**POWER REACTOR DESIGNS
AN ANNOTATED BIBLIOGRAPHY
VOLUME 2
SECTIONS FD-JF, INDEX**

JANUARY, 1969

**AEC RESEARCH &
DEVELOPMENT REPORT**

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Technology

POWER REACTOR DESIGNS
An Annotated Bibliography

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Technical Information

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LIQUID METAL COOLED REACTORS

DOMESTIC

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LIQUID METAL REACTORS, DOMESTIC

FD01

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NAME/OWNER U.S. AEC FAST REACTOR PROGRAM

TYPE LIQUID METAL COOLED FAST BREEDER

POWER MWE(MWT) 1000

CRITICAL AEC PROGRAM

COOLANT SODIUM

REMARKS PLANS INCLUDE FOUR STAGES,
1969, DECISION ON FAST REACTOR TECHNOLOGY
1973, PROTOTYPE OPERATION, 200 MWE
1980, IMPROVED DEMONSTRATION PLANTS, 400-800
MWE
1989, COMMERCIAL PLANT OPERATION, 1000 MWE
FIVE FACILITIES WILL PROVIDE DATA FOR
PROTOTYPE PLANT DESIGN,
ZPR-III, IDAHO
ZPR-IV, ARGONNE
FFTF
ZPPR
SEFOR
THE PLANT WILL BE SODIUM COOLED, WITH URANIUM
PLUTONIUM /METAL OR CERAMIC/ FUEL, AND A BREEDING
RATIO OF NOT LESS THAN 1.2,

REFERENCES U.S. ATOMIC ENERGY COMMISSION
NEWS RELEASE F-267 /DEC. 31, 1963/

AN EVALUATION OF FOUR DESIGN STUDIES OF A 1000 MWE
CERAMIC-FUELED FAST BREEDER REACTOR,
CHICAGO OPERATIONS OFFICE, REACTOR ENG. DIV.,
COO-279 /DEC. 1, 1964/

LMFBR, LIQUID METAL FAST BREEDER PROGRAM PLAN
AEC, DIV. REACTOR DEVELOPMENT
WASH-1101 /VOL. 1-10/ 1968

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FD02

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THE DESIGN OF A 1000 MWE FAST BREEDER REACTOR.
CE KLOTZ, OTHERS
TRANS. ANS, JUNE 1964.

AN EVALUATION OF FOUR DESIGN STUDIES OF A 1000 MWE
CERAMIC FUELED FAST BREEDER REACTOR.
REACTOR ENG. DIV., US AEC
COO-279 /DEC. 1, 1964/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

FD03

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NAME/OWNER SPUR/SPACE POWER UNIT REACTOR//AGN-USAF

DESIGNER AEROJET-GENERAL NUCLEONICS

PURPOSE R+D, SPACE POWER

TYPE LIQUID METAL COOLED, FAST REACTOR

POWER MWE(MWT) 300 KWE

CRITICAL DEVELOPMENT, NOW PART OF SNAP/50-SPUR PROGRAM

COOLANT LITHIUM OR POTASSIUM

FUEL MATERIAL URANIUM CARBIDE

REMARKS LITHIUM-COOLED FAST REACTOR, A NONBOILING SYSTEM, A POTASSIUM-COOLED BOILING SYSTEM, WERE STUDIED. PAPER STUDY, 300 KWE, SCALE-UP TO 1 MWE, OF A NUCLEAR TURBOELECTRIC UNIT, A 5 TO 6-YEAR PROGRAM FOR AIRESEARCH AND USAF. PROTOTYPE DEVELOPMENT TARGET 1963, COMPLETE SYSTEM TARGET 1965-66. AGN IS ALSO STUDYING RUBIDIUM AS A COOLANT FOR FAST REACTORS. THE FIRST CIRCULATING RUBIDIUM LOOP WILL OPERATE AT 1600 F WITH 100 POUNDS OF RB. WORKING FLUIDS STUDIED INCLUDED RUBIDIUM, LITHIUM, POTASSIUM, SODIUM, AND CESIUM. DEVELOPMENT FOR SPUR /SPACE POWER UNIT REACTOR/ HAS BEEN PLACED UNDER A JOINT AEC-NASA-AF SNAP-50/SPUR PROGRAM

REFERENCES BOILING VS. NON-BOILING LIQUID METAL COOLED REACTORS.
DL COCHRAN, KE BUCK
ARS SPACE POWER SYSTEMS CONFERENCE, SANTA MONICA, CALIF., SEPTEMBER 27-30, 1960

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

FD04

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NAME/OWNER SRE/SODIUM REACTOR EXPERIMENT//AEC,AI,S.CAL. ED.
DESIGNER ATOMICS INTERNATIONAL
OPERATOR ATOMICS INTERNATIONAL, S. CALIF. EDISON
LOCATION SANTA SUSANA, CALIF.
PURPOSE POWER EXPERIMENT.
TYPE SODIUM-GRAPHITE THERMAL BREEDER
POWER MWE(MWT) 5 20
45 MWT WITH URANIUM CARBIDE
CRITICAL 1957, CORE 3 IN 1963
SHUT DOWN 1964
COOLANT SODIUM
MODERATOR GRAPHITE, ZIRCONIUM ALLOY CANS
REFLECTOR, GRAPHITE
FUEL MATERIAL CORE 1 URANIUM SLUGS 0.75 IN. DIA./6 IN. LONG
CORE 2 CONTAINED THORIUM/URANIUM ALLOY
CORE 3, URANIUM CARBIDE FUEL
FUEL GEOMETRY RODS
FUEL CLADDING SS 0.01 IN. THICK, SODIUM-POTASSIUM BOND
FUEL ENRICH. CORE 1, 2.8 PER CENT U-235
CORE 2, 93.1 PER CENT
CORE 3, 5.2 PER CENT
FUEL ASSEMBLY CORE 1, 7-ROD CLUSTER, 43 ASSEMBLIES
CORE 2, 5-ROD CLUSTER
CORE 3, 9-ROD CLUSTER, 33 ASSEMBLIES
FUEL CHARGE CORE 1, 3000 KG. URANIUM
SPECIFIC POWER 240 KW/KG U-235
BURNUP(REFUEL) 2500 MWD/T 300 FULL-POWER DAYS
NEUTRON FLUX THERMAL AVE. 2×10^{13}
WITH URANIUM CARBIDE ELEMENTS 10×10^{14}
CONTROL BORON-NICKEL ALLOY RODS
COOLANT TEMP. INLET 650 F OUTLET 1200 F /CORE 3/

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FD04

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COOLANT PRESS, INLET 6 PSIG OUTLET 3 PSIG

REACTOR VESSEL FLAT-BOTTOMED OPEN TOP CYLINDER, SS, 1.5 IN. THICK
 11 FT. ID./18.87 FT. HIGH. OUTER TANK CARBON STEEL

REMARKS REACTOR INSTABILITY WAS NOTED AT 2 MWT OPERATION
 DUE TO THERMAL BOWING OF THE FUEL ELEMENTS.
 CONSTRAINT WAS IMPOSED BY MEANS OF A HELICAL WIRE
 WRAP AROUND THE FUEL CLUSTERS, RESULTING IN A
 REDUCED POWER COEFFICIENT. FUEL ELEMENT
 MODIFICATIONS WERE COMPLETED IN JANUARY 1962. IN
 JULY 1963 THE SRE CRITICAL ASSEMBLY ACHIEVED
 CRITICALITY WITH A FULL CORE LOADING OF 24 UC
 ELEMENTS, AND THE SRE PRODUCED POWER, ALSO IN JULY
 1963, WITH A FULL-SCALE UC ELEMENT IN THE CORE.
 THE AEC HAS ANNOUNCED THAT IT WILL DEACTIVATE
 THE REACTOR RATHER THAN CONVERT IT TO HIGH-
 TEMPERATURE TESTING OF BREEDER FUELS AND
 MATERIALS. MODIFICATIONS TO RAISE THE POWER FROM
 15 MWT TO 30 MWT HAVE BEEN COMPLETED, BUT THE
 REACTOR WAS NOT OPERATED AFTER SHUT-DOWN IN 1964.

REFERENCES OPERATING EXPERIENCE WITH THE SODIUM REACTOR
 EXPERIMENT.
 FE FARIS, OTHERS
 SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF
 ATOMIC ENERGY 9, 493-509 /1958/

SRE OPERATES AGAIN WITH CORE 2 BUT WITH 5 MWT
 POWER LIMIT.
 NUCLEONICS 20, 12 /JANUARY 1962/

PROCEEDINGS OF THE SYMPOSIUM ON SODIUM REACTORS
 TECHNOLOGY, MAY 24-25, 1961, LINCOLN, NEBRASKA.
 TID-7623 /JUNE 1962/

A 200 MWE PROTOTYPE SODIUM COOLED REACTOR HIGH
 EFFICIENCY POWER PLANT
 JA FALCON, PR KEEP
 CONF-51-4 /AMERICAN PUBLIC POWER ASSOCIATION
 ANNUAL CONVENTION, CLEVELAND, APRIL-MAY 1963/

NUCLEONICS WEEK DEC, 6, 1966 P, 2
 NEWS RELEASE

JANUARY 1969

BNWL-936

LIQUID METAL REACTORS. DOMESTIC

FD05

* * * * *

NAME/OWNER SGR-1000/AI
 LARGE ADVANCED SODIUM-GRAPHITE REACTOR

DESIGNER ATOMICS INTERNATIONAL

PURPOSE DESIGN, DEVELOPMENT

TYPE LIQUID METAL COOLED, THERMAL REACTOR, CALANDRIA

POWER MWE(MWT) 1000 2550

CRITICAL DESIGN

COOLANT SODIUM

MODERATOR GRAPHITE

FUEL MATERIAL URANIUM CARBIDE PELLETS 0.500 IN. DIA.

FUEL GEOMETRY RODS 14 FT. ACTIVE LENGTH /STACKED SLUGS/

FUEL CLADDING SS 0.010 IN. THICK /SODIUM BOND/

FUEL ENRICH. 3.6 PER CENT U-235

FUEL ASSEMBLY 18-ROD CLUSTER WITH CENTRAL SUPPORT TUBE
 595 ELEMENTS/CORE

FUEL CHARGE 73.8 TON URANIUM

SPECIFIC POWER 32 KW/KG URANIUM

BURNUP(REFUEL) 25,000 MWD/T 6 1/2 MONTHS

CONTROL RODS

COOLANT TEMP. INLET 750 F OUTLET 1150 F

REACTOR VESSEL CALANDRIA TANK CONTAINING MODERATOR, SS PROCESS
 TUBES. CALANDRIA IS A SINGLE LARGE VESSEL. THE
 PROCESS TUBES PENETRATING THE GRAPHITE AND JOINED
 TO TOP + BOTTOM OF CALANDRIA BY WELDED JOINTS.
 FUEL ELEMENTS STAND IN THE PROCESS TUBES.
 CALANDRIA VESSEL IS SUSPENDED FROM TOP SHIELD.

CONTAINMENT STEEL-LINED CONCRETE PIT IN OPERATING FLOOR OF
 REACTOR BUILDING

REMARKS SODIUM COMPONENTS TEST INSTALLATION AT SANTA
 SUSANA, CALIF. WILL TEST LARGE HEAT TRANSFER

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FD05

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SYSTEM COMPONENTS. THE STEAM GENERATORS ARE
MODULAR UNITS.
DESIGN FOR A SINGLE-LOOP, 200 MWE SGR HAS
BEEN COMPLETED.

REFERENCES

DESIGN, PERFORMANCE, AND ECONOMIC EVALUATION OF
SODIUM HEATED, MODULAR SUPERCRITICAL STEAM
GENERATORS.
DF CASEY, OTHERS
NAA-SR-8508

SODIUM-COOLED THERMAL REACTORS.
C STARR, OTHERS
THIRD U.N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY, GENEVA, 1964, A/CONF.28/P/206

AN OPTIMIZED CORE DESIGN FOR A 1000 MWE SODIUM-
GRAPHITE REACTOR.
H ROOD
TRANS. ANS. /JUNE 1964/

A 200 MWE PROTOTYPE SODIUM COOLED REACTOR
HIGH EFFICIENCY POWER PLANT.
JA FALCON, PR KEEP
CONF-51-4 /AMER. PUB. POWER ASSOC. ANNUAL
CONVENTION, CLEVELAND, APRIL 1963/

200 MWE PROTOTYPE LARGE SGR REACTOR.
STRUCTURE DESIGN AND EVALUATION
DR ANDERSON, KW FOSTER - EDS.
NAA-SR-11314 /1965/

1000 MWE SGR AND PROTOTYPE EVALUATION STUDY.
ATOMICS INTERNATIONAL
NAA-SR-9213

FEASIBILITY STUDY OF A 1000-MWE SODIUM-COOLED
FAST REACTOR
DT EGGEN, HA MOREWITZ
NAA-SR-11378 /VOL. 3, METHODS DEVELOPMENT/

JANUARY 1969

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LIQUID METAL REACTORS. DOMESTIC

FD06

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NAME/OWNER HALLAM NUCLEAR POWER FACILITY/AEC, CONSUMERS POWER
DESIGNER ATOMICS INTERNATIONAL
OPERATOR CONSUMERS POWER COMPANY
LOCATION HALLAM, NEBRASKA
PURPOSE POWER DEMONSTRATION, 1ST ROUND
TYPE SODIUM-GRAPHITE THERMAL REACTOR
POWER MWE(MWT) 75 240
CRITICAL AUG, 1962, OPERATION, OCT. 1963
SHUT DOWN. TO BE DISMANTLED.
COOLANT SODIUM
MODERATOR GRAPHITE
FUEL MATERIAL URANIUM-MOLYBDENUM ALLOY. SOME URANIUM CARBIDE
TEST ELEMENTS. CORE II URANIUM CARBIDE ELEMENTS.
FUEL GEOMETRY RODS 0.590 IN. DIA., 13-25 FT. ACTIVE LENGTH
FUEL CLADDING SS TUBE 0.660 IN. OD, 0.010 IN. THICK
FUEL ENRICH. 3.6 PER CENT U-235. CORE 2 4.9 PER CENT
FUEL ASSEMBLY 18-ROD CLUSTER, ZIRCALOY PROCESS TUBE.
INITIAL LOADING 137 ELEMENTS
FUEL CHARGE 29,200 KG. URANIUM
SPECIFIC POWER 256 KW/KG U-235
BURNUP(REFUEL) MAX. 15000 MWD/T 1/3 CORE
NEUTRON FLUX THERMAL AVE 1×10^{13}
CONTROL RODS WITH GADOLINIUM/SAMARIUM OXIDE POISON
MATERIAL
COOLANT TEMP. INLET 610 F OUTLET 945 F
REACTOR VESSEL VERTICAL SS CYLINDER 19 FT. DIA., 33 FT. HIGH,
OUTER VESSEL OF LOW ALLOY STEEL
CONTAINMENT HIGH DENSITY CONCRETE CELLS BELOW LEVEL OF

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HIGH-BAY FLOOR, CONVENTIONAL BUILDING.

REMARKS

SODIUM COOLANT SYSTEM CONSISTS OF THREE INDEPENDENT CIRCUITS, EACH DIRECTLY CONNECTED TO THE REACTOR VESSEL. THE HALLAM DESIGN HAS BEEN EXTRAPOLATED TO A 360 MWE AND TO A 525 MWE STUDY, THE 525 MWE CENTRAL STATION INCLUDING SUPER-CRITICAL STEAM GENERATION. PRELIMINARY STUDIES HAVE BEGUN ON A 200 MWE PROTOTYPE SGR, WHICH WILL USE URANIUM CARBIDE FUEL. THE REACTOR HAS BEEN SHUT DOWN BECAUSE OF FAILURE OF MODERATOR CLADDING SINCE THE FALL OF 1964, THE AEC HAS ANNOUNCED IT WILL BE DISMANTLED

REFERENCES

THE CONSUMERS PUBLIC POWER DISTRICT SODIUM GRAPHITE REACTOR.
RL OLSON
NAA-SR-2600 /1958/

75,000 KILOWATTS OF ELECTRICITY BY NUCLEAR FISSION AT THE HALLAM NUCLEAR POWER FACILITY.
FC GRONEMEYER
AI-5275 /1960/

HALLAM NUCLEAR POWER FACILITY PROTOTYPE FOR ADVANCED SODIUM-COOLED POWER STATIONS.
RW DICKINSON, OTHERS
AIEE TRANS. /POWER APP. SYST/, 1008-11
/FEBRUARY 1962/

DESIGN PRACTICE, HALLAM.
POWER REACTOR TECHNOLOGY 5, 39-51 /JUNE 1962/

A HIGH-PERFORMANCE SODIUM-GRAPHITE REACTOR POWER PLANT.
RW DICKINSON
ASME PREPRINT 62-WA-261 /1962/

FINAL SUMMARY SAFEGUARDS REPORT FOR THE HALLAM NUCLEAR POWER FACILITY. AND SUPPLEMENT.
ATOMICS INTERNATIONAL,
NAA-SR-5700 /APRIL 15, 1961/
NAA-SR-5700 /SUPPL. 4/ /DEC. 1, 1961/

1000 MWE SGR AND PROTOTYPE EVALUATION STUDY
/VOL. I/ AND VOL. II, 200 MWE SGR PROTOTYPE DESIGN
ATOMICS INTERNATIONAL
NAA-SR-9213 /DEC. 1963/

FINAL EVALUATION REPORT. HALLAM NUCLEAR POWER

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FACILITY.

JE PRICE, COMP.

NAA-SR-9777 /VOLS. 1-6/ /SEPT. 29, 1964/

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LIQUID METAL REACTORS. DOMESTIC

FD07

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NAME/OWNER AETR/ADVANCED EPITHERMAL THORIUM BREEDER//AEC,SAEA

PURPOSE POWER EXPERIMENT.

TYPE LIQUID METAL COOLED EPITHERMAL BREEDER

POWER MWE(MWT) 360 900

CRITICAL DEVELOPMENT

COOLANT SODIUM

MODERATOR BERYLLIUM OR GRAPHITE

FUEL MATERIAL THORIUM-URANIUM ALLOY.

FUEL GEOMETRY FOLDED-PLATE

FUEL CLADDING SS OR LOW-ALLOY STEEL

FUEL ASSEMBLY CRITICAL EXPERIMENT, SS-CLAD PLATELETS OF URANIUM
 OXIDE
 TEST CORE MOCKUP, THORIUM CARBIDE/U-233
 U-238 AND PU-235 WERE STUDIED AS FISSILE
 MATERIALS, AND THORIUM AND U-233 OR U-235
 SYSTEMS.

REMARKS SAEA, GE, W. GERMANY, EURATOM, AND AEC ARE
 COOPERATING IN CONSTRUCTION OF A LIQUID METAL
 COOLED FAST BREEDER TEST REACTOR IN ARKANSAS.
 SEE SEFOR, FD19

REFERENCES ADVANCED THORIUM REACTOR.
 S SIEGEL
 SNL-483 /p. 9/ /1958/

EPITHERMAL REACTOR SHOWS PROMISE FOR COMPETITIVE
 NUCLEAR POWER.
 ELECTRICAL WORLD 154, 52-4 /JULY 25, 1960/

EPITHERMAL THORIUM REACTORS.
 DT EGGEN
 TID-7560 /p. 148-71/ /1962/

THE EPITHERMAL REACTOR WITH THORIUM /AETR/
 DT EGGEN
 IND-ATOMIQUES 6, 63-78 /N. 11/12, 1962/

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LIQUID METAL REACTORS, DOMESTIC

FD08

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NAME/OWNER PASTE FUEL REACTOR STUDY/AI

DESIGNER ATOMICS INTERNATIONAL

PURPOSE STUDY

TYPE LIQUID METAL COOLED, PASTE FUEL, FAST REACTOR

POWER MWE(MWT) 300 704

CRITICAL STUDY

COOLANT SODIUM

MODERATOR GRAPHITE REFLECTOR

FUEL MATERIAL URANIUM CARBIDE IN SODIUM AS A PASTE

FUEL CLADDING CORE AND BLANKET STRUCTURE STAINLESS STEEL

REACTOR VESSEL CYLINDRICAL, CORE 5 FT. DIA. / 5 FT. HIGH,

REMARKS THE CORE STRUCTURAL MATERIAL IS STAINLESS STEEL, RADIAL BLANKET USES NATURAL URANIUM CARBIDE IN SODIUM AS A PASTE AND IS SURROUNDED BY A RADIAL GRAPHITE REFLECTOR. URANIUM METAL, URANIUM OXIDE, PLUTONIUM/URANIUM CARBIDE, PLUTONIUM/URANIUM METAL, AND PLUTONIUM/URANIUM DIOXIDE HAVE ALSO BEEN STUDIED.

REFERENCES OPTIMIZATION STUDIES ON PASTE-FUEL REACTORS
JM ZETTERBAUM, TW KERLIN
NAA-SR-MEMO-5996 /DEC. 28, 1960/

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LIQUID METAL REACTORS, DOMESTIC

FD09

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NAME/OWNER EBR-1 /EXP. BREEDER REACTOR-1//AEC

DESIGNER ARGONNE NATIONAL LABORATORY

OPERATOR ARGONNE NATIONAL LABORATORY

LOCATION NATIONAL REACTOR TEST STATION, IDAHO

PURPOSE POWER EXPERIMENT

TYPE LIQUID METAL COOLED, FAST BREEDER

POWER MWE(MWT) 0.2 1.4

CRITICAL MARK 1, 1951.
 MARK 4, 1962
 RETIRED DEC. 1963

COOLANT SODIUM-POTASSIUM NAK

MODERATOR URANIUM REFLECTOR

FUEL MATERIAL URANIUM-ZIRCONIUM SLUGS. SEE REMARKS

FUEL GEOMETRY ROD. SEE REMARKS

FUEL CLADDING SS, 0.022 IN. THICK. SEE REMARKS

FUEL ENRICH. 93.2 PER CENT U-235. SEE REMARKS

FUEL ASSEMBLY SINGLE ROD ELEMENT, 217 TO CORE.
 SEE REMARKS

SPECIFIC POWER 23 KW/KG U-235

BURNUP(REFUEL) 0.3 PER CENT

NEUTRON FLUX FAST AVE. 0.8×10^{14}

CONTROL MOVABLE URANIUM REFLECTOR

COOLANT TEMP. INLET 442 F OUTLET 601 F

COOLANT PRESS. 13 PSIG

REACTOR VESSEL SS VESSEL, 15.87 IN. ID.

CONTAINMENT CONCRETE SHIELDING, CONVENTIONAL BUILDING.

REMARKS THE MARK-3 CORE HAD FUEL RODS ASSEMBLED INTO

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HEXAGONAL UNITS OF 36 RODS EACH, CONTAINED IN
HEXAGONAL STAINLESS STEEL TUBES. IN 1961 EBR-1
WAS SHUT DOWN FOR INSTALLATION OF A PLUTONIUM
CORE. THE MARK-4 CORE WAS CRITICAL ON NOV. 27,
1962 ON ELEMENTS CONSISTING OF PLUTONIUM ALUMINUM
RODS CLAD IN ZIRCALOY, SURROUNDED BY AN INNER
BLANKET OF NATURAL URANIUM RODS AND AN OUTER
BLANKET OF NATURAL URANIUM BRICKS. THE MARK-4
CORE HAS PRODUCED 1.8 KWE OF POWER ON PLUTONIUM
FUEL. PLANT WAS RETIRED DECEMBER, 1963.

REFERENCES

EBR-1, MARK-3. DESIGN REPORT.
ARGONNE NATIONAL LABORATORY
ANL-5836 /MARCH 1958/

SAFETY ANALYSIS REPORT, EBR-1 MARK-4
RO HAROLDSSEN, OTHERS
ANL-6411 /FEB. 1963/

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LIQUID METAL REACTORS, DOMESTIC

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* * * * *
 NAME/OWNER EBR-2/EXP. BREEDER REACTOR-2//ABC
 DESIGNER ARGONNE NATIONAL LABORATORY
 OPERATOR ARGONNE NATIONAL LABORATORY
 LOCATION NATIONAL REACTOR TEST STATION, IDAHO
 PURPOSE POWER EXP., FAST BREEDER
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 20 60 /SEE REMARKS
 CRITICAL NOV. 1963
 DOWN FEB. 1968 BECAUSE OF SODIUM FIRE.
 OPERATION RESUMED IN ABOUT 2 WEEKS.
 COOLANT SODIUM
 FUEL MATERIAL FISSIUM ALLOY, BLANKET DEPLETED URANIUM
 CORE 2 URANIUM-PLUTONIUM-FISSIUM ALLOY
 FUEL GEOMETRY PINS, CORE 0.144 IN. DIA./14.22 IN. LONG + UPPER
 AND LOWER BLANKET ASSEMBLY AND INNER AND OUTER
 BLANKET ASSEMBLIES
 FUEL CLADDING SS HEXAGONAL CAN 0.009 IN. THICK.
 FUEL ENRICH. 49 PER CENT U-235
 FUEL ASSEMBLY CORE, 91-ELEMENT ASSEMBLY, 14.22 IN. ACT. LENGTH
 INNER AND OUTER BLANKET, 19-ELEMENT ASSEMBLY,
 55 IN. LONG.
 UPPER AND LOWER BLANKET 19-ELEMENT ASSEMBLY, 18
 IN. LONG
 A MIXED CARBIDE LMFBR SUBASSEMBLY CONSISTING OF A
 19-ROD BUNDLE OF URANIUM/PLUTONIUM CARBIDE FUEL
 RODS CLAD WITH SS AND INCOLOY-800 WERE INSERTED
 IN-CORE IN DEC. 1967.
 FUEL CHARGE 350 KG. URANIUM, 28,100 KG. DEPLETED URANIUM
 SPECIFIC POWER 154 KW/KG U
 BURNUP(REFUEL) FRACTIONAL
 NEUTRON FLUX FAST AVE. ABOVE 1.35 MEV 0.8×10^{15}
 FAST AVE. BELOW 1.35 MEV 2.97×10^{15}
 CONTROL MODIFIED FUEL ASSEMBLIES, VERTICAL MOTION

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LIQUID METAL REACTORS, DOMESTIC

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COOLANT TEMP. INLET 700 F OUTLET 900 F

REMARKS

CRITICALITY WAS ACHIEVED ON A LIQUID SODIUM COOLANT ON NOV. 11, 1963. INITIAL OPERATION WILL BE ON U-235 AS FUEL, LATER WITH PLUTONIUM. THE PLANT IS INTEGRATED WITH A FUEL PROCESSING FACILITY. THE REACTOR WAS SHUT DOWN IN OCT. 1964 WITH CONTROL ROD PROBLEMS. OPERATION STARTED IN APRIL 1965, BUT WILL BE LIMITED TO 15 MWE FOR REMAINDER OF LIFE OF 1ST CORE, WHEN SODIUM PUMP WILL BE REPLACED.

REFERENCES

EXPERIMENTAL BREEDER REACTOR 2 /EBR-2/, HAZARD SUMMARY REPORT.
LJ KOCH, OTHERS
ANL-5719 /MAY 1957/

CONSTRUCTION DESIGN OF EBR-2, AN INTEGRATED UNMODERATED NUCLEAR POWER PLANT.
LJ KOCH, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 323-5 /1958/

EBR-2, A CLOSED CYCLE FAST BREEDER,
NUCLEAR ENG. 7, 356-7 /SEPTEMBER 1962/

ADDENDIUM TO HAZARD SUMMARY REPORT,
EXPERIMENTAL BREEDER REACTOR-2 /EBR-2/
LJ KOCH, OTHERS
ANL-5719 /ADD./ /JAN. 7, 1964/

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BNWL-936

LIQUID METAL REACTORS, DOMESTIC

FD11

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NAME/OWNER LUNAR POWER PLANT

DESIGNER ARGONNE NATIONAL LABORATORY

PURPOSE LUNAR POWER PLANT.

TYPE LIQUID METAL COOLED, MERCURY VAPOR TURBINE
FAST REACTOR

POWER MWE(MWT) 1

CRITICAL STUDY

COOLANT BOILING MERCURY

FUEL MATERIAL URANIUM CARBIDE OR URANIUM

FUEL ENRICH. IF URANIUM METAL, SOME ENRICHMENT

FUEL ASSEMBLY RODS, BOLTED RATHER THAN JACKETED.
1381 RODS/CORE

BURNUP(REFUEL) 2-YEAR OPERATION

CONTAINMENT NO SHIELDING

REMARKS REACTOR IS SIMILAR TO EBR-1 MARK 3, WITH BOLTED
RATHER THAN JACKETED CORE FUEL RODS. ALL SURFACES
IN CONTACT WITH THE COOLANT WOULD BE A CHROMIUM-
MOLYBDENUM STEEL ALLOY. FOLDABLE RADIATORS
REMOVE CONDENSATION HEAT FROM THE MERCURY CYCLE.
SYSTEM USES THE RANKINE CYCLE. A COMPLETE
POWERPLANT CONSISTS OF 3 IDENTICAL UNITS.
CONCEPT IS FOR FABRICATION ON EARTH, DIRECT LAUNCH
AS PAYLOAD OF AN ADVANCED SATURN OR NOVA VEHICLE,
SOFT LANDING ON MOON.

REFERENCES NUCLEAR POWER PLANT FOR MOON OUTLINED.
EH KOLCUM
AVIATION WEEK 75, 50-53 /JULY 31, 1961/

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LIQUID METAL REACTORS. DOMESTIC

FD12

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NAME/OWNER FARET /ARGONNE FAST REACTOR TEST FACILITY//AEC
 DESIGNER ARGONNE NATIONAL LAB., ATOMICS INTERNATIONAL
 TITLE 1 AND 2 DESIGNS BY BECHTEL
 OPERATOR ARGONNE NATIONAL LABORATORY
 LOCATION NATIONAL REACTOR TEST STATION, IDAHO
 PURPOSE FAST REACTOR EXPERIMENTAL FACILITY.
 TYPE LIQUID METAL COOLED FAST REACTOR TEST FACILITY
 POWER MWE(MWT) 0 50
 CRITICAL DROPPED. SEE REMARKS.
 COOLANT SODIUM
 FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE PELLETS
 URANIUM/PULTONIUM CARBIDE, VIBRATORY COMPACTED
 URANIUM/PLUTONIUM ALLOY
 FUEL GEOMETRY RODS
 FUEL ASSEMBLY CERAMIC FUEL, 37-ELEMENT ASSEMBLY
 24 ASSEMBLIES
 ALLOY FUEL, 61-ELEMENT ASSEMBLY
 8 ASSEMBLIES
 CARBIDE FUEL, 16 ASSEMBLIES
 COOLANT TEMP. INLET 600-960 F OUTLET 840-1200 F
 REACTOR VESSEL DOUBLE-WALLED OUTER VESSEL AS AN INTEGRAL PART OF
 THE HEAT TRANSFER SYSTEM, AN INNER CORE-SUPPORT
 STRUCTURE AND REMOVABLE COVER.
 CONTAINMENT REINFORCED-CONCRETE STEEL-LINED CELL, NORMALLY
 FILLED WITH HIGH PURITY INERT GAS.
 REMARKS FARET HAS BEEN DROPPED IN FAVOR OF THE LARGER FFTF
 FAST FLUX TEST FACILITY.
 SEE FD30
 REFERENCES FARET-A FAST-REACTOR TEST FACILITY
 A SMAARDYK, OTHERS
 TRANS. ANS 5,435-6 /NOV. 1962/ /ABSTRACT/
 NUCLEONICS WEEK DEC. 2, 1965 P. 1
 NEWS RELEASE

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FAST REACTOR TEST FACILITY FARET
VOL. 1, DESCRIPTION AND PROGRAM
ARGONNE NATIONAL LAB.
ANL-7168, VOL.1 /MARCH 1966/

FARET CORE-1 REFERENCE DESIGN,
PJ PERSIANI, OTHERS
ANL-7120 P. 766-75 /1966/

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LIQUID METAL REACTORS. DOMESTIC

FD13

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NAME/OWNER ENRICO FERMI ATOMIC POWER PLANT/PRDC
DESIGNER ATOMIC POWER DEVELOPMENT ASSOCIATES, INC.
OPERATOR POWER REACTOR DEVELOPMENT COMPANY
LOCATION MONROE, MICHIGAN
PURPOSE POWER DEMONSTRATION
TYPE LIQUID METAL COOLED FAST BREEDER
POWER MWE(MWT) 60 200
INITIAL 110 MWT
CRITICAL AUG. 1963, SEE REMARKS
COOLANT SODIUM
FUEL MATERIAL URANIUM-MOLYBDENUM ALLOY
FUEL GEOMETRY ROD, CORE, ACT. LENGTH 30.5 IN.
UPPER AND LOWER AXIAL BLANKET 14.0 IN. LONG
RADIAL BLANKET 61.75 IN. LONG
FUEL CLADDING CORE ZIRCONIUM 0.005 IN. THICK
BLANKET SS 0.005 IN. THICK
FUEL ENRICH. 25.6 PER CENT U-235
BLANKET DEPLETED URANIUM
FUEL ASSEMBLY CORE 1
105-PIN ASSEMBLY, CORE AND BLANKET ASSEMBLIES
ENCLOSED IN SS TUBE, PLUS RADIAL BLANKET
ASSEMBLIES.
FUEL CHARGE 2000 KG. URANIUM
SPECIFIC POWER 675 KW/KG U-235
BURNUP(REFUEL) 48,800 MWD/T
NEUTRON FLUX 1.6×10^{15}
CONTROL RODS
COOLANT TEMP. INLET 550 F OUTLET 800 F
COOLANT PRESS. INLET 82 PSIG
REACTOR VESSEL SS VESSEL 14 FT. 2 IN. ID. /SODIUM POOL/

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VESSEL IS IN TWO PARTS, THE LOWER CONTAINING THE CORE. VESSEL IS ENCLOSED IN A CARBON STEEL LEAK-TIGHT VESSEL.

CONTAINMENT WELDED STEEL BUILDING.

REMARKS INITIAL CRITICALITY IN AUG. 1963 WAS FOLLOWED BY A PROGRAM OF LOW-POWER TESTS LEADING UP TO 200 MW. THE FERMI REACTOR WILL BE OPERATED AT A SUSTAINED 110 MWE WITH CORE A. TEST FUELS AND MATERIAL SPECIMENS WILL BE TESTED. FERMI WAS SHUT DOWN OCT. 5, 1966 FOLLOWING A MALFUNCTION PROBABLY INVOLVING FUEL MELTING IN ONE OR MORE SUBASSEMBLIES. SIGNIFICANT DAMAGE IS THOUGHT TO HAVE OCCURED. STARTUP IS EXPECTED AGAIN IN 1968-1969.

REFERENCES DESCRIPTION OF DEVELOPMENTAL FAST NEUTRON BREEDER POWER REACTOR PLANT
APDA-108 /SEPTEMBER 1955/

ENRICO FERMI ATOMIC POWER PLANT.
A.P. DONNELL, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY 8, 535-42 /1958/

ENRICO FERMI POWER PLANT.
APDA-124 /JANUARY 1959/

CIVILIAN POWER REACTOR PROGRAM, PART 3, STATUS
REPORT ON FAST REACTORS AS OF 1959.
TID-8518 /1/ BOOK I

ENRICO FERMI ATOMIC POWER PLANT REVISED LICENSE
APPLICATION, PART B. TECHNICAL INFORMATION AND
HAZARDS SUMMARY REPORT.
POWER REACTOR DEVELOPMENT COMPANY
NP-10458 /JULY 1961/

A REPORT ON FERMI.
OJ DU TEMPLE
NUCLEAR NEWS /ANS/ 7, 28-33 /JAN. 1964/

THE ENRICO FERMI FAST NEUTRON BREEDER.
DESCRIPTION AND OPERATION
J.F. ANDERSON /PRDC/
CONF-631201 /P. 9-16/
PROC. FAST NEUTRON BREEDER REACTOR CONF. DEC. 1963.

ENRICO FERMI POWER PLANT - IRRADIATION TEST

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FACILITY.

PR HUEBOTTER, WH JENS

ASME 65-WA/NE-5

NUCLEONICS WEEK OCT. 13, 1966 P. 1

NEWS RELEASE

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LIQUID METAL REACTORS. DOMESTIC

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NAME/OWNER LMTBR/LIQ. METAL THORIUM BREEDER REACTOR/
 DESIGNER BABCOCK AND WILCOX
 PURPOSE FAST BREEDER, POWER, DESIGN STUDY.
 TYPE LIQUID METAL COOLED, MOBILE FUEL, BREEDER REACTOR
 POWER MWE(MWT) 500 1065
 CRITICAL STUDY
 COOLANT BISMUTH. /URANIUM-BISMUTH SOLUTION/
 MODERATOR GRAPHITE
 REFLECTOR, GRAPHITE
 FUEL MATERIAL URANIUM SOLUTION IN BISMUTH
 BLANKET, THORIUM OXIDE-BISMUTH SLURRY
 FUEL GEOMETRY SOLUTION AND SLURRY
 FUEL CHARGE 620 KG. FUEL /TOTAL INVENTORY/
 SPECIFIC POWER 1.7 MWH/KG
 BURNUP(REFUEL) CORE FLUID REPROCESSING TIME 15.7 FULL POWER DAYS,
 BLANKET 155
 NEUTRON FLUX CORE, THERMAL AVE. 7.2×10^{14}
 EPITHERMAL AVE. 2.6×10^{15}
 BLANKET, THERMAL AVE. 3.4×10^{13}
 EPITHERMAL AVE. 1.3×10^{14}
 CONTROL RODS
 COOLANT TEMP. INLET 1000 F OUTLET 1300 F /CORE/
 INLET 1150 F OUTLET 1300 F /BLANKET/
 COOLANT PRESS. 250 PSI
 REACTOR VESSEL SS CYLINDER 15 FT 10 IN. ID./18 FT. 6 IN. LONG.
 LOW C STEEL INNER CLADDING.
 REMARKS AN EXTERNALLY COOLED CONCEPT FOR A BREEDER REACTOR
 USING URANIUM-BISMUTH SOLUTION AS FUEL-COOLANT
 AND A THORIUM OXIDE-BISMUTH SLURRY BLANKET,
 INTEGRATED ON-SITE CHEMICAL PROCESSING PLANT. THE
 CORE FLUID FLOW IS UPWARD THROUGH THE BOTTOM
 END-BLANKET, CORE, TOP END-BLANKET AND PLENUM INTO

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CORE FLUID HEAT EXCHANGER /TUBE-SIDE/. BLANKET FLUID FLOWS UPWARD FROM THE INNER BOTTOM PLENUM, THROUGH CRUCIFORM CHANNELS IN THE CORE AND THE INNER SIDE-BLANKET CHANNELS, UP THROUGH TOP END-BLANKET AND HORIZONTAL PASSAGES TO TOP INNER PLENUMS. REFERENCE DESIGN IS FOR A TWO-REACTOR /1000 MWE/ PLANT. CORE FLUID HEAT EXCHANGER IS A BAYONET-TYPE TANTALUM UNIT, BLANKET FLUID EXCHANGER HASTELLOY-X AND TANTALUM.

REFERENCES

THE LIQUID METAL THORIUM BREEDER REACTOR,
BASCOCK + WILCOX CO.
BAW-1171 /1960/

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LIQUID METAL REACTORS. DOMESTIC

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NAME/OWNER SETTLED BED FAST REACTOR/BNL
 SBFR

DESIGNER BROOKHAVEN NATIONAL LABORATORY

PURPOSE PRELIMINARY STUDY, FAST BREEDER POWER REACTOR.

TYPE LIQUID METAL COOLED, SETTLED BED, FAST BREEDER

POWER MWE(MWT) 1000 2500

CRITICAL REFERENCE DESIGN

COOLANT SODIUM

MODERATOR NONE

FUEL MATERIAL URANIUM/PLUTONIUM CARBIDE, HYPOSTOICHIOMETRIC

FUEL GEOMETRY SPHERES 0.120 IN. DIA.

FUEL CLADDING NONE

FUEL ENRICH. URANIUM/PLUTONIUM 7/1, DEPLETED URANIUM

FUEL ASSEMBLY CORE AND BLANKET AS BEDS OF SMALL, RANDOMLY-PACKED
 FUEL SPHERES. COOLANT FLOW IS DOWNWARD,
 RESTRAINING THE BED. THE BED IS SUPPORTED BY
 PERFORATED PLATE.
 ANNULAR CORE 6 FT. 9 IN. OD., 4 FT. 9 IN. ID.,
 10 FT. 6 IN. HIGH, IS SURROUNDED ON ALL SIDES BY
 BLANKET MATERIAL, CENTRAL BLANKET IS 4 FT. DIA.

FUEL CHARGE TOTAL WEIGHT OF FUEL IS 21,154 KG.

SPECIFIC POWER 1100 KW/KG PLUTONIUM CARBIDE

BURNUP(REFUEL) 100,000 MWD/T

CONTROL RODS, WITHIN CORE RING

COOLANT TEMP. INLET 550 F OUTLET 1200 F

COOLANT PRESS. INLET 316 PSIG OUTLET 20 PSIG

REACTOR VESSEL CYLINDRICAL, SS VESSEL
 16 FT. 10 IN. ID., 18 FT. HIGH, 5 IN. WALL
 PRESSURE VESSEL
 PERFORATED PLATES FORM THE FUEL BEDS

CONTAINMENT VERTICAL STEEL CYLINDER 115 FT. ID., 168 FT. HIGH

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65 FT. BELOW-GRADE.
PRESSURE VESSEL;
REACTOR, RADIOACTIVE COOLANT, AND FUEL
HANDLING SYSTEMS ARE BELOW OPERATING FLOOR.

REMARKS

TWO GENERAL REACTOR CONFIGURATIONS WERE STUDIED, AXIAL AND RADIAL FLOW DESIGNS. A ZERO-POWERED, COLD CRITICAL EXPERIMENT CONSISTING OF A TWO-REGION WATER-MODERATED FACILITY WITH A CENTRALLY LOCATED SETTLED BED IS PLANNED, TO BE FOLLOWED BY A LOW POWER, HOT CRITICAL EXPERIMENT USING CERAMIC FUEL LUMPS AND SODIUM COOLANT. A SIMILAR STUDY IS CONCERNED WITH URANIUM/PLUTONIUM DIOXIDE AND URANIUM DIOXIDE SPHERES AS BLANKET. POWER IS 359 MWE AND 881 MWE. DESIGN CONCEPTS FOR A 1000 MWE VERSION HAVE BEEN DONE. AXIAL TYPE WAS SELECTED FOR REFERENCE DESIGN
SEE ALSO OFBR, FD36

REFERENCES

CHARACTERISTICS OF FAST SETTLED BED REACTORS,
J CHERNICK
BNL-7592 /OCT. 1963/

NUCLEAR PARAMETER STUDIES OF THE FAST SETTLED BED REACTOR,
MM LEVINE, A ARONSON
BNL-7593 /OCT. 1963/

SETTLED-BED FUEL REACTORS,
LP HATCH, OTHERS
BNL-5830 /NOV. 1961/

PROC. CONFERENCE IN BREEDING, ECONOMICS, AND SAFETY IN LARGE FAST POWER REACTORS, OCTOBER 7-10, 1963,
ARGONNE NATIONAL LAB.
ANL-6792 /DEC. 1963/

NUCLEAR PARAMETER STUDIES OF THE FAST SETTLED BED REACTOR,
J CHERNICK, OTHERS.

1000 MWE SETTLED-BED FAST REACTOR PHYSICS,
A ARONSON, MM LEVINE
AMERICAN NUCLEAR SOC. TRANS. 7, 240-1 /NOV. 1964/

THE SETTLED-BED FAST REACTOR CONCEPT,
L. GREEN, OTHERS /BNL/
NUCLEAR APPLICATIONS 1, 107-130 /APRIL 1965/

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SETTLED-BED FAST REACTOR CONCEPT - STATUS REPORT,
C ROSEMAN, OTHERS
FAST REACTOR TECHNOLOGY, NATIONAL TOPICAL MEETING
APRIL 26-8, 1965, AMERICAN NUCLEAR SOCIETY,
ANS-100 P, 68-74

THE RANDOMLY-PACKED SETTLED-BED FAST REACTOR
CONCEPT, 1000 MWE REACTOR DESIGN
L GREEN, MM LEVINE, EDS.
BNL-887 /JUNE 1, 1965/

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER LMFBR /LIQ. METAL FAST BREEDER REACTOR/CE
 DESIGNER COMBUSTION ENGINEERING, INC.
 PURPOSE DESIGN STUDY, FAST BREEDER POWER REACTOR.
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 1000 2143
 CRITICAL DESIGN STUDY
 COOLANT SODIUM
 FUEL MATERIAL CORE, URANIUM/PLUTONIUM CARBIDE PELLETS
 0.26 IN. DIA.
 BLANKET, AXIAL AND RADIAL, 0.4 IN. DIA. PELLETS
 FUEL GEOMETRY RODS 30 IN. ACTIVE LENGTH + TOP AND BOTTOM
 BLANKET 18 IN.
 RADIAL BLANKET 54 IN. ACTIVE LENGTH
 FUEL CLADDING SS 0.011 IN. THICK, SODIUM BOND
 FUEL ENRICH. AVERAGE 13 PER CENT
 FUEL ASSEMBLY CORE, 169-PIN ASSEMBLY, INCLUDING AXIAL BLANKET,
 RADIAL BLANKET, 127-ROD ASSEMBLY
 157 CORE ASSEMBLIES
 156 RADIAL BLANKET ASSEMBLIES
 FUEL CHARGE 1155 KG. FISSILE METAL. BLANKET 106 KG.
 SPECIFIC POWER 1680 KW/KG FISSILE
 BURNUP(REFUEL) 100,000 MWD/T 1/8 CORE AND 1/24 BLANKET
 URANIUM + PLUTONIUM
 CONTROL RODS, BORON CARBIDE AND DEPLETED URANIUM CARBIDE
 COOLANT TEMP. INLET 850 F OUTLET 1120 F
 REACTOR VESSEL STRUCTURAL MATERIALS STAINLESS STEEL, REACTOR
 VESSEL CONTAINS CORE AND BLANKET ASSEMBLIES.
 REFERENCES LIQUID METAL FAST BREEDER REACTOR DESIGN STUDY,
 VOL. 1 AND 2,
 COMBUSTION ENGINEERING, NUCLEAR DIV.
 CEND-200 /VOL. 1 AND 2/ /JANUARY 1964/

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AN EVALUATION OF FOUR DESIGN STUDIES OF A 1000 MWE
CERAMIC FUELED FAST BREEDER REACTOR,
REACTOR ENG. DIV, CHICAGO OPERATIONS OFFICE,
C00-279 /DEC. 1, 1964/

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER LIMB /LIQUID METAL BREEDER//DOUGLAS AIRCRAFT

DESIGNER DOUGLAS AIRCRAFT

PURPOSE DESIGN, EVALUATION

TYPE LIQUID METAL THERMAL BREEDER, INTERNALLY COOLED

POWER MWE(MWT) 200

COOLANT MOLTEN LEAD

MODERATOR GRAPHITE

FUEL MATERIAL URANIUM-BISMUTH SOLUTION, BLANKET SOLUTION A
DISPERSION OF THORIUM-BISMUTHIDE IN MOLTEN LEAD--
BISMUTH.

FUEL ENRICH. NATURAL

FUEL ASSEMBLY GRAPHITE FUEL ELEMENT IS HEXAGONAL, A CENTRAL
PLUNGER, MOVING DOWNWARD, DISPLACES THE FUEL FLUID
COLLECTED IN THE BOTTOM OF THE OUTER GRAPHITE TUBE
UPWARD INTO THE CORE ZONE. AT CRITICALITY A
RESERVOIR IS FORMED ABOVE THE UPPER BLANKET
REGION. BLANKET FLUID CIRCULATES FROM TOP TO
BOTTOM BY MEANS OF CHANNELS IN THE PLUNGER. CORE,
UPPER AND LOWER BLANKETS ARE FORMED BY A CLUSTER
OF THE GRAPHITE ELEMENTS.

SPECIFIC POWER 4050 KW/KG

NEUTRON FLUX THERMAL AVE, 2.16×10^{-14}
EPITHERMAL AVE, 5.43×10^{-14}

COOLANT TEMP, 500 C

REACTOR VESSEL STEEL VESSEL CONTAINING A GRAPHITE STRUCTURE
FABRICATED TO CONDUCT THE COOLANT, FUEL, AND
BLANKET FLUIDS THROUGH THE REACTOR.

REMARKS TWO SIZES WERE SELECTED FOR DETAILED EVALUATION,
THE 200 MWT PLANT AND A 1000 MWT PLANT, SINGLE
UNIT CONSTRUCTION FOR ALL REACTOR FUNCTIONS,
INCLUDING PROCESSING BY MOLTEN SALT PROCESS, IS
PROPOSED.

REFERENCES LIQUID METAL BREEDER REACTOR /LIMB/
RU TEITEL /DOUGLAS AIRCRAFT/
PROC. THORIUM FUEL CYCLE SYMPOSIUM, P. 210-43

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TID-7650 /1962/

LIQUID METAL BREEDER REACTOR /LIMB/ NUCLEAR
EVALUATION.

RJ TEITEL, JB BROWN /DOUGLAS AIRCRAFT/

NUCLEAR APPLICATIONS 1/1/, 13-24 /FEB. 1965/

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LIQUID METAL REACTORS. DOMESTIC

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NAME/OWNER SEFOR /SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR/
 GE, SAEA, W. GERMANY, EURATOM, AEC

DESIGNER GENERAL ELECTRIC COMPANY

LOCATION FAYETTEVILLE, ARKANSAS

PURPOSE FAST BREEDER EXP.-TEST REACTOR

TYPE LIQUID METAL COOLED; FAST BREEDER EXPERIMENT

POWER MWE(MWT) 0 20

CRITICAL FUEL LOADING TARGET 1968

COOLANT SODIUM, TWO PARALLEL LOOPS

MODERATOR NICKEL REFLECTOR SLABS

FUEL MATERIAL PLUTONIUM/URANIUM DIOXIDE PELLETS, URANIUM DIOXIDE
 PELLETS, BLANKET

FUEL GEOMETRY RODS 1.00 IN. DIA., ACTIVE LENGTH 33.8 IN.

FUEL CLADDING SS 0.055 IN. THICK

FUEL ENRICH. 19 PER CENT PLUTONIUM

FUEL ASSEMBLY 6 RODS/CHANNEL, TOTAL 630 RODS

NEUTRON FLUX AVE. 3.4×10^{14}

CONTROL MOVABLE REFLECTOR CONTROL RODS, SURROUNDING CORE
 OUTSIDE REACTOR VESSEL.

COOLANT TEMP. INLET 700 F OUTLET 820 F

REACTOR VESSEL LOWER -CORE- SECTION SMALL DIA., UPPER SECTION
 LARGE DIA. SHIELDING.

CONTAINMENT OUTER ALL-WELDED STEEL CYLINDER, 50 FT. DIA.,
 114 FT. HIGH, BOTTOM LEVEL 60 FT. BELOW GRADE.
 TWO BARRIERS IN SERIES, INNER CONTAINMENT STEEL-
 REINFORCED CONCRETE WITH AN INERT GAS ATMOSPHERE.

REMARKS PROGRAM HAS BEEN UNDER AEC SPONSORSHIP SINCE 1959.
 PROGRAM CALLS FOR A 100-300 MWE PROTOTYPE FOR
 OPERATION BY 1970, AND A 500 MWE REACTOR ON-LINE
 BY 1975.
 CRITICAL ASSEMBLY MOCK-UP REACHED CRITICALITY IN

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ZPR-3 IN APRIL 1966.
SEFOR WILL DEVELOP DESIGN INFORMATION FOR THE
300 MWE DEMONSTRATION PLANT.

REFERENCES

FAST OXIDE BREEDER-REACTOR PHYSICS, PART I
PARAMETRIC STUDY OF 300 MWE REACTOR CORE,
P GREEBLER, OTHERS
GEAP-3721 /DECEMBER 1961/

EXPERIMENTAL FAST OXIDE REACTOR,
MJ MC NELLY, OTHERS
POWER REACTOR EXPERIMENTS, VOL. I, P. 317-43
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962,

EXPERIMENTAL FAST CERAMIC REACTOR DESIGN, STATUS
REPORT AS OF OCTOBER 31, 1961,
KM HORST, ED.
GEAP-3885 /APRIL 1962/

DEVELOPMENT OF THE FAST CERAMIC REACTOR,
K COHEN, B WOLFE
NUCLEAR ENG. 7, 358-9 /SEPTEMBER 1962/

DEVELOPMENT OF THE FAST CERAMIC REACTOR,
K COHEN, B WOLFE
NUCLEAR NEWS 6, 11-15 /FEBRUARY 1963/

CONCEPTUAL DESIGN OF A 565 MWE FAST CERAMIC
REACTOR,
HE DODGE, OTHERS
GEAP-4226 /APRIL 1963/

THE SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR,
K COHEN, OTHERS,
EIGHTH NUCLEAR CONGRESS, ROME, ITALY,
APED-4281 /JUNE 17-20, 1963/

SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR
DEVELOPMENT PROGRAM, FIRST QUARTERLY REPORT,
APRIL-JUNE 1964,
GEAP-4594 /JULY 1964/

PRELIMINARY SAFEGUARDS SUMMARY REPORT, PART 1,
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR
UNDATED
NP-15077 /MAY 1965/

SEFOR - A STATUS REPORT
B WOLFE, OTHERS
ANS-100 P. 247-67

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SEFOR READY SOON FOR FAST BREEDER EXPERIMENTS.
HT HOLMES
ELECTRICAL WORLD 169, 32-33 /MAY 13, 1968/

THE SEFOR PROJECT - ITS SIGNIFICANCE AND PROGRESS.
B WOLFE
AMERICAN POWER CONF. PROC. 29, 189-201 /1967/

SEFOR PLANT DESIGN
ANS TOPICAL MEETING ON FAST REACTORS, 1967,
ANS-101 P. 5-31, 5-54,

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LIQUID METAL REACTORS, DOMESTIC

FD20

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NAME/OWNER LMFBR /LIQ. METAL FAST BREEDER REACTOR/GE
 DESIGNER GENERAL ELECTRIC COMPANY
 PURPOSE DESIGN STUDY FOR AEC
 TYPE LIQUID METAL COOLED FAST BREEDER, PANCAKE CORE,
 POWER MWE(MWT) 1000 2500
 CRITICAL STUDY
 COOLANT SODIUM
 FUEL MATERIAL CORE, URANIUM/PLUTONIUM DIOXIDE CORED PELLETS
 0.22 IN. OD., 0.01 IN. ID.
 BLANKET, AXIAL AND RADIAL, DEPLETED URANIUM OXIDE
 PELLETS 0.058 AND 0.45 IN. DIA.
 FUEL GEOMETRY CORE, PINS 2 FT. ACT. LENGTH + 2X18 IN. UPPER AND
 LOWER AXIAL BLANKET
 RADIAL BLANKET, 30 IN. ACT. LENGTH
 FUEL CLADDING SS
 CORE, 15 MILS THICK
 RADIAL BLANKET, 20 MILS THICK
 FUEL ENRICH. AVERAGE 18 PER CENT
 FUEL ASSEMBLY CORE AND AXIAL BLANKET
 470 FUEL PINS
 138 BERYLLIA PINS
 225 ASSEMBLIES
 RADIAL BLANKET
 208 PINS
 108 ASSEMBLIES
 HEXAGONAL SS FUEL CHANNELS, CORE IS 2 FT. HIGH AND
 11.65 FT. DIA.
 FUEL CHARGE 2304 KG. FISSILE METAL, BLANKET 58 KG
 SPECIFIC POWER 900 KW/KG PLUTONIUM
 BURNUP(REFUEL) 100,000 MWD/T
 CONTROL RODS, BORON CARBIDE, SODIUM FOLLOWER
 COOLANT TEMP. INLET 800 F OUTLET 1100 F
 COOLANT PRESS. INLET 50 PSIA OUTLET 25 PSIA

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LIQUID METAL REACTORS, DOMESTIC

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REACTOR VESSEL PRIMARY TANK AND REACTOR VESSEL OF SS

CONTAINMENT LEAK-TIGHT BUILDING, FILLED BELOW OPERATING
FLOOR WITH INERT GAS.

REMARKS A JOINT STUDY EFFORT BY GE, COMMONWEALTH EDISON,
DUKE POWER, PACIFIC G + E, AND SAEA WILL BE
CARRIED OUT ON A PROTOTYPE AND DEMONSTRATION
300 MWE REACTOR. PRELIMINARY DESIGN, R + D WILL BE
DONE AT GE-S ADVANCED PRODUCTS OPERATION.
A COMPLEMENTARY 3-YEAR R + D STUDY FOR A 300 MWE
BREEDER PROTOTYPE WILL BE DONE BY GE AND ESADA.

REFERENCES LIQUID METAL FAST BREEDER REACTOR DESIGN STUDY
1000 MWE URANIUM/PLUTONIUM DIOXIDE FUELED PLANT,
VOL. 1-2.
MJ MC NELLY /GENERAL ELECTRIC CO., APED/
GEAP-4418 /VOL. 1 AND VOL. 2/ /JAN, 1963/

AN EVALUATION OF FOUR DESIGN STUDIES OF A 1000 MWE
CERAMIC FUELED FAST BREEDER REACTOR.
REACTOR ENG. DIV., CHICAGO OPERATIONS OFFICE
C00-279 /DEC. 1, 1964/

SAFETY AND ECONOMIC CHARACTERISTICS OF A 1000 MWE
FAST SODIUM-COOLED REACTOR
KP COHEN, GL O'NEILL
ADVANCES NUCLEAR SCI. TECH. 4, 67-107 /1968/

JANUARY 1969

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LIQUID METAL REACTORS. DOMESTIC

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NAME/OWNER MCR /MILITARY COMPACT REACTOR//DOD-ARMY

DESIGNER GENERAL MOTORS, ALLISON DIVISION

PURPOSE PROTOTYPE DEVELOPMENT, MOBILE REACTOR, EDS /ENERGY DEPOT SYSTEM/

TYPE LIQUID METAL COOLED, FAST REACTOR, HIGH TEMPERATURE, MOBILE PLANT.

POWER MWE(MWT) 3 15

CRITICAL DEVELOPMENT, COMPONENT TESTING AND FUEL DEVELOPMENT.

COOLANT POTASSIUM

MODERATOR NONE

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY ROD

FUEL CLADDING NIOBIUM-ZIRCONIUM ALLOY TUBES

REMARKS
 HIGHLY MOBILE NUCLEAR ELECTRIC GENERATING PLANT. THE LIQUID METAL COOLANT TRANSFERS ITS HEAT THROUGH TWO EXCHANGERS TO COMPRESSED AIR. HEATED AIR FROM EACH HEAT EXCHANGER RUNS AN OPEN BRAYTON-CYCLE GAS TURBINE. TURBINES ARE MODIFIED T-56 ENGINES. THE PLANT IS COMPOSED OF FIVE SEPARABLE PACKAGES WHICH CAN BE CARRIED CROSS COUNTRY IN FOUR TRAILERS AND 1 TRUCK.
 PACKAGE I. REMOVABLE SHIELD FOR REACTOR OPERATION.
 PACKAGE II. REACTOR AND SHUT-DOWN SHIELDING, PRIMARY COOLANT LOOP, SELF CONTAINED AFTERHEAT REMOVAL SYSTEM.
 PACKAGE III. ENGINES AND ALTERNATORS
 PACKAGE IV. SWITCHGEAR AND ELECTRICAL PROTECTIVE EQUIP.
 PACKAGE V. CONTROL CONSOLE PANEL, ASSOCIATED COMPUTER EQUIPMENT.
 THE EDS CONCEPT CALLS FOR THE USE OF A HIGHLY MOBILE REACTOR TO PRODUCE FUEL FROM AIR AND WATER FOR ARMY FIELD FORCES.

REFERENCES MCR PRELIMINARY DESIGN REPORT, VOLUME 2
 ALLISON DIV., GENERAL MOTORS CORP.

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GMAD-3078-8, VOL. 2 /DECLASSIFIED/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER LAMPRE /LOS ALAMOS MOLTEN PLUTONIUM REACTOR//AEC
DESIGNER LOS ALAMOS SCIENTIFIC LABORATORY
OPERATOR LOS ALAMOS SCIENTIFIC LABORATORY
LOCATION LOS ALAMOS, N. M.
PURPOSE POWER EXPERIMENT
TYPE LIQUID METAL COOLED, FAST REACTOR, LIQ. METAL FUEL
POWER MWE(MWT) 0 1
CRITICAL 1961. CORE REMOVED IN 1964
SEE REMARKS
COOLANT SODIUM
FUEL MATERIAL PLUTONIUM-IRON ALLOY /MOLTEN/ /SEE REMARKS/
FUEL GEOMETRY MOLTEN ALLOY
FUEL CLADDING TANTALUM-TUNGSTEN ALLOY CAPSULES
0.376 IN. ID. 8 IN. LONG
FUEL ENRICH. 90 PER CENT
FUEL ASSEMBLY CORE CONSISTS OF FOOT-LONG TANTALUM-TUNGSTEN
THIMBLES CONTAINING THE PLUTONIUM-IRON FUEL,
PLACED IN THE SODIUM COOLANT. THERE ARE 199
CAPSULES, SOME OCCUPIED BY UNFUELED REFLECTOR PINS
SPECIFIC POWER 40 W/G FUEL
COOLANT TEMP. INLET 450 C OUTLET 563 C
REACTOR VESSEL INNER CONTAINMENT VESSEL OF SS, OUTER VESSEL SS
REMARKS A NEW FUEL ALLOY UNDER DEVELOPMENT WILL BE A
TERNARY PLUTONIUM-COBALT-CESIUM ALLOY IN WHICH THE
PLUTONIUM CONTENT CAN BE VARIED OVER A WIDE RANGE.
A PROJECT ORIGINALLY DESIGNATED AS LAMPRE-2 IS
NOW KNOWN AS FRCTF /FAST REACTOR CORE TEST
FACILITY/
SEE FD23
REFERENCES LAMPRE, A MOLTEN PLUTONIUM FUELED REACTOR CONCEPT,
RM KIEHN, OTHERS
LA-2112 /JANUARY 1957/

JANUARY 1969

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LOS ALAMOS MOLTEN PLUTONIUM REACTOR EXPERIMENT,
/LAMPRE/ HAZARD REPORT,
EO SWICKARD
LA-2327 /JUNE 1959/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER FRCTF /FAST REACTOR CORE TEST FACILITY//AEC
 LAMPRE-2

DESIGNER LOS ALAMOS SCIENTIFIC LABORATORY

OPERATOR LOS ALAMOS SCIENTIFIC LABORATORY

LOCATION LOS ALAMOS, N. M.

PURPOSE EVALUATION OF FAST REACTOR CORE CONCEPTS, TEST BED

TYPE LIQUID METAL COOLED, ADVANCED CORE TEST FACILITY,
 FAST REACTOR.

POWER MWE(MWT) 15

COOLANT SODIUM

FUEL MATERIAL PLUTONIUM-IRON /MOLTEN/,
 BLANKET URANIUM-MOLYBDENUM

FUEL GEOMETRY MOLTEN ALLOY

FUEL ASSEMBLY CAPSULES /SEE LAMPRE/ CONTAINING MOLTEN FUEL,
 ONE CORE CONCEPT USES SPIRALS OF FLATTENED TUBING
 TO CONTAIN THE MOLTEN FUEL.

SPECIFIC POWER 517 W/G FUEL

COOLANT TEMP. 650 C MAX.

REACTOR VESSEL CIRCULAR SS VESSEL, 25 FT. DEEP, COAXIAL INNER
 SLEEVES, UPPER 4 FT. DIA. LOWER 7 FT. DIA.
 DOUBLE-WALL.

CONTAINMENT CONCRETE PITS, CONVENTIONAL BUILDING.

REFERENCES A PRELIMINARY STUDY OF A FAST REACTOR CORE TEST
 FACILITY.
 DB HALL, OTHERS
 LA-2332 /AUGUST 1959/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER DCR/DIRECT CONTACT REACTOR//LASL

DESIGNER LOS ALAMOS SCIENTIFIC LABORATORY

PURPOSE FAST BREEDER CONCEPT, STUDY

TYPE LIQUID METAL COOLED, FAST BREEDER,

POWER MWE(MWT) 227

CRITICAL DESIGN STUDY

COOLANT SODIUM

FUEL MATERIAL PLUTONIUM-CERIUM-COBALT COMPOSITION, MOLTEN
URANIUM DIOXIDE-SODIUM PASTE BLANKET

FUEL GEOMETRY MOLTEN ALLOY, PASTE BLANKET

FUEL CLADDING TANTALUM-TUNGSTEN ALLOY STRUCTURAL MATERIAL

FUEL ASSEMBLY VESSEL IS FILLED WITH THE LIQUID FUEL, AN
EXTERNAL JET OF LIQUID SODIUM CIRCULATES THE FUEL
AND SEPARATES THE LIQUIDS CENTRIFUGALLY. AFTER
SEPARATION FUEL RETURNS TO THE CORE. CORE
DIAMETER IS 70 CM.

FUEL CHARGE 350 LITERS OF FUEL /1 KG PLUTONIUM/LITER/

SPECIFIC POWER 0.65 KW/G PLUTONIUM /EXCLUDING BLANKET/

COOLANT TEMP. OUTLET 850 C

REACTOR VESSEL STRUCTURELESS VESSEL

REMARKS THE SODIUM COOLANT, IMMISCIBLE WITH THE MOLTEN
FUEL ALLOY, IS IN DIRECT CONTACT WITH IT.
SEPARATION IS DONE CENTRIFUGALLY BY THE ENERGY
FROM AN EXTERNAL JET OF SODIUM.

REFERENCES MOBILE FUEL PLUTONIUM BREEDERS A STUDY OF
ECONOMIC POTENTIAL,
RP HAMMOND, OTHERS
LA-2644 /NOV. 30, 1961/

DIRECT CONTACT CORE SYSTEMS,
RP HAMMOND, JR HUMPHREYS JR.
NUCLEAR SCIENCE AND ENGINEERING 18, 421-425
/APRIL 1964/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER FAST OXIDE REACTOR STUDY/LASL
DESIGNER LOS ALAMOS SCIENTIFIC LABORATORY
PURPOSE WATER DESALINATION
TYPE LIQUID METAL COOLED FAST BREEDER
POWER MWE(MWT) 25000
CRITICAL STUDY
COOLANT SODIUM
FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE PELLETS 0.260 IN. DIA.
URANIUM DIOXIDE AXIAL AND RADIAL BLANKET
FUEL GEOMETRY RODS, ACT. LENGTH 4 FT. + 2X3 FT. UPPER AND LOWER
AXIAL BLANKET
FUEL CLADDING SS 0.020 IN. THICK
FUEL ENRICH. 15 PER CENT
FUEL ASSEMBLY 400 RODS/ASSEMBLY
1016 ASSEMBLIES/CORE
SPECIFIC POWER 1.1 MW/KG PLUTONIUM
BURNUP(REFUEL) 100,000 MWD/MT BATCH, 3 MONTHS
COOLANT TEMP. INLET 593 F
REMARKS THE ENERGY IS USED ENTIRELY FOR THE PRODUCTION
OF DISTILLED WATER. WATER CONVERSION PLANT IS A
MULTISTAGE FLASH EVAPORATION UNIT CONSISTING OF
30 STAGES.
REFERENCES A PRELIMINARY EVALUATION OF FAST OXIDE BREEDERS
FOR SEA-WATER CONVERSION.
A SESONSKE, RP HAMMOND
LA-2733 /AUG, 1962/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

FD26

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NAME/OWNER	PWAR-6 /PRATT + WHITNEY AIRCRAFT REACTOR-6//PWAC	
DESIGNER	PRATT AND WHITNEY AIRCRAFT	
PURPOSE	NUCLEAR AIRCRAFT HEAT SOURCE	
TYPE	LIQUID METAL COOLED, CIRCULATING FUEL	
POWER MWE(MWT)	180	
CRITICAL	CONCEPTUAL DESIGN STUDY	
COOLANT	SODIUM-POTASSIUM NAK	
MODERATOR	BERYLLIUM REFLECTOR-MODERATOR, HOLLOW SPHERE SURROUNDING CORE.	
FUEL MATERIAL	FLUORIDE SALTS /SODIUM, ZIRCONIUM AND URANIUM/	
FUEL CLADDING	INCONEL MATERIAL OF CONSTRUCTION	
FUEL ASSEMBLY	FUEL FLOWS OUTSIDE THE HEAT EXCHANGER TUBES COUNTER CURRENT TO NAK FLOWING INSIDE THE TUBES.	
NEUTRON FLUX	THERMAL AVE. 1×10^{14} FAST AVE. 3×10^{14}	
CONTROL	CONTROL ROD	
COOLANT TEMP.	INLET 200 F	OUTLET 600 F
REACTOR VESSEL	HASTELLOY-X PRESSURE SHELL 70 IN. DIA, 1 IN. THICK. INNER SHELLS CONTAINING BORON-10, AND AN INCONEL SHELL JUST INSIDE THE PRESSURE SHELL.	
REMARKS	EVOLUTION OF ORNL FIREBALL REACTOR CONCEPT /ART DESIGN MODIFICATION/.	
REFERENCES	CORE-MODERATED CIRCULATING FUEL REACTOR STUDY, PRATT + WHITNEY AIRCRAFT, DIV. UNITED AIRCRAFT CORP. PWAC-186 /JULY 15, 1957/ THE P + W CIRCULATING FUEL REFLECTOR-MODERATED REACTOR. CC BIGELOW, ME GREENSTREET PWAC-189 /VOL. 1/ /NOVEMBER 15, 1957/ VOLUME 2, APPENDIX A, DESIGN SPECIFICATIONS AND REFERENCE INFORMATION FOR THE PWAR-6, FLYING TEST	

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BED APPLICATION.

CC BIGELOW, ME GREENSTREET, COMPS.

PWAC-189 /VOL. 2/ /NOVEMBER 15, 1957/

JANUARY 1969

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NAME/OWNER LCRE /LITHIUM COOLED REACTOR EXP. / PWAC

DESIGNER PRATT AND WHITNEY AIRCRAFT

OPERATOR PRATT AND WHITNEY AIRCRAFT

LOCATION CONNECTICUT AIRCRAFT NUCLEAR ENG. LAB. /CANEL/
 10 MWT EXPERIMENT
 SEE REMARKS

TYPE LIQUID METAL COOLED, INDIRECT CYCLE

COOLANT LITHIUM /POTASSIUM INTERMEDIATE LOOP/

MODERATOR BERYLLIUM OXIDE

FUEL MATERIAL URANIUM/BERYLLIUM OXIDE

REMARKS CANEL PROGRAM WAS CANCELED IN THE FINAL DESIGN
 STAGE OF A 10 MWT EXPERIMENT. AEC WILL PROCEED
 DIRECTLY TO THE DESIGN AND DEVELOPMENT OF A
 SNAP-50 REACTOR PROTOTYPE UNDER THE SNAP-50/SPUR
 PROGRAM FOR A LIQUID METAL COOLED FAST REACTOR
 SYSTEM /AEC-NASA-DOD/

REFERENCES DESIGN CRITERIA FOR LITHIUM-COOLED REACTOR
 VAPOR TURBINE
 DT HEDDEN
 CNLM-4043 /REV. A/ /SEPTEMBER 4, 1962/

 PRELIMINARY SAFETY ANALYSIS REPORT FOR THE
 LITHIUM COOLED REACTOR EXPERIMENT /LCRE/
 CC BIGELOW, P COLE, OTHERS
 PWAC-370 /SUPPL. 1/ /SEPTEMBER 29, 1962/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER FAST BREEDER DEMONSTRATION/WESTINGHOUSE, DUKE
POWER, COMMONWEALTH ED., DETRIOT ED.

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
COMMONWEALTH ASSOC.

PURPOSE PROTOTYPE DEVELOPMENT, DEMONSTRATION
DESIGN FOR A 1000 MWG REACTOR HAS BEEN DONE.

TYPE LIQUID METAL COOLED FAST BREEDER, MODULAR DESIGN.

POWER MWE(MWT) 200-400

CRITICAL CONSTRUCTION TARGET 1970
DEMONSTRATION OPERATION 1975-76

COOLANT SODIUM

MODERATOR NONE
INCONEL REFLECTOR

FUEL MATERIAL URANIUM/PLUTONIUM CARBIDE PELLETS 0.246 IN. OD
WITH PELLETS IN SUPPORT RODS 0.182 IN. OD.
AXIAL BLANKET URANIUM CARBIDE
RADIAL BLANKET URANIUM DIOXIDE

FUEL GEOMETRY RODS, VENTED, 0.286 IN. OD, ACTIVE LENGTH 48 IN.
CORE 1 WILL USE NON-VENTED RODS
BLANKET RODS 0.420 IN. OD

FUEL CLADDING SS TUBES, 0.013 IN. WALL THICKNESS, SODIUM BOND.
7 RODS, THE SUPPORT STRUCTURE, HAVE 0.045 IN.
THICK WALLS

FUEL ENRICH. 14 PER CENT PLUTONIUM
AXIAL AND RADIAL BLANKETS DEPLETED URANIUM.

FUEL ASSEMBLY 168-ROD ASSEMBLY, CENTRAL ROD REMOVED TO
ACCOMODATE IN-CORE INSTRUMENTATION THIMBLE,
HEXAGONAL, INCONEL GRID STRUCTURE
BLANKET ASSEMBLY SOLID CANNED STRUCTURE
91-ROD ASSEMBLY
57 CORE ASSEMBLIES
98 RADIAL BLANKET ASSEMBLIES

SPECIFIC POWER 123 KW/KG METAL

BURNUP(REFUEL) 100,000 MWD/T 1/3 CORE ANNUALLY
CORE 1, 50, 000 MWD/T

CONTROL RODS, BORON CARBIDE, FOLLOWER VOIDS + SODIUM

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COOLANT TEMP, INLET 700 F OUTLET 1000 F

REACTOR VESSEL CORE MODULES ARE HEXAGONAL CANS COMPOSED OF CORE, BLANKET, CONTROL, AND GRAPHITE BARRIER REGIONS. REACTOR VESSEL IS 18 FT. DIA./36 FT. HIGH

REMARKS THE REACTOR CONSISTS OF 7 IDENTICAL MODULES, EACH COMPOSED OF A CORE REGION, A BLANKET REGION, CONTROL, AND GRAPHITE BARRIER. ACTIVE CORE IN EACH MODULE IS A RIGHT CYLINDER APPROXIMATELY 6.25 FT. HIGH/ 2.75 FT. DIA, SURROUNDED BY APPROX. 1 FT. OF BLANKET ON ALL SIDES. SURROUNDING BLANKET REGION, ONLY ALONG VERTICAL SIDES, IS A GRAPHITE BARRIER. FUEL, BLANKET, AND GRAPHITE SUBASSEMBLIES ARE EXTERNALLY IDENTICAL, HEXAGONAL CAN ABOUT 5 IN. ACROSS FLATS AND 11 FT. LONG, INCLUDING END FITTINGS. SODIUM COOLANT ENTERS REACTOR VESSEL FROM ABOVE TOP OF CORE AND FLOWS DOWN ANNULUS WITHIN VESSEL, THROUGH ORIFICES INTO TWO PLENUM REGIONS IN THE BOTTOM OF THE VESSEL. ONE PLENUM FEEDS TO CORE REGIONS, THE OTHER, LOWER PRESSURE, THE BLANKET REGIONS. OAK RIDGE HAS ADAPTED THE CONCEPT TO A FAST REACTOR FOR POWER AND DESALINATION.

SEE FD29.

PROTOTYPE TO BE BUILT BY WEST AND UTILITIES WILL BE ONE MODULE OF A MULTI-MODULAR CORE PLANNED FOR IN A FULL-SCALE PLANT /1000 MWE/.

SIX OTHER UTILITIES HAVE JOINED THE PROGRAM. HOUSTON L-P, NORTHEAST UTILITIES, MONONGAHELA POWER, POTOMAC EDISON, S. CAROLINA G-E, AND WEST PENN POWER.

SEE ALSO FD34.

REFERENCES LIQUID METAL FAST BREEDER REACTOR DESIGN STUDY, FINAL REPORT.
RB STECH, COMP.
WESTINGHOUSE ELECTRIC CORP. ATOMIC POWER DIV.
WCAP 3251-1 /JANUARY 1964/

AN EVALUATION OF FOUR DESIGN STUDIES OF A 1000 MWE CERAMIC FUELED FAST BREEDER REACTOR
REACTOR ENG. DIV., CHICAGO OPERATIONS OFFICE
C00-279 /DEC. 1, 1964/

CONCEPTUAL DESIGN AND PRELIMINARY ACCIDENT ANALYSIS OF A SODIUM-COOLED, CARBIDE-FUELED, LARGE MODULAR FAST REACTOR.
JH WRIGHT, OTHERS

JANUARY 1969

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ANL-7120, P.205-29 /1966/

A PROTOTYPE PLANT WILL PROVE THE FAST BREEDER
CONCEPT.LCR KELLY JR., PG DEHUFF
WESTINGHOUSE ENG.DESIGN PHILOSOPHY FOR WESTINGHOUSE, PROTOTYPE FAST
BREEDER REACTOR.JH WRIGHT, OTHERS
ANS-101, P. 1-20

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER LIQUID METAL COOLED FAST BREEDER/ORNL

DESIGNER OAK RIDGE NATIONAL LABORATORY

PURPOSE DESALINATION AND/OR POWER
APPLICATIONS CONSIDERED ARE CENTRAL STATION
POWER, DUAL PURPOSE SELF-CONTAINED STATION,
AND PROCESS HEAT PLANT,

TYPE LIQUID METAL COOLED FAST BREEDER,
LOW TEMPERATURE, MODULAR CONCEPT

POWER MWE(MWT) 420 3500
DUAL PURPOSE

CRITICAL REFERENCE DESIGN

COOLANT SODIUM

FUEL MATERIAL CORE, URANIUM/PLUTONIUM DIOXIDE, VIBRATORY COMPACT
AXIAL BLANKET, URANIUM DIOXIDE
RADIAL BLANKET, URANIUM METAL

FUEL GEOMETRY CORE, PIN 0.246 IN. OD., 9 FT. ACT. LENGTH
PLUS 2X1 FT. AXIAL BLANKET
RADIAL BLANKET, ROD 0.731 IN. OD.

FUEL CLADDING SS
CORE 0.012 IN. THICK
RADIAL BLANKET 0.020 IN. THICK

FUEL ASSEMBLY 91-PIN BUNDLE, HEXAGONAL CONTAINER, SPACING BY
GRID-TYPE SPACERS FOR CORE MODULES AND BY
HELICAL WIRE WRAP FOR RADIAL BLANKET RODS.
CORE MODULE SEPARATED BY 5 ROWS OF RADIAL
BLANKET ASSEMBLIES
12 REACTOR MODULES, EACH SURROUNDED BY RADIAL
BLANKET AND CONTAINING 4 CONTROL RODS.
60 FUEL POSITIONS PER MODULE.

FUEL CHARGE CORE, 31,457 KG. URANIUM/PLUTONIUM OXIDE
AXIAL BLANKET, 12,071 KG. URANIUM OXIDE
RADIAL BLANKET, 226,123 KG. URANIUM

SPECIFIC POWER CORE, 88.7 KW/KG
BLANKET, 2.96 KW/KG

BURNUP(REFUEL) CORE, 100,000 MWD/T SHUT-DOWN
BLANKET, 41,000 MWD/T 6 MO.-1 YEAR

CONTROL ABSORBER RODS, 4 PER MODULE

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COOLANT TEMP, INLET 500 F OUTLET 800 F

REACTOR VESSEL MODULE CONTAINER OF SS, BIOLOGICAL SHIELD,
GRID STRUCTURE LOCATES AND SUPPORTS THE FUEL
ASSEMBLIES.

CONTAINMENT STEEL-LINED CELL BELOW OPERATING FLOOR OF MILL-
TYPE REACTOR BUILDING.

REMARKS DESIGN IS AN ADAPTATION OF THE WESTINGHOUSE
MODULAR CONCEPT FOR A HIGH TEMPERATURE FAST
BREEDER.

SEE FD28

CORE STRUCTURAL MATERIAL IS STAINLESS STEEL.
COOLANT FLOW IS UPWARD THROUGH REACTOR.
THE REFERENCE DESIGN ABSTRACTED REFERS TO A
DUAL PURPOSE SYSTEM.

REFERENCES A 3500 MWT LOW-TEMPERATURE SODIUM-COOLED FAST
BREEDER REACTOR FOR DESALINATION
RC OLSON, OTHERS
ORNL-TM-1143 /JUNE 10, 1965/

COST STUDY OF A LARGE SODIUM-COOLED FAST BREEDER
REACTOR FOR A SEA-WATER DESALINATION PLANT.
WR GALL
ORNL-TM-784 /MARCH 1964/

JANUARY 1969

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LIQUID METAL REACTORS. DOMESTIC

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NAME/OWNER FFTF /FAST FLUX TEST FACILITY/AEC

DESIGNER PRELIMINARY DESIGN PACIFIC NORTHWEST LAB.,
 BATTELLE MEMORIAL INSTITUTE,
 FINAL DESIGNER SELECTION IN 1968

TYPE LIQUID METAL COOLED FAST TEST REACTOR,
 PRESSURE-TUBE, SPLIT CONICAL CORE,
 FIRST DESIGN HAD A SKEWED-TUBE CORE.

POWER MWE(MWT) 400
 FIRST OPERATION 300 MWT

CRITICAL CONCEPTUAL DESIGN,
 DETAILED DESIGN 1968
 CRITICALITY TARGET 1973, OPERATION 1974

COOLANT SODIUM

FUEL MATERIAL URANIUM-PLUTONIUM OXIDE

FUEL GEOMETRY PINS, ACTIVE LENGTH ABOUT 3 FT.

FUEL CLADDING SS, THIN-WALL

FUEL ASSEMBLY DRIVER ASSEMBLY 217-PIN BUNDLE
 ASSEMBLIES WILL BE ARRANGED IN HEXAGONAL RINGS
 INCLINED SLIGHTLY TO THE VERTICAL.
 APPROX. 75 ASSEMBLIES.

FUEL CHARGE 600 KG PLUTONIUM

NEUTRON FLUX INITIAL FAST FLUX $0.7 \text{ E}+16$ AT 2 KW/GM PLUTONIUM

COOLANT TEMP. BULK SODIUM COOLANT HEATED TO 1200 F
 TEST LOOP COOLANT TO 1400 F

REMARKS DISPERSED CORE REACTOR, WITH PIPED HEAT REMOVAL
 SYSTEM AND A HOT CELL, SHIELDED FUEL HANDLING
 MACHINE. DISPERSED CORE WILL ACCOMODATE A RANGE
 OF BOTH VERTICAL AND INCLINED FUEL ASSEMBLIES AND
 TEST LOOPS.
 INITIAL CORE VOLUME 800-900 LITERS WITH MIXED
 OXIDE AS DRIVER FUEL,
 WESTINGHOUSE HAS BEEN SELECTED AS PRIME CONTRACTOR
 AND WILL AWARD BATTELLE-NORTHWEST CONTRACT ON
 BEHALF OF AEC. CORE DESIGN CHOICE IS BETWEEN THE
 SKEWED CORE AND WEST-S MODIFIED VERTICAL CORE.

REFERENCES THE FAST FLUX TEST FACILITY DESIGN CONCEPT.

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ER ASTLEY, LM FINCH, RJ HENNIG
ANS TRANS. 8, 607 /NOV. 1965/

PHYSICS ASPECTS OF THE FAST FLUX TEST REACTOR
WW LITTLE, PL HOFMANN
ANS TRANS. 8, 608 /NOV. 1965/

FFTF DRIVER FUEL. PLUTONIUM DIOXIDE-STAINLESS
STEEL CERMET.
WJ BAILEY, OTHERS
BNWL-SA-251 /NOV. 3, 1965/

FAST FLUX TEST FACILITY
A AMOROSI, OTHERS
APDA-178 P. 67-70

THE CONCEPTUAL EVALUATION OF A FAST FLUX TEST
FACILITY.
ER ASTLEY
FAST REACTORS, ANS NATIONAL TOPICAL MEETING,
APRIL 1967.
ANS-101 /BNWL-SA-978/

JANUARY 1969

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LIQUID METAL REACTORS, DOMESTIC

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NAME/OWNER GPU-AI FAST BREEDER STUDY
 DESIGNER GENERAL PUBLIC UTILITIES /GPU/ AND ATOMICS
 INTERNATIONAL /AI/.
 LOCATION PENNSYLVANIA /SUSQUEHANNA RIVER/
 PURPOSE POWER
 TYPE LIQUID METAL COOLED FAST REACTOR
 POWER MWE(MWT) 500 1250
 CRITICAL DEMONSTRATION PLANT PLANNED
 AI-S FEASIBILITY STUDY FOR A 1000 MWE REACTOR
 WAS FOR A MODULAR FLUX TRAP SYSTEM, A VERSION
 OF THE SSCR /SEE EDOI/
 THE FOLLOWING DATA REFERS TO THIS DESIGN.
 COOLANT SODIUM
 FUEL MATERIAL URANIUM-PLUTONIUM OXIDE PELLETS
 OR URANIUM-PLUTONIUM CARBIDE, CORED.
 BLANKET DEPLETED URANIUM DIOXIDE
 FUEL GEOMETRY ROD
 FUEL CLADDING STAINLESS STEEL
 FUEL ENRICH. BLANKET DEPLETED URANIUM
 FUEL ASSEMBLY BUNDLE
 CORE
 AXIAL BLANKET
 RADIAL BLANKET
 CONTROL TANTALUM ABSORBER, RODS
 COOLANT TEMP, INLET 760 F OUTLET 1060 F
 REACTOR VESSEL VESSEL SUSPENDED IN STEEL-LINED CONCRETE CAVITY.
 REMARKS THE CONCEPTUAL DESIGN STUDY BEGAN EARLY IN 1967.
 BECHTEL SELECTED AS ARCHITECT-ENGINEER.
 A DECISION IS EXPECTED BY 1970 ON CONSTRUCTION OF
 A 300-500 MWE PROTOTYPE, PROBABLY ON PENELEC
 SERVICE AREA.
 DUKE POWER, BALTIMORE G-E, AND SOUTH CAROLINA G-E
 HAVE JOINED THE PROGRAM. GPU MEMBERS ARE
 PENNSYLVANIA ELECTRIC, METROPOLITAN ED., NEW

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JERSEY P-L, AND JERSEY CENTRAL P-L.

REFERENCES

FEASIBILITY STUDY OF A 1000 MWE SODIUM-COOLED FAST
REACTOR.
VOL. 1, TECH. AND ECONOMIC POTENTIAL.
NAA-SR-11378 /VOL. 1/ JULY 1966

THE GPU-AI DEMONSTRATION FAST BREEDER REACTOR.
HM DIECKAMP, OTHERS
NUCLEAR NEWS JULY 1968, P. 41-50

ATOMICS INTERNATIONAL DEMONSTRATION FAST BREEDER
REACTOR.
HM DIECKAMP, OTHERS
ANS TOPICAL MEETING ON FAST REACTORS, 1967
ANS-101 /1967/

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NAME/OWNER LMFR PROGRAM, ARGONNE NATIONAL LABORATORY

DESIGNER PRELIMINARY DESIGN ARGONNE NATIONAL LABORATORY
REFERENCE DESIGN BABCOCK AND WILCOX

PURPOSE POWER

TYPE LIQUID METAL COOLED FAST BREEDER,
PRELIMINARY DESIGN FOR A MODULAR SYSTEM

POWER MWE(MWT) 1000 2510

CRITICAL PRELIMINARY AND REFERENCE DESIGNS
FOLLOWING DATA REFERS TO ARGONNE-S DESIGN

COOLANT SODIUM

MODERATOR BERYLLIUM, SS REFLECTOR

FUEL MATERIAL URANIUM-PLUTONIUM-TITANIUM ALLOY,
BLANKET URANIUM METAL

FUEL GEOMETRY PINS

FUEL CLADDING VANADIUM-TITANIUM ALLOY TUBES

FUEL ASSEMBLY 331-PIN BUNDLE IN HEXAGONAL TUBE OF 17-4 PH STEEL,
61 SUBASSEMBLIES PER MODULE
6 MODULES

FUEL CHARGE 17.94 METRIC TONS URANIUM PLUS PLUTONIUM

SPECIFIC POWER AVERAGE 860 KG/KW PLUTONIUM

CONTROL BORON CARBIDE RODS IN CENTRAL PART OF MODULE

COOLANT TEMP, 1100-1200 F

REACTOR VESSEL TANK, 20 FT. DIA./30 FT. HIGH

REMARKS AXIAL BLANKETS ARE INTEGRAL WITH THE CORE CLADDING
THE RADIAL BLANKET HAS TWO ZONES, WITH SMALLER
DIAMETER ELEMENTS IN THE INNER ZONE, WHICH ALSO
CONTAINS SOME BERYLLIUM. INNER SURFACE OF INNER
BLANKET IS FORMED BY TRIANGULAR PIECES OF
BERYLLIUM, AS IS THE OUTER SURFACE OF THE CORE
SUBASSEMBLY.
THE DESIGN INCLUDES ON-SITE FUEL CYCLE FACILITY,
CONTRACT TO BABCOCK + WILCOX IN FEB, 1967 FOR A
1000 MWE REFERENCE DESIGN.

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ANL WILL STUDY FIVE DESIGN CONCEPTS WITH
ATOMICS INTERNATIONAL, BABCOCK + WILCOX,
COMBUSTION ENGINEERING, GENERAL ELECTRIC, AND
WESTINGHOUSE.

REFERENCES 1000 MWE METAL-FUELED FAST BREEDER REACTOR,
LE LINK, OTHERS
ANL-7001 /JUNE 1966/

APPLIED ATOMICS FEB. 22, 1967 P. 7
NEWS RELEASE

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LIQUID METAL REACTORS. DOMESTIC

FD33.

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NAME/OWNER UMBR/UNCLAD METAL BREEDER REACTOR/ ORNL

DESIGNER OAK RIDGE NATIONAL LAB.

PURPOSE DESALINATION

TYPE LIQUID METAL COOLED FAST REACTOR

POWER MWE(MWT) 3500

CRITICAL CONCEPTUAL DESIGN

COOLANT SODIUM

FUEL MATERIAL THORIUM METAL WITH 16-URANIUM, 6-PLUTONIUM, AND
5-FISSION PRODUCTS
 RADIAL AND AXIAL BLANKETS URANIUM/PLUTONIUM
 METAL
 ALTERNATIVE FUEL CYCLES ARE HIGH- AND LOW-TEMP,
 MIXED FUEL CYCLES, AND URANIUM-PLUTONIUM CYCLE.

FUEL CLADDING NONE

FUEL ASSEMBLY ANNULAR OR CYLINDRICAL CORE GEOMETRY, ENCLOSED ON
 ALL SIDES BY BLANKET REGIONS.

REACTOR VESSEL TANK, CYLINDRICAL

REMARKS CONCEPT HAS GROWN OUT OF THE ORNL DESALTING
 PROGRAM. DOUBLING TIME IS CALCULATED AT 3-4 YEARS.

REFERENCES THE USE OF UNCLAD FUEL IN HIGH-GAIN BREEDERS FOR
 DESALTING OR POWER.
 RP HAMMOND, OTHERS
 ANS TRANS. 10/27, 644-5 /NOV. 1967/

 NUCLEAR NEWS MAY 1968 P. 17-18
 NOTES ON ANS MEETING, APRIL 1968.

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LIQUID METAL REACTORS, DOMESTIC

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* * * * *
 NAME/OWNER LARGE FAST BREEDER/ANL, WESTINGHOUSE
 TYPE LIQUID METAL COOLED FAST BREEDER
 ANNULAR DESIGN
 POWER MWE(MWT) 3880 10,000
 CRITICAL CONCEPTUAL DESIGN
 COOLANT SODIUM
 MODERATOR BERYLLIUM OXIDE REFLECTOR
 FUEL MATERIAL URANIUM/PLUTONIUM CARBIDE VIBRATORY COMPACTED INTO
 TUBES.
 BLANKET URANIUM-ZIRCONIUM ALLOY
 FUEL GEOMETRY ROD 0.275 IN. OD
 BLANKET PINS 0.385 IN. OD AND 0.515 IN. OD
 FUEL CLADDING CORE SS TUBES, WALL THICKNESS 0.015 IN.
 RADIAL BLANKETS A AND C, SS CLAD 0.385 IN. OD
 AND 0.022 IN. THICK
 RADIAL BLANKETS B AND D, SS CLAD 0.515 IN. OD
 AND 0.025 IN. THICK
 HELIUM BOND.
 FUEL ENRICH. AXIAL BLANKET DEPLETED URANIUM
 FUEL ASSEMBLY CORE, 331-ELEMENT ASSEMBLY, HEXAGONAL
 456 CORE ASSEMBLIES
 RADIAL BLANKETS A AND C, 217-PIN ASSEMBLY
 132 ASSEMBLIES
 RADIAL BLANKETS B AND D, 169-PIN ASSEMBLY
 B, 96 ASSEMBLIES
 D, 138 ASSEMBLIES
 FUEL CHARGE 10,500 KG PLUTONIUM
 BURNUP(REFUEL) CORE, 110,000 MWD/T 1/2 YEAR INTERVALS
 REACTOR, 35,000 MWD/T
 CONTROL POISON RODS
 COOLANT TEMP. INLET 720 F OUTLET 1050 F
 REACTOR VESSEL CYLINDRICAL STEEL VESSEL
 REFERENCES FEASIBILITY STUDY OF NUCLEAR STEAM SUPPLY SYSTEM
 USING 10,000-MW SODIUM COOLED BREEDER REACTOR.

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KA HUB, OTHERS

ANL-7183 /SEPT. 1966/

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LIQUID METAL REACTORS. DOMESTIC

FD35

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NAME/OWNER LMFBR/LIQ. METAL FAST BREEDER REACTOR/BAW, AEC

DESIGNER BABCOCK + WILCOX

TYPE LIQUID METAL COOLED FAST BREEDER

POWER MWE(MWT) 1000

CRITICAL DESIGN

COOLANT SODIUM

FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE, VIBRATORY COMPACTED
BLANKET URANIUM DIOXIDE

FUEL GEOMETRY PIN, VENTED. ACTIVE LENGTH 37 IN.

FUEL CLADDING SS

FUEL ENRICH. BLANKET DEPLETED URANIUM

FUEL ASSEMBLY HEXAGONAL ASSEMBLIES, UNCANNED
177 ASSEMBLIES/CORE
FIRST CORE WOULD BE NON-VENTED, EQUILIBRIUM
CORE VENTED TO SODIUM.

CONTROL RODS, SS-CLAD BORON CARBIDE

REACTOR VESSEL CORE VESSEL 17 1/2 IN. DIAM. WELDED SS PLATE,
2 IN. THICK. DEPTH 26 FT.
LARGER VESSEL ACCOMODATES ALL PRIMARY SYSTEM.

CONTAINMENT CONTROLLED LEAKAGE BUILDING, CYLINDRICAL
CONTAINMENT VESSEL 110 FT. ID.

REMARKS CONCEPT FOR A NUCLEAR ISLAND AND TURBINE
ISLAND COMPLEX.

REFERENCES DESIGN OF A 1000-MWE LIQUID-METAL-COOLED FAST
BREEDER POWER REACTOR.
RL BOYER, FX MASSETH
ASME PREPRINT 67-WA/NE-10 /1967/

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LIQUID METAL REACTORS, DOMESTIC

FD36

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NAME/OWNER OBFR /ORDERED BED FAST REACTOR/BNL
 DESIGNER BROOKHAVEN NATIONAL LABORATORY
 PURPOSE POWER
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 1000 2334
 CRITICAL DESIGN
 COOLANT SODIUM
 FUEL MATERIAL UNCLAD URANIUM/PLUTONIUM CARBIDE SPHERES
 0.410 IN. DIAM.
 FUEL GEOMETRY ORDERED BED OF FUELED SPHERES IN SHAPED CONTAINERS
 FUEL CLADDING FUEL CONTAINERS WALL THICKNESS 1/4 IN., FILLED
 HEIGHT /ACTIVE/ 48 IN.
 FUEL ASSEMBLY SQUARE CONTAINERS 12 X 12 X 59 IN.
 156 CONTAINERS/CORE
 CENTRAL BLANKET, 4
 OUTER BLANKET, 36
 CORE AND AXIAL BLANKET 116
 SPECIFIC POWER 383 KWT/KG
 BURNUP(REFUEL) 100,000 MWD/T EMPTYING AND REFILLING
 CONTAINERS
 CONTROL RODS
 COOLANT TEMP. INLET 700 F OUTLET 1200 F
 COOLANT PRESS. INLET 320 PSIG OUTLET 20 PSIG
 REACTOR VESSEL SS CYLINDER 241.5 IN. OD, 251.5 IN. HIGH
 WALL THICKNESS 7 IN.
 CONTAINMENT VERTICAL STEEL CYLINDER 124 FT. ID, 184 FT. HIGH
 WITH 72 FT. BELOW-GRADE, HOUSES REACTOR, PRIMARY
 SYSTEM, AND FUEL HANDLING SYSTEM.
 REMARKS OMFBR IS AN OUTGROWTH OF SBDR.
 SEE FD16
 REFERENCES THE ORDERED-BED FAST REACTOR CONCEPT

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1000 MWE POWER REACTOR DESIGN.

LG EPEL, OTHERS

BNL-50027 /JUNE 1966/

LIQUID METAL COOLED REACTORS

FOREIGN

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LIQUID METAL REACTORS, FOREIGN

FF01

* * * * *
 NAME/OWNER RAPSODIE/CEA, FRANCE
 DESIGNER CEA, FRANCE
 OPERATOR CEA, FRANCE
 LOCATION CADARACHE RESEARCH CENTER, FRANCE
 PURPOSE POWER EXPERIMENT
 TYPE FAST BREEDER EXPERIMENT
 POWER MWE(MWT) 20
 CRITICAL FULL POWER MARCH 1967
 COOLANT SODIUM. TWO PRIMARY SYSTEMS, CENTRAL AREA HIGH PRESSURE AND PERIPHERAL AREA LOW PRESSURE,
 FUEL MATERIAL CORE, URANIUM/PLUTONIUM DIOXIDE PELLETS
 5.8 MM. DIA., 11.5 MM. LONG
 BLANKET, URANIUM DIOXIDE
 FUEL GEOMETRY PENCILS, PELLET STACK 340 MM. HIGH
 FUEL CLADDING SS 0.45 MM. WALL THICKNESS
 FUEL ENRICH. PLUTONIUM-240 AND 241 10.2 PER CENT
 60 PER CENT U-235
 BLANKET, DEPLETED URANIUM
 FUEL ASSEMBLY 37 PENCILS/ASSEMBLY IN HEXAGONAL CASING.
 CORE PENCILS INCLUDE AXIAL BLANKET;
 53 ASSEMBLIES + 500 PERIPHERAL
 FERTILE ASSEMBLIES
 AXIAL BLANKET 14 PINS/ASSEMBLY
 RADIAL BLANKET 7 PINS/ASSEMBLY
 FUEL CHARGE 8 TONS URANIUM DIOXIDE
 SPECIFIC POWER 1750 W/CC. /1.52 KW/CC. FUEL/
 BURNUP(REFUEL) 30,000 MWD/TON FUEL
 NEUTRON FLUX HIGH 2×10^{15}
 CONTROL RODS IN PERIPHERY OF CORE, BORON CARBIDE
 COOLANT TEMP. INLET 450 C OUTLET 540 C
 REACTOR VESSEL SS SHELL 7 FT. 8 IN. DIA., 0.6 IN. THICK.

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FF01

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SAFETY VESSEL OF ORDINARY STEEL.

CONTAINMENT AIRTIGHT BUILDING HOUSES REACTOR AND THE TWO
 SODIUM SYSTEMS. FLAT-BOTTOMED CYLINDER WITH
 HEMISPHERICAL DOME, ALL STEEL, INSIDE A LEAK-PROOF
 CONCRETE BUILDING

REMARKS PARTICIPATION IN THE U.S.-EURATOM PLUTONIUM
 RECYCLE PROGRAM, WITH THE OBJECTIVE OF
 CONSTRUCTING LARGE-SCALE CRITICAL ASSEMBLIES,
 DESIGN OF 100 MWE REACTORS, AND STUDIES LEADING TO
 THE DESIGN OF FAST NEUTRON REACTORS USING THE
 URANIUM-THORIUM FUEL CYCLE. IN A FULL-SCALE
 REACTOR WITH A LARGER CORE NATURAL OR DEPLETED
 URANIUM OXIDE WOULD BE USED WITH PLUTONIUM OXIDE
 FOR THE CORE ELEMENTS. OPTIMIZATION STUDIES FOR
 A 1000 MWE REFERENCE DESIGN HAVE BEEN PERFORMED.
 FOR EXPERIMENTAL STUDY OF FAST PLUTONIUM SYSTEMS,
 MASURCA /0-POWER/ AND HARMONIE /FAST SOURCE
 REACTOR/ ARE UNDER CONSTRUCTION AT CADARACHE.
 NEXT STEP IN THE FRENCH PROGRAM WILL BE
 CONSTRUCTION OF AN 80 MWE PROTOTYPE. GOAL IS
 A 1000 MWE FAST BREEDER.
 SEE PHENIX, FF12

REFERENCES RAPSODIE
 G VENDRYES
 ENERGIE NUCLEAIRE 3, 25-46 /JANUARY-FEBRUARY 1961/

 THE FAST REACTOR RAPSODIE.
 CP ZALESKI, L VAUTREY
 POWER REACTOR EXPERIMENTS, VOL. I, P. 365-8
 INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962.
 /ABSTRACT ONLY/.

 THE RAPSODIE PROJECT.
 JR LEDUC
 TID-7623 /P. 168-70/ /1962/

 THE FAST BREEDER REACTOR RAPSODIE. VOLUME 1, TEST
 VOLUME 2, FIGURES /IN FRENCH/.
 CP ZALESKI, L VAUTREY
 CEA-2193 /1962/

 RAPSODIE--A VITAL FAST REACTOR PROJECT.
 R WUSTNER
 NUCLEAR ENG. 8, 316-21 /SEPTEMBER 1963/

 RAPSODIE
 G VENDRYES

JANUARY 1969

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FF01

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3RD UN, INTL, CONF, ON THE PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964
A/CONF. 28/P/42

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LIQUID METAL REACTORS. FOREIGN

FF02

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NAME/OWNER RAPTUS/RAPID THORIUM-URANIUM-SODIUM/CNEN, ITALY

DESIGNER CNEN, ITALY

PURPOSE DEVELOPMENT

TYPE LIQUID METAL COOLED, FAST REACTOR. MERCURY BINARY CYCLE.

POWER MWE(MWT) 60

CRITICAL DESIGN, DEVELOPMENT

COOLANT SODIUM

FUEL MATERIAL THORIUM/URANIUM-233 OXIDES AS SLURRY IN SODIUM, PASTE-TYPE FUEL

FUEL GEOMETRY SLURRY /PASTE/

REACTOR VESSEL CONTAINING SHELL FOR FUEL, SODIUM FLOWS THROUGH THE TUBES OF SUBASSEMBLIES RESEMBLING TUBE-TYPE HEAT EXCHANGERS.

REMARKS LONG TERM DEVELOPMENT PROJECT AIMED AT EXPLORING THE THORIUM-URANIUM FUEL CYCLE. HIGH TEMPERATURE SODIUM HEAT EXCHANGE STUDIES ARE IN PROGRESS. CONCEPT PROPOSES A SLURRY OF THORIUM/URANIUM-223 OXIDES SURROUNDING AN ARRAY OF TUBES CONTAINING LIQUID SODIUM. AIM OF THE PROJECT IS TO DEVELOP A PASTE-TYPE FUEL. ITALY IS ALSO STUDYING A FAST PLUTONIUM BREEDER USING CERAMIC FUEL.
SEE PEC, FF16

REFERENCES CNEN PROGRAM FOR A MERCURY BINARY CYCLE POWER PLANT.
A FORCELLA
PREPRINT PAPER NO. 14. ENGINEERS JOINT COUNCIL, N. Y. 1962.

FAST REACTORS - A WORLD SURVEY,
NUCLEAR POWER 17, 42-49 /DECEMBER 1962/

FORUM MEMO JULY 1963 P. 18-19
NEWS RELEASE.

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LIQUID METAL REACTORS, FOREIGN

FF03

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NAME/OWNER DFR /DOUNREAY FAST REACTOR/ AEA, UNITED KINGDOM
 DESIGNER AEA, UNITED KINGDOM
 OPERATOR AEA, UNITED KINGDOM
 LOCATION DOUNREAY, CAITHNESS, SCOTLAND
 PURPOSE POWER EXPERIMENT
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 15 60
 CRITICAL NOV, 1959
 COOLANT SODIUM-POTASSIUM NAK. LATER SODIUM.
 FUEL MATERIAL URANIUM-MOLYBDENUM ALLOY
 NATURAL URANIUM BLANKET
 FUEL GEOMETRY HOLLOW RODS.
 BLANKET SOLID RODS.
 FUEL CLADDING NIOBIUM /OUTER/ AND VANADIUM /INNER/.
 BLANKET SS.
 FUEL ENRICH. 40 PER CENT U-235
 FUEL ASSEMBLY ANNULAR TUBE 525 MM. LONG/18.75 MM. DIA. UPPER
 PART OF ELEMENT-THE BREEDER END-PIECE- IS 150 MM.
 LENGTH OF NATURAL URANIUM. BREEDER RODS SURROUND
 THE CORE. SEE REMARKS.
 345 ELEMENTS/CORE
 1872 BREEDER ELEMENTS
 SPECIFIC POWER 286 KW/KG U-235
 BURNUP(REFUEL) APPROX. 2 PER CENT
 CONTROL RODS. REACTIVITY CONTROL BY MOVEMENT OF FUEL.
 COOLANT TEMP. INLET 200 C OUTLET 400 C
 REACTOR VESSEL DOUBLE-WALL SS VESSEL, 20 FT. HIGH/10 FT. 6 IN.
 OD.
 REMARKS DOUNREAY WAS IN OPERATION IN 1960, SHUT DOWN FOR
 CORE MODIFICATIONS, WITH RESUMED OPERATION IN
 AUGUST 1960. LATTICE IS STAR-SHAPED. THE FORM

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FF03

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INSTALLED IN 1960 HAS A HEXAGONAL CENTER WHICH IS MOBILE. FUEL ELEMENT RECHARGING AND CORE MODIFICATIONS COMPLETED IN OCTOBER 1963. REFUELING, APRIL 1964. NEWLY DESIGNED URANIUM-MOLYBDENUM ELEMENTS IN NIOBIUM CANS WERE LOADED IN 1963. IRRADIATION PROGRAM IS BEING DEVOTED TO CERAMIC FUELS. REACTOR WAS DOWN FOR 15 WEEKS MODIFICATION IN 1965-1966, AND DOWN AGAIN FROM JULY 1967 TO JUNE 1968 BECAUSE OF LIQUID METAL LEAK FROM COOLING CIRCUIT.

REFERENCES

THE DOUNREAY FAST REACTOR - BASIC PROBLEMS IN DESIGN.
H CARTWRIGHT, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 316-22 /1958/

DOUNREAY.
NUCLEAR POWER 2, 221-48 /JUNE 1957/

DESIGN AND CONSTRUCTION OF THE DFR CORE, REACTOR VESSEL, FUEL HANDLING EQUIPMENT, AND SHIELDING.
J. TATLOCK, OTHERS
J. BRIT. NUCLEAR ENERGY CONF. 6, 166-188 /JULY 1961/

THE FAST BREEDER REACTOR.
RY MOORE, R HURST
J. BRIT. NUCLEAR ENERGY CONF. 6, 161-165 /JULY 1961/

THE DOUNREAY FAST BREEDER REACTOR EXPERIMENT.
JL PHILLIPS, AG FRAME
POWER REACTOR EXPERIMENTS VOL. 1, PP. 295-315
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962.

PERFORMANCE AND OPERATION OF THE DOUNREAY FAST REACTOR.
RR MATTHEWS, OTHERS
3RD UN. INTL. CONF. PEACEFUL USES OF ATOMIC ENERGY GENEVA, 1964. A/CONF. 28/P/130

DOUNREAY FAST REACTOR MODIFICATIONS.
JL PHILLIPS
NUCLEAR ENG. 12, 40-3 /JAN. 1967/

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LIQUID METAL REACTORS. FOREIGN

FF04

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NAME/OWNER PFR /PROTOTYPE FAST REACTOR/ UK ATOMIC ENERGY AUTH
 DESIGNER AEA, UNITED KINGDOM
 LOCATION DOUNREAY, SCOTLAND
 PURPOSE POWER PROTOTYPE, INTERMEDIATE TO 1000 MWE PLANT
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 250 600
 CRITICAL CONSTRUCTION, TARGET 1970.
 COOLANT SODIUM, PRIMARY AND SECONDARY CIRCUITS
 MODERATOR RADIAL GRAPHITE REFLECTOR
 FUEL MATERIAL PLUTONIUM/URANIUM OXIDE
 BREEDER MATERIAL U-238 OXIDE
 FUEL GEOMETRY PIN 0.23 IN. OD, 36 IN. LONG
 UPPER AND LOWER AXIAL BREEDER PINS 18 IN. LONG
 UPPER AXIAL PIN 0.75 IN. OD.
 FUEL CLADDING SS 0.015 IN. WALL THICKNESS
 FUEL ENRICH. TWO-ZONE, PLUTONIUM/URANIUM 1/3
 FUEL ASSEMBLY 325-PIN ASSEMBLY, HEXAGONAL
 78 ASSEMBLIES/CORE
 UPPER AXIAL BREEDER ELEMENTS 19-PIN ASSEMBLIES.
 SEE REMARKS
 BURNUP(REFUEL) 7.5 PER CENT OFF-LOAD
 CONTROL CONTROL AND SHUT-OFF RODS
 COOLANT TEMP. INLET 400-420 C OUTLET 560-585 C
 REACTOR VESSEL CYLINDRICAL SS TANK, 40 FT. DIAM, 50 FT. DEEP,
 WALL THICKNESS 1/2 IN, SURROUNDED BY ALLOY STEEL
 LEAK JACKET.
 CONTAINMENT REINFORCED CONCRETE VAULT BELOW GROUND LEVEL,
 LEAK-TIGHT BUILDING
 REMARKS INNER ZONE OF CORE CONTAINS 30 ELEMENTS, OUTER
 ZONE SOME 48. CORE IS SURROUNDED BY RADIAL CORE
 REFLECTOR, FOLLOWED BY SINGLE ROW OF RADIAL

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FF04

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BREEDER ASSEMBLIES. OUTSIDE THERE IS A BREEDER
REFLECTOR.
THE PROJECT INCLUDES FUEL FABRICATION FACILITIES
AT WINDSCALE.

REFERENCES

APPLIED ATOMICS FEB, 16, 1966 P. 1-4
NUCLEONICS WEEK FEB, 17, 1966 P. 1-2
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POWER FROM PLUTONIUM
W PENNEY
NEW SCIENTIST 29, 484-86 /FEB, 24, 1966/

FAST REACTORS ON THE LINE BY 1971
AG FRAME, RR MATTHEWS
NUCLEONICS 24, 54-59 /SEPT, 1966/

DESIGN OF THE PROTOTYPE FAST REACTOR.
AG FRAME, OTHERS
FAST BREEDER REACTORS, PROC. LONDON CONF. BRITISH
NUCLEAR ENERGY SOC., MAY 1966, P. 291-315
PERGAMON, 1967

STATUS OF UKAEA-S PROTOTYPE FAST REACTOR.
AG FRAME
FAST REACTORS, ANS NATIONAL TOPICAL MEETING 1967.
ANS-101, P. 6-15 TO 6-35

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LIQUID METAL REACTORS, FOREIGN

FF05

NAME/OWNER FAST BREEDER PROGRAM / W. GERMANY

TYPE LIQUID METAL COOLED FAST BREEDERS, SEE REMARKS

REMARKS IN SUPPORT OF THE PROGRAM TO DEVELOP FAST BREEDER REACTORS, THE KARLSRUHE NUCLEAR RESEARCH CENTER HAS SET UP FOUR EXPERIMENTAL RESEARCH PROGRAMS, SNEAK, A FAST ZERO-ENERGY REACTOR FOR UP TO 300 KG OF PLUTONIUM, CRITICAL MAY 1967, SUAK, A FAST SUBCRITICAL ASSEMBLY, SEFOR, THE FAST CERAMIC REACTOR TO BE CONSTRUCTED IN THE U.S. IN COLLABORATION WITH THE AEC, SEE FD19, STARK, A FAST-THERMAL COUPLED REACTOR, DEMAG AND AI HAVE INVESTIGATED A ZIRCONIUM HYDRIDE MODERATED REACTOR PROTOTYPE USING SODIUM AS A COOLANT, AND URANIUM CARBIDE AS FUEL, AT KARLSRUHE, PLUTONIUM REACTORS WITH HELIUM, DRY STEAM, AND SODIUM COOLANTS WILL BE TESTED, EURATOM HAS SIGNED A 5-YEAR ASSOCIATION CONTRACT WITH KRB FOR JOINT R + D ON FAST BREEDERS, SEE KNK, SEFOR A 300 MWE STEAM-COOLED FAST BREEDER PROTOTYPE IS SCHEDULED FOR 1968 CONSTRUCTION, TARGET 1973, THIS PROJECT MAY BE DISCONTINUED BECAUSE OF FUEL CLADDING PROBLEMS AND HIGH PLUTONIUM ALPHA FOUND WITHIN A RELATED STUDY BY GE-ECNG IN THE U.S, SEE ID11, IF06 W. GERMANY, THE NETHERLANDS AND BELGIUM WILL COOPERATE ON A SODIUM-COOLED PROJECT, PROTOTYPE TARGET IS 1974 WITH A 1000 MWE PLANT TO FOLLOW, SEE FF14

REFERENCES NEWS RELEASES

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LIQUID METAL REACTORS. FOREIGN

FF06

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NAME/OWNER KNK /KOMPAKTES Natrium Kernkraftwerk//W. GERMANY

DESIGNER INTERATOM

LOCATION GROSSWELZHEIN/KAHL-MAIN/, W. GERMANY
 KARLSRUHE

PURPOSE EUROPEAN FAST BREEDER PROGRAM

TYPE LIQUID METAL COOLED, ZIRCONIUM HYDRIDE MOD. FAST
 BREEDER. SEE REMARKS

POWER MWE(MWT) 21 58

CRITICAL CONSTRUCTION. TARGET 1970

COOLANT SODIUM

MODERATOR ZIRCONIUM HYDRIDE

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY ROD

FUEL ENRICH. 6.8 PER CENT U-235

FUEL ASSEMBLY RING-SHAPED ASSEMBLY, ENCLOSED BETWEEN CENTRAL
 CYLINDRICAL AND OUTER RING-SHAPED MODERATOR PART
 66 FUEL ASSEMBLIES/CORE
 CORE DIAM. 1175 MM, HEIGHT 1050 MM

FUEL CHARGE 1.68 TONS FUEL

BURNUP(REFUEL) 10,000 MWD/T

CONTROL RODS, BUILT-IN ABSORBING ELEMENTS

COOLANT TEMP. INLET 410 C OUTLET 560 C

REACTOR VESSEL DOUBLE TANK. INNER 1.9 M. DIA., 10.5 M. HIGH,
 SEPARATED FROM SECOND TANK BY NITROGEN ATMOSPHERE.

CONTAINMENT 17 M. DIA. STRUCTURE INCORPORATING THE REACTOR,
 HANDLING EQUIPMENT, PRIMARY SODIUM PLANT.

REMARKS A 300 MWE PROTOTYPE FAST REACTOR IS SCHEDULED FOR
 1968 CONSTRUCTION. PROGRAM INVOLVES SIEMENS,
 INTERATOM, AND DUTCH COMPANIES.
 REFERENCE DESIGN FOR A 1000 MWE FAST REACTOR HAS
 BEEN COMPLETED.

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LIQUID METAL REACTORS. FOREIGN

FF06

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SEE FF14

AFTER TECHNICAL TESTING, A FAST CORE WILL BE
INSTALLED. REACTOR WILL BE AVAILABLE AS RADIATION
SOURCE FOR FAST BREEDER FUELS.

REFERENCES

KARLSRUHE NUCLEAR RESEARCH CENTER.
EURONUCLEAR 2, 41-8 /JAN. 1965/

SAFETY ASPECTS OF THE EXPERIMENTAL POWER STATION
KNK
NUCLEAR ENGINEERING 10, 335-37 /SEPT. 1965/

COMPACT SODIUM-COOLED NUCLEAR REACTOR INSTALLATION
AT KARLSRUHE /KNK/
H TEBBERTS, OTHERS
ATOM U STROM 13, 117-29 /SEPT-OCT. 1967/

JANUARY 1969

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LIQUID METAL REACTORS, FOREIGN

FF07

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NAME/OWNER BR-5 /SOVIET BREEDER REACTOR//USSR
 DESIGNER USSR
 OPERATOR USSR
 LOCATION OBNINSK, USSR
 INST. PHYSICS AND POWER ENG. /PHYS-TECH. INST/
 PURPOSE FAST REACTOR R+D
 TYPE LIQUID METAL COOLED, FAST BREEDER
 POWER MWE(MWT) 5 KWE 5
 CRITICAL OPERATION SUMMER 1959
 COOLANT SODIUM-POTASSIUM NAK
 MODERATOR NICKEL REFLECTOR, INTERNAL URANIUM REFLECTOR
 FUEL MATERIAL PLUTONIUM DIOXIDE PELLETS 0.4 CM. DIA.
 BLANKET, URANIUM
 FUEL GEOMETRY PIN, 0.5 CM. OD., ACTIVE LENGTH 28 CM.
 BLANKET, ROD 0.9 CM. DIA.
 FUEL CLADDING SS TUBES 0.04 CM. WALL THICKNESS
 FUEL ASSEMBLY CORE, 19-PIN ELEMENT
 81 ASSEMBLIES/CORE
 BLANKET, 7-ROD ELEMENT
 40 ASSEMBLIES/CORE
 WITH UC FUEL THERE WOULD BE 100 7-PIN ELEMENTS
 IN THE CORE.
 NEUTRON FLUX FAST MAX. 1×10^{15}
 CONTROL MOVEMENT OF NICKEL REFLECTOR
 COOLANT TEMP. INLET 806 F OUTLET 932 F
 REACTOR VESSEL SODIUM COOLANT CONTAINER TUBE /ENCLOSES FUEL
 ASSEMBLIES/, WATER TANK, CAST IRON SHIELD.
 CONTAINMENT CAST IRON AND WATER SHIELDING, HIGH DENSITY
 CONCRETE STRUCTURE
 REMARKS BR-1, BUILT IN 1955, WAS A 100-WATT PLUTONIUM
 FUELED REACTOR.

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BR-2, BUILT IN 1956, WAS A 100-KWT MERCURY-COOLED, PLUTONIUM FUELED SYSTEM. BR-2 WAS REDESIGNED TO THE BR-5 FAST BREEDER. 50 ELEMENTS CONTAINING URANIUM DIOXIDE REPLACED PLUTONIUM ELEMENTS IN THE CORE ASSEMBLY, AND LATER 8 OF THESE WERE REPLACED BY URANIUM CARBIDE ELEMENTS. BY JANUARY 1965 THE CORE WAS TO BE COMPLETELY URANIUM CARBIDE.

REFERENCES

THE SOVIET FAST REACTOR BR-5.
RR MATTHEWS
NUCLEAR ENG. 4, 359-60 /OCTOBER 1959/

SOME PROBLEMS IN THE OPERATION OF THE BR-5 FAST NEUTRON REACTOR.

MS PINKHASIK, OTHERS
AEC-TR-5266

TRANSLATION FROM A PUBLICATION OF THE STATE COMMITTEE OF THE COUNCIL OF MINISTERS OF THE USSR ON THE USE OF ATOMIC ENERGY, MOSCOW, 1961

OPERATIONAL EXPERIENCE WITH THE BR-5 REACTOR.

AI LEIPINSKII, OTHERS

IAEA PREPRINT NO. CN-15/40 /CONFERENCE ON OPERATIONAL EXPERIENCE WITH ATOMIC POWER REACTORS, VIENNA, JUNE 4-10, 1963/
AEC-TR-5890 /TRANSLATION/

EXPERIMENTAL FAST REACTORS IN THE SOVIET UNION.

AI LEIPINSKY, OTHERS

PROC. 2ND. UN. INTL. CONF. PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1958, VOL. 9, P. 348-357

NUCLEAR REACTORS IN THE SOVIET UNION.

REPORT OF A RECIPROCAL EXCHANGE TRIP BY US SCIENTISTS, DEC. 11-22, 1964,
WASH-1060

JANUARY 1969

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LIQUID METAL REACTORS, FOREIGN

FF08

NAME/OWNER BN-50 / USSR

DESIGNER USSR

PURPOSE FEASIBILITY STUDY.

TYPE LIQUID METAL COOLED FAST BREEDER

POWER MWE(MWT) 50 200

CRITICAL DESIGN AND FEASIBILITY STUDY

COOLANT SODIUM

FUEL MATERIAL URANIUM-MOLYBDENUM ALLOY, URANIUM DIOXIDE IN
NICKEL MATRIX, OR SINTERED URANIUM DIOXIDE.

FUEL GEOMETRY RODS

COOLANT TEMP. INLET 315 C OUTLET 450 C

REMARKS PROPOSED PLANT HAS BEEN DISCONTINUED IN FAVOR OF A
350 MWE STATION, REPORTEDLY UNDER CONSTRUCTION.REFERENCES SODIUM COOLED FAST REACTORS
AI LEIPINSKII, OTHERS
THIRD UN. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY, GENEVA, 1964, A/CONF. 28/P/311

JANUARY 1969

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LIQUID METAL REACTORS. FOREIGN

FF09

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NAME/OWNER BN-350 / USSR
SHEVCHENKO STATION

DESIGNER USSR

LOCATION SCHEVCHENKO, USSR
EASTERN SHORE OF CASPIAN SEA, MANGYSHLAK
PENINSULA

PURPOSE POWER AND WATER DESALINATION

TYPE LIQUID METAL COOLED FAST BREEDER

POWER MWE(MWT) 150 1000
PRODUCTION OF 12,000 TONS FRESH WATER/DAY
DESIGN POWER 350 MWE

CRITICAL CONSTRUCTION. TARGET 1969

COOLANT SODIUM

FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE OR URANIUM CARBIDE
BLANKET, AXIAL AND RADIAL, URANIUM DIOXIDE

FUEL GEOMETRY PIN, 0.6 CM. DIA., 1060 MM. ACTIVE LENGTH
BLANKET, ROD 1.4 CM. OD.

FUEL CLADDING SS
CORE, 0.04 CM. THICK
BLANKET, 0.05 CM.

FUEL ENRICH. OXIDE FUEL, ZONED, 15 AND 20 PER CENT PLUTONIUM
BLANKET, DEPLETED URANIUM
CARBIDE FUEL, 23 PER CENT U-235

FUEL ASSEMBLY CORE, 169-PIN HEXAGONAL ASSEMBLY
211 ASSEMBLIES/CORE
BLANKET, 37-ROD ASSEMBLY
440 ASSEMBLIES
RADIAL AND AXIAL BLANKETS. THE CORE ASSEMBLY
INCLUDES DEPLETED URANIUM DIOXIDE RODS AT EACH END
THE SIDE BLANKET HAS 440 HEXAGONAL ASSEMBLIES IN
SHROUD CANS. ACTIVE LENGTH OF RADIAL BLANKET ROD
IS 1100 MM.

FUEL CHARGE 850 KG. PLUTONIUM-239

BURNUP(REFUEL) MAX. 5 PER CENT 30-33 SUBASSEMBLIES
REPLACED EVERY TWO
MONTHS

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LIQUID METAL REACTORS. FOREIGN

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NEUTRON FLUX MAX. 8×10^{15}

CONTROL BORON CARBIDE RODS, MOTION OF CENTRAL FUEL
ASSEMBLIES.
AUTOMATIC SYSTEM

COOLANT TEMP. INLET 572 F OUTLET 932 F

REACTOR VESSEL VARIABLE DIAMETER SS VESSEL, 6000-2200 MM. DIA.,
1300 MM. HIGH
WALL THICKNESS 30 MM.

CONTAINMENT REACTOR IS IN A CENTRAL PIT IN THE REACTOR
BUILDING.

REMARKS THE FIRST LOADING MAY BE ENRICHED URANIUM DIOXIDE
FUEL. THE 350 MWE REACTOR IS A STEP IN THE
DEVELOPMENT OF POWER REACTORS. THE BN-1000 IS
UNDER DEVELOPMENT. FUEL WILL BE A MIXTURE OF
URANIUM CARBIDE WITH A BREEDING RATIO OF 1.75.
A FAST PILOT REACTOR BOR IS ALSO UNDER DEVELOPMENT.
IT WILL BE A 40-60 MWT FACILITY WITH SODIUM
COOLANT TEMPERATURE OUTLET OF 630-650 C
CONDENSER COOLING WATER IS DRAWN FROM THE SEA,
DISCHARGED TO A DIKE-ENCLOSED DEPRESSION AND THEN
BY CHANNEL TO THE OPEN SEA.

REFERENCES SODIUM COOLED FAST REACTORS.
A LEIPUNSKI
3RD UN. INTL. CONF. PEACEFUL USES OF ATOMIC ENERGY
GENEVA, 1964. A/CONF. 28/P/311

NUCLEAR REACTORS IN THE SOVIET UNION.
REPORT OF A RECIPROCAL EXCHANGE TRIP TO USSR BY
US SCIENTISTS, DEC. 11-22, 1964,
WASH-1060

NUCLEAR POWER PLANT BN-350
AI LEIPUNSKY, OTHERS
ANS-100 /SUPPLEMENT/ P. 15-26
SEE ALSO JPRS-31193

THE BN-350 AND BOR FAST REACTORS.
AI LEIPUNSKII, OTHERS
FAST BREEDER REACTORS, PROC. LONDON CONF. BRITISH
NUCLEAR ENERGY SOC., MAY 1966 P. 243-74
PERGAMON, 1967

CONSTRUCTION OF AN ATOMIC ELECTRIC STATION BASED

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LIQUID METAL REACTORS. FOREIGN

FF09

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ON THE BN-350 REACTOR;
AI LEIPUNSKII, OTHERS
SOVIET ATOMIC ENERGY 23/5/, 1163-70 /NOV. 1967/

THE BN-350 ATOMIC POWER STATION;
AI LEIPUNSKII
JPRS-31193 /JULY 1965-TRANSLATION/

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LIQUID METAL REACTORS, FOREIGN

FF10

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NAME/OWNER BR-60/USSR
 BOR

DESIGNER USSR

OPERATOR USSR

LOCATION MELEKESS, USSR
 NUCLEAR REACTOR SCI. RES. INSTITUTE

PURPOSE FAST REACTOR EXPERIMENT.

TYPE LIQUID METAL COOLED FAST REACTOR, HIGH TEMPERATURE

POWER MWE(MWT) 10 60

CRITICAL CONSTRUCTION 1965, TARGET 1968

COOLANT SODIUM

MODERATOR ANNULAR STEEL REFLECTOR

FUEL MATERIAL COMPOSITIONS STUDIED INCLUDE ENRICHED URANIUM
 OXIDE, PLUTONIUM OXIDE, CARBIDES,
 BLANKET DEPLETED URANIUM DIOXIDE

FUEL GEOMETRY ROD 6.1 MM. DIAM, 400 MM. ACTIVE LENGTH
 RADIAL BLANKET ROD 14.5 MM. DIAM, 900 MM. LONG

FUEL CLADDING SS TUBES, WIRE WRAPPED, SEALED OR VENTED DESIGN.
 WALL THICKNESS FOR SEALED ELEMENTS 0.4 MM.
 WALL THICKNESS FOR VENTED ELEMENTS 0.25 MM.

FUEL ENRICH. WITH URANIUM DIOXIDE FUEL, 90 PER CENT U-235

FUEL ASSEMBLY CORE, HEXAGONAL ASSEMBLIES VARYING ACCORDING TO
 OPERATING CONDITIONS, BURNUP, AND TYPE OF FUEL.
 WITH 90 PER CENT ENRICHMENT THERE ARE 70-80
 ASSEMBLIES MADE UP OF 37-ELEMENT BUNDLES, RADIAL
 BLANKET, 7-ROD BUNDLE ASSEMBLIES.

FUEL CHARGE 150-160 KG U-235 WITH URANIUM DIOXIDE FUEL

SPECIFIC POWER 900 KW/L

BURNUP(REFUEL) 440-DAY FUEL LIFE

CONTROL BORON CARBIDE RODS, ONE MOVABLE FUEL ELEMENT

COOLANT TEMP. INLET 300-500 C OUTLET 650 C MAX.

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LIQUID METAL REACTORS. FOREIGN

FF10

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REACTOR VESSEL CYLINDER, MAX. DIAM. 1500 MM., 65 MM. HIGH,
WALL THICKNESS 16-20 MM. OF STEEL.

REMARKS THE REACTOR HAS SOME SIMILARITY TO US FARET DESIGN

REFERENCES NUCLEAR REACTORS IN THE SOVIET UNION.
REPORT OF A RECIPROCAL EXCHANGE TRIP TO USSR BY
US SCIENTISTS, DEC. 11-22, 1964,
WASH-1060

THE BN-350 AND THE BOR FAST REACTORS.
AI LEIPUNSKII, OTHERS
SOVIET ATOMIC ENERGY 21, 1146-57 /DEC, 1966/

THE BN-350 AND BOR FAST REACTORS.
AI LEIPUNSKII, OTHERS
FAST BREEDER REACTORS, PROC. LONDON CONF. BRITISH
NUCLEAR ENERGY SOC., MAY 1966, P. 243-74
PERGAMON, 1967.

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LIQUID METAL REACTORS. FOREIGN

FF11

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NAME/OWNER BN-1000/USSR

DESIGNER USSR

OPERATOR USSR

POWER MWE(MWT) 1000

CRITICAL PROPOSED. DESIGN AND DEVELOPMENT

FUEL MATERIAL URANIUM/PLUTONIUM CARBIDE
OR URANIUM CARBIDE

FUEL ASSEMBLY CORE WILL BE FLATTER THAN BN-350 CORE

REFERENCES NUCLEAR REACTORS IN THE SOVIET UNION,
REPORT OF A RECIPROCAL EXCHANGE TRIP TO USSR BY
US SCIENTISTS, DEC. 11-22, 1964,
WASH-1060

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LIQUID METAL REACTORS, FOREIGN

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NAME/OWNER PHENIX/CEA, FRANCE
 DESIGNER CEA, EDF, GAAA /FRANCE/
 LOCATION MARCOULE, FRANCE
 RHONE RIVER
 PURPOSE DEMONSTRATION,
 INTERMEDIATE BETWEEN RAPSODIE AND 1000 MWE REACTOR
 TYPE LIQUID METAL COOLED FAST BREEDER
 INTERGRAL DESIGN
 POWER MWE(MWT) 250 538
 CRITICAL CONSTRUCTION 1969, TARGET 1973
 COOLANT SODIUM. FLOW IS UPWARD
 FUEL MATERIAL URANIUM/PLUTONIUM OXIDE PELLETS 5.5 MM DIAM.
 FERTILE MATERIAL URANIUM DIOXIDE PELLETS
 15 MM. DIA.
 FUEL GEOMETRY PIN 6-6.85 MM. OD.
 FUEL CLADDING SS 0.45 MM THICK
 FUEL ENRICH. INNER ZONE 19 PER CENT PLUTONIUM-240
 OUTER ZONE 26 PER CENT PLUTONIUM-240
 BLANKET NATURAL URANIUM
 FUEL ASSEMBLY CORE, 271-PIN CLUSTERS
 97 ASSEMBLIES/CORE
 UPPER AND LOWER AXIAL BLANKET 37-PIN BUNDLES,
 RADIAL BLANKET 61-PIN BUNDLES,
 SPECIFIC POWER 1 MW/KG PLUTONIUM
 BURNUP(REFUEL) 50,000 MWD/T
 CONTROL VERTICAL RODS, BORON CARBIDE IN HEXAGONAL SHEATHS
 COOLANT TEMP. INLET 430 C OUTLET 590 C
 REACTOR VESSEL THREE COAXIAL TANKS.
 PRIMARY VESSEL 6 MM. DIAM/6 MM. HIGH CONTAINS
 CORE, BLANKETS, NEUTRON SHIELD, AND OPENS FREELY
 INTO MAIN TANK WHICH IS 11.5 M. DIAM/12 M. HIGH.
 SAFETY TANK ENCLOSED MAIN TANK,
 REMARKS MIXED CARBIDE AND NITRIDE FUELS WILL BE STUDIED,

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LIQUID METAL REACTORS, FOREIGN

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AS WELL AS OTHER CLADDING MATERIALS SUCH AS
VANADIUM AND SOME NICKEL ALLOYS.

REFERENCES

SOME ESSENTIAL ASPECTS OF THE STUDY OF LARGE
REACTORS. PRESENT SITUATION AND ORIENTATION.
CEA SERVICE D-ETUDES DES PILES RAPIDES
BUL. D-INFORM. SCI. TECH. NO. 95 P. 80-9 /JUL-AUG
1965/

PRELIMINARY STUDIES LEADING TO A CONCEPT OF A
1000 MWE FAST REACTOR
G VENDRYES, OTHERS
CEA-R-2554

THE PHENIX REACTOR
R CARLE, OTHERS
FAST REACTORS, ANS NATIONAL TOPICAL MEETING, 1967,
ANS-101 P. 3-39 TO 3-59.

PHENIX
M ROZENHOLC
ENERGIE NUCLEAIRE 10, 65-75 /MARCH-APRIL 1968/

JANUARY 1969

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LIQUID METAL REACTORS. FOREIGN

FF13

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NAME/OWNER FAST BREEDER REACTOR DESIGN/JAERI, JAPAN
 DESIGNER JAPAN ATOMIC ENERGY RESEARCH INST./JAERI/
 PURPOSE EXPERIMENTAL REACTOR
 TYPE LIQUID METAL COOLED FAST BREEDER
 POWER MWE(MWT) 100
 CRITICAL DESIGN. CONSTRUCTION 1968, TARGET 1971
 COOLANT SODIUM
 FUEL MATERIAL URANIUM DIOXIDE
 FUEL GEOMETRY CORE
 PIN, 5.4 MM. DIA.,
 ACT. LENGTH 600 MM. + 2x300 MM. AXIAL
 BLANKET
 RADIAL BLANKET
 ROD, 13.5 MM. DIA., ACT. LENGTH 1200 MM.
 FUEL CLADDING CLAD WILL BE 0.25 MM. THICK ON CORE ELEMENTS AND
 0.60 MM. THICK FOR RADIAL BLANKET ELEMENTS
 FUEL ENRICH. 50 PER CENT U-235
 BLANKET DEPLETED URANIUM
 FUEL ASSEMBLY CORE, 88-PIN -CORE + AXIAL BLANKET- BUNDLE
 55 ASSEMBLIES
 RADIAL BLANKET, 19-ROD ASSEMBLY
 65 ASSEMBLIES
 NEUTRON FLUX AVE. 2.8×10^{15}
 COOLANT TEMP. INLET 250 C OUTLET 400 C
 REMARKS A JOINT PROGRAM BY APDA /U.S./, THE CENTRAL
 RESEARCH INST. ELECTRIC POWER IND. /JAPAN/, AND
 DETROIT ED /U.S./ WILL BE CONCERNED WITH THE
 DEVELOPMENT OF A 350 MWE FAST BREEDER.
 REFERENCES PRELIMINARY DESIGN WORK OF THE 100 MWT
 EXPERIMENTAL FAST REACTOR
 T TETSUO, OTHERS
 NP-15572 /SEPT. 1, 1965/
 JAPAN FAST CRITICAL EXPERIMENT PROGRAM
 JAPAN ATOMIC ENERGY RESEARCH INSTITUTE

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LIQUID METAL REACTORS. FOREIGN

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NP-15573 /SEPT. 25, 1965/

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LIQUID METAL REACTORS, FOREIGN

FF14

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NAME/OWNER KARLSRUHE FAST REACTOR NA-2/W, GERMANY
FTR

DESIGNER SIEMENS-INTERATOM

PURPOSE POWER PROTOTYPE

TYPE LIQUID METAL COOLED FAST BREEDER

POWER MWE(MWT) 300 730

CRITICAL DESIGN

COOLANT SODIUM

FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE PELLETS 5.1 MM, DIAM.
BLANKET URANIUM DIOXIDE PELLETS 8.3 MM, DIAM
BY 15 MM. LONG

FUEL GEOMETRY ROD 6 MM DIAM /CORE/
9.5 MM DIAM /BLANKET

FUEL CLADDING INCOLOY
CORE 0.35 MM. THICK
BLANKET 0.6 MM. THICK

FUEL ASSEMBLY ZONE 1, 78 CORE ELEMENTS, INCLUDING AXIAL BLANKET
ZONE 2, 72 CORE ELEMENTS, INCLUDING AXIAL BLANKET
ZONE 3, 321 BLANKET ELEMENTS
CORE 169-ROD BUNDLE
BREEDER 91-ROD BUNDLE
HEXAGONAL ASSEMBLIES

BURNUP(REFUEL) 30,000 MWD/T

NEUTRON FLUX TOTAL, CORE CENTER 10 E+16

CONTROL RODS

COOLANT TEMP. INLET 380 C OUTLET 560 C

REACTOR VESSEL SS VESSEL 16,900 MM, HIGH, 7900 MM, OD.,
WALL THICKNESS 30 MM,

CONTAINMENT STEEL SHELL 35 M. DIAM/55.75 M. HIGH
INNER CONCRETE SHELL 27 M, DIAM/26 M. HIGH

REMARKS THE REFERENCE DESIGN FOR A 1000 MWT REACTOR IS
DESIGNATED NA-1.

REFERENCES THE KARLSRUHE REFERENCE DESIGN OF A 1000 MWE

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LIQUID METAL REACTORS, FOREIGN

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SODIUM COOLED FAST BREEDER REACTOR /FTR/
W HAFELE, OTHERS
KFK-369 /OCT, 1965/

FAST SODIUM-COOLED REACTOR NA-2,
K GAST, EG SCHLECHTENDAHL
EURFNR-462 /KFK-660/ 1967

NA-2 DESIGN, 300 MWE GERMAN FCR,
K GAST, OTHERS
ANS NATIONAL TOPICAL MEETING, FAST REACTORS,
SAN FRANCISCO, APRIL 1967.
ANS-101 P. 3-23 TO 3-28

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LIQUID METAL REACTORS. FOREIGN

FF15

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 NAME/OWNER BN-600/USSR
 DESIGNER USSR
 OPERATOR USSR
 LOCATION URAL MOUNTAINS, USSR
 PURPOSE POWER
 TYPE LIQUID METAL COOLED FAST REACTOR
 POWER MWE(MWT) 600 1430
 CRITICAL TARGET 1972-1973
 COOLANT SODIUM
 MODERATOR NONE
 FUEL MATERIAL DRIVER ZONE, URANIUM DIOXIDE OR URANIUM/PLUTONIUM
 DIOXIDE
 BLANKET, URANIUM
 FUEL GEOMETRY DRIVER ZONE, PIN 6.7 MM OD.
 BLANKET, ROD
 FUEL CLADDING DRIVER ZONE, SS 0.4 MM THICK
 BLANKET, SS 0.4 MM THICK, RIBBED
 FUEL ENRICH. DRIVER ZONE, LOW AND HIGH ENRICHMENT
 BLANKET, DEPLETED URANIUM
 FUEL ASSEMBLY DRIVER ZONE, 127-PIN BUNDLE, TRIANGULAR
 397 ELEMENTS
 BLANKET, 37-ROD BUNDLE, TRIANGULAR
 BURNUP(REFUEL) TEN PER CENT. PARTIAL EVERY 147 DAYS
 COOLANT TEMP. INLET 410 C OUTLET 580 C
 REFERENCES NUCLEAR INDUSTRY SEPT. 1968 p. 31
 NEWS RELEASE

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LIQUID METAL REACTORS, FOREIGN

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NAME/OWNER PEC /PROVA ELEMENTI DI COMBUSTIBILI/CNEN, ITALY
 ITALIAN FAST BREEDER PROGRAM

DESIGNER CONTRACT TO SNAM PROGETTI /ENI GROUP/

LOCATION BRASIMONE, IN APPENINES /NEAR TUSCANY/, ITALY

PURPOSE TEST BED IN ITALIAN FAST REACTOR DEVELOPMENT PROGRAM

TYPE LIQUID METAL COOLED FAST REACTOR, TWO-ZONE

POWER MWE(MWT) 116

CRITICAL CONCEPTUAL DESIGN COMPLETED. TARGET 1971

COOLANT SODIUM

MODERATOR NICKEL OR SS REFLECTORS

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET
BLANKET URANIUM DIOXIDE-BORON CARBIDE RODS
LATER CORES, PLUTONIUM DIOXIDE-SS CERMET

FUEL GEOMETRY PINS 8 MM. OD. ACTIVE LENGTH 900 MM.

FUEL CLADDING SS 0.4 MM. THICKNESS

FUEL ASSEMBLY 61-PIN ASSEMBLY, HEXAGONAL, CANNED

NEUTRON FLUX 3.5 E+15

CONTROL RODS, BORON CARBIDE

COOLANT TEMP. INLET 375 C OUTLET 525 C

REACTOR VESSEL CYLINDRICAL DOUBLE-WALLED TANK.

CONTAINMENT REACTOR TANK SURROUNDED BY GRAPHITE SHIELD AND
CONCRETE SHIELD;
REACTOR BUILDING.

REMARKS	PEC WILL BE USED FOR TESTING FUEL, ALSO HEAT EXCHANGERS AND STEAM GENERATORS. URANIUM DIOXIDE OR URANIUM/BERYLLIUM OXIDE CERAMIC FUEL CONSIDERED AS ALTERNATE.
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REFERENCES ITALY-S FAST BREEDER PROGRAM
NUCLEAR INDUSTRY MARCH 1967 P. 41

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THE PEC REACTOR, A FUEL TEST FAST REACTOR,
F. PIERANTONI, OTHERS
ANS-101 /SUPPLEMENT/, 1967

JANUARY 1969

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LIQUID METAL REACTORS, FOREIGN

FF17

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NAME/OWNER CORAL-1/SPAIN

LOCATION JUAN VIGON NATIONAL NUCLEAR CENTER, SPAIN

PURPOSE EXPERIMENT

TYPE FAST BREEDER EXPERIMENTAL FACILITY

POWER MWE(MWT) 0

CRITICAL MARCH 1968

FUEL MATERIAL URANIUM

FUEL ENRICH. 90 PER CENT U-235

FUEL CHARGE 22 KG. URANIUM

REFERENCES NEWS RELEASE

JANUARY 1969

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LIQUID METAL REACTORS. FOREIGN

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NAME/OWNER	KALPAKKAM FAST BREEDER/INDIA
LOCATION	KALPAKKAM, INDIA
PURPOSE	POWER EXPERIMENT
TYPE	LIQUID METAL COOLED FAST REACTOR
CRITICAL	PLANNED
COOLANT	SODIUM
REFERENCES	NUCLEAR CANADA APRIL 1967 P. 12 NEWS RELEASE

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LIQUID METAL REACTORS, FOREIGN

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NAME/OWNER	LIQUID METAL COOLED REACTOR/S, AFRICA
LOCATION	DESIGN STUDY
PURPOSE	POWER
TYPE	LIQ. METAL COOLED, HEAVY WATER MODERATED REACTOR, PEBBLE-BED
POWER MWE(MWT)	1000
COOLANT	SODIUM
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM SPHERES
FUEL GEOMETRY	SPHERES, UNCLAD
FUEL CLADDING	NONE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	UNCLAD FUEL SPHERES IN DIRECT CONTACT WITH SODIUM COOLANT
SPECIFIC POWER	40 W/GM
CONTROL	DISPLACEMENT OF MODERATOR BY HELIUM GAS
REFERENCES	S, A, NUCLEAR DESIGN WOULD PRODUCE TOO MUCH POWER, S. AFRICA MINING ENG. J, 78, 2491 /OCT. 6, 1967/

ORGANIC COOLED REACTORS

DOMESTIC

JANUARY 1969

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ORGANIC COOLED REACTORS, DOMESTIC

GD01

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NAME/OWNER POPR /PROTOTYPE ORGANIC POWER REACTOR//AEC
 DESIGNER ATOMICS INTERNATIONAL
 PURPOSE POWER PROTOTYPE
 TYPE ORGANIC MODERATED AND COOLED REACTOR
 POWER MWE(MWT) 50 160
 CRITICAL PROPOSAL
 COOLANT LIQUID HYDROCARBON
 MODERATOR LIQUID HYDROCARBON
 FUEL MATERIAL URANIUM DIOXIDE PELLETS
 FUEL GEOMETRY PIN
 FUEL CLADDING APM-ALUMINUM POWDERED METAL FINNED TUBING
 FUEL ASSEMBLY 54 PINS/ASSEMBLY /HEXAGONAL APM BOX WITH CENTRAL
 TUBE/
 121 ASSEMBLIES/CORE
 BURNUP(REFUEL) 9000 MWD/TON
 NEUTRON FLUX THERMAL 3×10^{13}
 CONTROL RODS, SS TUBES WITH BORON CARBIDE AT CENTER OF
 ELEMENTS.
 COOLANT TEMP. INLET 644 F OUTLET 700 F
 REACTOR VESSEL CYLINDRICAL, 11 FT. 6 IN. ID. AT UPPER PLENUM,
 8 FT. 6 IN. AT CORE REGION, 6 FT. AT BOTTOM
 SECTION. CYLINDRICAL INNER TANK CONTAINS CORE.
 CONTAINMENT REACTOR BUILDING /PRESSURE VESSEL/ 85 FT. DIA./160
 FT. HIGH
 REMARKS AEC PROGRAM INITIATED IN JANUARY 1961.
 PROPOSAL BY GRAND RIVER DAM AUTHORITY REFUSED BY
 AEC. A PROPOSAL WAS SUBMITTED TO AEC FOR A 30 MWE
 160 MWT PROCESS HEAT REACTOR FOR PACKAGING
 CORPORATION OF AMERICA-S PLANT AT FILER CITY,
 MICHIGAN.
 REFERENCES THE 50 MWE PROTOTYPE ORGANIC NUCLEAR PLANT.

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GD01

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CW WHEELLOCK, GS BUDNEY
ASME PREPRINT 61-WA-226 /1961/

PRELIMINARY POPR CONCEPTUAL DESIGN EXCURSION STUDY
FJ HALFEN
NAA-SR-MEMO-6448 /JUNE 1961/

PROTOTYPE ORGANIC POWER REACTOR,
ATOMICS INTERNATIONAL
NAA-SR-7400 /SECT. IV/ /NOVEMBER 15, 1962/

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ORGANIC COOLED REACTORS, DOMESTIC

GD02

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NAME/OWNER OMRE /ORGANIC MODERATED REACTOR EXP.//AEC-AI
DESIGNER ATOMICS INTERNATIONAL
OPERATOR ATOMICS INTERNATIONAL
LOCATION NATIONAL REACTOR TEST, STATION, IDAHO
PURPOSE POWER EXPERIMENT, DEMONSTRATION
TYPE ORGANIC MODERATED AND COOLED, CIRCULATING COOLANT
MODERATOR
POWER MWE(MWT) 5-15
CRITICAL SEPT, 1957
PHASED OUT IN 1963
COOLANT ORGANIC LIQUID /TERPHENYL/
MODERATOR ORGANIC LIQUID /TERPHENYL/
FUEL MATERIAL URANIUM DIOXIDE IN SS MATRIX, 20 MILS THICK
FUEL GEOMETRY PLATES ACTIVE AREA 36 IN. / 2 1/2 IN.
FUEL CLADDING SS 5 MILS THICK
FUEL ENRICH. HIGH
FUEL ASSEMBLY 16 PLATES PER BOX /2.9/2.8/60 IN./
31 BOXES / CORE
FUEL CHARGE 25.5 KG. U-235
SPECIFIC POWER 470 KW/KG U-235
NEUTRON FLUX THERMAL AVE. 4.1×10^{13}
FAST AVE. 1.8×10^{14}
CONTROL CYLINDRICAL RODS
COOLANT TEMP. INLET 500-700 F OUTLET 520-710 F
COOLANT PRESS. 200 PSIG
REACTOR VESSEL LOW ALLOY STEEL, 4.5 FT. ID.
CONTAINMENT NONE EXCEPT FOR REACTOR VESSEL AND PRIMARY COOLANT
PIPING

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ORGANIC COOLED REACTORS. DOMESTIC

GD02

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REMARKS

OPERATION FEBRUARY 1958. WAS SHUT DOWN FOR
SECOND CORE LOADING. PROJECT WAS PHASED OUT IN
MID-1963. THE OMRE, A PRESSURIZED SYSTEM, WAS
SPECIFICALLY DESIGNED AS A TEST FACILITY FOR
ORGANICS, WITH NO PROVISION FOR ELECTRICITY
GENERATION. COOLANT-MODERATOR LIQUID WAS
SANTOWAX O.M.

REFERENCES

OMRE
NUCLEAR ENG. 2/21/, 521 /DECEMBER 1957/

CONCEPTUAL DESIGN STUDY OF OMRE MODIFICATIONS.
WB WOLFE
NAA-SR-MEMO-3881 /JULY 1959/

ORGANIC MODERATED REACTOR EXPERIMENT SAFEGUARDS
SUMMARY.
HL SLETTEW, ED.
NAA-SR-2323 /FEBRUARY 1, 1958/

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ORGANIC COOLED REACTORS. DOMESTIC

GD03

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NAME/OWNER PIQUA NUCLEAR POWER FACILITY/AEG-CITY OF PIQUA
 DESIGNER ATOMICS INTERNATIONAL
 OPERATOR CITY OF PIQUA
 LOCATION PIQUA, OHIO
 GREAT MIAMI RIVER
 PURPOSE POWER DEMONSTRATION
 TYPE ORGANIC MODERATED AND COOLED
 POWER MWE(MWT) 11.4 45.5
 CRITICAL 1963. SHUT DOWN JANUARY 1966
 SEE REMARKS
 COOLANT TERPHENYL /SINGLE COOLANT LOOP/
 MODERATOR TERPHENYL
 FUEL MATERIAL URANIUM-MOLYBDENUM-ALUMINUM ALLOY
 FUEL GEOMETRY DOUBLE ANNULAR TUBES.
 INNER ANNULUS 3.6 IN. DIA./0.208 IN. THICK
 OUTER 4.63 IN. DIA./0.208 IN. THICK
 TOTAL ACTIVE LENGTH 54 IN.
 FUEL CLADDING ALUMINUM TUBES, CONCENTRIC, FINNED
 FUEL ENRICH. 1.9 PER CENT U-235
 FUEL ASSEMBLY NESTED FUEL ASSEMBLIES, 4 SETS OF COAXIAL TUBULAR
 ELEMENTS-STACKED /FULL CORE LENGTH/ IN THIN WALLED
 SS COOLANT DUCT.
 85 ASSEMBLIES/CORE /13CONTAIN CONTROL RODS/
 72 REGULAR FUEL ASSEMBLIES
 FUEL CHARGE 6550 KG. URANIUM
 BURNUP(REFUEL) 1000 MWD/TON 1/4 CORE BATCHES
 NEUTRON FLUX THERMAL AVE, 1.9×10^{13}
 FAST AVE, 4×10^{13}
 CONTROL RODS, BORON CARBIDE IN SMALL SS TUBES BRAZED
 TOGETHER TO FORM DOUBLE RING
 COOLANT TEMP. INLET 519 F OUTLET 575 F

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ORGANIC COOLED REACTORS. DOMESTIC

GD03

COOLANT PRESS. 120 PSIA

REACTOR VESSEL MILD STEEL CYLINDRICAL VESSEL 92 IN. ID./27 FT.
3 1/2 IN. HIGHCONTAINMENT STEEL-BUILDING WITH INNER CONCRETE LINING
ABOVE-GRADE, VERTICAL CYLINDER, 73 FT. DIA/85 FT.
HIGH

REMARKS INITIALLY THE NORMAL CORE LOADING WAS DECREASED BY
ABOUT 15 ASSEMBLIES, WITH DUMMY ASSEMBLIES
REPLACING THESE TO REDUCE EXCESS REACTIVITY.
COOLANT ENTERS THE CORE FROM THE TOP, FLOWS
DOWNWARD THROUGH THE CORE AND THEN UPWARD IN THE
ANNULUS BETWEEN THE GRID SUPPORT BARREL AND THE
PRESSURE VESSEL TO THE OUTLET NOZZLE. THE SINGLE
COOLANT LOOP CONSISTS OF TWO COOLANT PUMPS, A
SUPERHEATER, AND A STEAM GENERATOR. CRITICAL
JUNE 1963, ON-LINE NOVEMBER 1963,
PIQUA SHUT DOWN JAN. 1966 BECAUSE OF COKING OF THE
ORGANIC COOLANT. BY LOADING SPARE AND OLD
ASSEMBLIES SEVERAL MONTHS OF SERVICE LIFE WERE
GAINED. CORE WAS PULLED LATE IN 1966.

REFERENCES ENGINEERING DESIGN OF THE PIQUA OMR,
EF WEISNER
NUCLEAR ENG. 5. 68-9 /FEBRUARY 1960/

SELECTION OF THE PIQUA OMR FUEL ELEMENT.
EB BAUMEISTER
NAA-SR-4239 /MARCH 15, 1960/

THE PIQUA NUCLEAR POWER FACILITY.
EF WEISNER
PROC. ORGANIC COOLED REACTOR FORUM, P. 211-224
/OCTOBER 1960/
NAA-SR-5688 /DECEMBER 1960/

FINAL SAFEGUARDS SUMMARY REPORT FOR THE PIQUA
NUCLEAR POWER FACILITY.
ATOMICS INTERNATIONAL
NAA-SR-5608 /AUGUST 1961/

DESIGN PRACTICE. PIQUA NUCLEAR POWER FACILITY
POWER REACTOR TECHNOLOGY 5/4/, 51-60 /SEPT. 1962/

NUCLEONICS WEEK OCT. 19, 1967 P. 6
NEWS RELEASE

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ORGANIC COOLED REACTORS. DOMESTIC

GD04

NAME/OWNER EOCR /EXP. ORGANIC COOLED REACTOR//AEC
 DESIGNER ATOMICS INTERNATIONAL
 CONCEPTUAL DESIGN, PHILLIPS PETROLEUM
 OPERATOR ATOMICS INTERNATIONAL
 LOCATION NATIONAL REACTOR TEST. STATION, IDAHO
 PURPOSE TEST BED FOR FUEL ELEMENTS, ORGANIC COOLANTS.
 TYPE ORGANIC MODERATED AND COOLED
 POWER MWE(MWT) 40
 CRITICAL POSTPONED
 COOLANT TERPHENYL
 MODERATOR TERPHENYL
 FUEL MATERIAL URANIUM DIOXIDE IN SS MATRIX 0.020 IN. THICK
 FUEL GEOMETRY PLATES
 FUEL CLADDING SS 0.005 IN. THICK
 FUEL ENRICH. HIGH
 FUEL ASSEMBLY 28 PLATES + 1 DUMMY SPACER PLATE TO BOX
 7/4/6 1/2 IN./
 32 FUEL UNITS /20 DRIVER FUEL ELEMENTS AND 12
 CONTROL-ROD FOLLOWERS/
 CONTROL RODS-FUEL FOLLOWER TYPE
 COOLANT TEMP. INLET 500 F OUTLET 525 F
 COOLANT PRESS. OUTLET 157 PSI
 REACTOR VESSEL CARBON STEEL, 95 IN. ID./32 FT. LONG, CORE IS
 ENCLOSED IN AN INNER TANK
 REMARKS THIS PROJECT HAS BEEN INDEFINITELY DEFERRED WITH
 THE PLANT 99 PER CENT COMPLETE. CORE DESIGN
 CONSISTS OF RECTANGULAR FUEL ASSEMBLIES COMPOSED
 OF TWO SUBASSEMBLIES. SUBASSEMBLY CONTAINS 28
 ACTIVE PLATES AND ONE DUMMY PLATE, THE ACTIVE
 PLATES BEING OF HIGHLY ENRICHED URANIUM DIOXIDE-SS
 WITH STAINLESS STEEL CLADDING. CONCEPTUAL DESIGN

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ORGANIC COOLED REACTORS, DOMESTIC

GD04

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WAS BY PHILLIPS.

REFERENCES

EXPERIMENTAL ORGANIC COOLED REACTOR CONCEPTUAL
DESIGN.WE NYER, JH RAINWATER,
IDO-16570 /DECEMBER 1, 1959/EXPERIMENTAL ORGANIC COOLED REACTOR,
MR DUSBABEK

NAA-SR-5688 /P. 189-210/ /DECEMBER 1960/

EXPERIMENTAL ORGANIC COOLED REACTOR, PRELIMINARY
HAZARDS REPORT, ADDENDUM,
FLUOR CORP.

IDO-24034

IDO-24034 /ADD. / /NOVEMBER 1960/

IDO-24034 /ADD. 2/ /APRIL 1961/

THE EXPERIMENTAL ORGANIC COOLED REACTOR,
POWER REACTOR TECHNOLOGY 5/1/, 88-91 /DEC. 1961/

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ORGANIC COOLED REACTORS, DOMESTIC

GD05

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NAME/OWNER	OMR-SHIP PROPULSION STUDY / AI
DESIGNER	ATOMICS INTERNATIONAL
PURPOSE	SHIP PROPULSION
TYPE	ORGANIC MODERATED AND COOLED
POWER MWE(MWT)	10,000 SHP 30-36
CRITICAL	DESIGN
COOLANT	ORGANIC LIQUID
MODERATOR	ORGANIC LIQUID
FUEL MATERIAL	URANIUM DIOXIDE PELLETS OR URANIUM-MOLYBDENUM ALLOY
FUEL GEOMETRY	RODS /TUBES/
FUEL CLADDING	SS TUBING OR ALUMINUM TUBING WITH URANIUM-MOLYBDENUM ALLOY FUEL
FUEL ENRICH.	APPROX. 3.7 PER CENT U-235
FUEL ASSEMBLY	100-ROD ASSEMBLY /SS BOX/
CONTROL	RODS
COOLANT TEMP.	INLET 300 C OUTLET 325C
CONTAINMENT	CONTAINMENT SHELL WITHIN GAS-TIGHT REACTOR COMPARTMENT.
REMARKS	REFERENCE DESIGN FOR AN OMR-POWERED TANKER, WAS CONSIDERED UNDER AN INTERATOM DESIGN PROPOSAL FOR THE GKSS /GERMAN/ SHIP PROGRAM.
REFERENCES	<p>REFERENCE DESIGN FOR AN OMR-POWERED 38,000 DWT TANKER RJ GIMERA, RE STANBRIDGE NAA-SR-1851 AND SUPPLEMENT /MARCH 1957/</p> <p>MARITIME ORGANIC MODERATED AND COOLED REACTOR. NAA-SR-3859</p> <p>THE INTERATOM MARINE REACTOR. FE FARIS NUCLEAR POWER 6, 75-6 /MARCH 1961/</p>

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GD05

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SKETCH OF A SHIP REACTOR COOLED AND MODERATED
WITH ORGANIC SUBSTANCES.
KERNREAKTOREN FÜR SCHIFFSANTRIEBE, P. 33-6
VERLAG KARL THIEMIG AG. MUNICH, 1961

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ORGANIC COOLED REACTORS, DOMESTIC

GD06

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NAME/OWNER DCDR /DIRECT CYCLE DIPHENYL REACTOR//MARQUARDT
CORP.

DESIGNER MARQUARDT CORP.

PURPOSE POWER AND/OR PROCESS HEAT

TYPE ORGANIC MODERATED AND COOLED, DIRECT CYCLE

CRITICAL STUDY, PROTOTYPE PROPOSED

COOLANT DIPHENYL

MODERATOR DIPHENYL

FUEL MATERIAL URANIUM CARBIDE

FUEL CLADDING GRAPHITE

FUEL ENRICH. SLIGHT

COOLANT TEMP. 850 F

COOLANT PRESS. 400 PSIA

REACTOR VESSEL LOW-ALLOY STEEL

REMARKS R + D PROPOSAL, CONCEPTUAL DESIGN /DIRECT CYCLE
DIPHENYL REACTOR/. CONCEPT FOR POWER AND/OR
PROCESS HEAT. APPLICATION HAS BEEN MADE TO THE
AEC FOR R + D ASSISTANCE. MARQUARDT HAS ALSO
PROPOSED CONSTRUCTION OF THE DCDR AS A DUAL
PURPOSE REACTOR FOR WATER DESALINATION AND POWER
PRODUCTION

REFERENCES NUCLEONICS WEEK, SEPTEMBER 27, 1962, P. 3,
NEWS RELEASE

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ORGANIC COOLED REACTORS. DOMESTIC

GD07

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NAME/OWNER OMFBR /ORGANIC MOD. FLUIDIZED BED REACTOR//WEST
 DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
 PURPOSE POWER
 TYPE ORGANIC MODERATED AND COOLED, FLUIDIZED BED.
 POWER MWE(MWT) 50 150
 CRITICAL CONCEPTUAL DESIGN. DEVELOPMENT PROPOSED.
 COOLANT POLYPHENYL
 MODERATOR POLYPHENYL
 FUEL MATERIAL URANIUM
 FUEL GEOMETRY SPHERES
 FUEL ENRICH. APPROX. 2 PER CENT U-235
 FUEL ASSEMBLY FLUIDIZED BED OF URANIUM PELLETS.
 COOLANT IS HEATED ON PASSING THROUGH THE FUEL BED.
 FUEL CHARGE 15 TONS URANIUM
 CONTROL RATE OF COOLANT CIRCULATION.
 COOLANT TEMP. INLET 610 F OUTLET 690 F
 REACTOR VESSEL STRUCTURAL STEEL
 REMARKS PROPOSAL FOR DEVELOPMENT /BURLINGTON, VT. LIGHT
 DEPT./, CURRENT STATUS UNKNOWN.
 REFERENCES ATOMIC DEVELOPMENT AT WESTINGHOUSE,
 POWER ENG. 62, 44-50 /DECEMBER 1958/
 ORGANIC MODERATED FLUIDIZED BED REACTOR CONCEPT.
 JH WRIGHT
 TRANS. ANS 1/2/, 126-7 /DEC. 1958/

ORGANIC COOLED REACTORS

FOREIGN

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ORGANIC COOLED REACTORS, FOREIGN

GF01

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NAME/OWNER PRO /PROGRAMMA REATTORE ORGANICO/ CNEN, ITALY

DESIGNER CNEN, ITALY

OPERATOR SORIN-AGIP

LOCATION BOLOGNA, N. ITALY

PURPOSE POWER PROTOTYPE

TYPE ORGANIC MODERATED AND COOLED

POWER MWE(MWT) 30 /2ND CORE 60 MWT/

CRITICAL A ZERO-POWER EXPERIMENT ROSPO /REATTORE ORGANICO
SPERIMENTALE A POTENZA 0/ CRITICAL JUNE, 1963 AT
THE CASACCIA CENTER.
NO RECENT INFORMATION.

COOLANT ORGANIC LIQUID

MODERATOR ORGANIC LIQUID

FUEL MATERIAL URANIUM DIOXIDE IN SS MATRIX, FIRST CORE,
THORIUM WILL ALSO BE USED IN A THORIUM/URANIUM-233
CYCLE.

FUEL GEOMETRY PLATE /APPR-TYPE/

FUEL CLADDING SS /LATER SAP/

FUEL ENRICH. HIGH

COOLANT TEMP. 315-330 C

COOLANT PRESS. 30 KG/SQ. CM.

REMARKS A NUMBER OF CORES HAVE BEEN EXAMINED FOR THE
PURPOSE OF GIVING THE PLANT AN INCREASED
FLEXIBILITY FOR SECOND CORES. TWO MAJOR R+D
PROGRAMS ARE IN PROGRESS. PRO, THE ORGANIC REACTOR
PROGRAM FOR A 30 MWT REACTOR, AND PCUT, THE
URANIUM THORIUM CYCLE PROGRAM WHICH VISUALIZES A
URANIUM-THORIUM REPROCESSING PILOT PLANT. AIM IS
TO STUDY THE URANIUM-THORIUM CYCLE WITH A VIEW TO
A POWER REACTOR-REPROCESSING PLANT INTEGRATED
COMPLEX.
A CONSORTIUM INCLUDING CNEN IS INVESTIGATING AN
ORGANIC REACTOR FOR SMALL DESALINATION SYSTEMS.
SEE ROVI PROJECT, GF04.

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GF01

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REFERENCES

THE CNEN PROGRAM FOR REACTORS WITH ORGANIC LIQUID
AND THE URANIUM-THORIUM CYCLE.

F IPPOLITO, OTHERS

ENERGIA NUCLEARE /MILAN/ 8, 196-208 /MARCH 1961/

PRO REACTOR OPTIMIZATION CRITERIA.

S BALDETTI, OTHERS

ENERGIA NUCLEARE /MILAN/ 8, 413-21 /JUNE 1961/

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ORGANIC COOLED REACTORS, FOREIGN

GF02

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NAME/OWNER	ARBUS /ARCTIC MODULAR PLANT//USSR
DESIGNER	USSR
OPERATOR	USSR
LOCATION	MELEKESS, ULYANOVSK DISTRICT, RUSSIA
PURPOSE	PORTABLE POWER REACTOR.
TYPE	ORGANIC MODERATED AND COOLED, TRANSPORTABLE PLANT.
POWER MWE(MWT)	750 KWE 5
CRITICAL	OCTOBER 1963. PILOT OPERATION JUNE 1963
COOLANT	ORGANIC LIQUID
MODERATOR	ORGANIC LIQUID
FUEL MATERIAL	URANIUM-ALUMINUM ALLOY OR ALUMINUM-URANIUM DIOXIDE CERMET.
FUEL GEOMETRY	PLATES OR HEXAGONAL TUBES
FUEL CLADDING	ALUMINUM
FUEL ENRICH.	36 PER CENT U-235
FUEL ASSEMBLY	HEXAGONAL PLATES /ASSEMBLIES OF 3 HEX. TUBES/ 69 PLATES/CORE
FUEL CHARGE	62 KG. URANIUM
BURNUP(REFUEL)	APPROX. 2 YEARS
CONTROL	BORON STEEL RODS AND BORON CARBIDE RODS
COOLANT TEMP.	INLET 230 C OUTLET 243 C
COOLANT PRESS.	10 ATM.
REACTOR VESSEL	WELDED CYLINDER 4365 MM. HIGH, 1340 MM. DIA., 20 MM. WALL THICKNESS. INNER VESSEL TO FORM COOLANT FLOW AND AS CORE SUPPORT STRUCTURE. EQUIPMENT, FITTINGS AND PIPES ARE CARBON STEEL /PRIMARY CIRCUIT/.
CONTAINMENT	PLANT CONSISTS OF 19 UNITS, NO GREATER THAN 20 TONS EACH. ARBUS OCCUPIES A 12.36 / 28.5 M.

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ORGANIC COOLED REACTORS. FOREIGN

GF02

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BUILDING 6.36 M. HIGH.

REMARKS

COOLANT WILL BE CONTINUOUSLY CLEANED BY FILTRATION THROUGH METAL-CERAMIC FILTERS. CHEMICAL PURIFICATION WILL BE BY DISTILLATION. STANDARD INDUSTRIAL AND REFINERY EQUIPMENT OF LOW CARBON STEEL IS USED THROUGHOUT.

REFERENCES

ATOMIC ENERGY IN THE SOVIET UNION. TRIP REPORT OF THE U. S. ATOMIC ENERGY DELEGATION, MAY 1963.

ARBUS-SOVIET MODULAR NUCLEAR POWER PLANT
N SINEV
NUCLEAR ENGINEERING 8,429 /DEC. 1963/

STARTUP OF THE WORLD-S FIRST ATOMIC POWER STATION WITH AN ORGANIC-COOLED, ORGANIC MODERATED REACTOR. YU ARKHANGEL-SKII, I KOVALEV
AT. ENERG. /USSR/ 15,443 /NOV. 1963/

THE ARBUS ORGANIC COOLED AND MODERATED NUCLEAR POWER STATION.
KK POLUSHKIN, OTHERS
THIRD U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, MAY 1964, A/CONF. 28/P/307

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ORGANIC COOLED REACTORS, FOREIGN

GF03

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NAME/OWNER KBWP PROJECT/KBWP, W. GERMANY

DESIGNER INTERATOM

OPERATOR KERNKRAFTWERK BADENWURTTENBERG PLANNINGSGESELL-
SCHAFT MBH. FORMERLY AKS, W. GERMANY

LOCATION OBRIGHEIM, BADEN, W. GERMANY

PURPOSE POWER

TYPE ORGANIC MODERATED AND COOLED

POWER MWE(MWT) 150

CRITICAL PLANNED

COOLANT ORGANIC LIQUID

MODERATOR ORGANIC LIQUID

REMARKS DESIGN, PROJECT PLANNING COMPLETED MARCH 1962,
SPECIFICATIONS HAVE BEEN SUBMITTED TO EURATOM-U.S.
JOINT PROGRAM. THE REACTOR, SUPPLIED BY INTERATOM
WILL BE BASED ON THE PIQUA, OHIO DESIGN. KBWP IS
NEGOTIATING ON A SECOND PLANT WITH AEG/GE AND
SIEMENS/WEST.

REFERENCES APPLIED ATOMICS JUNE 13, 1962 P. 1:
NEWS RELEASE

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ORGANIC COOLED REACTORS, FOREIGN

GF04

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NAME/OWNER ROVI PROJECT/CNEN, ITALY
REATTORE ORGANICO VAPORE INDUSTRIALE

DESIGNER PROJECT BY A CONSORTIUM CONSISTING OF CNEN,
SNAM /SOCIETE NAZIONALE AZREPA METANODOTTI/, BREDA
BOMBIRINI PARODI-DELFINO.

PURPOSE ECONOMIC EVALUATION OF A 100-300 MWT ORGANIC
REACTOR FOR SMALL DESALTING UNITS.

TYPE ORGANIC COOLED REACTOR

POWER MWE(MWT) 300

COOLANT DIPHENYL + 30 PER CENT HBR

MODERATOR DIPHENYL + 30 PER CENT HBR

FUEL MATERIAL URANIUM DIOXIDE PELLET 7.5 MM. DIAM.

FUEL GEOMETRY ROD, ACTIVE LENGTH 2013 MM.

FUEL CLADDING ALUMINIUM ALLOY 1 MM. THICK, FINNED

FUEL ENRICH. 2.5 PER CENT U-235

FUEL ASSEMBLY CLUSTER, HEXAGONAL, BOXED

FUEL CHARGE 9300 KG. URANIUM

SPECIFIC POWER AVE. 12.8 KG/M

CONTROL BORON CARBIDE, RODS

COOLANT TEMP. INLET 150 C OUTLET 176 C

COOLANT PRESS. OUTLET 6.5 KG/SQ. CM.

REMARKS 100 MWT AND 300 MWT PLANTS EXAMINED.

REFERENCES ECONOMIC EVALUATION OF ORGANIC MODERATED AND
COOLED REACTORS /ROVI/ DESIGN TO PRODUCE VAPOR FOR
DESALTING PLANTS.
L LAZZARINO, R DI MENZA
DESALINATION 2, 220-6 /1967/

PRESSURIZED LIGHT WATER REACTORS

DOMESTIC

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD01

NAME/OWNER SM-1 /STATIONARY MEDIUM POWER-1/ DOD
 APPR-1

DESIGNER ALCO PRODUCTS INC.

OPERATOR US ARMY

LOCATION FT. BELVOIR, VIRGINIA

PURPOSE PROTOTYPE PACKAGE POWER FOR REMOTE LOCATIONS.

TYPE PWR, PACKAGE POWER

POWER MWE(MWT) 2 10

CRITICAL 1957, CORE 2, 1960, CORE 3, 1964

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET PLUS BORON COMPOUND

FUEL GEOMETRY PLATE 0.03 IN. THICK
 CORE 3, 0.040 IN.

FUEL CLADDING SS 0.005 IN. THICK

FUEL ENRICH. 93 PER CENT U-235

FUEL ASSEMBLY SANDWICH, BRAZED, CORE 3 WELDED.
 ACTIVE CORE HEIGHT 22 IN.
 38 STATIONARY, 7 MOVABLE PLATES, 7X7 WITH
 CORNERS MISSING.
 CORE 3, 37 ELEMENTS, 8 DUMMY ELEMENTS, WITH
 INCREASED FUEL AND BORON LOADINGS.

FUEL CHARGE 24 KG. URANIUM

SPECIFIC POWER 444 KW/KG U-235

BURNUP(REFUEL) AVE. 33 PER CENT 78 WEEKS

NEUTRON FLUX THERMAL AVE. 2.7×10^{13}
 FAST AVE. 1×10^{14}

CONTROL CONTROL-ROD-FUEL-ELEMENT AND MTR TYPE RODS

COOLANT TEMP. OUTLET 450 F

COOLANT PRESS. 1200 PSIA

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD01

REACTOR VESSEL CARBON STEEL 48 IN. ID./64 IN. LONG, SS-CLAD.

CONTAINMENT VAPOR CONTAINER A COMBINATION STEEL AND CONCRETE
STRUCTURE 32 FT. ID./60 FT. HIGH, 7/8 IN. THICK
STEEL CYLINDRICAL OUTER SHELL, INNER OF 2 FT.
THICK REINFORCED CONCRETE LINED WITH LIGHT STEEL
PLATE.

REMARKS REACTOR WILL BE OPERATED FOR THE NEXT FEW YEARS
FOR RESEARCH AND TRAINING.

REFERENCES HAZARDS SUMMARY REPORT FOR THE ARMY PACKAGE POWER
REACTOR SM-1
SS ROSEN, ED.
APAE-2 /1955/

ORNL-S DESIGN FOR A POWER REACTOR PACKAGE.
RS LIVINGSTON, AL BLOCH
NUCLEONICS 13, 24-7 /MAY 1955/

A PACKAGE POWER REACTOR FOR REMOTE LOCATIONS.
AL BLOCH
AECU-3170 /1955/

APPR-1, DESIGN, CONSTRUCTION, AND OPERATION.
APAE-23 /NOVEMBER 1957/

REACTOR ANALYSIS APPR-1, CORE 2
APAE-32 /1958/

PORTABLE NUCLEAR POWER PLANT OFFERS OPERATING
FLEXIBILITY, EASY MAINTENANCE, AND LONG LIFE FOR
REMOTE INDUSTRIAL, MINING, AND MILITARY SITES.
POWER 103, 61-3 /JANUARY 1959/

DESIGN ANALYSIS OF A PREPACKAGED NUCLEAR POWER
PLANT /1000 EKW/.
VOLUME 1, PRIMARY AND SECONDARY SYSTEM DESIGN.
VOLUME 2, REACTOR DESIGN ANALYSIS.
ALCO PRODUCTS INC.

CORE CHARACTERISTICS OF FOUR ARMY PACKAGE POWER
REACTORS.
JG GALLAGHER, OTHERS
NUCLEAR SCI. + ENG. 2 /SUPPLEMENT/, 15-16 /JUNE
1959/

HAZARDS REPORT FOR SM-1, CORE 3
FG MOOTE

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HD01

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ACNP-64516 /JAN. 1964/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD02

NAME/OWNER SM-1A /STATIONARY MEDIUM POWER-1A/ DOD
APPR-1A

DESIGNER ALCO PRODUCTS INC.

OPERATOR US ARMY

LOCATION FORT GREELY, ALASKA

PURPOSE POWER AND SPACE HEAT

TYPE PWR, PACKAGED POWER

POWER MWE(MWT) 1-6 20

CRITICAL MARCH 1962
CORE 2, 1965

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET, BORON ADDED

FUEL GEOMETRY PLATE 30 MILS THICK
CORE 3, PLATE 0.030 IN. MEAT

FUEL CLADDING SS 0.0050 IN. THICK

FUEL ENRICH. 93 PER CENT U-235

FUEL ASSEMBLY ASSEMBLY OF FUELED PLATES
CORE 3
16 PLATES/ASSEMBLY
7x7 ARRAY OF ASSEMBLIES, CORNER OMITTED
ACTIVE HEIGHT 22 IN.

FUEL CHARGE 22.38 KG. U-235
CORE 3, 36.26 KG. U-235

BURNUP(REFUEL) CORE LIFE 15 MW-YR
CORE 3, LIFETIME 32 MW-YR

NEUTRON FLUX THERMAL 1.94×10^{13} FOR CORE 3

CONTROL FUEL ELEMENTS WITH ABSORBER FOLLOWER AND MTR-TYPE
RODS

COOLANT TEMP. INLET 423 F OUTLET 443 F

COOLANT PRESS. 1200 PSIA

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REACTOR VESSEL FIRST PRESSURE VESSEL WAS CARBON STEEL,
WITH CORE 3, SS WILL REPLACE THE CARBON STEEL,
THIS CHANGE WILL ALSO BE MADE FOR PM-1 AND PM-3A

CONTAINMENT VAPOR CONTAINER /ENERGY QUENCH CONTAINMENT/
CONSISTS OF TWO CONCENTRIC CYLINDERS, THE INNER
3 1/2 FT. THICK CONCRETE SEALED AT THE TOP AND THE
OUTER STEEL.

REMARKS SHUT DOWN FOR REFUELING IN MARCH 1964, RE-STARTUP
APRIL 1964.

REFERENCES CHARACTERISTICS OF FOUR ARMY PACKAGE POWER
REACTORS,
JG GALLAGHER, OTHERS
NUCLEAR SCI. AND ENG. /SUPPLEMENT/ 2, 15-16 /JUNE
1959/

THE ARMY NUCLEAR POWER PROGRAM, ITS REACTORS, AND
THEIR APPLICATION TO THE LESS-DEVELOPED AREAS OF
THE WORLD.

JK BRATTON
SYMPOSIUM ON SMALL AND MEDIUM POWER REACTORS,
VIENNA, 1960.
PAPER SMPR-51 /1960/

HAZARDS REPORT - SM-1A CORE 2,
JR COMBE, OTHERS
ACNP-62832 /OCTOBER 18, 1962/

ADDENDUM TO SM-1A HAZARDS SUMMARY REPORT FOR
CORE 3.

HITTMAN ASSOC. INC.,
HIT-3534-1 /JUNE 30, 1965/

SEE ALSO SM-1

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HD03

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NAME/OWNER PM-2A /PORTABLE MEDIUM POWER 2A/ DOD
SKID-MOUNTED APPR

DESIGNER ALCO PRODUCTS INC.

OPERATOR US ARMY

LOCATION CAMP CENTURY, GREENLAND /IN 1965 NRTS, IDAHO/

PURPOSE POWER AND SPACE HEAT

TYPE PWR, PACKAGED POWER

POWER MWE(MWT) 1.5 10

CRITICAL 1960, TRANSFERRED TO NRTS, RE-STARTUP 1965

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET, BORON ADDED

FUEL GEOMETRY PLATE 30 MILS THICK

FUEL CLADDING SS 5 MILS THICK

FUEL ENRICH. 93 PERCENT U-235

FUEL ASSEMBLY ASSEMBLY OF FUELED PLATES

FUEL CHARGE 18.49 KG, U-235

BURNUP(REFUEL) CORE LIFE 10MW-YR

COOLANT TEMP. OUTLET 518 F

COOLANT PRESS. 1750 PSIA

CONTAINMENT UNDER-SNOW CONSTRUCTION, VAPOR CONTAINER.

REMARKS THE PLANT WAS DISMANTLED IN JANUARY, 1964, FOR
TRANSFER TO NRTS, IDAHO TO TAKE PART IN AEC-S
REACTOR SAFETY R+D PROGRAM.

REFERENCES HAZARDS SUMMARY REPORT. PREPACKAGED NUCLEAR
POWER PLANT FOR AN ICE-CAP STATION /PM-2A/
EM RIEBACK, OTHERS
APAE-49 /JULY 1959/ AND SUPPLEMENT /APRIL 1960/

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HD03

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SEE ALSO SM-1

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD04

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NAME/OWNER SM-2 /STATIONARY MEDIUM POWER-2/ AEG-DOD
APPR-1B

DESIGNER ALCO PRODUCTS INC.

PURPOSE POWER FOR NIKE-ZEUS INSTALLATIONS, REMOTE
LOCATIONS

TYPE PWR, PACKAGED POWER

POWER MWE(MWT) 6 28

CRITICAL DESIGN

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET, BORON ADDED

FUEL GEOMETRY PLATE

FUEL CLADDING SS

FUEL ENRICH. 93 PER CENT U-235

FUEL ASSEMBLY ASSEMBLY OF FUELED PLATES

FUEL CHARGE 36.2 KG. U-235

BURNUP(REFUEL) 2 CORES/YEAR

CONTROL FUEL ELEMENTS WITH ABSORBER FOLLOWER AND MTR-TYPE
CONTROL RODS

COOLANT TEMP. OUTLET 525 F

COOLANT PRESS. 2000 PSIA

CONTAINMENT SEPARATE VAPOR CONTAINMENT FOR EACH REACTOR IN A
MULTIPLE-REACTOR COMPLEX. 20 FT. VERTICAL
CYLINDER, PARTLY BELOW-GRADE,

REMARKS COMPLEX OF TWO SEPARATE REACTORS TO PROVIDE 12 MWE
FOR SITE POWER. CONSTRUCTION DEPENDS ON DOD
REQUIREMENTS.

REFERENCES CONCEPTUAL DESIGN OF SM-2 12000 KKW POWER COMPLEX,
ALCO PRODUCTS
APAE-68 /MAY 1960/

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SM-2 CORE AND VESSEL DESIGN ANALYSIS.
ALCO PRODUCTS
APAE-69 /VOL. 1,2, AND 3/ /MARCH 1961/

SEE ALSO SM-1

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD05

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NAME/OWNER	PL-3 /PORTABLE LOW-POWER-3//AEC,DOD
DESIGNER	ALCO PRODUCTS INC.
LOCATION	PROPOSED FOR BYRD STATION, ANTARCTICA
PURPOSE	POWER AND SPACE HEAT FOR ICE-CAP INSTALLATION.
TYPE	PWR, PACKAGED POWER
POWER MWE(MWT)	1 9.3
CRITICAL	DESIGN. FOR REDESIGN BY AC SEE PM-3B
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE-SS CERMET, ZIRCONIUM DIBORIDE ADDED.
FUEL GEOMETRY	PLATE 21.75 IN. ACT. LENGTH, 2.778 IN. WIDE, 0.030 IN. THICK
FUEL CLADDING	SS 0.005 IN. THICK
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	18-PLATE RECTANGULAR ASSEMBLY PLUS MOVABLE PLATES.
FUEL CHARGE	22.48 KG U-235
BURNUP(REFUEL)	AVE. 35 PER CENT, 2 YEARS
NEUTRON FLUX	THERMAL AVE 1×10^{13}
CONTROL	MTR-TYPE ROD, FUEL ELEMENT ABSORBER FOLLOWER
COOLANT TEMP.	INLET 454 F OUTLET 487 F
COOLANT PRESS.	1200 PSIA
REACTOR VESSEL	SS-LINED STEEL VESSEL 40 IN. ID, 11 FT. 6 IN. LONG
CONTAINMENT	SNOW TUNNEL, DOUBLE VAPOR CONTAINER COMPOSED OF VERTICAL CYLINDERS, ONE CONTAINING THE REACTOR VESSEL AND THE OTHER THE STEAM GENERATOR, PRESSURIZER, AND PRIMARY PUMP. VESSELS CONNECTED BY FLEXIBLE DUCTS.
REMARKS	NEW DESIGNATION IS PM-3B. PHASE I STUDY AND

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DESIGN RECOMMENDATION HAS BEEN COMPLETED. AC HAS
DONE A RE-EVALUATION OF ALL WORK DONE ON PM-3B
WITH THE OBJECTIVE OF A NEW DESIGN CONCEPT FOR A
LIGHTER, MORE COMPACT PORTABLE REACTOR OF AT
LEAST 1 MWE POWER RATING.

REFERENCES

PWR PRELIMINARY DESIGN DATA FOR PL-3,
ALCO PRODUCTS,
APAE-115 /VOL. 2/ /FEBRUARY 1962/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD06

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NAME/OWNER PM-3B/PORTABLE MEDIUM-POWER-3B/AEC-DOD
 REDESIGN OF PL-3

DESIGNER ALLIS-CHALMERS MANUFACTURING CO.

LOCATION PROPOSED FOR BYRD STATION, ANTARCTICA

PURPOSE REDESIGN OF PL-3 FOR ICE CAP STATION
 /BYRD STATION/

TYPE PWR, PACKAGED POWER

POWER MWE(MWT) 1.3 8.2

CRITICAL DESIGN, REDESIGN OF PL-3

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS MATRIX

FUEL GEOMETRY TUBE 0.506 IN. OD./0.416 IN. ID./ACT. LENGTH 30 IN

FUEL CLADDING SS 0.0060 IN. THICK, INNER AND OUTER

FUEL ENRICH. 93.2 PER CENT U-235

FUEL ASSEMBLY 129-TUBE BUNDLE
 6 FUEL BUNDLES/CORE
 FUEL BUNDLES CONTAIN CONTROL RODS WITH AN
 ABSORBER LENGTH OF EUROPIUM/TITANIUM OXIDE
 IN SS.

FUEL CHARGE 31.0 KG. U-235

BURNUP(REFUEL) CORE LIFE 24.0 MW-YR

NEUTRON FLUX THERMAL AVE. 1.16×10^{13}

CONTROL BURNABLE POISON ELEMENT, CONTROL RODS

COOLANT TEMP. 463 F

COOLANT PRESS. 1300 PSIA

REACTOR VESSEL STEEL PRESSURE VESSEL

REMARKS AC HAS EVALUATED ALL WORK DONE ON THE PM-3B /PL-3/
 DESIGN.

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REFERENCES

BYRD STATION STUDY. FINAL REPORT. INCLUDES
ADDENDUM 1.
ALLIS-CHALMERS MANUFACTURING CO.
ACNP-62848 AND ADD. 1 /FEBRUARY 1, 1963/

INLAND ANTARCTIC STATION NUCLEAR POWER PLANT
SUMMARY DESIGN REPORT.
VOL. 2. PRELIMINARY SAFETY ANALYSIS.
ALLIS-CHALMERS MANUFACTURING CO.
ACNP-63809 /VOL. 1-2/ /JULY 1963/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD07

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NAME/OWNER INDIAN POINT-1/CONSOLIDATED EDISON
 DESIGNER BABCOCK AND WILCOX
 OPERATOR CONSOLIDATED EDISON CO.
 LOCATION BUCHANAN /INDIAN POINT/ NEW YORK
 HUDSON RIVER
 PURPOSE POWER
 TYPE PWR, THORIUM-URANIUM CONVERTER.
 POWER MWE(MWT) 163 585
 CORE B, 282 MWE AND 615 MWT
 CRITICAL AUG, 1962, FULL POWER JAN, 1963
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL CORE 1 URANIUM/THORIUM DIOXIDE PELLETS
 0.26 IN. DIA./0.78 IN. LONG
 CORE 2 URANIUM DIOXIDE PELLETS, NO THORIUM
 0.313 IN. DIAM./0.620 IN. LONG
 FUEL GEOMETRY RODS, ACT. LENGTH 98.5 IN.
 CORE 2, 0.3417 IN. OD, 101.5 IN. ACT. LENGTH
 FUEL CLADDING SS 0.0205 IN. THICK
 CORE 2, 0.012 IN. THICK
 FUEL ENRICH. 93 PER CENT U-235, RADIAL.
 CORE 2 SLIGHT
 FUEL ASSEMBLY CORE 1, 195-ROD BUNDLE IN ZIRCALOY-2 ASSEMBLY,
 120 ASSEMBLIES/CORE
 CORE 2, 14 X 14 ROD BUNDLE, 23 RODS OMITTED,
 SS PERFORATED BOX,
 120 ASSEMBLIES/CORE
 FUEL CHARGE 1100 KG. U-235 AND 17,200 KG. THORIUM OXIDE
 BURNUP(REFUEL) 22000 MWD/T BATCH, CENTER 40
 ELEMENTS/YEAR WITH
 CORE B
 NEUTRON FLUX THERMAL AVE. 2×10^{13}
 CONTROL CONTROL RODS, FIXED SHIMS, SOLUBLE POISON, AND

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BURNABLE POSION IN THE FUEL CLADDING,

COOLANT TEMP. INLET 486 F OUTLET 570 F

COOLANT PRESS. 1500 PSIA

REACTOR VESSEL CARBON STEEL CYLINDER 36 FT. 9 IN. HIGH / 9 FT.
9 IN. ID. AND 6.95 IN. WALL THICKNESS.CONTAINMENT STEEL SPHERE 160 FT. ID. SURROUNDED BY CONCRETE
STRUCTURE WITH 5 1/2 FT. THICK WALLS AND 2 3/4 FT.
THICK DOMED ROOF.REMARKS SECOND CORE IS AN ADVANCED 3-REGION DESIGN.
REFUELING COMPLETED MARCH 16, 1966.
CRITICAL APRIL 1, FULL POWER END OF APRIL 1966.REFERENCES REACTOR STUDIES, FINAL REPORT, PART I,
TID-10117 /1955, DECLASSIFIED MARCH 1957/THE CONSOLIDATED EDISON THORIUM REACTOR
F WARD
BNL-483 /JANUARY 1958/CORE DESIGN AND CHARACTERISTICS OF THE
CONSOLIDATED EDISON REACTOR.
BAW-9 /REV.3/ /AUGUST 1958/THE CONSOLIDATED EDISON COMPANY OF NEW YORK
NUCLEAR ELECTRIC GENERATING STATION.
GR MILNE, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY 8. 483-9 /1958/HAZARDS SUMMARY REPORT, CONSOLIDATED EDISON
THORIUM REACTOR.
USAEC DOCKET 50-3, EXHIBIT K-5 /REV. 1/
BABCOCK AND WILCOX CO. /JANUARY 1960/CONSOLIDATED EDISON THORIUM REACTOR PHYSICS
DESIGN.
HS BARRINGER, OTHERS
BAW-120 /REV.1/ /JULY 1960/INDIAN POINT -CONSOLIDATED EDISON-S THORIUM
CONVERTER.
NUCLEAR ENG. 6. 413-23 /OCTOBER 1961/INDIAN POINT ON-THE-LINE.
NUCLEONICS REACTOR FILE NO. 14

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NUCLEONICS 21, 45-52 /APRIL 1963/

CONSOLIDATED EDISON NUCLEAR STEAM GENERATING
STATION.

POWER REACTOR TECHNOLOGY 6 /3/, 28-40 /JUNE 1963/

PRELIMINARY HAZARDS SUMMARY REPORT FOR THE
CONSOLIDATED EDISON INDIAN POINT REACTOR, CORE B,
CONSOLIDATED EDISON /N.Y./ AND WESTINGHOUSE
ELECTRIC CORPORATION.
NP-12869 /ND/CONCEPTUAL DESIGN OF CORE B, CONSOLIDATED EDISON
COMPANY.INDIAN POINT NUCLEAR FACILITY,
WESTINGHOUSE ELECTRIC CORP.
TID-20964

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD08

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NAME/OWNER MSR /MERCHANT SHIP REACTOR//AEC-MA
N.S. SAVANNAH,

DESIGNER BABCOCK AND WILCOX

OPERATOR MARITIME ADMINISTRATION, U. S. A.

LOCATION LAND-BASED PROTOTYPE AT LYNCHBURG, VA.

PURPOSE SHIP PROPULSION, SURFACE.

TYPE PWR

POWER MWE(MWT) 20,000 SHP 70

CRITICAL FEB, 1960
SAVANNAH WILL OPERATE THROUGH 1968
REFUELING SCHEDULED FOR AUG, 1968,

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.4245 IN. DIA./0.5 IN.
LONG

FUEL GEOMETRY ROD 66 IN. ACTIVE LENGTH

FUEL CLADDING SS TUBES 0.035 IN. WALL THICKNESS

FUEL ENRICH. 4.2 AND 4.6 PER CENT U-235

FUEL ASSEMBLY 164-TUBE ELEMENT. TUBES ARE HELD IN A RIGID BUNDLE
OF 41 ELEMENTS BY BRAZED SS FERRULES /EGG-CRATE
STRUCTURE/
32 ASSEMBLIES/CORE

FUEL CHARGE 312.4 KG U-235 SEE REMARKS

BURNUP(REFUEL) 7352 MWD/MTU SEE REMARKS

CONTROL CRUCIFORM RODS, BORON-SS, TOP-DRIVEN.

COOLANT TEMP. INLET 463 F OUTLET 519 F

COOLANT PRESS. 1750 PSIA

REACTOR VESSEL SS-LINED CARBON STEEL CYLINDER 98 IN. ID./26 FT.
10 IN. HIGH.

CONTAINMENT SHELL LYING LENGTH-WISE OF SHIP IS A CYLINDER WITH

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HEMISPHERICAL ENDS, CENTER CUPOLA, 35 FT. DIA.
BY 50 1/2 FT. LONG.
BY 50 1/2 FT. LONG.

REMARKS

N.S. SAVANNAH OPERATION, 1961.
CORE SHUFFLING IN SEPT/OCT 1968 INVOLVED REMOVAL
OF CENTRAL 4 ELEMENTS, SHUFFLING THE REMAINING 28,
AND INTRODUCTION OF 4 SPARES, TO GIVE FOUR MORE
YEARS OF OPERATION.

REFERENCES

THE POWER PLANT FOR THE FIRST NUCLEAR MERCHANT
SHIP /N.S. SAVANNAH/.
JW LANDIS
TID-7563 /P. 11/ /AUGUST 1958/

NUCLEAR MERCHANT SHIP REACTOR, FINAL SAFEGUARDS
REPORT, DESCRIPTION OF THE N. S. SAVANNAH.
GE KULYNCH
BAW-1164, VOL. I /JUNE 1960/

N.S. SAVANNAH.
NUCLEAR ENG. 5, 447-51 /OCTOBER 1960/

DESIGN PRACTICE . THE N.S. SAVANNAH.
POWER REACTOR TECHNOLOGY 6, 43-54
/DECEMBER 1962/

NUCLEAR PROPULSION FOR MERCHANT SHIPS.
AW KRAMER
US. GPO, WASHINGTON, D.C. 1962

LIFETIME STUDIES FOR THE N.S. SAVANNAH REACTOR.
EE GROSS, OTHERS
ORNL-3261, SUPPL. /APRIL 1963/

NUCLEONICS WEEK JULY 21, 1966
NEWS RELEASE

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NAME/OWNER CNSG /CONSOLIDATED NUCLEAR STEAM GENERATOR//BAW

DESIGNER BABCOCK AND WILCOX

PURPOSE SHIP PROPULSION

TYPE PWR, FORCED CIRCULATION, CLOSED CYCLE

POWER MWE(MWT) 27,500 SHP 62.4

CRITICAL REFERENCE DESIGN. SEE REMARKS.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS, COMPACTED

FUEL GEOMETRY PIN, SWAGED, 0.460 IN. DIA, ACT. LENGTH 42 IN.

FUEL CLADDING ZIRCALOY-2 0.021 IN. THICK

FUEL ENRICH. ZONE 1,2 AND 3, 1.6, 2.1, AND 3.1 PER CENT U-235

FUEL ASSEMBLY TYPE A, 108-PIN BUNDLE, TOTAL 13 ASSEMBLIES,
TYPE B, 121-ROD BUNDLE, TOTAL 24 ASSEMBLIES,
REGION 1, 1 TYPE A ELEMENT /CENTRAL/
REGION 2, 6 TYPE B ELEMENTS /INNER RING/ PLUS
RING OF 12 TYPE A ELEMENTS
REGION 3, 18 TYPE B ELEMENTS /OUTER RING/
CORE CONTAINER IS A SEGMENTED SS STRUCTURE

FUEL CHARGE 4100 KG. URANIUM DIOXIDE, 92.85 KG. U-235

BURNUP(REFUEL) 15,000 MWD/T FUEL SHUFFLING
URANIUM DIOXIDE

CONTROL CHEMICAL SHIM, BORIC ACID, CONTROL RODS

COOLANT TEMP. INLET 490.4 F OUTLET 520 F

COOLANT PRESS. 816 PSIA

REACTOR VESSEL STEEL CYLINDER 10 FT. DIA./27 FT. HIGH, OUTER
8 IN. THICK LEAD CLADDING BONDED TO SHELL. VESSEL
COMPLETELY SUBMERGED IN WATER. SEE REMARKS.

CONTAINMENT WATER-FILLED STEEL CYLINDRICAL VESSEL 19 FT. DIA./
38 FT HIGH. PRESSURE-SUPPRESSION. SEE REMARKS.

REMARKS THE CONCEPT IS BASED ON MSR AND IBR DESIGNS. IN

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REDESIGN STUDIES, CNSG-2 IS A COMPACT SYSTEM USING SOLID IN-CORE BURNABLE POISON, AND HAS WET CONTAINMENT BUT WITH THE WATER IN A WELL. CNSG-3 IS THE MOST ADVANCED DESIGN, WITH STEAM GENERATOR OR HEAT EXCHANGER WITHIN THE REACTOR PRESSURE VESSEL. CORE IS OF ROD OR PIN TYPE WITH URANIUM DIOXIDE PELLETS IN ZIRCALOY TUBES AND 4 ZONES OF ENRICHMENT, AVERAGING ABOUT 5 PER CENT. ACTIVE CONTROL ROD MATERIAL IS A CADMIUM-INDIUM-SILVER ALLOY AND THE BURNABLE POISON ZIRCONIUM DIBORIDE DISPERSED IN ZIRCONIUM OXIDE. CNSG-3 HAS THREE SIZES, 22,000, 44,000 AND 66,000 SHP. WITH ITS GERMAN AFFILIATE DEUTSCHE BABCOCK AND WILCOX, BAW HAS PREPARED A DESIGN BASED ON CNSG-1 WHICH WAS SELECTED FOR GERMANY-S NUCLEAR SHIP. IT DIFFERS ONLY IN THE FACT THAT THE STEAM GENERATOR IS MOVED OUTWARD FROM THE CORE, SUBSTITUTION OF AN IN-CORE BURNABLE POISON FOR CHEMICAL SHIM CONTROL, AND DRY, HOT WET CONTAINMENT. A COMPACT, NATURAL CIRCULATION SYSTEM FOR UNDERWATER SERVICE, CONTROLLED ONLY BY STEAM DEMAND, HAS BEEN DESIGNED.

SEE HD15

REFERENCES

CONSOLIDATED NUCLEAR STEAM GENERATOR FOR MERCHANT SHIP APPLICATION. A CONCEPTUAL DESIGN, BABCOCK + WILCOX CO. BAW-1243 /AUGUST 1962/

CONSOLIDATED NUCLEAR STEAM GENERATOR FOR MARINE APPLICATION. ENGINEER 214, 789-90 /NOVEMBER 2, 1962/

COMPACT MARINE REACTOR. NUCLEAR ENERGY, DECEMBER 1962, P. 465.

CNSG-3, MOST ADVANCED PWR FOR MERCHANT MARINE USE. NUCLEONICS 22, 23-25 /JULY 1964/

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HD10

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NAME/OWNER PALISADES PARK NUCLEAR STATION/CONSUMERS POWER
DESIGNER COMBUSTION ENGINEERING
OPERATOR CONSUMERS POWER CO.
LOCATION PALISADES PARK, MICHIGAN /LAKE MICHIGAN/
PURPOSE POWER
TYPE PWR, 2-LOOP SYSTEM
POWER MWE(MWT) 770 2200
CRITICAL TARGET NOV. 1969
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.359 IN. DIAM./0.5 IN.
FUEL GEOMETRY ROD, ACT. LENGTH 132 IN.
FUEL CLADDING ZIRCALOY-4, 0.365 IN. ID, 0.413 IN. OD,
 0.024 IN. WALL THICKNESS.
FUEL ENRICH. BATCH 1, 1.80 PER CENT U-235
 BATCH 2, 2.20
 BATCH 3, 2.74
FUEL ASSEMBLY 217-ROD BUNDLE, 15X15
 INSTRUMENTED BUNDLES, 216 RODS
 LEAF-SPRING SPACERS
 204-BUNDLES/CORE, 45 OF THEM INSTRUMENTED.
FUEL CHARGE 89,200 KG, URANIUM
SPECIFIC POWER 24.7 KW/KG URANIUM
BURNUP(REFUEL) 24,000 MWD/MTU 1/3 CORE
CONTROL ROD, BORON CARBIDE-SS, TOP-MOUNTED,
 CHEMICAL SHIM /BORIC ACID/
COOLANT TEMP. INLET 545 F OUTLET 591 F
COOLANT PRESS. 2100 PSIA
REACTOR VESSEL SS-CLAD STEEL SHELL 172 IN. ID/40 FT. HIGH

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HD10

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CLAD THICKNESS 3/16 IN.

CONTAINMENT PRESTRESSED CONCRETE CYLINDER, DOMED ROOF.
WALL THICKNESS 3 FT.
INNER LINING OF 1/4 IN. STEEL PLATE.
BUILDING ENCLOSES PRIMARY COOLANT SYSTEM,
SAFETY INJECTION, CORE SPRAY SYSTEMS.

REMARKS FIRST CORE WILL BE PURCHASED FROM CE UNDER A
SEPARATE CONTRACT. THE PLANT WILL BECOME PART
OF MICHIGAN POWER POOL INTERCONNECTING CONSUMERS
POWER AND DETROIT EDISON SYSTEMS.

REFERENCES PALISADES PLANT.
FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT
VOL. 1-2
CONSUMERS POWER COMPANY
DOCKET 50-255 /1966/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD11:

NAME/OWNER	NUCLEAR TANKER DESIGN STUDY/CE-AEC	
DESIGNER	COMBUSTION ENGINEERING, INC.	
PURPOSE	SHIP PROPULSION	
TYPE	PWR, FORCED CIRCULATION	
POWER MWE(MWT)	30,000 SHP	82
CRITICAL	REFERENCE DESIGN	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.312 IN. DIA./0.468 IN. LONG	
FUEL GEOMETRY	RODS, ACTIVE LENGTH 52 IN.	
FUEL CLADDING	SS TUBES 0.023 IN. WALL THICKNESS	
FUEL ENRICH.	5.4 PER CENT U-235. ZONE ENRICHMENT	
FUEL ASSEMBLY	91-ROD CLUSTER 87 CONTAIN FUEL AND 3 BURNABLE POISON 91 CLUSTERS/CORE, 19 ARE MOVABLE FOR CONTROL.	
FUEL CHARGE	4.424 METRIC TONS URANIUM	
BURNUP(REFUEL)	890 DAYS	
NEUTRON FLUX	THERMAL AVE. 1.7×10^{13}	
CONTROL	NEUTRON RECTIFIER ASSEMBLIES, BURNABLE POISON	
COOLANT TEMP.	INLET 589 F	OUTLET 620 F
COOLANT PRESS.	2000 PSIA	
REACTOR VESSEL	CARBON STEEL, SS LINED, 75 IN. OD./228 IN. LONG. WALL 4.75 IN. THICK.	
CONTAINMENT	VAPOR CONTAINER, STEEL, ENCLOSES ENTIRE MAIN COOLANT SYSTEM. CYLINDRICAL SHELL, HEMISPHERICAL ENDS, 34 FT. DIA. /52 FT. HIGH.	
REMARKS	DEVELOPMENT OF A REFERENCE CONCEPTUAL DESIGN FOR NUCLEAR CARGO OR TANKER, IN CONJUNCTION WITH	

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HD11

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GEORGE C. SHARP INC., FOR THE AEC.

REFERENCES

NUCLEAR POWERED TANKER DESIGN AND ECONOMIC
ANALYSIS PRESSURIZED WATER REACTOR,
COMBUSTION ENG. INC.
CEND-62 /1960/
NYO-2860 /1960/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD12

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NAME/OWNER ADVANCED SHIP REACTOR/CE
 DESIGNER COMBUSTION ENGINEERING, INC.
 PURPOSE SHIP PROPULSION
 TYPE PWR, INDIRECT CYCLE, SELF-PRESSURIZING
 POWER MWE(MWT) 30,000 SHP 79.2
 CRITICAL CONCEPTUAL DESIGN
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLET 0.514 IN. DIA.
 FUEL GEOMETRY ROD 0.594 IN. DIA./60 IN. ACTIVE LENGTH
 FUEL CLADDING SS TUBE 0.037 IN. WALL THICKNESS
 FUEL ENRICH. 4.3 PER CENT U-235. ZONE /3/ ENRICHMENT
 FUEL ASSEMBLY 58-ROD CLUSTER /FUEL/
 61-ROD CLUSTER /MOVABLE CONTROL/
 61 FUEL CLUSTERS, INCLUDING 12 MOVABLE
 CONTROL CLUSTERS, IN CORE.
 FUEL CHARGE 6.67 METRIC TONS URANIUM
 BURNUP(REFUEL) 14,100 MWD/MTU
 CONTROL NEUTRON RECTIFIER ASSEMBLIES, SILVER-INDIUM
 CADMIUM IN SS
 COOLANT TEMP. INLET 600 F OUTLET 642.7 F
 COOLANT PRESS. 2100 PSIA
 REACTOR VESSEL STEEL CYLINDER, SS INNER CLADDING, 90.8 IN. OD.
 AND 23.4 FT. LONG.
 CONTAINMENT STEEL CYLINDER, HEMISPHERICAL HEADS, 34 FT. DIA.
 BY 50 FT. HIGH, CONTAINING ALL MAJOR COMPONENTS OF
 THE REACTOR SYSTEM. THE VESSEL IS SEALED.
 REMARKS UP-DATING OF THE NUCLEAR TANKER REFERENCE DESIGN
 STUDY. A LOW-PRESSURE 1300 PSI SYSTEM WOULD
 UTILIZE THINNER CLADDING AND LOWER ENRICHMENT FUEL

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HD12

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REFERENCES

ADVANCED INDIRECT CYCLE WATER REACTOR STUDIES FOR
MARITIME APPLICATIONS. PART 2, PLANT CONCEPTUAL
STUDIES,
COMBUSTION ENG. INC.
CEND-150 /PT.2/ /1962/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD13

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NAME/OWNER	UMP /UNIFIED MODULAR PLANT//CE
DESIGNER	COMBUSTION ENGINEERING, INC.
PURPOSE	SHIP PROPULSION
TYPE	PWR, CLOSED CYCLE, MODULAR
POWER MWE(MWT)	30,000 SHP 80
CRITICAL	DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	ROD 0.328 IN. OD, OUTSIDE CLADDING, ACT. LENGTH 50 IN.
FUEL CLADDING	SS TUBES 0.015 IN. WALL THICKNESS
FUEL ENRICH.	5.9 PER CENT U-235, ZONE ENRICHMENT
FUEL ASSEMBLY	127-ROD BUNDLE. 12 MOVABLE BUNDLES INCLUDE A HOLLOW WATER-FILLED NEUTRON ABSORBING SECTION FOR COLD SHUT-DOWN. ALL ABSORBER SECTIONS ARE OUT OF CORE DURING OPERATION. 61 BUNDLES/CORE 36 ARE IN FIRST COOLANT PASS AND 25 IN SECOND, OR INNER, COOLANT PASS.
FUEL CHARGE	3.93 METRIC TONS URANIUM
BURNUP(REFUEL)	20,000 MWD/MTU
CONTROL	SELF-REGULATED CHANGES IN COOLANT DENSITY, AND MOVABLE ELEMENTS FOR COLD SHUT-DOWN.
COOLANT TEMP.	INLET 630/590 F OUTLET 668/636 F
COOLANT PRESS.	2500/2000 PSI
REACTOR VESSEL	STEEL VESSEL 71 IN. ID./22 FT. 4 IN. HIGH. HEAT EXCHANGER IS WITHIN THE PRESSURE VESSEL. WATER TIGHT CANNING SURROUNDS THE VESSEL, CIRCULATING PUMPS, AND COLD SHUT-DOWN MECHANISMS.
CONTAINMENT	VAPOR SUPPRESSION. VESSEL 16 FT. ID./34 FT. LONG

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HD13

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OF 1 1/2 IN. THICK STEEL. CONTAINMENT VESSEL
COMPLETELY ENCAPSULATES THE REACTOR VESSEL AND ITS
SHIELDING. SPACE BETWEEN THE CANNED REACTOR
ASSEMBLY AND CONTAINMENT VESSEL WALL IS FILLED
WITH BORATED WATER TO ABOVE REACTOR VESSEL HEAD.

REMARKS

TWO COOLANT PASSES, PERIPHERAL AND INNER, ARE
UPWARD. RADIAL POWER FLATTENING IN THE CORE IS
ACHIEVED BY THE USE OF TWO ENRICHMENT ZONES, AND
BURNABLE POISON IS USED TO MINIMIZE THE LIFETIME
REACTIVITY VARIATION.

REFERENCES

THE UNIFIED MODULAR PLANT, A COMPACT NUCLEAR
STEAM GENERATOR FOR MARINE APPLICATION,
PC SMOLA, OTHERS
CEND-169 /DEC. 1963/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD14

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NAME/OWNER ELPHR /EXPERIMENTAL LOW-TEMPERATURE PROCESS HEAT
REACTOR//AEC

DESIGNER ALLIS-CHALMERS, SARGENT + LUNDY

LOCATION PORT LOMA, CALIFORNIA-PROPOSED

PURPOSE WATER DESALINIZATION

TYPE PWR, CLOSED CYCLE

POWER MWE(MWT) 0 40

CRITICAL DESIGN STUDY

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY ROD 0.4 - 0.5 IN. DIA.

FUEL CLADDING SS 0.015 - 0.020 IN. THICK

FUEL ENRICH. 3-4.1 PER CENT U-235

FUEL ASSEMBLY SEE REMARKS

FUEL CHARGE 2970-3440 KG. URANIUM

BURNUP(REFUEL) 6388-14,600 MWT/T

CONTROL RODS, BURNABLE POISON

COOLANT TEMP. INLET 400-412 F OUTLET 429-454 F

COOLANT PRESS. 895-917 PSIA

REACTOR VESSEL STEEL VESSEL

REMARKS FLUOR CORP. EVALUATED AND COMPARED THE VARIOUS
PROPOSALS FOR A SALT WATER DISTILLATION AUXILIARY
REACTOR SYSTEM FOR CONSTRUCTION AT POINT LOMA,
CALIFORNIA. THE PROJECT HAS BEEN POST-PONED.REFERENCES COMPARISON AND EVALUATION OF REACTOR PACKAGE
PROPOSALS.
EXPERIMENTAL LOW TEMPERATURE PROCESS HEAT REACTOR
PROJECT.

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD14

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EH HYKAN, RA JOHNSON
SL-1767 /DECEMBER 1959/

EXPERIMENTAL LOW-TEMPERATURE PROCESS HEAT REACTOR
PROJECT.
CONTRACT TERMINATION REPORT.
SARGENT + LINDY, ALLIS-CHALMERS MNFG. CO.
TID-12385 /FEB. 24, 1961/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD15

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NAME/OWNER	COMPACT UNDERWATER PWR/OE NATURAL CIRCULATION CNSG
DESIGNER	COMBUSTION ENGINEERING
PURPOSE	UNDERWATER SERVICE
TYPE	PWR, NATURAL CIRCULATION
POWER MWE(MWT)	1000-7000 SHP 8 AND 16 MWT VERSIONS
CRITICAL	DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
CONTROL	BY STEAM DEMAND, NO CONTROL RODS.
REACTOR VESSEL	SINGLE PRESSURE VESSEL ENCLOSES ENTIRE PRIMARY SYSTEM.
REFERENCES	COMPACT, DEMAND-CONTROLLED, WATER-COOLED NUCLEAR REACTORS FOR UNDERWATER SERVICE, COMBUSTION ENG. INC. AIAA PREPRINT 65-572 CONF-650610-7

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD16

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NAME/OWNER PELICAN POINT REACTOR/AEC, MWD AND S. CALIF. ED.
 BOLSA ISLAND

DESIGNER BECHTEL CORP.-FEASIBILITY STUDY.

LOCATION PELICAN POINT /HUNTINGDON/, CALIF.
 ARTIFICIAL ISLAND

PURPOSE POWER AND WATER DESALINATION

TYPE PWR, TWIN REACTORS /OR BWR PLANTS/

POWER MWE(MWT) 900 3080 PER REACTOR

CRITICAL DROPPED
 SEE REMARKS

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL CLADDING ZIRCONIUM

FUEL ENRICH. SLIGHT

CONTAINMENT REINFORCED CONCRETE CYLINDER FOR EACH REACTOR
 137 FT. ID/90 FT. HIGH, 5.5 FT. THICK.

REMARKS THE NUCLEAR ISLAND STUDY INCLUDED A 150 MGD
 MULTISTAGE FLASH DISTILLATION PLANT AND TWO LARGE
 PWR OR BWR SYSTEMS.
 NUCLEAR PROJECT HAS BEEN DROPPED BECAUSE OF
 ESCALATING COSTS.

REFERENCES ENGINEERING AND ECONOMIC FEASIBILITY STUDY FOR A
 COMBINATION NUCLEAR POWER AND DESALTING PLANT.
 SUMMARY
 TID-22330 VOL. 3 /JAN. 1966/
 PREPARED BY BECHTEL CORP.

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD17

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NAME/OWNER ONCE-THROUGH PWR/BAW

DESIGNER BABCOCK AND WILCOX

PURPOSE POWER

TYPE PWR, ONCE-THROUGH STEAM-GENERATOR,
TWO-LOOP SYSTEM

POWER MWE(MWT) 750 2300

CRITICAL DESIGN

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL GEOMETRY PINS

FUEL CLADDING ZIRCALOY-4

FUEL ENRICH. 2.55 PER CENT U-235, AVE.

FUEL ASSEMBLY 177 ASSEMBLIES/CORE

CONTROL SILVER-INDIUM-CADMIUM RODS

COOLANT TEMP. 565.5 F

COOLANT PRESS. 2185.0 PSIG

REMARKS PRELIMINARY SAFETY REVIEW BY AEC REQUESTED

REFERENCES NUCLEAR INDUSTRY JAN. 1966 P. 9
NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD18

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NAME/OWNER ISRAELI PLANT STUDY/US-ISRAEL JOINT BOARD
PWR

DESIGNER KAISER ENG./CATALYTIC CONSTRUCTION

LOCATION NITZANIM OR NAHAL SOREQ /NEVE RUBIN/, ISRAEL
PREFERRED SITE NITZAMIN, NEAR ASHDOD.

PURPOSE POWER AND DESALINATION

TYPE PWR, INDIRECT CYCLE, 2-LOOP SYSTEM.

POWER MWE(MWT) 200 1500

CRITICAL ENGINEERING, ECONOMIC FEASIBILITY STUDY.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY RODS

FUEL CLADDING ZIRCALOY TUBES /THIN/

FUEL ASSEMBLY 3 CONCENTRIC CORE REGIONS

CONTAINMENT STEEL SPHERE OR CONCRETE CYLINDER, PRESSURE-TIGHT
REINFORCED CONCRETE, INNER STEEL LINER,
PRESTRESSED CONCRETE, STEEL LINER.

REMARKS DESALTING PLANT CAPACITY IS 100 MGD.
PLANT CONSISTS OF THE REACTOR, TURBINE GENERATOR,
FOUR MULTISTAGE FLASH EVAPORATOR UNITS.
A REFERENCE BWR PLANT IS ALSO CONSIDERED.
FUEL IS MODULAR, 7X7 ROD BUNDLE IN ZIRCALOY-4
CHANNEL. FUEL PELLETS OF URANIUM DIOXIDE IN
ZIRCALOY-2 CLAD RODS.

REFERENCES ENGINEERING FEASIBILITY AND ECONOMIC STUDY FOR
DUAL-PURPOSE POWER-WATER DESALTING PLANT,
KAISER ENG., CATALYTIC CONSTRUCTION CO.
REPORT NO. 66-1-RE /JAN. 1966/

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD19

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NAME/OWNER	N-REACTOR/AEC, WPPSS	
DESIGNER	GENERAL ELECTRIC COMPANY	
OPERATOR	DOUGLAS UNITED NUCLEAR /DUN/	
LOCATION	RICHLAND, WASHINGTON COLUMBIA RIVER	
PURPOSE	PLUTONIUM AND POWER PRODUCTION.	
TYPE	PWR, PRESSURE TUBE	
POWER MWE(MWT)	800	4000
	POWER-ONLY OPERATION	
CRITICAL	APRIL 1966. FULL POWER DEC. 1966.	
COOLANT	LIGHT WATER	
MODERATOR	GRAPHITE	
FUEL MATERIAL	URANIUM METAL. FOR PHASE 3, URANIUM DIOXIDE	
FUEL GEOMETRY	RODS, CO-EXTRUDED	
FUEL CLADDING	ZIRCALOY-2	
COOLANT TEMP.	INLET 469 F	OUTLET 572 F
CONTAINMENT	SEPARATE BUILDINGS FOR REACTOR AND HEAT EXCHANGERS. CONFINEMENT-VOLUME WALLS ARE REINFORCED CONCRETE COATED WITH AN ELASTOMER. FOG-SPRAY SYSTEM AND VENT STACKS /PRESSURE-RELEASE/.	
REMARKS	ELECTRIC GENERATING EQUIPMENT BUILT BY THE WASHINGTON PUBLIC POWER SUPPLY SYSTEM /WPPSS/ HAS CAPACITY OF 800 MWE. N-REACTOR PRODUCED ELECTRICITY IN APRIL 1966 WITH FIRST GENERATOR ON-LINE AT 200 MWE. FULL POWER 800 MWE DEC. 1966.	
REFERENCES	THE NEW PRODUCTION REACTOR. HW-SA-1755 /1959/ UTILITY PROPOSAL FOR POWER PLANT ADDITION TO HANFORD NEW PRODUCTION REACTOR. UNITED STATES CONGRESS JOINT COMMITTEE ON ATOMIC ENERGY. /JULY 1962/	

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HD19

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BASIS OF DESIGN: HANFORD NEW PRODUCTION REACTOR
/NPR/.

WJ DOWIS

HW-SA-2981 /APRIL 19, 1963/

NUCLEONICS WEEK APRIL 21, 1966

NEWS RELEASE

ANNUAL REPORT TO CONGRESS OF THE ATOMIC ENERGY
COMMISSION FOR 1965: /JAN, 1966/ P. 76-77

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD20

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NAME/OWNER PROCESS STEAM REACTOR/MARTIN
DESIGNER MARTIN-MARIETTA CORPORATION
PURPOSE PROCESS STEAM
TYPE PWR
POWER MWE(MWT) 0 45
CRITICAL CONCEPTUAL DESIGN
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLET 0.252 IN. DIA.
FUEL GEOMETRY ROD 0.280 IN. OD. 4.5 FT. LONG
FUEL CLADDING ALUMINUM ALLOY 0.012 IN. THICK /LEAD-BISMUTH BOND/
FUEL ENRICH. 2.5 PER CENT U-235
FUEL ASSEMBLY 19 BUNDLES CONTAINING 7250 RODS
FUEL CHARGE 3437 KG. URANIUM DIOXIDE
COOLANT TEMP. INLET 376 F OUTLET 430 F
COOLANT PRESS. 890 PSIA
REACTOR VESSEL SS-LINED CARBON STEEL VESSEL 14 FT. 5 IN. HIGH
 52 IN. ID. CYLINDER WITH HEMISPHERICAL ENDS.
CONTAINMENT ALUMINUM-LINED CONCRETE PIT FILLED WITH WATER,
 STEEL CONTAINMENT VESSEL.
REMARKS COOLANT ENTERS AT BOTTOM OF CORE, FLOWS UPWARD
 THROUGH OUTER 12 FUEL-ROD BUNDLES, DOWNWARD
 THROUGH ANNULUS BETWEEN PRESSURE VESSEL WALL AND
 INNER-MOST THERMAL SHIELD. ON SECOND PASS COOLANT
 FLOW IS THROUGH CENTRAL OF FUEL-ROD BUNDLES AND
 OUT OF PRESSURE VESSEL. MICHIGAN CHEMICAL CO.
 HAD PLANNED AN INSTALLATION. NO RECENT
 INFORMATION.
REFERENCES CONCEPTUAL DESIGN FOR A PROCESS STEAM REACTOR.
 C EICHELDERGER, OTHERS
 MND-RP-558-17 /JUNE 1958/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD21

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NAME/OWNER	PM-1 /PORTABLE MEDIUM-POWER-1/DOD SUNDANCE		
DESIGNER	MARTIN-MARIETTA CORPORATION		
OPERATOR	MARTIN-MARIETTA CORPORATION		
LOCATION	SUNDANCE, WYOMING		
PURPOSE	POWER AND SPACE HEAT		
TYPE	PWR, PACKAGED REACTOR		
POWER MWE(MWT)	1	9.3	
CRITICAL	FEB. 1962 CLOSED DOWN IN APRIL 1968,		
COOLANT	LIGHT WATER		
MODERATOR	LIGHT WATER		
FUEL MATERIAL	URANIUM DIOXIDE-SS CERMET 0.0285 IN. MEAT THICKNESS		
FUEL GEOMETRY	TUBE 0.506 IN. OD./0.417 IN. ID./30 IN. ACT. LENGTH		
FUEL CLADDING	SS 0.0085 IN. THICK, INNER AND OUTER		
FUEL ENRICH.	93.3 PER CENT U-235		
FUEL ASSEMBLY	121-ROD BUNDLE /PERIPHERAL/ 15-ROD BUNDLE /CENTRAL/ BUNDLES INCLUDE FUEL, POISON, AND DUMMY ELEMENTS. 741 RODS/CORE 6 PERIPHERAL BUNDLES AND 1 CENTRAL		
FUEL CHARGE	29.14 KG. U-235		
BURNUP(REFUEL)	9 KG. U-235	2 YEARS	
NEUTRON FLUX	THERMAL AVE. 1×10^{13}		
CONTROL	CONTROL RODS WITH EUROPIUM TITANATE AS ABSORBER MATERIAL, LUMPED BURNABLE POISON ELEMENTS, PARTIAL AND FULL LENGTH		
COOLANT TEMP.	463 F		

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COOLANT PRESS. 1300 PSIA

REACTOR VESSEL SS VESSEL 9.3 FT. HIGH/35 IN. ID.

CONTAINMENT PRIMARY SYSTEM UNCONTAINED, UNDERGROUND
CONSTRUCTION.

REMARKS BURNS AND ROE IS DEVELOPING A STANDARDIZED
PORTABLE NUCLEAR PLANT BASED ON THE SUNDANCE AND
MC-MURDO REACTORS. CORE 3 DEVELOPMENT BY MARTIN
CONSISTS OF TUBULAR SS CERMET ELEMENTS, BORON
CARBIDE-ZIRCALOY PELLET-IN-TUBE LUMPED BURNABLE
POISON ELEMENTS, AND PELLET-IN-TUBE FINGER-TYPE
CONTROL ELEMENTS. MAX. POWER WILL BE 30 MWT.
CORE IS INTENDED FOR REPLACEMENT OF PM-1 AND PM-3
CORES AND LATER PLANTS.

REFERENCES PM-1 NUCLEAR DESIGN ANALYSIS.
EA SCIECHITANO, RA HOFFMEISTER
MND-C-2487 /P. 25-55/ /1961/

PM-1 NUCLEAR POWER PLANT, ADDENDUM TO HAZARDS
SUMMARY EVALUATION.
W HAASS, J SIEG
MND-C-1853 /ADD. 1/ /FEBRUARY 1961/

PM-1 REACTOR CORE FINAL DESIGN REPORT.
RO BAGLEY, OTHERS
MND-M-1866 /JAN. 1962/

REACTOR FILE NO. 12, PM-1 ON-THE-LINE.
NUCLEONICS 20, 37-42 /SEPTEMBER 1962/

PM-1 CORE DESIGN
POWER REACTOR TECHNOLOGY 6 /3/, 43-46 /JUNE 1963/

PM RESEARCH AND DEVELOPMENT PROGRAM.
PM CORE 3 PARAMETRIC STUDY.
R LIGHTNER, OTHERS
MND-MD-2544 /OCT. 1963/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD22

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NAME/OWNER PM-3A/US NAVY
 MCMURDO SOUND, ANTARCTIC

DESIGNER MARTIN-MARIETTA CORPORATION

OPERATOR US NAVY

LOCATION MC MURDO SOUND, ANTARCTICA

PURPOSE POWER AND SPACE HEAT.

TYPE PWR, PACKAGED REACTOR

POWER MWE(MWT) 1.5 9.3

CRITICAL MARCH 1962. REFUELING JANUARY 1965

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE-SS CERMET

FUEL GEOMETRY TUBE 0.506 IN. OD./0.417 IN. ID./30 IN. ACT.
 LENGTH

FUEL CLADDING SS 0.0085 IN. THICK, INNER AND OUTER

FUEL ENRICH. 93.3 PER CENT U-235

FUEL ASSEMBLY 121-ROD BUNDLE /PERIPHERAL/
 15-ROD BUNDLE /CENTRAL/
 1 CENTRAL BUNDLE
 6 PERIPHERAL BUNDLES
 BUNDLES INCLUDE POISON AND DUMMY ELEMENTS.

FUEL CHARGE 29.14 KG. U-235

NEUTRON FLUX THERMAL AVE. 1×10^{13}

CONTROL BURNABLE POISON ELEMENTS, UNCLAD BORON-SS
 CYLINDERS, Y-SHAPED SS CLAD CERMET OF EUROPIUM-SS
 CONTROL ELEMENT

COOLANT TEMP. 463 F

COOLANT PRESS. 1300 PSIA

REACTOR VESSEL SS CYLINDRICAL VESSEL

REMARKS INSTALLATION DECEMBER 1961 AT BASE, AND STARTUP

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD22

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IN MARCH, 1962, CORE DESIGN FOR REPLACEMENT HAS BEEN DEVELOPED BY MARTIN. SEE PM-1. DISTILLATION PLANT OPERATED BY STEAM FROM THE REACTOR WAS TESTED SUCCESSFULLY IN FEB, 1966. THE PLANT BEGAN FULL-TIME OPERATION IN FALL OF 1966. EVAPORATOR PLANT CAN PRODUCE 11 GAL. FRESH WATER PER MINUTE AND STORE 55,000 GAL. SHUT-DOWN LATE SUMMER 1967 FOR REFUELING WITH ROD-TYPE CORE-3. LOW-ENRICHMENT CORE-4, DUE AT MCMURDO DEC. 1968, WILL SERVE AS BACK-UP CORE UNTIL NECESSARY REFUELING IN 1969-70. REDESIGNED RADIOACTIVE WASTE DISPOSAL SYSTEM IS ALSO ON TAP. REACTOR MAY BE REPLACED BY A NEW 5-MWE PLANT IN 1975.

REFERENCES

MARTIN DESIGN REPORT-ICE CAP NUCLEAR POWER PLANT, VOL. 1 AND 2,

RJ AKIN

MND-MPR-1581 /VOL 1 AND 2/ /1959/

THE PM-3A ANTARCTIC REACTOR,
U.S. AEC, U.S. NAVY
BROCHURE, DISTRIBUTED 1961,

PM-3A NUCLEAR POWER PLANT HAZARDS SUMMARY REPORT,
SAFETY EVALUATION.

T DOBRY

MND-M3A-2496-2 /ADD/ /NOVEMBER 1951/

OCEAN SCIENCE NEWS MARCH 4, 1966 P. 3
NEWS RELEASE

PM-3A NUCLEAR POWER PLANT HAZARDS SUMMARY REPORT,
DESCRIPTION OF PLANT EXPERIENCE AND CHANGES.

CH FOX, OTHERS

MND-3315-1 /JAN. 1964/

NUCLEONICS WEEK APRIL 6, 1967 P. 2
NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD23

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NAME/OWNER FBR /FLUIDIZED BED REACTOR//AEC
DESIGNER MARTIN-MARIETTA CORPORATION
OPERATOR CRITICAL EXPERIMENT-MARTIN
LOCATION CRITICAL EXPERIMENT, MIDDLE RIVER, MD.
PURPOSE POWER EXPERIMENT
TYPE PWR, FLUIDIZED BED
POWER MWE(MWT) 100 400
CRITICAL FEASIBILITY STUDY, CRITICAL EXPERIMENT,
SEE REMARKS.
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE CYLINDRICAL PELLETS 205 MILS DIA.
FUEL GEOMETRY PEBBLES /CYLINDERS/
FUEL CLADDING UNCLAD OR COATED, SEE REMARKS
FUEL ENRICH. 1.6 PER CENT U-235
FUEL ASSEMBLY FLUIDIZED BED OF FUEL PEBBLES.
COOLANT TEMP. 550 F
REACTOR VESSEL CYLINDRICAL TANK WITH RESTRAINING SCREENS ACROSS
EACH END.
REMARKS THE UNCLAD FUEL PELLETS ARE PLACED IN THE TANK
AND WATER IS PUMPED IN FROM THE BOTTOM. VELOCITY
OF THE FLOW SUSPENDS THE PELLETS. PELLETS WERE
PREPARED BY COLD COMPACTING FOLLOWED BY SINTERING,
OR BY THE CAPILLARY-DROP METHOD. EXPERIMENTAL
THIN NICKEL CLADDING BY THE ELECTROLESS NICKEL
PLATING METHOD WAS INVESTIGATED. CRITICAL
EXPERIMENT FAILED TO GO CRITICAL AFTER FULL
LOADING IN APRIL, 1962 BECAUSE OF ABRASION OF THE
UNCLAD FUEL. 4 PER CENT ENRICHED PELLETS WERE
ADDED TO THE REPLACEMENT FUEL. PROPOSAL FOR
REDESIGNED FUEL ELEMENTS SPECIFIED URANIUM
MOLYBDENUM ALLOY PELLETS ENRICHED TO 6 PER CENT
AND COATED WITH SS, NIOBIUM OR ALUMINUM. STUDIES

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HD23

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ARE ALSO BEING DONE ON ORGANIC LIQUIDS AS COOLANT
AND MODERATOR.

REFERENCES

FLUIDIZED BED REACTOR STUDY.
CL TEETER, OTHERS.
CF-57-8-14 /1957/

FLUIDIZED BED REACTOR STUDY. PHASE I-FEASIBILITY.
MR SCHEVE
MND-FBR-1696 /FEBRUARY 1959/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD24

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NAME/OWNER MH-1A /MOBILE HIGH-POWER 1A//DOD
DESIGNER MARTIN-MARIETTA CORPORATION
OPERATOR US ARMY
LOCATION TEST INSTALLATION FT. BELVOIR, VA.
PURPOSE EMERGENCY POWER FOR MILITARY INSTALLATIONS,
COASTAL CITIES. BARGE-MOUNTED.
TYPE PWR, BARGE-MOUNTED
POWER MWE(MWT) 10 45
SEE REMARKS
CRITICAL JANUARY 1967
FULL-POWER RUN APRIL-MAY 1967.
SEE REMARKS
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.4565 IN. DIA.
FUEL GEOMETRY ROD, ACTIVE LENGTH 36 IN.
FUEL CLADDING SS TUBES WITH BORON ADDED, 0.023 IN. WALL
THICKNESS
FUEL ENRICH. ZONE ENRICHMENT, OUTER 5.4 AND INNER 5.0 PER CENT
U-235
FUEL ASSEMBLY 104-ROD BUNDLE
32 BUNDLES/CORE WITH 12 INTERSPACED CONTROL
RODS
BURNUP(REFUEL) FUEL SHUFFLING
CONTROL RODS, BORON-10 AND SS
COOLANT TEMP. 490 F
COOLANT PRESS. 1600 PSI
REACTOR VESSEL SS-LINED STEEL VESSEL 80 IN. ID.
REMARKS THE REACTOR HOUSING IS A HULL SECTION THAT
REPLACED THE MID-BODY OF A WORLD WAR-2 LIBERTY

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SHIP CHARLES H. CUGLE, RENAMED STURGIS, THE PLANT
WILL BE AVAILABLE TO BE TOWED TO ANY PORT FOR
MILITARY OPERATIONS OR IN DISASTER AREAS.
REACTOR OUTPUT IS 10 MWE AT 60 CYCLES, OR 8083 KW
AT 50 CYCLES.
PROVISION FOR A DESALINATION PLANT IS INCLUDED.
STURGIS WAS MOVED TO THE CANAL ZONE IN AUG. 1968
WHERE IT WILL TEMPORARILY AUGMENT THE GATUN HYDRO
STATION.

REFERENCES

THE ARMY NUCLEAR POWER PROGRAM, ITS REACTORS, AND
THEIR APPLICATION TO THE LESS-DEVELOPED AREAS OF
THE WORLD.

SYMPOSIUM ON SMALL AND MEDIUM POWER REACTORS,
VIENNA, 1960.

PAPER SMPR-51 /VIENNA, 1960/

MECHANICAL DESIGN OF THE MH-1A REACTORS.

R PICKERING

AMERICAN NUCLEAR SOC. TRANS. 5/2/, 439-40
/NOV. 1962/

DESCRIPTION, APPLICATION, AND SITING OF THE
STURGIS /MH-1A/ FLOATING NUCLEAR POWER PLANT,
RM BUNKER

TRANS. AMERICAN NUCLEAR SOC. 8, 152 /JUNE 1965/

NUCLEAR INDUSTRY FEB, 1967 P. 38

NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD25

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NAME/OWNER BROOKWOOD NUCLEAR STATION/ROCHESTER GAS/ELECTRIC
 GINNA STATION

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR ROCHESTER GAS + ELECTRIC CORPORATION

LOCATION BROOKWOOD, LAKE ONTARIO, N.Y.
 NORTH OF ROCHESTER

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 450 1300

CRITICAL CONSTRUCTION. TARGET 1969

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.366 IN. DIAM./0.600 IN.

FUEL GEOMETRY ROD 0.422 IN. OD.

FUEL CLADDING ZIRCALLOY 0.0243 IN. THICK

FUEL ASSEMBLY 179-ROD BUNDLE, 14x14
 ASSEMBLIES ARE CAN-LESS, WITH SPRING-CLIP GRID
 120 ASSEMBLIES/CORE

CONTROL ROD CLUSTER CONTROL

COOLANT TEMP. INLET 556 F

COOLANT PRESS. 2250 PSIA

CONTAINMENT PRESTRESSED CONCRETE CYLINDER 105 FT. DIAM,
 HEMISPHERICAL DOME HEIGHT 99 FT., WALL 3 FT. 6 IN.
 DOME 2 FT. 6 IN. THICK. STEEL REINFORCED CONCRETE
 SHELL, VESSEL LINED WITH 3/8 IN. STEEL PLATE.

REMARKS CONTRACT AWARD SEPT. 1965
 CONSTRUCTION PERMIT APRIL 1966

REFERENCES NEWS RELEASES

 BROOKWOOD NUCLEAR STATION UNIT NO. 1
 PRELIMINARY FACILITY DESCRIPTION AND SAFETY

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD25

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ANALYSIS REPORT:
ROCHESTER GAS AND ELECTRIC CO.
NP-15908 VOL. 1 /ND/

ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1
FINAL FACILITY DESCRIPTION AND SAFETY ANALYSIS
REPORT
ROCHESTER GAS + ELECTRIC CO
DOCKET 50-244 VOL. 1-2

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD26

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NAME/OWNER INDIAN POINT 2 AND 3/CONSOLIDATED EDISON
 DESIGNER WESTINGHOUSE ELECTRIC CORP.
 OPERATOR CONSOLIDATED EDISON CO.
 LOCATION INDIAN POINT, N.Y.
 HUDSON RIVER
 PURPOSE POWER
 TYPE PWR, 4-LOOP SYSTEM
 TWO-REACTOR ADDITION
 POWER MWE(MWT) NO.2, 873 2758
 NO.3, 965 3025
 CRITICAL NO.2, 1969 /CONSTRUCTION/
 NO.3, 1971
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM./0.600 IN.
 FUEL GEOMETRY RODS 0.422 IN. OD., ACT. LENGTH 144 IN.
 FUEL CLADDING ZIRCALOY, 0.0243 IN. THICK
 FUEL ENRICH. REGIONAL, LOW
 FUEL ASSEMBLY 204-ROD BUNDLE, 15x15, 21 RODS OMITTED
 FOR RCC ELEMENTS, IN-CORE INSTRUMENTATION,
 193 ASSEMBLIES/CORE
 FUEL CHARGE 215,319 POUNDS URANIUM DIOXIDE
 BURNUP(REFUEL) 12,000 MWD/MTU
 CONTROL ROD-CLUSTER CONTROL, UNCANNED ASSEMBLIES,
 CHEMICAL SHIM
 COOLANT TEMP. INLET 549.7 F OUTLET 607.7 F
 COOLANT PRESS. OPERATING PRESSURE 2235 PSIG.
 REACTOR VESSEL 173-IN. ID./42 FT. 4 IN. HIGH, GLAD
 SS CLAD 5/32 IN. THICK
 CONTAINMENT CONCRETE CYLINDER, HEMISPHERICAL DOME, WELDED

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD26

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STEEL LINER 1/4 IN. THICK, BUILDING 135 FT. ID,
WALL THICKNESS 4 FT. 6 IN.

REMARKS

SITE ADJACENT TO INDIAN POINT-1 SELECTED
A CONTRACT HAS BEEN SIGNED WITH WESTINGHOUSE FOR
A THIRD REACTOR AT SITE. REACTOR CAPACITY WILL BE
965 MWE, TARGET 1971.

REFERENCES

INDIAN POINT NUCLEAR GENERATING UNIT NO. 2,
PRELIMINARY SAFETY ANALYSIS REPORT,
PLANT DESIGN DESCRIPTION AND SAFETY ANALYSIS,
CONSOLIDATED EDISON CO.,
NP-16181 /EXHIBIT B/, VOL. 2, PARTS A-B /1965/

INDIAN POINT NUCLEAR GENERATING STATION NO. 3
PRELIMINARY SAFETY ANALYSIS REPORT
CONSOLIDATED EDISON CO. OF N.Y. INC.
DOCKET 50-286

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD27

NAME/OWNER SHIPPINGPORT-1/AEC, DUQUESNE

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR DUQUESNE LIGHT COMPANY

LOCATION SHIPPINGPORT, PA.

PURPOSE POWER DEMONSTRATION

TYPE PWR, SEED AND BLANKET
SEE REMARKS.POWER MWE(MWT) 60 231 /CORE 1/
150 525 /CORE 2/

CRITICAL 1957, SEE REMARKS

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL CORE, URANIUM-ZIRCONIUM
CORE 2, URANIUM/ZIRCONIUM OXIDE
BLANKET, URANIUM DIOXIDE PELLETSFUEL GEOMETRY CORE, PLATES /SANDWICH/
CORE 2, COMPARTMENTED PLATESFUEL CLADDING CORE, ZIRCALOY-2 0.015 IN. THICK
CORE 2 ZIRCALOY-4
BLANKET, ZIRCALOY-2 TUBES 0.027 IN. WALL THICKNESS
CORE 2, COMPARTMENTED PLATESFUEL ENRICH. CORE 92.3 PER CENT U-235
BLANKET NATURALFUEL ASSEMBLY CORE, 15-PLATE ASSEMBLY, 4 ASSEMBLIES JOINED IN A
CLUSTER
BLANKET, 120-ROD BUNDLE, 7 BUNDLES STACKED
END-TO-END.
CORE HEIGHT 6 FT.
32 SEED CLUSTERS 5.6 IN./5.6 IN.
113 BLANKET ASSEMBLIES 5.5 IN./5.5 IN.
CORE 2, 20 SEED CLUSTERS 7.376 IN./7.376 IN.
77 BLANKET ASSEMBLIES 7.376 IN./7.40 IN.
CORE HEIGHT 8 FT.

FUEL CHARGE NATURAL URANIUM FUEL 14.16 TONS, ENR. FUEL 165 LBS

SPECIFIC POWER CORE 360 KW/KG U-235

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

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BLANKET 2.75 KW/KG URANIUM

BURNUP(REFUEL) SEE REMARKS

NEUTRON FLUX THERMAL AVE, CORE 6×10^4 E+13
 THERMAL AVE, BLANKET 4×10^4 E+13
 FAST AVE, CORE 2×10^4 E+14
 FAST AVE, BLANKET 1×10^4 E+14

CONTROL RODS AND LUMPED BURNABLE POISON IN SEED

COOLANT TEMP. INLET 508 F OUTLET 538 F

COOLANT PRESS. 2000 PSIA

REACTOR VESSEL CARBON STEEL CYLINDER, SS LINED, 31 FT./9 FT. ID.
 VESSEL WALLS 8 IN. THICK

CONTAINMENT INTERCONNECTING STEEL CONTAINERS 50 FT. DIA. BY
 100-135 FT. LONG. CONTAINERS SURROUNDED BY 5.7 FT.
 THICK CONCRETE AND BURIED IN EARTH TO ABOUT 3/4 OF
 HEIGHT

REMARKS SEED 2 WAS INSTALLED IN 1960 AFTER OPERATION OF
 5806 FULL POWER HOURS. 32 ENRICHED SEED ELEMENTS
 AS PARTIAL SEED 3 WERE INSTALLED IN 1962, AND SEED
 4 IN NOVEMBER 1962. REACTOR WAS SHUT DOWN IN NOV.
 1964 FOR INSTALLATION OF SECOND CORE AND
 MODIFICATIONS FOR 150 MWE OPERATION. CORE 2 SEED
 WILL BE ANNULAR WITH 20 HIGHLY-ENRICHED FUEL
 CLUSTERS AND 77 BLANKET CLUSTERS. OPERATIONAL
 TARGET OF JANUARY 1965 HAS BEEN DELAYED ABOUT
 3 MONTHS FOR REDESIGN OF HEAT EXCHANGER SUPPORT
 STRUCTURES. FOUR CONCEPTUAL DESIGNS HAVE EVOLVED
 FROM SHIPPINGPORT.

- 1, URANIUM CONVERTER-BURNER CORE
- 2, URANIUM CONVERTER, RECYCLE CORE
- 3, THORIUM CONVERTER-BURNER CORE
- 4, THORIUM CONVERTER, RECYCLE CORE.

DUQUESNE HAS AWARDED A CONTRACT TO WESTINGHOUSE
 FOR A SECOND REACTOR AT SITE. POWER WILL BE
 800 MWE, TARGET 1973

SEE HD55

REFERENCES PROGRESS IN NUCLEAR ENERGY, SERIES II, REACTORS,
 RA CHARPIE, OTHERS
 MC GRAW-HILL BOOK CO., NEW YORK /1956/

SHIPPINGPORT PRESSURIZED WATER REACTOR,
 AEC

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

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ADDISON-WESLEY, 1958.

SHIPPINGPORT STATION - A PIONEERING PROJECT IN
ATOMIC POWER.
WESTINGHOUSE ENG. ISSUE, MARCH 1958.

OPERATING EXPERIENCE, SHIPPINGPORT,
POWER REACTOR TECHNOLOGY 5, 61-72 /SEPTEMBER 1962/

SHIPPINGPORT ATOMIC POWER STATION OPERATING
EXPERIENCE, DEVELOPMENTS, AND FUTURE PLANS,
JT STEIFEL, OTHERS
WARD-TM-390 /APRIL 1963/

SPECIFIC REACTOR TYPES, SEED AND BLANKET,
POWER REACTOR TECHNOLOGY 7, 197-200 /SPRING 1964/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD28

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NAME/OWNER LSBR /LARGE SEED-BLANKET REACTOR/ WEST,
RICKOVER REACTOR

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

LOCATION PROPOSAL FOR PUMPING POWER, FEATHER RIVER PROJECT,
CONSIDERED BOTH COAST AND INLAND SITING.

PURPOSE PUMPING POWER FOR FEATHER RIVER PROJECT, PERHAPS
POWER AND WATER DESALINIZATION IF BUILT ON COAST.

TYPE PWR, SEED AND BLANKET, ADVANCED CONVERTER

POWER MWE(MWT) 525 1735

CRITICAL PLANNED

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM-235 AND THORIUM, OXIDE FUEL

FUEL GEOMETRY RODS

FUEL CHARGE FISSIONABLE 3300 KG., FERTILE 77000 KG.

SPECIFIC POWER 0.14 MWE/KG FISSIONABLE MATERIAL

BURNUP(REFUEL) 67 MWD/KG PER CYCLE CORE LIFE 10-12 YEARS

CONTROL MOVEMENT OF FUEL

COOLANT TEMP. INLET 271 C OUTLET 294 C

COOLANT PRESS. 136 ATM.

REMARKS CAL, DEPT, OF WATER RESOURCES PROPOSED THE LSBR
TO SUPPLY PART OF THE POWER REQUIREMENTS FOR THE
FEATHER RIVER PROJECT, BUT BECAUSE OF FUEL
DEVELOPMENT PROBLEMS THE STATION WILL NOT BE
CONTRACTED. SYSTEM DEVELOPMENT WILL BE REORIENTED
TO AN R+D PROGRAM DIRECTED TOWARD THERMAL BREEDER
TYPE DESIGN. LOS ANGELES DEPT, OF WATER AND POWER
MAY CONSIDER OFFER OF OFF-PEAK POWER FROM SEVERAL
UTILITIES FOR FEATHER RIVER, AND MAY STILL BE
CONSIDERING NUCLEAR POWER FROM SINGLE OR DUAL-
PURPOSE STATIONS.

REFERENCES DESIGN DATA FOR THE SEED-BLANKET REACTOR.

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NUCLEAR INDUSTRY 11, 5 /OCT, 1964/

REPORT ON LARGE POWER REACTOR /LPR/ PROGRAM,
BETTIS ATOMIC POWER LAB, WESTINGHOUSE
WAPD-LPR-181 /DEC, 1963/

PERFORMANCE POTENTIAL OF LARGE SEED-BLANKET
BREEDER REACTORS,
WAPD-LSBR-300 /FEB, 1965/

AEC NEWS RELEASE H-285 /DEC, 27, 1965/

SEE ALSO SHIPPINGPORT.

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

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NAME/OWNER YANKEE ATOMIC ELECTRIC PLANT/YAEC

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR YANKEE ATOMIC ELECTRIC COMPANY

LOCATION ROWE, MASSACHUSETTS
DEERFIELD RIVER

PURPOSE POWER DEMONSTRATION

TYPE PWR

POWER MWE(MWT) 110 392 /CORE 1/
134 482 /CORE 2/CRITICAL 1960, FULL POWER JAN. 1961,
SEE REMARKS

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.294 IN. DIA./0.60
IN. LONG

FUEL GEOMETRY ROD, ACTIVE LENGTH 90 IN.

FUEL CLADDING SS TUBE 0.021 IN. WALL THICKNESS
ZIRCALOY-CLAD FUEL BEING TESTED IN-CORE.FUEL ENRICH. 3.4 PERCENT U-235
CORE 2 4.1 PERCENTFUEL ASSEMBLY 36-ROD SUBASSEMBLY, 6X6
9 SUBASSEMBLIES/FUEL ASSEMBLY, OPEN TYPE,
76 ASSEMBLIES/CORE

FUEL CHARGE 20,840 KG. URANIUM

SPECIFIC POWER 18.8 MWT/MTU

BURNUP(REFUEL) 7830 MWD/MTU SINGLE BATCH
SEE REMARKSNEUTRON FLUX THERMAL AVE. 2.0×10^{13}

CONTROL CRUCIFORM RODS, 24 RODS AND 8 SHIMS

COOLANT TEMP. INLET 499 F OUTLET 603 F

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD29

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REACTOR VESSEL WELDED CYLINDRICAL SHELL, SS-LINED CARBON STEEL
9 FT, 1 IN. ID./31 FT, 6 IN. HIGH, SURROUNDED BY
AN ANNULAR WATER-FILLED SHIELD TANK.

CONTAINMENT SPHERICAL STEEL VESSEL SUPPORTED ON COLUMNS,
ENTIRELY ABOVE GROUND. VAPOR CONTAINER IS 125 FT.
DIA.

REMARKS CORE 2 INCLUDED A NEW OUTER RING OF 36 ELEMENTS,
4.1 PER CENT ENRICHED. OUTPUT REACHED 136 MWE, AND
485 MWT. CHEMICAL SHIM OPERATION WAS BEGUN WITH
CORE 2 OPERATION.
YANKEE IS ON THE 7-TH CORE CYCLE, HAVING HAD 4
COMPLETE CORES. REFUELING IN MARCH 1968 CONSISTED
OF ADDING 1/2 CORE. BURNUP WAS 23,400 MWD/T,
ACHIEVED BY CHANGE FROM 1-REGION BATCH-LOADED CORE
TO 2-REGION CYCLED CORE AND USE OF CHEMICAL SHIM.
FUEL DESIGN WAS NOT CHANGED. ZIRCALOY-CLAD
ASSEMBLIES HAVE BEEN PUT IN CORE FOR TESTING.

REFERENCES PRELIMINARY HAZARDS SUMMARY REPORT, PART B.
LICENSE APPLICATION.
YANKEE ATOMIC ELECTRIC CO.
YAEC-60 /APRIL 1957/

THE START-UP EXPERIMENT PROGRAM FOR THE YANKEE
REACTOR.
JM GALLAGHER, JR., OTHERS
YAEC-184 /JUNE 1961/

DESIGN PRACTICE, YANKEE NUCLEAR POWER STATION.
POWER REACTOR TECHNOLOGY 4, 47-55 /JUNE 1961/

YANKEE NUCLEAR POWER STATION, TECHNICAL
INFORMATION AND FINAL HAZARDS SUMMARY REPORT,
PART B. LICENSE APPLICATION.
YANKEE ATOMIC ELECTRIC CO.
YAEC-167 /VOLS. 1 AND 2/ /APRIL 1960/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD30

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NAME/OWNER : SAXTON EXPERIMENTAL POWER REACTOR/SNEC

DESIGNER : WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR : SAXTON NUCLEAR EXPERIMENT CORP,

LOCATION : SAXTON, PA
JUNIATA RIVER

PURPOSE : POWER EXPERIMENT.

TYPE : PWR, CLOSED CYCLE HOOK-ON REACTOR

POWER MWE(MWT) : 4-5 20

CRITICAL : APRIL 1962, FULL POWER WITH CHEMICAL SHIM MARCH
1963, CORE-2 1965
SEE REMARKS

COOLANT : LIGHT WATER

MODERATOR : LIGHT WATER

FUEL MATERIAL : URANIUM DIOXIDE PELLETS 0.397 IN. DIA.
SEE REMARKS

FUEL GEOMETRY : RODS ACT. LENGTH 36.6 IN.

FUEL CLADDING : SS TUBES

FUEL ENRICH. : 5.7 PER CENT U-235

FUEL ASSEMBLY : 72-ROD ASSEMBLY, INCORPORATED IN FUEL-FOLLOWER OR
BOTTOM SECTION OF EACH CONTROL ROD ASSEMBLY,
21 ASSEMBLIES/CORE

FUEL CHARGE : 1270 KG, URANIUM

SPECIFIC POWER : 13.3 KW/FT.

BURNUP(REFUEL) : 7300 MWD/T

CONTROL : CRUCIFORM RODS, SILVER-INDIUM-CADMIUM, FUEL ROD
FOLLOWER.

COOLANT TEMP. : INLET 520 F OUTLET 540 F

COOLANT PRESS. : 2000 PSI

REACTOR VESSEL : MULTILAYER CONSTRUCTION, 20 LAYERS OF 1 IN. STEEL

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD30

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EACH LAYER WRAPPED TIGHTLY AND WELDED ON PRECEDING LAYER.

CONTAINMENT

VERTICAL CARBON STEEL CYLINDER, WELDED HEMISPHERICAL HEAD, 50 FT. DIA./109 FT. 6 IN. HIGH BOTTOM OF VESSEL IS EMBEDDED IN CONCRETE 50 FT. BELOW GRADE. CONCRETE WALL WITH EXPANSION MATERIAL BETWEEN CONCRETE AND STEEL SHELL.

REMARKS

CHEMICAL SHIM STUDY UNDER ACTUAL OPERATING REACTOR CONDITIONS AND FUEL ELEMENT DEVELOPMENT. SAXTON CORE HAS PROVISIONS FOR REMOVABLE SUB-ASSEMBLIES, EXTENSIVE IN-CORE INSTRUMENTATION. A SUPERCRITICAL TEST LOOP HAS BEEN INSTALLED. CORE 2, INSTALLED IN 1965, HAS 9 CENTER FUEL ASSEMBLIES ENRICHED WITH PLUTONIUM DIOXIDE. CLADDING IS ZIRCALOY-4. THERMAL POWER HAS BEEN RAISED FROM THE DESIGN VALUE OF 23.5 MW TO 31 MW, AND ELECTRIC POWER FROM 4.3 MW TO 6.1 MW. POWER DENSITY PER FT. OF FUEL IS 18.5 KW. SAXTON WILL OPERATE AT PRESENT LEVELS UNTIL NEW CORE IS INSTALLED.

REFERENCES

THE SAXTON EXPERIMENTAL POWER REACTOR.
WE SHOUPP, OTHERS
POWER REACTOR EXPERIMENTS, VOL. 2, P. 229-51
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962.

SAXTON EXPERIMENTAL POWER REACTOR.
EW POWELL, OTHERS
NUCLEAR ENG. 7, 393-97 /OCTOBER 1962/

OPERATING EXPERIENCE AT SAXTON
WESTINGHOUSE ENG. MAY 1966 P. 93
NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS; DOMESTIC

HD31

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NAME/OWNER CONNECTICUT YANKEE STATION/CYAPC
 DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
 OPERATOR CONNECTICUT YANKEE ATOMIC POWER CO.
 LOCATION HADDAM NECK, CONNECTICUT
 CONNECTICUT RIVER
 PURPOSE POWER. AEC 3RD-ROUND ASSISTANCE;
 TYPE PWR, 4-LOOP SYSTEM
 POWER MWE(MWT) 463 1473
 490 GROSS, STRETCH 590 MWE
 CRITICAL JULY 1967;
 POWER OPERATION JAN. 1968
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS
 0.3825 IN. DIAM., 0.600 IN. LONG
 FUEL GEOMETRY ROD 0.422 IN. OD, 121.8 IN. ACTIVE LENGTH
 FUEL CLADDING SS TUBES 0.016 IN. WALL THICKNESS
 FUEL ENRICH. 3.00, 3.24, 3.27 PER CENT U-235, ZONED
 FUEL ASSEMBLY 15 X 15 ROD BUNDLE /204 RODS, WITH OMISSIONS/
 157 ASSEMBLIES/CORE
 SPRING-CLIP ASSEMBLY, GRID
 20 ROD-CLUSTER CONTROL ELEMENTS PER ASSEMBLY
 FUEL CHARGE 75,000 KG URANIUM DIOXIDE
 BURNUP(REFUEL) 20,000 MWD/MTU 12-14 MONTHS
 FIRST CYCLE 14,100 MWD/MTU
 NEUTRON FLUX THERMAL AVE. 2.3×10^{13}
 FAST AVE. 1.6×10^{14}
 CONTROL SS TUBE WITH SILVER-INDIUM-CADMIUM ALLOY, ROD-
 CLUSTER
 SOLUBLE POISON, BORON
 COOLANT TEMP. INLET 545 F OUTLET 583.5 F

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD31

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COOLANT PRESS. 2150 PSIG

REACTOR VESSEL STEEL CYCLINDER, SS LINED, 154 IN. ID/41 FT. HIGH.

CONTAINMENT REINFORCED CONCRETE CYLINDER, STEEL LINER
135 FT. ID, 119.5 FT. HIGH
SAFETY INJECTION SYSTEM, CONTAINMENT SPRAY SYSTEM.

REMARKS COLLAPSED SS CLADDING MAY BE SPECIFIED FOR FUEL
WITH ZIRCALOY POSSIBLE FOR LATER CORES. FUEL
OF EACH ENRICHMENT IS SYMMETRICALLY ARRANGED TO
REDUCE FUEL SHUFFLING.

REFERENCES CONNECTICUT YANKEE ATOMIC POWER COMPANY NUCLEAR
POWER PLANT-UNIT NUMBER ONE, HADDAM, CONNECTICUT,
PRELIMINARY HAZARDS SUMMARY REPORT,
CONNECTICUT YANKEE ATOMIC POWER CO.,
NYO-3250-1 /DEC. 1963/

TITLE 1 AND TITLE 2, DESIGN AND ENGINEERING.
ANNUAL REPORT, MARCH 1963-JUNE 1964,
CONNECTICUT YANKEE ATOMIC POWER CO.,
TID-21129 /AUG. 1964/

CONNECTICUT YANKEE
JN KILPATRICK, FS BEAL /WESTINGHOUSE/
NUCLEAR ENG. 10, 216-20 /JUNE 1965/

CONNECTICUT YANKEE ATOMIC POWER COMPANY,
FACILITY DESCRIPTION AND SAFETY ANALYSIS,
CONNECTICUT YANKEE ATOMIC POWER COMPANY,
NYO-3250-5 /VOL. 1 AND 2/ MAY 1966

DESIGN FEATURES OF THE CONNECTICUT YANKEE ATOMIC
POWER PLANT
DE VANDERBURGH
CONF-650105-9 /1967/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD32

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NAME/OWNER	MALIBU PLANT / LADWP CORRAL CANYON
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
OPERATOR	LOS ANGELES DEPT. WATER AND POWER
LOCATION	MALIBU BEACH, CALIF. /CORRAL CANYON/
PURPOSE	POWER.
TYPE	PWR, 4-LOOP SYSTEM
POWER MWE(MWT)	490 1473
CRITICAL	CONSTRUCTION. TARGET 1972 CONDITIONAL CONSTRUCTION PERMIT JULY 1966
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.375 IN. DIAM./0.550 IN.
FUEL GEOMETRY	ROD 0.4115 IN. OD, 120 IN. ACTIVE LENGTH
FUEL CLADDING	REGIONS 1,2 AND 3 USE SS, REGION 4 /AND FUTURE/ USES ZIRCALOY
FUEL ENRICH.	REGIONAL 3.8 PER CENT U-235
FUEL ASSEMBLY	217-ROD BUNDLE 15x15 156 ASSEMBLIES/CORE
CONTROL	ROD CLUSTER, CHEMICAL SHIM
CONTAINMENT	DOUBLE-BARRIER CONTAINMENT, LAYER OF POROUS CONCRETE BETWEEN INNER AND OUTER SHELLS OF STEEL AND REINFORCED CONCRETE.
REMARKS	AEC HAS ACCEPTED PROPOSAL FROM LADWP FOR R+D AND DESIGN ASSISTANCE UNDER MODIFIED THIRD-ROUND RULES STATION DESIGN IS SIMILAR TO CONNECTICUT YANKEE.
REFERENCES	TECHNICAL INFORMATION IN SUPPORT OF APPLICATION FOR CONSTRUCTION PERMIT AND LICENSE. MALIBU NUCLEAR PLANT UNIT NO. 1. DEPT. WATER AND POWER, CALIF., STONE + WEBSTER, NP-14290 /PT.8/ /NOV. 1963/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD32

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NUCLEONICS WEEK JULY 21, 1966

NEWS RELEASE

MALIBU NUCLEAR PLANT UNIT NO. 1 PRELIMINARY

HAZARDS SUMMARY REPORT,

DEPT. WATER AND POWER, LOS ANGELES

NYO-3266-1 /MAY 1965/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD 33

NAME/OWNER SAN ONOFRE NUCLEAR PLANT/S.CAL., ED., S. DIEGO G+E
CAMP PENDLETON

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR SOUTHERN CALIFORNIA EDISON COMPANY

LOCATION SAN CLEMENTE, CALIF.
 CAMP PENDLETON MARINE RESERVATION

PURPOSE	POWER
1. To determine the effect of the proposed changes on the company's financial performance.	1. To determine the effect of the proposed changes on the company's financial performance.
2. To determine the effect of the proposed changes on the company's operational efficiency.	2. To determine the effect of the proposed changes on the company's operational efficiency.
3. To determine the effect of the proposed changes on the company's customer satisfaction.	3. To determine the effect of the proposed changes on the company's customer satisfaction.
4. To determine the effect of the proposed changes on the company's employee morale.	4. To determine the effect of the proposed changes on the company's employee morale.
5. To determine the effect of the proposed changes on the company's market share.	5. To determine the effect of the proposed changes on the company's market share.
6. To determine the effect of the proposed changes on the company's brand reputation.	6. To determine the effect of the proposed changes on the company's brand reputation.
7. To determine the effect of the proposed changes on the company's risk management.	7. To determine the effect of the proposed changes on the company's risk management.
8. To determine the effect of the proposed changes on the company's innovation.	8. To determine the effect of the proposed changes on the company's innovation.
9. To determine the effect of the proposed changes on the company's sustainability.	9. To determine the effect of the proposed changes on the company's sustainability.
10. To determine the effect of the proposed changes on the company's overall success.	10. To determine the effect of the proposed changes on the company's overall success.

TYPE PWR, 3-LOOP SYSTEM, CLOSED CYCLE.

POWER MWE (MWT)	450	1347
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CRITICAL 1967, COMMERCIAL OPERATION JAN, 1968

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.383 IN. DIAM/0.60 IN.

FUEL GEOMETRY ROD 0.422 IN. OD., ACTIVE LENGTH 120 IN.
ACTIVE LENGTH 10 FT.

FUEL CLADDING SS TUBES, 0.0165 IN. WALL THICKNESS
0.0165 IN. THICK, 0.422 IN. OD.

FUEL ENRICH. 3.5 PER CENT U-235, ZONE ENRICHMENT

FUEL ASSEMBLY 180-ROD BUNDLE, 14x14
RCC ELEMENTS /ROD CLUSTER CONTROL/
157 ASSEMBLIES/CORE
3-REGION CORE ARRANGEMENT
RODS ARE OMITTED FOR RCC ASSEMBLIES

FUEL CHARGE 150,000 POUNDS URANIUM DIOXIDE
58,000 KG. URANIUM

BURNUP(REFUEL) 13,500 MWD FUEL SHUFFLING
14-MONTH INTERVALS

CONTROL ROD CLUSTER CONTROL /RCC/, A SERIES OF SMALL INDIVIDUAL CONTROL ELEMENTS ARRANGED IN A CLUSTER. CHEMICAL SHIM

COOLANT TEMP, INLET 553 F OUTLET 597 F

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD33

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COOLANT PRESS. 2065 PSIA

REACTOR VESSEL SS-LINED CARBON STEEL VESSEL 41 FT. LONG /12 FT. ID.

CONTAINMENT STEEL SPHERE 100 FT. DIA., 40 FT. BELOW GRADE, AIR-TIGHT, WITH CONCRETE STRUCTURE INSIDE SPHERE FOR SUPPORT AND SHIELDING. THE 6-FT. SHIELD CONTAINS COOLING COILS TO PREVENT OVERHEATING OR DEHYDRATION OF THE CONCRETE.

REMARKS BASIC THREE-LOOP REACTOR. VARYING PLANT SIZE IS ACHIEVED BY VARYING VESSEL AND CORE SIZE AND THE NUMBER OF LOOPS. LOOP COMPONENTS REMAIN THE SAME. SAN DIEGO GAS + ELECTRIC WILL CONTRIBUTE TO PLANT COSTS IN RETURN FOR SHARE OF POWER PRODUCED. CLADDING FOR SUBSEQUENT CORES WILL PROBABLY BE ZIRCALOY.

REFERENCES SOUTHERN CALIFORNIA EDISON REACTOR CHARACTERISTICS NUCLEONICS 18, 18 /JUNE 1960/

PRELIMINARY HAZARDS SUMMARY REPORT ON SOUTHERN CALIFORNIA EDISON COMPANY NUCLEAR STATION AT CAMP PENDLETON, CALIFORNIA. UNIT NO. 1. PART B. SOUTHERN CALIFORNIA EDISON CO. NP-12513 /JAN. 1963/

DESIGN FEATURES OF THE SAN ONOFRE NUCLEAR STATION HJ VON HOLLEN, CF CURREY WESTINGHOUSE ENG. 25, 142-47 /SEPT. 1965/

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. FINAL ENGINEERING AND SAFETY ANALYSIS VOL. 1, 2, 3 /S.CALIF. ED., SAN DIEGO/ NYO-3270-2 /ND/

SAN ONOFRE, WEST-S NEWEST NUCLEAR STATION ELECTRICAL WEST 134, 33-35, 39 /MAY 1967/

UNIQUE ASPECTS OF THE SAN ONOFRE NUCLEAR PLANT. KP BASKIN, OTHERS ELECTRICAL WEST 135/2/, 54 /1968/ ABSTRACT OF PAPER

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD34

NAME/OWNER SCOTT-R /SUPERCRIT ONCE THROUGH TUBE REACTOR/ WEST
 DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
 PURPOSE POWER
 TYPE PWR, PRESSURE TUBE
 POWER MWE(MWT) 1000 2297
 CRITICAL DESIGN DEVELOPMENT
 COOLANT LIGHT WATER
 MODERATOR GRAPHITE, GRAPHITE REFLECTOR
 FUEL MATERIAL URANIUM DIOXIDE
 FUEL GEOMETRY RODS, CONCENTRIC RINGS
 FUEL CLADDING SS 0.012 IN. THICK, TUBES
 FUEL ENRICH. 3.03 PER CENT U-235
 FUEL ASSEMBLY ASSEMBLY CONSISTS OF 1 ROD AND 4 CONCENTRIC RINGS.
 540 ASSEMBLIES IN 540 PRESSURE TUBES.
 FUEL CHARGE 121,900 KG URANIUM
 SPECIFIC POWER 18.9 KWT/KG URANIUM
 BURNUP(REFUEL) 16,500 MWD/MTU
 CONTROL BORON CARBIDE RODS
 COOLANT TEMP. INLET 506 F
 COOLANT PRESS. 3750 PSIA
 REACTOR VESSEL CARBON STEEL 42 FT. HIGH BY 35.5 FT. ID.
 PRESSURE TUBES ARE ZIRCONIUM ALLOY, INNER LINER OF
 ZIRCONIUM-TANTALUM-TUNGSTEN.
 REMARKS PRELIMINARY DESIGN OF THE 50 MWT SUPERHEAT POWER
 EXP. IS COMPLETED. TWO POWER CYCLES STUDIED WERE
 THE IN-CORE REHEAT, IN WHICH 600 PSIA STEAM
 EXHAUSTED FROM THE HIGH PRESSURE TURBINE IS
 REHEATED IN THE CORE TO 1000 F, AND CONDENSING
 STEAM REHEAT WHERE 182 PSIA STEAM IS REHEATED IN A
 HEAT EXCHANGER BY BLEED STEAM FROM THE HIGH

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD34

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PRESSURE TURBINE. IN THE REFERENCE DESIGN, THE COOLANT FLOW MAKES 4 CONSECUTIVE PASSES, OUTSIDE TO CENTER OF THE FUEL ASSEMBLY, SCOTT-R WAS SELECTED FOR FURTHER DEVELOPMENT BY AEC.

REFERENCES

THE ROLE OF A SUPERHEAT POWER EXPERIMENT IN THE DEVELOPMENT OF SUPERCRITICAL STEAM NUCLEAR-FIRED POWER PLANTS.

JH WRIGHT, OTHERS

ASME PREPRINT 62-WA-345 /DECEMBER 1962/

THE SCOTT-R DEVELOPMENT PROGRAM.

JH WRIGHT

WESTINGHOUSE ENG. 23. 50-53 /MARCH 1963/

SUPERCRITICAL WATER REACTORS.

POWER REACTOR TECHNOLOGY 6/3/, 73-8 /JUNE 1963/

1000-MWE SCOTT-R CONCEPTUAL DESIGN.

SN TOWER

TID-7674 /P. 65-6/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD35

NAME/OWNER RAVENSWOOD NUCLEAR UNIT/CONSOLIDATED EDISON

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

PURPOSE POWER

TYPE PWR, CLOSED CYCLE, 5-LOOP SYSTEM, OIL-FIRED
SUPERHEAT

POWER MWE(MWT) 1000 2850

CRITICAL PROPOSAL HAS BEEN WITHDRAWN

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS, 0.375 IN. DIA./0.736 IN.
LONG.

FUEL GEOMETRY RODS, 120 IN. ACTIVE LENGTH

FUEL CLADDING SS TUBE, 0.013 IN. WALL THICKNESS

FUEL ENRICH. ZONE ENRICHMENT 3.2, 3.6 AND 4 PER CENT U-235

FUEL ASSEMBLY 280-ROD BUNDLES, 17X17 /9RODS OMITTED FOR CONTROL
ROD PASSAGE/
156 ASSEMBLIES IN CORE, EACH ENRICHMENT ZONE
HAVING 52 ASSEMBLIES.

FUEL CHARGE 103,000 KG. URANIUM DIOXIDE

BURNUP(REFUEL) 12000 MWD/MTU

CONTROL CHEMICAL SHIM, CONTROL RODS

COOLANT TEMP. INLET 543 F OUTLET 588 F

COOLANT PRESS. 2035 PSIG

REACTOR VESSEL STEEL, 46 FT. 6 1/2 IN. LONG

CONTAINMENT MULTI-WALL CONTAINMENT, TWO CARBON STEEL SHELLS
WITH PERVIOUS CONCRETE BETWEEN THEM, AND NORMAL
HIGH-DENSITY REINFORCED CONCRETE OUTER SHELL.

REMARKS PROPOSAL FOR THE NUCLEAR PLANT WAS WITHDRAWN BY
CONSOLIDATED EDISON IN JANUARY 1964. SITE WAS TO
HAVE BEEN WITHIN NEW YORK CITY.

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD35

REFERENCES

PRELIMINARY HAZARDS SUMMARY REPORT, DOCKET 50-204.
RAVENSWOOD NUCLEAR GENERATING UNIT A,
CONSOLIDATED EDISON CO. OF N.Y., INC. 1962.
NP-12466 /VOL. 1, 2, AND 3/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD36

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NAME/OWNER POINT BEACH NUCLEAR STATION/WMPCO
 DESIGNER WESTINGHOUSE ELECTRIC CORP.
 OPERATOR WISCONSIN MICHIGAN POWER CO. /WMPCO/
 WISCONSIN ELECTRIC POWER COMPANY
 LOCATION TWO CREEKS, MANITOWOC COUNTY, WISCONSIN
 NEAR GREEN BAY.
 PURPOSE POWER
 TYPE PWR, CLOSED CYCLE, TWO-LOOP SYSTEM,
 TWO-REACTOR STATION
 POWER MWE(MWT) 500 1396 PER REACTOR
 CRITICAL TARGET NO.1, 1970
 TARGET NO.2, 1971
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.
 LONG
 FUEL GEOMETRY ROD 0.422 IN. OD, ACTIVE LENGTH 144 IN.
 FUEL CLADDING ZIRCALOY 0.0243 IN. THICK
 FUEL ENRICH. ZONED, 2.35, 2.50 2.80 PER CENT U-235
 FUEL ASSEMBLY 179-ROD BUNDLE, 14 X 14, WITH RCC ELEMENTS
 UNCANNED,
 121 ASSEMBLIES/CORE
 FUEL CHARGE 118,506 LBS. URANIUM DIOXIDE
 BURNUP(REFUEL) FIRST CYCLE AVE. 14,000 MWD/MTU
 EQUIL. CORE AVE. 27,000 MWD/MTU
 CONTROL ROD-CLUSTER CONTROL, 16-ROD CLUSTER
 CADMIUM-INDIUM-SILVER IN SS CLADDING
 COOLANT TEMP. INLET 551.8 F OUTLET 650 F
 REACTOR VESSEL VERTICAL STEEL CYLINDER 132 IN. ID/37 FT. HIGH
 INNER SS CLADDING 0.156 IN. THICK.
 CONTAINMENT PRESTRESSED CONCRETE CYLINDER, WALLS 3 FT. 6 IN.

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD36

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WELDED STEEL LINER.

REMARKS

CONSTRUCTION PERMIT FOR SECOND REACTOR JAN, 1968,
CONDENSER CIRCULATING WATER DRAWN FROM LAKE AND
DISCHARGED INTO LAKE VIA CANAL OR CONDUIT,

REFERENCES

POINT BEACH NUCLEAR PLANT, PRELIMINARY FACILITY
DESCRIPTION AND SAFETY ANALYSIS REPORT,
WISCONSIN MICHIGAN POWER CO,
DOCKET 50-266

POINT BEACH NUCLEAR PLANT UNIT NO. 2,
PRELIMINARY FACILITY DESCRIPTION AND SAFETY
ANALYSIS REPORT,
WISCONSIN ELECTRIC POWER CO,
DOCKET 50-301 /1968/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS; DOMESTIC

HD37

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NAME/OWNER HB ROBINSON UNIT 2/CAROLINA P+L
 HARTSVILLE NUCLEAR STATION

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR CAROLINA POWER AND LIGHT COMPANY

LOCATION HARTSVILLE, S. CAROLINA
 LAKE ROBINSON

PURPOSE POWER

TYPE PWR, 3-LOOP SYSTEM

POWER MWE(MWT) 663 2094

CRITICAL CONSTRUCTION, TARGET 1970

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.

FUEL GEOMETRY ROD 0.422 IN. OD/144 IN. ACTIVE LENGTH

FUEL CLADDING ZIRCALOY 0.0243 IN. WALL THICKNESS

FUEL ENRICH. ZONE. 2.28, 2.43, 2.73 PER CENT U-235

FUEL ASSEMBLY 204-ROD BUNDLE, 15X15, WITH RCC ELEMENTS
 157 ASSEMBLIES/CORE

FUEL CHARGE 179,000 POUNDS URANIUM DIOXIDE

BURNUP(REFUEL) FIRST CYCLE AVE. 14,000 MWD/TU
 EQUILIBRIUM CORE AVE. 27,000 MWD/TU

CONTROL ROD CLUSTER CONTROL, CADMIUM-INDIUM-SILVER IN SS

COOLANT TEMP. INLET 546.5 F OUTLET 600.6 F

COOLANT PRESS. 2485 PSIG

REACTOR VESSEL STEEL CYLINDER 155.5 IN. ID/41 FT. 6 IN. HIGH
 SS CLAD 0.156 IN. THICK

CONTAINMENT PRESTRESSED CONCRETE CYLINDER, HEMISPHERICAL DOME
 136 FT. DIAM/194 FT. HIGH, WALL THICKNESS 2 1/2 -
 3 1/2 FT.

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PRESSURIZED LIGHT WATER REACTORS; DOMESTIC

HD37

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C STEEL LINER.

REMARKS

CONDENSER COOLING WATER DRAWN FROM LAKE ROBINSON,
DISCHARGED TO LAKE VIA CANAL.

REFERENCES

NUCLEAR UNIT WILL HAVE REMOTE DISPATCH,
WB KINCAID
ELECTRICAL WORLD 170, 28-9 /AUG. 19, 1968/HB ROBINSON UNIT NO. 2
PRELIMINARY FACILITY DESCRIPTION AND SAFETY
ANALYSIS REPORT,
CAROLINA POWER AND LIGHT CO.,
DOCKET 50-261 /1966/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD38

NAME/OWNER TURKEY POINT 3 AND 4/FLORIDA POWER & LIGHT
DESIGNER WESTINGHOUSE ELECTRIC CORP.
OPERATOR FLORIDA POWER AND LIGHT COMPANY
LOCATION TURKEY POINT, FLORIDA
BISCAYNE BAY
TYPE PWR, 3-LOOP SYSTEM
POWER MWE(MWT) 652 2300
ULTIMATE 760 GROSS
CRITICAL TARGET NO. 1, 1971
TARGET NO. 2, 1972
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3699 IN. DIA/0.600 IN.
FUEL GEOMETRY ROD 0.422 IN. OD. ACT. LENGTH 144 IN.
FUEL CLADDING ZIRCALOY 0.0243 IN. THICK
FUEL ENRICH. ZONED, 2.73, 2.43, 2.28 PER CENT U-235
FUEL ASSEMBLY 204-ROD ASSEMBLY, 15 X 15, WITH RCC ELEMENTS
157 ASSEMBLIES/CORE
SPRING-CLIP GRID
FUEL CHARGE 179,000 POUNDS URANIUM DIOXIDE
BURNUP(REFUEL) 21,800 MWD/MTU
CONTROL ROD-CLUSTER CONTROL ASSEMBLIES
ABSORBER INDIUM-CADMIUM-SILVER IN SS TUBES
CHEMICAL SHIM
COOLANT TEMP. INLET 546.5 F OUTLET 600 F
COOLANT PRESS. 2236 PSIG
REACTOR VESSEL STEEL VESSEL 155.5 IN. ID./240 IN. OD. ACROSS
NOZZLES, HEIGHT 41 FT.
SS CLADDING 5/32 IN. THICK
CONTAINMENT TWIN STEEL-LINED, PRESTRESSED CONCRETE CYLINDERS,

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD38

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EACH STRUCTURE COMPLETELY ENCLOSING A REACTOR AND
ITS COOLANT SYSTEM. CYLINDERS ARE 116 FT. ID,
169 FT. INTERIOR HT, CYLINDRICAL WALL 3 FT. 9 IN.
THICK. STEEL LINING OF 1/4 IN. PLATE.

REMARKS

BOTH NUCLEAR UNITS WILL BE IDENTICAL EXCEPT FOR
CHANGES RESULTING FROM TECHNICAL ADVANCES.

REFERENCES

TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND 4,
PRELIMINARY SAFETY ANALYSIS REPORT
FLORIDA POWER AND LIGHT CO.
NP-16146 /1966/

TWO 760 MW UNITS TO BRING NUCLEAR POWER TO FLORIDA
WT PAYNE, RE STADE
ELECTRICAL WORLD JAN. 15, 1968 P. 29, 32

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD39

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NAME/OWNER : COONEE STATION/DUKE POWER
DESIGNER : BABCOCK AND WILCOX
OPERATOR : DUKE POWER COMPANY
LOCATION : KEOWEE LAKE, S. CAROLINA
PURPOSE : POWER
TYPE : PWR, 3-REACTOR STATION
POWER MWE(MWT) : 822 : 2460 : PER REACTOR
CRITICAL : TARGET NO.1, 1970
: NO.2, 1971
: NO.3, 1972
COOLANT : LIGHT WATER
MODERATOR : LIGHT WATER
FUEL MATERIAL : URANIUM DIOXIDE PELLETS 0.362 IN. DIAM/0.8 IN.
FUEL GEOMETRY : PIN 0.420 IN. OD, ACTIVE LENGTH 144 IN.
FUEL CLADDING : ZIRCALOY-4, 0.026 IN. THICK
FUEL ENRICH. : ZONE, 2.24 - 2.77 PER CENT U-235
FUEL ASSEMBLY : 208-PIN ASSEMBLY, 15 X 15
: 177 ASSEMBLIES/CORE
FUEL CHARGE : 201,520 LBS. URANIUM DIOXIDE
BURNUP(REFUEL) : 28,200 MWD/T
CONTROL : RODS, SILVER-INDIUM-CADMIUM IN SS CLADDING, RCC
: CHEMICAL SHIM
COOLANT TEMP. : INLET 555 F : OUTLET 603 F
COOLANT PRESS. : 2200 PSIA
REACTOR VESSEL : SS-CLAD STEEL VESSEL 171 IN. ID/42 FT. HIGH
CONTAINMENT : STEEL-LINED PRESTRESSED CONCRETE VERTICAL CYLINDER
: WITH SHALLOW DOMED ROOF, 116 FT. ID/206 FT. HIGH,
: VERTICAL WALL THICKNESS 3 3/4 FT.
REMARKS : CONDENSER COOLING WATER DRAWN FROM LAKE AND

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD39

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RETURNED.

REFERENCES

OCONEE NUCLEAR STATION TO COST 100 DOLLARS PER
NET KW.

WS LEE

ELECTRICAL WORLD 169, 27-29, 70 /APRIL 15, 1968/

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD40

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NAME/OWNER SALEM NUCLEAR STATION/DELAWARE VALLEY UTILITIES

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR PUBLIC SERVICE ELECTRIC & GAS, NEW JERSEY

LOCATION ARTIFICIAL ISLAND SITE IN NEW JERSEY
DELAWARE RIVER

PURPOSE POWER

TYPE PWR, CLOSED CYCLE, 4-LOOP SYSTEM,
TWO-REACTOR STATION

POWER MWE(MWT) 993 3250 PER REACTOR

CRITICAL TARGET NO. 1, 1972
NO. 2, 1973

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.6 IN.

FUEL GEOMETRY ROD, 0.422 IN. OD, ACTIVE LENGTH 144 IN.

FUEL CLADDING ZIRCALOY-4, 0.0243 IN. THICK

FUEL ENRICH. ZONE, 2.2, 2.7 3.2 PER CENT U-235

FUEL ASSEMBLY 204-ROD BUNDLE, 15 X 15, WITH RCC ELEMENTS,
UNCANNED
193 ASSEMBLIES/CORE

FUEL CHARGE 218,530 LBS. URANIUM DIOXIDE

SPECIFIC POWER 18.9 KW/FT.

BURNUP(REFUEL) 12,000 MWD/MTU

CONTROL ROD CLUSTER CONTROL, 23-ROD CLUSTER
CADMIUM-INDIUM-SILVER IN SS CLADDINGCONTAINMENT STEEL-LINED REINFORCED CONCRETE DOMED BUILDING
FOR EACH REACTOR AND ITS SYSTEMS.REFERENCES SALEM NUCLEAR GENERATING STATION /FORMERLY
BURLINGTON NUCLEAR GENERATING STATION/
PRELIMINARY FACILITY DESCRIPTION AND SAFETY

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD40

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ANALYSIS REPORT;

PUBLIC SERVICE ELECTRIC & GAS CO., N.J.

DOCKET 50-272 AND 50-311

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD41

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NAME/OWNER SURRY STATION/VIRGINIA ELECTRIC POWER
 DESIGNER WESTINGHOUSE ELECTRIC CORP.
 OPERATOR VIRGINIA ELECTRIC POWER CO.
 LOCATION HOG ISLAND /ON JAMES RIVER/ VIRGINIA
 PURPOSE POWER
 TYPE PWR, 3-LOOP SYSTEM
 TWO-REACTOR STATION
 POWER MWE(MWT) 800 2441 PER REACTOR
 STRETCH 847.5 MWT
 CRITICAL NO.1 REACTOR 1971
 NO.2 REACTOR 1972
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.
 FUEL GEOMETRY ROD, 0.422 IN. OD, ACTIVE LENGTH 144 IN.
 FUEL CLADDING ZIRCALOY-4 0.0243 IN. THICK
 FUEL ENRICH. ZONE, 2.44, 2.54 2.94 PER CENT U-235
 FUEL ASSEMBLY 204-ROD BUNDLE, 15 X 15, WITH RCC ELEMENTS.
 UNCANNED
 157 ASSEMBLIES/CORE
 FUEL CHARGE 177,000 LBS. URANIUM DIOXIDE
 BURNUP(REFUEL) FIRST CORE AVE. 21,800 MWD/MTU
 CONTROL ROD CLUSTER CONTROL, INDIUM-CADMIUM-SILVER IN SS,
 CHEMICAL SHIM
 COOLANT TEMP. INLET 542.9 F OUTLET 605.5 F
 COOLANT PRESS. 2235 PSIG
 REACTOR VESSEL STEEL VESSEL 157 IN. ID/42 FT. 4 IN. HIGH.
 SS LINING
 CONTAINMENT STEEL-LINED REINFORCED CONCRETE CYLINDRICAL

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD41

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BUILDING, DOMED, REDUCED PRESSURE CONTAINMENT.
EACH REACTOR HAS ITS OWN CONTAINMENT.

REFERENCES

SURREY POWER STATION UNITS 1 AND 2,
PRELIMINARY SAFETY ANALYSIS REPORT,
VIRGINIA ELECTRIC AND POWER CO.
DOCKET 50-280, 50-281 /1967/

JANUARY 1969

BNWL-938

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD42

NAME/OWNER FT. CALHOUN STATION/OMAHA PUBLIC POWER
DESIGNER COMBUSTION ENGINEERING
OPERATOR OMAHA PUBLIC POWER DISTRICT
LOCATION FT. CALHOUN, NEBRASKA. NEAR OMAHA,
MISSOURI RIVER
PURPOSE POWER
TYPE PWR, TWO-REACTOR STATION
POWER MWE(MWT) 450 1420 PER REACTOR
CRITICAL TARGET NO. 1, 1971
NO. 2, 1972
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.382 IN. DIAM/0.6 IN.
FUEL GEOMETRY ROD, 0.440 IN. OD, ACTIVE LENGTH 128 IN.
FUEL CLADDING ZIRCALOY-4 0.026 IN. THICK
FUEL ENRICH. ZONE, 1.60, 2.10, 2.95 PER CENT U-235
FUEL ASSEMBLY 176-ROD BUNDLE, 14 X 14,
ZIRCALOY SPACERS, OPEN LATTICE, GUIDE TUBES
FOR CONTROL ELEMENTS.
133 ASSEMBLIES/CORE
FUEL CHARGE 50,000 KG URANIUM
BURNUP(REFUEL) FIRST CORE AVE. 18,240 MWD/MTU 3-BATCH
MIXED CORE
CONTROL ROD, BORON CARBIDE IN INCONEL TUBE
CHEMICAL SHIM
COOLANT TEMP. INLET 547 F OUTLET 598 F
COOLANT PRESS. 2100 PSIA
REACTOR VESSEL VERTICAL STEEL CYLINDER 140 FT. ID/38 FT. 2 IN.
REMARKS CONTRACT AWARD OCTOBER 1966

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD42

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REFERENCES

FORT CALHOUN STATION NO. 1, VOL. 1-2
OMAHA PUBLIC POWER DISTRICT
DOCKET 50-285 /1967/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD43

NAME/OWNER THREE MILE ISLAND STATION/METROPOLITAN EDISON
 DESIGNER BABCOCK + WILCOX
 OPERATOR METROPOLITAN EDISON CO. /PENNSYLVANIA/
 LOCATION GOLDSBORO /NEAR HARRISBURG/, PENNSYLVANIA
 SUSQUEHANNA RIVER
 PURPOSE POWER
 TYPE 840 2452
 TWO REACTORS PLANNED
 POWER MWE(MWT) 840 PER REACTOR
 CRITICAL TARGET 1971
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.362 IN. DIAM.
 FUEL GEOMETRY ROD, 0.420 IN. OD, ACTIVE LENGTH 144 IN.
 FUEL CLADDING ZIRCALOY-4, 0.026 IN. THICK
 FUEL ENRICH. ZONE, 2.29, 2.64, 2.90 PER CENT U-235
 FUEL ASSEMBLY 208-ROD BUNDLE, 15 X 15, CANNED
 177 ASSEMBLIES/CORE
 FUEL CHARGE 91.61 TONS URANIUM DIOXIDE
 BURNUP(REFUEL) DESIGN 28,200 MWD/MTU
 CONTROL CADMIUM-INDIUM-SILVER RODS, SS-CLAD
 CHEMICAL SHIM
 COOLANT TEMP. OUTLET 604.3 F
 COOLANT PRESS. 2185 PSIG
 REACTOR VESSEL STEEL VESSEL 37 FT. 4 IN. HIGH, WALL 8 7/16 IN.
 CONTAINMENT REINFORCED CONCRETE CYLINDER 130 FT. ID/57 FT.
 HIGH, WALL THICKNESS 3 FT. 6 IN, WALLS AND DOME
 ARE PRESTRESSED. CARBON STEEL LINER IS 3/8 IN.
 THICK.

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD43

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REMARKS CONTRACT AWARD NOVEMBER 1966

REFERENCES METROPOLITAN EDISON COMPANY THREE MILE ISLAND
STATION UNIT 1.
PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1.
DOCKET 50-289

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD44

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NAME/OWNER DIABLO CANYON/PACIFIC GAS AND E

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR PACIFIC GAS AND ELECTRIC CO.

LOCATION DIABLO CANYON, NEAR SAN LUIS OBISPO, CALIF.
 ON PACIFIC OCEAN

PURPOSE POWER

TYPE PWR, TWO-REACTOR STATION

POWER MWE(MWT) NO. 1, 550
 NO. 2, 1070

CRITICAL TARGET NO. 1, 1972
 NO. 2, 1974

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.

FUEL GEOMETRY ROD, 0.422 IN. OD, ACTIVE LENGTH 144 IN.

FUEL CLADDING ZIRCALOY 0.0243 IN. THICK

FUEL ENRICH. ZONE, 2.17, 2.27, 2.67 PER CENT U-235

FUEL ASSEMBLY 204-ROD BUNDLE, 15 X 15 WITH RCC ELEMENTS
 UNCANNED, SPRING-CLIP ASSEMBLY
 193 ASSEMBLIES/CORE

FUEL CHARGE 220,217 LBS. URANIUM DIOXIDE

BURNUP(REFUEL) FIRST CYCLE AVE, 12,000 MWD/MTU
 EQUIL. CORE 33,000 MWD/MTU

CONTROL ROD-CLUSTER, 20-ROD ASSEMBLY
 CADMIUM-INDIUM-SILVER IN SS CLADDING,
 CHEMICAL SHIM

COOLANT TEMP. INLET 539 F OUTLET 646 F

REACTOR VESSEL STEEL SHELL 173 IN. ID/42 FT. HIGH

CONTAINMENT VERTICAL REINFORCED CONCRETE CYLINDER,
 DOME, 140 FT. ID, SIDE WALLS 4 FT. 6 IN. THICK.

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PRESSURIZED LIGHT WATER REACTORS. DOMESTIC

HD44

WELDED STEEL LINER 1/4 IN. THICK.

REMARKS

CONTRACT AWARD NOVEMBER 1966
CONSTRUCTION PERMIT APPLIED FOR JAN. 1967
CONDENSER WATER INTAKE, DISCHARGE BY CONDUITS,
OFF-SHORE.

REFERENCES

NUCLEAR PLANT, DIABLO CANYON SITE, VOL. 1-2
PRELIMINARY SAFETY ANALYSIS REPORT
NP-16580, VOL. 1-2

NUCLEAR POWER PLANT DIABLO CANYON SITE.
PRELIMINARY SAFETY ANALYSIS REPORT
PACIFIC GAS & ELECTRIC CO.
DOCKET 50-275

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD45

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NAME/OWNER CRYSTAL RIVER STATION/FLORIDA POWER
 DESIGNER BABCOCK AND WILCOX
 OPERATOR FLORIDA POWER COMPANY
 LOCATION CRYSTAL RIVER, FLORIDA
 ON GULF OF MEXICO
 PURPOSE POWER
 TYPE PWR, TWO-REACTOR STATION
 SECOND REACTOR CANCELED
 POWER MWE(MWT) 850 2452
 CRITICAL TARGET 1972
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.362 IN. DIAM/0.8 IN. LONG
 FUEL GEOMETRY ROD, 0.420 IN. OD, ACTIVE LENGTH 144 IN.
 FUEL CLADDING ZIRCALLOY-4, 0.026 IN. THICK
 FUEL ENRICH. ZONE, 2.29, 2.64, 2.90 PER CENT U-235
 FUEL ASSEMBLY 208-ROD ASSEMBLY, CANNED
 177 ASSEMBLIES/CORE
 FUEL CHARGE 201,520 LBS. URANIUM DIOXIDE
 BURNUP(REFUEL) AVE. 28,200 MWD/MTU
 CONTROL CADMIUM-INDIUM-SILVER RODS, SS CLADDING
 CHEMICAL SHIM
 COOLANT TEMP. INLET 555 F OUTLET 604 F
 COOLANT PRESS. 2185 PSIG
 REACTOR VESSEL STEEL VESSEL 171 IN. ID/37 FT. HIGH, SHELL
 THICKNESS 8 7/16 IN.
 SS INNER CLADDING PLUS 3 IN. INSULATION
 CONTAINMENT PRESTRESSED CONCRETE VERTICAL CYLINDER 130 FT. ID,
 187 FT. HIGH, 3 1/2 FT. THICK VERTICAL WALLS.

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD45

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SHALLOW DOMED ROOF.
STEEL LINER 3/8 IN. THICK

REMARKS CONTRACT AWARD MARCH 1967
INTAKE AND DISCHARGE CANALS FOR SERVICE WATER.

REFERENCES CRYSTAL RIVER UNITS 3 AND 4 NUCLEAR GENERATING
PLANT, PRELIMINARY SAFETY ANALYSIS REPORT,
FLORIDA POWER CO.
DOCKET 50-302, VOL. 1-4

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD46

NAME/OWNER MAINE YANKEE/MAINE YANKEE ATOMIC POWER CO.
DESIGNER COMBUSTION ENGINEERING
OPERATOR MAINE YANKEE ATOMIC POWER COMPANY
LOCATION BAILEY POINT /WISCASSET/, MAINE
BACK RIVER
PURPOSE POWER
TYPE PWR, 3-LOOP SYSTEM
POWER MWE(MWT) 800 2440
CRITICAL TARGET 1972
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.382 IN. DIAM/0.600 IN.
FUEL GEOMETRY ROD, 0.44 IN. OD, ACTIVE LENGTH 137 IN.
FUEL CLADDING ZIRCALOY 0.026 IN. THICK
FUEL ENRICH. ZONE, 1.80, 2.48 3.01 PER CENT U-235
FUEL ASSEMBLY 176-ROD ASSEMBLY
217 ASSEMBLIES/CORE
FUEL CHARGE 218,000 LBS. URANIUM DIOXIDE
CONTROL ROD-CLUSTER, BORON CARBIDE IN INCONEL CLADDING,
5-ROD BUNDLE
COOLANT TEMP. INLET 550 F OUTLET 601 F
COOLANT PRESS. 2235 PSIG
REACTOR VESSEL STEEL VESSEL 172 IN. ID/41 FT. HIGH
SS INNER CLADDING 5/32 IN. THICK
CONTAINMENT PRESTRESSED CONCRETE CYLINDER, 135 FT. ID/172 FT.
HIGH, WALL THICKNESS 4 1/2 FT.,
STEEL LINER.
REMARKS CONTRACT AWARD FEB. 1967
REFERENCES NUCLEAR CANADA OCT. 1967 P. 12

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD46

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NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD47

NAME/OWNER KEWAUNEE STATION/WISCONSIN UTILITY GROUP

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR WISCONSIN PUBLIC SERVICE CO.

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 527

CRITICAL TARGET 1972
CONSTRUCTION PERMIT AUG. 6, 1968

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

CONTAINMENT CONCRETE SHIELD BUILDING ENCLOSES A FREE-STANDING
STEEL VESSEL 105 FT. DIAM BY 205 FT. HIGH, WALLS
OF 1 1/2 IN. STEEL AND 3/4 IN. STEEL IN HEMISPHERICAL
DOME. REINFORCED CONCRETE BUILDING IS 115 FT. DIAM
BY 210 FT. HIGH, WITH 2 1/2 FT. THICK WALLS AND
SHALLOW DOME 2 FT. THICK. ANNULAR SPACE IS AT ATM.
PRESSURE.

REMARKS CONTRACT AWARD FEB. 1967

REFERENCES NEWS RELEASES

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD48

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NAME/OWNER OYSTER CREEK UNIT 2/JERSEY CENTRAL P & L.

DESIGNER BABCOCK AND WILCOX

OPERATOR JERSEY CENTRAL POWER AND LIGHT CO.

LOCATION OYSTER CREEK, NEW JERSEY
FORKED RIVER /BARNEGAT BAY/

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 900 2452

CRITICAL TARGET 1973

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.362 IN. DIAM.

FUEL GEOMETRY ROD, 0.420 IN. OD, ACTIVE LENGTH 144 IN.

FUEL CLADDING ZIRCALLOY-4 0.026 IN. THICK

FUEL ENRICH. LOW

FUEL ASSEMBLY 208-ROD BUNDLE
177 ASSEMBLIES/CORE

CONTROL ROD

COOLANT TEMP. OUTLET 604 F

COOLANT PRESS. 2185 PSIG

REACTOR VESSEL STEEL VESSEL

CONTAINMENT PRESTRESSED CONCRETE CYLINDER, DOMED ROOF,
WALLS 4.0 FT. THICK, CYLINDER 130 FT. ID/157 FT.
HIGH,
STEEL LINER 3/8 IN. THICK

REMARKS CONTRACT AWARD JAN. 1967
CONDENSER COOLING WATER DRAWN FROM BARNEGAT BAY BY
WAY OF S. BRANCH OF FORKED RIVER, DISCHARGED OFF-
SHORE INTO ATLANTIC BY MEANS OF UNDERWATER AND
UNDERGROUND PIPELINE ACROSS BARNEGAT BAY AND

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD48

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ISLAND BEACH.

REFERENCES

OYSTER CREEK NUCLEAR STATION UNIT 2.
SAFETY ANALYSIS REPORT VOL. 1
JERSEY CENTRAL POWER & LIGHT CO.
DOCKET 50-320 /1968/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD49

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NAME/OWNER CALVERT CLIFFS STATION/BALTIMORE G + E

DESIGNER COMBUSTION ENGINEERING

OPERATOR BALTIMORE GAS AND ELECTRIC COMPANY

LOCATION CALVERT CLIFFS, MARYLAND
CHESAPEAKE BAY

PURPOSE POWER

TYPE PWR, TWO-REACTOR STATION

POWER MWE(MWT) 800 2440 PER REACTOR

CRITICAL TARGET NO. 1, 1973
NO. 2, 1975

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.382 IN. DIAM/0.60 IN.

FUEL GEOMETRY ROD 0.44 IN. OD.

FUEL CLADDING ZIRCALOY 0.026 IN. THICK

FUEL ENRICH. ZONE, 1.91, 2.58 3.03 PER CENT U-235

FUEL ASSEMBLY 176-ROD BUNDLE WITH RCC ELEMENTS
217 ASSEMBLIES/CORE

BURNUP(REFUEL) FIRST CYCLE AVE. 12,600 MWD/T

CONTROL ROD-CLUSTER, BORON CARBIDE
5-ROD BUNDLE

COOLANT TEMP. INLET 550 F OUTLET 602 F

COOLANT PRESS. 2235 PSIG

REACTOR VESSEL STEEL CYLINDER 172 IN. ID/42 FT. HIGH.
SS INNER CLADDING 5/32 IN. THICK

CONTAINMENT PRESTRESSED CONCRETE CYLINDER 130 FT. ID BY
182 FT. HIGH, CURVED DOME ROOF-WALL THICKNESS
3 3/4 IN.
STEEL LINER.

REMARKS CONTRACT AWARD MAY 1967

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD49

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REFERENCES

CALVERT CLIFFS NUCLEAR POWER PLANT UNITS 1-2
PRELIMINARY SAFETY ANALYSIS REPORT, VOL. 1
BALTIMORE GAS & ELECTRIC CO.
DOCKET 50-317, 50-318 /JAN. 1968/

JANUARY 1969

BNWL 936

PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD50

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NAME/OWNER PRAIRIE ISLAND NUCLEAR STATION/NSP

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR NORTHERN STATES POWER

LOCATION REDWING, MINNESOTA
 MISSISSIPPI RIVER

PURPOSE 560 1650 PER REACTOR

TYPE PWR, TWO-LOOP SYSTEM
 TWO-REACTOR STATION

POWER MWE(MWT) 550 PER REACTOR

CRITICAL TARGET NO. 1, 1972
 NO. 2, 1974

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

CONTAINMENT PRIMARY STEEL SHELL ENCLOSES EACH REACTOR.
 SHELL WALLS 1 1/2 IN. THICK, VESSEL ID. 105 FT.,
 HEIGHT 205 FT. HEMISPHERICAL DOME 3/4 IN. THICK.
 SECONDARY CONCRETE VERTICAL SHIELD CYLINDER
 115 FT. DIAM/210 FT. HIGH, WALL THICKNESS 2 1/2 FT.
 ANNULAR SPACE AT ATM. PRESSURE.

REMARKS COOLING TOWERS WILL BE PROVIDED.

REFERENCES NEWS RELEASES

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD51

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NAME/OWNER DONALD C. COOK NUCLEAR PLANT/INDIANA-MICHIGAN
AEP STATION

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION

OPERATOR INDIANA AND MICHIGAN ELECTRIC COMPANY
/AMERICAN ELECTRIC POWER COMPANY SYSTEM/

LOCATION BRIDGMAN, MICHIGAN
ON LAKE MICHIGAN

PURPOSE POWER

TYPE PWR, 4-LOOP SYSTEM
TWO-REACTOR STATION

POWER MWE(MWT) 1100 3250 PER REACTOR

CRITICAL TARGET NO. 1, 1972
NO. 2, 1973

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.

FUEL GEOMETRY ROD 0.422 IN. OD

FUEL CLADDING ZIRCALOY 0.0243 IN. THICK

FUEL ENRICH. ZONE, 2.20, 2.70, 3.20 PER CENT U-235

FUEL ASSEMBLY 204-ROD ASSEMBLY, WITH RCC ELEMENTS
UNCANNED
193 ASSEMBLIES/CORE

FUEL CHARGE 218,530 LBS. URANIUM DIOXIDE

BURNUP(REFUEL) FIRST CYCLE AVE. 12,000 MWD/MTU
FIRST CORE AVE. 21,800 MWD/MTU

CONTROL ROD-CLUSTER, INDIUM-CADMIUM-SILVER IN SS CLADDING,
20-ROD CLUSTER

COOLANT TEMP. INLET 539 F OUTLET 602 F

COOLANT PRESS. 2235 PSIA

REACTOR VESSEL STEEL SHELL 173 IN. ID/42 FT. HIGH

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD51

SS INNER CLAD 5/32 IN. THICK

CONTAINMENT

ICE-CONDENSER CONTAINMENT WHICH MAKES USE OF A LOW TEMPERATURE HEAT SINK, LOCATED WITHIN THE CONTAINMENT, CONSISTING OF A QUANTITY OF BORATED ICE IN A COLD-STORAGE COMPARTMENT. THE CONTAINMENT STRUCTURE IS A REINFORCED CONCRETE VERTICAL CYLINDER WITH A DOMED ROOF. THE INTERIOR IS DIVIDED INTO 3 VOLUMES, THE LOWER VOLUME HOUSING THE REACTOR AND REACTOR COOLING SYSTEM, THE MIDDLE VOLUME HOUSING THE ENERGY-ABSORBING ICE BED, AND AN UPPER VOLUME TO ACCOMODATE AIR DISPLACED FROM THE OTHER TWO DURING A LOSS-OF-COOLANT ACCIDENT. THE CONTAINMENT HAS A WELDED STEEL LINER 3/8 IN. THICK. THE ICE BED IS A COMPLETELY ENCLOSED ANNULAR COMPARTMENT LOCATED AROUND THE UPPER PERIMETER OF THE BUILDING AND PENETRATING THE OPERATING DECK, EXTENDING INTO THE LOWER VOLUME. A REFRIGERATING SYSTEM AND INSULATION ARE PROVIDED.

REMARKS

CONTRACT FOR FIRST STATION AWARDED IN JULY 1967

REFERENCES

DONALD C. COOK NUCLEAR PLANT,
PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1
INDIANA + MICHIGAN ELECTRIC CO.
DOCKET 50-316 /1967/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD52

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NAME/OWNER RANCHO SECO STATION/SMUD

DESIGNER BABCOCK + WILCOX

OPERATOR SACRAMENTO MUNICIPAL UTILITY DISTRICT /SMUD/

LOCATION RANCHO SECO, NEAR CLAY, CALIFORNIA
LAKE NATOMA

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 800 2500

CRITICAL CONSTRUCTION SPRING 1969.
TARGET 1973

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

REMARKS WATER NEEDS SUPPLIED BY FOLSOM SOUTH CANAL OR BY
SEPARATE PIPELINE FROM LAKE NATOMA, ON-SITE
RESERVOIR WILL HAVE CAPACITY OF 2500 ACRE-FT,
WASTE HEAT DISCHARGED TO ATM, VIA COOLING TOWERS.

REFERENCES NEWS RELEASES

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD53

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NAME/OWNER ZION STATION/COMMONWEALTH EDISON
 DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
 OPERATOR COMMONWEALTH EDISON
 LOCATION ZION, ILLINOIS
 LAKE MICHIGAN
 PURPOSE POWER
 TYPE PWR
 TWO-REACTOR STATION
 POWER MWE(MWT) 1050 3250 PER REACTOR
 CRITICAL TARGET NO. 1, 1972
 NO. 2, 1973
 COOLANT LIGHT WATER
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.3669 IN. DIAM/0.600 IN.
 FUEL GEOMETRY ROD 0.422 IN. OD, ACTIVE LENGTH 144 IN.
 FUEL CLADDING ZIRCALOY TUBES 0.0243 IN. WALL THICKNESS
 FUEL ENRICH. ZONE, 2.2, 2.7, 3.2 PER CENT U-235
 FUEL ASSEMBLY 204-ROD ASSEMBLY, 15 X 15 WITH RCC ASSEMBLIES
 SPRING-CLIP GRID
 193 ASSEMBLIES/CORE
 FUEL CHARGE 218,530 LBS. URANIUM DIOXIDE
 BURNUP(REFUEL) FIRST CORE AVE. 21,800 MWD/MTU BATCH, 64
 EQUIL. CORE AVE, 33,000 ASSEMBLIES
 IN-OUT.
 CONTROL ROD-CLUSTER CONTROL, 20-ROD BUNDLE
 CADMIUM-INDIUM-SILVER RODS, SS-CLAD
 CHEMICAL SHIM.
 COOLANT TEMP. INLET 539 F OUTLET 646 F
 COOLANT PRESS. 2250 PSIA
 REACTOR VESSEL STEEL CYLINDRICAL VESSEL

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PRESSURIZED LIGHT WATER REACTORS; DOMESTIC

HD53

CONTAINMENT STEEL-LINED PRESTRESSED CONCRETE CYLINDER, DOMED
ROOF.

REMARKS SERVICE WATER DRAWN FROM LAKE MICHIGAN AND
DISCHARGED BACK INTO LAKE.

REFERENCES ZION STATION UNITS 1 AND 2
PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1
COMMONWEALTH EDISON CO.
DOCKET 50-295-1

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS: DOMESTIC

HD54

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NAME/OWNER RUSSELLVILLE STATION/ARKANSAS P + L

DESIGNER BABCOCK + WILCOX

OPERATOR ARKANSAS POWER + LIGHT

LOCATION RUSSELLVILLE, ARKANSAS
 ARKANSAS RIVER

PURPOSE POWER

TYPE PWR, 2-LOOP SYSTEM

POWER MWE(MWT) 800 2452

CRITICAL CONSTRUCTION SEPT. 1968
 TARGET 1972

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.362 IN. DIAM/0.8 IN.

FUEL GEOMETRY ROD 0.420 IN. OD, ACTIVE LENGTH 144 IN.

FUEL CLADDING ZIRCALOY-4, 0.026 IN. THICK

FUEL ENRICH. ZONE, 2.29, 2.64, 2.90 PER CENT U-235

FUEL ASSEMBLY 208-ROD BUNDLE, CANNED
 177 ASSEMBLIES/CORE

FUEL CHARGE 91.61 TONS URANIUM DIOXIDE

BURNUP(REFUEL) 28,200 MWD/MTU

CONTROL RODS, CADMIUM-INDIUM-SILVER, SS-CLAD,
 CHEMICAL SHIM.

COOLANT TEMP. INLET 555 F OUTLET 603 F

COOLANT PRESS. 2185 PSIG

REACTOR VESSEL CARBON STEEL VESSEL 171 IN. ID, 42 FT. HIGH
 SS-LINED

CONTAINMENT CONCRETE CYLINDER 116 FT. ID, 206 FT. INNER HEIGHT
 WALL THICKNESS 3 3/4 FT.
 WELDED STEEL LINER.

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PRESSURIZED LIGHT WATER REACTORS; DOMESTIC

HD54

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REMARKS

CONDENSER COOLING WATER DRAWN FROM DARDANELLE
RESERVOIR, UPSTREAM, AND DISCHARGED INTO ILLINOIS
BAYOU EMBAYMENT.

REFERENCES

RUSSELLVILLE NUCLEAR UNIT,
PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1
ARKANSAS POWER AND LIGHT
DOCKET 50-313 /VOL. 1/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD55

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NAME/OWNER	SHIPPINGPORT-2/DUQUESNE LIGHT, OHIO EDISON
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
LOCATION	SHIPPINGPORT, PENNA.
PURPOSE	POWER
TYPE	PWR
POWER MWE(MWT)	800
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	CONTRACT 1967
REFERENCES	NEWS RELEASES.

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD56

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NAME/OWNER	NORTH ANNA STATION/VIRGINIA ELECTRIC POWER
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
LOCATION	NORTH ANNA RIVER, VIRGINIA
PURPOSE	POWER FIRST OF PLANNED 4000 MWE NUCLEAR CENTER.
TYPE	PWR
POWER MWE(MWT)	800
CRITICAL	TARGET 1974
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	CONTRACT 1967 COOLING WATER WILL BE DRAWN FROM LAKE CREATED BY BUILDING A DAM, WITH DISCHARGE INTO A SERIES OF CANALS AND LAGOONS BEFORE RETURN TO LAKE.
REFERENCES	NEWS RELEASES

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD57

* * * * *

NAME/OWNER	HUTCHINSON ISLAND STATION/FLORIDA P & L
DESIGNER	COMBUSTION ENGINEERING
OPERATOR	FLORIDA POWER & LIGHT COMPANY
LOCATION	HUTCHINSON ISLAND, FLORIDA ATLANTIC OCEAN
PURPOSE	POWER
TYPE	PWR
POWER MWE(MWT)	850
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	OPTION ON SECOND REACTOR

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD58

* * * * *

NAME/OWNER	MIDLAND STATION/CONSUMERS POWER, DOW CHEMICAL
DESIGNER	BABCOCK + WILCOX COMPANY
LOCATION	MIDLAND, MICHIGAN
PURPOSE	POWER AND PROCESS STEAM
TYPE	PWR, TWO-REACTOR STATION
POWER MWE(MWT)	NO. 1, 800 2452 NO. 2, 550 2452
CRITICAL	TARGET NO.1, 1974 NO.2, 1975
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	CONTRACT AWARD JULY 1968

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD59

NAME/OWNER SEQUOYA STATION/TVA
DESIGNER WESTINGHOUSE ELECTRIC CORPORATION
OPERATOR TENNESSEE VALLEY AUTHORITY
LOCATION CHICKAMAUGA LAKE, TENNESSEE
PURPOSE POWER
TYPE PWR, TWO-REACTOR STATION
POWER MWE(MWT) 1175 3412 PER REACTOR
CRITICAL TARGET NO.1, 1973
NO.2, 1974
COOLANT LIGHT WATER
MODERATOR LIGHT WATER
CONTAINMENT ICE-CONDENSER CONTAINMENT SYSTEM
REMARKS CONTRACT JULY 1968

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD60

NAME/OWNER NEWINGTON STATION/N.H.; PUBLIC SERVICE
UNITED ILLUMINATING CO.,
CENTRAL MAINE POWER

LOCATION TIDEWATER, NEW HAMPSHIRE
PISCATAQUA RIVER, TIDAL ESTUARY

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 800 2660

CRITICAL TARGET 1974

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD61

* * * * *

NAME/OWNER TROJAN STATION/PORTLAND GENERAL ELECTRIC CO.

DESIGNER WESTINGHOUSE ELECTRIC CORPORATION.

OPERATOR PORTLAND GE

LOCATION NEAR RAINIER, OREGON
COLUMBIA RIVER

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 1100

CRITICAL TARGET 1974

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

REMARKS CONTRACT AWARD NOV. 1968

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, DOMESTIC

HD62

NAME/OWNER DAVIS-BESSE STATION/TOLEDO EDISON CO.
 CLEVELAND ELECTRIC ILLUM. CO.,

DESIGNER BABCOCK & WILCOX

LOCATION NEAR OAK HARBOR, OHIO
 LAKE ERIE

PURPOSE POWER

TYPE PWR

POWER MWE(MWT) 890 2650

CRITICAL TARGET 1974

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

REMARKS CONTRACT AWARD NOV. 1968

PRESSURIZED LIGHT WATER REACTORS

FOREIGN

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF01

NAME/OWNER BR-3/BELGIAN REACTOR-3/CEN, BELGIUM
BR-3/VULCAIN, SEE REMARKS

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR CEN, BELGIUM

LOCATION MOL, BELGIUM
LAGOON

PURPOSE POWER EXPERIMENT, TEST AND TRAINING

TYPE PWR

POWER MWE(MWT) 10 40

CRITICAL 1961, FULL POWER OCT. 1962.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS, 0.300 IN. DIA./0.600 IN.
LONG

FUEL GEOMETRY ROD, ACTIVE LENGTH 56 IN.

FUEL CLADDING SS TUBES, 0.343 IN. OD. AND 21 MILS WALL THICKNESS

FUEL ENRICH. ZONAL, INNER 3.7 PERCENT, PERIPHERAL 4.4

FUEL ASSEMBLY 110-111 ROD ASSEMBLY, BRAZED,
32 ASSEMBLIES IN CORE, 16 IN EACH
ENRICHMENT ZONE.

FUEL CHARGE 5000 LBS. FUEL

BURNUP(REFUEL) 7000 FULL-POWER HOURS LIFE, /BATCH, /FUEL SHUFFLING/

NEUTRON FLUX THERMAL AVE, 2.4×10^6 E+13
FAST AVE, 1.4×10^6 E+14

CONTROL RODS, SILVER-INDIUM-CADMIUM

COOLANT TEMP. INLET 491 F OUTLET 515 F

COOLANT PRESS. 2000 PSIA

REACTOR VESSEL CARBON STEEL VERTICAL CYLINDER, 58 IN. ID. AND
18 FT. HIGH. SS INNER CLADDING,

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF01

CONTAINMENT STEEL VESSEL 54 FT. DIA. BY 107 FT. HIGH, INNER
CONCRETE SHIELDING, 1/4 BELOW GROUND LEVEL.

REMARKS BR-3 WAS SHUT DOWN IN AUG. 1963 AND PLACED AT THE
DISPOSAL OF THE VULCAIN PROJECT. AFTER
MODIFICATIONS, A VULCAIN CORE WAS INSTALLED IN
MAY, 1966 AND CRITICAL TESTING DONE WITH BORATED
WATER. FIRST CRITICALITY OF BR-3/VULCAIN WITH
HEAVY WATER IN THE CIRCUITS WAS IN NOV. 1966 AND
DESIGN POWER REACHED IN DEC. 1966. THE VULCAIN
PROGRAM WILL BE ENDED IN 1970, WHEN A THIRD CORE
CONTAINING PLUTONIUM WILL BE INSTALLED IN BR-3.

REFERENCES BR-3, GENERAL DESCRIPTION, DESIGN PHILOSOPHY AND
PLANT CONSTRUCTION. CORE DESIGN AND TESTING,
L MERGAN, OTHERS
NUCLEAR ENG. 5, 337-52 /AUGUST 1960/

THE BR-3 REACTOR.
WF DAVIS
WESTINGHOUSE ENG. 20, 162-5 /NOVEMBER 1960/

VULCAIN PROJECT STATUS REPORT.
NUCLEAR ENG. 12, 34-6 /JAN. 1967/

ANNUAL REPORT 1966.
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE
NP-17126

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF03

* * * * *

NAME/OWNER FRANCO-BELGE ARDENNES STATION/SENA, FRANCE-BELGIUM

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR SOCIETE D-ENERGIE NUCLEAIRE FRANCO-BELGE DES
ARDENNES /SENA/, FRANCELOCATION CHOOZ, FRANCE /NEAR GIVET/
MEUSE RIVER

PURPOSE POWER, US-EURATOM PROJECT.

TYPE PWR

POWER MWE(MWT) 288 825
SEE REMARKSCRITICAL MARCH 1967
DOWN DUE TO MALFUNCTION IN COOLING SYSTEM
IN JAN. 1968, ON-LINE TARGET 1969.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.890 CM. DIAM.

FUEL GEOMETRY ROD, 2.68 M. ACTIVE LENGTH

FUEL CLADDING SS TUBES 0.978 CM. OD, WALL 0.038 CM.

FUEL ENRICH. 3.1 PER CENT U-235

FUEL ASSEMBLY 209-ROD BUNDLE
CENTRAL POSITION VACANT.
EGG-CRATE ASSEMBLY WITH SPRING CLIPS.
120 ASSEMBLIES/CORE

FUEL CHARGE 45000 KG URANIUM DIOXIDE

BURNUP(REFUEL) 14700 MWD/T BATCH, FUEL SHUFFLING.

NEUTRON FLUX THERMAL 2.3×10^{13} CONTROL SS TUBES CONTAINING SILVER-INDIUM-CADMIUM ALLOY
CHEMICAL SHIM

COOLANT TEMP. INLET 267 C OUTLET 300 C

COOLANT PRESS. 2148 PSIA

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF03

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REACTOR VESSEL STEEL VERTICAL CYLINDER 39.4 FT. HIGH BY 10.5 FT.
ID. SS INNER CLADDING

CONTAINMENT UNDERGROUND CONSTRUCTION /CAVERN/

REMARKS SECOND CORE WILL BE FABRICATED BY SOCIETE BELGE
METALLURGIE ET MECANIQUE NUCLEAIRE.

REFERENCES THE SENA UNDERGROUND PWR.
NUCLEAR POWER 7, 79 /FEBRUARY 1962/

THE ARDENNES NUCLEAR STATION.
PIERRE-A GRAU, PIERRE-A ERKES
INDUSTRIES ATOMIQUES NO. 1/2, 1964, p. 55-64

ARDENNES NUCLEAR CENTRAL STATION, SPECIAL FEATURES
AND IMPROVEMENTS IN COMPARISON WITH SIMILAR
EXISTANT PLANTS.

P ERKES
3RD. U.N. INTL. CONF, PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964.
A/CONF. 28/P/514

SENA--BELGIAN-FRENCH ATOMIC POWER STATION
ATOMWIRTSCHAFT 11, 444-46 /AUG-SEPT. 1966/

ARDENNES
ENERGIE NUCLEAIRE 8, 520-34 /DEC. 1966/

THE NUCLEAR DESIGN OF SENA REACTOR.
FJ FRANK
WCAP-2785 /MAY 1965/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF04

* * * * *

NAME/OWNER SSR-4 / FIAT, ANSALDO, CNEN-ITALY

DESIGNER FIAT, ITALY

PURPOSE NUCLEAR TANKER PROPULSION

TYPE PWR, FORCED CIRCULATION, COMPACT DESIGN.

POWER MWE(MWT) 23000 SHP 74

CRITICAL DESIGN AND DEVELOPMENT.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

CONTROL CHEMICAL SHIM

CONTAINMENT PRESSURE-SUPPRESSION.

REMARKS THE ITALIAN GOVERNMENT IS NEARING A DECISION TO BUILD A NUCLEAR POWERED NAVAL SUPPORT VESSEL, USING A COMPACT PWR, RATED AT 60 MWT, OF EXCLUSIVELY ITALIAN DESIGN. FUEL WOULD BE 4 PER CENT ENRICHED URANIUM. IN A SEPARATE PROJECT FIAT, ANSALDO, AND CNEN ARE COMPLETING DETAILS FOR BUILDING A FULL-SCALE LAND-BASED PROTOTYPE OF A COMPACT PWR.

REFERENCES NUCLEAR INDUSTRY FEB. 1966 P. 24-5
NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS: FOREIGN

HF050

NAME/OWNER	ENRICO FERMI NUCLEAR STATION/SELNI, ITALY		
DESIGNER	WESTINGHOUSE ELECTRIC CORP.		
OPERATOR	SOCIETA ELETTRONUCLEARE ITALIANA /SELNI/		
LOCATION	TRINO VERCELLESE /ON PO RIVER/, ITALY		
PURPOSE	POWER		
TYPE	PWR, CLOSED CYCLE		
POWER MWE(MWT)	290	825	WITH CHEMICAL SHIM
CRITICAL	JUNE 1964, POWER OPERATION SEPT, 1964		
COOLANT	LIGHT WATER		
MODERATOR	LIGHT WATER		
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, 0.35 IN. DIA. SINTERED		
FUEL GEOMETRY	ROD, ACTIVE LENGTH 103.2 IN.		
FUEL CLADDING	SS TUBE, 15 MILS WALL THICKNESS		
FUEL ENRICH.	2.7 PER CENT U-235 /3-REGION ENRICHMENT/		
FUEL ASSEMBLY	208-ROD ASSEMBLY, 15x15, OMISSIONS FOR CONTROL RODS SPRING-CLIP ASSEMBLY, BOX-TYPE 120 FUEL ASSEMBLIES		
BURNUP(REFUEL)	FUEL SHUFFLING, BATCH		
CONTROL	RODS, SILVER-INDIUM-CADMIUM, FUEL-ROD FOLLOWERS, CHEMICAL SHIM.		
COOLANT TEMP.	539.5 F		
COOLANT PRESS.	2200 PSIA		
REACTOR VESSEL	STEEL VESSEL 144 IN. OD. BY 465 IN. HIGH, 8 IN. THICK WALLS.		
CONTAINMENT	CONTAINMENT SHELL. ADJACENT ANNULUS PROVIDED BY SPLITTING THE SECONDARY BIOLOGICAL SHIELDING INTO TWO PORTIONS. THE ANNULUS CAN BE KEPT AT A PRESSURE SLIGHTLY BELOW ATMOSPHERIC.		

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF05

REMARKS: SELNI WILL PIONEER CHEMICAL SHIM CONTROL AND
3-REGION ENRICHMENT CORES. EVENTUAL OUTPUT WILL
BE 290 MWE BY THE INSTALLATION OF A FURTHER
TURBOGENERATOR.

REFERENCES: EUROPEAN POWER REACTORS. ITALY.
MECH. ENG. 81, 63 /NOVEMBER 1959/

ATOMIC ENERGY IN ITALY.
NUCLEAR POWER 7, 51-78 /FEBRUARY 1962/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF06

* * * * *

NAME/OWNER OCEANOGRAPHIC RESEARCH VESSEL/JAPSD-JAPAN

DESIGNER MITSUBISHI ATOMIC POWER INDUSTRY CO.,-JAPAN
/MAPI/

PURPOSE SHIP PROPULSION

TYPE PWR

POWER MWE(MWT) 35

CRITICAL NO CURRENT INFORMATION

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL CLADDING SS

FUEL ENRICH. TWO-REGION CORE, LOW ENRICHMENT.

BURNUP(REFUEL) 5860 MWD/T

REMARKS JAPSD HAS WORKED OUT A SET OF BASIC CONDITIONS FOR
PROPOSED CONSTRUCTION OF A 6,000 TON OCEANIC
OBSERVATION VESSEL POWERED BY NUCLEAR ENERGY.
SPECIFICATIONS WERE COMPLETED AND BIDS REQUESTED
IN FEBRUARY 1965.REFERENCES NUCLEONICS WEEK JULY 21, 1966
NEWS RELEASE

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF07

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NAME/OWNER NERO PROJECT/RCN, THE NETHERLANDS-EURATOM
NEREUS REACTOR

DESIGNER RCN, THE NETHERLANDS

LOCATION CRITICAL EXPERIMENT KRITO AT PETTEN RESEARCH
ESTAB., THE NETHERLANDS

PURPOSE SHIP PROPULSION

TYPE PWR, INTERNAL RECIRCULATION

POWER MWE(MWT) 20,000 SHP 63

CRITICAL DESIGN. SEE REMARKS

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 10.03 MM. DIA. BORON
CARBIDE BURNABLE POISON

FUEL GEOMETRY ROD 10 MM. DIAM. ACTIVE LENGTH 1370 MM.

FUEL CLADDING ZIRCALOY TUBE 1.7 MM. THICK.

FUEL ENRICH. TWO-ZONE, 4.4 AND 4.8 PER CENT U-235

FUEL ASSEMBLY 30 FULL-SIZED ELEMENTS
12 ZIRCALOY-CLAD ELEMENTS, HEXAGONAL, EQUIPPED
WITH CLUSTER-TYPE CONTROL RODS,
3300 FUEL RODS/CORE

FUEL CHARGE 3700 KG URANIUM DIOXIDE

BURNUP(REFUEL) 16,600 MWD/MT 4-YEAR PERIODS
URANIUM DIOXIDE

CONTROL ROD-CLUSTER CONTROL RODS WITH BORON CARBIDE
BURNABLE POISON IN FUEL PELLETS

COOLANT TEMP. INLET 273 C OUTLET 300 C

COOLANT PRESS. 150 KG/SQ. CM.

CONTAINMENT SPHERICAL STEEL VESSEL ENCLOSING COMPLETE PRIMARY
SYSTEM, EQUIPPED WITH INTERNAL VENTILATING SYSTEM

REMARKS KRITO, CRITICAL IN MARCH 1963, IS FUELED WITH 3.1

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF07

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AND 3.8 PERCENT URANIUM DIOXIDE PELLETS IN ALUMINUM TUBES, INCORPORATING BORON CARBIDE AS POISON MATERIAL. DESIGN OF NERO IS FOR A COMPACT INSTALLATION WITH A LONG CORE LIFE. INCREASED WATER CIRCULATION THROUGH THE CORE IS OBTAINED BY HYDRAULIC EJECTORS INSIDE THE REACTOR VESSEL AND A COMBINED UNIT FOR HEAT EXCHANGER, SUPERHEATER, AND PUMP FOR THE EXTERNAL CIRCUIT. DEVELOPMENT PROGRAM BY RCN AND EURATOM STARTED IN 1961, BASED ON DESIGN STUDY PROGRAM BASED ON 16 ITEMS. PROGRAM TERMINATED IN 1967. THE NEREUS REACTOR DESIGN IS FOR A SHIP-REACTOR.

REFERENCES

THE CRITICAL FACILITY KRITO
JG ACKERS, OTHERS
INTL. ATOMIC ENERGY AGENCY,
SYMP. OF EXPONENTIAL AND CRITICAL EXPERIMENTS
WITH CALCULATIONS, AMSTERDAM, SEPT. 1963,
EUR-498E /1964/

THE NERO REACTOR FOR SHIP PROPULSION.
M BOGAARDT, M MUYSKEN
3RD U.N. INTL. CONF. PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964,
A/CONF. 28/P/588

NERO DEVELOPMENT PROGRAM. REPORT COVERING PERIOD
JULY 1964-DECEMBER 1965.
REACTOR CENTRUM NEDERLAND
EUR-3125.E /1966/

DUTCH NUCLEAR PROPULSION SHIP REACTOR
W HOFMAN
RCN-76 /1967/

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF08

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NAME/OWNER	TIHANGE STATION/SYNATOM, FRANCE-BELGIUM EDF, EBES, INTERCOM
DESIGNER	WESTINGHOUSE, U.S., WITH BUILDERS AGE, COCKRILL- OUGREE, FRAMATOME
OPERATOR	FRENCH-BELGIAN UTILITIES GROUP SYNATOM
LOCATION	TIHANGE, BELGIUM MEUSE RIVER
PURPOSE	POWER
TYPE	PWR
POWER MWE(MWT)	750
CRITICAL	TARGET 1972
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REFERENCES	NEWS RELEASE.

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF10

NAME/OWNER : GOTAVERKEN PROJECT/GOTAVERKEN-SWEDEN
 DESIGNER : GOTAVERK., SWEDEN
 PURPOSE : TANKER PROPULSION
 TYPE : PWR
 POWER MWE(MWT) : 30,000 SHP
 CRITICAL : DESIGN AND DEVELOPMENT
 COOLANT : LIGHT WATER
 MODERATOR : LIGHT WATER
 FUEL MATERIAL : URANIUM METAL
 FUEL GEOMETRY : SLUGS
 FUEL ENRICH. : 1 PER CENT U-235 OR SMALL ADDITION OF PLUTONIUM
 FUEL ASSEMBLY : ROTATING FUEL ELEMENTS
 FUEL CHARGE : 24 TONS URANIUM
 CONTROL : NEUTRON ABSORPTION BY SHIELDS INCORPORATED IN THE FUEL CLADDING TUBE.
 CONTAINMENT : VERTICAL STEEL CYLINDER IN WHICH THE PRESSURE VESSEL IS SUSPENDED
 REMARKS : STUDY PROJECT, COOPERATION WITH BRITISH AND US B + W. PRIMARY SYSTEM, VERTICAL STEEL CYLINDER INSIDE OF WHICH THE PRESSURE VESSEL WOULD BE SUSPENDED. CORE DESIGN FEATURES ROTATING FUEL ELEMENTS WITH NEUTRON ABSORBENT SHIELDS COVERING A SECTION OF THE CYLINDER SURFACE TO CONTROL REACTOR OUTPUT. A 4-YEAR R AND D AGREEMENT ON A NUCLEAR SHIP HAS BEEN SIGNED BY THE NORWEGIAN INST. FOR ATOMIC ENERGY AND ATOMENERGI OF SWEDEN.
 REFERENCES : FIRST SCANDINAVIAN PROJECT FOR TANKER NUCLEAR PROPULSION.
 FA ABADIE-MAUMERT
 ENERGIE NUCLEAIRE 2, 44-5 /JANUARY-FEBRUARY 1960/

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF12

* * * * *
 NAME/OWNER APS-1 /SOVIET ATOMIC POWER STATION-1/USSR
 DESIGNER USSR
 OPERATOR USSR
 LOCATION OBNINSK, USSR
 PURPOSE POWER PROTOTYPE
 TYPE PWR, PRESSURE TUBE
 POWER MWE(MWT) 5 30
 CRITICAL 1954
 COOLANT LIGHT WATER
 MODERATOR GRAPHITE AND GRAPHITE REFLECTOR
 FUEL MATERIAL URANIUM-MOLYBDENUM-MAGNESIUM ALLOY
 FUEL GEOMETRY TUBES 0.9 CM. ID./1.36 CM. OD./170 CM. LONG
 FUEL CLADDING SS INNER 0.4 MM; OUTER 0.2 MM THICK
 FUEL ENRICH. 5 PER CENT U-235
 FUEL ASSEMBLY 4 CYLINDERS, SQUARE ARRAY, AROUND CENTRAL SS
 PRESSURE TUBE, GRAPHITE SUPPORT STRUCTURAL MEMBER
 128 FUEL CHANNELS.
 FUEL CHARGE 550 KG ENRICHED URANIUM
 SPECIFIC POWER 54.5 KW/KG ENRICHED URANIUM
 BURNUP(REFUEL) 20 PERCENT OF U-235
 PARTIAL, ABOUT 2 MONTHS
 NEUTRON FLUX THERMAL AVE. 5×10^{13}
 CONTROL SHIM AND REGULATING RODS
 COOLANT TEMP. INLET 190 C OUTLET 300 C
 COOLANT PRESS. INLET 109 KG/SQ.CM OUTLET 100 KG/SQ. CM.
 REACTOR VESSEL CARBON STEEL CYLINDER 320 MM. DIA., 15 MM. WALL
 THICKNESS
 CONTAINMENT REACTOR HALL ONLY

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF12

REMARKS

THE REACTOR HAS A THERMAL COLUMN AND SIX CHANNELS
FOR IRRADIATION EXPERIMENTS. IT HAS BEEN IN USE
AS A TEST-BED FOR BELOYARSK REACTOR FUEL ELEMENTS.

REFERENCES

DIRECTORY OF NUCLEAR REACTORS,
VOLUME 1. POWER REACTORS, P. 3-8
INTERNATIONAL ATOMIC ENERGY VIENNA, 1959.

THE FIRST ATOMIC POWER STATION OF THE USSR.
DI BLOKHINTSEV, NA NIKOLAEV
INTL. CONF. ON THE PEACEFUL USES OF ATOMIC
ENERGY 3. 35-55 /1955/

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF13

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NAME/OWNER	SIBERIAN REACTOR STATION/USSR
DESIGNER	USSR
OPERATOR	USSR
LOCATION	TROITSK, USSR
PURPOSE	POWER, SIX-REACTOR COMPLEX
TYPE	PWR, SIX-REACTOR STATION PLANNED.
POWER MWE(MWT)	100
CRITICAL	1958 /1ST REACTOR/
COOLANT	LIGHT WATER
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM METAL
FUEL GEOMETRY	RODS
FUEL CLADDING	ALUMINUM TUBES
FUEL ENRICH.	NATURAL
FUEL CHARGE	182,000 KG. URANIUM
COOLANT TEMP.	428 F
REMARKS	NO RECENT INFORMATION
REFERENCES	CATALOG OF NUCLEAR REACTORS, HS ISBN SECOND U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 8, 561-584 /1958/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF14

NAME/OWNER NOVO-VORONEZH NUCLEAR STATION/USSR
 WWER-1, WWER-2

DESIGNER USSR

OPERATOR USSR

LOCATION NOVO-VORONEZH, USSR
 DON RIVER

PURPOSE POWER

TYPE PWR, 4-REACTOR STATION

POWER MWE(MWT) 196 760
 LATER REACTORS UP-RATED TO 360 MWE AND 1500 MWT
 PER REACTOR

CRITICAL NO.1, 1963
 NO.2, CONSTRUCTION 1964, TARGET 1969
 NO.3, CONSTRUCTION 1967 TARGET 1972
 NO.4, CONSTRUCTION 1967 TARGET 1973

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY ROD 1.02 CM. DIA. 250 CM. ACTIVE LENGTH

FUEL CLADDING ZIRCONIUM-NIOBIUM ALLOY
 SEE REMARKS

FUEL ENRICH. 1.5 PER CENT U-235
 SEE REMARKS

FUEL ASSEMBLY 91-ROD ASSEMBLY IN ZIRCONIUM CANISTER 320 CM. LONG
 BY 16.5 CM. DIA. FUEL ELEMENTS SPACED AROUND THE
 WALLS.
 349 ASSEMBLIES/CORE

FUEL CHARGE 17 TONS URANIUM DIOXIDE

SPECIFIC POWER 19 KW/KG ENRICHED URANIUM

BURNUP(REFUEL) 2000-3000 MWD/T PARTIAL OR TOTAL
 SEE REMARKS

NEUTRON FLUX THERMAL AVE. 1×10^{13}

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF14

CONTROL REPLACEMENT OF FISSIONABLE MATERIAL BY ABSORBING
MATERIAL, EMERGENCY SHUT-DOWN CANS, ABSORBING RODS

COOLANT TEMP. 262.5 C

COOLANT PRESS. 100 KG./SQ. CM.

REACTOR VESSEL STEEL CYLINDER 3.8 M. DIA./12 M. HIGH.
SS INNER CLADDING

CONTAINMENT WATER-FILLED CIRCULAR TANK, REACTOR VAULT.

REMARKS FUEL FOR SECOND REACTOR WILL BE SLIGHTLY ENRICHED
URANIUM DIOXIDE WITH SS CLADDING, FOR DESIGN
BURNUP OF 30,000 MWD/T.
HUNGARY IS REPORTEDLY INTERESTED IN IMPORTING
TWO REACTORS OF THE VORONEZH TYPE FOR OPERATION
IN 1975-1976.
COOLING TOWERS WILL BE INSTALLED FOR THE VORONEZH
STATION

REFERENCES THE RUSSIAN 420 MW POWER STATION.
NUCLEAR ENG. 2, 431-6 /1957/

DIRECTORY OF NUCLEAR REACTORS, VOL. 1, P. 33-38
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1959.

WORLD POWER REACTORS 1966 /CHART/
NUCLEAR ENGINEERING APRIL 1966.

NEWS RELEASES

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF15

NAME/OWNER Leningrad Power Station/USSR

DESIGNER USSR

OPERATOR USSR

LOCATION Leningrad, USSR

PURPOSE POWER

TYPE PWR, TWO-REACTOR STATION ORIGINALLY PLANNED

POWER MWE(MWT) 210 760

CRITICAL PROJECT CANCELED

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL GEOMETRY RODS

FUEL CLADDING ZIRCONIUM

FUEL ENRICH. 1.5 PER CENT U-235

REMARKS STATION WAS TO HAVE BEEN SIMILAR TO THE VORONEZH STATION. THE PROJECT HAS BEEN DROPPED, PRESUMABLY BECAUSE OF CLOSE-IN SITING PROBLEMS.

REFERENCES PRESSURIZED WATER REACTORS IN THE USSR, SA SKARTSOV
SECOND U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 8, 415-20 /1958/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF16

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NAME/OWNER	TES-3 / USSR	
DESIGNER	USSR	
OPERATOR	USSR	
LOCATION	OBNISK, USSR	
PURPOSE	PORTABLE /PACKAGED/ POWER PLANT	
TYPE	PWR, MOBILE PLANT, PACKAGED,	
POWER MWE(MWT)	1.5	12
CRITICAL	1961	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE DISPERSED IN MELTABLE ALLOY	
FUEL ENRICH.	HIGH	
BURNUP(REFUEL)	250-DAY CORE LIFE	
CONTROL	RODS	
COOLANT TEMP.	INLET 275 C	OUTLET 300 C
COOLANT PRESS.	130 ATM.	
CONTAINMENT	TRANSPORTABLE LEAD SHIELDING, SHIELD TANK LOCATION IN TRENCH WITH OVERLAP AND WALLS OF FERRO-CONCRETE AND GROUND COVER.	
REMARKS	PLANT AND EQUIPMENT IS MOUNTED ON FOUR TRUCK TRAILERS. TES-3 IS A 2-CIRCUIT STEAM-TURBINE SET-UP, AND IS AUTOMATED FOR CHANGE IN POWER WITH CHANGING TURBOGENERATOR OVERLOAD. TRAILERS ARE EQUIPPED FOR MOVEMENT BY RAIL.	
REFERENCES	ATOMIC ENERGY IN THE SOVIET UNION. TRIP REPORT, U.S. ATOMIC ENERGY DELEGATION, MAY 1963, SMALL-GABARIT ATOMIC POWER PLANT TES-3: NM SINEV, OTHERS 3RD U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF. 28/P/310	

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF17

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NAME/OWNER	LENIN SHIP REACTOR/USSR	
DESIGNER	USSR	
OPERATOR	USSR	
LOCATION	NUCLEAR ICE-BREAKER LENIN	
PURPOSE	SHIP PROPULSION	
TYPE	PWR, 3-REACTOR PLANT.	
POWER MWE(MWT)	SEE REMARKS	90
CRITICAL	OPERATION 1959. REFUELED IN SPRING, 1963.	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE PELLETS	
FUEL GEOMETRY	ROD, 6.1 MM. DIA., 1.6 M. ACTIVE HEIGHT	
FUEL CLADDING	ZIRCONIUM ALLOY 0.75 MM. THICK. SEE REMARKS	
FUEL ENRICH.	5 PER CENT U-235	
FUEL ASSEMBLY	36-ROD BUNDLE IN CIRCULAR SHROUD, IN CONTAINMENT CHANNELS OF ZIRCONIUM ALLOY. 219 CHANNELS	
FUEL CHARGE	80 KG. U-235	
BURNUP(REFUEL)	11000-13000 MWD/T	
CONTROL	BURNABLE POISON DISTRIBUTED IN CONTAINMENT CHANNELS. RODS.	
COOLANT TEMP.	INLET 261°C	OUTLET 317°C
REACTOR VESSEL	CYLINDRICAL, 2 M. OD. BY 5 M. HIGH. LOW-ALLOY STEEL WITH SS SHELL.	
CONTAINMENT	STEEL AND LIMONITE CONCRETE PLUS SHIELDING.	
REMARKS	WITH THREE REACTORS OPERATING, THE FULL POWER OF 40,000 SHP CAN BE OBTAINED, NORMALLY ONLY TWO REACTORS OPERATE. ON THE FIRST REFUELING, ONE REACTOR WAS CHARGED WITH STAINLESS STEEL CLAD	

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PRESSURIZED LIGHT WATER REACTORS. FOREIGN

HF17

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ELEMENTS. TWO NEW ATOMIC ICEBREAKERS WILL HAVE 2
IMPROVED REACTORS EACH INSTEAD OF 3.

REFERENCES

A NUCLEAR ICE-BREAKER
AP ALEKSANDOV, OTHERS
SOVIET J. ATOMIC ENERGY 5, 1121-46 /1958/

USSR LENIN.
NUCLEAR ENG. 9, 364 AND FACING /OCTOBER 1964/

OPERATING EXPERIENCE OF THE ATOMIC POWER PLANT
ON THE ICE-BREAKER LENIN.
JJ APHRIKANTOV, OTHERS
3RD U.N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY, GENEVA, 1964,
A/CONF. 28/P/313

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF18

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NAME/OWNER SHIP REACTOR STUDIES /UK AEA

PURPOSE SHIP PROPULSION

REMARKS THE UK AEA HAS JOINED BELGONUCLEAIRE IN THE JOINT
DEVELOPMENT OF THE VULCAIN CONCEPT FOR NUCLEAR
SHIP PROPULSION. CURRENTLY ALL SHIP DESIGNS HAVE
BEEN REPORTED AS DROPPED EXCEPT THE VULCAIN
CONCEPT AND THE IBR /INTEGRAL BOILING REACTOR/,
A PRESSURE TUBE SYSTEM.

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF20

NAME/OWNER FDR /FORTSCHNITTLICHER DRUCKWASSERREAKTOR//GKSS
 OTTO HAHN

DESIGNER DEUTSCH BAW-INTERATOM, SEE REMARKS

OPERATOR GKSS-W GERMANY

PURPOSE SHIP PROPULSION, ORE CARRIER OTTO HAHN.

TYPE ADVANCED PWR, INTEGRAL DESIGN

POWER MWE(MWT) 10,000-11,000 SHP 38

CRITICAL FIRST CRUISE OF THE OTTO HAHN INTO THE BALTIC SEA
 IN NOVEMBER, 1968.

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY ROD, 11.0 MM. DIA., ACT. LENGTH 1120 MM.

FUEL CLADDING SS TUBES, WALL THICKNESS 0.35 MM.

FUEL ENRICH. ZONE ENRICHMENT 2.5, 2.9, 3.5 AND 4.3 PER CENT
 U-235

FUEL ASSEMBLY 226-ROD BUNDLES, 17x17 SQUARE, AND TRIANGULAR
 CORNER ASSEMBLIES.
 16 FUEL ASSEMBLIES/CORE

FUEL CHARGE 2.95 TONS URANIUM DIOXIDE

BURNUP(REFUEL) 7200-14,000 MWD/T 3-YEAR CORE LIFE

NEUTRON FLUX THERMAL AVE. 1×10^{13}
 FAST AVE. 7.5×10^{13}

CONTROL RODS, BORON CARBIDE-SS, AND BURNABLE POISON
 ZIRCONIUM BORIDE/ZIRCONIUM DIOXIDE

COOLANT TEMP. INLET 266 C OUTLET 278 C

COOLANT PRESS. 63.5 KG/SQ. CM.

REACTOR VESSEL VESSEL OF FORGED RINGS, 2300 MM. DIA. / 8700 MM.
 HIGH, DIVIDED BY A CYLINDRICAL WALL INTO INNER AND
 OUTER SPACE.

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF20

CONTAINMENT VERTICAL CYLINDER 13.1 M. HIGH, 9.5 M. DIA., 30 MM
WALL THICKNESS.

REMARKS AWARD WAS TO DEUTSCH B+W AND INTERATOM FOR THE
U.S. B+W DEVELOPED CONSOLIDATED NUCLEAR STEAM
GENERATOR. POWER PLANT WILL BE INSTALLED IN THE
RESEARCH VESSEL OTTO HAHN, WHICH WAS LAUNCHED IN
JUNE 1964.

REFERENCES GERMANY-S NUCLEAR SHIP.
NUCLEAR ENG. 9.8 /JANUARY 1964/

ADVANCED PRESSURIZED-WATER REACTOR FOR FIRST
GERMAN NUCLEAR ENERGY SHIP.
W KLIEFOTH
ATOMKERNENERGIE 8, 458-60 /DEC. 1963/

THE REACTOR PLANT OF THE RESEARCH SHIP OF
GESELLSCHAFT FOR KERNENERGIEVERWERTUNG IN
SCHIFFBAU U. SCHIFFFAHRT MBH.
W WIEBE, OTHERS
3RD U.N. INTL. CONF. PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964.
A/CONF. 28/P/540

NUCLEAR SHIP PROPULSION
EURO-NUCLEAR 2/4/, 174-8 /APRIL 1965/

GERMANY-S NUCLEAR SHIP
C SALANDER, D ULKEN /GKSS/
NUCLEAR ENG. 10, 324-9 /SEPT. 1965/

EXPERIMENTAL ORE CARRIER OTTO HAHN
ENGINEER 219, 54-6 /JAN. 1, 1965/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS; FOREIGN

HF21

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NAME/OWNER	OBRIGHEIM NUCLEAR STATION/KWO, W. GERMANY		
DESIGNER	SIEMENS-SCHUCKERTWERKE		
OPERATOR	KERNKRAFTWERK OBRIGHEIM GMBH /KWO/, W. GERMANY		
LOCATION	OBRIGHEIM AM NECKAR, W. GERMANY NECKAR RIVER		
PURPOSE	POWER		
TYPE	PWR, CLOSED CYCLE, TWO-LOOP SYSTEM		
POWER MWE(MWT)	283	907,5	
CRITICAL	TARGET FOR CORE LOADING 1968		
COOLANT	LIGHT WATER		
MODERATOR	LIGHT WATER		
FUEL MATERIAL	URANIUM DIOXIDE		
FUEL GEOMETRY	ROD, ACTIVE LENGTH 2750 MM, 10.7 MM OD.		
FUEL CLADDING	ZIRCALOY-4 TUBES		
FUEL ENRICH.	AVE. 3 PER CENT U-235, REGIONAL		
FUEL ASSEMBLY	180-ROD BUNDLE 14 x 14, 6 SITES ARE OCCUPIED BY CONTROL-ROD GUIDE TUBES, SPRING-CLIP ASSEMBLY 121 ELEMENTS/CORE		
FUEL CHARGE	35,200 KG URANIUM		
BURNUP(REFUEL)	24,000 MWD/T	FUEL SHUFFLING 1/3 CORE	
CONTROL	ROD-CLUSTER CONTROL CHEMICAL SHIM		
COOLANT TEMP.	INLET 283 C	OUTLET 310,4 C	
COOLANT PRESS.	145 KG/SQ. CM. ABS.		
REACTOR VESSEL	C-STEEL CYLINDER 3.27 M. ID, 10 M. HIGH SS-CLAD		
CONTAINMENT	SPHERICAL CONTAINMENT BUILDING.		

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF21

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DOUBLE CONTAINMENT SHELL WITH INTER-SPACE AIR
EXTRACTION. INNER SHELL IS A WELDED GAS-TIGHT
STEEL SPHERE 44 M. DAIM. OUTER SHELL IS
REINFORCED CONCRETE 60 CM - 80 CM THICK.

REMARKS

ORDER PLACED JULY 1964

REFERENCES

OBRIGHEIM NUCLEAR POWER STATION
EURONUCLEAR 2, 145-6 /MARCH 1965/

OBRIGHEIM, THE KWO NUCLEAR STATION WITH SEIMENS
PWR
GM LEPIE, AH MARTIN
NUCLEAR ENG. 12, 278-85 /APRIL 1967/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF22

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NAME/OWNER	NOK POWER STATION/NOK, SWITZERLAND BEZNAU NUCLEAR STATION		
DESIGNER	WESTINGHOUSE ELECTRIC CORP.		
OPERATOR	NOK /FORCES ELECTRIQUES DU NORD-EST DE LA SUISSE/		
LOCATION	BEZNAU-DOTTINGEN, SWITZERLAND ON AAR RIVER		
PURPOSE	POWER		
TYPE	PWR, CLOSED CYCLE, TWO-REACTOR STATION.		
POWER MWE(MWT)	350	1000	PER REACTOR
CRITICAL	TARGET NO.1, 1969 NO.2, 1972		
COOLANT	LIGHT WATER		
MODERATOR	LIGHT WATER		
FUEL MATERIAL	URANIUM DIOXIDE PELLETS		
FUEL GEOMETRY	ROD		
FUEL CLADDING	ZIRCALLOY		
FUEL ENRICH.	ZONE, AVE. 3 PER CENT U-235		
FUEL ASSEMBLY	ROD BUNDLE 120 ASSEMBLIES/CORE SPRING-CLIP ASSEMBLY		
FUEL CHARGE	40 TONS URANIUM		
SPECIFIC POWER	28 KW/KG URANIUM		
CONTROL	SILVER-INDIUM-CADMIUM RODS, SS CLAD CHEMICAL SHIM		
COOLANT PRESS.	210.4 PSIA		
REACTOR VESSEL	STEEL VESSEL 10.7 M. HIGH, 37 M. ID, WALL THICKNESS 16.6 CM.		
CONTAINMENT	DOUBLE-WALL ENCLOSURE CONSISTING OF A STEEL CYLINDER 61 M. HIGH, 33 M. ID, SURROUNDED BY AIR-TIGHT CONCRETE CYLINDER 38 M. ID. ANNULAR		

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF22

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SPACE SLIGHTLY UNDER-PRESSURIZED,
REACTOR VESSEL IN A CONCRETE CAVE IN THE REACTOR
FLOOR.

REMARKS

SITE IS AN ISLAND IN THE AAR RIVER FORMED BY A
CANAL. CONDENSER COOLING WATER IS DRAWN FROM THE
CANAL AND DISCHARGED INTO THE RIVER, THE
DIFFERENCE IN WATER LEVELS BETWEEN UPPER CANAL AND
THE RIVER DECREASING PUMP REQUIREMENTS.

REFERENCES

THE NOK NUCLEAR POWER STATION.
EURONUCLEAR 2, 430-33 /SEPT. 1965/

BEZNAU, 2 X 350 MW.
E ELMIGER
INDUSTRIES ATOMIQUES 12/3-4/, 67-73 /1968/

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF23

NAME/OWNER ZAN THAN NUCLEAR SHIP/CHINA
CHINESE DEMOCRATIC REPUBLIC

DESIGNER NUCLEAR COMMITTEE OF TIEN-TSIN

PURPOSE SHIP PROPULSION, COASTAL VESSEL

TYPE PWR

POWER MWE(MWT) 180

CRITICAL CONSTRUCTION 1964 AT TIEN-TSIN
NO RECENT INFORMATION

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL GEOMETRY TUBE

FUEL CLADDING ZIRCONIUM ALLOY TUBE

FUEL ENRICH. 1.7 PER CENT U-235

FUEL ASSEMBLY CORE CONSISTS OF 98 FUEL CELLS

FUEL CHARGE 8380 KG. URANIUM

CONTROL CRUCIFORM RODS AND TEMPERATURE CONTROL

REACTOR VESSEL CYLINDER, HEMISPHERICAL BOTTOM, TOP COVER

CONTAINMENT FOUR CONCENTRIC CYLINDRICAL THERMAL SHIELDS, SS.

REMARKS PROPULSION FOR A 20,000-TON COASTAL VESSEL.
SPEED 23.5 KNOTS

REFERENCES PEACEFUL USES OF NUCLEAR ENERGY IN THE CHINESE
DEMOCRATIC REPUBLIC.
LI YANG
ENERGIE NUCLEAIRE 8, 40-3 /JAN., FEB. 1966/

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF24

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NAME/OWNER	MIHAMA NUCLEAR STATION/KANSAI ELEC. POWER, JAPAN KANSAI TSURUGA
DESIGNER	WESTINGHOUSE ELECTRIC CORP.
OPERATOR	KANSAI ELECTRIC POWER CO., JAPAN
LOCATION	NIU, ON TSURUGA PENINSULA, HONSHU, JAPAN
PURPOSE	POWER
TYPE	PWR, TWO REACTOR STATION
POWER MWE(MWT)	NO.1, 325 NO.2, 500
CRITICAL	TARGET NO.1, 1970 NO.2, 1972
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REFERENCES	NEWS RELEASES

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF25

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NAME/OWNER EGYPTIAN POWER-DESALINATION STATION/UAR ATOMIC
ENERGY ESTAB.

DESIGNER WESTINGHOUSE ELECTRIC CORP.

OPERATOR UNITED ARAB REPUBLIC

LOCATION MEDITERRANEAN COAST NEAR BURG EL-ARAB, UAR

PURPOSE POWER AND DESALINATION

TYPE PWR

POWER MWE(MWT) 150

REMARKS WILL PRODUCE 5.3 MGD DESALTED WATER
NO RECENT INFORMATION.
UAR IS REPORTEDLY WORKING WITH THE USSR ON NUCLEAR
ENERGY DEVELOPMENT.

REFERENCES NUCLEONICS WEEK JUNE 30, 1966 P. 1
NEWS RELEASE

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF26

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NAME/OWNER	RHEINSBERG STATION, EAST GERMANY
DESIGNER	USSR
LOCATION	RHEINSBERG, E. GERMANY
TYPE	PWR, NOVO-VORONEZH TYPE
POWER MWE(MWT)	70
CRITICAL	REPORTEDLY ON-LINE IN 1966
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL CLADDING	ZIRCONIUM
FUEL ENRICH.	SLIGHT
REFERENCES	NEWS RELEASE

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS; FOREIGN

HF27

NAME/OWNER DOEL STATION/EBES; BELGIUM
FLANDERS STATION

DESIGNER ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI
/ACEC/, BELGIUM

OPERATOR TRACTION ET ELECT.

LOCATION DOELL; NEAR ANTWERP, BELGIUM

PURPOSE POWER

TYPE PWR, TWO-REACTOR STATION

POWER MWE(MWT) 365 PER REACTOR

CRITICAL TARGET NO.1, 1973
NO.2, 1975

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

REMARKS CONTRACT AWARD 1968

REFERENCES NEWS RELEASES

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF28

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NAME/OWNER	COMPACT PWR/FAIREY ENGINEERING
DESIGNER	FAIREY ENGINEERING, UNITED KINGDOM
PURPOSE	POWER AND/OR STEAM, REMOTE LOCATIONS
TYPE	PWR, INTEGRAL DESIGN
POWER MWE(MWT)	20-60
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL CLADDING	SS CANS
BURNUP(REFUEL)	2-3 YEARS
CONTROL	BURNABLE POISON IN CORE
REACTOR VESSEL	CONCRETE VESSEL CONTAINING CORE AND HEAT EXCHANGER
REMARKS	FAIREY ENG. IS PREPARED TO PROVIDE EITHER A PACKAGE DEAL OR COOPERATION WITH LOCAL INDUSTRY FOR INSTALLATION OF THE PACKAGE PLANT
REFERENCES	APPLIED ATOMICS SEPT. 21, 1966 P. 6 NEWS RELEASE

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF29

* * * * *

NAME/OWNER	PAKS STATION/HUNGARY
DESIGNER	USSR
LOCATION	SOUTH OF PAKS, HUNGARY ON DANUBE RIVER
PURPOSE	POWER
TYPE	PWR TWO-REACTOR STATION
POWER MWE(MWT)	400
CRITICAL	PLANNED FOR 1969 CONSTRUCTION, TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REFERENCES	NEWS RELEASES

PER REACTOR

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF30

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NAME/OWNER	STADE STATION/NKW-HEW, W. GERMANY	
DESIGNER	SEIMENS-SCHUCKERTWERKE	
OPERATOR	NORDWESTDEUTSCHE KRAFTWERK AG /NWK/ AND HAMBURGISCHE ELETRIZITATSWERKE /HEW/, W. GERMANY.	
LOCATION	STADERSAND, AT STADE NEAR HAMBURG, W. GERMANY ON ELBE RIVER	
PURPOSE	POWER	
TYPE	PWR, 4-LOOP SYSTEM	
POWER MWE(MWT)	630	1900
CRITICAL	TARGET 1972	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE	
FUEL GEOMETRY	PIN, ACTIVE LENGTH 3 M.	
FUEL CLADDING	ZIRCALOY-4 TUBES, 10.74 MM. OD, 0.72 MM. WALL	
FUEL ENRICH.	2.5 PER CENT U-235, REGIONAL	
FUEL ASSEMBLY	204-PIN BUNDLE EACH BUNDLE CONTAINS A 20-ROD CONTROL CLUSTER 157 ASSEMBLIES/CORE	
FUEL CHARGE	56.2 TONS URANIUM	
BURNUP(REFUEL)	23,000 - 31,000 MWD/T	ANNUAL, BATCH
CONTROL	ROD-CLUSTER CONTROL SOLUBLE POISON /BORIC ACID/ IN COOLANT	
COOLANT TEMP.	INLET 288.5 C	OUTLET 316.3 C
COOLANT PRESS.	158 ATM.	
REACTOR VESSEL	PRESSURE VESSEL 4.08 M. DIAM., 8.148 M. HIGH	
REFERENCES	STADE AND WURGASSEN NUCLEAR ENG. 12, 756-7 /OCT. 1967/	

JANUARY 1969

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PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF30

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THE 660 MW NUCLEAR POWER STATION STADE WITH
SIEMENS PWR,

H FREWER, W KELLER

ATOMWIRT. ATOMTECH. 12, 568-73 /DEC. 1967/

JANUARY 1969

BNWL 936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF31:

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NAME/OWNER BULGARIAN NUCLEAR STATION/GOVERNMENT OF BULGARIA

DESIGNER USSR

LOCATION KOZLODUY, BULGARIA

PURPOSE POWER

TYPE PWR
TWO-REACTOR STATION

POWER MWE(MWT) 400 PER REACTOR

CRITICAL TARGET NO. 1, 1972
NO. 2, 1974

REFERENCES NEWS RELEASES

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF32

NAME/OWNER BAC PHUN/CHINA
 NUCLEAR SHIP

PURPOSE SHIP PROPULSION

TYPE PWR

POWER MWE(MWT) 210

CRITICAL REPORTEDLY OPERATING IN 1967

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE

FUEL GEOMETRY ROD

FUEL CLADDING ZIRCONIUM ALLOY TUBES

FUEL ENRICH. 1.8 PER CENT U-235

FUEL ASSEMBLY 180 FUEL CHANNELS

FUEL CHARGE 9490 KG URANIUM

BURNUP(REFUEL) 10,300 MWD/T OF URANIUM DIOXIDE 10,000 HRS.

CONTROL RODS, CRUCIFORM

REMARKS SECOND ALL-PURPOSE NUCLEAR SHIP REPORTEDLY
 OPERATING IN 1967

REFERENCES NEWS RELEASES

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS. FOREIGN

HF33

* * * * *

NAME/OWNER BILIBINO STATION/USSR
 USSR

OPERATOR USSR

LOCATION CHUKKOTSK PENINSULA, USSR

PURPOSE POWER, EXPERIMENTAL STATION

TYPE PWR, FOUR-UNIT STATION

POWER MWE(MWT) 12 PER REACTOR

CRITICAL TARGET 1970
 REPORTEDLY UNDER CONSTRUCTION

JANUARY 1969

BNWL-936

PRESSURIZED LIGHT WATER REACTORS, FOREIGN

HF34

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NAME/OWNER MURMANSK STATION /USSR

DESIGNER USSR

OPERATOR USSR

LOCATION MURMANSK, USSR

PURPOSE POWER

TYPE PWR, TWO-REACTOR STATION

POWER MWE(MWT) 1000 FROM 2 REACTORS

CRITICAL TARGET 1972
REPORTEDLY UNDER CONSTRUCTION

STEAM OR SUPERCRITICAL WATER COOLED REACTORS

DOMESTIC

JANUARY 1969

BNWL-936

STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC

ID01

NAME/OWNER GBSR /GRAPHITE BOILING-SUPERHEAT REACTOR//AI
 DESIGNER ATOMICS INTERNATIONAL
 PURPOSE POWER
 TYPE BOILING-SUPERHEATING, PRESSURE TUBE.
 POWER MWE(MWT) 318 760
 CRITICAL CONCEPTUAL DESIGN
 COOLANT LIGHT WATER AND STEAM
 MODERATOR GRAPHITE, GRAPHITE REFLECTOR
 FUEL MATERIAL URANIUM CARBIDE IN GRAPHITE MATRIX
 FUEL GEOMETRY SLUGS 4.0 IN. DIA./3 FT. LONG
 FUEL CLADDING SILICON CARBIDE COATING
 FUEL ENRICH. 2.8 PER CENT U-235 AVERAGE
 FUEL ASSEMBLY BOILING, 480 FUEL CHANNELS
 SUPERHEAT, 448 FUEL CHANNELS
 REHEAT, 368 FUEL CHANNELS
 10 RODS/CHANNEL, STACKED. EXTRA FUEL
 CHANNELS ARE PROVIDED.
 FUEL CHARGE 120,000 KG. URANIUM
 SPECIFIC POWER 6.33 KW/KG URANIUM
 BURNUP(REFUEL) 25,000 MWD/MTU CONTINUOUS
 CONTROL RODS, BORON CARBIDE ABSORBER
 COOLANT TEMP. INLET 613 C OUTLET 645 C /BOILER/
 INLET 645 C OUTLET 1000 C /SUPERHEATER/
 INLET 660 C OUTLET 1000 C /REHEATER/
 COOLANT PRESS. BOILER 2200 PSIG
 SUPERHEATER 2120
 REHEATER 500
 REACTOR VESSEL STEEL VESSEL 51.31 FT. ID./62.5 FT. HIGH.
 CONCRETE SHIELDING ON SIDES, WITH BURIED COOLING
 COILS, FIRE BRICK AGAINST INTERIOR SURFACE OF
 CONTAINMENT TANK.

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC

ID01

CONTAINMENT PRESSURE-SUPPRESSION, CONVENTIONAL REINFORCED
CONCRETE OR CARBON STEEL STRUCTURE.

REMARKS EACH GRAPHITE BLOCK CONTAINS 4 VERTICAL FUEL
CHANNELS, EACH SURROUNDED BY 4 COOLANT TUBES.
CORE IS 3-REGION, CENTRAL BOILING, INNER ANNULAR
SUPERHEATING, AND OUTER ANNULAR REHEAT REGIONS.
WATER CIRCULATES IN THE CENTRAL SECTION THROUGH
THE COOLANT TUBES, STEAM IS SEPARATED IN A STEAM
DRUM AND RETURNS TO THE SUPERHEAT REGION, FROM
THERE IT FLOWS TO A HIGH PRESSURE TURBINE THROTTLE
RETURNING TO THE REACTOR TO BE REHEATED IN THE
ANNULAR REHEAT REGION. BOILER REGION PIPING IS
PH 15-7 MO OR ZIRCALLOY-2, IN THE SUPERHEAT AND
REHEAT REGIONS INCONEL-X.

REFERENCES STEAM-COOLED POWER REACTOR EVALUATION.
GRAPHITE MODERATED, BOILING WATER, STEAM-SUPERHEAT
REACTOR.
ATOMICS INTERNATIONAL
NAA-SR-6100 /SEPT. 1961/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC

ID02

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NAME/OWNER CBSR /COUPLED BREEDING SUPERHEATING REACTOR//ANL

DESIGNER ARGONNE NATIONAL LABORATORY

PURPOSE POWER

TYPE PWR, STEAM COOLANT, PRESSURE TUBE, FAST-THERMAL BREEDER.

POWER MWE(MWT) 65 216

CRITICAL CONCEPTUAL DESIGN

COOLANT THERMAL CORE LIGHT WATER
FAST CORE SUPERHEATED STEAM

MODERATOR LIGHT WATER

FUEL MATERIAL FAST

ZONE 1. PLUTONIUM DIOXIDE AND DEPLETED URANIUM DIOXIDE PELLETS, 0.287 CM. DIA.

ZONE 2,3A AND 3B /RADIAL BUFFER, UPPER AXIAL FAST BLANKET, LOWER AXIAL FAST BLANKET/, DEPLETED URANIUM DIOXIDE PELLETS, 0.856 CM. DIA.

THERMAL

ZONE 5. NATURAL URANIUM DIOXIDE PELLETS, 0.673 CM. DIA.

ZONE 6-7 /RADIAL THERMAL BLANKET/, ZONE 6, DEPLETED URANIUM DIOXIDE PELLETS 0.673 CM. DIA. ZONE 7, DEPLETED URANIUM, 1.214 CM. DIA.

ZONE 8A-8B /UPPER AXIAL THERMAL BLANKET, LOWER AXIAL THERMAL BLANKET/, DEPLETED URANIUM DIOXIDE PELLETS 0.673 CM.

FUEL GEOMETRY FAST

ZONE 1. ROD 0.318 CM. DIA

ZONES 2-3A,3B. ROD 0.952 CM. DIA.

THERMAL

ZONE 5-6. ROD, 0.785 CM. DIA.

ZONE 7. ROD. 1.407 CM. DIA.

ZONE 8A-8B. ROD 0.785 CM. DIA.

FUEL CLADDING FAST, STAINLESS STEEL;

ZONE 1, 0.0127 CM. THICK

ZONE 2, 3A,3B, 0.043 CM. THICK

THERMAL, ZIRCALOY-2.

ZONE 5,6,8A,8B. 0.051 CM. THICK

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ZONE 7. 0.089 CM. THICK

FUEL ASSEMBLY FAST, HEXAGONAL BUNDLES /CANS/,
 ZONE 1. 547-RODS/BUNDLE
 ZONES 2,3A,3B. 61-ROD BUNDLE
 TOTAL RODS,
 ZONE 1. 26,256
 ZONE 2. 793
 ZONE 3A. 3721
 ZONE 3B. 3721

THERMAL
 ZONES 5,6,8A,8B. 61 RODS/PRESSURE TUBE,
 ZONE 5. 42 PRESSURE TUBES,
 ZONE 7. 246,
 ZONE 8A AND 8B. 66 EACH
 ZONE 7. 19 RODS/PRESSURE TUBE. 246 PRESSURE
 TUBES.

FUEL CHARGE FAST CORE 242 KG. PLUTONIUM

BURNUP(REFUEL) FAST CORE 1 PER CENT

CONTROL RODS

COOLANT TEMP. INLET 308 C OUTLET 453 C AVERAGE

COOLANT PRESS. 95 ATM.

REACTOR VESSEL CARBON STEEL, SS CLAD, 228 CM. ID./648 CM. LONG.

REMARKS A HEAVY WATER SYSTEM WAS FIRST CONSIDERED, OTHER
 CONCEPTS INCLUDED ONE IN WHICH ALL STEAM FOR
 SUPERHEATING WAS PRODUCED IN THE THERMAL REGION
 /THERMAL-FAST SYSTEM/ WITH HEAVY WATER AS COOLANT,
 AND ONE IN WHICH NO STEAM IS GENERATED IN THE
 REACTOR. THE THERMAL PORTION OF THE COUPLED
 REACTOR ACTING AS A PRESSURIZED WATER PREHEATER
 FOR EXTERNAL BOILERS /FAST-THERMAL SYSTEM/.

REFERENCES COUPLED FAST-THERMAL BREEDER,
 R AVERY
 NUCLEAR SCI. ENG. 3,129 /1958/

CONCEPTUAL DESIGN OF A COUPLED BREEDING
 SUPERHEATING REACTOR CBSR.
 R AVERY, OTHERS
 ANL-6286 /MARCH 1961/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS. DOMESTIC ID03

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NAME/OWNER SCBR /STEAM COOLED BREEDER REACTOR//BAW-ECNG
 DESIGNER BABCOCK AND WILCOX
 PURPOSE POWER
 TYPE SUPERCRITICAL STEAM COOLED FAST BREEDER, DIRECT OR
 INDIRECT CYCLE, PRESSURE TUBE.
 POWER MWE(MWT) 1000 2320
 CRITICAL CONCEPTUAL DESIGN
 COOLANT STEAM, LIGHT/HEAVY WATER
 CIRCULATING COOLANT HEAVY WATER
 MODERATOR HEAVY WATER
 FUEL MATERIAL URANIUM-PLUTONIUM OXIDE
 BLANKET URANIUM DIOXIDE
 FUEL GEOMETRY ROD, 0.23 IN. DIA.
 FUEL CLADDING INCONEL, INCOLOY, HASTELLOY-X, 19-9 DL CONSIDERED.
 FUEL ENRICH. BLANKET NATURAL URANIUM
 FUEL ASSEMBLY 504-ROD BUNDLE WITH 1 BORON CONTROL ROD
 108 ASSEMBLIES/CORE
 CORE IS COMPLETELY SURROUNDED BY BLANKET
 SPECIFIC POWER 0.91 MW/KG PLUTONIUM
 BURNUP(REFUEL) 80,000 MWD/T
 CONTROL ROD
 COOLANT TEMP. INLET 750 F OUTLET 1000 F
 COOLANT PRESS. 3650 PSI
 REMARKS CONCEPTUAL DESIGN OF A 1000 MWE DIRECT CYCLE
 REACTOR HAS BEEN COMPLETED. ECNG, FORMED BY BAW
 AND 14 UTILITIES, WILL DEVELOP A 3500 PSI STEAM
 COOLED BREEDER FOR THE PRODUCTION OF LOW-COST
 ELECTRICAL ENERGY. LONG-RANGE PROGRAM IS EXPECTED
 TO LEAD TO A 1000 MWE DEMONSTRATION REACTOR IN THE
 1970-S.
 SEE ALSO NDA STUDY 1D-8
 REFERENCES STEAM COOLED REACTOR UNDER STUDY.

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ID03

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ELECTRICAL WORLD 162.40 /AUG. 24, 1964/

STEAM COOLED BREEDER REACTORS.

MC EDLUND, OTHERS

FAST REACTOR TECHNOLOGY. NATIONAL TOPICAL MEETING

APRIL 26-28, 1965,

AMERICAN NUCLEAR SOC.

ANS-100 P. 85-88

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC

ID04

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NAME/OWNER VESR /VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR/
 GE-ESADA
 DESIGNER GENERAL ELECTRIC COMPANY
 OPERATOR GENERAL ELECTRIC COMPANY
 LOCATION VALLECITOS ATOMIC LABORATORY, CALIF.
 PURPOSE EXPERIMENTAL AND TESTING, SUPERHEAT FUEL
 DEVELOPMENT.
 TYPE STEAM COOLED REACTOR, SEPARATE SUPERHEAT
 POWER MWE(MWT) 12.5
 CRITICAL NOV. 1963. FULL POWER MAY 1964
 COOLANT SATURATED STEAM. SEE REMARKS
 MODERATOR LIGHT WATER
 FUEL MATERIAL URANIUM DIOXIDE HOLLOW PELLETS
 FUEL GEOMETRY ANNULAR RODS
 FUEL CLADDING SS INNER AND OUTER, CONCENTRIC TUBES.
 FUEL ENRICH. 3.6 PER CENT U-235
 FUEL ASSEMBLY 9-ROD BUNDLE, ENCLOSED IN PROCESS TUBE
 32 BUNDLES/CORE
 FUEL CHARGE 5300 POUNDS URANIUM DIOXIDE
 BURNUP(REFUEL) 5000 MWD/T FIRST CORE
 COOLANT TEMP. 545 F
 COOLANT PRESS. 1000 PSI
 REACTOR VESSEL STEEL VESSEL
 CONTAINMENT CONVENTIONAL STEEL CONTAINMENT STRUCTURE
 INTEGRATED, LEAK-TIGHT VESSEL
 REMARKS THE SADE /SUPERHEAT ADVANCED DEMONSTRATION
 EXPERIMENT/ PROGRAM PRODUCED SUPERHEATED STEAM
 BY DIRECT NUCLEAR MEANS IN 1959. THE ESADA
 REACTOR IS DESIGNED TO TEST A LARGE NUMBER OF

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ID04

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EXPERIMENTAL FUEL ELEMENTS IN AN OPERATING REACTOR ENVIRONMENT. THE MARK 2 CORE DESIGN CONSISTS OF A 6X6 ARRAY OF 32 FUEL BUNDLES. COMBINATION BOILING-SUPERHEATING ELEMENTS WERE ALSO STUDIED. 300 AND 600 MWE CONCEPTS HAVE BEEN INVESTIGATED. THE 600 MWE REACTOR USING SOLID-ROD ELEMENTS. COOLING IS BY A COMBINATION OF MODERATOR BOILING AND FORCED CONVECTION COOLING WITH SATURATED STEAM
SEE ID05

REFERENCES

THE REACTOR AND PLANT DESIGN FOR ESADA AND EVSR.
J BARNARD
ASME PREPRINT 61-WA-223 /1961/

PRELIMINARY HAZARDS SUMMARY REPORT FOR THE VALLECITOS SUPERHEAT REACTOR.
GL MURRAY, ED.
GEAP-3642 /FEB. 1961/

THE ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR.
DH IMHOFF
POWER REACTOR EXPERIMENTS VOL.2, P. 53-79
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962.

FINAL HAZARDS SUMMARY REPORT FOR THE ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR.
JL MURRAY, ED.
APED-3958 /OCT. 1, 1962/

DESIGN AND OPERATING EXPERIENCE OF THE ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR.
W IANNI, OTHERS
APED-4784 /FEB. 1965/

PRELIMINARY HAZARDS SUMMARY REPORT FOR THE VALLECITOS SUPERHEAT REACTOR
JL MURRAY
GEAP-4643 /FEB. 1, 1961/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC ID05
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NAME/OWNER SSHR /SEPARATE SUPERHEAT REACTOR//GE

DESIGNER GENERAL ELECTRIC COMPANY

PURPOSE POWER

TYPE BWR-SEPARATE SUPERHEAT SYSTEM.

POWER MWE(MWT) 607 1202 BWR
 421 SSHR

CRITICAL STUDY

COOLANT LIGHT WATER STEAM

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS 0.450 IN. DIA.

FUEL GEOMETRY RODS 106 IN. ACTIVE LENGTH

FUEL CLADDING SS OR INCONEL 0.011 IN. THICK

FUEL ENRICH. 2.8 PER CENT U-235

FUEL ASSEMBLY SSHR.
 7-ROD CLUSTER IN A SINGLE PROCESS TUBE, FUEL
 ASSEMBLY CONSISTS OF 9 PROCESS TUBES, INLET
 AND OUTLET STEAM PLENUMS AND PIPINGS.
 172 ASSEMBLIES.
 SEE REMARKS

FUEL CHARGE 28,200 KG. URANIUM

BURNUP(REFUEL) 16,535 MWD/MTU BATCH, 20 PER CENT

CONTROL RODS, INCONEL ABSORBER MATERIAL

COOLANT TEMP. INLET 553.5 F OUTLET 950 F

COOLANT PRESS. INLET 1060 PSIA OUTLET 980 PSIA

REACTOR VESSEL SEPARATE STEEL VESSELS

CONTAINMENT SEPARATE LOW-PRESSURE VESSELS, PRESSURE-SUPPRESSION POOL.

REMARKS THE BWR IS A FORCED CIRCULATION SINGLE CYCLE
 PRESSURE VESSEL REACTOR WITH INTERNAL STEAM
 SEPARATION. SUPERHEAT REACTOR IS A SINGLE-PASS

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ID05

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REACTOR. THE BWR, A 1203 MWT PLANT, DELIVERS
STEAM TO THE SUPERHEAT REACTOR. BWR FUEL IS
URANIUM DIOXIDE WITH SS CLADDING. A PRELIMINARY
STUDY CONCERNED A 300 MWE PLANT USING ANNULAR FUEL
RODS, BOTH DOUBLE PASS AND ANNULAR PASS ELEMENTS
BEING STUDIED.

REFERENCES

STEAM-COOLED POWER REACTOR EVALUATION FOR 300 MWE
SEPARATE SUPERHEAT REACTOR.
GENERAL ELECTRIC CO, APED
GEAP-3589 /REV. 1/ /NOV. 1960/

DESIGN STUDY OF A 600 MWE BOILING WATER-SEPARATE
SUPERHEAT REACTOR PLANT.
RA SCHMIDT, OTHERS
GEAP-4057 /SEPT. 1962/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC ID06

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NAME/OWNER FSPPR /FAST SUPERCRITICAL PRESSURE POWER REACTOR/

DESIGNER GENERAL ELECTRIC COMPANY

PURPOSE POWER

TYPE SUPERCRITICAL STEAM COOLED FAST REACTOR, DIRECT
CYCLE.

POWER MWE(MWT) 300 677

CRITICAL CONCEPTUAL DESIGN

COOLANT LIGHT WATER STEAM /SUPERCRITICAL/

MODERATOR YTTRIUM OR ZIRCONIUM HYDRIDE CORE SUBDIVIDERS. THE
INNER CORE IS UNMODERATED.

FUEL MATERIAL DEPLETED URANIUM DIOXIDE-PLUTONIUM DIOXIDE

FUEL GEOMETRY MASSIVE FUEL ASSEMBLY PIERCED BY COOLANT TUBES,
5 FT. ACT. LENGTH.

FUEL CLADDING RENE-41, RENE-41 COOLANT TUBES.

FUEL ENRICH. 3.8 PER CENT PLUTONIUM

FUEL ASSEMBLY MASSIVE CERAMIC ELEMENT, TRIANGLE OR TRAPEZOID,
PIERCED BY HIGH-PRESSURE COOLANT TUBES. EACH
ELEMENT INCORPORATES AXIAL BLANKET SECTIONS.
72 ELEMENTS/CORE.
42 ARE FUEL-BEARING, 30 ARE RADIAL BLANKET
ELEMENTS.
SEE REMARKS.

FUEL CHARGE DEPLETED URANIUM 30,895 KG., PLUTONIUM 1559 KG.

SPECIFIC POWER 50 KW/KG URANIUM + PLUTONIUM

BURNUP(REFUEL) 82,700 MWD/T SHUT-DOWN
IN TANDEM /TWO-REACTOR PLANT/,
ONE REACTOR OPERATES WHILE
OTHER IS BEING REFUELED.

CONTROL RODS, SS-BORON

COOLANT TEMP. 1050 F INITIAL TURBINE THROTTLE CONDITIONS.

COOLANT PRESS. 3515 PSIA INITIAL TURBINE THROTTLE CONDITIONS.

REACTOR VESSEL SS TANK CONTAINING THE SEGMENTED CORE.

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ID06

CONTAINMENT STEEL BUILDING, PRESSURE-SUPPRESSION,

REMARKS

THE REACTOR IS COMPOSED OF 7 RADIAL REGIONS. THE CORE IS 5 FT. HIGH /5.28 FT. DIA., SURROUNDED BY RADIAL AND AXIAL BLANKETS EACH 0.6 FT. THICK. THIN LAYERS OF YTTRIUM OR ZIRCONIUM HYDRIDE SUBDIVIDE THE SEGMENTS, WITH A LAYER OF U-238 AS ABSORBING MATERIAL ON EACH SIDE OF THE MODERATING ELEMENT TO FORM AN ANNULAR FLUX TRAP. FOUR CONCENTRIC REGIONS ARE THE RADIAL BLANKET, FIRST CORE, AND SECOND CORE, SEPARATED BY THE MODERATOR-ABSORBER, AND THE UNMODERATED 3RD, OR CENTRAL CORE THERE ARE PROVISIONS FOR DUAL-REACTOR INSTALLATION AND REMOTE FUEL HANDLING. CONCEPT IS BASED ON THE SSPR DESIGN.

REFERENCES

ECONOMIC EVALUATION OF A 300 MWE SUPERCRITICAL POWER REACTOR /SSPR/.

H HARTY, OTHERS

HW-68420 /REV./ /JUNE 1961/

SEGMENTED CORE DESIGN FOR A SUPERCRITICAL PRESSURE WATER-COOLED FAST REACTOR,

RE PETERSON, SL STEWART

PROC. CONF. ON BREEDING, ECONOMICS AND SAFETY IN LARGE FAST POWER REACTORS. OCT. 7-10, 1963,

ANL-6792 p. 539-552

HW-SA-3149 /OCT. 3, 1963/

ECONOMIC EVALUATION OF A 300 MWE FAST SUPERCRITICAL PRESSURE POWER REACTOR.

DT AASE, OTHERS

HW-78953 /DEC. 9, 1963/

FAST SUPERCRITICAL WATER REACTOR

POWER REACTOR TECHNOLOGY 8, 186-93 /SUMMER 1965/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS. DOMESTIC

ID07

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NAME/OWNER MSSR /MIXED SPECTRUM SUPERHEAT REACTOR//GE
 DESIGNER GENERAL ELECTRIC COMPANY
 LOCATION CRITICAL ASSEMBLY AT VALLECITOS LAB., CALIF.
 TYPE STEAM COOLED BWR, TWO-REGION, FAST CORE
 POWER MWE(MWT) 75
 CRITICAL DEVELOPMENT, CRITICAL ASSEMBLY DEC, 1963
 COOLANT LIGHT WATER AND STEAM
 MODERATOR LIGHT WATER, FAST CORE UNMODERATED
 FUEL MATERIAL BOILING REGION URANIUM DIOXIDE
 FAST CORE PLUTONIUM DIOXIDE IN DEPLETED URANIUM
 DIOXIDE
 BUFFER DEPLETED URANIUM
 FUEL GEOMETRY ROD
 FUEL CLADDING SS
 FUEL ENRICH. BOILING REGION SLIGHT
 FAST CORE 19.6 PER CENT
 REMARKS SATURATED STEAM GENERATED IN THE BOILING REGION
 PASSES THROUGH AN INTERNAL STEAM SEPARATING SYSTEM
 AND GOES THROUGH THE INNER SUPERHEATING REGION OF
 THE CORE. IN THE 75 MWE PROTOTYPE THE FAST CORE
 IS ROUND, THE FUEL HEXAGONAL. THE MIXED SPECTRUM
 CRITICAL ASSEMBLY /MSCA/ WAS STARTED UP IN DEC.
 1963, AND THE FAST SPECTRUM SUPERHEATER LOADED
 IN MAY 1964, AT VALLECITOS. MSCA IS A SINGLE CORE
 REACTOR WITH TWO SEPARATE FUEL REGIONS.
 REFERENCES STEAM COOLED POWER REACTOR EVALUATION.
 MIXED SPECTRUM SUPERHEATER.
 B WOLFE
 GEAP-3590 /REV.1/ /NOV. 1960/
 CONCEPTUAL DESIGN FOR A 75 MWE MIXED SPECTRUM
 SUPERHEATING REACTOR POWER PLANT.
 GV BRYNSVOLD, OTHERS
 GEAP-4016 /FEB. 25, 1962/

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, DOMESTIC

ID08

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NAME/OWNER STEAM COOLED FAST REACTOR STUDY/NDA

DESIGNER NUCLEAR DEVELOPMENT CORPORATION OF AMERICA

PURPOSE POWER

TYPE STEAM COOLED FAST BREEDER, FORCED CIRCULATION,
DIRECT CYCLE.

POWER MWE(MWT) 300 840

CRITICAL FEASIBILITY STUDY, CONCEPTUAL DESIGN

COOLANT STEAM, LIGHT AND HEAVY WATER STUDIED.

MODERATOR NONE

FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE PELLETS,
BLANKET DEPLETED URANIUM DIOXIDE

FUEL GEOMETRY RODS 0.25 IN. DIA., 5 FT. ACT. LENGTH + BLANKET

FUEL CLADDING INCONEL-X TUBES 0.015 IN. THICK,
BLANKET SS

FUEL ENRICH. 15.4 PER CENT
BLANKET, DEPLETED URANIUM

FUEL ASSEMBLY CORE, 127-ROD CLUSTER
AXIAL AND RADIAL BLANKET, 37-ROD CLUSTER
326 CORE ASSEMBLIES
256 BLANKET ASSEMBLIES

SPECIFIC POWER 0.50 MWT/KG PLUTONIUM-239

BURNUP(REFUEL) 33,300 MWD/T PARTIAL, FUEL SHIFT

CONTROL BORON CARBIDE RODS

COOLANT TEMP. 945 F

COOLANT PRESS. 1400 PSIG

REACTOR VESSEL STEEL PLATE VESSEL, SS CLAD.
10.7 FT. ID./31 FT. HIGH.

REMARKS URANIUM / THORIUM DIOXIDE FUEL WAS ALSO STUDIED.

REFERENCES STEAM-COOLED POWER REACTOR EVALUATION, STEAM
COOLED FAST BREEDER REACTOR.

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ID08

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G SOFER, OTHERS
NDA-2148-4 /APRIL 1961/

CONCEPTUAL DESIGN AND ECONOMIC EVALUATION OF A
STEAM-COOLED FAST BREEDER REACTOR,
G SOFER, OTHERS
NDA-2148-5 /NOV. 1961/

THE NDA STEAM-COOLED FAST REACTOR CONCEPT,
NUCLEAR POWER 6, 75 /OCT. 1961/

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STEAM OR SUPERCRIT, WATER COOLED REACTORS, DOMESTIC

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NAME/OWNER	SWR /STEAM-WATER REACTOR//NDA	
DESIGNER	NUCLEAR DEVELOPMENT CORPORATION OF AMERICA	
PURPOSE	POWER	
TYPE	STEAM COOLED, HEAVY WATER MODERATED, PRESSURE TUBE /CALANDRIA/	
POWER MWE(MWT)	200	530
CRITICAL	FEASIBILITY STUDY	
COOLANT	STEAM /LIGHT WATER FOG/	
MODERATOR	HEAVY WATER	
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.750 IN. DIA./0.750 IN. LONG	
FUEL GEOMETRY	ROD, 24 IN. ACTIVE LENGTH	
FUEL CLADDING	SS 0.010 IN. THICK	
FUEL ENRICH.	1 PER CENT U-235	
FUEL ASSEMBLY	19-ROD BUNDLE, 2 BUNDLES/ASSEMBLY 5 ASSEMBLIES/PRESSURE TUBE BUNDLES INCLUDE THERMAL INSULATION 1260 BUNDLES/CORE REF. DESIGN 272 PRESSURE TUBES.	
FUEL CHARGE	9 METRIC TONS, URANIUM DIOXIDE	
BURNUP(REFUEL)	5500 MWD/T	
COOLANT TEMP.	1060 F	
COOLANT PRESS.	2015 PSIA	
REACTOR VESSEL	ALUMINUM CALANDRIA, ZIRCALOY PRESSURE TUBES.	
CONTAINMENT	CONCRETE BUILDING.	
REMARKS	AN ALTERNATE DESIGN WAS STUDIED IN WHICH SATURATED WATER INSTEAD OF STEAM IS SUPPLIED, AND BOILING OCCURS IN THE CENTRAL REGION OF THE REACTOR-- A BOILING-SUPERHEATING SWR. FUEL AND COOLANT ARE WITHIN THE PRESSURE TUBES WHICH PASS THROUGH THE CALANDRIA-CONTAINED HEAVY WATER MODERATOR. A	

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ID09

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STUDY REVIEW BY ECNG AND BAW WAS DONE FOR NDA.
 NDA IS ALSO ENGAGED IN A EURATOM PROJECT WITH
 CISE /ITALY/ FOR THE DESIGN OF FOG-COOLED REACTORS.
 SEE ALSO ITALY CAN, IF03

REFERENCES

STEAM COOLED REACTOR FEASIBILITY STUDY, STEAM
 WATER REACTOR /SWR/, VOL. 1 /SECTIONS 1-6/
 VOL. 2 /SECTIONS 7,8/ FINAL REPORT,
 EAST CENTRAL NUCLEAR GROUP, B + W /FOR NDA/
 NDA-2562-1 /VOL. 1 AND 2/ /AUGUST 1958/

STEAM-COOLED POWER REACTOR EVALUATION, STEAM
 COOLED HEAVY WATER MODERATED REACTOR,
 G SOFER, OTHERS
 NDA-2161-2 /APRIL 1961/

CAN-1, FOG COOLANT PROJECT,
 M SILVESTRI, OTHERS
 NUCLEONICS 19, 86-8 /JANUARY 1961/

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STEAM OR SUPERCRIT, WATER COOLED REACTORS, DOMESTIC

ID10

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NAME/OWNER	SWR /SUPERCRITICAL WATER REACTOR/
DESIGNER	BATTELLE MEMORIAL INSTITUTE
PURPOSE	UNDERSEA PROPULSION AND AUXILIARY POWER
POWER MWE(MWT)	250 KWE 1440 KWT
COOLANT	SUPERCRITICAL LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	FUEL COUPONS 40 MILS THICK IN SS PLATE
FUEL CLADDING	SS 7 MILS THICK
FUEL ENRICH.	FULL
FUEL ASSEMBLY	15-PLATE ELEMENT, SQUARE CAN 45-ELEMENT CORE
FUEL CHARGE	64.8 KG. U-235
CONTROL	SS-CLAD BORON CARBIDE VANES IN REFLECTOR
COOLANT TEMP.	INLET 300 F OUTLET 1000 F
COOLANT PRESS.	4340 PSI
REMARKS	THE BMI STUDY WAS CONCERNED WITH APPLICATION FOR PROPULSION AND AUXILIARY POWER IN A DEEP- SUBMERGENCE VEHICLE, CONSIDERED FOR MISSIONS TO 10,000 FT.
REFERENCES	A SUPERCRITICAL WATER REACTOR FOR PROPULSION AND AUXILIARY POWER IN A DEEP SUBMERSIBLE RESEARCH VEHICLE. JW RAY, JW CHASTAIN MARINE TECHNOLOGY SOCIETY MEETING WASHINGTON, JUNE 1965

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STEAM OR SUPERCRIT, WATER COOLED REACTORS, DOMESTIC

ID11

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NAME/OWNER ESCR /EXPERIMENTAL STEAM-COOLED REACTOR/ECNG-GE

DESIGNER GENERAL ELECTRIC COMPANY

TYPE STEAM-COOLED EXPERIMENTAL REACTOR, DEMONSTRATION

POWER MWE(MWT) 50

CRITICAL FEASIBILITY STUDY AND DESIGN

COOLANT STEAM

REMARKS GENERAL ELECTRIC AND ECNG HAVE TERMINATED THE
STEAM-BREEDER EFFORT AS OF JULY 1968 BECAUSE OF
FUEL ELEMENT PROBLEMS SUCH AS CREEP COLLAPSE AND
STRAIN CYCLING OF THE CLADDING UNDER HIGH EXTERNAL
STEAM PRESSURES.

REFERENCES NEWS RELEASES

STEAM OR SUPERCRITICAL WATER COOLED REACTORS

FOREIGN

JANUARY 1969

BNWL-936

STEAM OR SUPERCRIT. WATER COOLED REACTORS. FOREIGN

IF01

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NAME/OWNER HERMES/BELGONUCLEAIRE-BELGIUM
 DESIGNER BELGONUCLEAIRE, BELGIUM
 PURPOSE POWER
 TYPE STEAM COOLED, DIRECT CYCLE, FAST REACTOR,
 PRESSURE TUBE, MODULAR, LOEFFLER CYCLE,
 POWER MWE(MWT) 300 870
 CRITICAL DESIGN CONCEPT
 COOLANT DRY STEAM
 FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE
 FUEL GEOMETRY PINS 5.8 MM. OD.
 FUEL CLADDING INCONEL, INCOLOY, HASTELLOY, NIMONIC, AND
 RENE-41 STUDIED
 FUEL ENRICH. 20 PER CENT PLUTONIUM-239
 FUEL ASSEMBLY CLOSE-PACKED PRESSURE TUBES CONTAIN FUEL ELEMENTS.
 151-PIN ASSEMBLY
 MODULUS, CHANNEL DIA. 100 MM., HEXAGONAL TUBE
 WITH CIRCULAR INNER CHANNEL.
 MODULI FIT TOGETHER, A BUNDLE OR HYPERMODULES
 MAKING UP THE CORE CONSISTS OF 7 CHANNELS
 SEPARATED BY 3 MM. THICK WALLS
 SPECIFIC POWER 150 KWE/KG FISSIONABLE MATERIAL
 BURNUP(REFUEL) 30,000 MWD/T /CORE/ AND 5000 MWD/T /BLANKET/
 COOLANT TEMP. INLET 315C
 SUPERHEAT 540 C
 REMARKS BELGONUCLEAIRE, IN A EURATOM PROGRAM, HAS
 COMPLETED A DESIGN STUDY FOR A 1000 MWE STEAM-
 COOLED FAST REACTOR IN WHICH CORE, CIRCULATORS,
 AND STEAM GENERATORS ARE CONTAINED IN A PRE-
 STRESSED CONCRETE VESSEL.
 REFERENCES HERMES FAST NEUTRON SUPERHEATER REACTOR,
 G TAVERNIER, OTHERS
 3RD U. N. INTL. CONF. PEACEFUL USES OF ATOMIC
 ENERGY, GENEVA 1964, A/CONF. 28/P/516

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF01

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HERMES-A MODULAR STEAM COOLED FAST REACTOR CONCEPT
G TAVERNIER, OTHERS
ANS-100 P. 99-103

1000 MWE STEAM COOLED BREEDER WITH PRESTRESSED
CONCRETE VESSEL
J CHERMANNE, J HENRIETTE
EURFNR-522 /DEC. 1967/

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF02

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NAME/OWNER FOG COOLED REACTOR STUDY/AECL, CANADA

DESIGNER ATOMIC ENERGY OF CANADA LTD. /AECL/

PURPOSE POWER

TYPE STEAM/SPRAY/ COOLED, DIRECT CYCLE, PRESSURE TUBE,
HOT,

POWER MWE(MWT) 200

CRITICAL ECONOMIC STUDY

COOLANT LIGHT WATER STEAM OR SPRAY

MODERATOR HEAVY WATER

FUEL MATERIAL URANIUM DIOXIDE PELLETS

FUEL GEOMETRY RODS

FUEL CLADDING ZIRCALOY-2

FUEL ENRICH. NATURAL

FUEL ASSEMBLY 19-ROD BUNDLE

BURNUP(REFUEL) 8600 MWD/T

REACTOR VESSEL CALANDRIA, ZIRCONIUM ALLOY PRESSURE TUBES,

REMARKS THE PRESSURE TUBE IS SURROUNDED BY AN INSULATING
GAS, IN TURN SURROUNDED BY A CALANDRIA TUBE.

REFERENCES PARTIAL ECONOMIC STUDY OF STEAM COOLED HEAVY WATER
MODERATED REACTORS,
AECL, NUCLEAR ENG. BRANCH
AECL-1018 /APRIL 1963/

AFTER CANDU-FOG COOLED REACTORS.
GA PON
CANADIAN CHEM. PROCESSING 45, 83, 92-4
/OCTOBER 1961/

PROSPECTIVE HEAVY WATER-MODERATED POWER REACTORS,
GA PON, OTHERS
3RD U.N. INTL. CONF. PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964, A/CONF. 28/P/10

LIGHT WATER COOLED HEAVY WATER MODERATED NATURAL

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STEAM OR SUPERCRIT. WATER COOLED REACTORS. FOREIGN

IF02

URANIUM POWER REACTORS.

GA PON

AECL-1807 /P. 59-67/ /1963/

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF03

NAME/OWNER CAN-ITALY
 EURATOM-US PROGRAM INVOLVING CISE /ITALY/, NDA

DESIGNER ANSALDO /ITALY/, NDA

TYPE STEAM COOLED, HEAVY WATER MOD., PRESSURE TUBE

CRITICAL R+D

COOLANT WET STEAM /SPRAY/

MODERATOR HEAVY WATER

FUEL MATERIAL URANIUM-ZIRCONIUM ALLOY

FUEL GEOMETRY HOLLOW RODS

FUEL CLADDING ZIRCALOY-2

FUEL ENRICH. NATURAL

FUEL ASSEMBLY CLUSTER AND CONCENTRIC ELEMENTS STUDIED.
 PREFERRED ELEMENT CONSISTS OF TWO CONCENTRIC
 ANNULI OF ZIRCALOY-2 CANNED FUEL WITH THREE
 ANNULAR COOLANT FLOW CHANNELS AND A SOLID CENTRAL
 ZIRCALOY ROD.

REMARKS PRELIMINARY DESIGN AND DEVELOPMENT IN A STUDY
 CONTRACT UNDER THE US-EURATOM AGREEMENT. HEAT
 TRANSFER, HEAT FLUX, AND CORROSION INVESTIGATIONS
 /CAN-1, CAN-2, CAN-3/ HAVE BEEN COMPLETED.
 THE CIRENE PROGRAM /CISE REATTORIA NEBBIA/ AIMED
 AT THE DESIGN OF A 20 MWE, 100 MWT PROTOTYPE, IS
 TO BE COMPLETED IN 1971. SEE IF04

REFERENCES CALCULATION METHODS FOR THE CRITICAL SIZE OF A
 HEAVY WATER MODERATED, WET STEAM COOLED REACTOR
 WITH A NATURAL URANIUM CLUSTER FUEL ELEMENT.
 R BONALUME, OTHERS
 CISE-67 /1959/
 ENERGIA NUCLEARE 7, 192-209 /MARCH 1960/

PRELIMINARY DESIGN STUDIES ON FUEL ELEMENTS FOR A
 HEAVY WATER MODERATED, WET STEAM COOLED REACTOR.
 I CASAGRANDE, OTHERS
 CISE-68 /MAY 1959/

EVALUATION AND INTERPRETATION OF THE EXPERIMENTS
 ON ADIABATIC TWO-PHASE FLOW PERFORMED AT CISE
 UNDER THE CAN-1 PROGRAM.

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF03

CISE /ITALY/
 EURAEC-445 /1962/

ADVANCED RESEARCH PROGRAM ON THE APPLICATION OF
 STEAM-WATER SPRAY TO THE COOLING OF LIGHT-WATER
 REACTORS /CAN-2/,
 CISE /ITALY/
 EURAEC-475 /1962/

LARGE-SCALE AND IN-PILE TESTING OF LIGHT WATER
 STEAM MIXTURES AS REACTOR COOLANTS /CAN-3/,
 CISE /ITALY/
 EURAEC-476 /1962/

THE SPRAY COOLED REACTOR,
 JG COLLIER, PMC LACEY
 NUCLEAR POWER 5, 68-73 /AUGUST 1960/

CAN-1, FOG COOLANT PROJECT,
 M SILVESTRI, OTHERS
 NUCLEONICS 19, 86-8 /JANUARY 1961/

THE /CAN/ RESEARCH AND DEVELOPMENT PROGRAM ON THE
 APPLICATION OF STEAM-WATER MIXTURES TO THE REACTOR
 COOLING,
 E VILLANI /CISE/
 ENERGIA NUCLEARE /MILAN/ 9, 84-96 /FEBRUARY 1962/

INVESTIGATION OF WET STEAM AS A REACTOR COOLANT
 /CAN-2/, VOLUME 2, CONCEPTUAL DESIGN EVALUATION
 OF A FOG-COOLED LIGHT WATER REACTOR, FINAL REPORT
 M RABER, OTHERS
 UNC-5008-2 /AUGUST 10, 1962/

FINAL REPORT COVERING THE PERIOD OCTOBER, 1959 TO
 APRIL 30, 1960
 NDA-2132-5

SEE ALSO NDA STEAM COOLED REACTOR STUDIES.

JANUARY 1969

BNWL-936

STEAM OR SUPERCRIT. WATER COOLED REACTORS. FOREIGN

IF04

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NAME/OWNER CIRENE/CISE, CNEN, ENEL, EURATOM

DESIGNER CISE /ITALY/ AND EURATOM
 NUCLEAR CONTRACT FOR 35 MWE PROTOTYPE TO
 ANSALDO MECCANICA NUCLEARE

LOCATION LATINA, ITALY

PURPOSE POWER PROTOTYPE

TYPE HEAVY WATER MODERATED, LIGHT WATER FOG COOLED
 PWR, VERTICAL PRESSURE TUBE.

POWER MWE(MWT) 35 100

CRITICAL TARGET 1971

COOLANT LIGHT WATER FOG /STEAM/

MODERATOR HEAVY WATER-COLD, UNPRESSURIZED

FUEL MATERIAL URANIUM DIOXIDE PELLETS OR U METAL TUBES

FUEL GEOMETRY RODS OR TUBES

FUEL CLADDING ZIRCALOY-2

FUEL ENRICH. NATURAL

FUEL ASSEMBLY 19-ROD BUNDLES
 8 BUNDLES/CHANNEL, STACKED
 60 FUEL CHANNELS

BURNUP(REFUEL) 1000-1500 MWD/T

CONTAINMENT SHIELDING BY CONCRETE WALLS.

REMARKS AN R+D PROGRAM FOR A 20 MWE PROTOTYPE FOG-COOLED
 REACTOR INCLUDES CONSTRUCTION BY 1969.
 A PROTOTYPE 100 MWT REACTOR WILL BE DESIGNED
 UNDER A CNEN-EURATOM-CISE AGREEMENT. CISE WILL
 REQUEST ENEL AND INDUSTRY SUPPORT FOR PROTOTYPE
 DESIGN AND CONSTRUCTION. THE CONCEPT CONTEMPLATES
 DIRECT EXTRACTION AND TRANSFER OF HEAT TO THE
 TURBO-GENERATOR, ELIMINATING THE NEED FOR HEAT
 EXCHANGERS.

REFERENCES EURO-NUCLEAR MARCH 1965 P, 114-15
 NEWS RELEASE

JANUARY 1969

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STEAM OR SUPERCRIT, WATER COOLED REACTORS, FOREIGN

IF04

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THE CIRENE PROJECT

A BAHBOUT

EURONUCLEAR 2, 224-28 /MAY 1965/

A NATURAL URANIUM BOILING WATER REACTOR PROJECT,

A BAHBOUT

EURATOM 4, 54-60 /JUNE 1965/

NUCLEONICS WEEK MARCH 31, 1966 P. 8

NEWS RELEASE

APPLIED ATOMICS MARCH 29, 1967

NUCLEONICS WEEK APRIL 6, 1967 P. 2

NEWS RELEASES

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF05

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NAME/OWNER SCLMR /STEAM COOLED LIGHT WATER MODERATED REACTOR/
MITCHELL, UNITED KINGDOM

DESIGNER MITCHELL-UK

PURPOSE SHIP PROPULSION.

TYPE STEAM COOLED, PRESSURE TUBE, INDIRECT CYCLE.

COOLANT LIGHT WATER STEAM, SUPERHEATED

MODERATOR LIGHT WATER

FUEL MATERIAL URANIUM DIOXIDE HOLLOW PELLETS 0.33 IN. ID./0.54
IN. OD.

FUEL GEOMETRY ROD, ACT. LENGTH 5 FT. /CONCENTRIC TUBES/

FUEL ASSEMBLY 116-ROD CLUSTER, 11x11 /MINUS 4 FOR HOLD-DOWN
BOLTS AND 1 FOR SAMPLING AND THERMOCOUPLE TUBE,
21 ASSEMBLIES/CORE

CONTROL BORON-SS CRUCIFORM RODS

COOLANT TEMP. 850-900 F

COOLANT PRESS. 650 PSIA

REACTOR VESSEL CYLINDRICAL VESSEL CONTAINING MODERATOR AND CORE.

CONTAINMENT VESSEL 21 FT. DIA./30 FT. HIGH,
MODERATOR VESSEL PARTIALLY SUBMERGED IN A WATER
SHIELD TANK AS AN INDIRECT VAPOR-SUPPRESSION
SYSTEM.

REMARKS THE STEAM COOLANT FLOWS UPWARD THROUGH THE OUTER
ANNULUS BETWEEN PRESSURE AND BAFFLE TUBES, BACK
DOWN BETWEEN THE INNER AND OUTER FUEL CANS, OUTER
PRESSURE TUBE OF EACH FUEL ELEMENT, MADE OF
ZIRCONIUM, FORMS THE BOUNDARY BETWEEN THE
PRIMARY STEAM COOLANT AND THE MODERATOR, WHICH
FILLS THE SPACES BETWEEN THE FUEL RODS. THE HIGH
TEMPERATURE STEAM OUTLET PLENUM CHAMBER IS BENEATH
THE CORE. THE UK CONSIDERED THE CONCEPT IN ITS
NUCLEAR SHIP PROGRAM.

REFERENCES MITCHELL-S SCLMR-DESIGN OF COMPETITIVE MARINE
REACTOR.
HJ COLES
NUCLEAR ENG. 8, 58-63 /FEBRUARY 1963/

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF05

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NUCLEAR PROPULSION BY MITCHELL-FAIRFIELD,
NEW MARINE SYSTEM OF LONG LIFE, LOW WEIGHT,
G JACKSON
IMPULSE NO. 24, 6-11 /1964/

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS. FOREIGN

IF06

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NAME/OWNER KFK STEAM-COOLED BREEDER/KFK, W. GERMANY
 D-1 REACTOR

DESIGNER AEG, MAN, AND BELGIAN FIRMS

OPERATOR GESELLSCHAFT FUR KERNFORSCHUNG KARLSRUHE, W. GERM.

LOCATION KARLSRUHE, W. GERMANY

PURPOSE PROTOTYPE, FAST BREEDER PROGRAM

TYPE STEAM-COOLED FAST BREEDER, DIRECT CYCLE
 PANCAKE CORE

POWER MWE(MWT) 300

CRITICAL REFERENCE DESIGN.
 SEE REMARKS

COOLANT LIGHT WATER STEAM

FUEL MATERIAL URANIUM-PLUTONIUM DIOXIDE

FUEL GEOMETRY PIN, 7 MM. OD

FUEL CLADDING INCONEL-625, 0.4 MM. THICK, SPIRAL FINS

FUEL ENRICH. AVE. 17 PER CENT FISSILE PLUTONIUM

FUEL ASSEMBLY 39-PIN BUNDLE + CONTROL RODS, HEXAGONAL
 180 ELEMENTS/CORE

BURNUP(REFUEL) DESIGN, 75,000 MWD/T

CONTROL RODS, SUBASSEMBLY POSITIONS

COOLANT TEMP. INLET 365 C OUTLET 540 C

COOLANT PRESS. 170 KG/SQ. CM.

REACTOR VESSEL HEAVY STEEL CYLINDRICAL VESSEL

CONTAINMENT REINFORCED CONCRETE CELL, UPPER PART OF WHICH IS
 FILLED WITH WATER AND SERVING AS A REFUELING POOL.
 SECOND GAS-TIGHT ENVELOPE IN WHICH SMALL NEGATIVE
 PRESSURE IS MAINTAINED.

REMARKS A 25 MW HOT STEAM REACTOR AT GROSSWELZHEIM HAS
 BEEN TEST BED FOR THE STUDY PROJECT.
 THE PROJECT MAY BE TERMINATED. SEE ID11.

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN

IF06

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REFERENCES

REFERENCE STUDY FOR THE 1000 MWE STEAM-COOLED FAST
BREEDER D-1
A MUELLER, OTHERS
ORNL-TR-1541

DESIGN AND EVALUATION OF A STEAM-COOLED FAST
BREEDER REACTOR OF 1000 MWE
RA MUELLER, OTHERS
FAST BREEDER REACTORS, PROCC. LONDON CONF., BRITISH
NUCLEAR ENERGY SOC., 1966 P. 79-97,
PERGAMON, 1967

DESIGN CHARACTERISTICS OF A 300 MWE STEAM-COOLED
FAST REACTOR PROTOTYPE
P KILIAN, OTHERS
ANS TRANS. 11 /1/, 275 /JUNE, 1968/

JANUARY 1969

BNWL-936

STEAM OR SUPERCRIT. WATER COOLED REACTORS, FOREIGN IF07

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NAME/OWNER SWISS SCHWR/FED. INST. REACTOR RESEARCH, SWITZ.
 DESIGNER SWISS FED. INST. REACTOR RESEARCH /EIR/
 PURPOSE POWER
 TYPE STEAM COOLED, SUPERHEAT, DIRECT CYCLE
 HORIZONTAL PRESSURE-TUBE
 POWER MWE(MWT) 250 723,7
 CRITICAL DESIGN STUDY. PROPOSED FOR CONSTRUCTION
 COOLANT LIGHT WATER STEAM
 MODERATOR HEAVY WATER
 FUEL MATERIAL URANIUM DIOXIDE PELLETS 13,6 MM. DIA.
 FUEL GEOMETRY ROD, ACT. LENGTH 660 MM.
 FUEL CLADDING ZIRCONIUM ALLOY 0,8 MM. THICK, RIBBED
 FUEL ENRICH. 0,99 PER CENT U-235
 FUEL ASSEMBLY 18-ROD BUNDLE, RODS ARRANGED IN TWO CIRCLES WITH
 SPIDERS AND SPACERS,
 6 ELEMENTS/CHANNEL
 552 COOLANT CHANNELS, ZIRCONIUM-NIOBIUM
 PRESSURE TUBES, INTERNAL INSULATION.
 FUEL CHARGE 50,5 TONS URANIUM
 BURNUP(REFUEL) 12,930 MWD/TU ON-LOAD
 5 ELEMENTS/DAY
 NEUTRON FLUX THERMAL MAX. $6,7 \times 10^{13}$
 CONTROL RODS
 CHEMICAL SHIM
 COOLANT TEMP. INLET 324,3 C OUTLET 393,8 C
 COOLANT PRESS. INLET 112 BARS
 CONTAINMENT CYLINDRICAL BUILDING CONTAINING REACTOR,
 COLLECTORS, BOILERS AND BLOWERS, REFUELING
 EQUIPMENT AND FUEL STORAGE POOLS
 REMARKS VERTICAL AND HORIZONTAL DESIGNS.

JANUARY 1969

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STEAM OR SUPERCRIT. WATER COOLED REACTORS. FOREIGN

IF07

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A LOEFFLER-TYPE CYCLE IS ADOPTED, WITH WATER
EVAPORATED IN AN EXTERNAL HEAT EXCHANGER.
THE REACTOR ACTS AS A SUPERHEATER, DELIVERING
STEAM BOTH TO THE EVAPORATORS AND TO THE TURBINES.

REFERENCES

DESIGN OF A STEAM COOLED NUCLEAR POWER PLANT,
EIR, SWITZERLAND
NT /NEUE TECHNIK/ FEB. 1966 P. 1-10

NUCLEAR AUXILIARY POWER SYSTEMS
SNAP-TYPE REACTORS
DOMESTIC

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD01

NAME/OWNER AEC-S PROGRAM

TYPE SNAP SYSTEMS PROGRAM, AEC.

REMARKS AEC-S SNAP PROGRAM IS AIMED AT THE DEVELOPMENT OF COMPACT, LIGHTWEIGHT NUCLEAR ELECTRIC DEVICES FOR SPACE, SEA AND LAND APPLICATIONS. COMPACT POWER PACKAGES BASED ON THE CONVERSION OF FISSION OR RADIOACTIVE DECAY HEAT, OR ON REACTOR SYSTEMS, ARE UNDER DEVELOPMENT FOR USE IN SATELLITES AND SPACE VEHICLES, TO POWER REMOTE SCIENTIFIC STATIONS AND NAVIGATION DEVICES. SYSTEMS BASED ON THE CONVERSION OF HEAT FROM RADIOACTIVE SOURCES ARE ODD-NUMBERED. SYSTEMS EMPLOYING NUCLEAR REACTORS ARE EVEN-NUMBERED. REACTOR SYSTEMS UNDER DEVELOPMENT BY ATOMICS INTERNATIONAL ARE BASED ON HOMOGENEOUS FUEL-MODERATOR ELEMENTS, LIQUID METAL COOLANTS, WITH THE SYSTEM COUPLED TO A MERCURY VAPOR TURBINE GENERATOR.

SNAP-1, A CERIUM-144 FUELED SPACE POWER UNIT, WAS ASSIGNED TO MARTIN FOR DEVELOPMENT IN 1956, WITH DELIVERY OF THE FIRST COMPLETE UNIT SCHEDULED FOR SEPTEMBER 1959. THIS PROGRAM WAS SUBSEQUENTLY DISCONTINUED. UNDER THE BASIC MARTIN CONTRACT THE SNAP-3 PROGRAM WAS SUBCONTRACTED FOR THE DEVELOPMENT OF ADVANCED THERMOELECTRIC AND THERMIONIC HEAT-TO-ELECTRICITY CONVERSION SYSTEMS USING RADIOACTIVE HEAT SOURCES. MINNESOTA MINING AND MANUFACTURING DELIVERED A COMPLETE THERMOELECTRIC GENERATOR TO MARTIN IN DECEMBER 1958, AND POLONIUM-210 FUEL CAPSULES WERE FURNISHED BY AEC-S MOUND LABORATORY. THE ASSEMBLED AND TESTED UNIT WAS DELIVERED TO THE AEC IN JANUARY 1959, AS A PROOF-OF-PRINCIPLE DEMONSTRATION DEVICE. IT PRODUCED 2.5 WATTS WITH A HALF CHARGE OF POLONIUM-210 FUEL.

REFERENCES ENERGY CONVERSION SYSTEMS REFERENCE HANDBOOK, VOLUME XI, RADIOISOTOPE SYSTEM DESIGN, FINAL REPORT 390.
ELECTRO-OPTICAL SYSTEMS INC. /PASADENA, CALIF./
WADD-TR-60-699, VOL. XI /SEPTEMBER 1960/

THE SNAP PROGRAM. U.S. AEC-S SPACE-ELECTRIC POWER PROGRAM.
GM ANDERSON
NUCLEAR ENG. 5, 460-3 /OCTOBER 1960/

SNAP THERMOELECTRIC SYSTEMS.
AW THIELE, MG COOMBES

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD01

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ARS SPACE POWER SYSTEM CONFERENCE, SANTA MONICA,
CALIFORNIA, SEPTEMBER 27-30, 1960
PAPER 1330-60
AMERICAN ROCKET SOC., N.Y. /1960/

NUCLEAR FRONTIERS - 1960
A FORUM REPORT /NO. 32/
PROC. ANNUAL CONF. FOR MEMBERS AND GUESTS,
SAN FRANCISCO, CALIFORNIA, DECEMBER 14-16, 1960
EA WIGGIN, ED.
ATOMIC INDUSTRIAL FORUM, N.Y. /1961/

SNAP FACT SHEET.
AEC NEWS RELEASE, JUNE 15, 1962

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD02

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NAME/OWNER SNAP-2/AEC-AIR FORCE

DESIGNER ATOMICS INTERNATIONAL

PURPOSE SPACE AUXILIARY POWER

TYPE REACTOR SYSTEM, AUXILIARY POWER, LIQ. METAL COOLED
THERMOELECTRIC CONVERSION

POWER MWE(MWT) 3 KW 55 KW

CRITICAL DESIGN, DEVELOPMENT

COOLANT SODIUM-POTASSIUM NAK

MODERATOR HYDROGEN IN FUEL-MODERATOR ELEMENTS

FUEL MATERIAL URANIUM-ZIRCONIUM HYDRIDE

FUEL GEOMETRY RODS 1.25 IN. DIA.

FUEL CLADDING SS

FUEL ENRICH. 93 PER CENT U-235

FUEL ASSEMBLY 37 RODS/CORE

SPECIFIC POWER 0.03 PER CENT

BURNUP(REFUEL) LIFETIME 1 YEAR

NEUTRON FLUX 3.1×10^{11}

CONTROL DRUMS

COOLANT TEMP. INLET 1000F OUTLET 1200 F

CONTAINMENT STAINLESS STEEL

REMARKS POWER CONVERSION EQUIPMENT IS A MERCURY-RANKINE
COMBINED ROTATING UNIT. SNAP-2 AS A SYSTEM HAS
BEEN TERMINATED, BUT IS CONTINUING AS A BASIC
RESEARCH PROGRAM ON ZIRCONIUM HYDRIDE REACTOR
SYSTEMS. SEE JD05.

REFERENCES THE SNAP-2 CONCEPT,
HM DIECKAMP
ARS SPACE POWER SYSTEMS CONFERENCE, SANTA MONICA,
CALIFORNIA, SEPTEMBER 27-30, 1960
PAPER NO. 1324-60

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD02

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AMERICAN ROCKET SOC., N.Y. /1960/

AN ENRICHED UO₂-ZRH CRITICAL ASSEMBLY.
MV DAVIS, OTHERS
NAA-SR-5610 /NOVEMBER 1960/

SNAP-2, NUCLEAR SPACE POWER SYSTEM.
JR WETCH, HM DIECKAMP, DJ COCKERAM /AI/
ASTRONAUTICS 5 /12/, 24-5 /DECEMBER 1960/

PRELIMINARY RESULTS ON THE SNAP-2 EXPERIMENTAL
REACTOR.
MW HULIN, J BEALL, ED.
NAA-SR-5991 /APRIL 1961/

SNAP-2 POWER CONVERSION STUDIES.
DL SOUTHAM
SPACE POWER SYSTEMS, P. 291
NW SNYDER, ED.
ACADEMIC PRESS, N.Y.

SYSTEMS ANALYSIS OF NUCLEAR /SNAP-2/ LIQUID METAL
CELL SPACE POWER SYSTEM.
GENERAL MOTORS CORP.
EDR-3113 /DEC. 5, 1962/

NUCLEAR REACTOR SYSTEMS
GM ANDERSON /US AEC/
ASTRONAUTICS/AEROSPACE ENG. 1 /4/, 27-36 MAY 1963

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD03

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NAME/OWNER : SNAP-4/AEC-NAVY

DESIGNER : ATOMICS INTERNATIONAL

PURPOSE : UNATTENDED UNDERWATER OPERATION

TYPE : REACTOR SYSTEM, AUXILIARY POWER, BWR,
THERMOELECTRIC CONVERSION

POWER MWE(MWT) : 2 12

CRITICAL : DESIGN, DEVELOPMENT

COOLANT : LIGHT WATER

MODERATOR : HYDROGEN IN FUEL-MODERATOR ELEMENTS

FUEL MATERIAL : URANIUM-ZIRCONIUM HYDRIDE

FUEL GEOMETRY : RODS

FUEL CLADDING : SS

FUEL ENRICH. : 93 PER CENT U-235

BURNUP(REFUEL) : OPERATING LIFETIME 1-PLUS YEARS

COOLANT TEMP. : INLET 540 F OUTLET 570 F

REMARKS : SNAP-4 IS BEING PHASED OUT AS A SYSTEM BY THE AEC.
IN-PILE TESTING OF FUEL SAMPLES WILL BE FOLLOWED
THROUGH. AI WILL APPLY ACQUIRED TECHNOLOGY TO ITS
COMPACT /COMPACT MULTI-PURPOSE AUTOMATIC
CONTROLLED TRANSPORTABLE/ REACTOR EFFORT.

REFERENCES : SNAP FACT SHEET,
USAEC, NEWS RELEASE, JUNE 1962

HEARING BEFORE THE U.S. JOINT COMMITTEE ON ATOMIC
ENERGY,
CONGRESS OF THE UNITED STATES, 87TH CONGRESS,
SECOND SECTION ON PEACEFUL USES OF ATOMIC ENERGY
APRIL 10, 1962 /P. 140-143/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD04

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NAME/OWNER	SNAP-8/AEC-NASA	
DESIGNER	ATOMICS INTERNATIONAL	
LOCATION	S8ER AT SANTA SUSANA, CALIF.	
PURPOSE	SPACE POWER	
TYPE	REACTOR SYSTEM, AUXILIARY POWER, LIQ. METAL COOLED THERMOELECTRIC CONVERSION	
POWER MWE(MWT)	35 KWE	450-600 KWT
CRITICAL	SNAP-8ER DEC. 1963 SNAP-8DR JULY 1968	
COOLANT	SODIUM-POTASSIUM NAK	
MODERATOR	ZIRCONIUM HYDRIDE BERYLLIUM REFLECTOR	
FUEL MATERIAL	URANIUM-ZIRCONIUM HYDRIDE	
FUEL GEOMETRY	ROD 0.56 IN. DIA./14.5 IN. LONG	
FUEL CLADDING	HASTELLOY, 0.010 IN. THICK	
FUEL ENRICH.	FULL	
FUEL ASSEMBLY	BUNDLE 211 ELEMENTS/CORE /S8ER/	
FUEL CHARGE	6.56 KG. U-235	
BURNUP(REFUEL)	10,000 HOUR OPERATING LIFE	
NEUTRON FLUX	THERMAL AVE. 5×10^{12}	
CONTROL	6 REFLECTOR CONTROL DRUMS	
COOLANT TEMP.	INLET 1100 F	OUTLET 1300 F
COOLANT PRESS.	40 PSIA	
REACTOR VESSEL	9.75 IN. DIA./21 IN. HIGH VESSEL, SS	
CONTAINMENT	SHIELDING	
REMARKS	HIGH POWER, HIGH TEMPERATURE REACTOR DEVELOPMENT, MERCURY RANKINE CYCLE POWER CONVERSION SYSTEM, AS	

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JD04

OF APRIL 3, 1964, THE S8ER /SNAP-8 EXPERIMENTAL REACTOR/ PRODUCED AN INTEGRAL POWER OUTPUT OF OVER 1,000,000KWH/T/ DURING 48 DAYS OF OPERATION. AN ADVANCED TEST MODEL PROTOTYPE SNAP 8DR REACHED DRY CRITICALITY IN GROUND TESTS IN JULY 1968, AS A CONTINUATION OF SNAP-10A TECHNOLOGY. WET CRITICAL TESTING WAS WITH NAK. FULL POWER, 600 KWT.

REFERENCES

NUCLEAR POWER AND SPACE.

GT SEABORG

IRE TRANS. NUCLEAR SCI. NS-9, 1-8 /JANUARY 1962/

SNAP-8 REACTOR AND SHIELD

CE JOHNSON, CA GOETZ

AIAA J. 1 /10/, 2355-9 /OCT. 1963/

NUCLEAR REACTOR SYSTEMS

GM ANDERSON /US AEC/

ASTRONAUTICS/AERSOPACE ENG. 1 /4/, 27-36 MAY 1963

SNAP-8 REACTOR AND SHIELD DESIGNS AND OPERATING EXPERIENCE.

CE JOHNSON, DG MASON

J. SPACECRAFT AND ROCKETS 3, 1099-1105 /JULY 1966/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD05

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NAME/OWNER SNAP-10A/AEC-NASA

DESIGNER ATOMICS INTERNATIONAL

LOCATION SPACE

PURPOSE SPACE AUXILIARY POWER

TYPE REACTOR SYSTEM, AUXILIARY POWER, LIQ. METAL COOLED
 THERMOELECTRIC CONVERSION

POWER MWE(MWT) 500 WATTS 35 KWT

CRITICAL ORBITAL LAUNCH IN APRIL 1965

COOLANT SODIUM-POTASSIUM NAK

MODERATOR ZIRCONIUM HYDRIDE
 EXTERNAL BERYLLIUM REFLECTOR

FUEL MATERIAL URANIUM-ZIRCONIUM HYDRIDE

FUEL GEOMETRY ROD 1.25 IN. DIA./13 IN. LONG

FUEL CLADDING HASTELLOY-N 0.015 IN. THICK

FUEL ENRICH. 93 PER CENT U-235

FUEL ASSEMBLY 37 INDIVIDUAL ELEMENTS/CORE IN A
 CLOSE-PACKED TRIANGULAR MATRIX

FUEL CHARGE 4.75 KG U-235

BURNUP(REFUEL) 1-YEAR LIFETIME

NEUTRON FLUX 1.8×10^{11}

CONTROL ROTATING ELEMENTS OF REFLECTOR, RADIAL REGION

COOLANT TEMP. INLET 880 F OUTLET 990 F
 MAX. 1040 F

REACTOR VESSEL SS CYLINDER 8.94 IN. DIAM, 0.032 IN. WALL

CONTAINMENT SHIELDING

REMARKS SNAP-10A IS A TEMPERATURE AND POWER DERATED
 VERSION OF THE SNAP-2 CONCEPT. GROUND TESTING OF
 THE 500-WATT SYSTEM WAS DONE IN JANUARY 1965, AND
 COMPLETE SYSTEM LAUNCHED INTO POLAR ORBIT ON

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD05

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APRIL 3, 1965. POWER PRODUCTION WAS 600 WATTS
 AFTER STARTUP IN SPACE.
 AFTER SUCCESSFUL STARTUP IN SPACE. THE UNIT
 OPERATED CONTINUOUSLY FOR 43 CONSECUTIVE DAYS.
 GROUND CONTACT WITH THE SPACECRAFT WAS LOST ON
 MAY 16, 1965, DUE TO PREMATURE SHUT-DOWN AFTER
 FAILURE OF AN ON-BOARD ELECTRONIC DEVICE.
 THE SNAP-2/10A PROGRAM HAS EVOLVED INTO TWO
 SEPARATE SYSTEMS, SIOA AND SIOA/2, TO MEET THE
 REQUIREMENTS OF UNMANNED SPACE PROGRAMS.

REFERENCES

NUCLEAR POWER AND SPACE.
 GT SEABORG
 IRE TRANS. NUCLEAR SCI. NS-9, 1-8 /JANUARY 1962/

 NUCLEAR REACTOR SPACE POWER SYSTEMS.
 JR WETCH, MG COMBS
 PREPRINT PAPER CP 62-1203
 AMER. INST. ELECTRICAL ENGRS., N.Y. 1962

 REACTOR DIRECT-CONVERSION UNITS.
 HM DIECKAMP, OTHERS
 3RD U.N. INTL CONF. ON THE PEACEFUL USES OF ATOMIC
 ENERGY, GENEVA, 1964. A/CONF.20/P/218.

 DESIGN OF THE SNAP-10A REACTOR.
 AW DALCHER, JD SUTHERLAND /ATOMICS INTL/
 SOC. AUTOMOTIVE ENGRS. AIR TRANSPORT AND SPACE
 MEETING, NEW YORK, APRIL 1964.
 PREPRINT 861 D.

 SNAPTRAN EXPERIMENTAL MEASUREMENTS, INSTRUMENTATION
 VT BERTA /PHILLIPS PETROLEUM/
 IDO-17205 /JAN. 1967/

 SNAP-10-A, FIRS REACTOR IN SPACE
 RA JOHNSON, OTHERS
 NUCLEAR ENG. DESIGN 5, 7-21 /JAN-FEB. 1967/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD06

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NAME/OWNER SNAP-15A/AEC

DESIGNER GENERAL ATOMICS DIV, GENERAL DYNAMICS
NOW GULF GENERAL ATOMIC

PURPOSE AUXILIARY POWER TERRESTRIAL APPLICATION.

TYPE ISOTOPE SYSTEM, POWER GENERATOR

POWER MWE(MWT) 4-10 WATTS

CRITICAL OPERATION 1965 AS ACTIVATOR IN CONTROL DEVICE

FUEL MATERIAL PLUTONIUM-238

REFERENCES ISOTOPES AND RADIATION TECHNOLOGY,
VOL. 4/2/, P. 178 /WINTER 1966-1967/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD07

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NAME/OWNER PULSING TRIGA/GD

DESIGNER GENERAL ATOMICS DIV, GENERAL DYNAMICS
 NOW GULF GENERAL ATOMIC

PURPOSE OCEANOGRAPHIC RESEARCH VESSEL, AUXILIARY POWER

TYPE REACTOR SYSTEM, AUXILIARY POWER BWR OR PWR,
 THERMOELECTRIC CONVERSION

POWER MWE(MWT) 2.5

CRITICAL PROPOSAL

COOLANT LIGHT WATER

MODERATOR HYDROGEN IN FUEL-MODERATOR ELEMENTS

FUEL MATERIAL URANIUM-ZIRCONIUM HYDRIDE

REMARKS GD HAS PROPOSED THE SYSTEM TO THE NAVY AS A
 PORTABLE, SELF-REGULATING PACKAGE PLANT. THE
 EXTRAPOLATION IS BASED ON A 25-50 KWE REACTOR FOR
 POWER REQUIREMENTS FOR AN OCEANOGRAPHIC RESEARCH
 CRAFT, OR FOR SUBMERSIBLE OPERATION.

REFERENCES FORUM MEMO MARCH 1961 P. 10-11
 NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD08

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NAME/OWNER THERMIONIC REACTOR/GD

DESIGNER GENERAL ATOMICS DIV, GENERAL DYNAMICS
NOW GULF GENERAL ATOMIC

PURPOSE AUXILIARY POWER

TYPE REACTOR SYSTEM, AUXILIARY POWER
THERMIONIC CONVERSION

POWER MWE(MWT) 1 10

CRITICAL STUDY

COOLANT LIGHT WATER

FUEL MATERIAL URANIUM-ZIRCONIUM CARBIDE

FUEL GEOMETRY CYLINDRICAL RODS

FUEL CLADDING SS SHROUD

FUEL ENRICH. FULL

FUEL ASSEMBLY 35 SERIES-CONNECTED THERMIONIC ELEMENTS,
CYLINDRICAL FUEL RODS SURROUNDED BY
TUNGSTEN EMITTER AND NIOBIUM COLLECTOR,
ALUMINA INSULATION

FUEL CHARGE 56 KG U-235

CONTROL BORON-SS BLADES

REMARKS DEVELOPMENT, STUDY

REFERENCES A 1-MWE THERMIONIC REACTOR CONCEPTUAL DESIGN,
CW SAVERY, OTHERS /GD/
TRANS. AMERICAN NUCLEAR SOC, 6 /1/, 93 /JUNE 1963/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD09

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NAME/OWNER STAR /SPACE THERMIONIC AUXILIARY REACTOR//GE

DESIGNER GENERAL ELECTRIC COMPANY

PURPOSE SPACE AUXILIARY POWER

TYPE REACTOR SYSTEM, THERMIONIC CONVERSION

POWER MWE(MWT) 1 11

CRITICAL DEVELOPMENT

COOLANT SODIUM

MODERATOR NONE REFLECTOR, BERYLLIUM OXIDE

FUEL MATERIAL URANIUM DIOXIDE INDIVIDUAL RINGS

FUEL CLADDING TUNGSTEN, MOLYBDENUM, NIOBIUM, OR ALUMINA

FUEL ENRICH. FULL

FUEL ASSEMBLY HOLLOW CYLINDER COMPOSED OF SEGMENTED RINGS,
EACH RING CONSISTING OF INDIVIDUAL SEGMENTS OF
REACTOR FUEL AND CESIUM-PLASMA CONVERTER.

CONTROL MOTION OF END CONVERTER.

REMARKS DEVELOPMENT AT PLEASANTON, CALIF. LABORATORY. AN
AIR FORCE CONTRACT FOR A STAR-R THERMIONIC REACTOR
UNIT WAS AWARDED. 6-MONTH DESIGN ANALYSIS HAS BEEN
COMPLETED. PHASE 2 CONTRACT FOR STAR-C, A
DEVELOPMENT OF A 100 KWE - 1 MWE CONDUCTION-COOLED
REACTOR. AEC CONTRACT IS FOR IN-PILE TESTING OF
CONVERTERS.

REFERENCES DEVELOPMENT OF NUCLEAR THERMIONIC FUEL ELEMENT,
ANNUAL SUMMARY AND QUARTERLY PROGRESS REPORT
NO. 4, MARCH 1, 1963-MAY 30, 1963
GENERAL ELECTRIC CO., VALLECITOS LAB., PLEASANTON
GESR-2017 /ND/

LARGE TURBO-NUCLEAR SPACE POWER SYSTEMS.
MA ZYSKIN /GENERAL ELECTRIC., PHILA./
P. 201-59 3F ADVANCED PROPULSION CONCEPTS,
VOL. 1 N.Y., GORDON AND BREACH, 1963.

THERMIONIC CONVERTERS FOR SPACE POWER.
VC WILSON, RC HAMILTON /GEN. ELEC. CO. RES. LAB./
ASTRONAUTICS/AEROSPACE ENG. 1 /4/, 62-67 MAY 1963

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD10

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NAME/OWNER THERMOELECTRIC GENERATOR/AIR FORCE

DESIGNER GENERAL ELECTRIC COMPANY

LOCATION PROTOTYPE AT GE INSTALLATION

PURPOSE POWER FOR ELECTRONIC EQUIPMENT AND SMALL SATELLITES.

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.

POWER MWE(MWT) 0.5 WATT

CRITICAL PROTOTYPE TESTING 1963

FUEL MATERIAL THULIUM-170

FUEL ASSEMBLY PENCIL-SIZED THERMOCOUPLE MODULES OF LEAD TELLURIDE THERMOELECTRIC ELEMENTS, WITH THE ENCAPSULATED FUEL IN THE MIDDLE. MODULES ARE CONNECTED IN SERIES.

FUEL CHARGE 10,000 CURIES THULIUM-170

REMARKS GE HAS DESIGNED, BUILT, AND TESTED A PROTOTYPE UNIT. LONG-TERM PERFORMANCE TESTS ARE UNDER WAY. OTHER APPLICATIONS WOULD BE FOR UNDERWATER NAVIGATIONAL BEACONS AND OTHER REMOTE DEVICES.

REFERENCES FORUM MEMO OCT. 1963 P. 21, NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD11

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NAME/OWNER MFP /MIXED FISSION PRODUCTS GENERATOR/AEC

DESIGNER GENERAL INSTRUMENT CORPORATION

PURPOSE AUXILIARY POWER, UNDERWATER ENVIRONMENT

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION

POWER MWE(MWT) 5-10 WATTS

CRITICAL DEVELOPMENT, CONCEPTUAL DESIGN.

FUEL MATERIAL MIXED FISSION PRODUCTS /POTS FROM CALCINATION PROCESSES/

FUEL GEOMETRY POT /CYLINDER OR SPHERE/ OF HASTELLOY

FUEL ASSEMBLY SINGLE POT

BURNUP(REFUEL) 5-YEAR LIFETIME

REACTOR VESSEL STAINLESS STEEL CYLINDRICAL CONTAINER FOR HEAT TRANSFER FLUID, SURROUNDING THE POT FUEL, AND OUTER PRESSURE VESSEL.

CONTAINMENT CONCRETE AND IRON SHIELDING.

REMARKS AN ELECTRICALLY HEATED PROOF-OF-PRINCIPLE 3-5 WATT MFP GENERATOR WAS OPERATED CONTINUOUSLY FOR OVER A YEAR AT 4 PER CENT OVER ALL EFFICIENCY. PROGRAM REORIENTATION WILL DELAY DELIVERY DATE, ORIGINALLY SET FOR EARLY 1964, A FUELED MFP GENERATOR MAY BE ELIMINATED, WITH CONTINUED EXPERIMENTATION TO BE DIRECTED TOWARD GENERATORS WITH HIGHER OUTPUTS. THE GENERATOR WOULD BE FUELED AT AN AEC INSTALLATION. CONCEPTUAL DESIGNS FOR GENERATORS UP TO POWER LEVELS OF 1000 WATTS HAVE BEEN DONE.

REFERENCES DEVELOPMENT TECHNIQUES FOR POWER PRODUCTION FROM MIXED FISSION PRODUCTS. PHASE 2 MID-TERM REPORT. EJ LEMANSKI /GENERAL INSTRUMENT CORP./, NYO-9700 /MAY 21, 1962/

ECONOMIC FACTORS OF MFP THERMOELECTRIC GENERATORS. FINAL REPORT. EJ LEMANSKI /GENERAL INSTRUMENT CORP./, NYO-10462 /MAY 1963/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD12

NAME/OWNER SNAP-15B/AEC

DESIGNER GENERAL INSTRUMENT CORPORATION

PURPOSE AUXILIARY POWER, TERRESTRIAL USE

TYPE ISOTOPE SYSTEM

POWER MWE(MWT) MILLIWATT RANGE

CRITICAL DEVELOPMENT

FUEL MATERIAL PLUTONIUM-238

REMARKS AEC DEVELOPMENT CONTRACT FOR FUELED GENERATORS IN
THE MILLIWATT RANGE.

REFERENCES NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD13

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NAME/OWNER GLOWWORM/LASL

DESIGNER LOS ALAMOS SCIENTIFIC LABORATORY

PURPOSE CONCEPTUAL STUDY, SATELLITE POWER, RESEARCH FACILITY.

TYPE REACTOR SYSTEM, RADIATION HEAT EXCHANGE CONCEPT.

CRITICAL CONCEPTUAL DESIGN

COOLANT LIQUID OR GAS

MODERATOR GRAPHITE, BERYLLIUM OR GRAPHITE REFLECTOR

FUEL MATERIAL URANIUM/PLUTONIUM DIOXIDE OR CARBIDE IN GRAPHITE /CERMET/.

FUEL GEOMETRY CYLINDER OR SLEEVE, FUELED GRAPHITE

FUEL ENRICH. SLIGHT

FUEL ASSEMBLY SIMPLE CYLINDRICAL REACTOR, FUELED GRAPHITE SLEEVE
3-REGION REACTOR, TWO ANNULAR FUELED GRAPHITE SLEEVES, INTERMEDIATE AND INNER, WITH HIGHER FUEL CONCENTRATION IN INNER CYLINDER.
HOLLOW CORE
TUNGSTEN SLEEVES ARE ALSO CONSIDERED.

REMARKS EXPLORATORY STUDY OF EARLIER CONCEPT, LARRE /LOS ALAMOS RADIATION REACTOR EXPERIMENT/. VERY HIGH FUEL TEMPERATURE IS REQUIRED FOR ENERGY EXTRACTION BY RADIATION. HEAT EXCHANGERS WOULD BE IN THE REFLECTORS, AS TUBES OR HOLES IN THE GRAPHITE THROUGH WHICH COOLANT WOULD CIRCULATE. THE CENTER CAVITY COULD BE A RESEARCH CAVITY OR CONTAIN HEAT EXCHANGE SYSTEM.

REFERENCES A RADIATION REACTOR CONCEPT /GLOWWORM/
LDP KING
LAMS-2427 /NOV. 18, 1963/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD14

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NAME/OWNER SNAP-1 AND SNAP-1A/AEC
 DESIGNER MARTIN-MARIETTA CORPORATION
 PURPOSE DEVELOPMENT
 TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.
 POWER MWE(MWT) 125 WATTS 6500 WATTS
 CRITICAL DEVELOPMENT CONTRACT DROPPED, SEE SNAP-3
 FUEL MATERIAL CERIUM-144 OXIDE CERAMIC PELLETS
 FUEL GEOMETRY CAPSULES
 FUEL CLADDING TANTALUM CAPSULES
 FUEL ASSEMBLY 7 CAPSULES/GENERATOR, IN CHANNELS DRILLED IN AN INCONEL CYLINDER.
 FUEL CHARGE 0.88 MEGACURIES CERIUM-144
 BURNUP(REFUEL) 1-YEAR LIFETIME
 REACTOR VESSEL INCONEL-X CYLINDER /SOLID/ WITH CHANNELS FOR FUEL.
 CONTAINMENT BIOLOGICAL SHIELD OF MERCURY FILLS INTERNAL VOLUME OF OUTER SHELL, AND IS DRAINED BEFORE LAUNCH. OUTER SHELL IS AN ALUMINA-INSULATION-SS SANDWICH, WITH LEAD TELLURIDE THERMOCOUPLE ELEMENTS INSIDE THE INSULATION.
 REMARKS THE PROGRAM, ASSIGNED TO MARTIN IN 1965, WAS DISCONTINUED. THE SNAP-3 PROGRAM WAS SUBCONTRACTED UNDER THE BASIC MARTIN CONTRACT. SNAP-1 DESIGN USED MERCURY VAPOR AS HEAT CONVERSION WORKING FLUID. TASK 2 /SNAP-1A/ GENERATORS WERE DESIGNED FOR 1-YEAR LIFETIME IN A SATELLITE SYSTEM.
 REFERENCES SNAP-1 RADIOISOTOPE-FUELED TURBOELECTRIC POWER CONVERSION SYSTEM SUMMARY, JANUARY 1957 TO JUNE 1959,
 PJ DICK
 MND-P-2350 /JUNE 1960/
 FINAL SAFETY ANALYSES REPORT, SNAP-1A RADIOISOTOPE FUELED THERMOELECTRIC GENERATOR,
 MARTIN COMPANY /GP DIX/
 MND-P-2352 /JUNE 1960/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD15

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NAME/OWNER	SNAP-3/AEC-NAVY
DESIGNER	MARTIN-MARIETTA CORPORATION
OPERATOR	NAVY
LOCATION	SPACE
PURPOSE	AUXILIARY POWER, SPACECRAFT
TYPE	ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION
POWER MWE(MWT)	2.7 WATT 69 WATT
CRITICAL	DEMONSTRATION JANUARY 1959 TRANSIT OPERATION JUNE 1961
FUEL MATERIAL	DEMONSTRATION, POLONIUM-210 TRANSIT, PLUTONIUM-238
FUEL GEOMETRY	CAPSULES
FUEL CLADDING	STAINLESS STEEL CAPSULES
FUEL ASSEMBLY	2 CAPSULES CONTAINING FUEL IN A STAINLESS STEEL CANISTER.
FUEL CHARGE	2200 CURIES POLONIUM-210 95 GRAMS PLUTONIUM-238
BURNUP(REFUEL)	TRANSIT, 5-YEAR LIFETIME
REACTOR VESSEL	HEAVY VESSEL OF HAYNES ALLOY TO HOLD CANISTER.
CONTAINMENT	SPHERICAL COPPER SHELL CONTAINING THE GENERATOR, THERMOELECTRIC ELEMENTS PLACED AGAINST THE REACTOR VESSEL.
REMARKS	SNAP-3 SYSTEM DEVELOPMENT WITH PLUTONIUM-238 FUEL HAS RESULTED IN GENERATORS FOR THE TRANSIT /U.S. NAVY/ SATELLITES. TRANSIT-4B WITH PLUTONIUM- 238 GENERATOR WAS LAUNCHED IN JUNE 1961 AND A SECOND IN NOV. 1961, BOTH SATELLITES ARE STILL OPERATING.
REFERENCES	HAZARDS SUMMARY REPORT FOR A 3-WATT POLONIUM-210 FUELED THERMOELECTRIC GENERATOR, MARTIN COMPANY MND-P-2047 /JUNE 1959 DECLASSIFIED SEPTEMBER 1960/

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JD15

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FINAL SAFETY ANALYSIS REPORT, SNAP-3
THERMOELECTRIC GENERATOR,
H HAGIS, GP DIX
MND-P-2364 /JUNE 1960/

CONCEPTUAL DESIGN OF A SNAP-3 TYPE GENERATOR
FUELED WITH CERIUM-144,
RJ WILSON
MND-P-2369 /JUNE 1960/

NUCLEAR SAFETY ANALYSIS OF SNAP-3 FOR SPACE
MISSION,
W HAGIS, OTHERS
ARS J. 31L 1744-51 /DECEMBER 1961/

FROM SNAP-3 TO IMP
JG MORSE, CR FINK
IEEE TRANS. AEROSPACE 2, 642,5 /APRIL 1964/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD16

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NAME/OWNER	SNAP-7/AEC LCG-25
DESIGNER	MARTIN-MARIETTA CORPORATION
OPERATOR	SEE REMARKS
LOCATION	SEE REMARKS
PURPOSE	AUXILIARY POWER, TERRESTRIAL APPLICATIONS
TYPE	ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.
POWER MWE(MWT)	5-60 WATTS. SEE REMARKS.
CRITICAL	SEE REMARKS
FUEL MATERIAL	STRONTIUM-90 TITANATE
FUEL GEOMETRY	CYLINDER
FUEL ASSEMBLY	FUEL BLOCK IN HASTELLOY CYLINDRICAL CONTAINER.
FUEL CHARGE	SEE REMARKS
REACTOR VESSEL	FUEL BLOCK, HASTELLOY
CONTAINMENT	DOUBLE-WALLED HASTELLOY VESSEL, DEPLETED URANIUM SHIELD WITHIN THE WALLS.
REMARKS	<p>SNAP-7 INSTALLED AT UNMANNED WEATHER STATION ON AXEL HEIBERG ISLAND IN THE ARCTIC, AUG. 1961. 5 WATTS. 41,000 CURIES STRONTIUM-90.</p> <p>SNAP-7A INSTALLED IN FLOATING NAVIGATIONAL BUOY /COAST GUARD/ IN DEC. 1961 AT ARUNDEL COVE, MD. 5 WATTS. 41,000 CURIES STRONTIUM-90. HAS EXPERIENCED STEADY POWER DEGRADATION.</p> <p>SNAP-7B TRANSFERRED FROM CHESAPEAKE BAY NAVIGATION LIGHT TO OFF-SHORE DRILLING BARGE IN GULF OF MEXICO. 30 WATTS. 41,000 CURIES STRONTIUM-90.</p> <p>SNAP-7C INSTALLED AT REMOTE ANTARCTIC WEATHER STATION AT MCMURDO SOUND IN FEB. 1962 /NAVY/. 10-WATT. 41,000 CURIES STRONTIUM-90, OPERATION HAS BEEN SUCCESSFUL SINCE INSTALLATION.</p> <p>SNAP-7D, BARGE-MOUNTED WEATHER STATION /NOMAD/ IN GULF OF MEXICO, MID-1963, SUCCESSFUL OPERATION.</p>

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD16

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FIRST OF SERIES OF STATIONS PLANNED BY NAVY,
30 WATTS, 225,000 CURIES STRONTIUM-90.

SNAP-7E, AN 8-WATT GENERATOR, IN OPERATION IN JULY 1964 AS POWER SOURCE FOR NAVIGATIONAL AIDS, OFF JACKSONVILLE, FLORIDA, HAS RECENTLY COMPLETED 3RD YEAR OF OPERATION AT DEPTH OF 15,000 FT. AS POWER FOR SONAR BEACON.

SNAP-7F WAS PLACED ON AN OIL RIG IN THE GULF OF MEXICO FOR TRIAL USE IN 1964, 60 WATTS.

MARTIN WILL OFFER A COMMERCIAL GENERATOR PATTERNED ON THE SNAP-7 SERIES, THE LCG-25 LOW COST GENERATOR WILL BE A 25-WATT STRONTIUM-90 FUELED THERMOELECTRIC PACKAGE, WITH THE THERMOELECTRIC GENERATOR MOVED OUTSIDE THE RADIATION SHIELD. LATER VERSIONS MAY REACH 40-WATTS. THE NAVAL ELECTRONICS LAB. HAS BOUGHT A 25-WATT MODEL AND INSTALLED IT ON AN ISLAND IN BERING STRAIT OFF ALASKA TO POWER AN OCEANOGRAPHIC MEASURING STATION.

REFERENCES

HAZARDS SUMMARY REPORT FOR A 2-WATT STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR,
MARTIN COMPANY
MND-P-2048 /JUNE 1959 DECLASSIFIED SEPTEMBER 1960/

STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR POWER SOURCE-5-WATT U.S. NAVY WEATHER STATION. FINAL REPORT.
MARTIN COMPANY, NUCLEAR DIV.
MND-P-2707 /ND/

7A, STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR FOR 5-WATT U.S. COAST GUARD LIGHT BUOY. FINAL REPORT.
MARTIN COMPANY
MND-P-2720 /FEBRUARY 1962/

7C FINAL SAFETY ANALYSIS, 10-WATT STRONTIUM-90 FUELED GENERATOR FOR AN UNATTENDED METEOROLOGICAL STATION.
SNAP-7C.
MARTIN COMPANY
MND-P-2614 /FEBRUARY 1962/

7D, SNAP STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR POWER SOURCE 30-WATT U.S. NAVY FLOATING WEATHER STATION. FINAL REPORT,

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MARTIN COMPANY, NUCLEAR DIV.
MND-P-2835 /MARCH 15, 1963/

7E, FINAL SAFETY EVALUATION OF A 10-WATT
STRONTIUM-90 FUELED GENERATOR FOR A DEEP SEA
APPLICATION-SNAP-7E,
HN BERKOW, VG KELLY
MND-P-2761 /1962/

RADIOISOTOPES AND RADIATION DEVELOPMENTS IN THE
USA-1967.
EE FOWLER
ISOTOPES AND RADIATION TECH. 5/3/, 169-84/WINTER
1966-1967/

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD17

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NAME/OWNER SNAP-9A/AEC-NAVY

DESIGNER MARTIN-MARIETTA CORPORATION

LOCATION SPACE

PURPOSE AUXILIARY POWER; SPACE SYSTEMS.

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.

POWER MWE(MWT) 20 WATTS

CRITICAL TRANSIT LAUNCH SEPT. 1963

FUEL MATERIAL PLUTONIUM-238 CARBIDE

FUEL GEOMETRY CAPSULE

FUEL CLADDING STAINLESS STEEL CAPSULE

FUEL ASSEMBLY FUEL CAPSULES IN CANISTER

BURNUP(REFUEL) 5-YEAR LIFETIME

REMARKS THE NAVY NAVIGATIONAL SATELLITE WITH SNAP-9A
INSTALLED FAILED TO ACHIEVE ORBIT ON APRIL, 1964
LAUNCH. AEC REPORTED ALL FUEL BURNED UP COMPLETELY
EARLIER LAUNCHES IN SEPTEMBER AND DECEMBER
/TRANSIT/ WERE SUCCESSFUL AND THE GENERATORS ARE
PROVIDING DESIGN POWER. PROJECTS IMP, NIMBUS, AND
SURVEYOR WILL USE ADVANCED GENERATORS FOR HIGHER
PERFORMANCE. SEE SNAP-19.

REFERENCES SNAPS 9A AND 19A STATUS REPORT.
JG MORSE, CR FINK
MEETING MAY 18-19, 1964.

FROM SNAP-3 TO IMP
JG MORSE, CR FINK
IEEE TRANS. AEROSPACE 2, 642-5 /APRIL 1964/

JANUARY 1969

BNWL-936

NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD18

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NAME/OWNER SNAP-19/AEC-NASA

DESIGNER MARTIN-MARIETTA CORPORATION

OPERATOR NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PURPOSE AUXILIARY POWER

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.

POWER MWE(MWT) 15 WATTS

CRITICAL TARGET 1965

FUEL MATERIAL PLUTONIUM-238

BURNUP(REFUEL) 5-YEAR LIFETIME

REMARKS SNAP-19 IS A MULTI-PURPOSE FOLLOW-ON OF SNAP-9A,
 TAILORED TO NIMBUS-B REQUIREMENTS.
 A NIMBUS-B WEATHER SATELLITE WAS SCUTTLED AFTER
 TAKE-OFF WHEN THE THORAD-AGENA-D LAUNCH VEHICLE
 VEERED OFF COURSE, DROPPING TWO SNAP-19 GENERATORS
 INTO THE PACIFIC /MAY 1968/. THE MISSION IS TO
 BE REPEATED IN THE SPRING OF 1969.

REFERENCES SNAPS-9A AND 19: A STATUS REPORT.
 JG MORSE, CR FINK
 ATOMIC INDUSTRIAL FORUM. INDUSTRY INFORMATION
 MEETING MAY 18-19, 1964

 NUCLEONICS WEEK MAY 23, 1968 p,4
 NEWS RELEASE

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BNWL-936

NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD19

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NAME/OWNER SNAP-11/AEC-NASA
 DESIGNER MARTIN-MARIETTA CORPORATION
 PURPOSE AUXILIARY POWER, SURVEYOR SPACECRAFT.
 TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.
 POWER MWE(MWT) 25 WATTS
 CRITICAL DESIGN AND DEVELOPMENT
 FUEL MATERIAL CURIUM-242, GOLD-CURIUM ALLOY
 FUEL GEOMETRY HOLLOW CYLINDER
 FUEL CLADDING TANTALUM, THIN INNER AND OUTER LINER.
 FUEL ASSEMBLY THIN-WALLED TANTALUM CANISTERS
 FUEL CHARGE 6.3 GRAM CURIUM-242 FOR A 755-WATT UNIT.
 BURNUP(REFUEL) 6-MONTH MISSION.
 CONTAINMENT HASTELLOY OUTER VESSEL, TANTALUM INNER VESSEL. AN
 OUTER THIN ALUMINUM CYLINDER DISSIPATES HEAT TO
 ENVIRONMENT.
 REMARKS SURVEYOR PROJECT FOR SOFT-LANDING OF INSTRUMENTED
 PACKAGES ON THE MOON WILL USE CURIUM-242
 GENERATORS. ALTERNATE TO SNAP-11 IS SNAP-13.
 CURIUM-242 TECHNOLOGY IS BEING APPLIED TO STUDIES
 OF CURIUM-244. A THERMAL MOCKUP OF SNAP-11 HAS
 BEEN TESTED. PAYLOAD INTEGRATION TESTING UNDER WAY
 REFERENCES 100-WATT CURIUM-242 FUELED THERMOELECTRIC
 GENERATOR CONCEPTUAL DESIGN, SNAP SUBTASK 5.7
 FINAL REPORT,
 JB WEDDELL, J BLOOM
 MND-P-2342 /MAY 1960/

 13-WATT CURIUM-FUELED THERMOELECTRIC GENERATOR FOR
 A SIX-MONTH SPACE MISSION, FINAL REPORT,
 JL BLOOM
 MND-P-2373 /JULY 1960/

 SPACE ISOTOPIC POWER SYSTEMS,
 RT CARPENTER /USAF/
 ASTRONAUTICS AEROSPACE ENG. 1 /4/, 68-72 MAY 1963

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD19

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FROM SNAP-3 TO IMP

JG MORSE, CR FINK

IEEE TRANS. AEROSPACE 2, 642-5 /APRIL 1964/

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD20

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NAME/OWNER SNAP-13/AEC-NASA

DESIGNER MARTIN-MARIETTA CORPORATION

PURPOSE ALTERNATE TO SNAP-11, DEMONSTRATION UNIT

TYPE ISOTOPE SYSTEM, THERMIONIC CONVERSION.

POWER MWE(MWT) 12.5 WATT

CRITICAL DEMONSTRATION, 1964

FUEL MATERIAL CURIUM-242

FUEL GEOMETRY HOLLOW CYLINDER

BURNUP(REFUEL) 120-DAY LIFE

REMARKS ELECTRICALLY HEATED TEST UNIT AND A FUELED SNAP-13 ARE PROGRAMMED, WITH WORK ON AN IMPROVED UNIT EXTENDED. CURIUM-244 WILL LATER BE USED IN A SIMILAR UNIT. DEMONSTRATION UNIT OPERABLE IN 1964. GE-S PROPOSAL FOR A THERMIONIC SPACE POWER MODULE HAS BEEN SELECTED BY AEC FOR NEGOTIATION OF A 6-MONTH STUDY CONTRACT, AS PHASE-1 OF A 4-PHASE DESIGN EFFORT ON 100-WATT POLONIUM-210 AND CURIUM-244 GENERATORS. SANDIA LAB. WILL PROVIDE TECHNICAL DIRECTION.

REFERENCES SEE SNAP-11

SPACE ISOTOPIIC POWER SYSTEMS.
RT CARPENTER /USAF/
ASTRONAUTICS/AEROSPACE ENG. 1 /4/, 68-72 MAY 1963

NUCLEONICS WEEK MARCH 17, 1966 P. 7
NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD21

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NAME/OWNER DCR-1 /DIRECT CONVERSION REACTOR//MARTIN

DESIGNER MARTIN-MARIETTA CORPORATION

PURPOSE AUXILIARY POWER

TYPE REACTOR SYSTEM, AUXILIARY POWER, BWR THERMIONIC CONVERSION.

POWER MWE(MWT) 1 16

CRITICAL DEVELOPMENT

COOLANT LIGHT WATER

MODERATOR ZIRCONIUM HYDRIDE

FUEL MATERIAL URANIUM DIOXIDE-MOLYBDENUM CERMET, PELLETS.

FUEL GEOMETRY TUBES

FUEL CLADDING MOLYBDENUM CLADDING ON PELLETS, ZIRCONIUM OXIDE SLEEVE, AND SS TUBE.

FUEL ASSEMBLY 5-ELEMENT CLUSTER
CORE CONSISTS OF 33 FUEL BUNDLES,
CONTAINING 7 FUEL-TUBE CLUSTERS AND
ZIRCONIUM HYDRIDE MODERATOR. THERMIONIC
CONVERTER UNITS ARE INTEGRAL TO THE FUEL
BUNDLE.

REMARKS REACTOR SYSTEM IS A FORCED CIRCULATION, DIRECT
CYCLE BWR. AN ALTERNATE FUEL SYSTEM CONSIDERED WAS
THE URANIUM DIOXIDE-NIOBIUM SYSTEM, A CONCEPTUAL
LIQUID METAL COOLED SYSTEM USED PHOSPHORUS
SESQUISULFIDE OR NAK AS COOLANT, HOMOGENEOUS
URANIUM-ZIRCONIUM HYDRIDE FUEL-MODERATOR ELEMENTS,
CONVERSION WOULD BE THERMOELECTRIC. ADVANCED
APPROACHES INCLUDE NUCLEAR SUPERHEAT, A
PRELIMINARY DESIGN FOR A 100 KWE REACTOR CORE HAS
BEEN COMPLETED.

REFERENCES A WATER-COOLED THERMIONIC PORTABLE POWER PLANT,
GL REED
ANS TRANS. 6, 318-19 /NOV 1963/

FEASIBILITY STUDY OF A WATER-COOLED THERMIONIC
NUCLEAR POWER PLANT,
AEROSPACE DIV., MARTIN-MARIETTA CORP.,
MND-2903, VOL. 2 /NOV. 1962/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD22

NAME/OWNER TURPS /TERRESTRIAL UNATTENDED REACTOR POWER SYSTEM/MARTIN

DESIGNER MARTIN-MARIETTA CORPORATION

PURPOSE AUXILIARY POWER, REMOTE SITES OR UNDERSEA

TYPE REACTOR SYSTEM, AUXILIARY POWER, LIQ. METAL COOLED THERMOELECTRIC CONVERSION.

POWER MWE(MWT) 100KWE 1.56

CRITICAL RESEARCH AND DEVELOPMENT

COOLANT TETRAPHOSPHORUS TRISULFIDE, BOILING NATURAL CIRCULATION

MODERATOR ZIRCONIUM HYDRIDE

FUEL MATERIAL ZIRCONIUM-URANIUM HYDRIDE

FUEL GEOMETRY TWO-SEGMENT ELEMENT,
FUELED AND UNFUELED ZIRCONIUM HYDRIDE

CONTROL A CONTROL CONCEPT TO BE EVALUATED IS BASED ON THE MIGRATION OF HYDROGEN IN THE ZIRCONIUM HYDRIDE UNDER TEMPERATURE CHANGE, AND THE MODERATING ACTION OF THE HYDROGEN AS IT MIGRATES.

REMARKS A PLANT WOULD CONSIST OF SEVEN 20,000-POUND PACKAGES. FIRST PACKAGE WOULD BE THE REACTOR, GENERATOR, AND SHIELD TANK. PHOSPHORUS SULFIDE AS THE COOLANT WOULD BE BOILED IN THE REACTOR AND THE VAPOR TRANSPORTED TO THE THERMOELECTRIC GENERATOR BY NATURAL CIRCULATION. PLANT FEASIBILITY HAS BEEN DETERMINED. THE SYSTEM IS BEING SPONSORED BY THE AF SPECIAL WEAPONS CENTER, KIRTLAND AFB, UNDER A CONTRACT TO RUN UNTIL JANUARY 1966, AEC AND THE ARMY ARE EVALUATING THE CONCEPT. TURPS IS ALSO BEING EVALUATED AS AN UNDERSEA PLANT. MARTIN HAS RECEIVED A 9-MONTH CONTRACT FROM THE U. S. ARMY CORPS OF ENGINEERS FOR A FEASIBILITY STUDY OF THE TURPS CONCEPT FOR A MOBILE NUCLEAR PLANT.

REFERENCES TETRAPHOSPHORUS TRISULFIDE COOLED THERMOELECTRIC REACTOR PLANT, CONCEPTUAL DESIGN. CE MURPHY

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD22

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AMERICAN NUCLEAR SOC. TRANS. 6, 320-21 /NOV. 1963/

NUCLEONICS WEEK DEC. 16, 1965 P. 5
NEWS RELEASENUCLEONICS WEEK SEPT. 8, 1966 P. 4
NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD23

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NAME/OWNER	UNDERWATER THERMOELECTRIC POWER PLANT/MARTIN	
DESIGNER	MARTIN-MARIETTA CORPORATION	
PURPOSE	ELECTRICAL POWER FOR UNDERSEA OPERATIONS.	
TYPE	REACTOR SYSTEM, AUXILIARY POWER, PWR THERMOELECTRIC CONVERSION.	
POWER MWE(MWT)	100 KWE	2.5
CRITICAL	CONCEPTUAL DESIGN	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE PELLETS	
FUEL GEOMETRY	TUBES	
FUEL ENRICH.	LOW	
FUEL ASSEMBLY	104-TUBE BUNDLE 12 BUNDLES/CORE	
CONTROL	BURNABLE POISON, BORON, IN CLADDING.	
REACTOR VESSEL	SPHERICAL	
CONTAINMENT	THERMAL SHIELD, SEA-WATER SCREEN, AND SEA-WATER RETAINING SHELL.	
REMARKS	CONCEPTUAL DESIGN, A SELF-PRESSURIZED, NATURAL CIRCULATION REACTOR SYSTEM /PWR/, DESIGNED FOR REMOTE STARTUP AND COMPLETE UNATTENDED OPERATION. SYSTEM CONSISTS OF A LOWER PRESSURE VESSEL CONTAINING THE LOW-ENRICHMENT REACTOR CORE, A RISER, AN UPPER PLENUM, THREE SEVEN-PLATE ASSEMBLIES OF THERMOELECTRIC ELEMENTS, AND INTERCONNECTED PIPING.	
REFERENCES	AN 100 KWE UNDERWATER THERMOELECTRIC REACTOR PLANT CONCEPTUAL DESIGN. KH DUFRANE AMERICAN NUCLEAR SOC. TRANS. 6, 319-20 /NOV. 1963/	

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD24

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NAME/OWNER MPRE /MEDIUM POWER REACTOR EXPERIMENT//AEC
INTERMEDIATE REACTOR

DESIGNER OAK RIDGE NATIONAL LABORATORY

LOCATION EXPERIMENT AT ORNL

PURPOSE AUXILIARY POWER. INTERMEDIATE BETWEEN SNAP-8 AND
SNAP-50.

TYPE REACTOR SYSTEM, LIQUID METAL, BOILING.
DIRECT CYCLE.

POWER MWE(MWT) 125 KWE 1

CRITICAL DEVELOPMENT. EXPERIMENT BEING BUILT.

COOLANT BOILING POTASSIUM

FUEL MATERIAL URANIUM DIOXIDE

REMARKS REACTOR SYSTEM USING BOILING POTASSIUM AS THE HEAT
TRANSFER FLUID AND DIRECT WORKING FLUID. CORE IS A
ONE-LOOP SYSTEM, EXPECTED TO OPERATE AT ABOUT
1500 F. BOILING POTASSIUM COOLANT IS FED TO A
POTASSIUM TURBINE, THEN TO A RADIATOR, WHERE IT IS
PUMPED BACK INTO THE CORE.

REFERENCES BOILING POTASSIUM REACTOR FOR SPACE.
AP FRAAS
NUCLEONICS 22, 72-73 /JAN. 1964/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD25

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NAME/OWNER SNAP-50 /SNAP-50/SPUR//AEG-NASA-DOD

DESIGNER PRATT AND WHITNEY AIRCRAFT

PURPOSE AUXILIARY POWER, SPACE

TYPE REACTOR SYSTEM, LIQ. METAL COOLED, FAST.

POWER MWE(MWT) 300-1000 KWE

COOLANT LITHIUM

MODERATOR NONE

FUEL MATERIAL URANIUM/BERYLLIUM OXIDE,
CARBIDE AND NITRIDE STUDIED.

REMARKS SYSTEM CONSISTS OF A HIGH TEMPERATURE COMPACT REACTOR WITH LITHIUM COOLANT AND POTASSIUM VAPOR TURBINE. THE LCRE /LITHIUM COOLED REACTOR EXPERIMENT/ WHICH WAS TO HAVE BEEN BUILT AT AN IDAHO FACILITY HAS BEEN CANCELED. THE PROGRAM WILL PROCEED WITH SNAP-50 DESIGN AND DEVELOPMENT. THE SNAP-50 PROGRAM HAS BEEN REDUCED TO THE LEVEL OF TECHNOLOGICAL DEVELOPMENT, AND WILL BE MOVED TO LAWRENCE RADIATION LABORATORY IN CALIFORNIA. THE PRATT AND WHITNEY OPERATED INSTALLATION /CANEL/ HAS BEEN CLOSED OUT. LRL WORK WILL BE DIRECTED AT TRYING TO DETERMINE HOW TO BUILD THE HIGHEST TEMPERATURE REACTOR SYSTEM THAT COULD BE USED WITH RANKINE CYCLE, HIGH TEMPERATURE BRAYTON CYCLE, OR OUT-OF-CORE THERMIONIC SYSTEMS.

REFERENCES SNAP-50/SPUR REACTOR EXPERIMENT,
FD HAINES
TRANS. AMERICAN NUCLEAR SOC, 6 /1/, 88 /JUNE 1963/
/ABSTRACTS/

THE SNAP-50/SPUR NUCLEAR ELECTRIC SPACE POWER
PLANT PROGRAM
EM DOUTHETT, RI STROUGH /PAW/
CONF-650416-1, APRIL 28, 1965

NUCLEONICS WEEK DEC. 2, 1965 P. 4
NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD26

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NAME/OWNER LAMONT GEOPHYSICAL OBSERVATORY GENERATOR
DESIGNER ROYAL RESEARCH CORPORATION
PURPOSE AUXILIARY POWER; DEEP-SEA INSTALLATION.
TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION
POWER MWE(MWT) 5 WATT
CRITICAL DESIGN AND DEVELOPMENT
FUEL MATERIAL CESIUM-137 /CESIUM-POLYGLASS/
REMARKS RRC RECEIVED A STUDY CONTRACT FOR A THERMOELECTRIC
GENERATOR BASED ON THE LAMONT GENERATOR DESIGN.
REFERENCES THE CESIUM-137 POWER PROGRAM.
QUARTERLY REPORT NO. 2 /ROYAL RESEARCH CORP./
TID-19333 /JULY 31, 1961/

JANUARY 1969

BNWL-936

NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD27

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NAME/OWNER POODLE/AEC-USAF

DESIGNER TRW SPACE TECHNOLOGY LABS.

PURPOSE ROCKET PROPULSION

TYPE ISOTOPE SYSTEM, LIQUID HYDROGEN PROPELLANT.

POWER MWE(MWT) 10 KW

CRITICAL GROUND TEST 1965

FUEL MATERIAL POLONIUM-210

REMARKS TRW HAS DESIGNED AND PATENTED A NUCLEAR ROCKET, USING HEAT FROM AN ISOTOPIC SOURCE, WHICH WOULD USE LIQUID HYDROGEN AS A PROPELLANT BUT WOULD OPERATE AT LOWER POWER AND THRUST LEVELS THAN THE NUCLEAR ROCKET ROVER. A POODLE STAGE USING A 10 KW SOURCE OPERATING AT TEMPERATURES WITHIN THE LIMITS OF TODAYS ENCAPSULATION TECHNOLOGY WOULD HAVE A SPECIFIC IMPULSE OF UP TO 800 SECONDS AND A THRUST OF 0.5 POUNDS. GROUND TESTS OF POODLE AT MOUND LAB, PRODUCED A SPECIFIC IMPULSE OF 670-700 SEC., EQUAL TO A 2730 F CORE TEMPERATURE. THE NEXT STOP IN THE CONCEPT MAY BE A SNAP-POODLE, USING EXCESS HEAT FROM THE ENERGY SOURCE FOR ELECTRIC POWER IN SPACE UNITS. THE SYSTEM HAS ALSO BEEN PROPOSED FOR DEEP-SPACE PROBES AND MILITARY SATELLITES.

REFERENCES POODLE INTERESTS SATURN OFFICALS.
WE WILKS
MISSILES AND ROCKETS 14 /23/, 22-3 /JUNE 8, 1964/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD28

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NAME/OWNER	WANL SUBMERGED REACTOR UNIT/WEST
DESIGNER	WESTINGHOUSE ELECTRIC CORP. ASTRONUCLEAR LAB.
PURPOSE	UNDERSEA POWER, UNATTENDED
TYPE	REACTOR SYSTEM, AUXILIARY POWER, BWR, THERMOELECTRIC CONVERSION.
POWER MWE(MWT)	3 45
CRITICAL	FEASIBILITY STUDY.
COOLANT	LIGHT WATER BOILING SULFUR CONSIDERED FOR HIGH TEMPERATURE SYSTEM.
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE-NIOBIUM CERMET, URANIUM-BERYLLIUM OXIDE, OR URANIUM DIOXIDE.
FUEL GEOMETRY	RODS, WITH CONCENTRIC REGIONS OF THERMOELECTRIC MATERIAL, CONDUCTORS, INSULATION, AND CLADDING.
FUEL ENRICH.	LOW FOR URANIUM DIOXIDE, HIGH FOR CERMET FUELS.
FUEL ASSEMBLY	32-ROD BUNDLE /URANIUM DIOXIDE-NIOBIUM FUEL/ 64 BUNDLES/CORE
BURNUP(REFUEL)	2-3 YEAR LIFETIME
REMARKS	FEASIBILITY STUDY HAS BEEN COMPLETED, DESIGN AND DEVELOPMENT STATUS. THE BWR HAS NATURAL CONVECTION CIRCULATION.
REFERENCES	PRELIMINARY CORE DESIGN OF A 500 KW/E/ THERMOELECTRIC REACTOR. R MARKLEY, E SCHWARTZ WCAP-1737 /MARCH 1961/ FEASIBILITY STUDIES FOR MWE NUCLEAR THERMOELECTRIC PLANT. RA CLARK, OTHERS WANL-PR/A/-002 /DECEMBER 1961/ DIRECT CONVERSION THERMOELECTRIC REACTOR STUDIES. JC DANKO, OTHERS PREPRINT PAPER NO. 11, ENGINEERS JOINT COUNCIL,

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD28

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N.Y. 1962.

UNDERSEA REACTOR MAY POWER OCEAN-BOTTOM COMMUNITY.
MACH. DESIGN 34, 28 /DECEMBER 6, 1962/ NEWS ITEM.

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD29

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NAME/OWNER THERMIONIC CONVERSION REACTOR/MARTIN
DESIGNER MARTIN-MARIETTA CORPORATION
PURPOSE AUXILIARY POWER
TYPE REACTOR SYSTEM, LIQUID METAL COOLED,
 THERMIONIC CONVERSION
POWER MWE(MWT) 100 KWE
CRITICAL DESIGN
COOLANT SODIUM-POTASSIUM NAK
MODERATOR YTTRIUM HYDRIDE, BERYLLIA REFLECTOR
FUEL MATERIAL URANIUM/YTTRIUM HYDRIDE
FUEL CHARGE 145 KG. U-235
REMARKS PRELIMINARY DESIGN
REFERENCES PRELIMINARY DESIGN OF A 100 KWE THERMIONIC
 CONVERSION REACTOR CORE.
 FA RUSSO /MARTIN/
 TRANS. AMERICAN NUCLEAR SOC. 7, 378 /NOV. 1964/

JANUARY 1969

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD30

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NAME/OWNER SNAP-21A/AEC
DEEP-SEA RADIOISOTOPE THERMOELECTRIC GENERATOR

DESIGNER MINNESOTA MINING/MANUFACTURING CO.,
DEVELOPMENT OF MARTIN CONCEPT

PURPOSE DEEP SEA UNATTENDED POWER SOURCE

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION

POWER MWE(MWT) 10 WATTS 178 WATTS

CRITICAL OPERATIONAL TESTING, TARGET 1967

FUEL MATERIAL STRONTIUM TITANATE PELLETS /STRONTIUM-90/
STRONTIUM OXIDE STUDIED AS POSSIBLE
REPLACEMENT.

FUEL GEOMETRY CYLINDRICAL
SPHERICAL SHAPE STUDIED

FUEL CLADDING PLATINUM JACKET ON FUEL PELLET
FUEL CAPSULE OF HASTELLOY-C

FUEL ASSEMBLY HASTELLOY-C CAPSULE 2.89 IN. ID/3.89 IN. OD/4.06
IN. LONG
HASTELLOY-C LINER

FUEL CHARGE 28 KILOCURIES STRONTIUM-90

BURNUP(REFUEL) 5-YEAR MINIMUM LIFETIME

REACTOR VESSEL BERYLLIUM-COPPER ALLOY, FORGED VESSEL,
INSULATION ENVELOPE COMPOSED OF LAYERED FOILS
INTERSPERSED WITH NON-CONDUCTIVE SPACER MATERIAL.

CONTAINMENT BIOLOGICAL SHIELD, DEPLETED URANIUM-MOLYBDENUM
ALLOY, BARRIER MATERIAL BETWEEN BIOLOGICAL SHIELD,
SPIDER, AND INNER LINER IS SPRAYED ALUMINUM OXIDE.
URANIUM-MOLYBDENUM BIOLOGICAL SHIELD.

REMARKS 3M IS DEVELOPING THE SYSTEM FOR OCEANOGRAPHIC
RESEARCH AND UNDERWATER NAVIGATIONAL AIDS,
A 10-WATT POWER SUPPLY SYSTEM WAS CONSTRUCTED AND
TESTED FROM JULY 1966 TO DEC. 1967,
PHASE 2 IS A TECHNOLOGY PROGRAM LEADING TO THE
CONSTRUCTION OF A FULLY-QUALIFIED AND TESTED
10- AND 20-WATT SYSTEM.

REFERENCES A RADIOISOTOPE POWERED UNDERWATER ACOUSTIC BEACON.

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD30

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PHASE 1. FINAL REPORT. FEASIBILITY STUDY.
MARTIN CO.
MND-3180-1N /JAN. 1965/

DIRECT ENERGY CONVERSION DIGEST JULY 1966
NEWS RELEASE

SNAP-21 PROGRAM. PHASE 3
QUARTERLY REPORT NO. 3
MMM-3601-17

SNAP-21 PROGRAM.
QUARTERLY REPORT NO. 6
MMM-3691-26 /JAN. 1968/

SUMMARY REPORT. PHASE 1.
SNAP-21A TEN-WATT DEEP-SEA ISOTOPE POWER SUPPLY.
VOL. 1
MND-3322-25 /JUNE 1965/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD31:

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NAME/OWNER : SNAP-25/AEC

DESIGNER : LOCKHEED MISSILES/SPACE CO., NUMEC

PURPOSE : SPACE POWER

TYPE : ISOTOPE SYSTEM, CONVERSION BY THERMOCOUPLES

POWER MWE(MWT) : 75 WATTS

CRITICAL : DEVELOPMENT
SEE REMARKSREMARKS : WORK ON SNAP-25 HAS BEEN STOPPED, APPARENTLY
BECAUSE CONFIGURATION AND POTENTIAL USE OVERLAP
THE 50-WATT SNAP-27 GENERATOR

REFERENCES : NEWS RELEASES

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD32

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NAME/OWNER SNAP-27/AEC, NASA

DESIGNER GENERAL ELECTRIC CO.
DEVELOPMENT

OPERATOR NATIONAL AERONAUTICS AND SPACE ADMINISTRATION NASA

PURPOSE DEVELOPMENT FOR ALSEP /APOLLO LUNAR SURFACE
EXPERIMENT PACKAGE/

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION

POWER MWE(MWT) 50 WATTS

CRITICAL PROTOTYPE TO AEC JAN. 1967;
FLIGHT RATED SYSTEM DELIVERY TO NASA SUMMER 1967

FUEL MATERIAL PLUTONIUM-238

BURNUP(REFUEL) ONE-YEAR MISSION

REMARKS GENERAL ELECTRIC HAS RECEIVED AN AEC DEVELOPMENT
CONTRACT. FOUR SYSTEMS WILL BE REQUIRED FOR THE
APOLLO LUNAR-LANDING MISSION. THE 3M COMPANY WILL
DEVELOP THERMOELECTRIC MODULES.
ALSEP /APOLLO LUNAR SURFACE EXPERIMENT PACKAGE/
IN TESTS AT GENERAL ELECTRIC VALLEY FORGE TECH,
CENTER THE GENERATOR PRODUCED MORE THAN 70 WATTS
OF ELECTRIC POWER.

REFERENCES NUCLEAR INDUSTRY OCT. 1965 P. 35
NEWS RELEASE

NUCLEONICS WEEK JAN. 19, 1967 P. 6
NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD33

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NAME/OWNER REFLEX/WESTINGHOUSE
REACTOR FOR LUNAR EXPLORATION

DESIGNER WESTINGHOUSE ELECTRIC CORP.

TYPE LIQUID METAL COOLED, FAST REACTOR

POWER MWE(MWT) POWER, LUNAR BASE AND EXPLORATION MISSIONS

CRITICAL CONCEPTUAL DESIGN

COOLANT POTASSIUM

FUEL MATERIAL URANIUM DIOXIDE

BURNUP(REFUEL) 1-YEAR LIFE

CONTROL TOTALLY AUTOMATIC

COOLANT TEMP. OUTLET 1300 F

CONTAINMENT REACTOR IS TOTALLY SHIELDED

REMARKS POWER CONVERSION SYSTEM IS SIMILAR TO SNAP-8
THE POTASSIUM COOLANT DRIVES A MERCURY-VAPOR
TURBINE.

REFERENCES NUCLEAR POWER PLANT-LUNAR EXPLORATION SYSTEM
FOR APOLLO.
WESTINGHOUSE ASTRONUCLEAR LAB.
WANL-PR/S/-009-A /OCT. 1964/

SPACE APPLICATIONS OF FAST REACTORS,
DG OTT
FAST REACTOR TECHNOLOGY. NATIONAL TOPICAL MEETING
APRIL 26-28, 1965,
AMERICAN NUCLEAR SOC.
ANS-100 P.57-64

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD34

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NAME/OWNER	THERMIONIC CONVERTER PROPULSION SYSTEM/DOUGLAS
DESIGNER	DOUGLAS AIRCRAFT
PURPOSE	SPACE PROPULSION
TYPE	REACTOR SYSTEM, THERMIONIC CONVERSION
POWER MWE(MWT)	5
CRITICAL	CONCEPTUAL DESIGN
FUEL MATERIAL	URANIUM DIOXIDE-TUNGSTEN CERMET
COOLANT TEMP,	1595 F
REMARKS	PROPULSION PLANT INTEGRATED WITH PAYLOAD REQUIREMENTS FOR MANNED MARS MISSION. LAUNCH VEHICLE IS AN AUGMENTED SATURN G-5
REFERENCES	CONCEPTUAL DESIGN ANALYSIS OF A 5 MWE THERMIONIC REACTOR SPACE PROPULSION PLANT. FA ROSS, TF PLUNKETT NP-14985 /FEB. 1965/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD35

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NAME/OWNER MATTRAC
 MOBILE ARMY THERMAL THERMIONIC REACTOR
 AIR-COOLED

PURPOSE PORTABLE PLANT FOR SPACE OR TERRESTRIAL USES

TYPE REACTOR SYSTEM, THERMIONIC CONVERSION

POWER MWE(MWT) 100 KWE

COOLANT AIR

REMARKS MODULAR DESIGN USING A HEAT PIPE TO TRANSFER HEAT
 FROM THE REACTOR TO THE CONVERTER THROUGH BOILING
 OR CONDENSING OF A WORKING FLUID SUCH AS WATER OR
 LITHIUM. CAPILLARY ACTION RETURNS THE CONDENSATE
 TO THE HEAT SOURCE. NO PUMPS ARE NECESSARY,
 HITTMAN AND RCA ARE PREPARING A PROPOSAL.

REFERENCES NUCLEONICS WEEK MARCH 3, 1966 P. 6
 NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD36

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NAME/OWNER SNAP-29/AEC, DOD/NASA

DESIGNER MARTIN-MARIETTA CORP.

PURPOSE POWER FOR SHORT-LIVED EARTH-ORBITAL AND
 LUNAR SURFACE MISSIONS

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.

POWER MWE(MWT) 400 WATTS

CRITICAL DEVELOPMENT

FUEL MATERIAL POLONIUM-210

BURNUP(REFUEL) LIFETIME 139 DAYS

REFERENCES NUCLEONICS WEEK MARCH 24, 1966 P. 2
 NEWS RELEASE

 DIRECT ENERGY CONVERSION DIGEST MARCH 1966 P. 2
 NEWS RELEASE

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD37

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NAME/OWNER RISE /RADIOISOTOPE SUBMERSIBLE ENGINE/AGN

DESIGNER AEROJET-GENERAL NUCLEONICS

PURPOSE UNDERSEA PROPULSION OR POWER FOR
 MANNED PLATFORMS.

TYPE ISOTOPE SYSTEM

POWER MWE(MWT) 70 KW

CRITICAL CONCEPTUAL DESIGN

COOLANT WATER-STEAM. SEE REMARKS

FUEL MATERIAL CERIUM-144 AS CERIUM OXIDE

FUEL GEOMETRY PINS 1.495 IN. DIA., ACT. LENGTH 7.86 IN.

FUEL CLADDING HASTELLOY-C 0.050 IN. THICK

FUEL ASSEMBLY HEXAGONAL CLOSE-PACKED ASSEMBLY
 TOTAL 19 PINS

SPECIFIC POWER 1/3 CORE IN 6 MONTHS

COOLANT TEMP, INLET 141 F OUTLET 567 F

COOLANT PRESS. INLET 1200 PSIA OUTLET APPROX. 1200 PSIA

REACTOR VESSEL VESSEL 8-25 IN. OD./14.5 IN. LONG/0.2 IN. THICK

CONTAINMENT SHIELDING IS NATURAL OR DEPLETED URANIUM.

REMARKS AGN HAS PROPOSED AN ORGANIC-COOLED RISE TO THE
 AEC AS AN UNDERSEA PROPULSION SYSTEM, USING THE
 RANKINE CYCLE.

REFERENCES EVALUATION OF RADIOISOTOPE APPLICATIONS IN
 HYDROSPACE. FINAL REPORT,
 KE BUCK, OTHERS
 AGN-8135 /MARCH 1965/

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD38

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NAME/OWNER : SNAP-23/US AEC

DESIGNER : 3-M ISOTOPE POWER PRODUCTS

PURPOSE : AUXILIARY POWER FOR NAVIGATION BUOYS, LAND-BASED
MICROWAVE REPEATER STATIONS, REMOTE WEATHER
STATIONS

TYPE : ISOTOPE SYSTEM
THERMOELECTRIC CONVERSION

POWER MWE(MWT) : 25, 60, AND 100 WATT UNITS

CRITICAL : DEVELOPMENT. PROTOTYPE TARGET 1969

FUEL MATERIAL : STRONTIUM-90

FUEL GEOMETRY : CAPSULE

BURNUP(REFUEL) : 10-YEAR OPERATING LIFE

REMARKS : THREE-M HAS RELINQUISHED ALL WORK ON SNAP-23
EXCEPT CONVERTER DESIGN.
WESTINGHOUSE IS TO DELIVER TWO 25-WATT,
FOUR 60-WATT, AND ONE 100-WATT UNITS BY 1969.

REFERENCES : SNAP-23A PROGRAM.
THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM,
QUARTERLY REPORT NO. 4
MMM-3824-0017 /DEC. 1967/

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NUCLEAR AUXILIARY POWER SYSTEMS. DOMESTIC

JD39

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NAME/OWNER URIPS /UNDERSEA RADIO-ISOTOPE POWER SYSTEM/ AGN

DESIGNER AEROJET-GENERAL NUCLEONICS

LOCATION COMMERCIALY AVAILABLE

PURPOSE AUXILIARY POWER, UNDERWATER

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERTER

POWER MWE(MWT) 1 WATT

FUEL MATERIAL STRONTIUM-90

BURNUP(REFUEL) 10-YEAR LIFETIME

CONTAINMENT LEAD OR DEPLETED URANIUM SHIELDING

REMARKS SOLID-STATE THERMOELECTRIC GENERATOR FOR POWERING
UNDERWATER BENCH MARKS, WELL-HEAD MARKERS, REMOTE
DATA LINES ETC.
AVAILABLE POWER IS 3-28 VOLTS.
DEVICE IS DESIGNED FOR CONTINUOUS 10-YEAR USE TO
DEPTHS OF 2000 FT.
THE NAVY IS MAKING AN EVALUATION OF THE SYSTEM AT
THE NAVAL CIVIL ENG. LAB. AT POINT HUENEME, CALIF.

REFERENCES NUCLEONICS WEEK MARCH 2, 1967 P. 4
NUCLEAR INDUSTRY MARCH 1967 P. 34
NEWS RELEASES

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD40

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NAME/OWNER ISOMITE/ISOTOPE MINIATURE-THERMIONIC ELECTRIC/DWD
DESIGNER DONALD W. DOUGLAS LABORATORY
PURPOSE LOW-LEVEL COMPACT POWER SOURCE
TYPE ISOTOPE SYSTEM. THERMIONIC GENERATOR
POWER MWE(MWT) 10 MICROWATTS TO 10 MILLIWATTS
CRITICAL DEVELOPMENT
FUEL MATERIAL PROMETHIUM-147 AS PROMETHIUM OXIDE /POWDER/
REFERENCES A MINIATURE ATOMIC BATTERY BASED ON THERMIONIC
CONVERSION.
NS RASOR, OTHERS
PRESENTED TO SECOND INTERNATIONAL CONF. ON
THERMIONIC POWER GENERATION, STRESA, ITALY,
MAY 27-31, 1968.
DP-4947

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NUCLEAR AUXILIARY POWER SYSTEMS, DOMESTIC

JD41

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NAME/OWNER SPACE REACTOR/LAWRENCE RADIATION LAB.
DESIGNER LAWRENCE RADIATION LABORATORY
TYPE LIQ. METAL COOLED, COMPACT REACTOR,
 HEAT PIPE
POWER MWE(MWT) 10
CRITICAL STUDY
COOLANT LITHIUM
FUEL MATERIAL URANIUM NITRIDE
COOLANT TEMP. HEAT-PIPE WASTE HEAT REJECTION AT 1100 K
REMARKS OPERATING TEMPERATURE 1650 K.
 STRUCTURAL MATERIAL TUNGSTEN-RHENIUM ALLOY
REFERENCES CONCEPTUAL DESIGN OF A 10 MWE NUCLEAR RANKINE
 SYSTEM FOR SPACE POWER
 JH PITTS, CE WALTER
 UCRL-50382 /JAN. 30, 1968/

NUCLEAR AUXILIARY POWER SYSTEMS
SNAP-TYPE REACTORS
FOREIGN

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF01

NAME/OWNER FRENCH AUXILIARY POWER DEVELOPMENT PROGRAM,

DESIGNER CEA, FRANCE

PURPOSE RESEARCH AND DEVELOPMENT

POWER MWE(MWT) 12.5 WATTS

FUEL MATERIAL STRONTIUM TITANATE

REMARKS FRANCE WILL DEVELOP NUCLEAR UNITS SIMILAR TO U.S. SNAP GENERATORS. A PILOT PLANT AT SACLAY WILL SEPARATE CESIUM-137 AND STRONTIUM-90. FISSION REACTORS WILL ALSO BE STUDIED. TWO STRONTIUM-FUELED UNITS ARE BEING DEVELOPED FOR USE IN THE NATIONAL SATELLITE PROGRAM. AN R+D CONTRACT HAS BEEN AWARDED BY THE CENTRE NATIONALE D'ETUDES SPATIALES TO THE ELECTRONICS FIRMS CFS AND SNECMA. HISPANO-SUIZA, FRANCE, HAS A DEVELOPMENT CONTRACT FROM EURATOM FOR A STRONTIUM TITANATE FUELED THERMOELECTRIC SYSTEM. SIRENE-302, A THERMIONIC CONVERTER IN-PILE EXPERIMENT AT SACLAY, IS FUELED WITH MOLYBDENUM-CLAD URANIUM DIOXIDE AND COOLED BY NA-K.

REFERENCES NEWS RELEASES

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF02

* * * * *

NAME/OWNER RIPPLE/AERE, UNITED KINGDOM
 RADIOACTIVE ISOTOPE-POWERED PROLONGED-LIFE

DESIGNER AERE, UNITED KINGDOM

OPERATOR AERE, UNITED KINGDOM

LOCATION DEMONSTRATION AT HARWELL ATOMIC ENERGY RES.
 ESTAB., U.K.

PURPOSE REMOTE LOCATIONS, UNATTENDED OPERATION.

TYPE ISOTOPE SYSTEM, THERMOELECTRIC CONVERSION.

POWER MWE(MWT) RIPPLE-1, 75 MILLIWATTS /DEMONSTRATION/
 RIPPLE-2, 90 MILLIWATTS /DEMONSTRATION/
 RIPPLE-3, 750 MILLIWATTS /EXPERIMENT/
 RIPPLE-4, 2.5 WATTS /DESIGN/
 RIPPLE-5, 1 WATT
 RIPPLE-6, 1 WATT
 RIPPLE-7, 1 WATT

CRITICAL RIPPLE-1 /DEMONSTRATION/ MARCH 1965
 RIPPLE-2 /DEMONSTRATION/ MARCH 1965
 RIPPLE-3 /EXPERIMENTAL/ MARCH 1966
 RIPPLE-4 /SUBMARINE CABLE REPEATER/ DESIGN
 RIPPLE-5 /NAVIGATION LIGHT/ JULY 1966, IN LAB.
 RIPPLE-6 /NAVIGATION LIGHT-IN-SERVICE/ AUG, 1966
 RIPPLE-7 /NAVIGATION LIGHT-IN-SERVICE/ AUG, 1966

FUEL MATERIAL STRONTIUM-90 TITANATE PELLETS

FUEL CLADDING THIN SS CAPSULE

FUEL CHARGE 700 CURIES STRONTIUM-90

BURNUP(REFUEL) 28-YEAR HALF-LIFE, 10-YEAR LIFETIME

CONTAINMENT RIPPLE 1, LEAD SHIELDING,
 RIPPLE 2 AND 3, TUNGSTEN ALLOY SHIELDING
 RIPPLE 5 TO 8, DEPLETED URANIUM SHIELDING

REMARKS BISMUTH TELLURIDE THERMOELECTRIC ELEMENTS IN
 MODULE LOCATED ON ONE END OF CYLINDRICAL ISOTOPE
 CAN.
 RIPPLE-1 HAS BEEN EXHIBITED AT THE LONDON RADIO-
 ELECTRONICS CONFERENCE, AND RIPPLE-2 AT THE ROME
 INTERNATIONAL CONFERENCE ON LIGHTHOUSES AND AIDS
 TO NAVIGATION.

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF02

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RIPPLE-3 HAS BEEN UNDER TEST AT THE NAVAL CIVIL
ENGINEERING LAB, AT PT. HUENEME, CALIF.
RIPPLE-6 HAS BEEN INSTALLED ON A SMALL ISLAND NEAR
STOCKHOLM TO POWER A NAVIGATION BEACON.
RIPPLE-7 IS ON LOAN TO DANISH LIGHTHOUSE AUTHORITY
FOR IN SERVICE EVALUATION

REFERENCES

INTERIM REPORT ON THE FIRST BRITISH RADIOACTIVE
ISOTOPE POWERED THERMOELECTRIC GENERATORS RIPPLE-1
AND RIPPLE-2,
PD DUNN, FW YEATS
AERE-M-1594 /1965/

NEWS RELEASES

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF03

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NAME/OWNER	ROMASHKA/USSR
DESIGNER	USSR
LOCATION	KURCHATOV ATOMIC ENERGY INST., MOSCOW, USSR.
PURPOSE	AUXILIARY POWER
TYPE	REACTOR SYSTEM, THERMOELECTRIC CONVERSION CONDUCTION COOLED, FAST REACTOR
POWER MWE(MWT)	500 WATTS 40 KW
CRITICAL	OPERATION AUG. 1964
COOLANT	COOLING IS BY CONDUCTION.
MODERATOR	GRAPHITE BERYLLIUM REFLECTOR
FUEL MATERIAL	URANIUM CARBIDE, PIE-SHAPED SEGMENTS
FUEL GEOMETRY	GRAPHITE BOXES OR DISHES LOADED WITH URANIUM CARBIDE. 20 CM. DIA.
FUEL CLADDING	FUEL IS NOT COATED, NOT BONDED TO BOXES OR DISCS.
FUEL ENRICH.	90 PER CENT U-235
FUEL ASSEMBLY	STACKED-DISH ELEMENTS IN A GRAPHITE LINER, FORMING A CYLINDER APPROX. 2 IN. HIGH, 11 BOXES OR DISHES/CORE
FUEL CHARGE	49 KG. ENRICHED URANIUM
NEUTRON FLUX	TOTAL, CORE CENTER 1×10^{13} TOTAL, CORE BOUNDARY 7×10^{12}
CONTROL	BORON-SS NEUTRON ABSORBER, BERYLLIUM ALLOY NEUTRON REFLECTOR RODS
CONTAINMENT	LEAK-TIGHT VESSEL CONTAINING HELIUM ATMOSPHERE, COVER IS WATER-COOLED
REMARKS	THERMOELECTRIC CONVERSION IS BY MEANS OF SILICON- GERMANIUM THERMOCOUPLES CONNECTED TO THE REFLECTOR IN SERIES AND IN PARALLEL. HEAT DISSIPATION IS BY COPPER COOLING FINS AT THE COLD JUNCTIONS OF THE CONVERTERS. OPERATING TEMPERATURES ARE 3452 F IN THE FUEL AND 1650 F AT THE CONVERTER. REACTOR HAS

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF03

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NO MOVING COOLANT AND NO MOVABLE PARTS. ROMASHKA
REPORTEDLY HAS OPERATED AS A COMPLETE SYSTEM FOR
500 OR MORE HOURS.

REFERENCES

ROMASHKA IN PERSPECTIVE.

SD STRAUSS

NUCLEONICS 22 /12/, 68-70 /DEC. 1964/

HIGH TEMPERATURE DIRECT CONVERSION REACTOR
ROMASHKA.

MD MILLIONSHCHIKOV, OTHERS

3RD, UN INTL. CONF PEACEFUL USES ATOMIC ENERGY,
GENEVA, 1964, A /CONF.28/P/873,

NUCLEAR REACTORS IN THE SOVIET UNION.

REPORT OF RECIPROCAL EXCHANGE TRIP TO USSR BY
US ATOMIC SCIENTISTS, DEC, 11-22, 1964
WASH-1060

HIGH TEMPERATURE REACTOR-CONVERTER ROMASHKA

MD MILLIONSHCHIKOV, OTHERS

SOVIET ATOMIC ENERGY 17, 1071-77 /NOV. 1964/

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF04

* * * * *

NAME/OWNER BETA-1/USSR

DESIGNER USSR

OPERATOR USSR

LOCATION NEAR MOSCOW, REMOTE INSTALLATIONS, USSR.

PURPOSE AUXILIARY POWER, UNATTENDED OPERATION.

TYPE ISOTOPE SYSTEM

CRITICAL 1964

FUEL MATERIAL CERIUM-144

REMARKS AN AUTOMATIC ISOTOPE-POWERED WEATHER STATION
REPORTEDLY HAS COMPLETED A YEARS OPERATION
WITHOUT MAINTENANCE NEAR MOSCOW. MANY OF THE
DEVICES ARE SAID TO BE INSTALLED IN REMOTE
WEATHER STATIONS.
BETA-2 IS FUELED WITH STRONTIUM-90
MIG-67 IS AN IMPROVED VERSION OF BETA-3 AND IS
FUELED WITH PLUTONIUM-238

REFERENCES NEWS RELEASES.

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NUCLEAR AUXILIARY POWER SYSTEMS, FOREIGN

JF05

* * * * *

NAME/OWNER ITR /IN-CORE THERMIONIC REACTOR/
BUNDEMINISTERIUM FUR WISSENSCHAFTLICHE

DESIGNER INTERATOM, BROWN-BOVERI, SIEMENS /W. GERMANY/
FORSCHUNG /BMW F/, W. GERMANY

PURPOSE POWER SOURCE, POSSIBLY TV AND COMMUNICATION
SATELLITIES

TYPE LIQUID METAL COOLED REACTOR, SNAP-TYPE
COMPACT SYSTEM

POWER MWE(MWT) 20 KW

CRITICAL DESIGN
TEST INSTALLATION AT JUELICH
PROTOTYPE CONSTRUCTION PLANNED

COOLANT SODIUM

MODERATOR URANIUM AND ZIRCONIUM HYDRIDE CONSIDERED

FUEL MATERIAL URANIUM METAL HYDRIDE

FUEL GEOMETRY RODS

FUEL CLADDING MOLYBDEN TUBES COATED WITH TUNGSTEN

FUEL ENRICH. HIGH

FUEL ASSEMBLY 19 FUEL RODS/CORE
RODS WHICH PRODUCE CURRENT ARE PACKED AROUND
THE OUTSIDE
CORE IS 45 CM. LONG, 35 CM. DIAM.
EACH FUEL TUBE SURROUNDED BY INSULATED
CYLINDER COOLED BY LIQUID SODIUM TO 650 C.

CONTROL ADJUSTMENT OF BERYLLIUM REFLECTOR ELEMENTS.

COOLANT TEMP. INLET 610 C OUTLET 650 C

REFERENCES SECOND INTERNATIONAL CONFERENCE ON THERMIONIC
ELECTRIC POWER GENERATION, STRESA, ITALY, MAY 1968
REVIEW OF PAPERS,
NUCLEAR ENG. 13, 677-8 /AUG. 1968/

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NUCLEAR AUXILIARY POWER SYSTEMS. FOREIGN

JF06

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NAME/OWNER TI HEAT PIPE REACTOR/ISPRA, ITALY

TYPE LIQUID METAL COOLED REACTOR, SNAP-TYPE
 THERMIONIC CONVERSION

POWER MWE(MWT) 30-100 KW

COOLANT LITHIUM
 HEAT-PIPE, RADIATIVE HEAT TRANSFER

FUEL MATERIAL URANIUM CARBIDE AND 30 PER CENT ENRICHED ZIRCONIUM

CONTROL MOVABLE REFLECTOR SEGMENTS

REMARKS CONVERTERS ARE MOUNTED IN LITHIUM HEAT PIPES IN
 CROSSED LAYERS OUTSIDE THE REFLECTORS ON 4 SIDES
 OF THE CUBE-SHAPED CORE.

REFERENCES SECOND INTERNATIONAL CONFERENCE ON THERMIONIC
 ELECTRIC POWER GENERATION, STRESA, ITALY, MAY 1968
 REVIEW OF PAPERS.
 NUCLEAR ENG. 13, 678 /AUG, 1968/-PAPER B-8

PAGINATION IS BY THE ALPHA-NUMERIC CODE
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