as described in the UFSAR. This equipment and associated components have not been used for many years, and alternative waste processing methods have been implemented. This safety evaluation analyzed and evaluated these alternative methods for regulatory compliance and revised the UFSAR accordingly.

This safety evaluation demonstrated that the UFSAR changes did not adversely affect plant safety, security, or operation. This safety evaluation also demonstrated that this activity neither constituted an unreviewed safety question nor required a change to the Technical Specifications. Therefore, prior NRC approval for implementation of these changes was not required.

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Attachment - B

Major changes to Radioactive Liquid, Gaseous and Solid Waste Treatment Systems

LIQUID WASTE MANAGEMENT SYSTEM (UNIT 1)

Safety Evaluation PSL-ENG-SENS-98-096 Summary:

The 1996 UFSAR review effort identified a number of discrepancies for the Unit 2 UFSAR related to the Liquid Waste Management System (LWMS) operations described in the UFSAR. Specifically, the operation of the boric acid concentrators, waste concentrator and supporting components is not performed as described in the UFSAR. These components are no longer used for both units, and alternative waste processing methods have been implemented. This safety evaluation analyzed and evaluated these alternative methods for regulatory compliance and revised the Unit 1 UFSAR accordingly. Also, this evaluation justified the abandonment of liquid waste discharge radiation monitor RE-26-64.

This safety evaluation demonstrated that the UFSAR changes provided did not adversely affect plant safety, security or operation. This safety evaluation also demonstrated that this activity neither constituted an unreviewed safety question nor required a change to the Technical Specifications. Therefore, prior NRC approval for implementation of these changes was not required.

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EFFLUENT AND WASTE DISPOSAL SUPPLEMENTAL INFORMATION.

Attachment - C

ODCM Revision 21
(A complete copy)

FPL	**ST. LUCIE PLANT CHEMISTRY OPERATING PROCEDURE** SAFETY RELATED	Procedure No. **C-200**
		Current Rev. No. **21**
		Effective Date: **10/07/99**

Title:

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Responsible Department: **CHEMISTRY**

Revision Summary

Revision 21 - Changed C-72 to COP-01.06, changed definition of Dose Equivalent I-131,. explained why certain checks are not performed and identified rain run off, overflow of settling basins and storm preparation as NPDES permitted pathways. (R. E. Cox, 09/30/99)

AND

Changed C-72 to COP-01.06. (Jim George, 09/30/99)

Revision 20B - Changed C-70 to COP-01.05. (R. Cox, 07/13/99)

Revision 20A - Changed reference of C-70 to COP-01.05. (Ed Meyer, 05/21/99)

Revision	FRG Review Date	Approved By	Approval Date
0	04/22/82	C. M. Wethy Plant General Manager	04/27/82
Revision	**FRG Review Date**	**Approved By**	**Approval Date**
21	09/30/99	R. G. West Plant General Manager	09/30/99
		E. S. Katzman Designated Approver	09/30/99

S___OPS
DATE___
DOCT PROCEDURE
DOCN C-200
SYS___
COMP COMPLETED
ITM 21

003688832

1.0 TITLE:

OFFSITE DOSE CALCULATION MANUAL (ODCM)

2.0 REVIEW AND APPROVAL:

See cover page

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METHODOLOGY SECTION

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OFFSITE DOSE CALCULATION MANUAL (ODCM)

INTRODUCTION

The ODCM consists of the Controls Section followed by the Methodology Section.

The Controls Section provides the Control Statements, Limits, ACTION Statements, Surveillance Requirements and BASES for ensuring that Radioactive Liquid and Gaseous Effluents released to UNRESTRICTED AREAS and/or the SITE BOUNDARY will be maintained within the requirements of 10 CFR Part 20, 40 CFR Part 190, 10 CFR 50.36.a and 10 CFR Part 50 Appendix-I radioactive release criteria. All Control Statements and most Administrative Control Statements in the ODCM are directly tied to and reference the Plant Technical Specification (TS) Administrative Section. The Administrative Control for Major Changes to Radioactive Liquid, Gaseous and Solid Treatment Systems is as per the guidance of NUREG-1301, April 1991, Supplement No. 1 to NRC Generic Letter 89-01. The numbering sequences of Control Statements also follow the guidance of NUREG-1301 as applicable, to minimize differences.

The Methodology Section uses the models suggested by NUREG-0133, November, 1978 and Regulatory Guide 1.109 to provide calculation methods and parameters for determining results in compliance with the Controls Section of the ODCM. Simplifying assumptions have been applied where applicable to provide a more workable document for implementing the Control requirements. Alternate calculation methods may be used from those presented as long as the overall methodology does not change or as long as most up-to-date revisions of the Regulatory Guide 1.109 dose conversion factors and environmental transfer factors are substituted for those currently included and used in this document.

RECORDS AND NOTIFICATIONS

All records of reviews performed for changes to the ODCM shall be maintained in accordance with QI 17-PSL-1. All FRG approved changes to the ODCM, with required documentation of the changes per TS 6.14, shall be submitted to the NRC in the Annual Effluent Release Report. Procedures that directly implement, administer or supplement the requirements of the ODCM Controls and Surveillances are:

COP-01.05, Processing Aerated Liquid Waste
COP-01.06, Processing Gaseous Wastes /R21
COP-05.04, Chemistry Department Surveillances and Parameters
COP-07.05, Process Monitor Setpoints
The Radiological Environmental Monitoring Program is performed by the State of Florida as per FPL Juno Nuclear Plant Services Corporate Environmental Procedure Number NBS-NPS-HP-WP-002.

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

1.0 DEFINITIONS for CONTROLS SECTION OF ODCM

The defined terms of this section appear in capitalized type and are applicable throughout these Controls.

ACTION

1.1 ACTION shall be that part of a Control that prescribes remedial measures required under designated conditions.

CHANNEL CALIBRATION

1.4 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

1.5 A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

CHANNEL FUNCTIONAL TEST

1.6 A CHANNEL FUNCTIONAL TEST shall be the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY of alarm, interlock and/or trip functions. The CHANNEL FUNCTIONAL TEST shall include adjustments, as necessary, of the alarm, interlock and/or Trip Setpoints such that the setpoints are within the required range and accuracy.

1.0 DEFINITIONS for CONTROLS SECTION OF ODCM

DOSE EQUIVALENT I-131

1.10 DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microCurie/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be: /R21

For Reactor Unit 1, use thyroid dose conversion factors listed in ICRP-30, Supplement to Part 1, Pages 192-212, Tables entitled, "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity (Sv/Bq)." Reference PLA #98-007, PMAI 99-06-170. /R21

For Reactor Unit 2, use thyroid dose conversion factors listed in Table III of TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites or Table E-7 of NRC Regulatory Guide 1.109, Revision 1, October 1977. /R21

FREQUENCY NOTATION

1.13 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.1.

MEMBER (S) OF THE PUBLIC

1.17 MEMBER OF THE PUBLIC means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

OFFSITE DOSE CALCULATION MANUAL

1.18 The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by TS section 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by TS 6.9.1.7 and 6.9.1.8.

1.0 DEFINITIONS for CONTROLS SECTION OF ODCM

OPERABLE - OPERABILITY

1.19 A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

OPERATIONAL MODE - MODE

1.20 An OPERATIONAL MODE (i.e., MODE) shall correspond to any one inclusive combination of core reactivity condition, power level and average reactor coolant temperature specified in Table 1.2 of the St. Lucie Plant TS.

PURGE - PURGING

1.24 PURGE or PURGING shall be any controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

RATED THERMAL POWER

1.25 RATED THERMAL POWER shall be a total reactor core heat transfer rate to the reactor coolant of 2700 MWt.

REPORTABLE EVENT

1.27 A REPORTABLE EVENT shall be any of those conditions specified in Section 50.73 of 10 CFR Part 50.

SITE BOUNDARY

1.30 SITE BOUNDARY means that line beyond which the land or property is not owned, leased or otherwise controlled by the licensee.

SOURCE CHECK

1.31 A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

THERMAL POWER

1.33 THERMAL POWER shall be the total reactor core heat transfer rate to the reactor coolant.

UNPLANNED RELEASE

1.34 **UNPLANNED RELEASE** is the unintended discharge of a volume of liquid or airborne radioactivity to the environment. The following guidance is presented to classify differences between unplanned releases and other releases that are not considered as an **UNPLANNED RELEASE:**

Is an **UNPLANNED RELEASE** if:

1. The wrong waste gas decay tank or liquid radwaste release tank is released off site.
2. Failure of process system to automatically divert a process stream to a radioactive treatment system upon radioactivity being present in the process at the detection level or at a certain level of activity, and the result is a discharge off site occurs.
3. Large losses from unexpected pipe or valve leaks where the resulting loss of radioactive material to off site such that a 10 CFR Part 50.72 or 10 CFR Part 50.73 report is required.

UNPLANNED RELEASE (continued)

1.34 (continued)

Is not an **UNPLANNED RELEASE** if:

1. It cannot be shown that the release went off site, i.e., gas went to another part of the system(s) that contained the loss.

2. Normal losses through the Plant Vent due to valve and pipe leakage and purging activities to make the system safe for maintenance activities. Pressures drops in Gas Decay Tank(s) due to thermal cooling, shifting the Gas Analyzer sampling point, Chemistry Grab Sampling, or planned maintenance activities are not an **UNPLANNED RELEASE.**

UNRESTRICTED AREA

1.35 UNRESTRICTED AREA means an area, access to which is neither limited nor controlled by the licensee.

VENTILATION EXHAUST TREATMENT SYSTEM

1.39 A VENTILATION EXHAUST TREATMENT SYSTEM shall be any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal absorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Features Atmospheric Cleanup Systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

1.0 DEFINITIONS for CONTROLS SECTION OF ODCM

VENTING

1.40 VENTING shall be the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent, used in system names, does not imply a VENTING process.

WASTE GAS HOLDUP SYSTEM

1.41 A WASTE GAS HOLDUP SYSTEM shall be any system designed and installed to reduce radioactive gaseous effluents by collecting Reactor Coolant System offgases from the Reactor Coolant System and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

TABLE 1.1

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
4/M*	At least 4 per month at intervals of no greater than 9 days and minimum of 48 per year.
M	At least once per 31 days.
Q	At lease once per 92 days.
SA	At least once per 184 days.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
N.A.	Not Applicable.
P**	Completed prior to each release

* For Radioactive Effluent Sampling
** For Radioactive Batch Releases Only

3/4 CONTROLS AND SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

CONTROLS

3.0.1 Compliance with the Controls contained in the succeeding controls is required during the conditions specified therein; except that upon failure to meet the Control, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Control shall exist when the requirements of the Control and associated ACTION requirements are not met within the specified time intervals. If the Control is restored prior to expiration of the specified time intervals, completion of the ACTION requirements is not required.

SURVEILLANCE REQUIREMENTS

4.0.1 Surveillance Requirements shall be met during the conditions specified for individual Controls unless otherwise stated in an individual Surveillance Requirement.

4.0.2 Each Surveillance Requirement shall be performed within the specified time interval with:

a. A maximum allowable extension not to exceed 25% of the surveillance interval.

INSTRUMENTATION

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.3.9 In accordance with St. Lucie Plant TS 6.8.4.f.1), the radioactive liquid effluent monitoring instrumentation channels shown in Table 3.3-12 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Control 3.11.1.1 are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the OFFSITE DOSE CALCULATION MANUAL (ODCM).

APPLICABILITY: At all times.

ACTION:

a. With a radioactive liquid effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above control, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3-12. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why this inoperability was not corrected in a timely manner.

c. Report all deviations in the Annual Radioactive Effluent Release Report.

SURVEILLANCE REQUIREMENTS

4.3.3.9 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table 4.3-8.

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TABLE 3.3-12

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	ACTION
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release		
a) Liquid Radwaste Effluent Line	1	35
b) Steam Generator Blowdown Effluent Line	1/SG	36
2. Flow Rate Measurement Devices		
a) Liquid Radwaste Effluent Line	N.A.	38
b) Discharge Canal	N.A.	38
c) Steam Generator Blowdown Effluent Lines	N.A.	38

SG - Denotes Steam Generator

TABLE 3.3-12 (Continued)

ACTION STATEMENTS

ACTION 35 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may continue for up to 14 days provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with the Surveillance Requirement for concentration limit of Control 4.11.1.1.1. and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive éffluents via this pathway.

ACTION 36 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are analyzed for gross radioactivity (beta or gamma) at a limit of detection of at least 2.E-07 micro-Curie/ml:

a. At least once per 8 hours when the specific activity of the secondary coolant is greater than 0.01 micro-Curies/gram DOSE EQUIVALENT I-131 or

b. At least once per 24 hours when the specific activity of the secondary coolant is less than or equal to 0.01 micro-Curies/gram DOSE EQUIVALENT I-131.

ACTION 38 - Minimum system design flow of required running pumps shall be utilized for ECL calculations for discharge canal flow and maximum system design flow be utilized for ECL calculations for effluent line flow.

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TABLE 4.3-8

RADIOACTIVE LIQUID EFFLUENT MONITORING
INSTRUMENTATION SURVEILLANCE REQUIREMENTS (4) /R21

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a) Liquid Radwaste Effluent Line	D	P	R (2)	Q (1)
b) Steam Generator Blowdown Effluent Line	D	M	R (2)	Q (1)
2. Flow Rate Measurement Devices				
a) Liquid Radwaste Effluent Line	D (3)	N.A.	R	Q
b) Discharge Canal	D (3)	N.A.	R	Q
c) Steam Generator Blowdown Effluent Line	D (3)	N.A.	R	Q

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TABLE 4.3-8 (Continued)

TABLE NOTATIONS

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards traceable to the National Institute of Standards & Technology (NIST) or using standards that have been calibrated against standards certified by the NIST. These standards should permit calibrating the system over its intended range of energy and rate capabilities that are typical of normal plant operation. For subsequent CHANNEL CALIBRATION, button sources that have been related to the initial calibration may be used.

(3) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic or batch releases are made.

(4) The requirements to perform the surveillances is not applicable, if Table 3.3-12 list the INSTRUMENT MINIMUM CHANNELS OPERABLE as not applicable (N.A.). (Reference CR 99-0361, PMAI 99-04-106). /R21

INSTRUMENTATION

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

CONTROLS

3.3.3.10 In accordance with St. Lucie Plant TS 6.8.4.f.1), the radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.3-13 shall be OPERABLE with their Alarm/Trip Setpoints set to ensure that the limits of Control 3.11.2.1.are not exceeded. The Alarm/Trip Setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the ODCM.

APPLICABILITY: As shown in Table 3.3-13

ACTION:

a. With a radioactive gaseous effluent monitoring instrumentation channel Alarm/Trip Setpoint less conservative than required by the above control, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable or change the setpoint so it is acceptably conservative.

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION shown in Table 3.3-13. Restore the inoperable instrumentation to OPERABLE status within 30 days and, if unsuccessful, explain in the next Annual Radioactive Effluent Release Report why this inoperability was not corrected in a timely manner.

c. Report all deviations in the Annual Radioactive Effluent Release Report.

SURVEILLANCE REQUIREMENTS

4.3.3.10 Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST at the frequencies shown in Table 4.3-9.

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TABLE 3.3-13

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
1. Waste Gas Holdup System			
a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	1/Rx	*	45
2. Condenser Evacuation System			
a) Noble Gas Activity Monitor	1/Rx	**	47
3. Plant Vent System			
a) Noble Gas Activity Monitor (Low Range)	1/Rx	*	47
b) Iodine Sampler	1/Rx	*	51
c) Particulate Sampler	1/Rx	*	51
d) Flow Rate Monitor	N.A.	*	53
e) Sampler Flow Rate Monitor	1/Rx	*	46
4. Fuel Storage Area Ventilation System			
a) Noble Gas Activity Monitor (Low Range)	1/Rx	*	47
b) Iodine Sampler	1/Rx	*	51
c) Particulate Sampler	1/Rx	*	51
d) Flow Rate Monitor	N.A.	*	53
e) Sampler Flow Rate Monitor	1/Rx	*	46

TABLE 3.3-13 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS OPERABLE	APPLICABILITY	ACTION
5. Laundry Area Ventilation System			
a) Noble Gas Activity Monitor (Low Range)	1/Rx	*	47
b) Iodine Sampler	1/Rx	*	51
c) Particulate Sampler	1/Rx	*	51
d) Flow Rate Monitor	N.A.	*	53
e) Sampler Flow Rate Monitor	1/Rx	*	46
6. Steam Generator Blowdown Building Vent			
a) Noble Gas Activity Monitor (Low Range)	1	*	47
b) Iodine Sampler	1	*	51
c) Particulate Sampler	1	*	51
d) Flow Rate Monitor	N.A.	*	53
e) Sampler Flow Rate Monitor	1	*	46

TABLE 3.3-13 (Continued)
TABLE NOTATIONS

*	- At all times while making releases via this pathway
**	- At all times when air ejector exhaust is not directed to plant vent.
Rx	- Denotes reactor

ACTION STATEMENTS

ACTION 45 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, the contents of the tank(s) may be released to the environment for up to 14 days provided that prior to initiating a release:

a. At least two independent samples of the tank's contents are analyzed and

b. At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup.

Otherwise, suspend release of radioactive effluents via this pathway.

ACTION 46 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

ACTION 47 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE, effluent releases via this pathway may continue for up to 30 days provided:

a. If channel inoperability is due to loss of activity indication, Then grab samples are taken at least once per 8 hours and these samples are analyzed for isotopic activity within 24 hours.

OR

b. If channel inoperability is due to loss of Control Room alarm annunciation discovered during a channel functional test because of any one or more of the following reasons listed, Then channel checks are performed once per hour to verify normal indication and current assigned setpoints are NOT exceeded.

   1. Failure to annunciate when testing alarm/trip setpoints.

   2. Circuit failure.

   3. Downscale failure.

   4. Controls NOT set in OPERATE mode.

TABLE 3.3-13 (Continued)
TABLE NOTATIONS

ACTION STATEMENTS
(continued)

ACTION 51 - With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via the affected pathway may continue for up to 30 days provided samples are continuously collected with auxiliary sampling equipment as required in Table 4.11-2.

ACTION 53 - Maximum system flows shall be utilized in the determination of the instantaneous release monitor alarm setpoint.

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TABLE 3.3-14
RADIOACTIVE EFFLUENT MONITOR SETPOINT BASIS

ODCM Effluent Gas Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1PV LOW RANGE GAS	01-05	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
1FHB LOW RANGE GAS	04-05	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
2A PV PIG LOW RANGE GAS	423	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g] For Plant Vent #2
2B PV PIG LOW RANGE GAS	433	C-200[a]	5 x Bkg.	
2PV WRGM LOW RANGE GAS	621	C-200[a]	5 x Bkg.	
2FHB LOW RANGE GAS	413	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
SGBDB LOW RANGE GAS	45-6	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
1 CONDENSER AIR EJECTOR	35	C-200	2 x Bkg.[b]	3 x Bkg.
2 CONDENSER AIR EJECTOR	403	C-200	2 x Bkg.[b]	3 x Bkg.
1 BATCH GAS EFFLUENT	42	C-200[a]	As Per COP-01.06	As Per COP-01.06[a,h]
2 BATCH GAS EFFLUENT	203	C-200[a]	As Per COP-01.06	As Per COP-01.06[a,h]

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ODCM Related Particulate Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1PV PARTICULATE	01-01	FUSAR	5000 CPM	10,000 CPM[c]
1FHB PARTICULATE	04-01	FUSAR & TS[d]	5000 CPM	10,000 CPM[c]
2A PV PIG PARTICULATE	421	FUSAR	5000 CPM	10,000 CPM[c]
2B PV PIG PARTICULATE	431	FUSAR	5000 CPM	10,000 CPM[c]
2FHB PARTICULATE	411	FUSAR & TS[d]	5000 CPM	10,000 CPM[c]
SGBDB PARTICULATE	45-4	FUSAR	5000 CPM	10,000 CPM[c]

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TABLE 3.3-14 (continued)
RADIOACTIVE EFFLUENT MONITOR SETPOINT BASIS

ODCM Related Iodine Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1PV IODINE	01-03	FUSAR	5000 CPM	10,000 CPM[c]
1FHB IODINE	04-03	FUSAR	5000 CPM	10,000 CPM[c]
2A PV PIG IODINE	422	FUSAR	5000 CPM	10,000 CPM[c]
2B PV PIG IODINE	432	FUSAR	5000 CPM	10,000 CPM[c]
2FHB IODINE	412	FUSAR	5000 CPM	10,000 CPM[c]
SGBDB IODINE	45-5	FUSAR	5000 CPM	10,000 CPM[c]

ODCM Related Liquid Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1A S/G BLOWDOWN	44	C-200	2 x Bkg.	2.E-04 uCi/ml[f,m]
1B S/G BLOWDOWN	45	C-200	2 x Bkg.	2.E-04 uCi/ml[f,m]
2A S/G BLOWDOWN	121	C-200	2 x Bkg.	2.E-04 uCi/ml[m]
2B S/G BLOWDOWN	122	C-200	2 x Bkg.	2.E-04 uCi/ml[m]
1 BATCH LIQUID EFFLUENT	R6627	C-200	As Per COP-01.05	As Per COP-01.05[n]
2 BATCH LIQUID EFFLUENT	301	C-200	As Per COP-01.05	As Per COP-01.05[n]

Table Notations:

a - ODCM Control 3.11.2.1a

b - ODCM Table 4.11-1 Note (7)

c - ODCM Control 3.11.2.1.b

d - TS Table 3.3-6 required instrument 2.a.ii with setpoint per ODCM

e - Setpoints may be rounded for analog and digital display input limitations.

f - The channel setpoint to be in cpm equivalent to this activity

g - per ODCM Methodology Step 2.2.2

h - Batch Gaseous Release Rate and Maximum activity limits shall be used such that Plant Vent (PV) Release HIGH setpoints should not be exceeded.

i, j, k, and l not used in notation for clarity

m - Continuous Liquid setpoint methodology per ODCM 1.3.2

n - Batch liquid setpoint methodology per ODCM 1.3.1

FUSAR - Channel listed in fusar, but not required by ODCM Control 3.3.10 Table 3.3-13. The setpoints are used to provide alarm well before exceeding ODCM Control 3.11.2.1.b Site Dose Rate Limit. The inoperability of a fusar channel above does not involve an ACTION statement unless TS (Technical Specification) is noted.

2 x Bkg., 3 x Bkg., 5 x Bkg. etc., denotes the number of times the normal channel reading is the appropriate Alarm Setting. These type of setpoints should be periodically evaluated to insure alarm sensitivity is maintained as per COP-07.05.

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TABLE 4.3-9

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS (4) /R21

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	Modes in which surveillance required
1. Waste Gas Holdup System					
a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	P	P	R (3)	Q (1)	*
2. Condenser Evacuation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	**
3. Plant Vent System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*
4. Fuel Storage Area Ventilation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*

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TABLE 4.3-9 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING
INSTRUMENTATION SURVEILLANCE REQUIREMENTS (4) /R21

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	Modes in which surveillance required
5. Laundry Area Ventilation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*
6. Steam Generator Blowdown Building Vent					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*

TABLE 4.3-9 (Continued)

TABLE NOTATIONS

* - At all times when making releases via this pathway.

** - At all times when air ejector exhaust is not directed to plant vent.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards traceable to the National Institute of Standards & Technology (NIST) or using standards that have been calibrated against standards certified by the NIST. These standards should permit calibrating the system over its intended range of energy and rate capabilities that are typical of normal plant operation. For subsequent CHANNEL CALIBRATION, button sources that have been related to the initial calibration may be used.

(4) The requirements to perform the surveillances is not applicable, if Table 3.3-13 list the INSTRUMENT MINIMUM CHANNELS OPERABLE as not applicable (N.A.). (Reference CR 99-0361, PMAI 99-04-106). /R21

3/4.11 RADIOACTIVE EFFLUENTS

3/4.11.1 LIQUID EFFLUENTS

CONCENTRATION

CONTROLS

3.11.1.1 In accordance with the St. Lucie Plant TS 6.8.4.f.2) and 3), the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS (see TS Figure 5.1-1) shall be limited to ten times the concentrations specified in 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.E-04 micro-Curie/ml total activity.

APPLICABILITY: At all times.

ACTION:

a. With the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS exceeding the above limits, immediately restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 4.11-1.

4.11.1.1.2 The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in the ODCM to assure that the concentrations at the point of release are maintained within the limits of Control 3.11.1.1.

4.11.1.1.3 Post-release analyses of samples composited from batch releases shall be performed in accordance with Table 4.11-1 and results of the previous post-release analyses shall be used with the calculational methods in the ODCM to assure that the concentrations at the point of release were maintained within the limits of Control 3.11.1.1.

TABLE 4.11-1 RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection LLD (1) (µCi/ml)
A. Batch Waste Release Tanks (2)	P Each Batch	Each Batch	P.G.E. (3)	5.E-07
			I-131	1.E-06
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	P Each Batch	M Composite (4)	H-3	1.E-05
			Gross Alpha	1.E-07
	P Each Batch	Q Composite (4)	Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06
B. Continuous Releases (5, 6)	Daily	4/M Composite	P.G.E.(3)	5.E-07
			I-131	1.E-06
	Daily Grab Sample	4/M Composite	Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	Daily	M Composite	H-3	1.E-05
			Gross Alpha	1.E-07
	Daily	Q Composite	Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06
C. Settling Basin (7)	W Grab Sample	W	P.G.E. (3)	5.E-07
			I-131	1.E-06
D. Settling Basin as a Batch Release Pathway. (Reference CR 99-1165 PMAI 99-08-084	P Each Batch (8)	Each Batch	P.G.E. (3)	5.E-07
			I-131	1.E-06
			Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	Each Batch	Each Batch	H-3	1.E-05
			Gross Alpha	1.E-07
			Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06

/R21

P.G.E. - Denotes Principal Gamma Emitter

TABLE 4.11-1 (Continued)

TABLE NOTATION

(1) The LLD is defined for purposes of these controls, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22E{+}06 \cdot Y \cdot \exp(-\lambda \cdot \Delta T)}$$

Where:

LLD	=	the a priori lower limit of detection (micro-Curie per unit mass or volume),
S_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),
E	=	the counting efficiency (counts per disintegration),
V	=	the sample size (units of mass or volume),
2.22E+06	=	the number of disintegrations per minute per micro-Curie.,
Y	=	the fractional radiochemical yield, when applicable,
λ	=	the radioactive decay constant for the particular radionuclide (sec^{-1}) and
ΔT	=	the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y and ΔT should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

TABLE 4.11-1 (Continued)

TABLE NOTATIONS (Continued)

(2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

(3) The principal gamma emitters for which the LLD control applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137 and Ce-141 and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Control 3.11.2.6 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(4) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(5) A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(6) If Component Cooling Water activity is > 1.E-5 μCi/ml, perform a weekly gross activity on the Intake Cooling Water System outlet to ensure the activity level is less than or equal to 2.E-07 μCi/ml LLD limit. If ICW is >2.E-07 μCi/ml, perform analysis in accordance with a Plant Continuous Release on this Table.

(7) Grab samples to be taken when there is confirmed primary to secondary system leakage indicated by the air ejector monitor indicating greater than or equal to 2x background.

(8) At least two independent samples are analyzed in accordance with the surveillance requirement for concentration limit of control 4.11.1.1.1 and at least two technically qualified members of the facility staff independently verify the release rate calculations. /R21

RADIOACTIVE EFFLUENTS

DOSE

CONTROLS

3.11.1.2 In accordance with St. Lucie Plant TS 6.8.4.f.4) and 6.8.4.f.5), the dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each unit, to UNRESTRICTED AREAS (see TS Figure 5.1-1) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrems to the whole body and to less than or equal to 5 mrems to any organ and

b. During any calendar year to less than or equal to 3 mrems to the whole body and to less than or equal to 10 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.11.1.2 Cumulative dose contributions from liquid effluents for the current calendar quarter and the current calendar year shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

LIQUID RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.1.3 In accordance with St. Lucie Plant TS 6.8.4.f.6), the Liquid Radwaste Treatment System shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see TS Figure 5.1-1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31-day period.

APPLICABILITY: At all times.

ACTION:

a. With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that includes the following information:

    1. Explanation of why liquid radwaste was being discharged without treatment, identification of any inoperable equipment or subsystems and the reason for the inoperability,

    2. Action(s) taken to restore the inoperable equipment to OPERABLE status and

    3. Summary description of action(s) taken to prevent a recurrence.

SURVEILLANCE REQUIREMENTS

4.11.1.3.1 Doses due to liquid releases from each unit to UNRESTRICTED AREAS shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when Liquid Radwaste Treatment Systems are not being fully utilized.

4.11.1.3.2 The installed Liquid Radwaste Treatment System shall be demonstrated OPERABLE by operating the liquid radwaste treatment system equipment for at least 30 minutes at least once per 92 days unless the liquid radwaste system has been utilized to process radioactive liquid effluents during the previous 92 days.

RADIOACTIVE EFFLUENTS

3/4.11.2 GASEOUS EFFLUENTS

DOSE RATE

CONTROLS

3.11.2.1 In accordance with St. Lucie Plant TS 6.8.4.f.3) and 7), the dose rate resulting from radioactive materials released in gaseous effluents to areas at or beyond the SITE BOUNDARY (see TS Figure 5.1-1) shall be limited to the following:

a. For noble gases: Less than or equal to 500 mrems/yr to the total body and less than or equal to 3000 mrems/yr to the skin and

b. For Iodine-131, for Iodine-133, for tritium and for all radionuclides in particulate form with half-lives greater than 8 days: Less than or equal to 1500 mrems/yr to any organ

APPLICABILITY: At all times.

ACTION:

a. With the dose rate(s) exceeding the above limits, immediately restore the release rate to within the above limit(s).

SURVEILLANCE REQUIREMENTS

4.11.2.1.1 The dose rate due to noble gases in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM.

4.11.2.1.2 The dose rate due to Iodine-131, Iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the above limits in accordance with the methodology and parameters in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.11-2.

TABLE 4.11-2 RADIOACTIVE GASEOUS WASTE SAMPLING & ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (1) (µCi/cc)
1. Waste Gas Storage Tank	P Each Tank Grab Sample	P Each Tank	Noble Gas P.G.E. (2)	1.E-04
2. Containment Purge	P Each Purge (6) Grab Sample	P Each Purge (6) (7)	Noble Gas P.G.E. (2)	1.E-04
			H-3	1.E-06
3. Vents: a. Plant b. Fuel Bldg (5) c. Laundry d. S/G Blowdown Bldg.	4/M Grab Sample	4/M (7)	Noble Gas P.G.E. (2)	1.E-04
			H-3	1.E-06
4. All Release Types as listed in 3. above	Continuous (3)	4/M Charcoal Sample (4)	I-131	1.E-12
		4/M Particulate Sample (4)	P.G.E.	1.E-11
		M Composite Particulate Sample	Gross Alpha	1.E-11
		Q Composite Particulate Sample	Sr-89, Sr-90	1.E-11
		Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1.E-06

P.G.E. - Denotes Principal Gamma Emitters

TABLE 4.11-2 (Continued)

TABLE NOTATIONS

(1) The LLD is defined for purposes of these controls, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22E{+}06 \cdot Y \cdot \exp(-\lambda \cdot \Delta T)}$$

Where:

LLD	=	the a priori lower limit of detection (micro-Curie per unit mass or volume),
S_b	=	the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),
E	=	the counting efficiency (counts per disintegration),
V	=	the sample size (units of mass or volume),
2.22E+06	=	the number of disintegrations per minute per micro-Curie.,
Y	=	the fractional radiochemical yield, when applicable,
λ	=	the radioactive decay constant for the particular radionuclide (sec^{-1}) and
ΔT	=	the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y and ΔT should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

TABLE 4.11-2 (Continued)

TABLE NOTATIONS (Continued)

(2) The principal gamma emitters for which the LLD control applies include the following radionuclides: Kr-87,Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 in noble gas releases and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141 and Ce-144 in Iodine and particulate releases. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Control 3.11.2.6 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(3) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Controls 3.11.2.1, 3.11.2.2 and 3.11.2.3.

(4) Samples shall be changed at least four times per month and analyses shall be completed within 48 hours after changing or after removal from sampler. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or THERMAL POWER change exceeding 15% of RATED THERMAL POWER within a 1-hour period and analyses shall be completed within 48 hours of changing. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement does not apply if: (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the reactor coolant has not increased more than a factor of 3; and (2) the noble gas monitor shows that effluent activity has not increased by more than a factor of 3.

(5) Tritium grab samples shall be taken at least 4/M from the ventilation exhaust from the spent fuel pool area, whenever spent fuel is in the spent fuel pool.

(6) Sampling and analysis shall also be performed following shutdown, startup or a THERMAL POWER change exceeding 15% of RATED THERMAL POWER within 1 hour unless (1) analysis shows that the DOSE EQUIVALENT I-131 concentration in the primary coolant has not increased more than a factor of 3; and (2) the noble gas activity monitor shows that effluent activity has not increased by more than a factor of 3.

(7) Tritium analysis may be delayed for up to 14 days if the LLD is still attainable at the new counting time.

RADIOACTIVE EFFLUENTS

DOSE - NOBLE GASES

CONTROLS

3.11.2.2 In accordance with St. Lucie Plant TS 6.8.4.f.5) and 8), the air dose due to noble gases released in gaseous effluents, from each unit, to areas at and beyond the SITE BOUNDARY (see TS Figure 5.1-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation and

b. During any calendar year: Less than or equal to 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation.

APPLICABILITY: At all times.

ACTION:

a. With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.11.2.2 Cumulative dose contributions for the current calendar quarter and current calendar year for noble gases shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIOACTIVE MATERIAL IN PARTICULATE FORM

CONTROLS

3.11.2.3 In accordance with St. Lucie Plant TS 6.8.4.f.5) and 9), the dose to a MEMBER OF THE PUBLIC from Iodine-131, Iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released, from each unit, to areas at and beyond the SITE BOUNDARY (see TS Figure 5.1-1) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrems to any organ and,

b. During any calendar year: Less than or equal to 15 mrems to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.11.2.3 Cumulative dose contributions for the current calendar quarter and current calendar year for Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days shall be determined in accordance with the methodology and parameters in the ODCM at least once per 31 days.

RADIOACTIVE EFFLUENTS

GASEOUS RADWASTE TREATMENT SYSTEM

CONTROLS

3.11.2.4 In accordance with St. Lucie Plant TS 6.8.4.f.6), the VENTILATION EXHAUST Treatment System and the WASTE GAS HOLDUP SYSTEM shall be OPERABLE and appropriate portions of the system shall be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see TS Figure 5.1-1) would exceed:

a. 0.2 mrad to air from gamma radiation or

b. 0.4 mrad to air from beta radiation or

c. 0.3 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

a. With radioactive gaseous waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that includes the following information:

   1. Identification of any inoperable equipment or subsystems and the reason for the inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status and

   3. Summary description of action(s) taken to prevent a recurrence.

RADIOACTIVE EFFLUENTS

GASEOUS RADWASTE TREATMENT SYSTEM (Continued)

SURVEILLANCE REQUIREMENTS

4.11.2.4.1 Doses due to gaseous releases from each unit to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM when Gaseous Radwaste Treatment Systems are not being fully utilized.

4.11.2.4.2 The installed VENTILATION EXHAUST TREATMENT SYSTEM and WASTE GAS HOLDUP SYSTEM* shall be demonstrated OPERABLE by operating the WASTE GAS HOLDUP SYSTEM equipment and VENTILATION EXHAUST TREATMENT SYSTEM equipment for at least 30 minutes, at least once per 92 days unless the appropriate system has been utilized to process radioactive gaseous effluents during the previous 92 days.

* - If the WASTE GAS HOLDUP SYSTEM is not being fully utilized, an Administrative FUNCTIONAL TEST on the WASTE GAS HOLDUP SYSTEM shall also be performed (in addition to the requirements of 4.11.2.4.2's "at least 30 minutes") once per 92 days, by performing the following:

1) Place a Gas Decay Tank (containing less than 30 psi) in service.

2) With a Waste Gas Compressor, charge the Gas Decay Tank to at least 150 psi.

3) Following appropriate holdup decay time, sample and release the Gas Decay Tank with an OPERABLE Waste Gas Holdup System Noble Gas Activity Monitor (per TABLE 3.3-13).

4) If discrepancies exist, repairs shall be made and the WASTE GAS HOLDUP SYSTEM Administrative FUNCTIONAL TEST shall be repeated until completed successfully.

RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE

CONTROLS

3.11.4 In accordance with St. Lucie Plant TS 6.8.4.f.10), the annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to less than or equal to 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems.

APPLICABILITY: At all times.

ACTION:

a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Control 3.11.1.2.a, 3.11.1.2.b, 3.11.2.2.a, 3.11.2.2.b, 3.11.2.3.a or 3.11.2.3.b, calculations shall be made including direct radiation contributions from the units (including outside storage tanks etc.) to determine whether the above limits of Control 3.11.4 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the above limits and includes the schedule for achieving conformance with the above limits. This Special Report, as defined in Subpart M of 10 CFR Part 20, shall include an analysis that estimates the radiation exposure (dose) to a MEMBER OF THE PUBLIC from uranium fuel cycle sources, including all effluent pathways and direct radiation, for the calendar year that includes the release(s) covered by this report. It shall also describe levels of radiation and concentrations of radioactive material involved and the cause of the exposure levels or concentrations. If the estimated dose(s) exceeds the above limits and if the release condition resulting in violation of 40 Part 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR Part 190. Submittal of the report is considered a timely request and a variance is granted until staff action on the request is complete.

RADIOACTIVE EFFLUENTS

3/4.11.4 TOTAL DOSE (Continued)

SURVEILLANCE REQUIREMENTS

4.11.4.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Controls 4.11.1.2, 4.11.2.2 and 4.11.2.3 and in accordance with the methodology and parameters in the ODCM.

4.11.4.2 Cumulative dose contributions from direct radiation from the units (including outside storage tanks etc.) shall be determined in accordance with the methodology and parameters in the ODCM. This requirement is applicable only under conditions set forth in ACTION a. of Control 3.11.4.

RADIOACTIVE EFFLUENTS

3/4.11.5 MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS AND SOLID WASTE TREATMENT SYSTEMS*

ADMINISTRATIVE CONTROLS

3.11.2.5 Licensee initiated major changes to the radioactive waste systems (liquid, gaseous and solid):

1) Shall be reported to the Commission in the Annual Radioactive Effluent Release Report for the period in which the evaluation was reviewed by the Facility Review Group (FRG). The discussion of each shall contain:

   a) A summary of the evaluation that led to the determination that the change could be made in accordance with 10 CFR 50.59.
   b) Sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;
   c) A detailed description of the equipment, components and processes involved and the interfaces with other plant systems;
   d) An evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste that differ from those previously predicted in the license application and amendments thereto;
   e) An evaluation of the change which shows the expected maximum exposure to individuals in the UNRESTRICTED AREA and to the general population that differ from those previously estimated in the license application and amendments thereto;
   f) A comparison of the predicted releases of radioactive materials, in liquid and gaseous effluents and in solid waste, to the actual releases for the period when the changes are to be made;
   g) An estimate of the exposure to plant operating personnel as a result of the change; and
   h) Documentation of the fact that the change was reviewed and found acceptable by the FRG.

2) Shall become effective upon review and acceptance by the FRG.

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* Licensees may choose to submit the information called for in this Administrative Control as part of the annual FUSAR update.

RADIOACTIVE EFFLUENTS

3/4.11.6 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT TO THE COMMISSION*

ADMINISTRATIVE CONTROLS

3.11.2.6 As per Technical Specification 6.9.1.7, a Annual Radioactive Effluent Release Report covering the operation of each unit during the previous 12 months of operation shall be submitted within 60 days after January 1 of each year. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from each unit. The material provided shall be (1) consistent with the objectives outlined in by items a) through f) below, using the example report format in the ODCM and (2) be in conformance with 10 CFR 50.36a and Section IV.B.1 of Appendix I to 10 CFR Part 50.

a. The Radioactive Effluent Release Reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit as outlined in Regulatory Guide 1.21, Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

b. The Radioactive Effluent Release Report to be submitted within 60 days after January 1 of each year shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary may be either in the form of an hour-by-hour listing on magnetic tape of wind speed, wind direction, atmospheric stability and precipitation (if measured) or in the form of joint frequency distributions of wind speed, wind direction and atmospheric stability.** This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the unit or station during the

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* - A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

** - In lieu of submission with the Radioactive Effluent Release Report, the licensee has the option of retaining this summary of required meteorological data on site in a file that shall be provided to the NRC upon request.

RADIOACTIVE EFFLUENTS

3/4.11.6 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT TO THE COMMISSION (Continued)

ADMINISTRATIVE CONTROLS

3.11.2.6 (Continued)

b. (Continued)

previous calendar year. This same report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY (see TS Figure 5.1-1) during the report period. All assumptions used in making these assessments, i.e., specific activity, exposure time and location, shall be included in these reports. The meteorological conditions concurrent with the time of release of radioactive materials in gaseous effluents, as determined by sampling frequency and measurement, shall be used for determining the gaseous pathway doses. The assessment of radiation doses shall be performed in accordance with the methodology and parameters in the ODCM.

c. Every 2 years using the previous 6 months release history for isotopes, determine the controlling age group for liquid pathways. Every 2 years using the previous 1 year or longer interval (to include a refueling outage) and historical meteorological data determine the controlling age group for gaseous pathways. If changed from current submit change to ODCM to reflect new tables for these groups and use the new groups in subsequent dose calculations.

d. The Radioactive Effluent Release Report to be submitted 60 days after January 1 of each year shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases for the previous calendar year. Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in Regulatory Guide 1.109 March 1976.

RADIOACTIVE EFFLUENTS

3/4.11.6 ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT TO THE COMMISSION (Continued)

ADMINISTRATIVE CONTROLS

3.11.2.6 (Continued)

e. The Radioactive Effluent Release Reports shall include the following information for each class of solid waste (as defined by 10 CFR Part 61) shipped offsite during the report period:
   1. Volume
   2. Total Curie quantity (specify whether determined by measurement or estimate)
   3. Principal radionuclides (specify whether determined by measurement or estimate)
   4. Type of waste (e.g., dewatered spent resin, compacted dry waste, evaporator bottoms)
   5. Type of container (e.g., LSA, Type A, Type B, Large Quantity) and
   6. Solidification agent or absorbent (e.g., cement, urea formaldehyde).

f. The Radioactive Effluent Release Reports shall include a list and description of unplanned releases from the site to UNRESTRICTED AREAS of radioactive materials in gaseous and liquid effluents made during the reporting period.

g. The Radioactive Effluent Release Reports shall include any changes made during the reporting period to the PROCESS CONTROL PROGRAM (PCP) and to the OFFSITE DOSE CALCULATION MANUAL (ODCM), as well as a listing of new locations for dose calculations and/or environmental monitoring identified by the Land Use Census of ODCM Control 3.12.2.

h. The format for an Annual Radioactive Effluent Release Report is provided in ODCM Methodology Section 4.0. The information contained in an annual report shall not apply to any ODCM Control Dose Limit(s) since the methodology for the annual report is based on actual meteorological data, instead of historical conditions that the ODCM Controls and Control required calculations are based on.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

CONTROLS

3.12.1 In accordance with St. Lucie Plant TS 6.8.4.g.1), the Radiological Environmental Monitoring Program shall be conducted as specified in Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

a. With the Radiological Environmental Monitoring Program not being conducted as specified in Table 3.12-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report required by Control 3.12.4, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the confirmed* level of radioactivity as the result of plant effluents in an environmental sampling medium at a specified location exceeding the reporting levels of Table 3.12-2 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days, pursuant to Plant TS 6.9.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce radioactive effluents so that the potential annual dose** to a MEMBER OF THE PUBLIC is less than the calendar year limit of Controls 3.11.1.2, 3.11.2.2 or 3.11.2.3. When more than one of the radionuclides in Table 3.12-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{concentration\ (1)}{reporting\ level\ (1)} + \frac{concentration\ (2)}{reporting\ level\ (2)} + \ > or = 1.0$$

When radionuclides other than those in Table 3.12-2 are

* A confirmatory reanalysis of the original, a duplicate or a new sample may be desirable, as appropriate. The results of the confirmatory analysis shall be completed at the earliest time consistent with the analysis but in any case within 30 days.

** The methodology and parameters used to estimate the potential annual dose to a MEMBER OF THE PUBLIC shall be indicated in this report.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.1 MONITORING PROGRAM

Controls (Continued)

Action b. (Continued)

detected and are the result of plant effluents, this report shall be submitted if the potential annual dose, to a MEMBER OF THE PUBLIC from all radionuclides is equal to or greater than the calendar year limits of Control 3.11.1.2, 3.11.2.2 or 3.11.2.3. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report required by Control 3.12.4.

c. With milk or broad leaf vegetation samples unavailable from one or more of the sample locations required by Table 3.12-1, identify specific locations for obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Control 3.11.2.6, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.

SURVEILLANCE REQUIREMENTS

4.12.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.12-1 from the specific locations given in the table and figure(s) in the ODCM and shall be analyzed pursuant to the requirements of Table 3.12-1 and the detection capabilities required by Table 4.12-1.

TABLE 3.12-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a)]

EXPOSURE PATHWAY and/or SAMPLE	NUMBER OF REPRESENTATIVE SAMPLES AND SAMPLE LOCATIONS[b) c)]	SAMPLING AND COLLECTION FREQUENCY[d)]	TYPE AND FREQUENCY [d)] OF ANALYSIS
1. Direct Radiation[e)]	27 Monitoring Locations	Continuous monitoring with sample collection quarterly [f)]	Gamma exposure rate - quarterly
2. Airborne Radioiodine and Particulates	5 Locations	Continuous sampler operation with sample collection weekly or more frequently if required by dust loading	Radioiodine filter: I-131 analysis weekly Particulate Filter: Gross beta radioactivity analysis ≥24 hours following a filter change[g)] Gamma isotopic[h)] analysis of composite [g)] (by location) quarterly
3. Waterborne			
a) Surface[k)]	1 Location[m)]	Weekly	Gamma isotopic[h)] & tritium analyses weekly
	1 Location[n)]	Monthly	Gamma isotopic[h)] & tritium analyses monthly
b) Sediment from shoreline	2 Locations	Semiannually	Gamma isotopic[h)] analyses semiannually
4. Ingestion			
a) Fish and Invertebrates			
1) Crustacea	2 Locations	Semiannually	Gamma isotopic[h)] analyses semiannually
2) Fish	2 Locations	Semiannually	Gamma isotopic [h)] analyses semiannually
b) Food Products			
1) Broad leaf vegetation	3 Locations[p)]	Monthly when available	Gamma isotopic[h)] and I-131 analyses monthly

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 3.12-1 (Continued)

TABLE NOTATIONS

a. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment or other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, corrective action shall be taken prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

b. Specific parameters of distance and direction sector from the centerline of one reactor and additional description where pertinent, shall be provided for each sample location required by Table 3.12-1, in Appendix-E and applicable figures.

c. At times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program.

d. The following definition of frequencies shall apply to Table 3.12-1 only:

Weekly -	Not less than once per calendar week. A maximum interval of 11 days is allowed between the collection of any two consecutive samples.
Semi-Monthly -	Not less than 2 times per calendar month with an interval of not less than 7 days between sample collections. A maximum interval of 24 days is allowed between collection of any two consecutive samples.
Monthly -	Not less than once per calendar month with an interval of not less than 10 days between sample collections.
Quarterly -	Not less than once per calendar quarter.
Semiannually -	One sample each between calendar dates (January 1 - June 30) and (July 1 - December 31). An interval of not less than 30 days will be provided between sample collections.

The frequency of analyses is to be consistent with the sample collection frequency.

TABLE 3.12-1 (Continued)

TABLE NOTATIONS (Continued)

e. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of or in addition to, integrating dosimeters. For purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters.

f. Refers to normal collection frequency. More frequent sample collection is permitted when conditions warrant.

g. Airborne particulate sample filters are analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. In addition to the requirement for a gamma isotopic on a composite sample a gamma isotopic is also required for each sample having a gross beta radioactivity which is >1.0 pCi per cubic meters and which is also >10 times that of the most recent control sample.

h. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

k. Discharges from the St. Lucie Plant do not influence drinking water or ground water pathways.

m. Atlantic Ocean, in the vicinity of the public beaches along the eastern shore of Hutchinson Island near the St. Lucie Plant (grab sample)

n. Atlantic Ocean, at a location beyond influence from plant effluents (grab sample).

p. Samples of broad leaf vegetation grown nearest each of two different offsite locations of highest predicted annual average ground level D/Q and one sample of similar broad leaf vegetation at an available location 15-30 kilometers distant in the least prevalent wind direction based upon historical data in the ODCM.

[i, j, l (lower case) and o are not used on notation for clarity reasons]

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 3.12-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

REPORTING LEVELS

ANALYSIS	WATER pCi/l	AIRBORNE PARTICULATE OR GASES pCi/m^3	FISH pCi/kg, wet	MILK pCi/l	FOOD PRODUCTS pCi/kg, wet
H-3	30,000*				
Mn-54	1,000		30,000		
Fe-59	400		10,000		
Co-58	1,000		30,000		
Co-60	300		10,000		
Zn-65	300		20,000		
Zr-Nb-95***	400				
I-131	2**	0.9		3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-La-140***	200			300	

l - as in pCi/l denotes liter

* - Since no drinking water pathway exists, a value of 30,000 pCi/l is used. For drinking water samples, a value of 20,000 pCi/l is used; this is 40 CFR Part 141 value.

** - Applies to drinking water pathway exists, 2 pCi/l is the limit for drinking water.

*** - An equilibrium mixture of the parent daughter isotopes which corresponds to the reporting value of the parent isotope.

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 4.12-1

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS(1) (2)

LOWER LIMIT OF DETECTION (LLD)(3)

ANALYSIS	WATER pCi/l	AIRBORNE PARTICULATE OR GASES pCi/m^3	FISH pCi/kg, wet	MILK pCi/l	FOOD PRODUCTS pCi/kg, wet	SEDIMENT pCi/kg, dry
Gross Beta	4	0.01				
H-3	3000*					
Mn-54	15		130			
Fe-59	30		260			
Co-58, Co-60	15		130			
Zn-65	30		260			
Zr-95, Nb-95(4)	15					
I-131	1**	0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140, La-140(4)	15			15		

* No drinking water pathway exists, a value of 2000 pCi/l is for drinking water.

** LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

TABLE 4.12-1 (Continued)

TABLE NOTATIONS

(1) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

(2) Required detection capabilities for thermoluminescent dosimeters used for environmental measurements are given in Regulatory Guide 4.13.

(3) The LLD is defined for purposes of these controls, as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal.

For a particular measurement system, which may include radiochemical separation:

$$LLD = \frac{4.66\ S_b}{E \cdot V \cdot 2.22 \cdot Y \cdot \exp(-\lambda \cdot \Delta T)}$$

Where:

LLD = the a priori lower limit of detection (pico-Curie per unit mass or volume),

S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E = the counting efficiency (counts per disintegration),

V = the sample size (units of mass or volume),

2.22 = the number of disintegrations per minute per pico-Curie,

Y = the fractional radiochemical yield, when applicable,

λ = the radioactive decay constant for the particular radionuclide (sec^{-1}) and

ΔT = the elapsed time between the midpoint of sample collection and the time of counting (sec).

Typical values of E, V, Y and ΔT should be used in the calculation.

TABLE 4.12-1 (Continued)

TABLE NOTATIONS (Continued)

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

(4) An equilibrium mixture of the parent and daughter isotopes which corresponds to 15 pCi/Liter of the parent isotope.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS

CONTROLS

3.12.2 In accordance with St. Lucie Plant TS 6.8.4.g.2), a Land Use Census shall be conducted and shall identify within a distance of 8 km (5 miles) the location in each of the 16 meteorological sectors of the nearest milk animal, the nearest residence and the nearest garden* of greater than 50 square meters (500 square feet) producing broad leaf vegetation.

APPLICABILITY: At all times.

ACTION:

a. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Control 4.11.2.3, pursuant to Control 3.11.2.6, identify the new location(s) in the next Annual Radioactive Effluent Release Report.

b. With a Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20% greater than at a location from which samples are currently being obtained in accordance with Control 3.12.1, add the new location(s) within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s), via the same exposure pathway, may be deleted from this monitoring program after October 31 of the year in which this Land Use Census was conducted. Pursuant to TS 6.14, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.

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* Broad leaf vegetation sampling may be performed at the SITE BOUNDARY in each of two different direction sectors with the highest predicted D/Qs in lieu of the garden census. Controls for broad leaf vegetation sampling in Table 3.12-1, Part 4.b., shall be followed, including analysis of control samples.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.2 LAND USE CENSUS (Continued)

SURVEILLANCE REQUIREMENTS

4.12.2 The Land Use Census shall be conducted during the growing season at least once per 12 months using that information that will provide the best results, such as by a door-to-door survey, aerial survey or by consulting local agriculture authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 In accordance with St. Lucie Plant TS 6.8.4.g.3), analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program that correspond to samples required by Table 3.12-1. /R21

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above, report the corrective action taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

SURVEILLANCE REQUIREMENTS

4.12.3 A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4. If the Interlaboratory Comparison Program is other than the program conducted by the EPA, then the Interlaboratory Comparison Program shall be described in the ODCM.

/R21

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.4 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR)*

ADMINISTRATIVE CONTROLS

3.12.4 In accordance with St. Lucie Plant TS 6.9.1.8, an Annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted before May 1 of each year. The report shall include summaries, interpretations and information based on trend analysis of the results of the Radiological Environmental Monitoring Program for the reporting period. The material provided in the AREOR shall be consistent with the objectives outlined below and with Sections IV.B.2, IV.B.3 and IV.C of Appendix I to 10 CFR Part 50.

The Annual Radiological Environmental Operating Reports shall include summaries, interpretations and information based on trend analysis of the results of the radiological environmental surveillance activities for the report period, including a comparison, as appropriate, with preoperational studies, with operational controls and with previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of land use census required by Control 3.12.2.

The Annual Radiological Environmental Operating Reports shall include the results of analysis of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the Table and Figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The reports shall also include the following: a summary description of the radiological environmental monitoring program; at least two legible maps** covering all sampling locations keyed to a table giving distances and directions from the centerline of one reactor; the results of the Interlaboratory Comparison Program, required by Control 3.12.3; discussion of all deviations from the sampling schedule of Table 3.12-1; and discussion of all analyses in which the LLD required by Table 4.12-1 was not achievable.

* - A single submittal may be made for multiple unit station.
** - One map shall cover stations near the SITE BOUNDARY; a second shall include the more distant stations.

BASES

for the

CONTROLS

AND

SURVEILLANCE REQUIREMENTS

NOTE
The BASES contained in succeeding pages summarize the reasons for the Controls in Section 3.0 and 4.0, but are not part of these Controls.

INSTRUMENTATION

BASES

3.3.3.9 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluent during actual or potential releases of liquid effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

3.3.3.10 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluent during actual or potential releases of gaseous effluents. The Alarm/Trip Setpoints for these instruments shall be calculated and adjusted in accordance with the methodology and parameters in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

3/4.11 RADIOACTIVE EFFLUENTS

BASES

3/4.11.1 LIQUID EFFLUENTS

3/4.11.1.1 CONCENTRATION

This control is provided to ensure that the concentration of radioactive materials released in liquid waste effluents to UNRESTRICTED AREAS will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water in UNRESTRICTED AREAS will result in exposures within: (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to a MEMBER OF THE PUBLIC and (2) the limits of 10 CFR Part 20. The concentration limit for dissolved or entrained noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its ECL in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

This control applies to the release of radioactive materials in liquid effluents from all units at the site.

The required detection capabilities for radioactive materials in liquid waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in Currie, L.A., Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, NUREG/CR-4007 (September 1984) and in the HASL Procedures Manual, HASL-300.

3/4.11.1.2 DOSE

This control is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix I, 10 CFR Part 50. The Control implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents to UNRESTRICTED AREAS will be kept as low as is reasonably achievable. Also, for fresh water sites with drinking water supplies that can be potentially affected by plant operations, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in the finished drinking water that are in excess of the requirements of 40 CFR Part 141. The dose calculation

3/4.11 RADIOACTIVE EFFLUENTS (Continued)

BASES

3/4.11.1 LIQUID EFFLUENTS (Continued)

3/4.11.1.2 DOSE (Continued)

methodology and parameters in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.113, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, April 1977.

This control applies to the release of radioactive materials in liquid effluents from each unit at the site. For units with shared Radwaste Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system.

3/4.11.1.3 LIQUID RADWASTE TREATMENT SYSTEM

The OPERABILITY of the Liquid Radwaste Treatment System ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept as low as is reasonably achievable. This control implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the Liquid Radwaste Treatment System were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50 for liquid effluents.

This control applies to the release of radioactive materials in liquid effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the liquid effluents from the shared system are to be proportioned among the units sharing that system.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2 GASEOUS EFFLUENTS

3/4.11.2.1 DOSE RATE

This control is provided to ensure that the dose at any time at and beyond the SITE BOUNDARY from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 to UNRESTRICTED AREAS. The annual dose limits are the doses associated with the concentration of 10 CFR Part 20, Appendix B, Table 2, Column I. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of a MEMBER OF THE PUBLIC in an UNRESTRICTED AREA, either within or outside the SITE BOUNDARY, to an annual average concentration exceeding the limits specified in Appendix B, Table 2 of 10 CFR Part 20 (Subpart D of 10 CFR Part 20). For MEMBERS OF THE PUBLIC who may at times be within the SITE BOUNDARY, the occupancy of that MEMBER OF THE PUBLIC will usually be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the SITE BOUNDARY. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to a MEMBER OF THE PUBLIC at or beyond the SITE BOUNDARY to less than or equal to 500 mrems/year to the total body or to less than or equal to 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to a child via the inhalation pathway to less than or equal to 1500 mrems/year.

This control applies to the release of radioactive materials in gaseous effluents from all units at the site.

The required detection capabilities for radioactive materials in gaseous waste samples are tabulated in terms of the lower limits of detection (LLDs). Detailed discussion of the LLD and other detection limits can be found in Currie, L. A., Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, NUREG/CR-4007 (September 1984) and in the HASL Procedures Manual, HASL-300.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.1 DOSE - NOBLE GASES

This control is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The control implements the guides set forth in Section I.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept as low as is reasonably achievable. The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The dose calculation methodology and parameters established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents are consistent with the methodology provided in Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1, July 1977. The ODCM equations provided for determining the air doses at and beyond the SITE BOUNDARY are based upon the historical average atmospheric conditions.

This control applies to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are to be proportioned among the units sharing that system.

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIOACTIVE MATERIAL IN PARTICULATE FORM

This control is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Controls are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents to UNRESTRICTED AREAS will be kept as low as is reasonably achievable. The ODCM calculational methods specified in the

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.1 DOSE - NOBLE GASES (Continued)

3/4.11.2.3 DOSE - IODINE-131, IODINE-133, TRITIUM AND RADIOACTIVE MATERIAL IN PARTICULATE FORM (Continued)

Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a MEMBER OF THE PUBLIC through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methodology and parameters for calculating the doses due to the actual release rates of the subject material are consistent with the methodology provided in Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, October 1977 and Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors, Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate controls for Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days are dependent upon the existing radionuclide pathways to man in the areas at and beyond the SITE BOUNDARY. The pathways that were examined in the development of the calculations were: (1) individual inhalation of airborne radionuclides, (2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, (3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man and (4) deposition on the ground with subsequent exposure of man.

This control applies to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

RADIOACTIVE EFFLUENTS

BASES

3/4.11.2.4 GASEOUS RADWASTE TREATMENT SYSTEM

The OPERABILITY of the WASTE GAS HOLDUP SYSTEM and the VENTILATION EXHAUST TREATMENT SYSTEM ensure that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these systems be used, when specified, provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept as low as is reasonably achievable. This control implements the requirements of 10 CFR 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the dose design objectives set forth in Section II.B and II.C of Appendix I, 10 CFR Part 50 for gaseous effluents.

This control applies to the release of radioactive materials in gaseous effluents from each unit at the site. For units with shared Radwaste Treatment Systems, the gaseous effluents from the shared system are proportioned among the units sharing that system.

3/4.11.2.5 NOT USED

3/4.11.2.6 NOT USED

3/4.11.3 NOT USED

3/4.11.4 TOTAL DOSE

This control is provided to meet the dose limitations of 10 CFR Part 190 that have been incorporated into 10 CFR Part 20 by 46 FR 18525. The control requires the preparation and submittal of a Special Report whenever the calculated doses due to releases of radioactivity and to radiation from uranium fuel cycle sources exceed 25 mrems to the whole body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrems. For sites containing up to four reactors, it is highly unlikely that the resultant dose to a MEMBER OF THE PUBLIC will exceed the dose limits of 40 CFR Part 190 if the individual reactors remain within twice the dose design objectives of Appendix I,and if direct radiation doses from the units (including outside storage tanks, etc.) are kept small. The Special Report will describe a course of action that should result in the limitation

RADIOACTIVE EFFLUENTS

BASES

3/4.11.4 TOTAL DOSE (Continued)

of the annual dose to a MEMBER OF THE PUBLIC to within the 40 CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the MEMBER OF THE PUBLIC from other uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 8 kilometers must be considered. If the dose to any MEMBER OF THE PUBLIC is estimated to exceed the requirements of 40 CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40 CFR Part 190 have not already been corrected), in accordance with the provisions of 40 CFR 190.11 and Subpart M of 10 CFR Part 20, is considered to be a timely request and fulfills the requirements of 40 CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40 CFR Part 190 and does not apply in any way to the other requirements for dose limitation of 10 CFR Part 20, as addressed in Controls 3.11.1.1 and 3.11.2.1. An individual is not considered a MEMBER OF THE PUBLIC during any period in which he/she is engaged in carrying out any operation that is part of the nuclear fuel cycle.

3/4.12 RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.1 MONITORING PROGRAM

The Radiological Environmental Monitoring Program required by this control provides representative measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of MEMBERS OF THE PUBLIC resulting from the plant operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the Radiological Effluent Monitoring Program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and the modeling of the environmental exposure pathways. Guidance for this monitoring program is provided by the Radiological Assessment Branch Technical Position on Environmental Monitoring, Revision 1, November 1979. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The required detection capabilities for environmental sample analyses are tabulated in terms of the lower limits of detection (LLDs). The LLDs required by Table 4.12-1 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as an a posteriori (after the fact) limit for a particular measurement.

Detailed discussion of the LLD and other detection limits can be found in Currie, L. A., Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements, NUREG/CR-4007 (September 1984) and in the HASL Procedures Manual, HASL-300.

3/4.12.2 LAND USE CENSUS

This control is provided to ensure that changes in the use of areas at and beyond the SITE BOUNDARY are identified and that modifications to the Radiological Environmental Monitoring Program given in the ODCM are made if required by the results of this census. The best information from the door-to-door survey, from aerial survey or from consulting with local agricultural authorities shall be used.

RADIOLOGICAL ENVIRONMENTAL MONITORING

BASES

3/4.12.2 LAND USE CENSUS (Continued)

This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 50 square meters provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kilograms/year) of leafy vegetables assumed in Regulatory Guide 1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were made: (1) 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage) and (2) a vegetation yield of 2 kilograms per square meter.

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

This requirement for participation in an approved Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

METHODOLOGY

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GLOSSARY OF COMMONLY USED TERMS IN METHODOLOGY SECTION

D_B	-	Dose from Beta Radiation
CC or cc	-	Cubic centimeter
Ci	-	Curies - a unit of radioactivity see µCi
C_i	-	Activity or concentration of a nuclide in the release source. Units of µCi, µCi/cc or µCi/ml
CFR	-	Code of Federal Regulations
Control(s)	-	Regulations for operating, controlling, monitoring and reporting radioactive effluent related activity as indicated by the Controls Section of the ODCM.
Dose	-	The exposure, in mrem or mrad, the organ or the individual receives from radioactive effluents
Dose Factor	-	Normally, a factor that converts the effect of ingesting radioactive material into the body, to dose to a specific organ. Body elimination, radioactive decay and organ uptake are some of the factors that determine a dose factor for a given nuclide
Dose Pathway	-	A specific path that radioactive material physically travels through prior to exposing an individual to radiation. The Grass-Cow-Milk-Infant is a dose pathway
Dose Rate	-	The dose received per unit time
(D/Q)	-	A long term D over Q - a factor with units of $1/m^2$ which describes the deposition of particulate matter from a plume at a point downrange from the source. It can be thought of as what part of the cloud is going to fallout and deposit over one square meter of ground. (See Appendix C).
ECL	-	Effluent Concentration Limit
FUSAR	-	Final Updated Safety Analysis Report.

GLOSSARY OF COMMONLY USED TERMS IN METHODOLOGY SECTION (continued)

Y	-	A gamma photon - The dose from Gammas in air, etc.
Ground Plane	-	Radioactive material deposited uniformly over the ground emits radiation that produces an exposure pathway when an individual is standing, sitting, etc., in the area. It is assumed that an adult receives the same exposure as an infant, regardless of the physical height differences. Only the whole body is considered for the ODCM.
H-3	-	Hydrogen-3 or Tritium, a weak Beta emitter
I&8DP	-	Radioiodines and particulates with half-lives greater than 8 days
m^3	-	Cubic Meters
m^2	-	Square Meters
nuclide	-	For the purposes of this manual, a radioactive isotope. Nuclide (i) signifies a specific nuclide, the 1st, 2nd, 3rd one under consideration. If nuclide (i) is I-131, then the Mi (dose factor) under consideration should be $M_{I\text{-}131}$ for example.
Organ	-	For the ODCM either the bone, liver, thyroid, kidney, lung, GI-LLI or the Whole Body. Whole Body is considered an organ for ease of writing the methodology in the ODCM.
pCi	-	1 pico-Curie = 1.E-12 Curies.
$(Q\ Dot)_i$	-	$(Q\ Dot)_i$ - Denotes a release rate in µCi/sec for nuclide (i).
Q_i	-	Denotes µCi of nuclide (i) released over a specified time interval.
Radioiodines	-	Iodine-131 and Iodine I-133 for gaseous release pathways.

GLOSSARY OF COMMONLY USED TERMS IN METHODOLOGY SECTION (continued)

Receptor - The individual receiving the exposure in a given location or who ingests food products from an animal for example. A receptor can receive dose from one or more pathways.

Release Source(s) - A subsystem, tank or vent where radioactive material can be released independently of other radioactive release points.

TS - The St. Lucie Plant Standard Technical Specifications

Total Body - Same as Whole Body in Control Statements

μCi - micro Curies. 1 μCi = 10^{-6} Curies. The μCi is the standard unit of radioactivity for all dose calculations in the ODCM.

(X/Q) - A long term Chi over Q. It describes the physical dispersion characteristics of a semi-infinite cloud of noble gases as the cloud traverses downrange from the release point. Since Noble Gases are inert, they do not tend to settle out on the ground. (See Appendix C).

$(X/Q)_D$ - A long term Depleted Chi over Q. It describes the physical dispersion characteristics of a semi-infinite cloud of radioactive iodines and particulates as the cloud travels downrange. Since Iodines and particulates tend to settle out (fallout of the cloud) on the ground, the $(X/Q)_D$ represents what physically remains of the cloud and its dispersion qualities at a given location downrange from the release point. (See Appendix F).

dt, Δt or delta t - A specific delta time interval that corresponds with the release interval data etc.

1.0 LIQUID RELEASES METHODOLOGY

1.1 Radioactive Liquid Effluent Model Assumptions

The FUSAR contains the official description of the site characteristics. The description that follows is a brief summary for dose calculation purposes:

The St. Lucie Plant is located on an island surrounded on two sides by the Atlantic Ocean and the Indian River, an estuary of the Atlantic Ocean. Normally, all radioactive liquid releases enter the Atlantic Ocean where the Circulating Water Discharge Pipe terminates on the ocean floor at a point approximately 1200 feet offshore (Figure 1-1 Point "L"). No credit is taken for subsequent mixing of the discharge flume with the ocean. The diffusion of radioactive material into the ocean is dependent on the conditions of tide, wind and some eddy currents caused by the Gulf Stream. The conditions are sufficiently random enough to distribute the discharges over a wide area and no concentrating effects are assumed.

There are no direct discharge paths for liquid effluents to either of the north or south private property boundary lines. The Big Mud Creek (part of the Indian River) does connect to a normally locked shut dam, that is intended to provide an emergency supply of circulating water to the Intake Cooling Water Canal in the event a Hurricane causes blockage of the Intake Canal. No radioactive water could be discharged directly into the Intake Cooling Water Canal because all plant piping is routed to the discharge canal and no back flow can occur. Consult the FUSAR for a detailed description of characteristics of the water bodies surrounding the plant site.

Only those nuclides that appear in the Liquid Dose Factor Tables will be considered for dose calculation.

1.2 Determining the Fraction F of 10 CFR Part 20 ECLs Limits for A Liquid Release Source

Discussion - Control 3.11.1.1 requires that the sampling and analysis results of liquid waste (prior to discharge) be used with calculation methods in the in-plant procedures to assure that the concentration of liquid radioactive material in the unrestricted areas will not exceed ten times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2. Chemistry Procedure COP-01.05 "Processing Aerated Liquid Waste" provides instruction for ensuring batch release tanks will be sampled after adequate mixing. This section presents the calculation method to be used for this determination. This method only addresses the calculation for a specific release source. The in-plant procedures will provide instructions for determining that the summation of each release source's F values do not exceed the site's 10 CFR Part 20 ECL. The values for release rate, dilution rate, etc., will also have to be obtained from in-plant procedures. The basic equation is:

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(ECL)_i}$$

Where:

F_L = the fraction of 10 CFR Part 20 ECL that would result if the release source was discharged under the conditions specified.

R = The undiluted release rate in gpm of the release source.
Liquid Rad Waste = 170 gpm for Waste Monitor Tank
Steam Generator = 125 gpm/Steam Generator
Liquid Rad Waste = 60 gpm for AWST #2
Liquid Rad Waste = 60 gpm for Laundry Drain Pumps 2A/2B

D = The dilution flow in gpm of Intake Cooling Water or Circulating Water Pumps
Intake Cooling flow is 14,500 gpm/pump
Circulating Water flow is 121,000 gpm/pump

C_i = The undiluted concentration of nuclide (i) in µCi/ml from sample assay

$(ECL)_i$ = The Effluent Concentration Limit of nuclide (i) in µCi/ml from Table L-1. For dissolved or entrained noble gases the ECL value is 2 X 10^{-4} µCi/ml for the sum of all gases.

1.2 (continued)

The fraction of the 10 CFR Part 20 ECL limit may be determined by a nuclide-by-nuclide evaluation or for purposes of simplifying the calculation by a cumulative activity evaluation. If the simplified method is used, the value of 3×10^{-8} µCi/ml (unidentified ECL value) should be substituted for $(ECL)_i$ and the cumulative concentration (sum of all identified radionuclide concentrations) or the gross concentration should be substituted for C_i. As long as the diluted concentration (C_{total} R/D) is less than 3×10^{-8} µCi/ml, the nuclide-by-nuclide calculation is not required to demonstrate compliance with the 10 CFR Part 20 ECL. The following section provides a step-by-step procedure for determining the ECL fraction.

1. Calculation Process for Solids

   A. Obtain from the in-plant procedures, the release rate value (R) in gpm for the release source.

   B. Obtain from the in-plant procedures, the dilution rate (D) in gpm. No credit is taken for any dilution beyond the discharge canal flow.

   C. Obtain (C_i), the undiluted assay value of nuclide (i), in µCi/ml. If the simplified method is used, the cumulative concentration (C_{total}) is used.

   D. From Table L-1, obtain the corresponding (ECL) for nuclide (i) in µCi/ml. The value of 3×10^{-8} µCi/ml should be used for the simplified method.

   E. Divide C_i by $(ECL)_i$ and write·down the quotient

   F. If the simplified method is used, proceed to the next step. If determining the ECL fraction by the nuclide-by-nuclide evaluation, repeat steps 1.2.1.C through 1.2.1.E for each nuclide reported in the assay, for H_3 from previous month composite and for SR89/90 and Fe55 from previous quarter composite with known results.

1.2 (continued)

1. (continued)

G. Add each C_i/(ECL) quotient from step 1.2.1.E and solve for F_L as follows:

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(ECL)\ i}$$

F_L = a unit-less value where:

the value of F_L could be $\leq$ or >1. The purpose of the calculation is to determine what the initial value of F_L is for a given set of release conditions.

H. The F_L value just obtained is for one release pathway. The TS and ODCM control 3.11.1.1 allow for a site limit of F_L less than or equal to 10. Chemistry Procedure COP-01.05 administratively controls each pathway's allocation. Compare your F_L result with the administrative control for the release pathway in COP-01.05.

2. Calculation Process for Gases in Liquid

A. Sum the µCi/ml of each noble gas activity reported in the release.

B. The values of R and D from 1.2.1 above shall be used in the calculations below:

$$F_g = \frac{(sum\ of\ 1.2.2.A)\ \mu Ci/ml}{1} \times \frac{R}{D}$$

C. F_g shall be less than 2 X 10^{-4} µCi/ml for the site for all releases in progress. Each release point will be administratively controlled. Consult COP-01.05 procedure for instructions.

1.3 Determining Setpoints for Radioactive Liquid Effluent Monitors

1.3.1 Setpoints for Batch Liquid Release Monitors channel numbers R6627 and 301 on Table 3.3-14, Radioactive Effluent Monitor Setpoint Basis, are the Batch Liquid Effluent Monitors.

Discussion - Control 3.3.3.9 requires that the liquid effluent monitoring instrumentation alarm/trip setpoints be set to initiate an alarm or trip so that the radioactivity concentration in water in the unrestricted area does not exceed the concentration of 10 CFR Part 20, Appendix B, Table 2 as a result of radioactivity in liquid effluents (Control 3.11.1.1).

Gross cpm vs. total liquid activity curves are available for Batch Liquid Effluent Monitors based on a composite of real release data. A direct correlation between gross cpm and the concentrations that would achieve 10 CFR Part 20 ECL levels in the discharge canal can be estimated. The 1978 liquid release data from annual reports was used to determine the average undiluted release concentration. These concentrations were then projected to a diluted concentration in the discharge canal assuming a 1 gpm release rate and a constant dilution flow of 121,000 gpm from 1 circ. water pump. This diluted activity was divided by the nuclide's respective 10 CFR Part 20 ECL value (Table L-1) to obtain the Mi column on the table that follows:

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1.3 (continued)

TABLE 1.3

NUCLIDE SYMBOL	1978 UNDILUTED µCi/ml[1]	M_i[2] (no units)
I-131	4.43 E-5	3.66 E-4
I-132	2.23 E-7	1.84 E-8
I-133	3.17 E-6	3.74 E-6
I-135	1.31 E-6	3.61 E-7
Na-24	1.72 E-7	2.84 E-8
Cr-51	2.51 E-5	4.15 E-7
Mn-54	5.64 E-6	1.55 E-6
Mn-56	1.11 E-9	1.31 E-10
Co-57	3.69 E-7	5.08 E-8
Co-58	1.51 E-4	6.24 E-5
Fe-59	2.92 E-6	2.41 E-6
Co-60	3.66 E-5	1.01 E-4
Zn-65	4.55 E-7	7.52 E-7
Ni-65	8.23 E-7	6.8 E-8
Ag-110	1.96 E-6	2.70 E-6
Sn-113	5.75 E-7	1.58 E-7
Sb-122	2.15 E-6	1.78 E-6
Sb-124	8.40 E-6	9.92 E-6
W-187	3.51 E-6	9.67 E-7
Np-239	1.57 E-7	6.49 E-8
Br-82	3.64 E-7	7.52 E-8
Zr-95	2.82 E-5	1.17 E-5
Zr-97	4.05 E-6	3.72 E-6
Mo-99	3.24 E-6	1.34 E-6
Ru-103	3.84 E-8	1.06 E-8
Sb-125	2.26 E-6	6.23 E-7
Cs-134	2.14 E-5	1.97 E-4
Cs-136	7.82 E-7	1.08 E-6
Cs-137	4.85 E-5	4.01 E-4
Ba-140	6.44 E-7	6.65 E-7
Ce-141	3.04 E-8	8.38 E-9
Ce-144	2.37 E-6	6.53 E-6
A_{tot}=	4.01 E-4	
M_{Total}=		1.18 E-3

(1) 1978 Undiluted Release Volume = 7 E 9 ml.

(2) $$M_I = \frac{1978\ Undil.\ Act\ Nuclide\ (i)}{ECL_I\ (from\ Table\ L\text{-}1)} X \frac{1\ gpm\ (release\ rate)}{121000\ gpm\ (dil\ rate)}$$

1.3 (continued)

A_{Tot} is the total average µCi/ml concentration of the reference mixture and M_{Tot} is the fraction of the MPC of all nuclides for the release conditions specified. Dividing A_{Tot} by M_{Tot} yields A_{Max}, which is the maximum total activity concentration equivalent to the ECL limit for the nuclide distribution typical of radwaste discharges. The Technical Specifications allow 10 times the ECL limit where the Site Limit is 10 times A_{Max} as follows:

$$A_{Max} = \frac{A_{Tot}}{M_{Tot}} = \frac{4.01\ E\text{-}4}{1.18\ E\text{-}3} = 0.34\ \mu Ci/ml = ECL\ Limit$$

Site Limit = 10 x A_{Max} = 10 x 0.34 = 3.4 µCi/ml

To provide conservative administrative control, A_{Max} of 0.34 µCi/ml should be used as follows:

1. If the effluent monitor requires counts per minute units, a (C_{max}) value in cpm should be obtained for the A_{max} (0.34 µCi/ml) from the release sources radioactive liquid effluent monitor curve of cpm vs. µCi/ml.

NOTE
This setpoint is for a specified release of 1 gpm into 121000 gpm dilution flow.

2. For establishing the setpoint prior to liquid radwaste discharges, the A_{max} (or C_{max}) will be adjusted as needed to account for actual release conditions (i.e., actual design maximum discharge flow rate, dilution flow rate and the contribution of dissolved and entrained Nobles Gas Activity to the Monitor Activity Level).

1.3 (continued)

1.3.2 Setpoints for Continuous Liquid Release Monitors

Discussion - The activity mixture described in 1.3.1 for Liquid Batch Release Monitors cannot be used for Continuous Liquid Pathways since the Steam Generator (S/G) Blowdown Secondary Side is subject to what the current Reactor Coolant System (RCS) activity and primary-to-secondary leakage exist at any time. Although S/G blowdown is not normally aligned to the Site Liquid Radwaste Release Point (Figure 1-1), the monitor setpoints will be based on the ODCM maximum design S/G blowdown rate of 125 gpm with 1 Circulating Water Pump (CWP) 121,000 gpm in operation. The ODCM and COP-01.05, Processing Liquid Waste assume that the fraction of solids entering the Discharge Canal to the site release point are controlled less than or equal to 1.0, with batch release using 80% and the remaining 20% allocated to continuous sources on site. The actual site limit for solids is 10 times the concentration specified in 10 CFR Part 20, therefore a conservation factor of 10 is already included in the administrative site limit.

Since source in-leakage to a S/G cannot be controlled, a High alarm monitor setpoint is calculated based on one S/G releasing to the discharge canal at design blowdown rate while attaining the 20 percent of the site limit (F_L) assuming all the gross solid activity is I-131. The contribution from Dissolved and Entrained Gases is assumed to be zero with all of the gaseous activity going to the Steam Condenser and Air Ejector pathway.

$$F_L \text{ at } 20\% = \frac{0.2}{1} = \frac{\text{Design blowdown rate}}{\text{1 CWP Dilution rate}} \times \frac{\text{I-131 uCi/ml (S/G)}}{\text{I-131 uCi/ml (Table L-1ECL)}}$$

$$F_L \text{ at } 20\% = \frac{0.2}{1} = \frac{\text{125 gal/min}}{\text{121,000 gal/min}} \times \frac{\text{I-131 uCi/ml (S/G)}}{\text{1.E-06 uCi/ml (I-131 Table L-1ECL)}}$$

Solving for the **S/G High Alarm Setpoint I-131 Activity,**
I-131 uCi/ml (S/G) = **~2E-04 uCi/ml I-131** is the maximum S/G activity that could be allowed such that 20 percent of the administrative discharge canal limit would not be exceeded.

1.3 (continued)

1.3.2 (continued)

This S/G Monitor High Alarm Setpoint activity may be converted to cpm using Liquid Monitor uC/ml to cpm conversion constants.

This Setpoint is conservative given that the actual Liquid Site Limit is a factor of ten times higher than the administrative limit used for calculation purposes, that I-131's ECL is conservative vs other isotope mixtures, and that it is unlikely that more than one S/G would be allowed to operate with a 20 gallon per day primary-to-secondary leak rate.

1.4 Determining the Dose for Radioactive Liquid Releases

Discussion - Control 3.11.1.2 requires calculations be performed at least once per 31 days to verify that cumulative radioactive liquid effluents do not cause a dose in excess of 1.5 mrem to the whole body and 5 mrem to any organ during any calendar quarter and not in excess of 3 mrem to the whole body and 10 mrem to any organ during any calendar year. This section presents calculational method to be used for this verification.

This method is based on the methodology suggested by sections 4.3 and 4.3.1 of NUREG-0133 Revision 1, November, 1978. The dose factors are a composite of both the fish and shellfish pathways so that the fish-shellfish pathway is the only pathway for which dose will be calculated. The dose for adult, child and teenager can also be calculated by this method provided that their appropriate dose factors are used for the organ of interest. An infant is excluded from Liquid Dose Pathway at St. Lucie since they do not eat fish-shellfish. The effluent supervisor will track which age group is the controlling (most restrictive) age group (see control 3.11.2.6.c). Only those nuclides that appear in the Tables of this manual will be considered. /R21

1.4 (continued)

1. This method provides for a dose calculation to the whole body or any organ for a given age group based on real release conditions during a specified time interval for radioactive liquid release sources. The equation is:

$$D_{1_T} = \frac{A_{iT}\ dt_1\ Q_{i1}}{(DF)_1}$$

Where:

D_{1_T} = dose commitment in mrem received by organ T of age group (to be specified) during the release time interval dt_1.

A_{iT} = the composite dose factor for the fish-shellfish pathway for nuclide (i) for organ T of age group (to be specified). The A_{iT} values listed in the Tables in this manual are independent of any site specific information and have the units $\frac{\text{mrem-ml}}{\mu\text{Ci-hr}}$

dt_1 = the number of hours that the release occurs.

Q_{i1} = The total quantity of nuclide (i) release during dt_1 (μCi)

$(DF)_1$ = The total volume of dilution that occurred during the release time period dt_1 (i.e., the circulating water flow times time)

The doses associated with each release may then be summed to provide the cumulative dose over a desired time period (e.g., sum all doses for release during a 31 day period, calendar quarter or a year).

$$D_{total_T} = \Sigma\ D_{1_T}$$

Where:

D_{T_T} = the total dose commitment to organ $_T$ due to all releases during the desired time interval (mrem)

1.4 (continued)

1. (continued)

NOTE
Table 1.4 may be used for compiling the dose accounting.

A. Determine the time interval dt_l in hours that the release took place. For once per 31 day dose calculations dt_l would be for the entire month's hours.

For quarterly dose calculations dt_l would be the hours in the quarter, and for annual dose calculations dt_l would be the hours in the year. If required, dt_l may be hours of duration of a single release to evaluate a batch release.

B. Obtain $(DF)_l$ for the time period dt_l from Liquid Waste Management Records for the release source(s) of interest.

C. Obtain Q_{il} for nuclide (i) for the time period dt_l from the Liquid Waste Management Records

D. Obtain A_{iT} from the appropriate Liquid Dose Factor Table

Age Group	Dose Factor Table
Infant	N/A
Child	L-4
Teen	L-3
Adult	L-2

1.4 (continued)

1. (continued)

TABLE 1.4
FISH AND SHELLFISH PATHWAY

TIME/DATE START:____:____ ___/___/___ TIME/DATE STOP:____:____ ___/___/___HOURS

TOTAL DILUTION VOLUME:____________mls

AGE GROUP:__________ ORGAN:_______________ DOSE FACTOR TABLE #:________

NUCLIDE (i)	C_i (μCi)	A_{IT}	DOSE (i) mrem
		TOTAL DOSE $_T$ =	mrem

E. Solve for Dose (i)

$$Dose\ (i) = \frac{Q_{i1}\ dt_1\ A_{IT}}{(DF)_1}$$

1.4 (continued)

1. (continued)

F. For the age group(s) of interest, repeat steps 1.4.1.C through 1.4.1.E for each nuclide reported and each organ required.

G. For the age group(s) of interest, sum the Dose (i) values to obtain the total dose to organ T from the fish-shellfish pathway.

1.5 Projecting Dose for Radioactive Liquid Effluents

Discussion - Control 3.11.1.3 requires that appropriate subsystems of the liquid radwaste treatment system be used to reduce radioactive material in liquid effluents when the projected doses due to the liquid effluent, from each unit, to UNRESTRICTED AREAS (see TS Figure 5.1-1) would exceed 0.06 mrem to the whole body or 0.2 mrem to any organ in a 31 day period. The following calculation method is provided for performing this dose projection. The method is based on dose as calculated in section 1.4 with the adult as the bases for projecting.

1. For the controlling age group obtain the latest result of the monthly calculation of the whole body dose and the highest organ dose. These doses can be obtained from the in-plant records.

2. Divide each dose by the number of days the reactor plant was operational during the month.

3. Multiply the quotient of each dose by the number of days the reactor plant is projected to be operational during the next month. The products are the projected dose for the next month. These values should be adjusted as needed to account for any changes in failed fuel or other identifiable operating conditions that could significantly alter the actual releases.

4. If the projected dose is greater than 0.06 mrem to the whole body or greater than 0.2 mrem to the adults highest exposed organ, the liquid radwaste system shall be used.

2.0 GASEOUS RELEASES METHODOLOGY

2.1 Gaseous Effluent Model Assumptions

Description of Site - (The FUSAR contains the official description of the site characteristics. The description that follows is a brief summary for dose calculation purposes only). The St. Lucie Plant is located on an island surrounded on two sides by the Atlantic Ocean and the Indian River, an estuary of the Atlantic Ocean. Private property adjoins the plant site in the north and south directions. A meteorological tower is located north of the plant near the site property line. There are 16 sectors, for dose calculation purposes, divided into 22.5° each. The MET tower is calibrated such that a zero degree bearing coincides with TRUE NORTH. A bearing of zero degrees dissects the north sector such that bearings of 348.75° and 11.25° define the boundaries of the north sector. The nearest distance to private property occurs in the north sector at approximately 0.97 miles. For ease of calculation, this 0.97 mile radius is assumed in all directions, although the real Unrestricted Area Boundary is defined in Figure 5.1-1 of the TS. Doses calculated over water areas do not apply to Controls or the annual report and may be listed as O.W. (over water) in lieu of performing calculations. The 0.97 mile range in the NW sector is O.W., but it was chosen as the worst sector for conservative dose calculations using the historical MET data.

Historical MET Data - MET data, between September 1, 1976 and August 31, 1978, from the St. Lucie MET Tower was analyzed by Dames & Moore of Washington, D.C. The methodology used by Dames & Moore was consistent with methods suggested by Regulatory Guide 1.111, Revision 1. Recirculation correction factors were also calculated for the St. Lucie Site and are incorporated into the historical MET tables (Tables M5, M6 and M7) in Appendix A of this manual. It was determined that these two years are representative data for this locale.

Dose Calculations - Dose calculations for Control dose limits are normally calculated using historical MET data and receptor location(s) which yield calculated doses no lower than the real location(s) experiencing the most exposure. Actual MET data factors are calculated and used in dose calculations for the annual reports.

Live MET data and hour-by-hour dose calculations are beyond the scope of this manual. Historical information and conservative receptor locations, etc., are only used for ease of Control dose limit calculations. Dose calculations for Control dose limits may be performed using actual MET data and real receptor locations. Any dose calculations performed with actual data should note the source of the data in the annual report. Actual MET data reduction should be performed in accordance with Regulatory Guide 1.111, Revision 1 and should incorporate Recirculation Correction Factors from Table M-4 of this manual.

2.1 (continued)

Dose Calculations - (continued)

The St. Lucie site uses the long term ground release model for all gaseous effluents. Only those radionuclides that appear in the gaseous effluent dose factor tables will be considered in any dose calculations. Radioiodines are defined as Iodine-131 and I-133 for application to Controls. Other nuclides of Iodine may be included in dose calculations for ease of performing calculations, but their dose contribution does not have to be included in the Control requirements. Land Census information will apply to the calendar year following the year that the census was taken in to avoid splitting quarters, etc.

2.2 Determining the Total Body and Skin Dose Rates for Noble Gas Releases And Establishing Setpoints for Effluent Monitors

Discussion - Control 3.11.2.1 limits the dose rate from noble gases in airborne releases to <500 mrem/yr - total body and <3000 mrem/yr - skin. Control 3.3.3.11 requires that the gaseous radioactive effluent monitoring instrumentation be operable with alarm/trip setpoints set to ensure that these dose rate limits are not exceeded. The results of the sampling and analysis program of Control Table 4.11-2 are used to demonstrate compliance with these limits.

The following calculation method is provided for determining the dose rates to the total body and skin from noble gases in airborne releases. The alarm/trip setpoints are based on the dose rate calculations. The Controls apply to all airborne releases on the site but all releases may be treated as if discharged from a single release point. Only those noble gases appearing in Table G-2 will be considered. The calculation methods are based on Sections 5.1 and 5.2 of NUREG-0133, November 1978. The equations are:

For TOTAL BODY Dose Rate:

$$DR_{TB} = \sum_{i}^{n} K_i \, (X/Q) \, (Q\ DOT)_i$$

For TOTAL SKIN Dose Rate:

$$DR_{skin} = \sum_{i}^{n} [L_i + 1.1\ M_i] \, (X/Q) \, (Q\ DOT)_i$$

2.2 (continued)

Where:

DR_{TB} = total body dose rate from noble gases in airborne releases (mrem/yr)

DR_{skin} = skin dose rate from noble gases in airborne releases (mrem/yr)

$\sum_{i}^{n}$ = a mathematical symbol to signify the operations to the right of the symbol are to be performed for each noble gas nuclide (i) through (n) and the individual nuclide doses are summed to arrive at the total dose rate for the release source:

K_i = the total body dose factor due to gamma emissions for each noble gas nuclide reported in the release source. (mrem-m^3/µCi-yr)

L_i = the skin dose factor due to beta emissions for each noble gas nuclide (i) reported in the assay of the release source. (mrem-m^3/µCi-yr)

M_i = the air dose factor due to gamma emissions for each noble gas nuclide (i) reported in the assay of the release source. The constant 1.1 converts mrad to mrem since the units of M_i are in (mrad-m^3/µCi-yr)

(X/Q) = for ground level, the highest calculated annual long term historic relative concentration for any of the 16 sectors, at or beyond the exclusion area boundary (sec/m^3)

$(Q\ DOT)_i$ = The release rate of noble gas nuclide (i) in µCi/sec from the release source of interest

2.2 (continued)

1. Setpoint Determination

A. To comply with Control 3.3.3.10, the alarm/trip setpoints are established to ensure that all noble gas releases in progress do not exceed the ODCM Control 3.11.2.1 noble gas release rate limit for the site. Using pre-ODCM Revision 0 data, the total body dose was determined to be more limiting than the calculated skin dose, therefore the site release rate limit of total body dose rate of 500 mrem/yr has been determined to be equivalent to 3.5E+05 uCi/sec being released from the site. Using 3.5E+05 uCi/sec as the equivalent of 100 percent of the site limit, each release point on site may be allotted a portion of the 100 percent, such that the sum of all release point portions allotted shall be less than or equal to 100 percent. The release point's actual monitor setpoint shall take into account the physical release characteristics of maximum expected volume release rate and its percent allotment for a single release point since uCi/sec is proportional to volume rate. The ODCM actual release points and an example of percent allotments is provided:

Site Limit in Percent = 100%
Site Limit in uCi/sec = 3.5E+05 uCi/sec

ODCM Release Point	**(Example)** Percent Allotment
Unit 1 Plant Vent	40
Unit 1 Fuel Bldg. Vent	5
ECCS 1A	1
ECCS 1B	1
Unit 2 Plant Vent	40
Unit 2 Fuel Bldg. Vent	5
ECCS 2A	1
ECCS 2B	1
Blowdown Bldg. Vent	+ 5
Total Percent Allocated=	99 or 1 percent below the Site Limit

2.2 (continued)

1. (continued)

A. (continued)

More or less percentage may be used for a release point, but the sum of the total percent allocated to the above Release Points shall never be allowed to exceed 100 percent. The ECCS Reactor Auxiliary Building Exhaust are not ODCM required monitored release points, but a small percentage should be allotted to each to cover short periodic fan surveillance runs. This allocation is controlled per Chemistry Procedure COP-07.05, Process Monitor Setpoints where Chemistry Supervisor approval is required. COP-07.05 provides calculation steps to calculate a Noble Gas Release Rate Setpoint based on the methodology steps described below. A release point's percent allotment will be converted into the release point's indicating engineering unit of uCi/cc that will be equivalent to the allocated portion of the site limit.

1. Obtain the release point's maximum expected process flow release rate **(V)** in Cubic Feet per Minute (cfm) from the Effluent Supervisor.

2. Obtain the release point's percent of site limit allotment **(PA)** from the Chemistry Supervisor.

3. Substitute the release point's **V** and **PA** values into the below equation to obtain the Release Point's Setpoint (SP).

$$SP = \frac{3.5E{+}05\ \text{uCi}}{\text{sec}} \times \frac{60\ \text{sec}}{\text{min}} \times \frac{\text{min}}{\mathbf{V}\ \text{ft3}} \times \frac{\text{ft}}{28317\ \text{cc}} \times \frac{\text{PA}}{100\%}$$

SP = __________uCi/cc which is the TABLE 3.3-14 HIGH SETPOINT for ODCM Effluent Gas Channels that have a "Allotted % of Site Limit" declared as their HIGH SETPOINT.

2.2 (continued)

1. (continued)

A. (continued)

In the case of Unit 2 Plant Vent there are 3 ODCM Effluent Gas Channels Monitoring the Plant Vent. The HIGH SETPOINT in uCi/cc is the same for 2A PV PIG LOW RANGE GAS, 2B PIG LOW RANGE GAS, and 2PV WRGM LOW RANGE GAS since they are monitoring the same release point (i.e., each of these channels does not receive their own allotted % of the Site Limit).

4. The significance of an ODCM Effluent Gas Channel that has a "Allotted % of Site Limit" HIGH Setpoint requires further discussion (Mid and High Noble Gas Accident Channels are not part of this discussion):

a. For Plant Vent Release Points on each reactor unit, the "Allotted % of Site Limit" needs to be high enough to allow for Batch Releases from Gas Decay Tank and Containment Venting Operations, and at the same time COP-01.06, Processing Gaseous Waste shall provide instruction for administratively controlling Batch Releases such that the radioactive concentration and release rate will not be allowed to exceed the site limit at any time. /R21

b. The receipt of a valid HIGH Alarm on a release point where the ODCM Low Range Gas Channel's radioactivity is approximately equal to the HIGH Alarm setpoint does not mean the site limit has been exceeded, rather it is at a concentration that is equivalent to the "Allotted % of Site Limit".

2.2 (continued)

1. (continued)

A. (continued)

4. (continued)

c. The receipt of a valid HIGH Alarm on a release point where the ODCM Low Range Gas Channel's radioactivity is greater than the HIGH Alarm setpoint may quickly be estimated based on:

$F_{SL} = RP_{SL}$ + (Sum of all other Release Point's RP_{SL} on site)

RP_{SL} = Rel Pt's Channel's uCi/cc x Rel Pt's Release Rate x volume conv. const. x time conv. const. x 1/(site limit)

$$RP_{SL} = \frac{uCi}{cc} \times \frac{V\ ft^3}{min} \times \frac{28317\ cc}{ft_3} \times \frac{min}{60\ sec} \times \frac{sec}{3.5E{+}05\ uCi}$$

Where:

F_{SL} = Fraction of the Site Limit
RP_{SL} = Fraction of a Release Point's contribution to the site limit
(Sum of all other Release Point's RP_{SL} on site) is normally less than 0.10 under normal operating conditions.
V = in ft^3/min, the Release Point's actual process Volume flow release rate

A value of RP_{SL} >1.0 or a F_{SL} >1.0 would be exceeding the Site Limit Based on the above estimate. Off Normal Procedure allow 1 hour to obtain a grab sample of the Release Point so that the actual site limit situation may be evaluated. This method is discussed in the following step.

2.2 (continued)

1. (continued)

A. (continued)

5. To quantify the Release Point's actual Noble Gas Dose Rate, the following would need to be performed:

   a. A Noble Gas Activity Grab Sample would be obtained and analyzed to determine each Noble Gas Isotopic concentration.

   b. The results would be used to perform calculations per ODCM Step 2.2.2 for Noble Gas Total Body Dose Rate and Skin Dose Rate.

   c. If the Release Point's HIGH Alarms were received on the Table 3.3-14 ODCM Related Particulate and/or Iodine Channel, then ODCM Step 2.3 calculations should be performed as soon as possible after the continuous collection medium(s) and a Tritium Sample can be pulled and analyzed to evaluate compliance with ODCM Control 3.11.2.1.b.

2.2 (continued)

1. (continued)

B. No Particulate or Iodine Radioactivity Channels are required by the ODCM. Table 3.3-13 requires Iodine and Particulate Samplers only. Technical Specification Table 3.3-6 requires a Fuel Building Vent Particulate Channel (the bases for the setpoint on the Fuel Building Vent Particulate Channel is described in 2.2.1.C). The FUSAR does describe Particulate and Iodine Radioactivity Channels. These Channels are listed in ODCM Table 3.3-14 and ALERT and HIGH Setpoints are provided. The intent of providing these setpoints is to provide early warning that the effluent pathway conditions have increased such that a grab sample should be obtained if a HIGH Alarm Setpoint is reached or exceeded. The Particulate and Iodine HIGH Alarm Setpoint bases is that the collection mediums are fixed filter where continuing deposition of radioactivity would cause a increase in the channel count rate up to the setpoint level(s), the resulting dose rate can be shown to be less than 1 percent of the site limit for ODCM Control 3.11.2.1.b for Iodine-131, Iodine-133, and all radionuclides in particulate from with half-lives greater than 8 days, is that these channel detectors are gross activity monitors of the scintillation type where the count rate is not dependent (above threshold) on the energy of the isotope entrained on the collection medium, and that these channels are qualitative trend indicators since the channel count rate cannot be corrected for the accrued sample collection volume. Plant historical trends have shown that Noble Gas Activity may contribute to the count rate of the Reactor Auxiliary Building (Plant) Vent Particulate and Iodine Channel(s). In this event the Noble Gas contribution may be added to the Table 3.3-14 Alert and High Setpoints for Plant Vents only.

The sampling mediums associated with the Particulate and Iodine Channels in Table 3.3-14 are also controlled by the requirements of ODCM Table 4.11-2 which requires 4/M Minimum Analysis Frequency of the sampling mediums. These analysis are used to confirm and quantify the isotopic composition of the radioactivity being monitored by these channels. The presence of Noble Gas on collection medium would be confirmed by these analysis.

2.2 (continued)

1. (continued)

B. (continued)

If an alarm occurs, Channel Check(s) should be performed on these channel(s), an ALERT Alarm should be investigated and a HIGH Alarm shall require isotopic analysis of particulate and/or iodine channel medium of the affected channel(s). The Isotopic analysis of the medium shall be used to evaluate particulate and/or iodine dose rate levels per the methodology of ODCM 2.3.

C. To comply with Technical Specification 3.3.3.1, Table 3.3-6 Radiation Monitoring Instrumentation, "Instrument 2.a.ii. Particulate Activity", with Alarm/Trip Setpoint determined and set in accordance with the requirements of the Offsite Dose Calculation Manual, the following is the BASES for Fuel Building Particulate Channel High Alarm Setpoints for Unit 1 and Unit 2:

Unit 1 Fuel Building:
The 10,000 cpm High Setpoint is based on an Infant's Maximum Exposed Organ Dose Rate (Liver) from Inhalation of Cs-137 at the Site Boundary. The value of 10,000 cpm is very conservative relative to the site dose rate limit of 1500 mrem/yr. The methodology is based on measured particulate channel count rates when the detector was calibrated with a known source activity of Cs-137, and on default assumptions as follows:

1. The particulate channel read 32,385 ccpm when exposed to a 7.67 uCi source of Cs-137.

2. Assuming that 7.67 uCi of Cs-137 were collected during 1 hour of skid sample collection (fixed filter), the typical sample volume would yield ~3.3E+06 cc's. Greater than 99% sample filter efficiency is assumed.

2.2 (continued)

1. (continued)

C. (continued)

3. The maximum building process flow exhaust is ~24,576 cfm.

4. Q(dot) for Cs-137 uCi/sec release rate is approximately 27 uCi/sec as follows:

$$\frac{7.67\ \text{uCi}}{\text{hour}} \times \frac{\text{hour}}{3.3\text{E+06cc.s}} \times \frac{28317\ \text{cc's}}{\text{ft3}} \times \frac{24576\ \text{ft3}}{\text{min}} \times \frac{\text{min}}{60\ \text{sec}} = \frac{27\ \text{uCi}}{\text{sec}}$$

5. The default historical (X/Q)d for the worst sector (NW) at the site boundary is 1.3E-06 meters/sec.

6. The dose rate (equivalent to 10,000 cpm) is calculated per ODCM Section 2.3 Inhalation Dose Rate to an Infant. The resulting dose rates yield.

Bone mrem/yr	Liver mrem/yr	Thyroid mrem/yr	Kidney mrem/yr	Lung mrem/yr	GI-LLI mrem/yr	W.Body mrem/yr
7.4E+00	7.9E+00	0.0E+00	4.2E-01	1.0E+00	1.5E-02	4.8E-01

7. The ODCM 3.11.2.1.b dose rate limit to any organ is 1500 mrem/yr. From the preceding calculation the Infant's Liver is the maximum exposed organ at 0.52 percent of the site dose rate limit.

8. A particulate channel setpoint of 10,000 cpm provides a conservative setpoint given that this channel analyzes gross activity on a fixed filter, Cs-137 is a typical long-lived fission product present at all times with spent fuel in the pool, and that sample collection intervals shorter than 1 hour would provide adequate warning response if significant particulate activity were being released, i.e., the above assumptions assume a Cs-137 activity of ~2.3E-06 uCi/cc.

2.2 (continued)

1. (continued)

C. (continued)

9. The setpoint of 10,000 cpm was administratively chosen to provide early detection/alarm of a problem. The above dose rate calculations are provided to document that the particulate channel is capable of detection sensitivities to insure compliance with the ODCM site limit. Grab samples should be performed to accurately calculate actual releases associated with real high alarm events as per the ODCM methodology for performing dose rate calculations.
(End of Unit 1 Fuel Building evaluation)

Unit 2 Fuel Building:
The 10,000 cpm High Setpoint is based on an Infant's Maximum Exposed Organ Dose Rate (Liver) from Inhalation of Cs-137 at the Site Boundary. The value of 10,00 cpm is very conservative relative to the site dose rate limit of 1500 mrem/yr. The methodology is based on measured particulate channel count rates when the detector was calibrated with a known source activity of Cs-137, and on default assumptions as follows:

1. The particulate channel read 39,782 ccpm when exposed to a 7.59 uCi source of Cs-137 (decayed to June 19, 1996 data).

2. Assuming that 7.59 uCi of Cs-137 were collected during 1 hour of skid sample collection (fixed filter), the typical sample volume would yield ~5.32E+06 cc's. Greater than 99% sample filter efficiency is assumed.

3. The maximum building process flow exhaust is ~31,584 cfm.

4. Q(dot) for Cs-137 uCi/sec release rate is approximately 21 uCi/sec as follows:

$$\frac{7.59\ \text{uCi}}{\text{hour}} \times \frac{\text{hour}}{5.32\text{E+06cc.s}} \times \frac{28317\ \text{cc's}}{\text{ft3}} \times \frac{31584\ \text{ft3}}{\text{min}} \times \frac{\text{min}}{60\ \text{sec}} = \frac{21.26\ \text{uCi}}{\text{sec}}$$

2.2 (continued)

1. (continued)

C. (continued)

5. The default historical (X/Q)d for the worst sector (NW) at the site boundary is 1.3E-06 meters/sec.

6. The dose rate (equivalent to 10,000 cpm) is calculated per ODCM Section 2.3 Inhalation Dose Rate to an Infant. The resulting dose rates yield.

Bone	Liver	Thyroid	Kidney	Lung	GI-LLI	W.Body
mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr
4.8E+00	5.08E+00	0.0E+00	2.7E-01	7.0E-01	1.0E-02	3.1E-01

7. The ODCM 3.11.2.1.b dose rate limit to any organ is 1500 mrem/yr. From the preceding calculation the Infant's Liver is the maximum exposed organ at 0.34 percent of the site dose rate limit.

8. A particulate channel setpoint of 10,000 cpm provides a conservative setpoint given that this channel analyzes gross activity on a fixed filter, Cs-137 is a typical long-lived fission product present at all times with spent fuel in the pool, and that sample collection intervals shorter than 1 hour would provide adequate warning response if significant particulate activity were being released, i.e., the above assumptions assume a Cs-137 activity of ~1.4E-06 uCi/cc.

9. The setpoint of 10,000 cpm was administratively chosen to provide early detection/alarm of a problem. The above dose rate calculations are provided to document that the particulate channel is capable of detection sensitivities to insure compliance with the ODCM site limit. Grab samples should be performed to accurately calculate actual releases associated with real high alarm events as per the ODCM methodology for performing dose rate calculations.

2.2 (continued)

2. Total Body and Skin Nuclide Specific Dose Rate Calculations

The following outline provides a step-by-step explanation of how the total body dose rate is calculated on a nuclide-by-nuclide basis to evaluate compliance with Control 3.11.2.1. This method is only used if the actual releases exceed the value of 3.5 X 10^5 µCi/sec.

A. The (X/Q) value =__________sec/m^3 and__________is the most limiting sector at the exclusion area. (See Table M-1 for value and sector.)

B. Enter the release rate in ft^3/min of the release source and convert it to:

$$= \frac{(\qquad) ft^3}{\text{min}} X \frac{2.8317\ X\ 10^4 cc}{ft^3} X \frac{\text{min}}{60\ \text{sec}}$$

= cc/sec volume release rate

C. Solve for(Q DOT)$_i$ for nuclide (i) by obtaining the µCi/cc assay value of the release source and multiplying it by the product of 2.2.2.B above.

(Q DOT)$_i$ = (nuclide [i])

$$\frac{(assay)\quad \mu Ci}{cc} X \frac{(2.2.2.B\ value)\ cc}{\text{sec}}$$

(Q DOT)$_i$ = µCi/sec for nuclide (i)

D. To evaluate the total body dose rate obtain the K_i value for nuclide (i) from Table G-2.

E. Solve for DR_{TBI}

$$DR_{TBI} = K_i(X/Q)\ (Q\ DOT)_i = \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr} X \frac{\text{sec}}{m^3} X \frac{\mu Ci}{\text{sec}}$$

DR_{TBI} = $\frac{\text{mrem}}{\text{yr}}$ total body dose from nuclide (i) for the specified release source

2.2 (continued)

2. (continued)

F. To evaluate the skin dose rate, obtain the L_i and M_i values from Table G-2 for nuclide (i).

G. Solve for $DR_{skin\ i}$

$$DR_{skin\ i} = [L_i + 1.1\ M_i]\ (X/Q)(Q\ DOT)_i$$

$DR_{skin\ i}$ = $\frac{mrem}{yr}$ skin dose from nuclide (i) for the specified release source

H. Repeat steps 2.2.2.D through 2.2.2.G for each noble gas nuclide (i) reported in the assay of the release source.

I. The Dose Rate to the Total Body from radioactive noble gas gamma radiation from the specified release source is:

$$DR_{TB} = \sum_{i}^{n} DR_{TBi}$$

J. The Dose Rate to the skin from noble gas radiation from the specified release source is:

$$DR_{skin} = \sum_{i}^{n} DR_{skin\ i}$$

The dose rate contribution of this release source shall be added to all other gaseous release sources that are in progress at the time of interest. Refer to in-plant procedures and logs to determine the Total Dose Rate to the Total Body and Skin from noble gas effluents.

2.3 Determining the Radioiodine & Particulate Dose Rate to Any Organ From Gaseous Releases

Discussion - Control 3.11.2.1 limits the dose rate from I-131, I-133, tritium and all radionuclides in particulate form with half lives >eight days to ≤1500 mrem/yr to any organ. The following calculation method is provided for determining the dose rate from radioiodines (see 2.1) and particulates and is based on Section 5.2.1 and 5.2.1.1 through 5.2.1.3 in NUREG-0133, November 1978. The Infant is the controlling age group in the inhalation, ground plane and cow/goat milk pathways, which are the only pathways considered for releases. The long term $(X/Q)_D$ (depleted) and (D/Q) values are based on historical MET data prior to implementing Appendix I. Only those nuclides that appear on their respective table will be considered. The equations are:

For Inhalation Pathway (excluding H-3):

$$DR_{I\&8DP_T} = \sum_{i}^{n} R^{*}_{i_T} \, (X/Q)_D \, (Q\ DOT)_i$$

For Ground Plane:

$$DR_{I\&8DP_T} = \sum_{i}^{n} P_{i_T} \, (D/Q)(Q\ DOT)_i$$

For Grass-Cow/Goat-Milk:

$$DR_{I\&8DP_T} = \sum_{i}^{n} R^{*}_{i_T} \, (D/Q)(Q\ DOT)_i$$

For Tritium Releases (Inhalation & Grass-Cow/Goat-Milk):

$$DR_{H3_T} = R^{*}_{H-3_T} \, (X/Q)_D \, (Q\ DOT)_{H-3}$$

* Normally should be Pi_T, but Ri_T values are the same, thus use Ri_T tables in Appendix A.

2.3 (continued)

For Total Dose Rate from I & 8DP and H-3 To An Infant Organ T:

$$DR_T = \sum_Z [DR_{I\&8DP_T} + DR_{H\text{-}3_T}]$$

Where:

T	=	The organ of interest for the infant age group
z	=	The applicable pathways
$DR_{I\&8DP_T}$	=	Dose Rate in mrem/yr to the organ T from iodines and 8 day particulates
$DR_{H\text{-}3T}$	=	Dose Rate in mrem/yr to organ T from Tritium
DR_T	=	Total Dose Rate in mrem/yr to organ T from all pathways under consideration
$\sum_i^n$	=	A mathematical symbol to signify the operations to the right of the symbol are to be performed for each nuclide (i) through (n) and the individual nuclide dose rates are summed to arrive at the total dose rate from the pathway.
$\sum_Z$	=	A mathematical symbol to indicate that the total dose rate D_T to organ T is the sum of each of the pathways dose rates
R_i	=	The dose factor for nuclide (i) for organ T for the pathway specified (units vary by pathway)
P_i	=	The dose factor for instantaneous ground plane pathway in units of $\dfrac{\text{mrem-m}^2\text{ sec}}{\mu\text{Ci-yr}}$

2.3 (continued)

From an evaluation of the radioactive releases and environmental pathways, the grass-cow/goat-milk pathway has been identified as the most limiting pathway with the infant's thyroid being the critical organ. This pathway typically contributes >90% of the total dose received by the infant's thyroid and the radioiodine contribute essentially all of this dose. Therefore, it is possible to demonstrate compliance with the release rate limit of Control 3.11.2.1 for radioiodines and particulates by only evaluating the infant's thyroid dose for the release of radioiodines via the grass-cow/goat-milk pathway. The calculation method of Section 2.3.3 is used for this determination. If this limited analysis approach is used, the dose calculations for other radioactive particulate matter and other pathways need not be performed. Only the calculations of Section 2.3.3 for the radioiodines need be performed to demonstrate compliance with the Control dose rate limit.

The calculations of Sections 2.3.1, 2.3.2, 2.3.4 and 2.3.5 may be omitted. The dose rate calculations as specified in these sections are included for completeness and are to be used only for evaluating unusual circumstances where releases of particulate materials other than radioiodines in airborne releases are abnormally high. The calculations of Sections 2.3.1, 2.3.2, 2.3.4 and 2.3.5 will typically be used to demonstrate compliance with the dose rate limit of Control 3.11.2.1 for radioiodines and particulates when the measured releases of particulate material (other than radioiodines and with half lives >8 days) are >10 times the measured releases of radioiodines.

1. The Inhalation Dose Rate Method:

NOTE
The H-3 dose is calculated as per 2.3.4.

A. The controlling location is assumed to be an Infant located in the ______________ sector at the ______________ mile range. The $(X/Q)_D$ for this location is ______________ sec/m^3. This value is common to all nuclides. (See Table M-2 for value, sector and range.)

B. Enter the release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\_\_\_\_\_\_\_\_ \ ft^3}{\min} X \frac{2.8317 \ X \ 10^4 cc}{ft^3} X \frac{\min}{60 \text{ sec.}} = cc/\text{sec}$$

2.3 (continued)

1. (continued)

C. Solve for $(Q\ DOT)_i$ for nuclide (i) by obtaining the μCi/cc assay value of the release source activity and multiplying it by the product of 2.3.1.B above.

$$(Q\ DOT)_i = \frac{(nuclide\ [i]\ assay)\ \mu Ci}{cc} \times \frac{(Value\ 2.3.1.B)\ cc}{sec}$$

$(Q\ DOT)_i =$ μCi/sec for nuclide (i)

D. Obtain the R_i value from Table G-5 for the organ T.

E. Solve for DR_i

$$DR_{iT} = R_{iT}\ (X/Q)_D\ (Q\ DOT)_i = \frac{mrem\text{-}m^3}{\mu Ci\text{-}yr} \times \frac{sec}{m^3} \times \frac{\mu Ci}{sec}$$

$DR_{iT} = \frac{mrem}{yr}$ The Dose Rate to organ T from nuclide (i)

F. Repeat steps 2.3.1.C through 2.3.1.E for each nuclide (i) reported in the assay of the release source.

G. The Dose Rate to the Infants organ T from the Inhalation Pathway is:

$$DR_{Inhalation_T} = DR_1 + DR_2 + \_\_\_\_\_ + DR_n$$

for all nuclides except H-3. This dose rate shall be added to the other pathways as per 2.3.5 - Total Organ Dose.

> NOTE
> Steps 2.3.1.C through 2.3.1.G need to be completed for each organ T of the Infant.

2.3 (continued)

2. The Ground Plane Dose Rate Method:

NOTE
Tritium dose via the ground plane is zero.

A. The controlling location is assumed to be an Infant located in the __________ sector at the __________ mile range. The (D/Q) for this location is __________ $1/m^2$. This value is common to all nuclides. (See Table M-2 for sector, range and value.)

B. Enter the release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\quad ft^3}{min} \; X \; \frac{2.8317 \; X \; 10^4 cc}{ft^3} \; X \; \frac{min}{60 \text{ sec.}} = cc/\text{sec}$$

C. Solve for $(Q\ DOT)_i$ for nuclide (i) by obtaining the µCi/cc assay value from the release source activity and multiplying it by the product of 2.3.2.B above.

$$(Q\ DOT)_i = \frac{(nuclide\ [i]\ assay)\ \mu Ci}{cc} \; X \; \frac{(Value\ 2.3.2.B)\ cc}{\text{sec}}$$

$(Q\ DOT)_i$ = µCi/sec for nuclide (i)

D. Obtain the P_i value from Table G-3

E. Solve for DR_i

$$DR_i = P_{iT}\ (D/Q)\ (Q\ DOT)_i = \frac{mrem\text{-}m^2 - \text{sec}}{\mu Ci\text{-}yr} \; X \; \frac{1}{m^2} \; X \; \frac{\mu Ci}{\text{sec}}$$

$DR_i = \frac{mrem}{yr}$ The Dose Rate to organ T from nuclide (i)

2.3 (continued)

2. (continued)

F. Repeat steps 2.3.2.C through 2.3.2.E for each nuclide (i) reported in the assay of the release source.

G. The Dose Rate to the Infant's Whole Body from the Ground Plane Pathway is:

$DR_{Gr\,Pl} = DR_1 + DR_2 + \_\_\_\_\_\_\_\_ + DR_n$

for all nuclides. This dose rate shall be added to the other pathways as per 2.3.5.

3. The Grass-Cow/Goat-Milk Dose Rate Method:

NOTE H-3 dose is calculated as per 2.3.4.

A. The controlling animal was established as a __________ located in the __________ sector at __________ miles. The (D/Q) for this location is __________ $1/m^2$. This value is common to all nuclides. (See Table M-3 for sector, range and value.)

B. Enter the anticipated release rate in ft^3/min of the release source and convert to cc/sec.

$$= \frac{\_\_\_\_\_\_ ft^3}{min} X \frac{2.8317 X 10^4 cc}{ft_3} X \frac{min}{60 \text{ sec.}} = cc/\text{sec}$$

C. Solve for $(Q\ DOT)_i$ for nuclide (i) by obtaining the µCi/cc assay value of the release source activity and multiplying it by the product of 2.3.3.B above.

$$(Q\ DOT)_i = \frac{(nuclide\ [i]\ assay)\ \mu Ci}{cc} X \frac{(value\ 2.3.3.B)\ cc}{sec}$$

$(Q\ DOT)_i$ = µCi/sec for nuclide (i)

2.3 (continued)

3. (continued)

D. Obtain the R_I value from Table G-6(7) (whichever is the controlling animal, cow/goat, for infant).

If the limited analysis approach is being used, limit the calculation to the infant thyroid.

E. Solve for DR_{iT}

$$DR_{iT} = R_{iT}\ (D/Q)\ (Q\ DOT)_i = \frac{mrem\text{-}m^2 - \sec}{\mu Ci\text{-}yr} \times \frac{1}{m^2} \times \frac{\mu Ci}{\sec}$$

$DR_{iT} = \frac{mrem}{yr}$ the Dose Rate to organ T from nuclide (i)

F. Repeat steps 2.3.3.C through 2.3.3.E for each nuclide (i) reported in the assay of the release source.

Only the radioiodines need to be included if the limited analysis approach is being used.

G. The Dose Rate to the Infant's organ T from Grass-__________-Milk pathway is:

DR_{grass}-________-$Milk_T$ = $DR_1 + DR_2 +$ ______ $+ DR_n$

for all nuclides. This dose rate shall be added to the other pathways as per 2.3.5 - Total Organ Dose.

NOTE

Steps 2.3.3.C through 2.3.3.G need to be completed for each organ of the Infant. Limit the calculation to the infant thyroid if the limited analysis approach is being used.

2.3 (continued)

4. The H-3 Dose Rate Method:

A. The controlling locations and their $(X/Q)_D$ values for each pathway are:

Inhalation - Infant at __________ range in the __________ sector.

$(X/Q)_D$ = sec/m^3 (See Table M-2 for range, sector and value)

Ground Plane - Does not apply to H-3

Grass-Cow/Goat-Milk-__________ located in the __________ sector at _____miles with an Infant at the exclusion area in the __________ sector drinking the milk. The $(X/Q)_D$ for the __________ location is $(X/Q)_D$ = __________ sec/m^3. (From Table M-6 at the range and sector corresponding to the location of the Milk Animal above.)

B. Enter the anticipated release rate in ft^3/min of the release source and convert it to cc/sec.

$$= \frac{\_\_\_\_\_\ ft^3}{min} X \frac{2.8317\ X\ 10^4\ cc}{ft^3} X \frac{min}{60\ sec.}$$

= cc/sec volume release rate

C. Solve for $(Q\ DOT)_{H-3}$ for Tritium, by obtaining the µCi/cc assay value of the release source and multiplying it by the product of 2.3.4.B above.

$$(Q\ DOT)_{H-3} = \frac{(H\text{-}3)\ \mu Ci}{cc} X \frac{(2.3.4.B\ value)\ cc}{sec}$$

$(Q\ DOT)_{H-3}$ = µCi/sec activity release rate

D. Obtain the Tritium dose factor (R_I) for Infant organ T from:

PATH	TABLE #
Inhalation	G-5
Grass-Cow/Goat-Milk	G-6(7)

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)
METHODOLOGY SECTION

2.3 (continued)

4. (continued)

E. Solve for D_{H-3} (Inhalation) using the $(X/Q)_D$ for inhalation from 2.3.4.A and R_{H-3} (Inhalation) from 2.3.4.D.

$$DR_{H-3_{inh_T}} = R_{H-3}\ (X/Q)_D\ (Q\ DOT)_{H-3}$$

$DR_{H-3_{inh_T}}$ = *mrem/yr from H-3 Infant Inhalation for organ T*

F. Solve for D_{H-3} (Grass-__________-Milk) using the $(X/Q)_D$ for Grass-__________-Milk from 2.3.4.A and R_{H-3} (Grass-__________-Milk) from 2.3.4.D

$$DR_{H-3_{G\ \ M_T}} = R_{H-3_{G\ \ M_T}}\ (X/Q)_D\ (Q\ DOT)_{H-3}$$

$DR_{H-3_{G\ \ M_T}}$ = *mrem/yr from H-3 Infant*

G. Repeat steps 2.3.4.D through 2.3.4.F for each Infant organ T of interest.

H. The individual organ dose rates from H-3 shall be added to the other organ pathway dose rates as per 2.3.5.

2.3 (continued)

5. Determining the Total Organ Dose Rate from Iodines, 8D-Particulates, and H-3 from Release Source(s)

A. The following table describes all the pathways that must be summed to arrive at the total dose rate to an organ T:

PATHWAY	DOSE RATE	STEP # REF.
Inhalation (I&8DP)		2.3.1.G
Ground Plane (I&8DP)	(Whole Body only)	2.3.2.G
Gr-________Milk (I&8DP)		2.3.3.G
Inhalation (H-3)		2.3.4.E
Gr-________-Milk (H-3)		2.3.4.F
DR_T=	(sum of above)	

B. Repeat the above summation for each Infant organ T.

C. The DR_T above shall be added to all other release sources on the site that will be in progress at any instant. Refer to in-plant procedures and logs to determine the Total DR_T to each organ.

2.4 Determining the Gamma Air Dose for Radioactive Noble Gas Release Source(s)

Discussion - Control 3.11.2.2 limits the air dose due to noble gases in gaseous effluents for gamma radiation to <5 mrads for the quarter and to <10 mrads in any calendar year. The following calculation method is provided for determining the noble gas gamma air dose and is based on section 5.3.1 of NUREG-0133, November 1978. The dose calculation is independent of any age group. The equation may be used for Control dose calculation, the dose calculation for the annual report or for projecting dose, provided that the appropriate value of (X/Q) is used as outlined in the detailed explanation that follows. The equation for gamma air dose is:

$$D_{\gamma}\text{-}air = \sum_{i}^{n} 3.17 \times 10^{-8} M_i (X/Q) Q_i$$

2.4 (continued)

Where:

D_γ-air = gamma air dose in mrad from radioactive noble gases.

Σ = A mathematical symbol to signify the operations to the right side of the symbol are to be performed for each nuclide (i) through (n) and summed to arrive at the total dose, from all nuclides reported during the interval. No units apply.

3.17×10^{-8} = the inverse of the number of seconds per year with units of year/sec.

M_i = the gamma air dose factor for radioactive noble gas nuclide (i) in units of $\frac{\text{mrad-m}^3}{\mu\text{Ci-yr}}$

(X/Q) = the long term atmospheric dispersion factor for ground level releases in units of sec/m^3. The value of (X/Q) is the same for all nuclides (i) in the dose calculation, but the value of (X/Q) does vary depending on the Limiting Sector the Control is based on, etc.

Q_i = the number of micro-curies of nuclide (i) released (or projected) during the dose calculation exposure period. (e.g., month, quarter or year)

2.4 (continued)

The following steps provide a detailed explanation of how the radionuclide specific dose is calculated.

1. To determine the applicable (X/Q) refer to Table M-1 to obtain the value for the type of dose calculation being performed. (i.e., Quarterly Control or Dose Projection for examples). This value of (X/Q) applies to each nuclide (i).

2. Determine (M_i) the gamma air dose factor for nuclide (i) from Table G-2.

3. Obtain the micro-Curies of nuclide (i) from the in-plant radioactive gaseous waste management logs for the sources under consideration during the time interval.

4. Solve for D_i as follows:

$$D_i = \frac{3.17 \times 10^{-8}\ yr}{sec} \times \frac{M_i\ mrad\text{-}m^3}{\mu Ci\text{-}yr} \times \frac{(X/Q)\ sec}{m^3} \times \frac{Q_i\ \mu Ci}{1}$$

   D_i = mrad = the dose from nuclide (i)

5. Perform steps 2.4.2 through 2.4.4 for each nuclide (i) reported during the time interval in the source.

6. The total gamma air dose for the pathway is determined by summing the D_i dose of each nuclide (i) to obtain D_γ-air dose.

   $D_{\gamma\text{-air}} = D_1 + D_2 + \_\_\_\_\_ + D_n$ = mrad

7. Refer to in-plant procedures for comparing the calculated dose to any applicable limits that might apply.

2.5 Determining the Beta Air Dose for Radioactive Noble Gas Releases

Discussion - Control 3.11.2.2 limits the quarterly air dose due to beta radiation from noble gases in gaseous effluents to <10 mrads in any calendar quarter and <20 mrads in any calendar year. The following calculation method is provided for determining the beta air dose and is based on Section 5.3.1 of NUREG-0133, November 1978. The dose calculation is independent of any age group. The equation may be used for Control dose calculation, dose calculation for annual reports or for projecting dose, provided that the appropriate value of (X/Q) is used as outlined in the detailed explanation that follows.

The equation for beta air dose is:

$$D_{B\text{-}air} \sum_{i}^{n} = 3.17 X 10^{-8} N_i (X/Q)\ Q_i$$

Where:

$D_{B\text{-air}}$	=	beta air dose in mrad from radioactive noble gases.
$\sum_{i}^{n}$	=	a mathematical symbol to signify the operations to the right side of the symbol are to be performed for each nuclide (i) through (n) and summed to arrive at the total dose, from all nuclides reported during the interval. No units apply.
$3.17 X 10^{-8}$	=	the inverse of the number of seconds per year with units of year/sec.
N_i	=	the beta air dose factor for radioactive noble gas nuclide (i) in units of $\frac{\text{mrad-m}^3}{\mu\text{Ci-yr}}$
(X/Q)	=	the long term atmospheric dispersion factor for ground level releases in units of sec/m^3. The value of (X/Q) is the same for all nuclides (i) in the dose calculation, but the value of (X/Q) does vary depending on the Limiting Sector the Control is based on, etc.
Q_i	=	the number of micro-Curies of nuclide (i) released (or projected) during the dose calculation exposure period

2.5 (continued)

The following steps provide a detailed explanation of how the dose is calculated.

1. To determine the applicable (X/Q) refer to Table M-1 to obtain the value for the type of dose calculation being performed (i.e., quarterly Control or Dose projection for examples). This value of (X/Q) applies to each nuclide (i).

2. Determine (N_i) the beta air dose factor for nuclide (i) from Table G-2.

3. Obtain the micro-curies of nuclide (i) from the in-plant radioactive gaseous waste management logs for the source under consideration during the time interval.

4. Solve for D_i as follows:

$$D_i = \frac{3.17 \ X \ 10^{-8} \ yr}{\text{sec}} \ X \ \frac{N_i \ mrad\text{-}m^3}{\mu Ci\text{-}yr} \ X \ \frac{(X/Q) \ \text{sec}}{M^3} \ X \ \frac{Q_i \ \mu Ci}{1}$$

   D_i = mrad = the dose from nuclide (i)

5. Perform steps 2.5.2 through 2.5.4 for each nuclide (i) reported during the time interval in the release source.

6. The total beta air dose for the pathway is determined by summing the D_i dose of each nuclide (i) to obtain $D_{B\text{-}air}$ dose.

   $D_{B\text{-}air} = D_1 + D_2$ ________ $+ D_n$ = mrad

7. Refer to in-plant procedures for comparing the calculated dose to any applicable limits that might apply.

2.6 Determining the Radioiodine and Particulate Dose To Any Age Group's Organ From Cumulative Releases

Discussion - Control 3.11.2.3 limits the dose to the whole body or any organ resulting from the release of I-131, I-133, tritium and particulates with half-lives >8 days to ≤7.5 mrem during any calendar quarter and ≤15 mrem during any calendar year. The following calculation method is provided for determining the critical organ dose due to releases of radioiodines and particulates and is based on Section 5.3.1 of NUREG-0133, November 1978. The equations can be used for any age group provided that the appropriate dose factors are used and the total dose reflects only those pathways that are applicable to the age group. The Effluent Supervisor will track which age group is the controlling (most restrictive) age group (see control 3.11.2.6.c). The $(X/Q)_D$ symbol represents a DEPLETED-(X/Q) which is different from the Noble Gas (X/Q) in that $(X/Q)_D$ takes into account the loss of I&8DP and H-3 from the plume as the semi-infinite cloud travels over a given distance. The (D/Q) dispersion factor represents the rate of fallout from the cloud that affects a square meter of ground at various distances from the site. The I&8DP and H-3 notations refer to I-131, I-133 Particulates having half-lives >8 days and Tritium. For ease of calculations, dose from other Iodine nuclides may be included (see 2.1). Tritium calculations are always based on $(X/Q)_D$. The first step is to calculate the I&8DP and H-3 dose for each pathway that applies to a given age group. The total dose to an organ can then be determined by summing the pathways that apply to the receptor in the sector. The infant age group does not apply to Grass-Cow-Meat or Vegetation pathway dose since they are assumed to eat only milk.

The equations are:

For Inhalation Pathway (excluding H-3):

$$D_{I\&8DP_T} = \sum_{i}^{n} 3.17 \, X \, 10^{-8} R_i \, (X/Q)_D Q_i$$

For Ground Plane, Grass-Cow/Goat-Milk, Grass-Cow/Goat-Milk, or Vegetation

$$D_{I\&8DP_T} = \sum_{i}^{n} 3.17 \, X \, 10^{-8} R_i \, (D/Q) Q_i$$

For each pathway above (excluding Ground Plane) For Tritium:

$$D_{H\text{-}3_T} = 3.17 \, X \, 10^{-8} R_{H\text{-}3T} (X/Q)_D Q_i$$

2.6 (continued)

For Total Dose from Particulate Gaseous effluent to organ T of a specified age group:

$$D_T = \sum_{Z} [D_{I\&8DP} + D_{H\text{-}3}]$$

Where:

T	=	the organ of interest of a specified age group
z	=	the applicable pathways for the age group of interest
$D_{I\&8DP}$	=	Dose in mrem to the organ T of a specified age group from radioiodines and 8D Particulates
$D_{H\text{-}3}$	=	Dose in mrem to the organ T of a specified age group from Tritium
D_T	=	Total Dose in mrem to the organ T of a specified age group from Gaseous particulate Effluents
$\sum_{i}^{n}$	=	A mathematical symbol to signify the operations to the right of the symbol are to be performed for each nuclide (i) through (n) and the individual nuclide doses are summed to arrive at the total dose from the pathway of interest to organ T.
$\sum_{Z}$	=	A mathematical symbol to indicate that the total dose D_T to organ T is the sum of each of the pathway doses of I&8DP and H-3 from gaseous particulate effluents.
3.17×10^{-8}	=	The inverse of the number of seconds per year with units of year/sec.
R_i	=	The dose factor for nuclide (i) (or H-3) for pathway Z to organ T of the specified age group. The units are either

$$\frac{mrem\text{-}m^3}{yr\text{-}\mu Ci} \text{ for pathways using } (X/Q)_D \quad OR \quad \frac{mrem\text{-}m^2\text{ - sec}}{yr\text{-}\mu Ci} \text{ for pathways using } (D/Q)$$

2.6 (continued)

$(X/Q)_D$ = The depleted-(X/Q) value for a specific location where the receptor is located (see discussion). The units are sec/m^3

(D/Q) = the deposition value for a specific location where the receptor is located (see discussion). The units are 1/m^2 where m=meters.

Q_i = The number of micro-Curies of nuclide (i) released (or projected) during the dose calculation exposure period.

Q_{H-3} = the number of micro-Curies of H-3 released (or projected) during the dose calculation exposure period.

1. The Inhalation Dose Pathway Method:

NOTE
The H-3 dose should be calculated as per 2.6.4.

A. Determine the applicable $(X/Q)_D$ from Table M-2 for the location where the receptor is located. This value is common to each nuclide (i)

B. For the age group(s) of interest, determine the R_i factor of nuclide (i) for the organ T and age group from the appropriate table number.

Age Group	Inhalation Dose Factor Table Number
Infant	G-5
Child	G-8
Teen	G-13
Adult	G-18

C. Obtain the micro-Curies (Q_i) of nuclide (i) from the radioactive gas waste management logs for the release source(s) under consideration during the time interval.

D. Solve for D_i

$D_i = 3.17 \text{ X } 10^{-8} Ri(X/Q)_D Q_i$

D_i = mrem from nuclide (i)

2.6 (continued)

1. (continued)

E. Perform steps 2.6.1.B through 2.6.1.D for each nuclide (i) reported during the time interval for each organ.

F. The Inhalation dose to organ T of the specified age group is determined by summing the D_i Dose of each nuclide (i)

$$D_{\substack{Inhalation \\ (Age\ Group)}} = D_1 + D_2 + \_\_\_\_\_ + D_n = \qquad mrem$$

Refer to 2.6.5 to determine the total dose to organ T from radioiodines & 8D Particulates

2. The Ground Plane Dose Pathway Method:

NOTE
Tritium dose via the ground plane is zero. The Whole Body is the only organ considered for the Ground Plane pathway dose.

A. Determine the applicable (D/Q) from Table M-2 for the location where the receptor is located. This (D/Q) value is common to each nuclide (i)

B. Determine the Ri factor of nuclide (i) for the whole body from Table G-4. The ground plane pathway dose is the same for all age groups.

C. Obtain the micro-Curies (Q_i) of nuclide (i) from the radioactive gas waste management logs for the source under consideration.

D. Solve for D_i

$$D_i = 3.17\ X\ 10^{-8} R_i\ (D/Q) Q_i$$

D_i = mrem for nuclide (i)

2.6 (continued)

2. (continued)

E. Perform steps 2.6.2.B through 2.6.2.D for each nuclide (i) reported during the time interval.

F. The Ground Plane dose to the whole body is determined by summing the Di Dose of each nuclide (i)

$D_{Gr.Pl.-WBody} = D_1 + D_2 + \_\_\_\_\_ + D_n =$ mrem

Refer to step 2.6.5 to calculate total dose to the Whole Body.

3. The Grass-Cow/Goat-Milk Dose Pathway Method:

NOTE
Tritium dose is calculated as per 2.6.4.

A. A cow or a goat, will be the controlling animal; (i.e., dose will not be the sum of each animal), as the human receptor is assumed to drink milk from only the most restrictive animal. Refer to Table M-3 to determine which animal is controlling based on its (D/Q).

B. For the age group(s) of interest, determine the dose factor R_I for nuclide (i), for organ T, from the appropriate table number for the applicable milk animal.

Age Group	Cow Milk Dose Factor Table Number	Goat Milk Dose Factor Table Number
Infant	G-6	G-7
Child	G-9	G-10
Teen	G-14	G-15
Adult	G-19	G-20

/R21

2.6 (continued)

3. (continued)

C. Obtain the micro-Curies (Q_i) of nuclide (i) from the radioactive gas waste management logs for the release source under consideration during the time interval.

D. Solve for D_i

$D_i = 3.17 \times 10^{-8} R_i (D/Q) Q_i$

D_i = mrem from nuclide (i)

E. Perform steps 2.6.3.B through 2.6.3.D for each nuclide (i) reported during the time interval. Only the radioiodines need to be included if the limited analysis approach is used.

F. The Grass-Cow-Milk (or Grass-Goat-Milk) pathway dose to organ T is determined by summing the Di dose of each nuclide(i).

$D_{G\text{-}C\text{-}M}$ (or $D_{G\text{-}G\text{-}M}$) = $D_1 + D_2 +$ _____ $+ D_n =$ mrem

The dose to each organ should be calculated in the same manner with steps 2.6.3.B through 2.6.3.F. Refer to step 2.6.5 to determine the total dose to organ T from radioiodines &8D Particulates. If the limited analysis approach is being used the infant thyroid dose via the grass-cow(goat)-milk pathway is the only dose that needs to be determined. Section 2.6.5 can be omitted.

4. The Grass-Cow/Goat-Meat Dose Pathway method:

NOTE
Tritium dose is calculated as per 2.6.6.

A. Determine the controlling herd location by:

1. For dose calculations (other than the annual report) the historical herd was determined to be located in Sector ______ at _________ miles. This herd shall be used for all ODCM Control required dose calculations.

2.6 (continued)

4. (continued)

A. (continued)

2. For annual report dose calculations the herd from the Land Use Census having the highest (D/Q) at its location will be the reporting herd. The Land Use Census for 1978 (for example) shall apply to the calendar year 1979 (for example) and will locate the nearest herd in each sector over land. The real (D/Q) will be determined from actual met data that occurred during the reporting period.

B. Determine the applicable (D/Q) from Table M-3 for the location(s) of the herd as determined in 2.6.4.A above.

C. Determine the dose factor Ri for nuclide (i) for organ tau from the Table specified below:

Age	Meat Dose Factor Table No.
Infant	N/A *
Child	G-11
Teen	G-16
Adult	G-21

* The infant does not eat meat and therefore dose does not apply to this pathway.

D. Obtain the micro-Curies (Qi) of nuclide (i) from the radioactive gas waste management logs (for projected doses - the micro-Curies of nuclide (i) to be projected) for the release source(s) under consideration during the time interval. The dose can be calculated from a single release source, but the total dose for ODCM Control Limits or annual reports shall be from all gaseous release sources.

2.6 (continued)

4. (continued)

E. Solve for Di

Di = 3.17 X 10 Ri (D/Q) Qi

Di = ________________ mrem from nuclide (i)

F. Perform Steps 2.6.4.C through 2.8.4.E for each nuclide (i) reported during the time interval.

G. The Grass-Cow-Meat pathway dose to organ tau is determined by summing the Di dose of each nuclide (i).

Dose = D1 + D2 + D3 + ... + Dn = ___________mrem

Grass-Cow-Meat
Excluding Tritium
(Child, Teen, or Adult)

5. The Vegetation (Garden) Dose Pathway method:

A. Determine the controlling garden location by:

1. For dose calculations (other than annual reports) the historical garden was determined to be located in Sector ______ at __________miles. This garden shall be used for all ODCM Control dose calculations.

2. For annual report dose calculations the Land Census Garden having the highest real (D/Q) at its location will be the reporting garden. The Land Use Census for 1978 (for example) shall apply to the calendar year 1979 (for example) and will locate the nearest garden in each sector. The real (D/Q) will be determined from actual met data that occurred during the reporting period.

B. Determine the applicable (D/Q) from Table M-3 for the location(s) of the garden(s) as determined above.

2.6 (continued)

5. (continued)

C. Determine the dose factor Ri for nuclide (i) for organ tau from the Table specified below:

Age	Vegetation Dose Factor Table No.
Infant	N/A *
Child	G-12
Teen	G-17
Adult	G-22

* denotes the infant does not eat vegetation and therefore does not apply to this pathway.

D. Obtain the micro-Curies (Qi) of nuclide (i) from the radioactive gas waste management logs (for projected doses - the micro-Curies of nuclide (i) to be projected) for the release source(s) under consideration during the time interval. The dose can be calculated from a single release source, but the total dose for ODCM Control Limits or annual reports shall be from all gaseous release sources.

E. Solve for Di

$$Di = 3.17 \times 10^{-8}\ Ri\ (D/Q)\ Qi$$

Di = ________________ mrem from nuclide (i)

F. Perform Steps 2.6.5.C through 2.6.5.E for each nuclide (i) reported during the time interval.

G. The Vegetation pathway dose to organ tau is determined by summing the Di dose of each nuclide (i).

Dose = D1 + D2 + D3 + ... + Dn = ___________mrem

Vegetation
(Excluding Tritium)
(Child, Teen, or Adult)

2.6 (continued)

6. The Gaseous Tritium Dose (Each Pathway) Method:

A. The controlling locations for the pathway(s) has already been determined by:

Inhalation	- as per 2.6.1.A
Ground Plane	- not applicable for H-3
Grass-Cow/Goat-Milk	- as per 2.6.3.A
Grass-Cow/Goat-Milk	- as per 2.6.4.A
Vegetation (Garden)	- as per 2.6.5.A

B. Tritium dose calculations use the depleted $(X/Q)_D$ instead of (D/Q). Table M-2 describes where the $(X/Q)_D$ value should be obtained from.

C. For the age group(s) of interest, determine the Pathway Tritium dose factor $(R_{H\text{-}3})$ for the organ T of interest from the Table specified below:

AGE	INHALATION	MILK	
		COW	GOAT
Infant	G-5	G-6	G-7
Child	G-8	G-9	G-10
Teen	G-13	G-14	G-15
Adult	G-18	G-19	G-20

D. Obtain the micro-Curies (Q) of Tritium from the radioactive gas waste management logs (for projected doses - the micro-Curies of nuclide (i) to be projected) for the release source(s) under consideration during the time interval. The dose can be calculated from a single release source, but the total dose for Control limits or quarterly reports shall be from all gaseous release sources.

E. Solve for $D_{H\text{-}3}$

$$D_{H\text{-}3} = 3.17 \times 10^{-8} R_{H\text{-}3}(X/Q)_D Q$$

$D_{H\text{-}3}$ = mrem from Tritium in the specified pathway for organ T of the specified age group

2.6 (continued)

7. Determining the Total Organ Dose From Iodines, 8D-Particulates and H-3 From Cumulative Gaseous Releases

> **NOTE**
> Control dose limits for I&8DP shall consider dose from all release sources from the reactor unit of interest.

A. The following pathways shall be summed to arrive at the total dose to organ T from a release source or if applicable to Control, from all release sources:

Age Group: INFANT CHILD TEEN ADULT Organ: BONE LIVER THYROID KIDNEY LUNG GI-LLI WHOLE BODY			
PATHWAY	DOSE	Reference to STEP No.	Remark
Inhalation (I&8DP)		2.6.1.F	
Inhalation (Tritium)		2.6.6.E	
Ground Plane (I&8DP)		2.6.2.F	
Grass-________-Milk (I&8DP)		2.6.3.F	
Grass-________-Milk (Tritium)		2.6.6.E	
Grass-________-Meat (I&8DP)		2.6.4.G	N/A for INFANT
Grass-________-Meat (Tritium)		2.6.6.E	N/A for INFANT
Vegetable Garden (I&8DP)		2.6.5.G	N/A for INFANT
Vegetable Garden (Tritium)		2.6.6.E	N/A for INFANT
$Dose_T$ =	(sum of above)		

B. The dose to each of the applicable age group's ORGANS shall be calculated:

BONE, LIVER, THYROID, KIDNEY, LUNG, WHOLE BODY, & GI-LLI

The age group organ receiving the highest exposure relative to its Control Limit is the most critical organ for that age group resulting from the radioiodine & 8D Particulates gaseous effluents.

2.7 Projecting Dose for Radioactive Gaseous Effluents

Discussion - Control 3.11.2.4 requires that the waste gas holdup system be used to reduce releases of radioactivity when the projected doses in 31 days due to gaseous effluent releases, from each unit, to areas at and beyond the SITE BOUNDARY (see TS Figure 5-1-1) would exceed 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation. The following calculation method is provided for determining the projected doses. This method is based on using the results of the calculations performed in Sections 2.4 and 2.5.

1. Obtain the latest results of the monthly calculations of the gamma air dose (Section 2.4) and the beta air dose if performed (Section 2.5). These doses can be obtained from the in-plant records.

2. Divide these doses by the number of days the plant was operational during the month.

3. Multiply the quotient by the number of days the plant is projected to be operational during the next month. The product is the projected dose for the next month. The value should be adjusted as needed to account for any changes in failed-fuel or other identifiable operating conditions that could significantly alter the actual releases.

4. If the projected doses are >0.2 mrads gamma air dose or > 0.4 mrads beta air dose, the appropriate subsystems of the waste gas holdup system shall be used.

3.0 40 CFR 190 Dose Evaluation

Discussion - Dose or dose commitment to a real individual from all uranium fuel cycle sources be limited to ≤25 mrem to the whole body or any organ (except thyroid, which is limited to ≤75 mrem) over a period of 12 consecutive months. The following approach should be used to demonstrate compliance with these dose limits. This approach is based on NUREG-0133, Section 3.8.

3.1 Evaluation Bases

Dose evaluations to demonstrate compliance with the above dose limits need only be performed if the quarterly doses calculated in Sections 1.4, 2.4 and 2.6 exceed twice the dose limits of Controls 3.11.1.2.a, 3.11.1.2.b, 3.11.2.2a, 3.1.2.2b, 3.11.2.3a and 3.11.2.3b respectively; i.e., quarterly doses exceeding 3 mrem to the whole body (liquid releases), 10 mrem to any organ (liquid releases), 10 mrads gamma air dose, 20 mrads beta air dose or 15 mrem to the thyroid or any organ from radioiodines and particulates (atmospheric releases). Otherwise, no evaluations are required and the remainder of this section can be omitted.

3.2 Doses From Liquid Releases

For the evaluation of doses to real individuals from liquid releases, the same calculation method as employed in Section 1.4 will be used. However, more realistic assumptions will be made concerning the dilution and ingestion of fish and shellfish by individuals who live and fish in the area. Also, the results of the Radiological Environmental Monitoring program will be included in determining more realistic dose to these real people by providing data on actual measured levels of plant related radionuclides in the environment.

3.3 Doses From Atmospheric Releases

For the evaluation of doses to real individuals from the atmospheric releases, the same calculation methods as employed in Section 2.4 and 2.6 will be used. In Section 2.4, the total body dose factor (K_i) should be substituted for the gamma air dose factor (M_i) to determine the total body dose. Otherwise the same calculation sequence applies. However, more realistic assumptions will be made concerning the actual location of real individuals, the meteorological conditions and the consumption of food (e.g., milk). Data obtained from the latest land use census (Control 3.12.2) should be used to determine locations for evaluating doses. Also, the results of the Radiological Environmental Monitoring program will be included in determining more realistic doses to these real people by providing data on actual measured levels of radioactivity and radiation at locations of interest.

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OFFSITE DOSE CALCULATION MANUAL (ODCM)
METHODOLOGY SECTION

4.0 Annual Radioactive Effluent Report

Discussion - The information contained in a annual report shall not apply to any Control. The reported values are based on actual release conditions instead of historical conditions that the Control dose calculations are based on. The Control dose limits are therefore included in item 1 of the report, for information only. The ECLs in item 2 of the report shall be those listed in Tables L-1 and G-1 of this manual. The average energy in item 3 of the report is not applicable to the St. Lucie Plant. The format, order of nuclides and any values shown as an example in Tables 3.3 through 3.8 are samples only. Other formats are acceptable if they contain equivalent information. A table of contents should also accompany the report. The following format should be used:

RADIOACTIVE EFFLUENTS - SUPPLEMENTAL INFORMATION

1. Regulatory Limits:

1.1 For Radioactive liquid waste effluents:

a. The concentration of radioactive material released from the site (see TS Figure 5.1-1) shall be limited to ten times the concentrations specified in 10 CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2 X 10^{-4} µCi/ml total activity.

b. The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released from each reactor unit to unrestricted areas (See TS Fig. 5.1-1) shall be limited during any calendar quarter to $\leq$1.5 mrem to the whole body and to $\leq$5 mrem to any organ and $\leq$3 mrem to the whole body and $\leq$10 mrem to any organ during any calendar year.

1.2 For Radioactive Gaseous Waste Effluents:

a. The dose rate resulting from radioactive materials released in gaseous effluents to areas at or beyond the SITE BOUNDARY (See TS Figure 5.1-1) shall be limited to the following values:

The dose rate limit for noble gases shall be $\leq$500 mrem/yr to the total body and $\leq$3000 mrem/yr to the skin and

4.0 (continued)

1. (continued)

1.2 (continued)

a. (continued)

The dose rate limit from I-131, I-133, Tritium and particulates with half-lives >8 days shall be $\leq$1500 mrem/yr to any organ.

b. The air dose (see TS Figure 5.1-1) due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the SITE BOUNDARY shall be limited to the following:

During any calendar quarter, to $\leq$5 mrad for gamma radiation and $\leq$10 mrad for beta radiation and during any calendar year to $\leq$10 mrad for gamma radiation and $\leq$20 mrad for beta radiation

c. The dose to a MEMBER OF THE PUBLIC from I-131, I-133, Tritium and all radionuclide in particulate form, with half-lives >8 days in gaseous effluents released from each reactor unit to areas at and beyond the SITE BOUNDARY (see Figure 5.1-1 in the TS-A) shall be limited to the following:

During any calendar quarter to $\leq$7.5 mrem to any organ and during any calendar year to $\leq$15 mrem to any organ.

2. Effluent Limiting Concentrations:

Air - as per attached Table G-1

Water - as per attached Table L-1

3. Average energy of fission and activation gases in gaseous effluents is not applicable to the St. Lucie Plant.

4.0 (continued)

4. Measurements and Approximations of Total Radioactivity:

A summary of liquid effluent accounting methods is described in Table 3.1.

A summary of gaseous effluent accounting methods is described in Table 3.2.

Estimate of Errors:

Error Topic	LIQUID Avg. %	LIQUID Max. %	GASEOUS Avg. %	GASEOUS Max. %
Release Point Mixing	2	5	NA	NA
Sampling	1	5	2	5
Sample Preparation	1	5	1	5
Sample Analysis	3	10	3	10
Release Volume	2	5	4	15
Total %	9	30	10	35

(above values are examples only)

The predictability of error for radioactive releases can only be applied to nuclides that are predominant in sample spectrums. Nuclides that are near background relative to the predominant nuclides in a given sample could easily have errors greater than the above listed maximums.

4.0 (continued)

4. (continued)

TABLE 3.1
RADIOACTIVE LIQUID EFFLUENT SAMPLING AND ANALYSIS

LIQUID SOURCE	SAMPLING FREQUENCY	TYPE OF ANALYSIS	METHOD OF ANALYSIS
MONITOR TANK RELEASES	EACH BATCH	PRINCIPAL GAMMA EMITTERS	p.h.a.
	MONTHLY COMPOSITE	TRITIUM	L.S.
		GROSS ALPHA	G.F.P.
	QUARTERLY COMPOSITE	Sr-89, Sr-90, Fe-55	C.S.
STEAM GENERATOR BLOWDOWN RELEASES	FOUR PER MONTH	PRINCIPAL GAMMA EMITTERS AND DISSOLVED GASES	p.h.a.
	MONTHLY COMPOSITE	TRITIUM	L.S.
		GROSS ALPHA	G.F.P.
	QUARTERLY COMPOSITE	Sr-89, Sr-90, Fe-55	C.S.

TABLE NOTATION:

p.h.a. - gamma spectrum pulse height analysis using Lithium Germanium detectors. All peaks are identified and quantified.

L.S. - Liquid Scintillation counting

C.S. - Chemical Separation

G.F.P. - Gas Flow Proportional Counting

4.0 (continued)

4. (continued)

TABLE 3.2
RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS

GASEOUS SOURCE	SAMPLING FREQUENCY	TYPE OF ANALYSIS	METHOD OF ANALYSIS
Waste Gas Decay Tank Releases	Each Tank	Principal Gamma Emitters	G, p.h.a.
Containment Purge Releases	Each Purge	Principal Gamma Emitters	G, p.h.a.
		H-3	L.S.
Plant Vent	Four per Month	Principal Gamma Emitters	(G, C, P) - p.h.a.
		H-3	L.S.
	Monthly Composite (Particulates)	Gross Alpha	P - G. F. P.
	Quarterly Composite (Particulates)	Sr-90 Sr-89	C.S.

G - Gaseous Grab Sample

C - Charcoal Filter Sample

P - Particulate Filter Sample

L.S. - Liquid Scintillation Counting

C.S. - Chemical Separation

p.h.a. - Gamma spectrum pulse height analysis using Lithium Germanium detectors. All peaks are identified and quantified.

G.F.P. - Gas Flow Proportional Counting

4.0 (continued)

5. Batch Releases

A. Liquid

1. Number of batch releases: ______
2. Total time period of batch releases: ______minutes
3. Maximum time period for a batch release: ______minutes
4. Average time period for a batch release: ______minutes
5. Minimum time period for a batch release: ______minutes
6. Average dilution stream flow during the period (see Note 1 on Table 3.3): ______GPM

All liquid releases are summarized in tables

B. Gaseous

1. Number of batch releases: ______
2. Total time period for batch releases: ______minutes
3. Maximum time period for a batch release: ______minutes
4. Average time period for batch releases: ______minutes
5. Minimum time period for a batch release: ______minutes

All gaseous waste releases are summarized in tables

4.0 (continued)

6. Unplanned Releases

   A. Liquid

      1. Number of releases: ______

      2. Total activity releases: ______Curies

   B. Gaseous

      1. Number of releases: ______

      2. Total activity released: ______Curies

   C. See attachments (if applicable) for:

      1. A description of the event and equipment involved.

      2. Cause(s) for the unplanned release.

      3. Actions taken to prevent a recurrence

      4. Consequences of the unplanned release

7. Description of dose assessment of radiation dose from radioactive effluents to the general public due to their activities inside the site are reported on the January annual report.

8. Offsite dose calculation manual revisions initiated during this reporting period. See Control 3.11.2.6 for required attachments to the Annual Report.

9. Solid waste and irradiated fuel shipments as per requirements of Control 3.11.2.6.

10. Process Control Program (PCP) revisions as per requirements of TS 6.13.

11. Major changes to Radioactive Liquid, Gaseous and Solid Waste Treatment Systems as per requirements of Control 3.11.2.5.

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TABLE 3.3: LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

		UNIT	QUARTER #	QUARTER #
A.	Fission and Activation Products			
	1. Total Release - (Not including Tritium, Gases, Alpha)	Ci	______E	______E
	2. Average Diluted Concentration During Period	µCi/ml	______E	______E
B.	Tritium			
	1. Total Release	Ci	______E	______E
	2. Average Diluted Concentration During Period	µCi/ml	______E	______E
C.	Dissolved and Entrained Gases			
	1. Total Release	Ci	______E	______E
	2. Average Diluted Concentration During Period	µCi/ml	______E	______E
D.	Gross Alpha Radioactivity			
	1. Total Release	Ci	______E	______E

TABLE 3.3: LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES
(continued)

		UNIT	QUARTER #	QUARTER #
E.	Volume of Waste Released (Prior to Dilution)	LITERS	______E	______E
F.	Volume of Dilution Water Used During Period[1]	LITERS	______E	______E

1 - The volume reported should be for the entire interval of the reporting period, not just during release intervals. This volume should also be used to calculate average dilution stream flow during the period.

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TABLE 3.4: LIQUID EFFLUENTS (EXAMPLE FORMAT)

NUCLIDES RELEASED*	UNIT	CONTINUOUS MODE		BATCH MODE	
		QUARTER #	QUARTER #	QUARTER #	QUARTER #
I-131	CI	E	E	E	E
I-133	CI	E	E	E	E
I-135	CI	E	E	E	E
NA-24	CI	E	E	E	E
CR-51	CI	E	E	E	E
MN-54	CI	E	E	E	E
CO-57	CI	E	E	E	E
CO-58	CI	E	E	E	E
FE-59	CI	E	E	E	E
CO-60	CI	E	E	E	E
ZN-65	CI	E	E	E	E
NI-65	CI	E	E	E	E
AG-110	CI	E	E	E	E
SN-113	CI	E	E	E	E
SB-122	CI	E	E	E	E
SB-124	CI	E	E	E	E
W-187	CI	E	E	E	E
NP-239	CI	E	E	E	E
ZR-95	CI	E	E	E	E
MO-99	CI	E	E	E	E
RU-103	CI	E	E	E	E
CS-134	CI	E	E	E	E
CS-136	CI	E	E	E	E
CS-137	CI	E	E	E	E
BA-140	CI	E	E	E	E
CE-141	CI	E	E	E	E
BR-82	CI	E	E	E	E
ZR-97	CI	E	E	E	E
SB-125	CI	E	E	E	E

* All nuclides that were detected should be added to the partial list of the example format.

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TABLE 3.4: LIQUID EFFLUENTS (EXAMPLE FORMAT)
(continued)

NUCLIDES RELEASED	UNIT	CONTINUOUS MODE		BATCH MODE	
		QUARTER #	QUARTER #	QUARTER #	QUARTER #
CE-144	CI	E	E	E	E
SR-89	CI	E	E	E	E
SR-90	CI	E	E	E	E
UNIDENTIFIED	CI	E	E	E	E
TOTAL FOR PERIOD (ABOVE)	CI	E	E	E	E

AR-41	CI	E	E	E	E
KR-85	CI	E	E	E	E
XE-131M	CI	E	E	E	E
XE-133	CI	E	E	E	E
XE-133M	CI	E	E	E	E
XE-135	CI	E	E	E	E

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TABLE 3.5
LIQUID EFFLUENTS - DOSE SUMMATION

Age Group: __________ Location: _______________

Exposure Interval: From_______________ Through_______________

Fish & Shellfish Pathway to Organ	CALENDAR YEAR DOSE (mrem)
BONE	
LIVER	
THYROID	
KIDNEY	
LUNG	
GI-LLI	
WHOLE BODY	

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TABLE 3.6: GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QUARTER #	QUARTER #
A. Fission and Activation Gases			
1. Total Release	Ci	_____E	_____E
2. Average Release Rate For Period	µCi/SEC	_____E	_____E
B. Iodines			
1. Total Iodine-131	Ci	_____E	_____E
2. Average Release Rate for Period	µCi/SEC	_____E	_____E
C. Particulates			
1. Particulates T-1/2 > 8 Days	Ci	_____E	_____E
2. Average Release Rate for Period	µCi/SEC	_____E	_____E
3. Gross Alpha Radioactivity	Ci	_____E	_____E
D. Tritium			
1. Total Release	Ci	_____E	_____E
2. Average Release Rate for Period	µCi/SEC	_____E	_____E

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TABLE 3.7 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES
(EXAMPLE FORMAT)

NUCLIDES RELEASED*	UNIT	CONTINUOUS MODE		BATCH MODE	
		QUARTER #	QUARTER #	QUARTER #	QUARTER #
1. Fission Gases					
AR-41	CI	E	E	E	E
KR-85	CI	E	E	E	E
KR-85M	CI	E	E	E	E
KR-87	CI	E	E	E	E
KR-88	CI	E	E	E	E
XE-131M	CI	E	E	E	E
XE-133	CI	E	E	E	E
XE-133M	CI	E	E	E	E
XE-135	CI	E	E	E	E
XE-135M	CI	E	E	E	E
XE-138	CI	E	E	E	E
UNIDENTIFIED	CI	E	E	E	E
TOTAL FOR PERIOD (ABOVE)	CI	E	E	E	E
2. Iodines					
I-131	CI	E	E	E	E
I-133	CI	E	E	E	E
I-135	CI	E	E	E	E
TOTAL FOR PERIOD (ABOVE)	CI	E	E	E	E
3. Particulates					
CO-58	CI	E	E	E	E
SR-89	CI	E	E	E	E
SR-90	CI	E	E	E	E

*All nuclides that were detected should be added to the partial list of the example format.

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TABLE 3.8
GASEOUS EFFLUENTS - DOSE SUMMATION - CALENDAR YEAR
AGE GROUP: INFANT EXPOSURE INTERVAL: FROM________ THROUGH________

PATHWAY	BONE (mrem)	LIVER (mrem)	THYROID (mrem)	KIDNEY (mrem)	LUNG (mrem	GI-LLI (mrem)	WHOLE BODY (mrem)
Ground Plane (A)							
Grass- -Milk (B)							
Inhalation (A)							
TOTAL							

(A)	SECTOR:	RANGE: miles

(B)	COW / GOAT	SECTOR:	RANGE: miles

NOBLE GASES	CALENDAR YEAR (mrad)
Gamma Air Dose	
Beta Air Dose	
Sector:	Range: 0.97 miles

NOTE
The dose values above were calculated using actual meteorological data during the specified time interval with MET data reduced as per Reg. Guide 1.111, March 1976.

APPENDIX A

ECL, DOSE FACTOR

AND

HISTORICAL METEOROLOGICAL TABLES

TABLE L-1
EFFLUENT CONCENTRATION LIMITS IN WATER IN UNRESTRICTED AREAS

NOTE

If a nuclide is not listed below, refer to 10 CFR Part 20, Appendix B, Table 2 Effluent Concentrations Column 2 and use the most conservative ECL listed for the nuclide.

Nuclide	ECL (μCi/ml)	Nuclide	ECL (μCi/ml)	Nuclide	ECL (μCi/ml)
H-3	1 E-3	Y-90	7 E-6	Te-129	4 E-4
Na-24	5 E-5	Y-91m	2 E-3	Te-131m	8 E-6
P-32	9 E-6	Y-91	8 E-6	Te-131	8 E-5
Cr-51	5 E-4	Y-92	4 E-5	Te-132	9 E-6
Mn-54	3 E-5	Y-93	2 E-5	I-130	2 E-5
Mn-56	7 E-5	Zr-95	2 E-5	I-131	1 E-6
Fe-55	1 E-4	Zr-97	9 E-6	I-132	1 E-4
Fe-59	1 E-5	Nb-95	3 E-5	I-133	7 E-6
Co-57	6 E-5	Nb-97	3 E-4	I-134	4 E-4
Co-58	2 E-5	Mo-99	2 E-5	I-135	3 E-5
Co-60	3 E-6	Tc-99m	1 E-3	Cs-134	9 E-7
Ni-65	1 E-4	Tc-101	2 E-3	Cs-136	6 E-6
Cu-64	2 E-4	Ru-103	3 E-5	Cs-137	1 E-6
Zn-65	5 E-6	Ru-105	7 E-5	Cs-138	4 E-4
Zn-69	8 E-4	Ru-106	3 E-6	Ba-139	2 E-4
Br-82	4 E-5	Ag-110	6 E-6	Ba-140	8 E-6
Br-83	9 E-4	Sn-113	3 E-5	Ba-141	3 E-4
Br-84	4 E-4	In-113m	7 E-4	Ba-142	7 E-4
Rb-86	7 E-6	Sb-122	1 E-5	La-140	9 E-6
Rb-88	4 E-4	Sb-124	7 E-6	La-142	1 E-4
Rb-89	9 E-4	Sb-125	3 E-5	Ce-141	3 E-5
Sr-89	8 E-6	Te-125m	2 E-5	Ce-143	2 E-5
Sr-90	5 E-7	Te-127m	9 E-6	Ce-144	3 E-6
Sr-91	2 E-5	Te-127	1 E-4	Pr-144	6 E-4
Sr-92	4 E-5	Te-129m	7 E-6	W-187	3 E-5
				Np-239	2 E-5

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TABLE L-2
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H-3	0.	3.60E-01	3.60E-01	3.60E-01	3.60E-01	3.60E-01	3.60E-01
NA-24	6.08E-01	6.08E-01	6.08E-01	6.08E-01	6.08E-01	6.08E-01	6.08E-01
P-32	1.67E+07	1.05E+06	0.	0.	0.	1.88E+06	6.47E+05
CR-51	0.	0.	3.34E+00	1.23E+00	7.42E+00	1.41E+03	5.59E+00
MN-54	0.	7.07E+03	0.	2.10E+03	0.	2.17E+04	1.35E+03
MN-56	0.	1.78E+02	0.	2.26E+02	0.	5.68E+03	3.17E+01
FE-55	1.15E+05	5.19E+05	0.	0.	6.01E+05	2.03E+05	1.36E+05
FE-59	8.08E+04	1.92E+05	0.	0.	5.32E+04	6.33E+05	7.29E+04
CO-57	0.	1.42E+02	0.	0.	0.	3.60E+03	2.36E+02
CO-58	0.	6.05E+02	0.	0.	0.	1.22E+04	1.35E+03
CO-60	0.	1.74E+03	0.	0.	0.	3.26E+04	3.83E+03
NI-65	2.02E+02	2.63E+01	0.	0.	0.	6.65E+02	1.20E+01
CU-64	0.	2.15E+02	0.	5.41E+02	0.	1.83E+04	1.01E+02
ZN-65	1.62E+05	5.13E+05	0.	3.43E+05	0.	3.23E+05	2.32E+05
ZN-69	3.43E+02	6.60E+02	0.	4.27E+02	0.	9.87E+01	4.57E+01

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-2
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
BR-82	0.	0.	0.	0.	0.	4.68E+00	4.08E+00
BR-83	0.	0.	0.	0.	0.	1.05E-01	7.26E-02
BR-84	0.	0.	0.	0.	0.	7.38E-07	9.42E-02
BR-85	0.	0.	0.	0.	0.	0.	3.86E-03
RB-86	0.	6.25E+02	0.	0.	0.	1.23E+02	2.91E+02
RB-88	0.	1.79E+00	0.	0.	0.	0.	9.50E-01
RB-89	0.	1.19E+00	0.	0.	0.	0.	8.38E-01
SR-89	5.01E+03	0.	0.	0.	0.	8.01E+02	1.44E+02
SR-90	1.23E+05	0.	0.	0.	0.	1.65E+03	3.02E+04
SR-91	9.43E+01	0.	0.	0.	0.	4.75E+02	4.15E+00
SR-92	3.50E+01	0.	0.	0.	0.	6.91E+02	1.51E+00
Y-90	6.07E+00	0.	0.	0.	0.	6.43E+04	1.63E-01
Y-91M	5.74E-02	0.	0.	0.	0.	1.68E-01	2.23E-03
Y-91	8.89E+01	0.	0.	0.	0.	4.89E+04	2.38E+00
Y-92	5.34E-01	0.	0.	0.	0.	9.33E+03	1.56E-02

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-2
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
Y-93	1.69E+00	0.	0.	0.	0.	5.36E+04	4.67E-02
ZR-95	1.60E+01	5.13E+00	0.	8.09E+00	0.	1.59E+04	3.47E+00
ZR-97	8.82E-01	1.78E-01	0.	2.69E-01	0.	5.51E+04	8.19E-02
NB-95	4.48E+02	2.49E+02	0.	2.47E+02	0.	1.51E+06	9.79E+01
NB-97	3.76E+00	9.50E-01	0.	1.11E+00	0.	3.51E+03	3.47E-01
MO-99	0.	1.28E+02	0.	2.90E+02	0.	2.97E+02	2.43E+01
TC-99M	1.30E-02	3.67E-02	0.	5.57E-01	1.80E-02	2.17E+01	4.67E-01
TC-101	1.33E-02	1.93E-02	0.	3.47E-01	9.82E-03	0.	1.89E-01
RU-103	1.07E+02	0.	0.	4.09E+02	0.	1.25E+04	4.61E+01
RU-105	8.90E+00	0.	0.	1.15E+02	0.	5.44E+03	3.51E+00
RU-106	1.59E+03	0.	0.	3.08E+03	0.	1.03E+05	2.01E+02
AG-110	1.57E+03	1.45E+03	0.	2.85E+03	0.	5.92E+05	8.62E+02
SB-124	2.78E+02	5.23E+00	6.71E-01	0.	2.15E+02	7.85E+03	1.10E+02
SB-125	2.20E+02	2.37E+00	1.96E-01	0.	2.30E+04	1.95E+03	4.42E+01
TE-125M	2.17E+02	7.89E+01	6.54E+01	8.83E+02	0.	8.67E+02	2.91E+01

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-2
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
TE-127M	5.50E+02	1.92E+02	1.40E+02	2.23E+03	0.	1.84E+03	6.70E+01
TE-127	8.92E+00	3.20E+00	6.61E+00	3.63E+01	0.	7.04E+02	1.93E+00
TE-129M	9.32E+02	3.49E+02	3.20E+02	3.89E+03	0.	4.69E+03	1.48E+02
TE-129	2.55E+00	9.65E-01	1.95E+00	1.07E+01	0.	1.92E+00	6.21E-01
TE-131M	1.41E+02	6.87E+01	1.09E+02	6.95E+02	0.	6.81E+03	5.72E+01
TE-131	1.60E+00	6.68E-01	1.31E+00	7.00E+00	0.	2.39E-01	5.04E-01
TE-132	2.05E+03	1.33E+02	1.46E+02	1.28E+03	0.	6.25E+03	1.24E+02
I-130	3.98E+01	1.18E+02	1.50E+04	1.83E+02	0.	1.01E+02	4.63E+01
I-131	2.18E+02	3.13E+02	1.02E+05	5.36E+02	0.	8.24E+01	1.79E+02
I-132	1.07E+01	2.85E+01	3.76E+03	4.55E+01	0.	5.36E+00	1.01E+01
I-133	7.51E+01	1.30E+02	2.51E+04	2.27E+02	0.	1.15E+02	3.98E+01
I-134	5.57E+00	1.51E+01	1.96E+03	2.41E+01	0.	1.32E-02	5.41E+00
I-135	2.33E+01	6.14E+01	8.03E+03	9.77E+01	0.	6.88E+01	2.25E+01
CS-134	6.85E+03	1.63E+04	0.	5.29E+03	1.75E+03	2.85E+02	1.33E+04
CS-136	7.17E+02	2.83E+03	0.	1.58E+03	2.16E+02	3.22E+02	2.04E+03

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-2
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
CS-137	8.79E+03	1.20E+04	0.	4.09E+03	1.36E+03	2.31E+02	7.88E+03
CS-138	6.08E+00	1.20E+01	0.	8.84E+00	8.73E-01	5.12E-05	5.96E+00
BA-139	7.87E+00	5.61E-03	0.	5.24E-03	3.18E-03	1.39E+01	2.30E-01
BA-140	1.65E+03	2.07E+00	0.	7.04E-01	1.18E+00	3.39E+03	1.09E+02
BA-141	0.	2.89E-03	0.	2.68E-03	1.64E-03	1.80E-09	1.29E-01
BA-142	1.73E+00	1.78E-03	0.	1.50E-03	1.01E-03	0.	1.09E-01
LA-140	1.58E+00	7.95E-01	0.	0.	0.	5.83E+04	2.11E-01
LA-142	8.07E-02	3.67E-02	0.	0.	0.	2.68E+02	9.15E-03
CE-141	3.43E+00	2.32E+00	0.	1.08E+00	0.	8.87E+03	2.63E-01
CE-143	6.05E-01	4.47E+02	0.	1.97E-01	0.	1.67E+04	4.95E-02
CE-144	1.79E+02	7.48E+01	0.	4.43E+01	0.	6.05E+04	9.60E+00
PR-144	1.91E-02	7.88E-03	0.	4.45E-03	0.	2.73E-09	9.65E-04
W-187	9.17E+00	7.68E+00	0.	0.	0.	2.51E+03	2.69E+00
NP-239	3.56E-02	3.50E-03	0.	1.08E-02	0.	7.12E+02	1.92E-03

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	2.17E-01	2.17E-01	2.74E-01	2.17E-01	2.17E-01	2.17E-01
NA--24	4.63E-01	4.63E-01	4.63E-01	4.63E-01	4.63E-01	4.63E-01	4.63E-01
P---32	1.27E+07	7.98E+05	0.	0.	0.	1.43E+06	4.93E+05
CR--51	0.	0.	2.54E+00	9.38E-01	5.64E+00	1.07E+03	4.25E+00
MN--54	0.	5.38E+03	0.	1.60E+03	0.	1.65E+04	1.03E+03
MN--56	0.	1.36E+02	0.	1.72E+02	0.	4.32E+03	2.42E+01
FE--55	8.78E+04	3.95E+05	0.	0.	4.57E+05	1.54E+05	1.04E+05
FE--59	6.14E+04	1.46E+05	0.	0.	4.05E+04	4.81E+05	5.55E+04
CO--57	0.	1.08E+02	0.	0.	0.	2.74E+03	1.79E+02
CO--58	0.	6.12E+02	0.	0.	0.	8.26E+03	1.39E+03
CO--60	0.	1.70E+03	0.	0.	0.	2.04E+04	3.88E+03
NI--65	1.54E+02	2.00E+01	0.	0.	0.	5.07E+02	9.11E+00
CU--64	0.	1.64E+02	0.	4.12E+02	0.	1.39E+04	7.69E+01
ZN--65	1.23E+05	3.90E+05	0.	2.61E+05	0.	2.46E+05	1.77E+05
ZN--69	2.61E+02	5.02E+02	0.	3.24E+02	0.	7.50E+01	3.47E+01
BR--82	0.	0.	0.	0.	0.	3.55E+00	3.10E+00
BR--83	0.	0.	0.	0.	0.	7.95E-02	5.52E-02
BR--84	0.	0.	0.	0.	0.	5.61E-07	7.16E-02
BR--85	0.	0.	0.	0.	0.	0.	2.94E-03

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH   AGE GROUP - TEENAGER

ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
RB--86	0.	4.76E+02	0.	0.	0.	9.37E+01	2.22E+02
RB--88	0.	1.37E+00	0.	0.	0.	0.	7.23E-01
RB--89	0.	9.04E-01	0.	0.	0.	0.	6.38E-01
SR--89	5.67E+03	0.	0.	0.	0.	6.15E+02	1.63E+02
SR--90	1.28E+05	0.	0.	0.	0.	2.71E+03	3.17E+04
SR--91	7.18E+01	0.	0.	0.	0.	3.61E+02	3.16E+00
SR--92	2.66E+01	0.	0.	0.	0.	5.25E+02	1.15E+00
Y---90	1.58E+01	0.	0.	0.	1.80E+04	5.23E+04	4.25E-01
Y--91M	4.36E-02	0.	0.	0.	0.	1.28E-01	1.69E-03
Y---91	9.40E+01	0.	0.	0.	0.	3.61E+04	2.51E+00
Y---92	4.06E-01	0.	0.	0.	0.	7.10E+03	1.18E-02
Y---93	1.29E+00	0.	0.	0.	0.	4.08E+04	3.55E-02
ZR--95	1.49E+01	4.96E+00	0.	6.16E+00	0.	1.07E+04	3.46E+00
ZR--97	6.72E-01	1.36E-01	0.	2.05E-01	0.	4.20E+04	6.24E-02
NB--95	3.97E+02	2.39E+02	0.	1.88E+02	0.	9.76E+05	1.35E+02
NB--97	2.87E+00	7.24E-01	0.	8.45E-01	0.	2.67E+03	2.64E-01
MO--99	0.	9.74E+01	0.	2.21E+02	0.	2.26E+02	1.85+01
TC-99M	9.87E-03	2.79E-02	0.	4.24E-01	1.37E-02	1.65E+01	3.56E-01
TC-101	1.02E-02	1.47E-02	0.	2.64E-01	7.47E-03	0.	1.44E-01

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE L-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (MREM/HR PER μCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
RU-103	1.04E+02	0.	0.	3.11E+02	0.	8.13E+03	4.66E+01
RU-105	6.77E+00	0.	0.	8.74E+01	0.	4.14E+03	2.67E+00
RU-106	1.76E+03	0.	0.	2.34E+03	0.	7.95E+04	2.21E+02
AG110	1.19E+03	1.10E+03	0.	2.17E+03	0.	4.51E+05	6.56E+02
SB-124	2.11E+02	3.99E+00	5.11E-01	0.	1.64E+02	5.98E+03	8.35E+01
SB-125	1.68E+02	1.81E+00	1.49E-01	0.	1.75E+04	1.48E+03	3.37E+01
TE 125M	2.36E+02	8.45E+01	6.66E+01	6.72E+02	0.	6.60E+02	3.13E+01
TE 127M	4.18E+02	1.46E+02	1.07E+02	1.70E+03	0.	1.40E+03	5.09E+01
TE-127	9.31E+00	3.28E+00	6.35E+00	2.76E+01	0.	7.52E+02	1.99E+00
TE 129M	1.02E+03	3.79E+02	3.27E+02	2.96E+03	0.	3.58E+03	1.61E+02
TE-129	1.94E+00	7.34E-01	1.49E+00	8.14E+00	0.	1.46E+00	4.72E-01
TE 131M	1.07E+02	5.22E+01	8.26E+01	5.29E+02	0.	5.18E+03	4.35E+01
TE-131	1.21E+00	5.08E-01	9.99E-01	5.33E+00	0.	1.82E-01	3.83E-01
TE-132	2.19E+02	1.37E+02	1.46E+02	9.74E+02	0.	4.93E+03	1.30E+02
I--130	3.03E+01	8.95E+01	1.14E+04	1.39E+02	0.	7.67E+01	3.52E+01
I--131	2.23E+02	3.14E+02	9.07E+04	4.08E+02	0.	5.95E+01	1.87E+02
I--132	8.11E+00	2.17E+01	2.86E+03	3.46E+01	0.	4.08E+00	7.71E+00
I--133	8.11E+01	1.37E+02	2.50E+04	1.73E+02	0.	9.99E+01	4.24E+01
I--134	4.24E+00	1.15E+01	1.49E+03	1.83E+01	0.	1.00E-02	4.12E+00

Based on 1 μCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
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TABLE L-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
I--135	1.77E+01	4.68E+01	6.11E+03	7.43E+01	0.	5.23E+01	1.71E+01
CS-134	6.75E+03	1.63E+04	0.	4.03E+03	1.97E+03	1.88E+02	7.60E+03
CS-136	5.46E+02	2.16E+03	0.	1.20E+03	1.65E+02	2.45E+02	1.55E+03
CS-137	8.98E+03	1.21E+04	0.	3.11E+03	1.60E+03	1.61E+02	4.24E+03
CS-138	4.63E+00	9.15E+00	0.	6.73E+00	6.65E-01	3.90E-05	4.54E+00
BA-139	5.99E+00	4.27E-03	0.	3.99E-03	2.42E-03	1.06E+01	1.75E-01
BA-140	1.75E+03	2.15E+00	0.	5.35E-01	1.44E+00	2.55E+02	1.12E+02
BA-141	0.	2.20E-03	0.	2.04E-03	1.25E-03	1.37E-09	9.80E-02
BA-142	1.31E+00	1.35E-03	0.	1.14E-03	7.64E-04	0.	8.26E-02
LA-140	1.67E+00	8.25E-01	0.	0.	0.	4.55E+04	2.18E-01
LA-142	6.14E-02	2.79E-02	0.	0.	0.	2.04E+02	6.95E-03
CE-141	3.51E+00	2.36E+00	0.	8.19E-01	0.	6.38E+03	2.70E-01
CE-143	4.60E-01	3.40E+02	0.	1.50E-01	0.	1.27E+04	3.76E-02
CE-144	2.01E+02	8.25E+01	0.	3.37E+01	0.	4.74E+04	1.07E+01
PR-144	1.45E-02	5.99E-03	0.	3.39E-03	0.	2.08E-09	7.34E-04
W--187	6.98E+00	5.85E+00	0.	0.	0.	1.91E+03	2.05E+00
NP-239	2.71E-02	2.67E-03	0.	8.25E-03	0.	5.43E+02	1.46E-03

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE L-4.
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/HR PER μCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H----3	0.	1.81E-01	1.81E-01	1.19E-01	1.81E-01	1.81E-01	1.81E-01
NA--24	2.03E-01	2.03E-01	2.03E-01	2.03E-01	2.03E-01	2.03E-01	2.03E-01
P---32	5.53E+06	3.47E+05	0.	0.	0.	6.22E+05	2.14E+05
CR--51	0.	0.	1.12E+00	4.13E-01	2.48E+00	4.70E+02	1.87E+00
MN--54	0.	2.34E+03	0.	6.95E+02	0.	7.15E+03	4.46E+02
MN--56	0.	5.88E+01	0.	7.46E+01	0.	1.88E+03	1.05E+01
FE--55	3.87E+04	1.74E+05	0.	0.	2.02E+05	6.81E+04	4.58E+04
FE--59	2.71E+04	6.43E+04	0.	0.	1.79E+04	2.12E+05	2.45E+04
CO--57	0.	4.78E+01	0.	0.	0.	1.21E+03	7.94E+01
CO--58	0.	5.05E+02	0.	0.	0.	3.00E+03	1.52E+03
CO--60	0.	1.41E+03	0.	0.	0.	7.80E+03	4.23E+03
NI--65	6.73E+01	8.74E+00	0.	0.	0.	2.22E+02	3.98E+00
CU--64	0.	7.15E+01	0.	1.80E+02	0.	6.09E+03	3.36E+01
ZN--65	5.47E+04	1.74E+05	0.	1.16E+05	0.	1.09E+05	7.86E+04
ZN--69	1.16E+02	2.23E+02	0.	1.44E+02	0.	3.34E+01	1.55E+01
BR--82	0.	0.	0.	0.	0.	1.59E+00	1.39E+00
BR--83	0.	0.	0.	0.	0.	3.55E-02	2.47E-02
BR--84	0.	0.	0.	0.	0.	2.51E-07	3.20E-02
BR--85	0.	0.	0.	0.	0.	0.	1.31E-03

Based on 1 μCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
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TABLE L-4
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
RB--86	0.	2.08E+02	0.	0.	0.	4.09E+01	9.68E+01
RB--88	0.	5.96E-01	0.	0.	0.	0.	3.16E-01
RB--89	0.	3.95E-01	0.	0.	0.	0.	2.78E-01
SR--89	7.53E+03	0.	0.	0.	0.	2.81E+02	2.16E+02
SR--90	9.39E+04	0.	0.	0.	0.	1.25E+03	2.38E+04
SR--91	3.18E+01	0.	0.	0.	0.	1.60E+02	1.40E+00
SR--92	1.18E+01	0.	0.	0.	0.	2.33E+02	5.08E-01
Y---90	9.00E+00	0.	0.	0.	0.	2.57E+04	2.42E-01
Y--91M	1.95E-02	0.	0.	0.	0.	5.71E-02	7.55E-04
Y---91	1.25E+02	0.	0.	0.	0.	1.66E+04	3.34E+00
Y---92	1.81E-01	0.	0.	0.	0.	3.16E+03	5.28E-03
Y---93	5.73E-01	0.	0.	0.	0.	1.82E+04	1.58E-02
ZR--95	1.80E+01	4.19E+00	0.	2.67E+00	0.	4.33E+03	3.81E+00
ZR--97	2.91E-01	5.87E-02	0.	8.86E-02	0.	1.82E+04	2.70E-02
NB--95	4.61E+02	1.97E+02	0.	8.11E+01	0.	3.41E+05	1.45E+02
NB--97	1.24E+00	3.12E-01	0.	3.64E-01	0.	1.15E+03	1.14E-01
MO--99	0.	4.23E+01	0.	9.59E+01	0.	9.81E+01	8.05E+00
TC-99M	4.34E-03	1.23E-02	0.	1.86E-01	6.01E-03	7.26E+00	1.57E-01
TC-101	4.47E-03	6.45E-03	0.	1.16E-01	3.29E-03	0.	6.33E-02

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

TABLE L-4
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
RU-103	1.33E+02	0.	0.	1.39E+02	0.	3.50E+03	5.38E+01
RU-105	3.03E+00	0.	0.	3.91E+01	0.	1.85E+03	1.19E+00
RU-106	2.34E+03	0.	0.	1.05E+03	0.	3.63E+04	2.91E+02
AG110	5.18E+02	4.80E+02	0.	9.43E+02	0.	1.96E+05	2.85E+02
SB-124	9.13E+01	1.72E+00	2.21E-01	0.	7.08E+01	2.58E+03	3.61E+01
SB-125	7.24E+01	7.80E-01	6.43E-02	0.	7.57E+03	6.40E+02	1.46E+01
TE 125M	3.11E+02	8.43E+01	8.73E+01	2.97E+02	0.	3.00E+02	4.15E+01
TE 127M	1.85E+02	6.47E+01	4.72E+01	7.50E+02	0.	6.19E+02	2.25E+01
TE-127	1.23E+01	3.27E+00	8.46E+00	1.22E+01	0.	5.24E+02	2.63E+00
TE129M	1.35E+03	3.77E+02	4.31E+02	1.31E+03	0.	1.63E+03	2.09E+02
TE-129	8.59E-01	3.25E-01	6.58E-01	3.60E+00	0.	6.47E-01	2.09E-01
TE131M	4.75E+01	2.31E+01	3.66E+01	2.34E+02	0.	2.29E+03	1.93E+01
TE-131	5.38E-01	2.25E-01	4.42E-01	2.36E+00	0.	8.05E-02	1.70E-01
TE-132	2.78E+02	1.23E+02	1.81E+02	4.31E+02	0.	2.15E+03	1.48E+02
I--130	1.33E+01	3.94E+01	5.01E+03	6.12E+01	0.	3.38E+01	1.55E+01
I--131	2.87E+02	2.94E+02	9.55E+04	1.79E+02	0.	2.51E+01	2.22E+02
I--132	3.57E+00	9.55E+00	1.26E+03	1.52E+01	0.	1.79E+00	3.39E+00
I--133	1.05E+02	1.30E+02	3.13E+04	7.61E+01	0.	5.26E+01	5.10E+01
I--134	1.86E+00	5.06E+00	6.58E+02	8.07E+00	0.	4.41E-03	1.81E+00

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
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TABLE L-4
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS FOR LIQUID DISCHARGES
PATHWAY - SALT WATER FISH AND SHELLFISH AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/HR PER µCi/ML)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
I–135	7.79E+00	2.06E+01	2.69E+03	3.27E+01	0.	2.30E+01	7.54E+00
CS-134	8.14E+03	1.37E+04	0.	1.75E+03	1.52E+03	7.42E+01	2.92E+03
CS-136	2.37E+02	9.34E+02	0.	5.20E+02	7.13E+01	1.06E+02	6.73E+02
CS-137	1.13E+04	1.10E+04	0.	1.35E+03	1.29E+03	6.69E+01	1.64E+03
CS-138	2.01E+00	3.96E+00	0.	2.92E+00	2.88E-01	1.69E-05	1.97E+00
BA-139	2.65E+00	1.89E-03	0.	1.77E-03	1.07E-03	4.69E+00	7.75E-02
BA-140	2.25E+03	1.98E+00	0.	2.37E-01	1.18E+00	1.15E+02	1.32E+02
BA-141	0.	9.71E-04	0.	9.03E-04	5.51E-04	6.06E-10	4.34E-02
BA-142	5.81E-01	5.98E-04	0.	5.05E-04	3.38E-04	0.	3.66E-02
LA-140	2.16E+00	7.52E-01	0.	0.	0.	2.14E+04	2.54E-01
LA-142	2.74E-02	1.24E-02	0.	0.	0.	9.09E+01	3.10E-03
CE-141	4.67E+00	2.34E+00	0.	3.66E-01	0.	2.93E+03	3.48E-01
CE-143	2.05E-01	1.52E+02	0.	6.69E-02	0.	5.67E+03	1.68E-02
CE-144	2.66E+02	8.33E+01	0.	1.50E+01	0.	2.16E+04	1.42E+01
PR-144	6.46E-03	2.67E-03	0.	1.51E-03	0.	9.26E-10	3.27E-04
W--187	3.03E+00	2.54E+00	0.	0.	0.	8.31E+02	8.90E-01
NP-239	1.18E-02	1.16E-03	0.	3.58E-03	0.	2.36E+02	6.34E-04

Based on 1 µCi/sec release rate of each isotope in discharge flow of 1 cc/sec with no additional dilution

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TABLE G-1
EFFLUENT CONCENTRATION LIMITS IN AIR IN UNRESTRICTED AREAS

NOTE
If a nuclide is not listed below, refer to 10 CFR Part 20, Appendix B, Table 2 Effluent Concentrations Column 1 and use the most conservative ECL listed for the nuclide.

Nuclide	ECL µCi/ml	Nuclide	ECL µCi/ml	Nuclide	ECL µCi/ml
Ar-41	1 E-8	Co-57	9 E-10	Sb-124	3 E-10
Kr-83m	5 E-5	Co-58	1 E-9	Sb-125	7 E-10
Kr-85m	1 E-7	Fe-59	5 E-10	Te-125m	1 E-9
Kr-85	7 E-7	Co-60	5 E-11	Te-127m	4 E-10
Kr-87	2 E-8	Zn-65	4 E-10	Te-129m	3 E-10
Kr-88	9 E-9	Rb-86	1 E-9	I-130	3 E-9
Kr-89	None	Rb-88	9 E-8	I-131	2 E-10
Kr-90	None	Sr-89	2 E-10	I-132	2 E-8
Xe-131m	2 E-6	Sr-90	6 E-12	I-133	1 E-9
Xe-133m	6 E-7	Y-91	2 E-10	I-134	6 E-8
Xe-133	5 E-7	Zr-95	4 E-10	I-135	6 E-9
Xe-135m	4 E-8	Nb-95	2 E-9	Cs-134	2 E-10
Xe-135	7 E-8	Ru-103	9 E-10	Cs-136	9 E-10
Xe-137	None	Ru-106	2 E-11	Cs-137	2 E-10
Xe-138	2 E-8	Ag-110	1 E-10	Ba-140	2 E-9
H-3	1 E-7	Sn-113	8 E-10	La-140	2 E-9
P-32	1 E-9	In-113m	2 E-7	Ce-141	8 E-10
Cr-51	3 E-8	Sn-123	2 E-10	Ce-144	2 E-11
Mn-54	1 E-9	Sn-126	8 E-11		

TABLE G-2
DOSE FACTORS FOR NOBLE GASES*

RADIONUCLIDE	TOTAL BODY DOSE FACTOR K_i (mrem/yr per $\mu Ci/m^3$)	SKIN DOSE FACTOR L_i (mrem/yr per $\mu Ci/m^3$)	GAMMA AIR DOSE FACTOR M_i (mrad/yr per $\mu Ci/m^3$)	BETA AIR DOSE FACTOR N_i (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56E-02**	-------	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

* The listed dose factors are for radionuclides that may be detected in gaseous effluents.

** 7.56E-02 = 7.56×10^{-2}

TABLE G-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS P (I) FOR GASEOUS DISCHARGES
PATHWAY - GROUND PLANE DEPOSITION AGE GROUP - INFANT
ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	WHOLE BODY
H-3	0.
CR-51	6.68E+06
MN-54	1.10E+09
FE-59	3.92E+08
CO-57	1.64E+08
CO-58	5.27E+08
CO-60	4.40E+09
ZN-65	6.87E+08
RB-86	1.29E+07
SR-89	3.07E+04
SR-90	5.94E+05
Y-91	1.53E+06
ZR-95	6.94E+08
NB-95	1.95E+08
RU-103	1.57E+08
RU-106	2.99E+08
AG-110	3.18E+09

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

TABLE G-3
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS P (I) FOR GASEOUS DISCHARGES
PATHWAY - GROUND PLANE DEPOSITION AGE GROUP - INFANT
ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	WHOLE BODY
SN-126	4.80E+09
SB-124	8.42E+08
SB-125	7.56E+08
TE-125M	2.19E+06
TE-127M	1.15E+06
TE-129M	5.49E+07
I-130	7.90E+06
I-131	2.46E+07
I-132	1.78E+06
I-133	3.54E+06
I-134	6.43E+05
I-135	3.66E+06
CS-134	2.82E+09
CS-136	2.13E+08
CS-137	1.15E+09
BA-140	2.39E+08
CE-141	1.95E+07
CE-144	9.52E+07

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

TABLE G-4

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R (I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION AGE GROUP - CHILD - TEEN-ADULT & INFANT

ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	WHOLE BODY
H-3	0.
CR-51	4.68E+06
MN-54	1.38E+09
FE-59	2.75E+08
CO-57	1.89E+08
CO-58	3.80E+08
CO-60	2.15E+10
ZN-65	7.43E+08
RB-86	9.01E+06
SR-89	2.17E+04
SR-90	5.35E+06
Y-91	1.08E+06
ZR-95	5.01E+08
NB-95	1.36E+08
RU-103	1.10E+08
RU-106	4.19E+08
AG-110	3.58E+09

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

TABLE G-4

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R (I) FOR GASEOUS DISCHARGES

PATHWAY - GROUND PLANE DEPOSITION AGE GROUP - CHILD - TEEN-ADULT & INFANT

ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	WHOLE BODY
SN-126	5.16E+10
SB-124	5.98E+08
SB-125	2.30E+09
TE-125M	1.55E+06
TE-127M	8.79E+05
TE-129M	3.85E+07
I-130	5.53E+06
I-131	1.72E+07
I-132	1.25E+06
I-133	2.48E+06
I-134	4.50E+05
I-135	2.56E+06
CS-134	6.99E+09
CS-136	1.49E+08
CS-137	1.03E+10
BA-140	1.68E+08
CE-141	1.37E+07
CE-144	1.13E+08

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

TABLE G-5
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - INFANT

ORGAN DOSE FACTOR (MREM/YR PER µCi/Cu Meter)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H-3	0.	4.30E+02	4.30E+02	1.88E+02	4.30E+02	4.30E+02	4.30E+02
P-32	2.31E+05	1.35E+04	0.	0.	0.	1.51E+04	8.78E+03
CR-51	0.	0.	1.40E+01	3.99E+00	2.52E+03	5.81E+02	1.75E+01
MN-54	0.	6.93E+03	0.	1.72E+03	2.45E+05	1.35E+04	1.10E+03
FE-59	2.06E+03	4.86E+06	0.	0.	1.78E+05	3.29E+04	1.85E+03
CO-57	0.	1.21E+02	0.	0.	6.47E+04	5.50E+03	1.18E+02
CO-58	0.	1.18E+02	0.	0.	8.79E+05	1.21E+04	1.68E+02
CO-60	0.	8.40E+02	0.	0.	5.57E+06	3.28E+04	1.17E+03
ZN-65	5.67E+03	1.81E+04	0.	1.21E+04	1.53E+05	9.35E+03	8.15E+03
RB-86	0.	2.37E+04	0.	0.	0.	2.91E+03	1.03E+04
SR-89	4.31E+04	0.	0.	0.	2.31E+06	6.80E+04	1.24E+03
SR-90	1.32E+07	0.	0.	0.	1.53E+07	1.39E+05	8.06E+05
Y-91	5.98E+04	0.	0.	0.	2.63E+06	7.17E+04	1.60E+03
ZR-95	1.08E+04	2.73E+03	0.	9.48E+03	1.81E+06	1.41E+04	1.95E+03
NB-95	1.28E+03	5.75E+02	0.	1.35E+03	4.77E+05	1.21E+04	3.37E+02
RU-103	1.69E+02	0.	0.	1.02E+03	5.66E+05	1.58E+04	5.85E+01
RU-106	9.31E+03	0.	0.	2.34E+04	1.50E+07	1.76E+05	1.14E+03
AG-110	1.89E+03	1.75E+03	0.	3.44E+03	8.12E+05	5.29E+04	1.04E+03

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

TABLE G-5
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - INFANT
ORGAN DOSE FACTOR (MREM/YR PER µCi/Cu Meter)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	3.11E+04	6.45E+02	6.45E+02	0.	3.61E+06	5.99E+04	1.02E+03
SN-126	2.21E+05	5.85E+03	1.72E+03	0.	1.64E+06	2.23E+04	8.40E+03
SB-124	5.46E+03	1.03E+02	1.32E+01	0.	4.34E+05	7.11E+04	2.17E+03
SB-125	1.16E+04	1.25E+02	1.03E+01	0.	3.85E+05	1.76E+04	2.32E+03
TE-125M	4.54E+02	1.95E+02	1.53E+02	2.17E+03	4.96E+05	1.36E+04	6.16E+01
TE-127M	2.21E+03	9.83E+02	5.75E+02	8.01E+03	1.68E+05	2.62E+04	2.74E+02
TE-129M	1.32E+03	5.80E+02	5.08E+02	6.40E+03	1.83E+06	7.32E+04	2.06E+02
I-130	8.02E+02	2.35E+03	3.05E+05	3.65E+03	0.	1.35E+03	9.25E+02
I-131	3.63E+04	4.27E+04	1.41E+07	1.07E+04	0.	1.07E+03	2.51E+04
I-132	2.03E+02	5.70E+02	7.67E+04	9.09E+02	0.	7.11E+01	2.03E+02
I-133	1.34E+04	1.93E+04	4.66E+06	4.55E+03	0.	2.28E+03	5.87E+03
I-134	1.13E+02	3.02E+02	4.02E+04	4.82E+02	0.	1.76E-01	1.08E+02
I-135	4.70E+02	1.22E+03	1.64E+05	1.95E+03	0.	9.18E+02	4.51E+02
CS-134	4.80E+05	8.25E+05	0.	5.04E+04	1.01E+05	1.37E+03	7.32E+04
CS-136	6.85E+03	2.56E+04	0.	1.50E+04	2.10E+03	2.04E+03	1.95E+04
CS-137	6.86E+05	7.31E+05	0.	3.89E+04	9.45E+04	1.32E+03	4.41E+04
BA-140	5.70E+03	4.27E+00	0.	2.93E+00	1.64E+06	3.88E+03	2.95E+02
CE-141	2.52E+03	1.55E+03	0.	1.10E+03	5.24E+05	2.06E+04	1.81E+02
CE-144	4.68E+05	1.82E+05	0.	1.48E+05	1.27E+07	1.61E+05	2.49E+04

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

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TABLE G-6
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT
ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H-3	0.	2.37E+03	2.37E+03	1.04E+03	2.37E+03	2.37E+03	2.37E+03
P-32	1.82E+10	1.14E+09	0.	0.	0.	2.05E+09	7.05E+08
CR-51	0.	0.	1.82E+04	6.72E+03	4.04E+04	7.66E+06	3.05E+04
MN-54	0.	8.96E+06	0.	2.67E+06	0.	2.74E+07	1.71E+06
FE-59	3.17E+07	7.52E+07	0.	0.	2.09E+07	2.48E+08	2.86E+07
CO-57	0.	1.36E+06	0.	0.	0.	3.46E+07	2.27E+06
CO-58	0.	2.55E+07	0.	0.	0.	6.60E+07	6.24E+07
CO-60	0.	8.73E+07	0.	0.	0.	2.16E+08	2.09E+08
ZN-65	1.46E+09	4.65E+09	0.	3.11E+09	0.	2.93E+09	2.10E+09
RB-86	0.	2.77E+09	0.	0.	0.	5.45E+08	1.29E+09
SR-89	1.47E+10	0.	0.	0.	0.	2.75E+08	4.22E+08
SR-90	1.65E+11	0.	0.	0.	0.	1.61E+09	4.21E+10
Y-91	8.12E+04	0.	0.	0.	0.	5.37E+06	2.16E+03
ZR-95	2.12E+05	9.41E+04	0.	1.86E+04	0.	7.47E+07	5.56E+04
NB-95	5.49E+05	2.47E+05	0.	4.84E+04	0.	1.98E+08	1.45E+05
RU-103	8.30E+03	0.	0.	4.16E+03	0.	1.04E+05	2.86E+03
RU-106	2.01E+05	0.	0.	4.20E+04	0.	1.56E+06	2.46E+04
AG-110	6.21E+07	5.75E+07	0.	1.13E+08	0.	2.35E+10	3.42E+07

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition
Note: The units for C-14 and H-3 are (MREM/YR Per µCi/Cu. Meter)

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TABLE G-6
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT
ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-126	1.75E+09	3.48E+07	1.01E+07	0.	4.97E+06	1.16E+09	5.25E+07
SB-124	2.75E+07	5.19E+05	6.64E+04	0.	2.13E+07	7.78E+08	1.09E+07
SB-125	3.59E+07	3.27E+06	2.93E+06	3.96E+06	2.83E+09	2.43E+08	6.62E+06
TE-125M	1.57E+08	5.30E+07	5.18E+07	7.05E+07	0.	7.57E+07	2.10E+07
TE-127M	5.54E+07	1.93E+07	1.79E+07	2.00E+08	0.	3.24E+08	7.38E+06
TE-129M	5.87E+08	2.02E+08	2.21E+08	2.70E+08	0.	3.54E+08	8.95E+07
I-130	4.54E+05	1.35E+06	1.71E+08	2.09E+06	0.	1.15E+06	5.29E+05
I-131	2.59E+09	3.09E+09	9.94E+11	7.24E+08	0.	1.16E+08	1.81E+09
I-132	1.78E-01	4.76E-01	6.26E+01	7.58E-01	0.	8.93E-02	1.69E-01
I-133	3.75E+07	5.48E+07	1.30E+10	1.29E+07	0.	9.74E+06	1.66E+07
I-134	0.	0.	1.06E-09	0.	0.	0.	0.
I-135	1.49E+04	3.94E+04	5.15E+06	6.26E+04	8.07E-02	4.41E+04	1.44E+04
CS-134	4.43E+10	7.97E+10	0.	4.65E+09	9.12E+09	1.90E+08	6.75E+09
CS-136	2.78E+08	1.10E+09	0.	6.11E+08	8.37E+07	1.25E+08	7.90E+08
CS-137	6.44E+10	7.21E+10	0.	3.66E+09	8.69E+09	1.86E+08	4.14E+09
BA-140	2.45E+08	2.47E+05	0.	1.22E+04	1.51E+05	8.13E+06	1.27E+07
CE-141	2.65E+05	1.62E+05	0.	9.72E+03	0.	7.87E+07	1.90E+04
CE-144	2.10E+07	8.29E+06	0.	5.67E+05	0.	8.66E+08	1.13E+06

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition.
Note: The units for C-14 and H-3 are (MREM/YR Per µCi/Cu. Meter)

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TABLE G-7
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT
ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H-3	0.	4.84E+03	4.84E+03	2.11E+03	4.84E+03	4.84E+03	4.84E+03
P-32	2.19E+10	1.37E+09	0.	0.	0.	2.46E+09	8.46E+08
CR-51	0.	0.	2.19E+03	8.07E+02	4.85E+03	9.19E+05	3.66E+03
MN-54	0.	1.08E+06	0.	3.20E+05	0.	3.29E+06	2.05E+05
FE-59	4.12E+05	9.78E+05	0.	0.	2.72E+05	3.23E+06	3.72E+05
CO-57	0.	1.64E+05	0.	0.	0.	4.15E+06	2.72E+05
CO-58	0.	3.06E+06	0.	0.	0.	7.92E+06	7.49E+06
CO-60	0.	1.05E+07	0.	0.	0.	2.59E+07	2.51E+07
ZN-65	1.76E+08	5.57E+08	0.	3.73E+08	0.	3.51E+08	2.52E+08
RB-86	0.	3.32E+08	0.	0.	0.	6.54E+07	1.55E+08
SR-89	3.09E+10	0.	0.	0.	0.	5.77E+08	8.87E+08
SR-90	3.46E+11	0.	0.	0.	0.	3.35E+09	8.83E+10
Y-91	9.74E+03	0.	0.	0.	0.	6.45E+05	2.60E+02
ZR-95	2.54E+04	1.13E+04	0.	2.23E+03	0.	8.95E+06	6.67E+03
NB-95	6.59E+04	2.97E+04	0.	5.81E+03	0.	2.37E+07	1.75E+04
RU-103	9.96E+02	0.	0.	4.99E+02	0.	1.24E+04	3.43E+02
RU-106	2.41E+04	0.	0.	5.04E+03	0.	1.87E+05	2.96E+03
AG-110	7.45E+06	6.90E+06	0.	1.36E+07	0.	2.81E+09	4.10E+06

Based on 1 µCi/sec release rate of each isotope in and a Value of 1. for X/Q, depleted X/Q and Relative Deposition

Note: The units for C-14 and H-3 are 1MREM/Yr per µCi/Cu meter.

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TABLE G-7
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I)/P(I) FOR GASEOUS DISCHARGES
PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - INFANT

ORGAN DOSE FACTOR (SQ. METER - MREM/YR PER µCi/Sec)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-126	2.10E+08	4.17E+06	1.22E+06	0.	5.97E+05	1.40E+08	6.30E+06
SB-124	3.30E+06	6.22E+04	7.97E+03	0.	2.56E+06	9.33E+07	1.30E+06
SB-125	4.31E+06	3.92E+05	3.52E+05	4.76E+05	3.40E+08	2.92E+07	7.94E+05
TE-125M	1.89E+07	6.36E+06	6.21E+06	8.46E+06	0.	9.09E+06	2.52E+06
TE-127M	6.64E+06	2.31E+06	2.15E+06	2.40E+07	0.	3.88E+07	8.85E+05
TE-129M	7.05E+07	2.42E+07	2.66E+07	3.23E+07	0.	4.25E+07	1.07E+07
I-130	5.45E+05	1.61E+06	2.05E+08	2.51E+06	0.	1.38E+06	6.35E+05
I-131	3.11E+09	3.70E+09	1.19E+12	9.28E+08	0.	1.39E+08	2.17E+09
I-132	2.13E-01	5.71E-01	7.51E+01	9.10E-01	0.	1.07E-01	2.03E-01
I-133	4.50E+07	6.57E+07	1.55E+10	1.55E+07	0.	1.17E+07	1.99E+07
I-134	0.	0.	1.27E-09	0.	0.	0.	0.
I-135	1.79E+04	4.72E+04	6.18E+06	7.51E+04	2.42E-01	5.29E+04	1.73E+04
CS-134	1.33E+11	2.39E+11	0.	1.39E+10	2.74E+10	5.69E+08	2.02E+10
CS-136	8.34E+08	3.29E+09	0.	1.83E+09	2.51E+08	3.74E+08	2.37E+09
CS-137	1.93E+11	2.16E+11	0.	1.10E+10	2.61E+10	5.59E+08	1.24E+10
BA-140	2.95E+07	2.96E+04	0.	1.47E+03	1.81E+04	9.76E+05	1.52E+06
CE-141	3.17E+04	1.95E+04	0.	1.17E+03	0.	9.44+06	2.28E+03
CE-144	2.52E+06	9.95E+05	0.	6.80E+04	0.	1.04E+08	1.36E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition.

Note: The units for C-14 and H-3 are 1MREM/Yr per µCi/Cu meter.

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TABLE G-8
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/YR PER µCi/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	7.51E+02	7.51E+02	4.96E+02	7.51E+02	7.51E+02	7.51E+02
P---32	6.11E+05	3.57E+04	0.	0.	0.	4.00E+04	2.32E+04
CR--51	0.	0.	2.75E+01	1.06E+01	6.66E+03	1.54E+03	4.63E+01
MN--54	0.	1.83E+04	0.	4.55E+03	6.48E+05	3.58E+04	2.91E+03
FE--59	5.44E+03	1.28E+07	0.	0.	4.70E+05	8.70E+04	4.88E+03
CO--57	0.	3.20E+02	0.	0.	1.71E+05	1.45E+04	3.10E+02
CO--58	0.	1.52E+02	0.	0.	1.13E+06	3.62E+04	2.68E+02
CO--60	0.	1.07E+03	0.	0.	6.92E+06	9.36E+04	1.88E+03
ZN--65	1.50E+04	4.77E+04	0.	3.19E+04	4.03E+05	2.47E+04	2.15E+04
RB--86	0.	6.25E+04	0.	0.	0.	7.70E+03	2.73E+04
SR--89	5.37E+04	0.	0.	0.	2.24E+06	1.69E+05	1.54E+03
SR--90	1.64E+07	0.	0.	0.	1.48E+07	3.45E+05	9.99E+05
Y---91	7.44E+04	0.	0.	0.	2.55E+06	1.78E+05	1.98E+03
ZR--95	1.41E+04	3.28E+03	0.	2.51E+04	2.12E+06	5.74E+04	2.98E+03
NB--95	1.70E+03	7.25E+02	0.	3.58E+03	5.85E+05	3.32E+04	5.33E+02
RU-103	2.16E+02	0.	0.	2.70E+03	6.33E+05	4.22E+04	8.73E+01
RU-106	1.15E+04	0.	0.	6.18E+04	1.45E+07	4.37E+05	1.44E+03
AG110	5.00E+03	4.63E+03	0.	9.10E+03	2.15E+06	1.40E+05	2.75E+03

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-8
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - CHILD
ORGAN DOSE FACTOR (MREM/YR PER µCi/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	3.85E+04	6.44E+02	6.81E+02	0.	3.50E+06	1.49E+05	1.27E+03
SN-126	5.85E+05	1.55E+04	4.55E+03	0.	4.33E+06	5.88E+04	2.22E+04
SB-124	1.44E+04	2.72E+02	3.49E+01	0.	1.15E+06	1.88E+05	5.74E+03
SB-125	3.06E+04	3.30E+02	2.72E+01	0.	1.02E+06	4.66E+04	6.14E+03
TE 125M	5.62E+02	1.94E+02	1.61E+02	5.74E+03	4.81E+05	3.38E+04	7.62E+01
TE 127M	5.85E+03	2.60E+03	1.52E+03	2.12E+04	4.44E+05	6.92E+04	7.25E+02
TE 129M	1.64E+03	5.85E+02	5.40E+02	1.69E+04	1.80E+06	1.82E+05	2.60E+02
I--130	2.12E+03	6.22E+03	8.07E+05	9.66E+03	0.	3.56E+03	2.45E+03
I--131	4.55E+04	4.63E+04	1.54E+07	2.84E+04	0.	2.65E+03	3.50E+04
I--132	5.37E+02	1.51E+03	2.03E+05	2.40E+03	0.	1.88E+02	5.37E+02
I--133	1.68E+04	2.05E+04	5.03E+06	1.20E+04	0.	5.55E+03	8.03E+03
I--134	2.98E+02	7.99E+02	1.06E+05	1.27E+03	0.	4.66E-01	2.85E+02
I--135	1.24E+03	3.23E+03	4.33E+05	5.14E+03	0.	2.43E+03	1.19E+03
CS-134	6.22E+05	9.95E+05	0.	1.33E+05	1.19E+05	3.77E+03	2.23E+05
CS-136	1.81E+04	6.77E+04	0.	3.96E+04	5.55E+03	5.40E+03	5.14E+04
CS-137	8.66E+05	7.99E+05	0.	1.03E+05	1.00E+05	3.41E+03	1.25E+05
BA-140	7.14E+03	4.66E+00	0.	7.73E+00	1.74E+06	9.92E+03	4.22E+02
CE-141	3.13E+03	1.57E+03	0.	2.90E+03	5.14E+05	5.44E+04	2.33E+02
CE-144	5.81E+05	1.82E+05	0.	3.92E+05	1.23E+07	4.00E+05	3.10E+04

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-9
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H----3	0.	1.57E+03	1.57E+03	1.04E+03	1.57E+03	1.57E+03	1.57E+03
P---32	1.82E+10	1.14E+09	0.	0.	0.	2.05E+09	7.05E+08
CR--51	0.	0.	1.82E+04	6.72E+03	4.04E+04	7.66E+06	3.05E+04
MN--54	0.	8.96E+06	0.	2.67E+06	0.	2.74E+07	1.71E+06
FE--59	3.17E+07	7.52E+07	0.	0.	2.09E+07	2.48E+08	2.86E+07
CO--57	0.	1.36E+06	0.	0.	0.	3.46E+07	2.27E+06
CO--58	0.	1.25E+07	0.	0.	0.	7.41E+07	3.76E+07
CO--60	0.	4.22E+07	0.	0.	0.	2.33E+08	1.27E+08
ZN--65	1.46E+09	4.65E+09	0.	3.11E+09	0.	2.93E+09	2.10E+09
RB--86	0.	2.77E+09	0.	0.	0.	5.45E+08	1.29E+09
SR--89	6.92E+09	0.	0.	0.	0.	2.58E+08	1.98E+08
SR--90	1.13E+11	0.	0.	0.	0.	1.52E+09	2.87E+10
Y---91	3.80E+04	0.	0.	0.	0.	5.05E+06	1.01E+03
ZR--95	1.06E+05	4.47E+04	0.	1.86E+04	0.	7.68E+07	3.29E+04
NB--95	2.75E+05	1.18E+05	0.	4.84E+04	0.	2.03E+08	8.63E+04
RU-103	3.99E+03	0.	0.	4.16E+03	0.	1.05E+05	1.61E+03
RU-106	9.39E+04	0.	0.	4.20E+04	0.	1.46E+06	1.17E+04
AG110	6.21E+07	5.75E+07	0.	1.13E+08	0.	2.35E+10	3.42E+07

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

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TABLE G-9
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	1.75E+09	3.48E+07	1.01E+07	0.	4.97E+06	1.16E+09	5.25E+07
SB-124	2.75E+07	5.19E+05	6.64E+04	0.	2.13E+07	7.78E+08	1.09E+07
SB-125	3.13E+07	1.41E+06	1.18E+06	3.96E+06	2.83E+09	2.43E+08	5.99E+06
TE 125M	7.38E+07	2.00E+07	2.07E+07	7.05E+07	0.	7.12E+07	9.84E+06
TE 127M	5.18E+07	1.78E+07	1.46E+07	2.00E+08	0.	2.99E+08	6.60E+06
TE 129M	2.77E+08	7.73E+07	8.85E+07	2.70E+08	0.	3.33E+08	4.28E+07
I--130	4.54E+05	1.35E+06	1.71E+08	2.09E+06	0.	1.15E+06	5.29E+05
I--131	1.24E+09	1.27E+09	4.12E+11	7.74E+08	0.	1.09E+08	9.56E+08
I--132	1.78E-01	4.76E-01	6.26E+01	7.58E-01	0.	8.93E-02	1.69E-01
I--133	1.78E+07	2.20E+07	5.30E+09	1.29E+07	0.	8.90E+06	8.63E+06
I--134	0.	0.	1.06E-09	0.	0.	0.	0.
I--135	1.49E+04	3.94E+04	5.15E+06	6.26E+04	8.07E-02	4.41E+04	1.44E+04
CS-134	2.17E+10	3.65E+10	0.	4.65E+09	4.06E+09	1.97E+08	7.76E+09
CS-136	2.78E+08	1.10E+09	0.	6.11E+08	8.37E+07	1.25E+08	7.90E+08
CS-137	3.08E+10	2.98E+10	0.	3.66E+09	3.49E+09	1.81E+08	4.44E+09
BA-140	1.17E+08	1.02E+05	0.	1.22E+04	6.09E+04	7.75E+06	6.84E+06
CE-141	1.24E+05	6.22E+04	0.	9.72E+03	0.	7.80E+07	9.26E+03
CE-144	1.00E+07	3.14E+06	0.	5.67E+05	0.	8.15E+08	5.34E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

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TABLE G-10
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	3.20E+03	3.20E+03	2.11E+03	3.20E+03	3.20E+03	3.20E+03
P--32	2.19E+10	1.37E+09	0.	0.	0.	2.46E+09	8.46E+08
CR--51	0.	0.	2.19E+03	8.07E+02	4.85E+03	9.19E+05	3.66E+03
MN--54	0.	1.08E+06	0.	3.20E+05	0.	3.29E+06	2.05E+05
FE--59	4.12E+05	9.78E+05	0.	0.	2.72E+05	3.23E+06	3.72E+05
CO--57	0.	1.64E+05	0.	0.	0.	4.15E+06	2.72E+05
CO--58	0.	1.50E+06	0.	0.	0.	8.90E+06	4.51E+06
CO--60	0.	5.06E+06	0.	0.	0.	2.80E+07	1.52E+07
ZN--65	1.76E+08	5.57E+08	0.	3.73E+08	0.	3.51E+08	2.52E+08
RB--86	0.	3.32E+08	0.	0.	0.	6.54E+07	1.55E+08
SR--89	1.45E+10	0.	0.	0.	0.	5.43E+08	4.16E+08
SR--90	2.37E+11	0.	0.	0.	0.	3.16E+09	6.02E+10
Y---91	4.56E+03	0.	0.	0.	0.	6.06E+05	1.22E+02
ZR--95	1.27E+04	5.37E+03	0.	2.23E+03	0.	9.22E+06	3.96E+03
NB--95	3.30E+04	1.41E+04	0.	5.81E+03	0.	2.44E+07	1.04E+04
RU-103	4.79E+02	0.	0.	4.99E+02	0.	1.26E+04	1.94E+02
RU-106	1.13E+04	0.	0.	5.04E+03	0.	1.75E+05	1.40E+03
AG110	7.45E+06	6.90E+06	0.	1.36E+07	0.	2.81E+09	4.10E+06

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

TABLE G-10
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - CHILD

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	2.10E+08	4.17E+06	1.22E+06	0.	5.97E+05	1.40E+08	6.30E+06
SB-124	3.30E+06	6.22E+04	7.97E+03	0.	2.56E+06	9.33E+07	1.30E+06
SB-125	3.75E+06	1.70E+05	1.43E+05	4.76E+05	3.40E+08	2.92E+07	7.19E+05
TE 125M	8.85E+06	2.40E+06	2.49E+06	8.46E+06	0.	8.54E+06	1.18E+06
TE 127M	6.21E+06	2.14E+06	1.75E+06	2.40E+07	0.	3.58E+07	7.92E+05
TE 129M	3.32E+07	9.27E+06	1.06E+07	3.23E+07	0.	4.00E+07	5.15E+06
I--130	5.45E+05	1.61E+06	2.05E+08	2.51E+06	0.	1.38E+06	6.35E+05
I--131	1.48E+09	1.52E+09	4.94E+11	9.28E+08	0.	1.30E+08	1.15E+09
I--132	2.13E-01	5.71E-01	7.51E+01	9.10E-01	0.	1.07E-01	2.03E-01
I--133	2.14E+07	2.64E+07	6.36E+09	1.55E+07	0.	1.07E+07	1.04E+07
I--134	0.	0.	1.27E-09	0.	0.	0.	0.
I--135	1.79E+04	4.72E+04	6.18E+06	7.51E+04	2.42E-01	5.29E+04	1.73E+04
CS-134	6.50E+10	1.10E+11	0.	1.39E+10	1.22E+10	5.92E+08	2.33E+10
CS-136	8.34E+08	3.29E+09	0.	1.83E+09	2.51E+08	3.74E+08	2.37E+09
CS-137	9.23E+10	8.93E+10	0.	1.10E+10	1.05E+10	5.44E+08	1.33E+10
BA-140	1.40E+07	1.23E+04	0.	1.47E+03	7.31E+03	9.30E+05	8.21E+05
CE-141	1.49E+04	7.46E+03	0.	1.17E+03	0.	9.36E+06	1.11E+03
CE-144	1.20E+06	3.76E+05	0.	6.80E+04	0.	9.78E+07	6.41E+04

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

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TABLE G-11
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H----3	0.	2.33E+02	2.33E+02	1.54E+02	2.33E+02	2.33E+02	2.33E+02
P---32	1.74E+09	1.09E+08	0.	0.	0.	1.96E+08	6.73E+07
CR--51	0.	0.	1.58E+03	5.82E+02	3.50E+03	6.63E+05	2.64E+03
MN--54	0.	3.42E+06	0.	1.02E+06	0.	1.05E+07	6.54E+05
FE--59	9.95E+07	2.36E+08	0.	0.	6.55E+07	7.79E+08	8.98E+07
CO--57	0.	2.10E+06	0.	0.	0.	5.33E+07	3.50E+06
CO--58	0.	1.69E+07	0.	0.	0.	1.00E+08	5.10E+07
CO--60	0.	6.77E+07	0.	0.	0.	3.75E+08	2.03E+08
ZN--65	1.33E+08	4.22E+08	0.	2.82E+08	0.	2.66E+08	1.91E+08
RB--86	0.	1.82E+08	0.	0.	0.	3.59E+07	8.50E+07
SR--89	5.04E+08	0.	0.	0.	0.	1.88E+07	1.44E+07
SR--90	1.05E+10	0.	0.	0.	0.	7.02E+08	2.67E+09
Y---91	1.76E+06	0.	0.	0.	0.	2.33E+08	4.69E+04
ZR--95	4.62E+06	1.51E+06	0.	7.47E+05	0.	2.22E+09	1.20E+06
NB--95	2.68E+06	1.15E+06	0.	4.72E+05	0.	1.98E+09	8.41E+05
RU-103	1.45E+08	0.	0.	1.51E+08	0.	3.81E+09	5.87E+07
RU-106	4.51E+09	0.	0.	2.02E+09	0.	7.01E+10	5.61E+08
AG110	2.50E+06	2.31E+06	0.	4.55E+06	0.	9.44E+08	1.38E+06

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

ST. LUCIE PLANT
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TABLE G-11
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - CHILD

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	6.92E+09	1.37E+08	4.02E+07	0.	2.41E+06	2.31E+09	1.98E+08
SB-124	7.40E+06	1.40E+05	1.79E+04	0.	5.74E+06	2.10E+08	2.93E+06
SB-125	7.66E+07	1.84E+07	1.90E+07	6.47E+07	9.26E+08	1.44E+08	1.08E+07
TE 125M	5.69E+08	1.54E+08	1.60E+08	5.44E+08	0.	5.49E+08	7.59E+07
TE 127M	4.40E+08	1.51E+08	1.24E+08	1.70E+09	0.	2.54E+09	5.61E+07
TE 129M	1.84E+09	5.12E+08	5.87E+08	1.78E+09	0.	2.21E+09	2.84E+08
I--130	8.87E-07	2.63E-06	3.34E-04	4.08E-06	0.	2.25E-06	1.03E-06
I--131	1.58E+07	1.62E+07	5.25E+09	9.86E+06	0.	1.38E+06	1.22E+07
I--132	0.	0.	0.	0.	0.	0.	0.
I--133	6.86E-01	8.47E-01	2.04E+02	4.97E-01	0.	3.43E-01	3.33E-01
I--134	0.	0.	0.	0.	0.	0.	0.
I--135	3.21E-02	2.96E-02	0.	1.12E-02	3.37E-03	6.92E-04	1.32E-02
CS-134	8.83E+08	1.49E+09	0.	1.89E+08	1.65E+08	8.04E+06	3.16E+08
CS-136	4.41E+06	1.74E+07	0.	9.69E+06	1.33E+06	1.98E+06	1.25E+07
CS-137	1.27E+09	1.23E+09	0.	1.51E+08	1.44E+08	7.50E+06	1.84E+08
BA-140	4.37E+07	3.84E+04	0.	4.59E+03	2.29E+04	6.03E+06	2.57E+06
CE-141	2.10E+04	1.05E+04	0.	1.65E+03	0.	1.32E+07	1.57E+03
CE-144	2.38E+06	7.46E+05	0.	1.35E+05	0.	1.94E+08	1.27E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

ST. LUCIE PLANT
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TABLE G-12
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	2.47E+02	2.47E+02	1.63E+02	2.47E+02	2.47E+02	2.47E+02
P--32	4.22E+08	2.64E+07	0.	0.	0.	4.74E+07	1.63E+07
CR--51	0.	0.	4.68E+03	1.73E+03	1.04E+04	1.97E+06	7.83E+03
MN--54	0.	1.98E+07	0.	5.89E+06	0.	6.07E+07	3.78E+06
FE--59	1.48E+07	3.51E+07	0.	0.	9.75E+06	1.16E+08	1.34E+07
CO--57	0.	7.53E+05	0.	0.	0.	1.91E+07	1.25E+06
CO--58	0.	6.94E+06	0.	0.	0.	4.13E+07	2.09E+07
CO--60	0.	2.33E+07	0.	0.	0.	1.29E+08	6.98E+07
ZN--65	2.08E+07	6.59E+07	0.	4.41E+07	0.	4.15E+07	2.98E+07
RB--86	0.	5.28E+07	0.	0.	0.	1.04E+07	2.46E+07
SR--89	4.84E+09	0.	0.	0.	0.	1.81E+08	1.39E+08
SR--90	7.79E+10	0.	0.	0.	0.	1.52E+09	1.98E+10
Y---91	2.12E+06	0.	0.	0.	0.	2.82E+08	5.65E+04
ZR--95	4.06E+05	9.87E+04	0.	6.07E+04	0.	1.08E+08	8.81E+04
NB--95	6.20E+04	2.64E+04	0.	1.09E+04	0.	4.58E+07	1.94E+04
RU-103	2.24E+06	0.	0.	2.34E+06	0.	5.88E+07	9.05E+05
RU-106	5.19E+07	0.	0.	2.32E+07	0.	8.07E+08	6.46E+06
AG110	6.87E+05	6.36E+05	0.	1.25E+06	0.	2.59E+08	3.78E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

ST. LUCIE PLANT
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TABLE G-12
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - CHILD
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	1.71E-05	2.14E-07	2.26E-07	0.	0.	8.50E-06	4.21E-07
SN-126	3.87E+08	7.68E+06	2.25E+06	0.	1.75E+06	3.44E+08	1.19E+07
SB-124	1.02E+07	1.93E+05	2.47E+04	0.	7.93E+06	2.89E+08	4.04E+06
SB-125	1.22E+07	6.99E+05	6.22E+05	2.09E+06	1.04E+09	9.02E+07	2.29E+06
TE 125M	4.12E+07	1.12E+07	1.16E+07	3.94E+07	0.	3.97E+07	5.49E+06
TE 127M	2.88E+07	9.90E+06	8.09E+06	1.11E+08	0.	1.65E+08	3.67E+06
TE 129M	1.56E+08	4.35E+07	4.99E+07	1.51E+08	0.	1.88E+08	2.41E+07
I-130	1.60E+05	4.73E+05	6.02E+07	7.35E+05	0.	4.05E+05	1.86E+05
I-131	1.24E+08	1.27E+08	4.13E+10	7.75E+07	0.	1.09E+07	9.58E+07
I-132	2.26E+01	6.05E+01	7.97E+03	9.65E+01	0.	1.14E+01	2.15E+01
I-133	3.61E+06	4.46E+06	1.08E+09	2.62E+06	0.	1.81E+06	1.75E+06
I-134	4.18E-05	1.14E-04	1.47E-02	1.81E-04	0.	9.89E-08	4.06E-05
I-135	1.64E+04	4.33E+04	5.67E+06	6.89E+04	3.51E-03	4.85E+04	1.59E+04
CS-134	9.97E+08	1.68E+09	0.	2.14E+08	1.87E+08	9.08E+06	3.57E+08
CS-136	1.35E+07	5.32E+07	0.	2.96E+07	4.06E+06	6.05E+06	3.83E+07
CS-137	1.41E+09	1.37E+09	0.	1.68E+08	1.60E+08	8.34E+06	2.04E+08
BA-140	1.70E+08	1.56E+05	0.	1.78E+04	8.87E+04	2.08E+08	9.96E+06
CE-141	1.17E+05	5.84E+04	0.	9.13E+03	0.	7.33E+07	8.69E+03
CE-144	9.23E+06	2.89E+06	0.	5.22E+05	0.	7.51E+08	4.92E+05

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-13
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (MREM/YR PER µCI/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	8.48E+02	8.48E+02	1.07E+03	8.48E+02	8.48E+02	8.48E+02
P---32	1.32E+06	7.72E+04	0.	0.	0.	8.64E+04	5.02E+04
CR--51	0.	0.	5.95E+01	2.28E+01	1.44E+04	3.32E+03	1.00E+02
MN--54	0.	3.96E+04	0.	9.84E+03	1.40E+06	7.74E+04	6.30E+03
FE--59	1.18E+04	2.78E+07	0.	0.	1.02E+06	1.88E+05	1.06E+04
CO--57	0.	6.92E+02	0.	0.	3.70E+05	3.14E+04	6.71E+02
CO--58	0.	1.76E+02	0.	0.	1.37E+06	9.52E+04	2.34E+02
CO--60	0.	1.24E+03	0.	0.	8.56E+06	2.35E+05	1.65E+03
ZN--65	3.24E+04	1.03E+05	0.	6.90E+04	8.72E+05	5.34E+04	4.66E+04
RB--86	0.	1.35E+05	0.	0.	0.	1.66E+04	5.90E+04
SR--89	3.87E+04	0.	0.	0.	2.50E+06	3.54E+05	1.11E+03
SR--90	1.18E+07	0.	0.	0.	1.66E+07	7.24E+05	7.23E+05
Y---91	5.38E+04	0.	0.	0.	2.86E+06	3.74E+05	1.44E+03
ZR--95	1.09E+04	3.63E+03	0.	5.42E+04	2.56E+06	1.33E+05	2.54E+03
NB--95	1.36E+03	8.24E+02	0.	7.74E+03	7.17E+05	8.80E+04	4.62E+02
RU-103	1.63E+02	0.	0.	5.83E+03	7.51E+05	9.44E+04	7.32E+01
RU-106	8.40E+03	0.	0.	1.34E+05	1.64E+07	9.28E+05	1.06E+03
AG110	1.08E+04	1.00E+04	0.	1.97E+04	4.64E+06	3.02E+05	5.94E+03

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-13
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (MREM/YR PER μCI/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	2.79E+04	6.14E+02	4.92E+02	0.	3.91E+06	3.13E+05	9.20E+02
SN-126	1.26E+06	3.34E+04	9.84E+03	0.	9.36E+06	1.27E+05	4.80E+04
SB-124	3.12E+04	5.89E+02	7.55E+01	0.	2.48E+06	4.06E+05	1.24E+04
SB-125	6.61E+04	7.13E+02	5.87E+01	0.	2.20E+06	1.01E+05	1.33E+04
TE 125M	4.07E+02	1.86E+02	1.17E+02	1.24E+04	5.36E+05	7.08E+04	5.53E+01
TE 127M	1.26E+04	5.62E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05	1.57E+03
TE 129M	1.19E+03	5.64E+02	3.90E+02	3.66E+04	2.03E+06	3.84E+05	1.92E+02
I--130	4.58E+03	1.34E+04	1.74E+06	2.09E+04	0.	7.69E+03	5.29E+03
I--131	3.37E+04	4.72E+04	1.39E+07	6.14E+04	0.	5.96E+03	2.82E+04
I--132	1.16E+03	3.26E+03	4.38E+05	5.19E+03	0.	4.06E+02	1.16E+03
I--133	1.23E+04	2.06E+04	3.83E+06	2.60E+04	0.	1.00E+04	6.34E+03
I--134	6.45E+02	1.73E+03	2.30E+05	2.75E+03	0.	1.01E+00	6.16E+02
I--135	2.69E+03	6.99E+03	9.36E+05	1.11E+04	0.	5.25E+03	2.58E+03
CS-134	4.83E+05	1.10E+06	0.	2.88E+05	1.44E+05	8.96E+03	5.44E+05
CS-136	3.91E+04	1.46E+05	0.	8.56E+04	1.20E+04	1.17E+04	1.11E+05
CS-137	6.42E+05	8.24E+05	0.	2.22E+05	1.18E+05	7.68E+03	3.03E+05
BA-140	5.30E+03	4.85E+00	0.	1.67E+01	2.02E+06	2.12E+04	3.42E+02
CE-141	2.27E+03	1.52E+03	0.	6.26E+03	5.83E+05	1.14E+05	1.74E+02
CE-144	4.19E+05	1.74E+05	0.	8.48E+05	1.38E+07	8.40E+05	2.24E+04

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

TABLE G-14
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - TEENAGER

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H----3	0.	9.93E+02	9.93E+02	1.26E+03	9.93E+02	9.93E+02	9.93E+02
P---32	2.21E+10	1.38E+09	0.	0.	0.	2.48E+09	8.54E+08
CR--51	0.	0.	2.21E+04	8.15E+03	4.90E+04	9.29E+06	3.69E+04
MN--54	0.	1.09E+07	0.	3.23E+06	0.	3.33E+07	2.07E+06
FE--59	3.84E+07	9.12E+07	0.	0.	2.53E+07	3.01E+08	3.47E+07
CO--57	0.	1.65E+06	0.	0.	0.	4.19E+07	2.75E+06
CO--58	0.	8.10E+06	0.	0.	0.	1.10E+08	1.85E+07
CO--60	0.	2.73E+07	0.	0.	0.	3.27E+08	6.23E+07
ZN--65	1.77E+09	5.63E+09	0.	3.77E+09	0.	3.55E+09	2.55E+09
RB--86	0.	3.35E+09	0.	0.	0.	6.61E+08	1.56E+09
SR--89	2.80E+09	0.	0.	0.	0.	3.03E+08	8.03E+07
SR--90	8.29E+10	0.	0.	0.	3.38E+06	1.76E+09	2.05E+10
Y---91	1.54E+04	0.	0.	0.	0.	5.93E+06	4.12E+02
ZR--95	4.78E+04	2.84E+04	0.	2.25E+04	0.	1.15E+08	1.60E+04
NB--95	1.24E+05	7.46E+04	0.	5.87E+04	0.	3.05E+08	4.21E+04
RU-103	1.69E+03	0.	0.	5.04E+03	0.	1.32E+05	7.56E+02
RU-106	3.83E+04	0.	0.	5.09E+04	0.	1.73E+06	4.81E+03
AG-110	7.53E+07	6.97E+07	0.	1.37E+08	0.	2.84E+10	4.14E+07

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

TABLE G-14

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - TEENAGER

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	2.12E+09	4.21E+07	1.24E+07	0.	6.03E+06	1.41E+09	6.37E+07
SB-124	3.33E+07	6.29E+05	8.05E+04	0.	2.59E+07	9.43E+08	1.32E+07
SB-125	3.45E+07	9.58E+05	5.05E+05	4.80E+06	3.43E+09	2.95E+08	6.82E+06
TE 125M	3.00E+07	1.08E+07	8.47E+06	8.55E+07	0.	8.39E+07	3.98E+06
TE 127M	6.02E+07	2.11E+07	1.59E+07	2.43E+08	0.	3.02E+08	7.45E+06
TE 129M	1.13E+08	4.18E+07	3.61E+07	3.27E+08	0.	3.93E+08	1.78E+07
I--130	5.51E+05	1.63E+06	2.07E+08	2.53E+06	0.	1.40E+06	6.41E+05
I--131	5.12E+08	7.24E+08	2.09E+11	9.38E+08	0.	1.37E+08	4.31E+08
I--132	2.16E-01	5.76E-01	7.59E+01	9.19E-01	0.	1.08E-01	2.05E-01
I--133	7.33E+06	1.24E+07	2.26E+09	1.56E+07	0.	9.02E+06	3.83E+06
I--134	0.	0.	1.29E-09	0.	0.	0.	0.
I--135	1.81E+04	4.77E+04	6.24E+06	7.58E+04	9.79E-02	5.34E+04	1.75E+04
CS-134	9.44E+09	2.28E+10	0.	5.63E+09	2.76E+09	2.63E+08	1.06E+10
CS-136	3.37E+08	1.33E+09	0.	7.41E+08	1.02E+08	1.51E+08	9.58E+08
CS-137	1.28E+10	1.72E+10	0.	4.43E+09	2.28E+09	2.29E+08	6.04E+09
BA-140	4.84E+07	5.95E+04	0.	1.48E+04	3.98E+04	9.16E+06	3.11E+06
CE-141	5.05E+04	3.39E+04	0.	1.18E+04	0.	9.18E+07	3.89E+03
CE-144	4.10E+06	1.68E+06	0.	6.87E+05	0.	9.65E+08	2.17E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

ST. LUCIE PLANT
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TABLE G-15
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	2.03E+03	2.03E+03	2.56E+03	2.03E+03	2.03E+03	2.03E+03
P---32	2.65E+10	1.66E+09	0.	0.	0.	2.98E+09	1.03E+09
CR--51	0.	0.	2.65E+03	9.78E+02	5.88E+03	1.11E+06	4.43E+03
MN--54	0.	1.30E+06	0.	3.88E+05	0.	3.99E+06	2.49E+05
FE--59	4.99E+05	1.19E+06	0.	0.	3.29E+05	3.91E+06	4.51E+05
CO--57	0.	1.98E+05	0.	0.	0.	5.03E+06	3.30E+05
CO--58	0.	9.72E+05	0.	0.	0.	1.31E+07	2.22E+06
CO--60	0.	3.28E+06	0.	0.	0.	3.93E+07	7.48E+06
ZN--65	2.13E+08	6.76E+08	0.	4.52E+08	0.	4.26E+08	3.06E+08
RB--86	0.	4.02E+08	0.	0.	0.	7.93E+07	1.88E+08
SR--89	5.87E+09	0.	0.	0.	0.	6.37E+08	1.69E+08
SR--90	1.74E+11	0.	0.	0.	4.05E+05	3.68E+09	4.30E+10
Y---91	1.85E+03	0.	0.	0.	0.	7.11E+05	4.94E+01
ZR--95	5.74E+03	3.41E+03	0.	2.70E+03	0.	1.38E+07	1.93E+03
NB--95	1.49E+04	8.96E+03	0.	7.05E+03	0.	3.66E+07	5.05E+03
RU-103	2.03E+02	0.	0.	6.05E+02	0.	1.58E+04	9.08E+01
RU-106	4.59E+03	0.	0.	6.11E+03	0.	2.08E+05	5.78E+02
AG110	9.04E+06	8.36E+06	0.	1.64E+07	0.	3.41E+09	4.97E+06

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

TABLE G-15
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - TEENAGER

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	2.54E+08	5.05E+06	1.48E+06	0.	7.23E+05	1.69E+08	7.64E+06
SB-124	4.00E+06	7.54E+04	9.66E+03	0.	3.10E+06	1.13E+08	1.58E+06
SB-125	4.14E+06	1.15E+05	6.06E+04	5.77E+05	4.12E+08	3.54E+07	8.19E+05
TE 125M	3.61E+06	1.29E+06	1.02E+06	1.03E+07	0.	1.01E+07	4.78E+05
TE 127M	7.23E+06	2.52E+06	1.91E+06	2.92E+07	0.	3.63E+07	8.94E+05
TE 129M	1.35E+07	5.02E+06	4.34E+06	3.92E+07	0.	4.72E+07	2.13E+06
I--130	6.61E+05	1.96E+06	2.49E+08	3.04E+06	0.	1.68E+06	7.69E+05
I--131	6.15E+08	8.68E+08	2.50E+11	1.13E+09	0.	1.64E+08	5.17E+08
I--132	2.59E-01	6.92E-01	9.11E+01	1.10E+00	0.	1.30E-01	2.46E-01
I--133	8.79E+06	1.49E+07	2.71E+09	1.88E+07	0.	1.08E+07	4.59E+06
I--134	0.	0.	1.55E-09	0.	0.	0.	0.
I--135	2.17E+04	5.73E+04	7.49E+06	9.10E+04	2.94E-01	6.41E+04	2.10E+04
CS-134	2.83E+10	6.83E+10	0.	1.69E+10	8.27E+09	7.88E+08	3.19E+10
CS-136	1.01E+09	3.99E+09	0.	2.22E+09	3.05E+08	4.54E+08	2.87E+09
CS-137	3.84E+10	5.16E+10	0.	1.33E+10	6.85E+09	6.88E+08	1.81E+10
BA-140	5.81E+06	7.14E+03	0.	1.78E+03	4.78E+03	1.10E+06	3.73E+05
CE-141	6.06E+03	4.07E+03	0.	1.41E+03	0.	1.10E+07	4.66E+02
CE-144	4.92E+05	2.02E+05	0.	8.24E+04	0.	1.16E+08	2.61E+04

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per μCi/cu. meter)

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TABLE G-16
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	1.93E+02	1.93E+02	2.44E+02	1.93E+02	1.93E+02	1.93E+02
P---32	2.76E+09	1.73E+08	0.	0.	0.	3.10E+08	1.07E+08
CR--51	0.	0.	2.50E+03	9.22E+02	5.55E+03	1.05E+06	4.18E+03
MN--54	0.	5.42E+06	0.	1.61E+06	0.	1.66E+07	1.04E+06
FE--59	1.58E+08	3.74E+08	0.	0.	1.04E+08	1.24E+09	1.42E+08
CO--57	0.	3.33E+06	0.	0.	0.	8.45E+07	5.54E+06
CO--58	0.	1.44E+07	0.	0.	0.	1.94E+08	3.27E+07
CO--60	0.	5.73E+07	0.	0.	0.	6.87E+08	1.31E+08
ZN--65	2.11E+08	6.69E+08	0.	4.47E+08	0.	4.21E+08	3.03E+08
RB--86	0.	2.89E+08	0.	0.	0.	5.69E+07	1.35E+08
SR--89	2.66E+08	0.	0.	0.	0.	2.89E+07	7.64E+06
SR--90	1.01E+10	0.	0.	0.	2.79E+08	1.02E+09	2.49E+09
Y---91	9.34E+05	0.	0.	0.	0.	3.59E+08	2.49E+04
ZR--95	2.67E+06	1.24E+06	0.	1.18E+06	0.	4.20E+09	7.61E+05
NB--95	1.58E+06	9.51E+05	0.	7.48E+05	0.	3.88E+09	5.37E+05
RU-103	8.05E+07	0.	0.	2.40E+08	0.	6.28E+09	3.60E+07
RU-106	2.40E+09	0.	0.	3.20E+09	0.	1.09E+11	3.02E+08
AG110	3.97E+06	3.67E+06	0.	7.21E+06	0.	1.50E+09	2.18E+06

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per μCi/cu. meter)

TABLE G-16
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	1.10E+10	2.18E+08	6.38E+07	0.	3.82E+06	3.66E+09	3.14E+08
SB-124	1.17E+07	2.21E+05	2.84E+04	0.	9.11E+06	3.32E+08	4.64E+06
SB-125	5.01E+07	1.31E+07	1.02E+07	1.03E+08	1.47E+09	2.25E+08	7.60E+06
TE 125M	3.03E+08	1.08E+08	8.55E+07	8.63E+08	0.	8.47E+08	4.02E+07
TE 127M	6.68E+08	2.34E+08	1.77E+08	2.69E+09	0.	3.35E+09	8.28E+07
TE 129M	9.78E+08	3.63E+08	3.13E+08	2.83E+09	0.	3.41E+09	1.53E+08
I--130	1.41E-06	4.16E-06	5.30E-04	6.47E-06	0.	3.57E-06	1.64E-06
I--131	8.54E+06	1.21E+07	3.48E+09	1.56E+07	0.	2.28E+06	7.19E+06
I--132	0.	0.	0.	0.	0.	0.	0.
I--133	3.69E-01	6.26E-01	1.14E+02	7.88E-01	0.	4.55E-01	1.93E-01
I--134	0.	0.	0.	0.	0.	0.	0.
I--135	5.08E-02	4.69E-02	0.	1.78E-02	5.34E-03	1.10E-03	2.08E-02
CS-134	5.03E+08	1.21E+09	0.	3.00E+08	1.47E+08	1.40E+07	5.66E+08
CS-136	6.99E+06	2.76E+07	0.	1.54E+07	2.11E+06	3.14E+06	1.99E+07
CS-137	6.92E+08	9.31E+08	0.	2.40E+08	1.24E+08	1.24E+07	3.27E+08
BA-140	2.37E+07	2.93E+04	0.	7.28E+03	1.95E+04	9.19E+06	1.53E+06
CE-141	1.12E+04	7.51E+03	0.	2.61E+03	0.	2.03E+07	8.61E+02
CE-144	1.28E+06	5.23E+05	0.	2.14E+05	0.	3.00E+08	6.76E+04

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H---3 are (mrem/yr per µCi/cu. meter)

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TABLE G-17
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	2.09E+02	2.09E+02	2.64E+02	2.09E+02	2.09E+02	2.09E+02
P---32	6.81E+08	4.27E+07	0.	0.	0.	7.66E+07	2.64E+07
CR--51	0.	0.	7.56E+03	2.79E+03	1.68E+04	3.18E+06	1.27E+04
MN--54	0.	3.20E+07	0.	9.52E+06	0.	9.80E+07	6.11E+06
FE--59	2.39E+07	5.67E+07	0.	0.	1.57E+07	1.87E+08	2.16E+07
CO--57	0.	1.22E+06	0.	0.	0.	3.09E+07	2.02E+06
CO--58	0.	6.01E+06	0.	0.	0.	8.12E+07	1.37E+07
CO--60	0.	2.01E+07	0.	0.	0.	2.41E+08	4.58E+07
ZN--65	3.35E+07	1.06E+08	0.	7.12E+07	0.	6.70E+07	4.82E+07
RB--86	0.	8.52E+07	0.	0.	0.	1.68E+07	3.97E+07
SR--89	2.61E+09	0.	0.	0.	0.	2.83E+08	7.48E+07
SR--90	7.61E+10	0.	0.	0.	2.41E+08	2.31E+09	1.88E+10
Y---91	1.15E+06	0.	0.	0.	0.	4.41E+08	3.06E+04
ZR--95	2.35E+05	8.19E+04	0.	9.81E+04	0.	1.92E+08	5.61E+04
NB--95	3.72E+04	2.24E+04	0.	1.76E+04	0.	9.14E+07	1.26E+04
RU-103	1.27E+06	0.	0.	3.77E+06	0.	9.87E+07	5.66E+05
RU-106	2.82E+07	0.	0.	3.75E+07	0.	1.28E+09	3.54E+06
AG110	1.11E+06	1.03E+06	0.	2.02E+06	0.	4.19E+08	6.10E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-17
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - TEENAGER
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	9.25E-06	1.53E-07	1.22E-07	0.	0.	1.33E-05	2.28E-07
SN-126	6.25E+08	1.24E+07	3.64E+06	0.	2.83E+06	5.55E+08	1.94E+07
SB-124	1.65E+07	3.12E+05	3.99E+04	0.	1.28E+07	4.67E+08	6.53E+06
SB-125	1.73E+07	5.97E+05	3.48E+05	3.38E+06	1.68E+09	1.45E+08	3.40E+06
TE 125M	2.23E+07	7.99E+06	6.30E+06	6.36E+07	0.	6.24E+07	2.96E+06
TE 127M	4.46E+07	1.55E+07	1.18E+07	1.80E+08	0.	2.23E+08	5.51E+06
TE 129M	8.46E+07	3.14E+07	2.71E+07	2.45E+08	0.	2.95E+08	1.33E+07
I--130	2.58E+05	7.64E+05	9.72E+07	1.19E+06	0.	6.55E+05	3.00E+05
I--131	6.84E+07	9.66E+07	2.79E+10	1.25E+08	0.	1.83E+07	5.76E+07
I--132	3.65E+01	9.77E+01	1.29E+04	1.56E+02	0.	1.84E+01	3.47E+01
I--133	1.98E+06	3.36E+06	6.10E+08	4.23E+06	0.	2.44E+06	1.04E+06
I--134	6.75E-05	1.83E-04	2.38E-02	2.92E-04	0.	1.60E-07	6.56E-05
I--135	2.65E+04	7.00E+04	9.15E+06	1.11E+05	5.67E-03	7.84E+04	2.57E+04
CS-134	5.79E+08	1.40E+09	0.	3.45E+08	1.69E+08	1.61E+07	6.52E+08
CS-136	2.18E+07	8.60E+07	0.	4.78E+07	6.56E+06	9.77E+06	6.19E+07
CS-137	7.83E+08	1.05E+09	0.	2.72E+08	1.40E+08	1.41E+07	3.70E+08
BA-140	9.38E+07	1.21E+05	0.	2.88E+04	7.73E+04	3.19E+08	6.04E+06
CE-141	6.32E+04	4.24E+04	0.	1.47E+04	0.	1.15E+08	4.86E+03
CE-144	5.03E+06	2.06E+06	0.	8.43E+05	0.	1.19E+09	2.67E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-18
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/YR PER µCI/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03
P---32	1.32E+06	7.72E+04	0.	0.	0.	8.64E+04	5.02E+04
CR--51	0.	0.	5.95E+01	2.28E+01	1.44E+04	3.32E+03	1.00E+02
MN--54	0.	3.96E+04	0.	9.84E+03	1.40E+06	7.74E+04	6.30E+03
FE--59	1.18E+04	2.78E+07	0.	0.	1.02E+06	1.88E+05	1.06E+04
CO--57	0.	6.92E+02	0.	0.	3.70E+05	3.14E+04	6.71E+02
CO--58	0.	1.58E+03	0.	0.	9.28E+05	1.06E+05	2.07E+03
CO--60	0.	1.15E+04	0.	0.	5.98E+06	2.85E+05	1.48E+04
ZN--65	3.24E+04	1.03E+05	0.	6.90E+04	8.72E+05	5.34E+04	4.66E+04
RB--86	0.	1.35E+05	0.	0.	0.	1.66E+04	5.90E+04
SR--89	3.04E+05	0.	0.	0.	1.40E+06	3.50E+05	8.72E+03
SR--90	9.92E+07	0.	0.	0.	9.60E+06	7.22E+05	6.10E+06
Y---91	4.62E+05	0.	0.	0.	1.70E+06	3.85E+05	1.24E+04
ZR--95	1.07E+05	3.44E+04	0.	5.42E+04	1.78E+06	1.50E+05	2.33E+04
NB--95	1.41E+04	7.82E+03	0.	7.74E+03	5.06E+05	1.04E+05	4.21E+03
RU-103	1.53E+03	0.	0.	5.83E+03	5.06E+05	1.10E+05	6.58E+02
RU-106	6.91E+04	0.	0.	1.34E+05	9.44E+06	9.12E+05	8.72E+03
AG110	1.08E+04	1.00E+04	0.	1.97E+04	4.64E+06	3.02E+05	5.94E+03

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-18
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - INHALATION AGE GROUP - ADULT
ORGAN DOSE FACTOR (MREM/YR PER µCI/CU. METER)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	2.42E+05	5.33E+03	4.53E+03	0.	2.30E+06	3.14E+05	7.86E+03
SN-126	1.26E+06	3.34E+04	9.84E+03	0.	9.36E+06	1.27E+05	4.80E+04
SB-124	3.12E+04	5.89E+02	7.55E+01	0.	2.48E+06	4.06E+05	1.24E+04
SB-125	6.61E+04	7.13E+02	5.87E+01	0.	2.20E+06	1.01E+05	1.33E+04
TE 125M	3.42E+03	1.58E+03	1.05E+03	1.24E+04	3.14E+05	7.06E+04	4.67E+02
TE 127M	1.26E+04	5.62E+03	3.29E+03	4.58E+04	9.60E+05	1.50E+05	1.57E+03
TE 129M	9.76E+03	4.67E+03	3.44E+03	3.66E+04	1.16E+06	3.83E+05	1.58E+03
I–130	4.58E+03	1.34E+04	1.74E+06	2.09E+04	0.	7.69E+03	5.29E+03
I–131	2.52E+04	3.58E+04	1.19E+07	6.14E+04	0.	6.28E+03	2.05E+04
I–132	1.16E+03	3.26E+03	4.38E+05	5.19E+03	0.	4.06E+02	1.16E+03
I–133	8.64E+03	1.49E+04	2.93E+06	2.60E+04	0.	8.72E+03	4.54E+03
I–134	6.45E+02	1.73E+03	2.30E+05	2.75E+03	0.	1.01E+00	6.16E+02
I–135	2.69E+03	6.99E+03	9.36E+05	1.11E+04	0.	5.25E+03	2.58E+03
CS-134	3.74E+05	8.48E+05	0.	2.88E+05	9.76E+04	1.04E+04	7.29E+05
CS-136	3.91E+04	1.46E+05	0.	8.56E+04	1.20E+04	1.17E+04	1.11E+05
CS-137	4.78E+05	6.22E+05	0.	2.22E+05	7.53E+04	8.40E+03	4.29E+05
BA-140	3.90E+04	4.90E+01	0.	1.67E+01	1.27E+06	2.18E+05	2.57E+03
CE-141	1.99E+04	1.35E+04	0.	6.26E+03	3.62E+05	1.20E+05	1.53E+03
CE-144	3.43E+06	1.43E+06	0.	8.48E+05	7.78E+06	8.16E+05	1.84E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

TABLE G-19
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - ADULT

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	9.73E+02	9.73E+02	9.73E+02	9.73E+02	9.73E+02	9.73E+02
P---32	1.71E+10	1.07E+09	0.	0.	0.	1.92E+09	6.62E+08
CR--51	0.	0.	1.71E+04	6.32E+03	3.80E+04	7.20E+06	2.86E+04
MN--54	0.	8.41E+06	0.	2.50E+06	0.	2.58E+07	1.61E+06
FE--59	2.98E+07	7.06E+07	0.	0.	1.96E+07	2.33E+08	2.69E+07
CO--57	0.	1.28E+06	0.	0.	0.	3.25E+07	2.13E+06
CO--58	0.	4.72E+06	0.	0.	0.	9.56E+07	1.06E+07
CO--60	0.	1.65E+07	0.	0.	0.	3.08E+08	3.62E+07
ZN--65	1.37E+09	4.36E+09	0.	2.92E+09	0.	2.75E+09	1.98E+09
RB--86	0.	2.60E+09	0.	0.	0.	5.12E+08	1.21E+09
SR--89	1.46E+09	0.	0.	0.	0.	2.33E+08	4.17E+07
SR--90	4.70E+10	0.	0.	0.	0.	6.37E+08	1.15E+10
Y---91	8.60E+03	0.	0.	0.	0.	4.73E+06	2.31E+02
ZR--95	3.18E+04	1.75E+04	0.	1.75E+04	0.	1.05E+08	6.95E+03
NB--95	8.26E+04	4.59E+04	0.	4.55E+04	0.	2.79E+08	1.80E+04
RU-103	1.02E+03	0.	0.	3.91E+03	0.	1.19E+05	4.41E+02
RU-106	2.04E+04	0.	0.	3.95E+04	0.	1.32E+06	2.58E+03
AG110	5.84E+07	5.40E+07	0.	1.06E+08	0.	2.20E+10	3.21E+07

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H---3 are (mrem/yr per µCi/cu. meter)

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TABLE G-19
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - COWS MILK (CONTAMINATED FORAGE) AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	1.65E+09	3.27E+07	9.56E+06	0.	4.67E+06	1.09E+09	4.94E+07
SB-124	2.58E+07	4.87E+05	6.24E+04	0.	2.00E+07	7.31E+08	1.02E+07
SB-125	2.64E+07	6.06E+05	2.99E+05	3.72E+06	2.66E+09	2.29E+08	5.23E+06
TE 125M	1.63E+07	5.91E+06	4.91E+06	6.63E+07	0.	6.50E+07	2.18E+06
TE 127M	4.63E+07	1.63E+07	1.21E+07	1.88E+08	0.	2.11E+08	5.72E+06
TE 129M	6.06E+07	2.27E+07	2.09E+07	2.53E+08	0.	3.04E+08	9.61E+06
I--130	4.27E+05	1.26E+06	1.61E+08	1.96E+06	0.	1.08E+06	4.97E+05
I--131	2.96E+08	4.25E+08	1.39E+11	7.27E+08	0.	1.12E+08	2.43E+08
I--132	1.67E-01	4.47E-01	5.88E+01	7.12E-01	0.	8.39E-02	1.59E-01
I--133	4.00E+06	6.94E+06	1.33E+09	1.21E+07	0.	6.10E+06	2.12E+06
I--134	0.	0.	9.98E-10	0.	0.	0.	0.
I--135	1.40E+04	3.70E+04	4.84E+06	5.88E+04	7.58E-02	4.14E+04	1.36E+04
CS-134	5.66E+09	1.35E+10	0.	4.36E+09	1.45E+09	2.36E+08	1.10E+10
CS-136	2.61E+08	1.03E+09	0.	5.74E+08	7.87E+07	1.17E+08	7.43E+08
CS-137	7.39E+09	1.01E+10	0.	3.44E+09	1.14E+09	1.95E+08	6.62E+09
BA-140	2.69E+07	3.38E+04	0.	1.15E+04	1.93E+04	5.70E+07	1.78E+06
CE-141	2.91E+04	1.97E+04	0.	9.13E+03	0.	7.52E+07	2.23E+03
CE-144	2.15E+06	8.97E+05	0.	5.32E+05	0.	7.26E+08	1.15E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

TABLE G-20
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	1.99E+03	1.99E+03	1.99E+03	1.99E+03	1.99E+03	1.99E+03
P---32	2.05E+10	1.29E+09	0.	0.	0.	2.31E+09	7.94E+08
CR--51	0.	0.	2.05E+03	7.58E+02	4.56E+03	8.64E+05	3.43E+03
MN--54	0.	1.01E+06	0.	3.00E+05	0.	3.09E+06	1.93E+05
FE--59	3.87E+05	9.18E+05	0.	0.	2.55E+05	3.03E+06	3.50E+05
CO--57	0.	1.54E+05	0.	0.	0.	3.90E+06	2.55E+05
CO--58	0.	5.67E+05	0.	0.	0.	1.15E+07	1.27E+06
CO--60	0.	1.98E+06	0.	0.	0.	3.70E+07	4.34E+06
ZN--65	1.65E+08	5.24E+08	0.	3.50E+08	0.	3.30E+08	2.37E+08
RB--86	0.	3.12E+08	0.	0.	0.	6.15E+07	1.45E+08
SR--89	3.06E+09	0.	0.	0.	0.	4.89E+08	8.76E+07
SR--90	9.87E+10	0.	0.	0.	0.	1.32E+09	2.41E+10
Y---91	1.03E+03	0.	0.	0.	0.	5.68E+05	2.77E+01
ZR--95	3.82E+03	2.10E+03	0.	2.10E+03	0.	1.26E+07	8.34E+02
NB--95	9.92E+03	5.51E+03	0.	5.46E+03	0.	3.34E+07	2.17E+03
RU-103	1.23E+02	0.	0.	4.69E+02	0.	1.43E+04	5.30E+01
RU-106	2.45E+03	0.	0.	4.73E+03	0.	1.58E+05	3.10E+02
AG110	7.00E+06	6.48E+06	0.	1.27E+07	0.	2.64E+09	3.85E+06

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per μCi/cu. meter)

TABLE G-20

ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES

PATHWAY - GOATS MILK (CONTAMINATED FORAGE) AGE GROUP - ADULT

ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	1.97E+08	3.92E+06	1.15E+06	0.	5.61E+05	1.31E+08	5.92E+06
SB-124	3.10E+06	5.85E+04	7.49E+03	0.	2.40E+06	8.77E+07	1.22E+06
SB-125	3.16E+06	7.28E+04	3.58E+04	4.47E+05	3.19E+08	2.74E+07	6.29E+05
TE 125M	1.96E+06	7.10E+05	5.89E+05	7.95E+06	0.	7.81E+06	2.62E+05
TE 127M	5.57E+06	1.94E+06	1.47E+06	2.26E+07	0.	2.52E+07	6.86E+05
TE 129M	7.27E+06	2.72E+06	2.51E+06	3.04E+07	0.	3.65E+07	1.15E+06
I--130	5.12E+05	1.52E+06	1.93E+08	2.36E+06	0.	1.30E+06	5.96E+05
I--131	3.56E+08	5.10E+08	1.67E+11	8.72E+08	0.	1.34E+08	2.92E+08
I--132	2.00E-01	5.36E-01	7.06E+01	8.55E-01	0.	1.01E-01	1.91E-01
I--133	4.80E+06	8.32E+06	1.60E+09	1.45E+07	0.	7.32E+06	2.54E+06
I--134	0.	0.	1.20E-09	0.	0.	0.	0.
I--135	1.68E+04	4.44E+04	5.80E+06	7.05E+04	2.28E-01	4.97E+04	1.63E+04
CS-134	1.70E+10	4.04E+10	0.	1.31E+10	4.34E+09	7.06E+08	3.30E+10
CS-136	7.84E+08	3.09E+09	0.	1.72E+09	2.36E+08	3.52E+08	2.23E+09
CS-137	2.22E+10	3.03E+10	0.	1.03E+10	3.42E+09	5.83E+08	1.99E+10
BA-140	3.23E+06	4.05E+03	0.	1.38E+03	2.32E+03	6.84E+06	2.13E+05
CE-141	3.49E+03	2.36E+03	0.	1.10E+03	0.	9.02E+06	2.68E+02
CE-144	2.58E+05	1.08E+05	0.	6.39E+04	0.	8.71E+07	1.38E+04

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per μCi/cu. meter)

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TABLE G-21
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	4.13E+02	4.13E+02	4.13E+02	4.13E+02	4.13E+02	4.13E+02
P---32	4.67E+09	2.93E+08	0.	0.	0.	5.25E+08	1.81E+08
CR--51	0.	0.	4.23E+03	1.56E+03	9.38E+03	1.78E+06	7.07E+03
MN--54	0.	9.18E+06	0.	2.73E+06	0.	2.81E+07	1.75E+06
FE--59	2.67E+08	6.33E+08	0.	0.	1.76E+08	2.09E+09	2.41E+08
CO--57	0.	5.64E+06	0.	0.	0.	1.43E+08	9.38E+06
CO--58	0.	1.83E+07	0.	0.	0.	3.70E+08	4.09E+07
CO--60	0.	7.55E+07	0.	0.	0.	1.41E+09	1.66E+08
ZN--65	3.56E+08	1.13E+09	0.	7.57E+08	0.	7.13E+08	5.12E+08
RB--86	0.	4.89E+08	0.	0.	0.	9.64E+07	2.28E+08
SR--89	3.03E+08	0.	0.	0.	0.	4.84E+07	8.67E+06
SR--90	1.25E+10	0.	0.	0.	0.	1.45E+09	3.05E+09
Y---91	1.14E+06	0.	0.	0.	0.	6.26E+08	3.05E+04
ZR--95	3.78E+06	1.67E+06	0.	2.01E+06	0.	8.30E+09	8.26E+05
NB--95	2.30E+06	1.28E+06	0.	1.27E+06	0.	7.75E+09	5.02E+05
RU-103	1.06E+08	0.	0.	4.06E+08	0.	1.24E+10	4.59E+07
RU-106	2.80E+09	0.	0.	5.41E+09	0.	1.81E+11	3.54E+08
AG110	6.71E+06	6.21E+06	0.	1.22E+07	0.	2.53E+09	3.69E+06

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per µCi/cu. meter)

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TABLE G-21
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - MEAT (CONTAMINATED FORAGE) AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	0.	0.	0.	0.	0.	0.	0.
SN-126	1.86E+10	3.69E+08	1.08E+08	0.	6.46E+06	6.19E+09	5.33E+08
SB-124	1.99E+07	3.75E+05	4.80E+04	0.	1.54E+07	5.62E+08	7.85E+06
SB-125	6.65E+07	1.58E+07	1.29E+07	1.74E+08	2.49E+09	3.80E+08	1.05E+07
TE 125M	3.59E+08	1.30E+08	1.08E+08	1.46E+09	0.	1.43E+09	4.81E+07
TE 127M	1.13E+09	3.93E+08	2.96E+08	4.56E+09	0.	5.11E+09	1.39E+08
TE 129M	1.14E+09	4.29E+08	3.95E+08	4.79E+09	0.	5.76E+09	1.82E+08
I--130	2.38E-06	7.05E-06	8.96E-04	1.10E-05	0.	6.04E-06	2.77E-06
I--131	1.08E+07	1.55E+07	5.06E+09	2.65E+07	0.	4.07E+06	8.85E+06
I--132	0.	0.	0.	0.	0.	0.	0.
I--133	4.40E-01	7.63E-01	1.47E+02	1.33E+00	0.	6.71E-01	2.33E-01
I--134	0.	0.	0.	0.	0.	0.	0.
I--135	8.60E-02	7.94E-02	0.	3.01E-02	9.04E-03	1.86E-03	3.53E-02
CS-134	6.58E+08	1.57E+09	0.	5.08E+08	1.68E+08	2.74E+07	1.28E+09
CS-136	1.18E+07	4.67E+07	0.	2.60E+07	3.56E+06	5.31E+06	3.36E+07
CS-137	8.73E+08	1.19E+09	0.	4.06E+08	1.35E+08	2.30E+07	7.82E+08
BA-140	2.88E+07	3.63E+04	0.	1.23E+04	2.07E+04	6.87E+07	1.90E+06
CE-141	1.41E+04	9.52E+03	0.	4.41E+03	0.	3.63E+07	1.08E+03
CE-144	1.46E+06	6.10E+05	0.	3.62E+05	0.	4.93E+08	7.83E+04

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

Note - the units for C---14 and H----3 are (mrem/yr per μCi/cu. meter)

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TABLE G-22
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER µCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
H---3	0.	4.02E+02	4.02E+02	4.02E+02	4.02E+02	4.02E+02	4.02E+02
P---32	1.04E+09	6.51E+07	0.	0.	0.	1.17E+08	4.02E+07
CR--51	0.	0.	1.15E+04	4.25E+03	2.56E+04	4.85E+06	1.93E+04
MN--54	0.	4.87E+07	0.	1.45E+07	0.	1.49E+08	9.31E+06
FE--59	3.64E+07	8.64E+07	0.	0.	2.40E+07	2.85E+08	3.29E+07
CO--57	0.	1.85E+06	0.	0.	0.	4.70E+07	3.08E+06
CO--58	0.	6.89E+06	0.	0.	0.	1.40E+08	1.54E+07
CO--60	0.	2.38E+07	0.	0.	0.	4.46E+08	5.23E+07
ZN--65	5.11E+07	1.62E+08	0.	1.09E+08	0.	1.02E+08	7.34E+07
RB--86	0.	1.30E+08	0.	0.	0.	2.56E+07	6.06E+07
SR--89	2.67E+09	0.	0.	0.	0.	4.26E+08	7.64E+07
SR--90	8.49E+10	0.	0.	0.	0.	2.14E+09	2.07E+10
Y---91	1.26E+06	0.	0.	0.	0.	6.92E+08	3.37E+04
ZR--95	2.93E+05	9.82E+04	0.	1.49E+05	0.	3.34E+08	6.38E+04
NB--95	4.87E+04	2.71E+04	0.	2.68E+04	0.	1.64E+08	1.06E+04
RU-103	1.50E+06	0.	0.	5.75E+06	0.	1.76E+08	6.49E+05
RU-106	2.95E+07	0.	0.	5.71E+07	0.	1.91E+09	3.74E+06
AG110	1.69E+06	1.56E+06	0.	3.08E+06	0.	6.38E+08	9.30E+05

Based on 1 µCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE G-22
ENVIRONMENTAL PATHWAY-DOSE CONVERSION FACTORS R(I) FOR GASEOUS DISCHARGES
PATHWAY - FRESH FRUITS AND VEGETABLES AGE GROUP - ADULT
ORGAN DOSE FACTOR (SQ. METER-MREM/YR PER μCI/SEC)

NUCLIDE	BONE	LIVER	THYROID	KIDNEY	LUNG	GI-LLI	WHOLE BODY
SN-123	1.00E-05	1.66E-07	1.41E-07	0.	0.	2.04E-05	2.45E-07
SN-126	9.52E+08	1.89E+07	5.54E+06	0.	4.31E+06	8.46E+08	2.94E+07
SB-124	2.52E+07	4.75E+05	6.08E+04	0.	1.95E+07	7.12E+08	9.94E+06
SB-125	2.58E+07	7.23E+05	4.03E+05	5.14E+06	2.56E+09	2.22E+08	5.10E+06
TE 125M	2.38E+07	8.65E+06	7.17E+06	9.69E+07	0.	9.51E+07	3.19E+06
TE 127M	6.75E+07	2.36E+07	1.77E+07	2.73E+08	0.	3.06E+08	8.32E+06
TE 129M	8.93E+07	3.34E+07	3.08E+07	3.73E+08	0.	4.49E+08	1.42E+07
I–130	3.93E+05	1.16E+06	1.48E+08	1.81E+06	0.	9.98E+05	4.58E+05
I–131	7.78E+07	1.12E+08	3.65E+10	1.91E+08	0.	2.94E+07	6.38E+07
I–132	5.57E+01	1.49E+02	1.96E+04	2.38E+02	0.	2.80E+01	5.29E+01
I–133	2.13E+06	3.69E+06	7.10E+08	6.44E+06	0.	3.24E+06	1.13E+06
I–134	1.03E-04	2.79E-04	3.63E-02	4.45E-04	0.	2.43E-07	9.99E-05
I–135	4.04E+04	1.07E+05	1.40E+07	1.70E+05	8.65E-03	1.19E+05	3.91E+04
CS-134	6.82E+08	1.62E+09	0.	5.26E+08	1.74E+08	2.84E+07	1.33E+09
CS-136	3.32E+07	1.31E+08	0.	7.29E+07	9.99E+06	1.49E+07	9.43E+07
CS-137	8.90E+08	1.22E+09	0.	4.14E+08	1.37E+08	2.34E+07	7.98E+08
BA-140	1.03E+08	1.35E+05	0.	4.39E+04	7.38E+04	6.65E+08	6.77E+06
CE-141	7.16E+04	4.85E+04	0.	2.25E+04	0.	1.85E+08	5.49E+03
CE-144	5.19E+06	2.17E+06	0.	1.29E+06	0.	1.75E+09	2.78E+05

Based on 1 μCi/sec release rate of each isotope in and a value of 1. for X/Q, depleted X/Q and relative deposition

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TABLE M-1

Selecting the Appropriate Long Term (X/Q) for Dose Calculations Involving Noble Gases for:

(1) Total Body dose from instantaneous releases

(2) Skin dose from instantaneous releases

(3) Gamma air dose (cumulative)

(4) Beta air dose (cumulative)

<table>
<tr><th>TYPE OF DOSE CALCULATION</th><th>LIMITING RANGE (miles)</th><th>LIMITING Sector</th><th>(X/Q) VALUE sec/m^3</th></tr>
<tr><td>Instantaneous</td><td>0.97</td><td>NW</td><td>1.6×10^{-6}</td></tr>
<tr><td>1/31 days</td><td>0.97</td><td colspan="2" rowspan="3">1. Normally (X/Q) = 1.6×10^{-6} sec/m^3
2. May use option of actual meteorological data for time of concern.</td></tr>
<tr><td>Quarterly
Yearly</td><td>0.97</td></tr>
<tr><td>12 Consecutive months</td><td>0.97</td></tr>
<tr><td>Annual Report</td><td>0.97</td><td>N/A</td><td>Note-1</td></tr>
</table>

NOTE 1

The (X/Q) has to be calculated based on actual meteorological data that occurred during the period of interest. The sector of interest is N/A because the limiting (X/Q) will be determined from the actual meteorological data and may occur in any sector.

0.97 miles — Corresponds to the minimum site boundary distance in the north direction and 0.97 miles was chosen for all other sectors for ease of calculations when the averaging is done for quarterly reports.

TABLE M-2

Selecting the Appropriate Long Term $(X/Q)_D$ or (D/Q) for Dose

Calculations Involving Radioiodines & 8 D Particulates for:

(1) Inhalation (2) Tritium (All gas pathways) (3) Ground Plane

TYPE OF DOSE CALCULATION	LIMITING RANGE (miles)	LIMITING SECTOR (OL)	$(X/Q)_D$ sec/m^3	(D/Q) 1/m^2
Instantaneous	0.97	NW	B 1.3×10^{-6}	
		WNW		8.2×10^{-9}
Annual Report	0.97	A	A, B	
	0.97	A		A
1/31 days, Qtr. yearly, Annual Total Dose	0.97	NW	B 1.3×10^{-6}	
	0.97	WNW		8.2×10^{-9}

(OL) Over land areas only

(A) To be determined by reduction of actual met data occurring during each quarter

(B) For Tritium in the Milk Animal Pathway, the $(X/Q)_D$ value should be that of the respective controlling sector and range where the Milk Animal is located as per Table M-3. Example: If a cow was located at 4.25 miles in NW sector, use the $(X/Q)_D$ for 4.25 miles NW.

TABLE M-3

Selecting the Appropriate Long Term (D/Q) for Dose Calculations Involving Radioiodines and 8D Particulates for Grass-Cow-Milk or Grass-Goat-Milk:

TYPE OF DOSE CALCULATION	LIMITING RANGE	LIMITING SECTOR	(D/Q) Value $1/m^2$
Release Rate	A	A	A
1/31 Days	B	B	B
Quarterly - Yearly	B	B	B
Annual (Calendar Year)	B	B	B
Annual Report	C	C	C

A. The worst cow or goat as per locations from land census. If no milk animal in any sector, assume a cow at 4.25 miles in the highest (D/Q) sector over land.

B. The historical (D/Q) of all land sectors with the worst cow or goat from each sector as reported in the Land Census. A 4.25 mile cow should be assumed in the worst sector over land when no milk animal is reported.

C. The highest (D/Q) at a milk animal location of all milk animals reported in the Land Census Report. (If no milk animals within 5 miles a 4.25 mile cow should be assumed in the sector having the highest (D/Q) at 4.25 miles over land). Actual Met Data should be used for the selection of the worst case milk animal and for the dose calculations. If both goat and milk animals are reported inside 5 miles, dose calculations should be performed on each animal and the higher dose animal contribution should be used.

The historical wind frequency fractions for each sector are listed in Table M-8.

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TABLE M-4
TERRAIN CORRECTION FACTORS

Florida Power & Light Company
St. Lucie Unit 1
Hutchinson Island, Florida
Dames and Moore Job No: 4598 - 112

Terrain Correction Factors (PUFF / STRAIGHT LINE)
Period of Record: 8/29/77 to 8/31/78
Base Distance in Miles/Kilometers

AFFECTED SECTOR	DESIGN DISTANCE MILES	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.906	1.576	1.465	1.404	1.338	1.318	1.334	1.386	1.346	1.338
NE	0.	1.887	1.581	1.461	1.391	1.310	1.259	1.164	1.128	1.101	1.116
ENE	0.	1.452	1.230	1.122	1.081	1.047	1.033	.941	.941	.906	.902
E	0.	1.662	1.425	1.277	1.193	1.151	1.123	1.097	1.121	1.123	1.122
ESE	0.	1.690	1.483	1.328	1.260	1.246	1.190	1.134	1.094	1.032	.968
SE	0.	1.818	1.691	1.470	1.427	1.435	1.361	1.366	1.331	1.279	1.239
SSE	0.	1.812	1.586	1.370	1.302	1.270	1.263	1.229	1.193	1.171	1.151
S	0.	1.398	1.321	1.125	1.083	1.108	1.127	1.073	1.063	1.047	1.024
SSW	0.	1.534	1.411	1.296	1.192	1.205	1.132	1.135	1.116	1.077	1.060
SW	0.	1.685	1.492	1.294	1.233	1.200	1.222	1.160	1.160	1.198	1.196
WSW	0.	1.620	1.333	1.210	1.173	1.082	1.091	1.099	1.056	1.034	1.004
W	0.	1.651	1.415	1.290	1.218	1.154	1.099	1.081	1.067	1.093	1.083
WNW	0.	1.720	1.430	1.267	1.185	1.150	1.133	1.125	1.085	1.033	1.045
NW	0.	1.681	1.407	1.257	1.173	1.119	1.078	1.063	.995	.998	.978
NNW	0.	1.739	1.488	1.316	1.212	1.172	1.122	1.135	1.080	1.099	1.091
N	0.	1.816	1.524	1.389	1.285	1.257	1.263	1.285	1.267	1.231	1.213

Note 1: Any interpolations between stated mileages will be done by log-log

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TABLE M-5
HISTORICAL LONG TERM - (X/Q) (Frequency corrected)

Terrain / Recirculation Adjusted   Program ANNXOQ9 Version - 11/18/76

Florida Power & Light Company
St. Lucie Unit 1   Average Annual Relative Concentration (sec/cubic meter)
Hutchinson Island, Florida   Period of Record: 9/1/76 to 8/31/78
Dames and Moore Job No: 1.4598 - 112   Base Distance in Miles/Kilometers

AFFECTED SECTOR	DESIGN DISTANCE MILES	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.1E-05	1.7E-06	7.8E-07	4.5E-07	3.1E-07	2.2E-07	1.7E-07	1.5E-07	1.2E-07	1.0E-07
NE	0.	1.3E-05	2.1E-06	8.9E-07	5.1E-07	3.4E-07	2.4E-07	1.7E-07	1.4E-07	1.1E-07	9.8E-08
ENE	0.	9.3E-06	1.4E-06	6.2E-07	3.7E-07	2.5E-07	1.9E-07	1.3E-07	1.1E-07	8.8E-08	7.5E-08
E	0.	9.8E-06	1.6E-06	6.5E-07	3.7E-07	2.5E-07	1.8E-07	1.4E-07	1.2E-07	9.9E-08	8.4E-08
ESE	0.	1.2E-05	1.9E-06	8.1E-07	4.8E-07	3.2E-07	2.4E-07	1.8E-07	1.4E-07	1.1E-07	9.0E-08
SE	0.	1.4E-05	2.4E-06	9.7E-07	5.7E-07	4.0E-07	2.9E-07	2.3E-07	1.9E-07	1.4E-07	1.2E-07
SSE	0.	1.1E-05	1.7E-06	7.3E-07	4.3E-07	2.9E-07	2.1E-07	1.6E-07	1.3E-07	1.1E-07	9.1E-08
S	0.	6.2E-06	1.0E-06	4.2E-07	2.5E-07	1.8E-07	1.4E-07	1.0E-07	8.0E-08	6.6E-08	5.5E-08
SSW	0.	5.7E-06	9.0E-07	4.0E-07	2.3E-07	1.6E-07	1.1E-07	8.9E-08	7.0E-08	5.7E-08	4.8E-08
SW	0.	6.1E-06	9.4E-07	3.9E-07	2.2E-07	1.6E-07	1.1E-07	8.6E-08	7.0E-08	6.0E-08	5.1E-08
WSW	0.	7.3E-06	1.1E-06	4.6E-07	2.7E-07	1.7E-07	1.3E-07	1.0E-07	8.0E-08	6.5E-08	5.4E-08
W	0.	7.6E-06	1.2E-06	5.2E-07	2.9E-07	2.0E-07	1.3E-07	1.0E-07	8.4E-08	7.2E-08	6.1E-08
WNW	0.	1.4E-05	2.1E-06	9.1E-07	5.2E-07	3.4E-07	2.6E-07	2.0E-07	1.5E-07	1.2E-07	1.0E-07
NW	0.	1.6E-05	2.4E-06	1.0E-06	5.9E-07	3.9E-07	2.8E-07	2.1E-07	1.7E-07	1.4E-07	1.2E-07
NNW	0.	1.5E-05	2.2E-06	9.6E-07	5.5E-07	3.6E-07	2.6E-07	2.0E-07	1.6E-07	1.3E-07	1.2E-07
N	0.	9.1E-06	1.4E-06	6.3E-07	3.6E-07	2.4E-07	1.8E-07	1.4E-07	1.2E-07	9.4E-08	7.9E-08

Number of Valid Observations = 17135   Number of Calms Lower Level = 95
Number of Invalid Observations = 385   Number of Calms Upper Level = 0
Note 1 - Any interpolations between stated mileages will be done by log-log

TABLE M-6

HISTORICAL LONG TERM DEPLETED - $(X/Q)_D$ (Frequency corrected)

Terrain / Recirculation Adjusted Program ANNXOQ9 Version - 11/18/76

Florida Power & Light Company
St. Lucie Unit 1 Average Annual Relative Concentration Depleted (sec/cubic meter)
Hutchinson Island, Florida Period of Record: 9/1/76 to 8/31/78
Dames and Moore Job No: 4598 - 112 Base Distance in Miles/Kilometers

AFFECTED SECTOR	DESIGN DISTANCE MILES	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	1.1E-05	1.6E-06	6.6E-07	3.8E-07	2.4E-07	1.7E-07	1.3E-07	1.1E-07	9.2E-08	7.6E-08
NE	0.	1.2E-05	1.7E-06	7.6E-07	4.3E-07	2.8E-07	1.9E-07	1.4E-07	1.1E-07	8.6E-08	7.4E-08
ENE	0.	8.9E-06	1.2E-06	5.3E-07	3.0E-07	2.0E-07	1.4E-07	1.0E-07	8.4E-08	6.6E-08	5.6E-08
E	0.	9.1E-06	1.3E-06	5.6E-07	3.1E-07	2.1E-07	1.5E-07	1.1E-07	9.1E-08	7.5E-08	6.3E-08
ESE	0.	1.2E-05	1.6E-06	6.9E-07	3.9E-07	2.6E-07	1.9E-07	1.4E-07	1.1E-07	8.5E-08	6.7E-08
SE	0.	1.3E-05	2.0E-06	8.2E-07	4.7E-07	3.3E-07	2.3E-07	1.8E-07	1.3E-07	1.1E-07	9.0E-08
SSE	0.	1.1E-05	1.6E-06	6.3E-07	3.5E-07	2.4E-07	1.8E-07	1.4E-07	1.0E-07	8.2E-08	6.8E-08
S	0.	5.9E-06	9.1E-07	3.6E-07	2.1E-07	1.4E-07	1.1E-07	7.7E-08	6.2E-08	5.0E-08	4.1E-08
SSW	0.	5.4E-06	8.0E-07	3.4E-07	1.9E-07	1.3E-07	8.9E-08	6.9E-08	5.5E-08	4.3E-08	3.6E-08
SW	0.	5.7E-06	8.4E-07	3.4E-07	1.8E-07	1.2E-07	9.2E-08	6.7E-08	5.3E-08	4.6E-08	3.8E-08
WSW	0.	7.0E-06	9.6E-07	4.0E-07	2.2E-07	1.4E-07	1.0E-07	8.0E-08	6.1E-08	5.0E-08	4.0E-08
W	0.	7.3E-06	1.1E-06	4.4E-07	2.4E-07	1.6E-07	1.1E-07	8.2E-08	6.4E-08	5.5E-08	4.4E-08
WNW	0.	1.3E-05	1.9E-06	7.9E-07	4.4E-07	2.9E-07	2.0E-07	1.6E-07	1.2E-07	9.3E-08	7.8E-08
NW	0.	1.5E-05	2.1E-06	8.9E-07	4.9E-07	3.1E-07	2.3E-07	1.7E-07	1.3E-07	1.0E-07	8.5E-08
NNW	0.	1.4E-05	2.1E-06	8.3E-07	4.5E-07	2.9E-07	2.0E-07	1.6E-07	1.2E-07	1.0E-07	8.6E-08
N	0.	8.7E-06	1.3E-06	5.4E-07	3.0E-07	2.0E-07	1.4E-07	1.1E-07	8.9E-08	7.0E-08	5.8E-08

Number of Valid Observations = 17135 Number of Calms Lower Level = 95
Number of Invalid Observations = 385 Number of Calms Upper Level = 0
Note 1 - Any interpolations between stated mileages will be done by log-log

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TABLE M-7
HISTORICAL LONG TERM - (D/Q) (Frequency corrected)

TERRAIN / RECIRCULATION ADJUSTED PROGRAM ANNXOQ9 VERSION - 11/18/76

Florida Power & Light Company
St. Lucie Unit 1 Average Annual Relative Deposition Rate (square meter - 1)
Hutchinson Island, Florida Period of Record: 9/1/76 to 8/31/78
Dames and Moore Job No: 4598 - 112 Base Distance in Miles/Kilometers

AFFECTED SECTOR	DESIGN DISTANCE MILES	.25 .40	.75 1.21	1.25 2.01	1.75 2.82	2.25 3.62	2.75 4.42	3.25 5.23	3.75 6.03	4.25 6.84	4.75 7.64
NNE	0.	6.5E-08	9.3E-09	3.7E-09	2.1E-09	1.3E-09	9.0E-10	6.8E-10	5.5E-10	4.3E-10	3.5E-10
NE	0.	6.0E-08	8.9E-09	3.5E-09	1.9E-09	1.2E-09	8.1E-10	5.6E-10	4.3E-10	3.3E-10	2.8E-10
ENE	0.	3.2E-08	4.8E-09	1.9E-09	1.0E-09	6.6E-10	4.6E-10	3.2E-10	2.4E-10	1.9E-10	1.5E-10
E	0.	3.0E-08	4.6E-09	1.8E-09	9.5E-10	6.0E-10	4.2E-10	3.1E-10	2.5E-10	2.0E-10	1.6E-10
ESE	0.	3.7E-08	5.8E-09	2.3E-09	1.2E-09	8.0E-10	5.4E-10	3.9E-10	3.0E-10	2.2E-10	1.7E-10
SE	0.	6.4E-08	1.0E-08	4.0E-09	2.1E-09	1.4E-09	9.7E-10	7.2E-10	5.6E-10	4.3E-10	3.5E-10
SSE	0.	6.2E-08	9.5E-09	3.6E-09	2.0E-09	1.2E-09	8.7E-10	6.4E-10	4.9E-10	3.9E-10	3.1E-10
S	0.	4.2E-08	7.0E-09	2.6E-09	1.4E-09	9.5E-10	6.9E-10	4.9E-10	3.8E-10	3.0E-10	2.5E-10
SSW	0.	3.4E-08	5.4E-09	2.2E-09	1.1E-09	7.5E-10	5.0E-10	3.7E-10	2.9E-10	2.3E-10	1.8E-10
SW	0.	4.5E-08	7.0E-09	2.6E-09	1.5E-09	9.0E-10	6.6E-10	4.6E-10	3.6E-10	3.0E-10	2.5E-10
WSW	0.	5.3E-08	7.7E-09	3.0E-09	1.6E-09	1.0E-09	7.3E-10	5.5E-10	4.1E-10	3.3E-10	2.6E-10
W	0.	5.0E-08	7.5E-09	3.0E-09	1.6E-09	9.8E-10	6.7E-10	5.0E-10	3.8E-10	3.2E-10	2.6E-10
WNW	0.	8.8E-08	1.3E-08	4.9E-09	2.6E-09	1.7E-09	1.1E-09	8.7E-10	6.6E-10	5.1E-10	4.2E-10
NW	0.	8.2E-08	1.2E-08	4.7E-09	2.5E-09	1.6E-09	1.1E-09	7.9E-10	5.8E-10	4.7E-10	3.8E-10
NNW	0.	8.2E-08	1.2E-08	4.6E-09	2.4E-09	1.5E-09	1.1E-09	8.1E-10	5.9E-10	4.8E-10	4.0E-10
N	0.	5.1E-08	7.3E-09	2.9E-09	1.5E-09	9.8E-10	7.1E-10	5.4E-10	4.2E-10	3.2E-10	2.7E-10

Number of Valid Observations = 17135 Number of Calms Lower Level = 95
Number of Invalid Observations = 385 Number of Calms Upper Level = 0
Note 1 - Any interpolations between stated mileages will be done by log-log

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TABLE M-8

Joint Wind Frequency Distribution   Data Period: September 1, 1976 - August 31, 1978

All Winds   St. Lucie Unit 2
Data Source: On-Site   Hutchinson Island, Florida
Wind Sensor Height 10.00 Meters   Florida Power & Light Co.
Table Generated: 12/05/78. 07.42.18.   Dames and Moore Job No: 4598 - 112 - 27

Wind Speed Categories (Meters per Second)

WIND SECTOR	0.0-1.5	1.5-3.0	3.0-5.0	5.0-7.5	7.5-10.0	>10.0	TOTAL[1]	MEAN SPEED
NNE	71 .43	206 1.25	318 1.92	71 .43	3 .02	0 0.00	669 4.05	3.32
NE	62 .38	292 1.77	385 2.33	128 .77	0 0.00	0 0.00	867 5.25	3.43
ENE	60 .36	334 2.02	505 3.06	158 .96	0 0.00	0 0.00	1057 6.40	3.51
E	69 .42	355 2.15	510 3.09	76 .46	0 0.00	0 0.00	1010 6.11	3.25
ESE	115 .70	684 4.14	744 4.50	72 .44	1 .01	0 0.00	1616 9.78	3.04
SE	183 1.11	660 3.99	749 4.53	28 .17	0 0.00	0 0.00	1620 9.81	2.88
SSE	129 .78	579 3.50	656 3.97	93 .56	1 .01	0 0.00	1458 8.82	3.10
S	72 .44	310 1.88	407 2.46	99 .60	8 .05	1 .01	897 5.43	3.36
SSW	84 .51	372 2.25	446 2.70	105 .64	33 .20	4 .02	1044 6.32	3.48
SW	129 .78	440 2.66	336 2.03	106 .64	14 .08	0 0.00	1025 6.20	3.10
WSW	155 .94	320 1.94	186 1.13	29 .18	5 .03	0 0.00	695 4.21	2.59
W	174 1.05	267 1.62	119 .72	37 .22	2 .01	0 0.00	599 3.63	2.43
WNW	203 1.23	304 1.84	172 1.04	17 .10	0 0.00	0 0.00	696 4.21	2.34
NW	143 .87	518 3.14	424 2.57	50 .30	0 0.00	0 0.00	1135 6.87	2.85
NNW	85 .51	379 2.29	535 3.24	70 .42	1 .01	0 0.00	1070 6.46	3.22
N	91 .55	194 1.17	531 3.21	148 .90	5 .03	0 0.00	969 5.86	3.69
CALM	95 .57						95 .57	CALM
TOTAL	1920 11.62	6214 37.61	7023 42.51	1287 7.79	73 .44	5 .03	16522 100.00	3.10

NUMBER OF VALID OBSERVATIONS	16522	94.30 PCT.	Key	XXX Number of Occurrences
NUMBER OF INVALID OBSERVATIONS	988	5.70 PCT.		XXX Percent Occurrences
TOTAL NUMBER OF OBSERVATIONS	17520	100.00 PCT.		

[1] - Totals below are given in hours & percent for wind frequency by sectors

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APPENDIX B
RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

ST. LUCIE PLANT
Key to Sample Locations

PATHWAY	LOCATION	DESCRIPTION	SAMPLES COLLECTED	SAMPLE COLLECTION FREQUENCY	APPROXIMATE DISTANCE (miles)	DIRECTION SECTOR
Direct Radiation	N-1	North of Blind Creek	TLD	Quarterly	1	N
Direct Radiation	NNW-5	South of Pete Stone Creek	TLD	Quarterly	5	NNW
Direct Radiation	NNW-10	C. G. Station	TLD	Quarterly	9	NNW
Direct Radiation	NW-5	Indian River Drive at Rio Vista Drive	TLD	Quarterly	6	NW
Direct Radiation	NW-10	Intersection of SR 68 and SR 607	TLD	Quarterly	10	NW
Direct Radiation	WNW-2	Cemetery South of 7107 Indian River Drive	TLD	Quarterly	3	WNW
Direct Radiation	WNW-5	US-1 at SR 712	TLD	Quarterly	5	WNW
Direct Radiation	WNW-10	SR 70, West of Turnpike	TLD	Quarterly	10	WNW
Direct Radiation	W-2	7609 Indian River Drive	TLD	Quarterly	2	W
Direct Radiation	W-5	Oleander and Sager Streets	TLD	Quarterly	5	W
Direct Radiation	W-10	I-95 and SR 709	TLD	Quarterly	9	W
Direct Radiation	WSW-2	8503 Indian River Drive	TLD	Quarterly	2	WSW
Direct Radiation	WSW-5	Prima Vista Blvd. at Yacht Club	TLD	Quarterly	5	WSW
Direct Radiation	WSW-10	Del Rio and Davis Streets	TLD	Quarterly	10	WSW
Direct Radiation	SW-2	9207 Indian River Drive	TLD	Quarterly	2	SW
Direct Radiation	SW-5	US 1 and Village Green Drive	TLD	Quarterly	5	SW
Direct Radiation	SW-10	Port St. Lucie Blvd. and Cairo Road	TLD	Quarterly	10	SW
Direct Radiation	SSW-2	10307 Indian River Drive	TLD	Quarterly	3	SSW

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

APPENDIX B
RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE
(continued)
ST. LUCIE PLANT
Key to Sample Locations

PATHWAY	LOCATION	DESCRIPTION	SAMPLES COLLECTED	SAMPLE COLLECTION FREQUENCY	APPROXIMATE DISTANCE (miles)	DIRECTION SECTOR
Direct Radiation	SSW-5	Port St. Lucie Blvd. and US 1	TLD	Quarterly	6	SSW
Direct Radiation	SSW-10	Pine Valley and Westmoreland Roads	TLD	Quarterly	8	SSW
Direct Radiation	S-5	13179 Indian River Drive	TLD	Quarterly	5	S
Direct Radiation	S-10	US 1 and SR 714	TLD	Quarterly	10	S
Direct Radiation	S/SSE-10	Indian River Drive and Quail Run Lane	TLD	Quarterly	10	SSE
Direct Radiation	SSE-5	Entrance of Nettles Island	TLD	Quarterly	5	SSE
Direct Radiation	SSE-10	Elliot Museum	TLD	Quarterly	10	SSE
Direct Radiation	SE-1	South of Cooling Canal	TLD	Quarterly	1	SE
Direct Radiation	*H-32	U. of Florida - 1FAS Entomology Lab Vero Beach	TLD	Quarterly	19	NNW
Airborne	H08	FPL Substation - Weatherby Road	Radioiodine & Particulates	Weekly	6	WNW
Airborne	*H12	FPL Substation - SR 76, Stuart	Radioiodine & Particulates	Weekly	12	S
Airborne	H14	Onsite - near south property line	Radioiodine & Particulates	Weekly	1	SE
Airborne	H30	Power Line - 7609 Indian River Drive	Radioiodine & Particulates	Weekly	2	W

*Denotes Control Sample

APPENDIX B
RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE
(continued)
ST. LUCIE PLANT
Key to Sample Locations

PATHWAY	LOCATION	DESCRIPTION	SAMPLES COLLECTED	SAMPLE COLLECTION FREQUENCY	APPROXIMATE DISTANCE (miles)	DIRECTION SECTOR
Airborne	H34	Onsite - At Meteorological Tower	Radioiodine & Particulates	Weekly	0.5	N
Waterborne	H15	Atlantic Ocean vicinity of public beaches east side of Route A1A	Surface Water (ocean) Sediment from shoreline	Weekly Semi-Annually	< 1	ENE/E/ESE
Waterborne	*H59	Near south end of Hutchinson Island	Surface Water (ocean) Sediment from shoreline	Monthly Semi-Annually	10-20	S/SSE
Food Products	H15	Ocean side vicinity of St. Lucie Plant (NOTE 1)	Crustacea Fish	Semi-Annually Semi-Annually	<1	ENE/E/ESE
Food Products	H51	Offsite near north property line	Broad Leaf vegetation (mangrove)	Monthly (when available)	1	N/NNW

*Denotes control sample

APPENDIX B
RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE
(continued)
ST. LUCIE PLANT
Key to Sample Locations

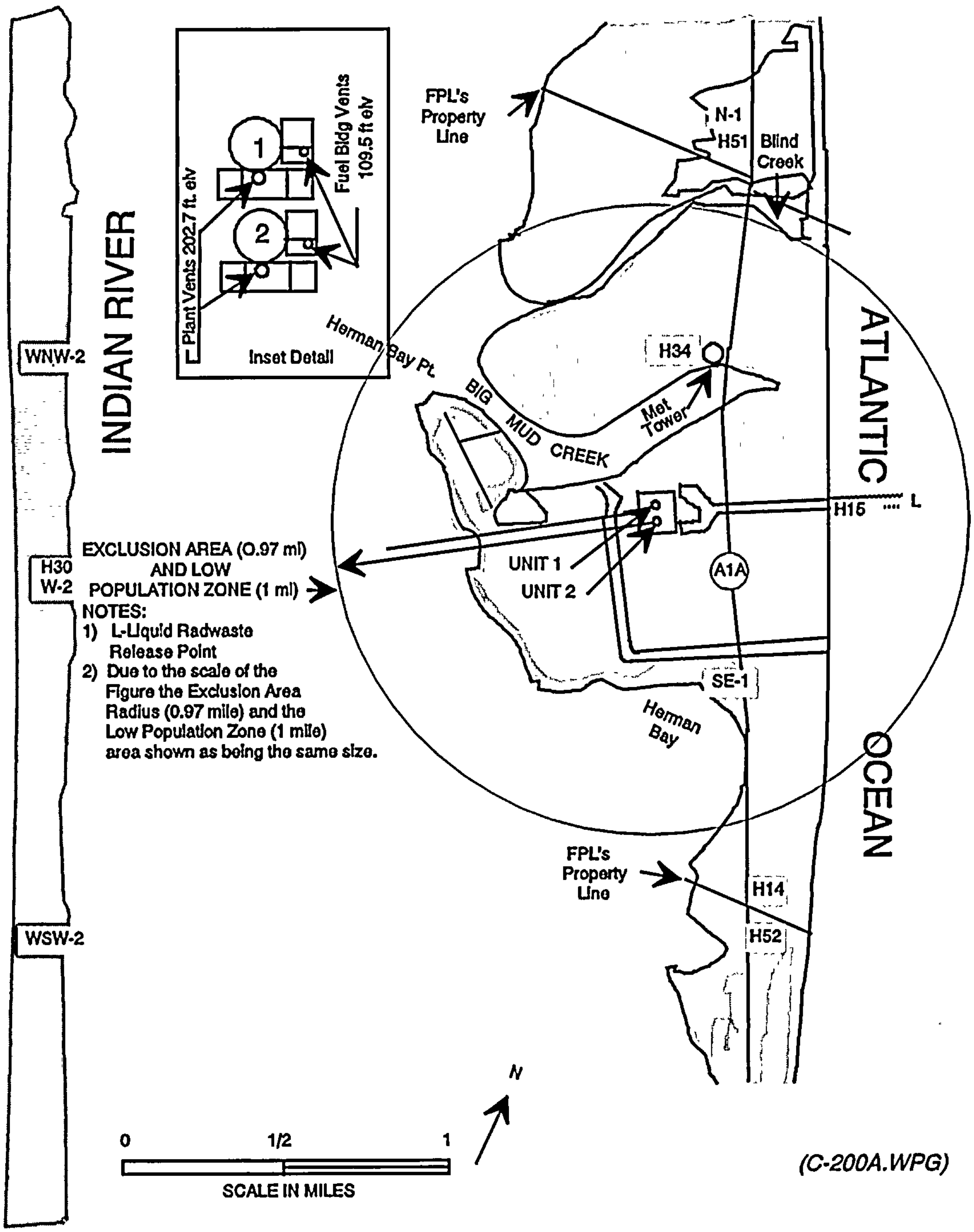
PATHWAY	LOCATION	DESCRIPTION	SAMPLES COLLECTED	SAMPLE COLLECTION FREQUENCY	APPROXIMATE DISTANCE (miles)	DIRECTION SECTOR
Food Products	H52	Offsite near south property line	Broad leaf vegetation (mangrove)	Monthly (when available)	1	S/SSE
Food Products	*H59	Near south end of Hutchinson Island	Crustacea Fish Broad leaf vegetation (mangrove)	Semi-Annually Semi-Annually Monthly	10-20	S/SSE

*Denotes control sample

It is the policy of Florida Power & Light Company (FPL) that the St. Lucie 1 & 2 Radiological Environmental Monitoring Programs are conducted by the State of Florida Department of Health and Rehabilitative Services (DHRS), pursuant to an Agreement between FPL and DHRS and; that coordination of the Radiological Environmental Monitoring Programs with DHRS and compliance with the Radiological Environmental Monitoring Program Controls are the responsibility of the Nuclear Energy Services Department.

> NOTE 1
> These samples may be collected from or supplemented by samples collected from the plant intake canal if the required analyses are unable to be performed due to unavailability or inadequate quantity of sample from the ocean side location.

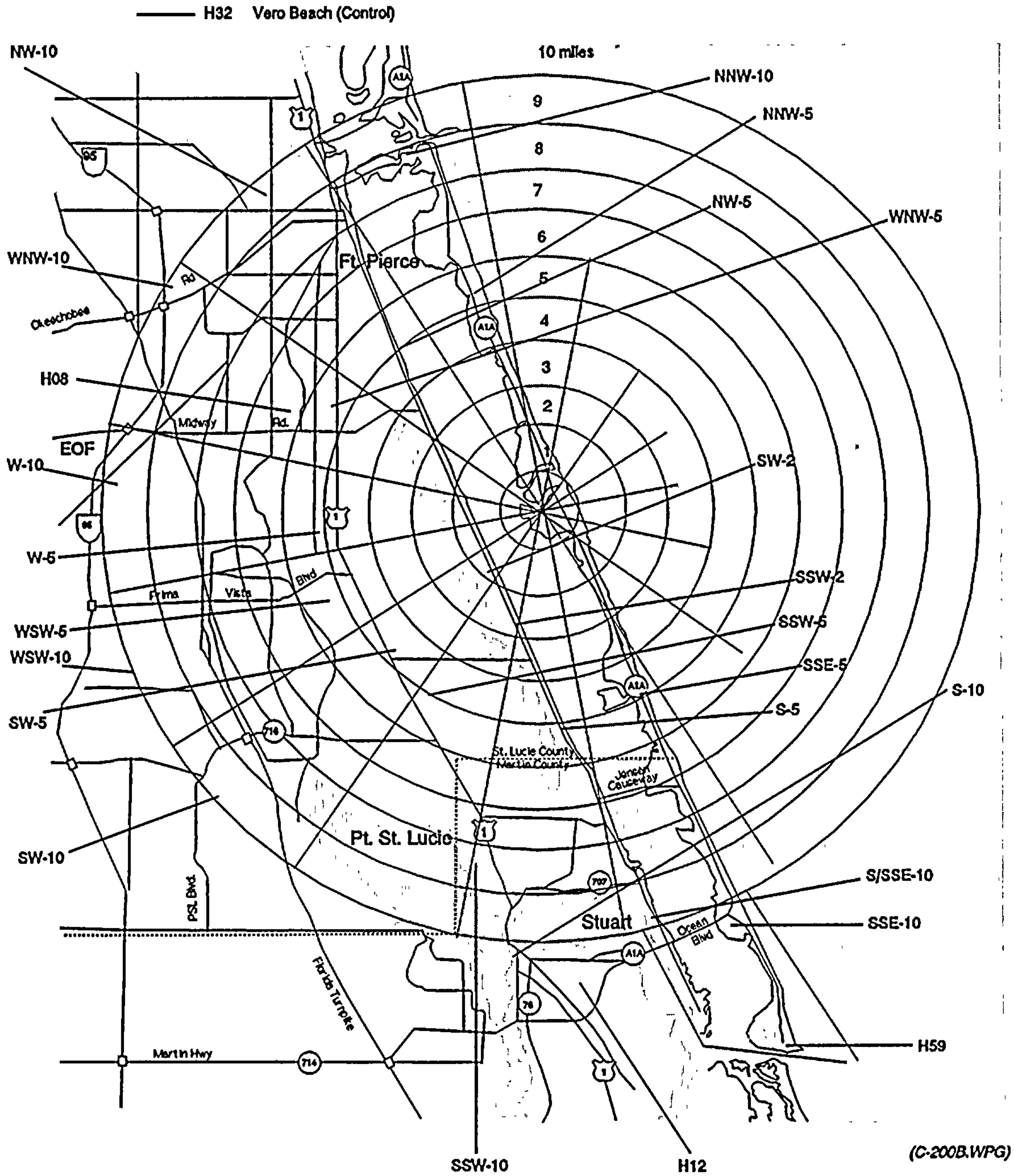
FIGURE 1-1
SITE AREA MAP & ENVIRONMENTAL SAMPLE LOCATIONS



(C-200A.WPG)

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

FIGURE 1-2
ENVIRONMENTAL SAMPLE LOCATIONS (10 MILES)



(C-200B.WPG)

ST. LUCIE PLANT
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APPENDIX C
METEOROLOGICAL DISPERSION FORMULAS*

For X/Q:

$$X/Q = \frac{2.032}{(\bar{u})D\sqrt{(\sigma_z^2 + \frac{cV^2}{\pi})}} \qquad \text{EQ (1)}$$

$$X/Q = \frac{2.032}{\sqrt{3}\ \sigma_z\ (\bar{u})D} \qquad \text{EQ (2)}$$

Where:

C	= .5
V	= 207.5 ft. (63.2 meters)
$(\bar{u})$	= a name for one term

X/Q was calculated using each of the above EQs for each hour. The highest X/Q from EQ (1) or EQ (2) was selected. The total integrated relative concentration at each sector and distance was then divided by the total number of hours in the data base.

* Terrain correction factors given by Table M-4 were also applied to Dispersion Formulas

APPENDIX C
METEOROLOGICAL DISPERSION FORMULAS*
(continued)

For Depleted X/Q:

$(X/Q)_D$ = (X/Q) X (Depletion factor of Figure 2 of R.G. 1.111-R1)

For Deposition (D/Q):

D/Q = RDep/(2 sin [11.25] X) X (Freq. distribution)

Where:

D/Q	=	Ground deposition rate
X	=	Calculation distance
RDep	=	Relative ground deposition rate from Figure 6 of R.G. 1.111, R1

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 21
OFFSITE DOSE CALCULATION MANUAL (ODCM)

APPENDIX D
DESCRIPTION OF THE INTERLABORATORY COMPARISON PROGRAM (ICP)
(Page 1 of 2)

The State of Florida, Department of Health-Bureau of Radiation Control (BRC) Laboratory shall participate in an INTERLABORATORY COMPARISON PROGRAM.

1. The sample matrices and analytical methods shall be: /R21

   A. Gamma isotopic on a filter sample simulating airborne radioiodine and particulate collection.

   B. Gamma isotopic on a water sample simulating a surface water grab sample.

   C. Gamma isotopic on either sediment (or soil) or broad leaf vegetation.

   > NOTE
   > Steps D, E and F reference NRC IR 99-04, PMAI 99-0716.

   /R21

   D. Gross Beta on an Air Filter matrix. /R21

   E. Tritium in water, using method employed in REMP. /R21

   F. Strontium-89 and Strontium-90 in water medium if milk samples are being obtained per land use census identified milk animals within 5 miles of the plant site. /R21

2. The source of samples for this program:

   A. A Federal Government Laboratory Program (e.g., DOE-LAP, EPA Safe Drinking Water Program)

   B. A State, Federal, or private (commercial) laboratory capable of providing NIST traceable samples. To be eligible, a Commercial Laboratory shall meet the FPL Quality Assurance criteria of "Quality Related".

   C. For Gamma Analysis only, a FPL Nuclear Site Laboratory may prepare sample matrices using known quantities of radioactivity from isotopes provided by a FPL Contract Laboratory currently approved as PC-1 Level vendor. These prepared matrices may be prepared by the vendor, or by FPL personnel, but shall not exceed the participant(s) form and/or license quantities for allowed radioactivity.

APPENDIX D
DESCRIPTION OF THE INTERLABORATORY COMPARISON PROGRAM (ICP)
(Page 2 of 2)

3. Analysis of Matrix samples shall be capable of achieving ODCM Table 4.12-1 prescribed LLDs on a blank sample.

4. Results within 20% of expected shall be considered acceptable. Results exceeding 20% but within 35% require a description of probable cause and actions performed to bring the analysis into conformance. Results exceeding 35% are considered Not Acceptable; the Matrix shall be replaced and reanalyzed.

5. The frequency for performing the interlaboratory comparison program shall be annually with a maximum of 15 months between comparisons of similar matrices.

ATTACHMENT - D

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT NOS. 1 & 2

LICENSE NUMBERS DPR-67 AND NPF-16

<u>MARKED UP PAGES FROM ODCM REVISIONS 20A & 20B</u>

INTRODUCTION

The ODCM consists of the Controls Section followed by the Methodology Section.

The Controls Section provides the Control Statements, Limits, ACTION Statements, Surveillance Requirements and BASES for ensuring that Radioactive Liquid and Gaseous Effluents released to UNRESTRICTED AREAS and/or the SITE BOUNDARY will be maintained within the requirements of 10 CFR Part 20, 40 CFR Part 190, 10 CFR 50.36.a and 10 CFR Part 50 Appendix-I radioactive release criteria. All Control Statements and most Administrative Control Statements in the ODCM are directly tied to and reference the Plant Technical Specification (TS) Administrative Section. The Administrative Control for Major Changes to Radioactive Liquid, Gaseous and Solid Treatment Systems is as per the guidance of NUREG-1301, April 1991, Supplement No. 1 to NRC Generic Letter 89-01. The numbering sequences of Control Statements also follow the guidance of NUREG-1301 as applicable, to minimize differences.

The Methodology Section uses the models suggested by NUREG-0133, November, 1978 and Regulatory Guide 1.109 to provide calculation methods and parameters for determining results in compliance with the Controls Section of the ODCM. Simplifying assumptions have been applied where applicable to provide a more workable document for implementing the Control requirements. Alternate calculation methods may be used from those presented as long as the overall methodology does not change or as long as most up-to-date revisions of the Regulatory Guide 1.109 dose conversion factors and environmental transfer factors are substituted for those currently included and used in this document.

RECORDS AND NOTIFICATIONS

All records of reviews performed for changes to the ODCM shall be maintained in accordance with QI 17-PSL-1. All FRG approved changes to the ODCM, with required documentation of the changes per TS 6.14, shall be submitted to the NRC in the Annual Effluent Release Report. Procedures that directly implement, administer or supplement the requirements of the ODCM Controls and Surveillances are:

COP-01.05
~~C-70~~ Processing Aerated Liquid Waste
C-72 Processing Gaseous Wastes
COP-05.04, Chemistry Department Surveillances and Parameters
COP-07.05, Process Monitor Setpoints
The Radiological Environmental Monitoring Program is performed by the State of Florida as per FPL Juno Nuclear Plant Services Corporate Environmental Procedure Number NBS-NPS-HP-WP-002.

TABLE 3.3-14 (continued)
RADIOACTIVE EFFLUENT MONITOR SETPOINT BASIS

ODCM Related Iodine Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1PV IODINE	01-03	FUSAR	5000 CPM	10,000 CPM[c]
1FHB IODINE	04-03	FUSAR	5000 CPM	10,000 CPM[c]
2A PV PIG IODINE	422	FUSAR	5000 CPM	[illegible]
2B PV PIG IODINE	432	FUSAR	5000 CPM	10,000 CPM[c]
2FHB IODINE	412	FUSAR	5000 CPM	10,000 CPM[c]
SGBDB IODINE	45-5	FUSAR	5000 CPM	10,000 CPM[c]

ODCM Related Liquid Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT[e]	HIGH SETPOINT[e]
1A S/G BLOWDOWN	44	C-200	2 x Bkg.	2.E-04 uCi/ml[f,m]
1B S/G BLOWDOWN	45	C-200	2 x Bkg.	2.E-04 uCi/ml[f,m]
2A S/G BLOWDOWN	121	C-200	2 x Bkg.	2.E-04 uCi/ml[m]
2B S/G BLOWDOWN	122	C-200	2 x Bkg.	2.E-04 uCi/ml[m]
1 BATCH LIQUID EFFLUENT	R6627	C-200	As Per ~~C-70~~	As Per ~~C-70~~[n]
2 BATCH LIQUID EFFLUENT	301	C-200	As Per ~~C-70~~	As Per ~~C-70~~[n]

COP-01.05

Table Notations:

- a - ODCM Control 3.11.2.1a
- b - ODCM Table 4.11-1 Note (7)
- c - ODCM Control 3.11.2.1.b
- d - TS Table 3.3-6 required instrument 2.a.ii with setpoint per ODCM
- e - Setpoints may be rounded for analog and digital display input limitations.
- f - The channel setpoint to be in cpm equivalent to this activity
- g - per ODCM Methodology Step 2.2.2
- h - Batch Gaseous Release Rate and Maximum activity limits shall be used such that Plant Vent (PV) Release HIGH setpoints should not be exceeded.
- i, j, k, and l not used in notation for clarity
- m - Continuous Liquid setpoint methodology per ODCM 1.3.2
- n - Batch liquid setpoint methodology per ODCM 1.3.1

FUSAR - Channel listed in fusar, but not required by ODCM Control 3.3.10 Table 3.3-13. The setpoints are used to provide alarm well before exceeding ODCM Control 3.11.2.1.b Site Dose Rate Limit. The inoperability of a fusar channel above does not involve an ACTION statement unless TS (Technical Specification) is noted.

2 x Bkg., 3 x Bkg., 5 x Bkg. etc., denotes the number of times the normal channel reading is the appropriate Alarm Setting. These type of setpoints should be periodically evaluated to insure alarm sensitivity is maintained as per COP-07.05.

1.2 Determining the Fraction F of 10 CFR Part 20 ECLs Limits for A Liquid Release Source

Discussion - Control 3.11.1.1 requires that the sampling and analysis results of liquid waste (prior to discharge) be used with calculation methods in the in-plant procedures to assure that the concentration of liquid radioactive material in the unrestricted areas will not exceed ten times the concentrations specified in 10 CFR Part 20, Appendix B, Table 2. Chemistry Procedure ~~C-70~~ COP-01.05 "Processing Aerated Liquid Waste" provides instruction for ensuring batch release tanks will be sampled after adequate mixing. This section presents the calculation method to be used for this determination. This method only addresses the calculation for a specific release source. The in-plant procedures will provide instructions for determining that the summation of each release source's F values do not exceed the site's 10 CFR Part 20 ECL. The values for release rate, dilution rate, etc., will also have to be obtained from in-plant procedures. The basic equation is:

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(ECL)_i}$$

Where:

F_L = the fraction of 10 CFR Part 20 ECL that would result if the release source was discharged under the conditions specified.

R = The undiluted release rate in gpm of the release source.
Liquid Rad Waste = 170 gpm for Waste Monitor Tank
Steam Generator = 125 gpm/Steam Generator
Liquid Rad Waste = 60 gpm for AWST #2
Liquid Rad Waste = 60 gpm for Laundry Drain Pumps 2A/2B

D = The dilution flow in gpm of Intake Cooling Water or Circulating Water Pumps
Intake Cooling flow is 14,500 gpm/pump
Circulating Water flow is 121,000 gpm/pump

C_i = The undiluted concentration of nuclide (i) in µCi/ml from sample assay

$(ECL)_i$ = The Effluent Concentration Limit of nuclide (i) in µCi/ml from Table L-1. For dissolved or entrained noble gases the ECL value is 2 X 10^{-4} µCi/ml for the sum of all gases.

1.2 (continued)

1. (continued)

G. Add each $C_i/(ECL)$ quotient from step 1.2.1.E and solve for F_L as follows:

$$F_L = \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(ECL)\ i}$$

F_L = a unit-less value where:

the value of F_L could be $\leq$ or >1. The purpose of the calculation is to determine what the initial value of F_L is for a given set of release conditions.

H. The F_L value just obtained is for one release pathway. The TS and ODCM control 3.11.1.1 allow for a site limit of F_L less than or equal to 10. Chemistry Procedure ~~C-70~~ administratively controls each pathway's allocation. Compare your F_L result with the administrative control for the release pathway in ~~C-70~~. COP-01.05

2. Calculation Process for Gases in Liquid

A. Sum the µCi/ml of each noble gas activity reported in the release.

B. The values of R and D from 1.2.1 above shall be used in the calculations below:

$$F_g = \frac{(\text{sum of } 1.2.2.A)\ \mu Ci/ml}{1} \times \frac{R}{D}$$

C. F_g shall be less than 2 X 10^{-4} µCi/ml for the site for all releases in progress. Each release point will be administratively controlled. Consult C-70 procedure for instructions.

FPL	ST. LUCIE PLANT CHEMISTRY OPERATING PROCEDURE SAFETY RELATED	Procedure No. C-200 Current Rev. No. 20A Effective Date 05/28/99

Title:

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Responsible Department: CHEMISTRY

Revision Summary

Revision 20A Changed reference of C-70 to COP-01.05. (Ed Meyer, 05/21/99)

This page attached for information only

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DATE VERIFIED ______ INITIAL ______

Revision	FRG Review Date	Approved By	Approval Date
0	04/22/82	C. M. Wethy Plant General Manager	04/27/82
Revision	FRG Review Date	Approved By	Approval Date
20A	12/22/98	R. G. West Plant General Manager	12/22/98
		R. O. Enfinger Designated Approver	05/21/99

S___OPS
DATE ______
DOCT PROCEDURE
DOCN C-200
SYS ______
COMP COMPLETED
ITM 20A

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE C-200, REVISION 20A
OFFSITE DOSE CALCULATION MANUAL (ODCM)
METHODOLOGY SECTION

1.2 (continued)

1. (continued)

G. Add each C/(ECL) quotient from step 1.2.1.E and solve for F_ι as follows:

$$F_\iota - \frac{R}{D} \sum_{i=1}^{n} \frac{C_i}{(ECL)\ i}$$

F_ι = a unit-less value where:

the value of F_ι could be $\leq$ or >1. The purpose of the calculation is to determine what the initial value of F_ι is for a given set of release conditions.

The F_ι value just obtained is for one release pathway. The TS and ODCM control 3.11.1.1 allow for a site limit of F_ι less than or equal to 10. Chemistry Procedure COP-01.05 administratively controls each pathway's allocation. Compare your F_ι result with the administrative control for the release pathway in COP-01.05. /R20

2. Calculation Process for Gases in Liquid

A. Sum the µCi/ml of each noble gas activity reported in the release.

B. The values of R and D from 1.2.1 above shall be used in the calculations below:

$$F_g - \frac{(sum\ of\ 1.2.2.A)\ \mu Ci/ml}{1} \times \frac{R}{D}$$

C. F_g shall be less than 2 X 10^{-4} µCi/ml for the site for all releases in progress. Each release point will be administratively controlled. Consult ~~C-70~~ COP-01.05 procedure for instructions.

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE C-200, REVISION 20A
OFFSITE DOSE CALCULATION MANUAL (ODCM)
METHODOLOGY SECTION

1.3 (continued)

COP-01.05

1.3.2 Setpoints for Continuous Liquid Release Monitors

Discussion - The activity mixture described in 1.3.1 for Liquid Batch Release Monitors cannot be used for Continuous Liquid Pathways since the Steam Generator (S/G) Blowdown Secondary Side is subject to what the current Reactor Coolant System (RCS) activity and primary-to-secondary leakage exist at any time. Although S/G blowdown is not normally aligned to the Site Liquid Radwaste Release Point (Figure 1-1), the monitor setpoints will be based on the ODCM maximum design S/G blowdown rate of 125 gpm with 1 Circulating Water Pump (CWP) 121,000 gpm in operation. The ODCM and ~~C-70~~, Processing Liquid Waste assume that the fraction of solids entering the Discharge Canal to the site release point are controlled less than or equal to 1.0, with batch release using 80% and the remaining 20% allocated to continuous sources on site. The actual site limit for solids is 10 times the concentration specified in 10 CFR Part 20, therefore a conservation factor of 10 is already included in the administrative site limit.

Since source in-leakage to a S/G cannot be controlled, a High alarm monitor setpoint is calculated based on one S/G releasing to the discharge canal at design blowdown rate while attaining the 20 percent of the site limit (F_L) assuming all the gross solid activity is I-131. The contribution from Dissolved and Entrained Gases is assumed to be zero with all of the gaseous activity going to the Steam Condenser and Air Ejector pathway.

$$F_L \text{ at } 20\% = \frac{0.2}{1} = \frac{\text{Design blowdown rate}}{\text{1 CWP Dilution rate}} \times \frac{\text{I-131 uCi/ml (S/G)}}{\text{I-131 uCi/ml (Table L-1ECL)}}$$

$$F_L \text{ at } 20\% = \frac{0.2}{1} = \frac{\text{125 gal/min}}{\text{121,000 gal/min}} \times \frac{\text{I-131 uCi/ml (S/G)}}{\text{1.E-06 uCi/ml (I-131 Table L-1ECL)}}$$

Solving for the **S/G High Alarm Setpoint I-131 Activity,**

I-131 uCi/ml (S/G) = **~2E-04 uCi/ml I-131** is the maximum S/G activity that could be allowed such that 20 percent of the administrative discharge canal limit would not be exceeded.

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 20B
OFFSITE DOSE CALCULATION MANUAL (ODCM)

INTRODUCTION

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The Methodology Section uses the models suggested by NUREG-0133, November, 1978 and Regulatory Guide 1.109 to provide calculation methods and parameters for determining results in compliance with the Controls Section of the ODCM. Simplifying assumptions have been applied where applicable to provide a more workable document for implementing the Control requirements. Alternate calculation methods may be used from those presented as long as the overall methodology does not change or as long as most up-to-date revisions of the Regulatory Guide 1.109 dose conversion factors and environmental transfer factors are substituted for those currently included and used in this document.

RECORDS AND NOTIFICATIONS

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COP-01.05, Processing Aerated Liquid Waste /R20A
COP-01.06 ~~C-72~~ Processing Gaseous Wastes
COP-05.04, Chemistry Department Surveillances and Parameters
COP-07.05, Process Monitor Setpoints
The Radiological Environmental Monitoring Program is performed by the State of Florida as per FPL Juno Nuclear Plant Services Corporate Environmental Procedure Number NBS-NPS-HP-WP-002.

1.0 DEFINITIONS for CONTROLS SECTION OF ODCM

DOSE EQUIVALENT I-131

1.10 DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microCurie/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be ~~those listed in [Table III of TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites or Table E-7 of NRC Regulatory Guide 1.109, Revision 1, October 1977].~~

Insert as of Definition 1.10

FREQUENCY NOTATION

1.13 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 1.1.

MEMBER (S) OF THE PUBLIC

1.17 MEMBER OF THE PUBLIC means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

OFFSITE DOSE CALCULATION MANUAL

1.18 The OFFSITE DOSE CALCULATION MANUAL (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints and in the conduct of the Environmental Radiological Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs required by TS section 6.8.4 and (2) descriptions of the information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports required by TS 6.9.1.7 and 6.9.1.8.

For Reactor Unit 1, ~~we~~ use thyroid dose conversion factors listed in ICRP-30, Supplement to Part 1, pages 192-212, Tables entitled, "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity (Sv/Bq)." Reference PLA #98-007 PMAI 99-06-170
For Reactor Unit 2, use ~~dose~~ thyroid dose conversion factors listed in Table III of TID-14844, Calculation of Distance Factors for Power and Test Reactor Sites or Table E-7 of NRC Regulatory Guide 1.109, Revision 1, October 1977.

TABLE 4.3-8

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS(4)

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1. Radioactivity Monitors Providing Alarm and Automatic Termination of Release				
a) Liquid Radwaste Effluent Line	D	P	R (2)	Q (1)
b) Steam Generator Blowdown Effluent Line	D	M	R (2)	Q (1)
2. Flow Rate Measurement Devices				
a) Liquid Radwaste Effluent Line	D (3)	N.A.	R	Q
b) Discharge Canal	D (3)	N.A.	R	Q
c) Steam Generator Blowdown Effluent Line	D (3)	N.A.	R	Q

TABLE 4.3-8 (Continued)

TABLE NOTATIONS

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate automatic isolation of this pathway and control room alarm annunciation occur if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards traceable to the National Institute of Standards & Technology (NIST) or using standards that have been calibrated against standards certified by the NIST. These standards should permit calibrating the system over its intended range of energy and rate capabilities that are typical of normal plant operation. For subsequent CHANNEL CALIBRATION, button sources that have been related to the initial calibration may be used.

(3) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic or batch releases are made.

(4) The requirements to perform the surveillances is Not Applicable, IF Table 3.3-12 list the Instrument Minimum Channels OPERABLE as Not Applicable (N.A.). (Reference CR 99-0361, PMAI 99-04-106).

all Caps please

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 20B
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 4.3-9

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS(4)

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	Modes in which surveillance required
1. Waste Gas Holdup System					
a) Noble Gas Activity Monitor - Providing Alarm and Automatic Termination of Release	P	P	R (3)	Q (1)	*
2. Condenser Evacuation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	**
3. Plant Vent System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*
4. Fuel Storage Area Ventilation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 20B
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 4.3-9 (Continued)

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS (4)

2

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST	Modes in which surveillance required
5. Laundry Area Ventilation System					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*
6. Steam Generator Blowdown Building Vent					
a) Noble Gas Activity Monitor	D	M	R (3)	Q (2)	*
b) Iodine Sampler	W	N.A.	N.A.	N.A.	*
c) Particulate Sampler	W	N.A.	N.A.	N.A.	*
d) Flow Rate Monitor	D	N.A.	R	Q	*
e) Sampler Flow Rate Monitor	D	N.A.	R	N.A.	*

TABLE 4.3-9 (Continued)

TABLE NOTATIONS

* - At all times when making releases via this pathway.

** - At all times when air ejector exhaust is not directed to plant vent.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate automatic isolation of this pathway and control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint or
2. Circuit failure or
3. Instrument indicates a downscale failure or
4. Instrument controls not set in operate mode.

(3) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards traceable to the National Institute of Standards & Technology (NIST) or using standards that have been calibrated against standards certified by the NIST. These standards should permit calibrating the system over its intended range of energy and rate capabilities that are typical of normal plant operation. For subsequent CHANNEL CALIBRATION, button sources that have been related to the initial calibration may be used.

(4) The requirements to perform the surveillances is Not Applicable, IF Table 3.3-13 list the INSTRUMENT MINIMUM CHANNELS OPERABLE as Not Applicable (N.A). (Reference CR 99-0361, PMAI 99-04-106)

TABLE 4.11-1 RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection LLD (1) (µCi/ml)
A. Batch Waste Release Tanks (2)	P Each Batch	Each Batch	P.G.E. (3)	5.E-07
			I-131	1.E-06
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	P Each Batch	M Composite (4)	H-3	1.E-05
			Gross Alpha	1.E-07
	P Each Batch	Q Composite (4)	Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06
B. Continuous Releases (5, 6)	Daily	4/M Composite	P.G.E.(3)	5.E-07
			I-131	1.E-06
	Daily Grab Sample	4/M Composite	Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	Daily	M Composite	H-3	1.E-05
			Gross Alpha	1.E-07
	Daily	Q Composite	Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06
C. Settling Basin (7)	W Grab Sample	W	P.G.E. (3)	5.E-07
			I-131	1.E-06

P.G.E. - Denotes Principal Gamma Emitter

Insert Item "D." from Page 34A (attached), as part of the Table above i.e., five columns

Insert for Page 34 of 226
Item "D"

D. Settling Basin as a Batch Release Pathway. (Reference CR 99-1165 PMAI 99-08-084)	P Each Batch(8)	Each Batch	P.G.E.(3)	5.E-07
			I-131	1.E-06
			Dissolved and Entrained Gases (Gamma Emitters)	1.E-05
	Each Batch	Each Batch	H-3	1.E-05
			Gross Alpha	1.E-07
			Sr-89, Sr-90	5.E-08
			Fe-55	1.E-06

TABLE 4.11-1 (Continued)

TABLE NOTATIONS (Continued)

(2) A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated and then thoroughly mixed by a method described in the ODCM to assure representative sampling.

(3) The principal gamma emitters for which the LLD control applies include the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137 and Ce-141 and Ce-144. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported in the Annual Radioactive Effluent Release Report pursuant to Control 3.11.2.6 in the format outlined in Regulatory Guide 1.21, Appendix B, Revision 1, June 1974.

(4) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(5) A continuous release is the discharge of liquid wastes of a nondiscrete volume, e.g., from a volume of a system that has an input flow during the continuous release.

(6) If Component Cooling Water activity is > 1.E-5 µCi/ml, perform a weekly gross activity on the Intake Cooling Water System outlet to ensure the activity level is less than or equal to 2.E-07 µCi/ml LLD limit. If ICW is >2.E-07 µCi/ml, perform analysis in accordance with a Plant Continuous Release on this Table.

(7) Grab samples to be taken when there is confirmed primary to secondary system leakage indicated by the air ejector monitor indicating greater than or equal to 2x background.

(8) at least two independent samples are analyzed in accordance with the Surveillance Requirement for concentration limit of Control 4.11.1.1.1, and at least two technically qualified members of the Facility Staff independently verify the release rate calculations.

RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.12.3 INTERLABORATORY COMPARISON PROGRAM

CONTROLS

3.12.3 In accordance with St. Lucie Plant TS 6.8.4.g.3), analyses shall be performed on all radioactive materials, supplied as part of an Interlaboratory Comparison Program ~~that has been approved by the Commission*~~, that correspond to samples required by Table 3.12-1.

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above; report the corrective action taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4.

SURVEILLANCE REQUIREMENTS

4.12.3 A summary of the results obtained as part of the above required Interlaboratory Comparison Program shall be included in the Annual Radiological Environmental Operating Report pursuant to Control 3.12.4. If the Interlaboratory Comparison Program is other than the program conducted by the EPA, then the Interlaboratory Comparison Program shall be described in the ODCM.

~~* This condition is satisfied by participation in the Environmental Radioactivity Laboratory Intercomparison Studies Program conducted by the Environmental Protection Agency (EPA).~~

1.3 (continued)

1.3.2 (continued)

This S/G Monitor High Alarm Setpoint activity may be converted to cpm using Liquid Monitor uC/ml to cpm conversion constants.

This Setpoint is conservative given that the actual Liquid Site Limit is a factor of ten times higher than the administrative limit used for calculation purposes, that I-131's ECL is conservative vs other isotope mixtures, and that it is unlikely that more than one S/G would be allowed to operate with a 20 gallon per day primary-to-secondary leak rate.

1.4 Determining the Dose for Radioactive Liquid Releases

Discussion - Control 3.11.1.2 requires calculations be performed at least once per 31 days to verify that cumulative radioactive liquid effluents do not cause a dose in excess of 1.5 mrem to the whole body and 5 mrem to any organ during any calendar quarter and not in excess of 3 mrem to the whole body and 10 mrem to any organ during any calendar year. This section presents calculational method to be used for this verification.

This method is based on the methodology suggested by sections 4.3 and 4.3.1 of NUREG-0133 Revision 1, November, 1978. The dose factors are a composite of both the fish and shellfish pathways so that the fish-shellfish pathway is the only pathway for which dose will be calculated. The dose for adult, child and teenager can also be calculated by this method provided that their appropriate dose factors are used ~~available~~ for the organ of interest. An infant is excluded from Liquid Dose Pathway at St. Lucie since they do not eat fish-shellfish. The effluent supervisor will track which age group is the controlling (most restrictive) age group (see control 3.11.2.6.c). Only those nuclides that appear in the Tables of this manual will be considered.

2.6 (continued)

2. (continued)

E. Perform steps 2.6.2.B through 2.6.2.D for each nuclide (i) reported during the time interval.

F. The Ground Plane dose to the whole body is determined by summing the Di Dose of each nuclide (i)

$D_{Gr.Pl.\text{-}WBody} = D_1 + D_2 + \_\_\_\_\_ + D_n =$ mrem

Refer to step 2.6.5 to calculate total dose to the Whole Body.

3. The Grass-Cow/Goat-Milk Dose Pathway Method:

NOTE
Tritium dose is calculated as per 2.6.4.

A. A cow or a goat, will be the controlling animal; (i.e., dose will not be the sum of each animal), as the human receptor is assumed to drink milk from only the most restrictive animal. Refer to Table M-3 to determine which animal is controlling based on its (D/Q).

B. For the age group(s) of interest, determine the dose factor R_i for nuclide (i), for organ T, from the appropriate table number for the applicable milk animal.

Age Group	Cow Milk Dose Factor Table Number	Goat Milk Dose Factor Table Number
Infant	G-6	G-7
Child	G-9	G-10
Teen	G-14	G-15
Adult	G-19	G-20

~~If the limited analysis approach is being used, limit the calculation to the infant thyroid.~~

APPENDIX D
DESCRIPTION OF THE INTERLABORATORY COMPARISON PROGRAM (ICP)

The State of Florida, Department of Health-Bureau of Radiation Control (BRC) Laboratory shall participate in an INTERLABORATORY COMPARISON PROGRAM.

1. The sample matrices ~~or~~ and analytical methods shall be:

   A. Gamma isotopic on a filter sample simulating airborne radioiodine and particulate collection.

   B. Gamma isotopic on a water sample simulating a surface water grab sample.

   C. Gamma isotopic on either sediment (or soil) or broad leaf vegetation.

Insert

2. The source of samples for this program:

   A. A Federal Government Laboratory Program (e.g., DOE-LAP, EPA Safe Drinking Water Program)

   B. A State, Federal, or private (commercial) laboratory capable of providing NIST traceable samples. To be eligible, a Commercial Laboratory shall meet the FPL Quality Assurance criteria of "Quality Related".

   C. For Gamma Analysis only, a FPL Nuclear Site Laboratory may prepare sample matrices using known quantities of radioactivity from isotopes provided by a FPL Contract Laboratory currently approved as PC-1 Level vendor. These prepared matrices may be prepared by the vendor, or by FPL personnel, but shall not exceed the participant(s) form and/or license quantities for allowed radioactivity.

3. Analysis of Matrix samples shall be capable of achieving ODCM Table 4.12-1 prescribed LLDs on a blank sample.

4. Results within 20% of expected shall be considered acceptable. Results exceeding 20% but within 35% require a description of probable cause and actions performed to bring the analysis into conformance. Results exceeding 35% are considered Not Acceptable; the Matrix shall be replaced and reanalyzed.

5. The frequency for performing the interlaboratory comparison program shall be annually with a maximum of 15 months between comparisons of similar matrices.

NOTE D, E, and F Reference ~~of~~ NRC IR 99-04, PMAI 99-0716

D. Gross Beta on an Air Filter matrix.

E. Tritium in water, using method employed in REMP.

F. Strontium-89 and Strontium-90 in water medium IF Milk Samples are being obtained per Land Use Census identified Milk Animals within 5 miles of the plant site.

APPENDIX C
PROCEDURE MINOR CORRECTION FORM
(Page 1 of 1)

BLOCK 1 (Completed By Initiator) Page 1 of 4

Procedure Number: ~~C-70~~ C-200 Current Revision: ~~41~~ ~~20A~~ B

Procedure Title: PROCESSING GASEOUS WASTE

Description of Corrections: (Attach additional pages, if needed)

CHANGE C-72 TO COP-01.06

Reason For Corrections: (Attach additional pages, if needed)

NEW FORMAT / UPGRADED PROCEDURE, DELETING C-72

Requested By: [signature] Jim GEORGE 7/12/99
Signature Print Name Date

BLOCK 2 (Completed By Information Services)

Tracking Number: 29903

Reviewed By: BM Gilmour B.M. Gilmour 9-28-99
Signature Print Name Date

Other Reviews Required: None

BLOCK 3 (Completed By Discipline Reviewer, if required)

☐ Corrections Acceptable

☐ Corrections NOT Acceptable:

Reviewed By: N/A
Signature Print Name Date

BLOCK 4 (Completed By Designated Approver)

☒ No Safety Significance

☐ PGM Advised Of Safety Significance

☐ Corrections Acceptable

☐ Corrections NOT Acceptable:

Approved By: ES Katzman ES KATZMAN 9/30/99
Signature Print Name Date

Form #PSL-F001 Effective Date 03/23/99

END OF APPENDIX C

ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 20A
OFFSITE DOSE CALCULATION MANUAL (ODCM)

INTRODUCTION

The ODCM consists of the Controls Section followed by the Methodology Section.

The Controls Section provides the Control Statements, Limits, ACTION Statements, Surveillance Requirements and BASES for ensuring that Radioactive Liquid and Gaseous Effluents released to UNRESTRICTED AREAS and/or the SITE BOUNDARY will be maintained within the requirements of 10 CFR Part 20, 40 CFR Part 190, 10 CFR 50.36.a and 10 CFR Part 50 Appendix-I radioactive release criteria. All Control Statements and most Administrative Control Statements in the ODCM are directly tied to and reference the Plant Technical Specification (TS) Administrative Section. The Administrative Control for Major Changes to Radioactive Liquid, Gaseous and Solid Treatment Systems is as per the guidance of NUREG-1301, April 1991, Supplement No. 1 to NRC Generic Letter 89-01. The numbering sequences of Control Statements also follow the guidance of NUREG-1301 as applicable, to minimize differences.

The Methodology Section uses the models suggested by NUREG-0133, November, 1978 and Regulatory Guide 1.109 to provide calculation methods and parameters for determining results in compliance with the Controls Section of the ODCM. Simplifying assumptions have been applied where applicable to provide a more workable document for implementing the Control requirements. Alternate calculation methods may be used from those presented as long as the overall methodology does not change or as long as most up-to-date revisions of the Regulatory Guide 1.109 dose conversion factors and environmental transfer factors are substituted for those currently included and used in this document.

RECORDS AND NOTIFICATIONS

All records of reviews performed for changes to the ODCM shall be maintained in accordance with QI 17-PSL-1. All FRG approved changes to the ODCM, with required documentation of the changes per TS 6.14, shall be submitted to the NRC in the Annual Effluent Release Report. Procedures that directly implement, administer or supplement the requirements of the ODCM Controls and Surveillances are:

COP-01.05, Processing Aerated Liquid Waste /R20A
~~C-72~~, Processing Gaseous Wastes
COP-05.04, Chemistry Department Surveillances and Parameters
COP-07.05, Process Monitor Setpoints
The Radiological Environmental Monitoring Program is performed by the State of Florida as per FPL Juno Nuclear Plant Services Corporate Environmental Procedure Number NBS-NPS-HP-WP-002.

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ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE C-200, REVISION 20A
OFFSITE DOSE CALCULATION MANUAL (ODCM)
METHODOLOGY SECTION

2.2 (continued)

1. (continued)

A. (continued)

In the case of Unit 2 Plant Vent there are 3 ODCM Effluent Gas Channels Monitoring the Plant Vent. The HIGH SETPOINT in uCi/cc is the same for 2A PV PIG LOW RANGE GAS, 2B PIG LOW RANGE GAS, and 2PV WRGM LOW RANGE GAS since they are monitoring the same release point (i.e., each of these channels does not receive their own allotted % of the Site Limit).

4. The significance of an ODCM Effluent Gas Channel that has a "Allotted % of Site Limit" HIGH Setpoint requires further discussion (Midland High Noble Gas Accident Channels are not part of this discussion):

a. For Plant Vent Release Points on each reactor unit, the "Allotted % of Site Limit" needs to be high enough to allow for Batch Releases from Gas Decay Tank and Containment Venting Operations, and at the same time ~~C-72~~, Processing Gaseous Waste shall provide instruction for administratively controlling Batch Releases such that the radioactive concentration and release rate will not be allowed to exceed the site limit at any time.

b. The receipt of a valid HIGH Alarm on a release point where the ODCM Low Range Gas Channel's radioactivity is approximately equal to the HIGH Alarm setpoint does not mean the site limit has been exceeded, rather it is at a concentration that is equivalent to the "Allotted % of Site Limit".

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ST. LUCIE PLANT
CHEMISTRY OPERATING PROCEDURE NO. C-200, REVISION 20A
OFFSITE DOSE CALCULATION MANUAL (ODCM)

TABLE 3.3-14
RADIOACTIVE EFFLUENT MONITOR SETPOINT BASIS

ODCM Effluent Gas Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT*	HIGH SETPOINT*
1PV LOW RANGE GAS	01-05	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
1FHB LOW RANGE GAS	04-05	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
2A PV PIG LOW RANGE GAS	423	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g] For Plant Vent #2
2B PV PIG LOW RANGE GAS	433	C-200[a]	5 x Bkg.	
2PV WRGM LOW RANGE GAS	621	C-200[a]	5 x Bkg.	
2FHB LOW RANGE GAS	413	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
SGBDB LOW RANGE GAS	45-6	C-200[a]	5 x Bkg.	Allotted % Of Site Limit[g]
1 CONDENSER AIR EJECTOR	35	C-200	2 x Bkg.[b]	3 x Bkg.
2 CONDENSER AIR EJECTOR	403	C-200	2 x Bkg.[b]	3 x Bkg.
1 BATCH GAS EFFLUENT	42	C-200[a]	As Per ~~C-72~~	As Per ~~C-72~~[a,h]
2 BATCH GAS EFFLUENT	203	C-200[a]	As Per ~~C-72~~	As Per ~~C-72~~[a,h]

ODCM Related Particulate Channels	CHANNEL ID	BASIS DOCUMENT	ALERT SETPOINT*	HIGH SETPOINT*
1PV PARTICULATE	01-01	FUSAR	5000 CPM	10,000 CPM[c]
1FHB PARTICULATE	04-01	FUSAR & TS[d]	5000 CPM	10,000 CPM[c]
2A PV PIG PARTICULATE	421	FUSAR	5000 CPM	10,000 CPM[c]
2B PV PIG PARTICULATE	431	FUSAR	5000 CPM	10,000 CPM[c]
2FHB PARTICULATE	411	FUSAR & TS[d]	5000 CPM	10,000 CPM[c]
SGBDB PARTICULATE	45-4	FUSAR	5000 CPM	10,000 CPM[c]

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ATTACHMENT - E

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT NOS. 1 & 2

LICENSE NUMBERS DPR-67 & NPF-16

CORRECTION TO THE

COMBINED ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

FOR THE PERIOD

JANUARY 1, 1998 THROUGH DECEMBER 31, 1998

Affected Pages: Page 10 is the only affected page.

Two Items were corrected for St. Lucie Unit 2 Liquid Effluents:

1) B. Tritium 1. Total Release Curies for Quarter # 4

2) B. Tritium 2. Average diluted Concentration During Period for Quarter # 4

Remark: The typo induced error on page 10 did not affect any other previously reported liquid dose calculation. The error only impacted the reported Tritium Curies for St. Lucie Unit 2 Liquid in Quarter 4 of 1998.

00368848

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE UNIT # 2
ANNUAL REPORT
JANUARY 1, 1998 THROUGH DECEMBER 31, 1998

TABLE 3.3-2 LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES(Continued)

	UNIT	QTR#3	QTR#4
A. Fission and Activation Products			
1. Total Release - (Not including Tritium, Gases, and Alpha)	Ci	5.13E-03	2.50E-02
2. Average Diluted Concentration During Period	uCi/ml	9.99E-12	1.28E-11
B. Tritium			
1. Total Release	Ci	1.00E+02	1.67E+02 Corrected value
2. Average Diluted Concentration During Period	uCi/ml	1.95E-07	8.57E-08 Corrected value
C. Dissolved and Entrained Gases			
1. Total Release	Ci	1.37E-03	4.94E-02
2. Average Diluted Concentration During Period	uCi/ml	2.67E-12	2.53E-11
D. Gross Alpha Radioactivity			
1. Total Release	Ci	0.00E+00	0.00E+00
E. Volume of Waste Released (Prior to Dilution)	Liters	5.83E+05	1.13E+06
F. Volume of Dilution Water Used During Period	Liters	5.14E+11	1.95E+12