BNWL-936
VOL. 1

3-

POWER REACTOR DESIGNS
AN ANNOTATED BIBLIOGRAPHY

VOLUME 1

GLOSSARY, SECTIONS AD—EF

JANUARY, 1969

AEC RESEARCH & DEVELOPMENT REPORT

BATTELLE NORTHWEST
BATTELLE MEMORIAL INSTITUTE · PACIFIC NORTHWEST LABORATORY
BATTELLE BOULEVARD, P. O. BOX 999, RICHLAND, WASHINGTON 99352

BNWL-936

LEGAL NOTICE

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

AEC-RL RICHLAND, WASH.

BNWL-936 VOL1

UC-80, Reactor
Technology

POWER REACTOR DESIGNS
An Annotated Bibliography

Compiled by
E. R. Appleby
Technical Information

January 1969

BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON 99352

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy $3.00; Microfiche $0.65

NOTE: This document is three-hole punched so that it may be placed in a three-ring binder.

TABLE OF CONTENTS

INTRODUCTION

This Report is a complete revision of BNWL-326, an annotated bibliography of power and heat reactor design studies, produced by computer printout of information available as of December 1968. The computer program will permit frequent up-dating of the information and periodic publication of revisions. The program will also permit subject searches and the preparation of bibliographies from the stored information.

Sections of the Bibliography group the designs into broad reactor types, as listed in the Table of Contents. Each design is given an alpha-numeric code. Pagination follows this alpha-numeric order, with the reactor code number appearing at the upper right hand corner of each page. Tabs are provided for locating the sections.

BNWL-326 and revisions may be discarded.

GLOSSARY

AND

ADDRESSES

* * * * * * * * * * * * * * * * *

AC	ALLIS-CHALMERS MANUFACTURING CO. NUCLEAR POWER DEPT. 6935 ARLINGTON ROAD BETHESDA, MARYLAND 20014 FORMERLY NUCLEAR PRODUCTS ERCO DIV. ACF
ACF	ACF INDUSTRIES NUCLEAR PRODUCTS - ERCO DIVISION DIVISION ACQUIRED BY ALLIS-CHALMERS IN 1959
AEC	U.S. ATOMIC ENERGY COMMISSION WASHINGTON 25, D.C.
AEP	AMERICAN ELECTRIC POWER CO. 2 BROADWAY NEW YORK, N.Y. 10004
AEPSCO	AMERICAN ELECTRIC POWER SERVICE CORP. SUBSIDIARY, AMERICAN ELECTRIC POWER CO.
AGN	AEROJET-GENERAL NUCLEONICS SUBSIDIARY OF AEROJET-GENERAL CORPORATION P.O. BOX 78 SAN RAMON, CALIF. 94583
AI	ATOMICS INTERNATIONAL DIV. NORTH AMERICAN AVIATION INC. 8900 DE SOTO AVE. CANOGA PARK, CALIF. 91304 AFFILIATED WITH INTERATOM, DANATOM
AIRESEARCH	AIRESEARCH MANUFACTURING CO. DIV. GARRETT CORP. 402 S. 36TH ST. PHOENIX, ARIZ. 85034
ALCO	ALCO PRODUCTS INC. NUCLEAR PROJECTS DEPT. 220 SCHENECTADY, N.Y.
AMES	AMES INSTITUTE FOR ATOMIC RESEARCH IOWA STATE UNIVERSITY AMES, IOWA 50010
AMF	AMF ATOMICS

* * * * * * * * * * * * * * * * *

	DIV. AMERICAN MACHINE + FOUNDRY CO. 140 GREENWICH AVE. GREENWICH, CONN. 06830
AMSTAN	AMERICAN STANDARD CORP. DIV. AMERICAN RADIATOR AND STANDARD SANITARY CORP. 1682 BROADWAY REDWOOD CITY, CALIF. 94063 ADVANCED TECHNOLOGY LABORATORIES 369 WHISMAN ROAD MOUNTAIN VIEW, CALIF. 94040
ANL	ARGONNE NATIONAL LABORATORY 9700 SOUTH CASS AVE. ARGONNE, ILL. 60439
APDA	ATOMIC POWER DEVELOPMENT ASSOCIATES, INC. 1911 FIRST STREET DETRIOT, MICHIGAN 48226 UTILITIES GROUP
ARDA	ADVANCED REACTOR DEVELOPMENT ASSOCIATES UTILITIES GROUP PUBLIC SERVICE COMPANY OF COLORADO DENVER, COLORADO
ARKANSAS P+L	ARKANSAS POWER + LIGHT CO. 9-TH AND LOUISIANA STS. LITTLE ROCK, ARK. 72203 SUBSID. MIDDLE SOUTH UTIL. INC.
ARMOUR	ARMOUR RESEARCH FOUNDATION SEE IITRI 10 W. 35TH STREET CHICAGO 6, ILLINOIS
ASDA	ATOMIC AND SPACE DEVELOPMENT AUTHORITY STATE OF NEW YORK
ASTRA	ASTRA INC. BOX 266 RALEIGH, N.C.
ATL	ADVANCED TECHNOLOGY LABORATORIES AMERICAN STANDARD CORPORATION 369 WHISMAN ROAD MOUNTAIN VIEW, CALIF. 94040
ATLANTIC CITY	ATLANTIC CITY ELECTRIC CO.

	1600 PACIFIC AVE. ATLANTIC CITY, N.J. 08404 MEMBER DELAWARE VALLEY UTIL.
BALTIMORE G+E	BALTIMORE GAS + ELECTRIC CO. GAS + ELECTRIC BUILDING BALTIMORE, MD. 21203
BAR	BURNS AND ROE INC. 700 KINDERKAMACK ROAD ORADELL, N.J. 07649
BAW	BABCOCK AND WILCOX ATOMIC ENERGY DIVISION P.O. BOX 1260 LYNCHBURG, VIRGINIA
BECHTEL	BECHTEL CORPORATION 220 BUSH STREET SAN FRANCISCO, CALIF. 94119
BMI	BATTELLE MEMORIAL INSTITUTE COLUMBUS, OHIO
BNL	BROOKHAVEN NATIONAL LABORATORY UPTON, LONG ISLAND, N.Y.
BOSTON ED	BOSTON EDISON COMPANY 800 BOYLSTON ST. BOSTON, MASS. 02199
CALRD	CALIFORNIA RESEARCH AND DEVELOPMENT CO. LIVERMORE RESEARCH LABORATORY LIVERMORE, CALIF.
CAROLINA P-L	CAROLINA POWER + LIGHT CO. 336 FAYETTVILLE ST. RALEIGH, N.C. 27602
CATALYTIC	CATALYTIC CONSTRUCTION COMPANY 1528 WALNUT STREET PHILADELPHIA, PENNA. 19102
CDWR	CALIFORNIA DEPT. OF WATER RESOURCES
CE	COMBUSTION ENGINEERING INC. NUCLEAR DIVISION PO BOX 500 WINDSOR, CONNECTICUT 06095 ACQUIRED GENERAL NUCLEAR ENGINEERING
CENTRAL HUDSON	CENTRAL HUDSON GAS + ELECTRIC CO.

* * * * * * * * * * * * * * * * *

	SOUTH ROAD POUGHKEEPSIE, N.Y. 12602
CENTRAL IOWA	CENTRAL IOWA POWER COOPERATIVE PO BOX 389 MARION, IOWA 52302
CENTRAL UTILITIES	CENTRAL UTILITIES ATOMIC POWER ASSOCIATES 10-UTILITY GROUP
CLEVELAND ELECTRIC	CLEVELAND ELECTRIC ILLUMINATING CO. PO BOX 5000 CLEVELAND, OHIO 44101
COM/ED	COMMONWEALTH EDISON COMPANY 72 WEST ADAMS ST. CHICAGO, ILL. 60690
CON/ED	CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. 4 IRVING PLACE NEW YORK, NEW YORK 10003
CONNECTICUT L+P	CONNECTICUT LIGHT + POWER CO. PO BOX 2010 HARTFORD, CONNECTICUT 06101
CONNECTICUT YANKEE	CONNECTICUT YANKEE ATOMIC POWER CO. PO BOX 2010 HARTFORD, CONNECTICUT 06101
CONSUMERS POWER	CONSUMERS POWER CO. 212 W. MICHIGAN AVE. JACKSON, MICHIGAN 49201
CONSUMERS PUBLIC	CONSUMERS PUBLIC POWER DISTRICT OF NEBRASKA 1452 TWENTY-FIFTH AVE. COLUMBUS, NEBRASKA 68601
CORN BELT	CORN BELT POWER COOPERATIVE 1300 THIRTEENTH ST. HUMBOLDT, IOWA 50548
CVNPA	CAROLINAS VIRGINIA NUCLEAR POWER ASSOC. INC. SOUTH CAROLINA ELECTRIC + GAS CO. PO BOX 390 COLUMBIA, SOUTH CAROLINA
DAIRYLAND	DAIRYLAND POWER COOPERATIVE 2615 EAST AVE. S. LA CROSSE, WIS. 54601

* * * * * * * * * * * * * * * * *

DDL	DONALD W. DOUGLAS LABORATORIES RICHLAND, WASH. 99352
DELAWARE VALLEY	DELAWARE VALLEY UTILITIES PUBLIC SERVICE-ELECTRIC AND GAS, N.J. PHILADELPHIA ELECTRIC CO. DELMARVA POWER AND LIGHT CO. ATLANTIC CITY ELECTRIC CO.
DELMARVA	DELMARVA POWER + LIGHT CO. OF MARYLAND SALISBURY, MD. 21801 MEMBER, DELAWARE VALLEY UTILITIES
DETROIT/ED	DETROIT EDISON CO. 2000 SECOND AVE. DETROIT, MICH. 48226
DOD	DEPARTMENT OF DEFENSE USA
DOUGLAS	DOUGLAS AIRCRAFT MISSILE AND SPACE SYSTEMS DIV. 5301 BOLSA AVENUE HUNTINGTON BEACH, CALIFORNIA 92646
DOW	DOW CHEMICAL CO. MIDLAND, MICH. 48640
DUKE	DUKE POWER COMPANY 422 S. CHURCH ST. CHARLOTTE, N.C. 28202
DUN	DOUGLAS UNITED NUCLEAR INC. FEDERAL BLDG. RICHLAND, WASHINGTON 99352
DUPONT	E.I. DU PONT DE NEMOURS AND CO., INC. 1007 MARKET ST. WILMINGTON, DEL. 19898
DUQUESNE	DUQUESNE LIGHT COMPANY 435 6-TH AVE. PITTSBURGH, PENNA. 15219
ECFWCNG	EAST CENTRAL FLORIDA WEST COAST NUCLEAR GROUP FLORIDA WEST COAST GROUP 101 SOUTH 5TH STREET ST. PETERSBURG, FLA. 33701
ECNG	EAST CENTRAL NUCLEAR GROUP

* * * * * * * * * * * * * * * * *

UTILITIES GROUP

ESADA	EMPIRE STATE ATOMIC DEVELOPMENT ASSOC. INC. 4 IRVING PLACE NEW YORK 3, NEW YORK
EUGENE W+E	EUGENE WATER + ELECTRIC BOARD 500 4-TH AVE. EAST EUGENE, OREGON 97401
FAIRCHILD	FAIRCHILD ENGINE AND AIRPLANE CORP. NEPA DIVISION OAK RIDGE, TENN. 37830
FICO	FORD INSTRUMENT COMPANY DIVISION SPERRY RAND CORP. 31-10 THOMSON AVE. LONG ISLAND CITY, N.Y. 11101
FITCHBURG G+E	FITCHBURG GAS + ELECTRIC CO. 655 MAIN ST. FITCHBURG, MASS. 01420
FLORIDA P-L	FLORIDA POWER AND LIGHT COMPANY PO BOX 3100 MIAMI, FLORIDA 33101
FLORIDA POWER	FLORIDA POWER CORPORATION 101 FIFTH ST. SOUTH ST. PETERSBURG, FLA. 33701
FLUOR	FLUOR CORPORATION LTD. 2500 S. ATLANTIC BLVD. LOS ANGELES, CALIF. 90022
FW	FOSTER WHEELER CORP. 110 S. ORANGE AVE. LIVINGSTON, N.J. 07039
FWCNG	FLORIDA WEST COAST NUCLEAR GROUP FLORIDA POWER CORPORATION FLORIDA POWER AND LIGHT COMPANY TAMPA ELECTRIC COMPANY
GA	SEE GGA
GD	GENERAL DYNAMICS CORPORATION GENERAL ATOMICS DIVISION SAN DIEGO, CALIF. GENERAL ATOMICS DIV. HAS BEEN BOUGHT BY

* * * * * * * * * * * * * * * * *

GULF OIL CO. SEE GGA.

GE	GENERAL ELECTRIC COMPANY ATOMIC POWER EQUIPMENT DEPT. 2151 FIRST ST. SAN JOSE, CALIF. 95112
GEORGIA POWER	GEORGIA POWER COMPANY 210 PEACHTREE ST. ATLANTA, GA. 30303 SUBSIDIARY SOUTHERN CO. SYSTEM.
GGA	GULF GENERAL ATOMIC COMPANY GULF OIL CORPORATION PITTSBURGH, PENNA FORMERLY GEN. ATOMICS DIV. GEN. DYNAMICS
GIC	GENERAL INSTRUMENT CORPORATION 65 GOVERNEUR STREET NEWARK, N.J. 07104
GILBERT	GILBERT ASSOCIATES INC. 525 LANCASTER AVE. READING, PENNA. 19603
GM	GENERAL MOTORS CORPORATION ALLISON DIVISION INDIANAPOLIS 6, INDIANA
GNEC	GENERAL NUCLEAR ENGINEERING CORP. DIVISION COMBUSTION ENGINEERING
GOLDEN VALLEY	GOLDEN VALLEY ELECTRIC ASSOCIATION 758 ILLINOIS ST. FAIRBANKS, ALASKA 99701
GPU	GENERAL PUBLIC UTILITIES CORPORATION 80 PINE ST. NEW YORK, N.Y. 10005
HERC	HERCULES INCORPORATED HERCULES TOWER 910 MARKET ST. WILMINGTON, DEL. 19899
HITTMAN	HITTMAN ASSOCIATES INC. 4715 E. WABASH AVENUE BALTIMORE, MARYLAND 21215
HTRDA	HIGH TEMPERATURE REACTOR DEVELOPMENT ASSOC.

	89 EAST AVE. ROCHESTER, NEW YORK 14604
IITRI	ILLINOIS INST. TECHNOLOGY RES. INST. 10 W. 35 STREET CHICAGO, ILL. 60016
INDIANA-MICHIGAN	INDIANA AND MICHIGAN ELECTRIC COMPANY PO BOX 18 BOWLING GREEN STATION, N.Y. 10004 SUBSIDIARY OF AEP
INTERNUC	INTERNUCLEAR CO. 7 NORTH BRENTWOOD BLVD. CLAYTON, MO. 63105
IOWA ELECTRIC	IOWA ELECTRIC LIGHT AND POWER COMPANY 206 E. SECOND ST. DAVENPORT, IOWA 52808
IOWA-ILLINOIS	IOWA-ILLINOIS GAS AND ELECTRIC CO. 206 E. SECOND ST. DAVENPORT, IOWA 52808
JERSEY CENTRAL	JERSEY CENTRAL POWER AND LIGHT CO. MADISON AVE. AT PUNCH BOWL RD. MORRISTOWN, N.J. 07960
JPL	JET PROPULSION LABORATORY CALIF. INST. TECHNOLOGY 4800 OAK GROVE DRIVE PASADENA, CALIF. 91103
KANSAS G-E	KANSAS GAS + ELECTRIC CO. 201 N. MARKET ST. WICHITA, KANSAS 67201
KE	KAISER ENGINEERS DIVISION HENRY J. KAISER CO. KAISER CENTER OAKLAND, CALIF. 94612
KIDDE	WALTER KIDDE NUCLEAR LABORATORIES GARDEN CITY, N.Y. 11530
LADWP	LOS ANGELES DEPARTMENT OF WATER AND POWER PO BOX 111 LOS ANGELES, CALIFORNIA 90054
LAMONT	LAMONT GEOPHYSICAL OBSERVATORY

* * * * * * * * * * * * * * * * * *

	COLUMBIA UNIVERSITY PALISADES, N.Y. 10964
LASL	LOS ALAMOS SCIENTIFIC LABORATORY P.O. BOX 1663 LOS ALAMOS, N.M. 87544
LEWIS RESEARCH	LEWIS RESEARCH CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CLEVELAND, OHIO
LILCO	LONG ISLAND LIGHTING CO. 250 OLD COUNTRY RD. MINEOLA, NEW YORK 11501
LOCKHEED	LOCKHEED MISSILES AND SPACE COMAPNY DIVISION OF LOCKHEED AIRCRAFT CORPORATION SUNNYVALE, CALIF.
LRL	LAWRENCE RADIATION LAB. UNIV. CALIF. LIVERMORE, CALIF.
MA	MARITIME ADMINISTRATION USA
MADISON G+E	MADISON GAS AND ELECTRIC COMPANY 100 N. FAIRCHILD ST. MADISON, WIS. 53701
MAINE YANKEE	MAINE YANKEE ATOMIC POWER CO. 9 GREEN ST. AUGUSTA, MAINE 04330 UTILITY GROUP
MAPP	MID-CONTINENT AREA POWER PLANNERS 50 UTILITIES FROM MINNESOTA, WISCONSIN, IOWA, NEVADA, MONTANA, THE DAKOTAS
MARQ	MARQUARDT CORPORATION NUCLEAR SYSTEMS DIVISION 16555 SATICOY STREET VAN NUYS, CALIF. 91406
MARTIN	MARTIN-MARIETTA CORPORATION NUCLEAR DIVISION BALTIMORE, MD. 21203 MARTIN-MARIETTA NUCLEAR DIV. HAS BEEN ACQUIRED BY ISOTOPES, SUBSID. OF NUCLEAR SYSTEMS DIV., TELEDYNE

* * * * * * * * * * * * * * * * *

	CORP.
MET-ED	METROPOLITAN EDISON COMPANY 2800 POTTSVILLE PIKE READING, PENNA. 19603 SUBSIDIARY GENERAL PUBLIC UTILITIES
MONSANTO	MONSANTO CHEMICAL COMPANY 800 N. LINDBERGH BLVD. ST. LOUIS, MO. 63166
MWD	METROPOLITAN WATER DISTRICT OF S. CALIFORNIA
NAA	NORTH AMERICAN AVIATION ATOMICS INTERNATIONAL DIV.
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION 400 MARYLAND AVE. SW WASHINGTON, D.C.
NDA	NUCLEAR DEVELOPMENT CORPORATION OF AMERICA SEE UNITED NUCLEAR CORP.
NEE	NEW ENGLAND ELECTRIC SYSTEM 441 STUART ST. BOSTON, MASS. 02116
NEW HAMPSHIRE	NEW HAMPSHIRE PUBLIC SERVICE COMPANY
NIAGARA MOHAWK	NIAGARA MOHAWK POWER CORP. 300 ERIE BLVD. WEST SYRACUSE, NEW YORK 13202
NIPSCO	NORTHERN INDIANA PUBLIC SERVICE CO. 5265 HOHMAN AVE. HAMMOND, INDIANA 46325
NPG	NUCLEAR POWER GROUP CHICAGO, ILLINOIS 8-COMPANY GROUP
NRDS	NUCLEAR ROCKET DEVELOPMENT STATION JACKASS FLATS, NEVADA
NRTS	NATIONAL REACTOR TEST STATION IDAHO FALLS, IDAHO
NSP	NORTHERN STATES POWER CO. 414 NICOLLET MALL MINNEAPOLIS, MINN. 55401

* * * * * * * * * * * * * * * * *

NTS	NEVADA TEST SITE JACKASS FLATS, NEVADA
NUMEC	NUCLEAR MATERIALS AND EQUIPMENT CORPORATION N. SEVENTH AND WARREN AVE. APOLLO, PENNA. 15613 SUBSIDIARY ATLANTIC RICHFIELD.
NUTMEG	NUTMEG ELECTRIC COMPANIES ATOMIC PROJECT CONNECTICUT UTILITIES STUDY GROUP HARTFORD ELECTRIC LIGHT UNITED ILLUMINATING CONNECTICUT LIGHT AND POWER
NY STATE	NEW YORK STATE ELECTRIC + GAS CORPORATION ITHACA, N.Y. 14850
OMAHA PUBLIC	OMAHA PUBLIC POWER DISTRICT 1623 HARNEY ST. OMAHA, NEBRASKA 68102
OPPD	SEE OMAHA PUBLIC
ORANGE+ROCKLAND	ORANGE + ROCKLAND UTILITIES INCORPORATED 10 N. BROADWAY NYACK, N.Y. 10960
ORNL	OAK RIDGE NATIONAL LABORATORY OAK RIDGE, TENNESSEE
ORSORT	OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY OAK RIDGE, TENNESSEE
OSW	OFFICE OF SALINE WATER DEPARTMENT OF THE INTERIOR U.S.A.
PENNA P+L	PENNSYLVANIA POWER + LIGHT COMPANY 901 HAMILTON ST. ALLENTOWN, PENNA. 18101
PGE	PACIFIC GAS + ELECTRIC COMPANY 245 MARKET ST. SAN FRANCISCO, CALIF. 94106
PHILADELPHIA	PHILADELPHIA ELECTRIC CO. 1000 CHESTNUT ST. PHILADELPHIA, PENNA. 19105 MEMBER DELAWARE VALLEY UTILITIES
PHILLIPS	PHILLIPS PETROLEUM COMPANY

* * * * * * * * * * * * * * * * *

	BARTLESVILLE, OKLAHOMA 74003
PNPG	PACIFIC NORTHWEST POWER GROUP RICHLAND, WASHINGTON 99352
PNWL	BATTELLE MEMORIAL INSTITUTE PACIFIC NORTHWEST LABORATORY PO BOX 999 RICHLAND, WASHINGTON 99352
PORTLAND GE	PORTLAND GENERAL ELECTRIC COMPANY 621 SW ALDER ST. PORTLAND, OREGON 97205
PRDC	POWER REACTOR DEVELOPMENT COMPANY 1911 FIRST STREET DETROIT, MICHIGAN 48226 UTILITIES GROUP
PRWRA	PUERTO RICO WATER RESOURCES AUTHORITY PO BOX 4267 SAN JUAN, PUERTO RICO
PSCC	PUBLIC SERVICE COMPANY OF COLORADO PO BOX 840 DENVER, COLORADO 80201
PUBLIC SERVICE-NH	PUBLIC SERVICE CO. OF NEW HAMPSHIRE 1087 ELM ST. MANCHESTER, N.H. 03105
PUBLIC SERVICE-NJ	PUBLIC SERVICE ELECTRIC + GAS, NEW JERSEY 80 PARK PLACE NEWARK, N.J. 07101 MEMBER DELAWARE VALLEY UTILITIES
PWAC	PRATT AND WHITNEY AIRCRAFT DIVISION OF UNITED AIRCRAFT EAST HARTFORD, CONNECTICUT
RCA	RADIO CORPORATION OF AMERICA 30 ROCKFELLER PLAZA NEW YORK, N.Y. 10020
RCPA	RURAL COOPERATIVE POWER ASSOC. HIGHWAY 10 S.E. ELK RIVER, MINNESOTA 55330
ROCHESTER G-E	ROCHESTER GAS AND ELECTRIC CORPORATION 89 EAST AVENUE

	ROCHESTER, NEW YORK 14604
RRC	ROYAL RESEARCH CORPORATION HAYWARD, CALIF.
S CAL ED	SOUTHERN CALIFORNIA EDISON CO. PO BOX 351 LOS ANGELES, CALIFORNIA 90053
SAEA	SOUTHWEST ATOMIC ENERGY ASSOCIATES 306 PYRAMID BUILDING LITTLE ROCK, ARKANSAS 72201 UTILITIES GROUP
SAL	SARGENT + LUNDY 140 S. DEARBORN STREET CHICAGO, ILL. 60603
SAN DIEGO G+E	SAN DIEGO GAS + ELECTRIC CO. 861 SIXTH AVE. SAN DIEGO, CALIF. 92112
SAP	SANDERSON + PORTER 72 WALL STREET NEW YORK 5, N.Y.
SMUD	SACRAMENTO MUNICIPAL UTILITY DISTRICT SACRAMENTO, CALIF.
SNEC	SAXTON NUCLEAR EXPERIMENT CORPORATION PO BOX 542 READING, PENNA. 18501 SUBSIDIARY GENERAL PUBLIC UTILITIES
SNPO	SPACE NUCLEAR PROPULSION OFFICE U.S. ATOMIC ENERGY COMMISSION NATIONAL AERONAUTICS AND SPACE ADMIN.
SOUTHERN CO	SOUTHERN COMPANY 3390 PEACHTREE ROAD ATLANTA, GA. 30326
STL	SPACE TECHNOLOGY LABORATORIES INC. THOMPSON RAMO WOOLRIDGE INC. REDONDO BEACH, CALIF.
STUD	STUDEBAKER-PACKARD CORPORATION 635 S. MAIN STREET SOUTH BEND, IND. 46627
TAMPA ELECTRIC	TAMPA ELECTRIC COMPANY

* * * * * * * * * * * * * * * * *

	111 N. DALE MABRY HIGHWAY TAMPA, FLA. 33609
THIOKOL	THIOKOL CHEMICAL CORPORATION NEWPORTVILLE-FALSINGTON RD. BRISTOL, PENNA. 19007
TOLEDO ED	TOLEDO EDISON COMPANY 420 MADISON AVE. TOLEDO, OHIO 43601
TRG	TECHNICAL RESEARCH GROUP 17 UNION SQUARE WEST NEW YORK, N.Y. 10003
TRW	TRW SPACE TECHNOLOGY LABORATORIES ONE SPACE PARK REDONDO BEACH, CALIF. 90278 THOMPSON RAMO WOOLRIDGE
TVA	TENNESSEE VALLEY AUTHORITY NEW SPRANKLE BLDG. KNOXVILLE, TENNESSEE 37902
UAC	UNITED AIRCRAFT CORP. 400 MAIN ST. EAST HARTFORD, CONN. 06108
UCRL	UNIV. CALIF. RADIATION LAB. LIVERMORE, CALIF.
UNC	UNITED NUCLEAR CORPORATION GRASSLANDS ROAD ELMSFORD, N.Y. 10523
UNITED ILLUM	UNITED ILLUMINATING COMPANY 80 TEMPLE ST. NEW HAVEN, CONN. 06510
USAF	UNITED STATES AIR FORCE
USBM	UNITED STATES BUREAU OF MINES WASHINGTON 25, D.C.
USN	U.S. NAVY
VEPCO	VIRGINIA ELECTRIC + POWER CO. 700 E. FRANKLIN ST. RICHMOND, VA. 23219
VERMONT YANKEE	VERMONT YANKEE NUCLEAR POWER CORPORATION

* * * * * * * * * * * * * * * * *

	77 GROVE ST. RUTLAND, VERMONT 05701 10-UTILITY GROUP
VITRO	VITRO CORPORATION OF AMERICA 90 PARK AVENUE NEW YORK, NEW YORK 10016
WEPCO	WISCONSIN ELECTRIC POWER COMPANY 231 W. MICHIGAN ST. MILWAUKEE, WIS. 53201
WEST	WESTINGHOUSE ELECTRIC CORPORATION BETTIS ATOMIC POWER LABORATORY P.O. BOX 1468 PITTSBURGH, PENNA. 15230
WMPCO	WISCONSIN MICHIGAN POWER COMPANY 231 WEST MICHIGAN ST. MILWAUKEE, WISCONSIN 53201 SUBSIDIARY WEPCO
WP+L	WISCONSIN POWER + LIGHT COMPANY 122 W. WASHINGTON ST. MADISON, WIS. 53701
WPPSS	WASHINGTON PUBLIC POWER SUPPLY SYSTEM 130 VISTA WAY PO BOX 166 KENNEWICK, WASHINGTON 99336
WPS	WISCONSIN PUBLIC SERVICE CORPORATION 1029 N. MARSHALL ST. MILWAUKEE, WIS. 53201
YAEC	YANKEE ATOMIC ELECTRIC COMPANY 441 STUART ST. BOSTON, MASS. 02116
YANKEE-DIXIE	YANKEE-DIXIE POWER CO. NORTH CAROLINA-VIRGINIA
3M	MINNESOTA MINING AND MANUFACTURING COMPANY NUCLEAR RESEARCH DEPT. 2501 HUDSON ROAD ST. PAUL, MINN. 55101

* * * * * * * * * * * * * * * * *

ARGENTINA

CNEA COMISION NACIONAL DE ENERGIA ATOMICA
BUENOS AIRES, ARGENTINA

SEGMA SEGMA POWER COMPANY
ARGENTINA

AUSTRALIA

AAEC AUSTRALIAN ATOMIC ENERGY COMMISSION
45 BEACH STREET
COOGEE
NEW SOUTH WALES, AUSTRALIA

AUSTRIA

OBRFA OSTERREICHISCHE BERATENDE
REGIERUNGSKOMMISSION FUR FRAGEN
DER ATOMENERGIE
3 HOHENSTAUFENGASSE
VIENNA 1, AUSTRIA

SGAE AUSTRIAN ATOMIC ENERGY STUDY GROUP
VIENNA, AUSTRIA

BELGIUM

ACEC ATELIERS DE CONSTRUCTIONS
ELECTRIQUES DE CHARLEROI S.A.
ATOMIC ENERGY DIVISION
AVENUE E. ROUSSEAU
CHARLEROI, BELGIUM
ASSOCIATED COMPANIES,
WESTINGHOUSE /U.S./
FRAMATOME /FRANCE/

BELGONUC SOCIETE BELGE POUR L INDUSTRIE
NUCLEAIRE S.A. /BELGONUCLEAIRE/
35 RUE DES COLONIES
BRUSSELS, BELGIUM

CEA COMMISSARIAT A L ENERGIE ATOMIQUE
8 RUE DE LA LOI
BRUSSELS, BELGIUM

CEN CENTRE D ETUDE DE L ENERGIE NUCLEAIRE

* * * * * * * * * * * * * * * * *

BRUSSELS, BELGIUM

CENTRATOME	SOCIETE REUNIES D-ENERGIE DU BASSIN DE L-ESCANT /EBES/ SOCIETE INTERCOMMUNALE BELGE DE GAZ ET D-ELECTRICITE /INTERCOM/
EBES	SOCIETE REUNIES D-ENERGIE DU BASSIN DE L-ESCAUT 31 RUE DE LA SCIENCE BRUSSELS 4, BELGIUM
INTERCOM	SOCIETE INTERCOMMUNALE BELGE DE GAZ ET D-ELECTRICITE 1 PLACE DU TRONE BRUSSELS, BELGIUM
TRACTION-ELEC	TRACTION ET ELECTRICITE BELGIUM

BRAZIL

CNEN	COMISSAO NACIONAL DE ENERGIA NUCLEAR 350 AVENIDA MARECHAL CAMARA RIO DE JANEIRO, BRAZIL

CANADA

AECL	ATOMIC ENERGY OF CANADA, LTD. P.O. BOX 711 OTTAWA, ONTARIO, CANADA
CGE	CANADIAN GENERAL ELECTRIC COMPANY, LTD. 107 PARK STREET PETERBOROUGH, ONTARIO, CANADA
HYDRO-QUEBEC	QUEBEC HYDRO-ELECTRIC COMMISSION 75 DORCHESTER BLVD. WEST MONTREAL, QUEBEC, CANADA
ONTARIO-HYDRO	HYDRO-ELECTRIC COMMISSION BOX 113 CHALK RIVER, ONTARIO, CANADA
WEST-CAN	CANADIAN WESTINGHOUSE INTERNATIONAL CO. LTD BOX 510 HAMILTON, ONTARIO, CANADA

* * * * * * * * * * * * * * * * *

CHINA

CHINA	CHINESE DEMOCRATIC REPUBLIC ACADEMIA SINICA PEKING, CHINA COMMITTEE OF NUCLEAR SCIENCE

CZECHOSLOVAKIA

NEA	MINISTRY OF POWER NUCLEAR ENERGY ADMINISTRATION JUNGMANNOVA 29 PRAGUE 2, CZECHOSLOVAKIA

DENMARK

DAEC	DANISH ATOMIC ENERGY COMMISSION CHRISTIANSBORG RIDEBANE 10 COPENHAGEN K, DENMARK
DANATOM	DANISH ASSOCIATION FOR INDUSTRIAL DEVELOPMENT OF ATOMIC ENERGY STRANDVEJEN 102 HELLERUP /NEAR COPENHAGAN/, DENMARK

EAST GERMANY

AKK	GERMAN DEMOCRATIC REPUBLIC /EAST GERMANY/ AMT FUR KERNFORSCHUN UND KERNTECHNIK SCHNELLERSTRASSE 1-5 BERLIN-NIEDERSCHONEWIEDE GERMAN DEMOCRATIC REPUBLIC
ATOMKRAFTWERK NORD	ATOMKRAFTWERK NORD EAST GERMANY /GERMAN DEMOCRATIC REPUBLIC/

FINLAND

IMATRAN	IMITRAN VOIMA OY STATE-OWNED POWER COMPANY
SUOMEN	SUOMEN VESIVOIMEN LIITO FINNISH HYDROELECTRIC POWER ASSOCIATION
SUOMEN-ATOM	SUOMEN ATOMITEOLLISUUSRHYMA
YDIN VOIMA	YDIN VOIMAHYDISTYS

* * * * * * * * * * * * * * * * *

NUCLEAR POWER CO. LTD.
WILL BE DISSOLVED, MEMBERS TO FORM
STUDY GROUP SANKOYHTYMA /POWER CONCERN/
WITH SUOMEN VESIVOIMEN GROUP.

FORMOSA

AEC	/REPUBLIC OF CHINA/ ATOMIC ENERGY COUNCIL 11 SOUTH CHUNG SHAN ROAD TAIPEI, FORMOSA

FRANCE

ALSTHOM	SOCIETE GENERALE DE CONSTRUCTIONS ELECTRIQUES ET MECANIQUES SERVICES D-ETUDES NUCLEAIRES 20 RUE D-ATHENES 75 PARIS 9E FRANCE
ATEN	ASSOCIATION TECHNIQUE POUR LA PRODUCTION ET L UTILIZATION DE L ENERGIE NUCLEAIRE 26 RUE DE CLICHY PARIS 8, FRANCE
BREVATOME	BREVATOME 25 RUE DE PONTHIEU PARIS 8, FRANCE
CAFL	COMPAGNIE DES ATELIERS ET FORGES DE LA LOIRE 12, RUE DE LA ROCHEFOUCAULD PARIS 9, FRANCE MEMBER OF INDATOM
CEA	COMMISSARIAT A L ENERGIE ATOMIQUE 29-33 RUE DE LA FEDERATION PARIS 7, FRANCE
EDF	ELECTRICITE DE FRANCE 2 RUE LOUIS-MURAT PARIS 8, FRANCE CLAMART /SEINE/, FRANCE
FR-ATOM	FRANCE-ATOME 6 ET 8 BOULEVARD HAUSSMAN

* * * * * * * * * * * * * * * * *

	PARIS 9, FRANCE
GAAA	GROUPEMENT ATOMIQUE ALSACIENNE ATLANTIQUE 20 AVENUE EDCUARD-HERRIOT 92/LE PLESSIS-ROBINSON /SEINE/ FRANCE
INDATOM	INDATOM 48 RUE LA BOETIE PARIS 8, FRANCE 10-COMPANY ORGANIZATION
KUHLMANN	SOCIETE UGINE KUHLMANN 10 RUE DU GENERAL-FOY PARIS 8, FRANCE
PECHINEY	PECHINEY DIV. ENERGIE ET APPLICATIONS ATOMIQUES 23 RUE BALZAC PARIS 8, FRQNCE
SCHNEIDER-CREUSOT	SOCIETE DES FORGES ET ATELIERS DU CREUSOT DEPT. DES ACTIVITES NUCLEAIRES 15 RUE PASQUIER, 75 PARIS 8, FRANCE
SEEN	SOCIETE D-ETUDES ET D-ENTERPRISES NUCLEAIRE 15 RUE PASQUIER PARIS 8, FRANCE
SENA	SOCIEITE D-ENERGIE NUCLEAIRE FRANCO-BELGE DES ARDENNES
SENTA	SOCIETE D-ETUDES NUCLEAIRES ET DE TECHNIQUES AVANCEES 13 RUE DU R. P. CLOAREC, 92 PARIS, FRANCE
SNECMA	SOCIETE NATIONALE D ETUDES ET DE CONSTRUCTION DE MOTEURS D AVIATION DIVISION ATOMIQUE 150 BOULEWARD HAUSMANN PARIS 8, FRANCE ASSOCIATE COMPANY, INDATOM
SOCIA	SOCIETE POUR L-INDUSTRIE ATOMIQUE 48 RUE LA BOETIE, 75 PARIS 8, FRANCE INDATOM AND SEEN
SOCIETE RATEAU	SOCIETE RATEAU

	141 RUE RATEAU 93-LA COURNEUVE, FRANCE
SOGERCA	SOCIETE GENERALE POUR L-ENTERPRISE DE REACTEURS ET DE CENTRALES ATOMIQUES GAAA ALSTHOM

HUNGARY

HUNGARY	NATIONAL ATOMIC ENERGY COMMISSION BUDAPEST, HUNGARY

INDIA

AEC	ATOMIC ENERGY COMMISSION APOLLO PIER ROAD BOMBAY, INDIA

INTERNATIONAL

ENEA	EUROPEAN NUCLEAR ENERGY AGENCY O.E.E.C. 38 BOULEVARD SUCHET PARIS 16, FRANCE
EURATOM	EUROPEAN ATOMIC ENERGY COMMUNITY 51-53 RUE BELLIARD BRUSSELS, BELGIUM
INTER-NUCLEAR	INTER NUCLEAR SA THE NUCLEAR POWER GROUP /UK/ SNAM PROGETTI /ITALY/ GUTEHOFFNUNGSHUETTE /W. GERM./ BELGONUCLEAIRE /BELG./ FORMED TO MARKET HTGR SYSTEMS
IURN	INSTITUT UNIFIE DE RECHERCHES NUCLEAIRES DUBNA, ON VOLGA, USSR
OECD	OECD EUROPEAN NUCLEAR ENERGY AGENCY /ENEA/ 38 BOULEVARD SUCHET PARIS 16, FRANCE OECD HALDEN REACTOR PROJECT PO BOX 173 HALDEN, NORWAY

* * * * * * * * * * * * * * * * *

	OECD HIGH TEMPERATURE REACTOR PROJECT DRAGON ATOMIC ENERGY ESTABLISHMENT WINFRITH, DORCHESTER, ENGLAND
SENA	SOCIETE D-ENERGIE NUCLEAIRE FRANCO-BELGE DES ARDENNES
SYNATOM	FRENCH-BELGIAN COMBINE OPERATION OF TIHANGE STATION

ISRAEL

IAEC	ISRAEL ATOMIC ENERGY COMMISSION P.O. BOX 7056 HAYIRYA TEL-AVIV, ISRAEL
ISRATOM	ISRAEL NUCLEAR ENGINEERING CO., LTD. 6 AHUZAT BAYIT ST. TEL-AVIV, ISRAEL

ITALY

AGIP	AGIP NUCLEARE S.P.A CASELLA POSTALE 4179 MILAN, ITALY
ANSALDO	ANSALDO MECCANIO NUCLEARE RECAPITO ANSALDO 2 PIAZZA CARIGNANO GENOA, ITALY
CISE	CENTRO INFORMAZIONI STUDI EXPERIENZE VIA REDECESIO 12 SEGRATE MILAN, ITALY
CNEN	NATIONAL COMMITTEE FOR NUCLEAR ENERGY /COMITATO NAZIONALE PER L ENGERGIA NUCLEAR/ VIA BELISARIO 15 ROME, ITALY
ENEL	ENTE NAZIONALE PER L-ENERGIA ELLETRICA 181 VIA DEL TRITONE ROME, ITALY
FIAT	FIAT SPA

	SEZIONE ENERGIA NUCLEARE CORSO SETTEMBRINI 23 TURIN, ITALY
MONTECATINI	MONTECATINI ENERGY DEPT. NUCLEAR DIVISION LARGO GUIDO - DONEGANI 1-2 MILAN, ITALY
SELNI	SOCIETA ELETTRONUCLEARE ITALIANA FORO BUONAPARTE 31 MILAN, ITALY
SENN	SOCIETA ELETTRONUCLEARE NAZIONALE VIA TORINO 6 ROME, ITALY
SIMEA	SOCIETA ITALIANA MERIDIONALE ENERGIA ATOMICA VIA S TERESA 35 ROME, ITALY
SNAM-PROGETTI	SNAM PROGETTI S.P.A. 20100 MILAN /PO BOX 4172/ ITALY
SORIN	SOCIETA RICERCHE IMPIANTI NUCLEARI VIA FATEBENEFRATELLI 19 MILAN, ITALY

JAPAN

HOKURIKI	HOKURIKI ELECTRIC POWER COMPANY
AEC	ATOMIC ENERGY COMMISSION OF JAPAN 2-2 KASUMIGASEKI CHIYODA-KU TOKYO, JAPAN
CHOGOKU ELECTRIC	CHOGOKU ELECTRIC POWER CO.
CHUBU ELECTRIC	CHUBU ELECTRIC POWER CO.
FAPIG	FIRST ATOMIC POWER INDUSTRY GROUP TOKYO BOEKI KAIKAN BLDG. 2, 1-CHOME OHTEMACHI CHIUODA-KU TOKYO, JAPAN
HITACHI	HITACHI LTD.

* * * * * * * * * * * * * * * * *

	ATOMIC ENERGY DEPT. 4, 1-CHOME MARUNOUCHI CHIYODA-KU TOKYO, JAPAN
HOKAIDO	HOKAIDO ELECTRIC POWER COMPANY
JAERI	JAPAN ATOMIC ENERGY RESEARCH INSTITUTE 1-1 SHIBA TAMURACHO MINATO-KU TOKYO, JAPAN
JAORG	JAPAN ATOMIC POWERED ORE CARRIER RESEARCH GROUP TOKYO, JAPAN
JAPCO	JAPAN ELECTRIC POWER CO.
JAPSD	JAPAN ATOMIC POWERED SHIP DEVELOPMENT CORP. TOKYO, JAPAN
KANSAI E-P	KANSAI ELECTRIC POWER COMPANY JAPAN
KYUSHU ELECTRIC	KYUSHU ELECTRIC POWER CO.
MAPI	SEE MITSUBISHI
MITSU	MITSUBISHI ATOMIC POWER INDUSTRIES, INC. OTEMACHI BLDG. CHIYODA-KU TOKYO, JAPAN
NAIG	NIPPON ATOMIC INDUSTRY GROUP CO., LTD. NO. 4 YURAKUCHO 2-CHOME CHIYODA-KU TOKYO, JAPAN
SHIKOKU ELECTRIC	SHIKOKU ELECTRIC POWER CO.
SUMITOMO	SUMITOMO ATOMIC ENERGY INDUSTRIES LTD. 5-22 KITAHAMA HIGASHI-KU OSAKA, JAPAN
TOHOKU	TOHUKU ELECTRIC POWER COMPANY
TOKYO ELECTRIC	TOYKO ELECTRIC POWER COMPANY TOKYO, JAPAN

KOREA

KOREA ELECTRIC	KOREA ELECTRIC CO.
OAE	OFFICE OF ATOMIC ENERGY ATOMIC ENERGY COMMISSION 77 SECHONG-RO CHONGRO-KU SEOUL, KOREA

MEXICO

CNEN	COMISION ON NACIONAL DE ENERGIA NUCLEAR AV. INSURGENTES SUR 1079, TERCER PISO MEXICO 18, D.F., MEXICO

NETHERLANDS

CAE	NUCLEAR ENERGY COMMISSION /COMMISSIE VOOR ATOOM ENERGIE/ LE VAN DE BOSCHSTRAAT THE HAGUE, NETHERLANDS
GKN	GEMEENSCHAPPELIJKE KERNENERGIECENTRALE NEDERLAND JOINT NETHERLAND NUCLEAR POWER STATION
KEMA	COMPANY FOR TESTING ELECTROTECH. MATLS ARNHEM, NETHERLANDS
NERATOOM	NERATOOM N.V. NOORDEINE 38 THE HAGUE, NETHERLANDS ORGANIZATION OF DUTCH FIRMS
RCN	REACTOR CENTRUM NEDERLAND SCHEVEVINGSEWEG 112 THE HAGUE, NETHERLANDS
SEP	SAMENWERKENDE ELECTRICITEITS PRODUCTIEBEDRIJVEN UTRECHTSEWEG 310 ARNHEM, NETHERLANDS
SKK	STICHTING KERNVOORTSTUWING KOOPVAARDIJSCHEPEN /FOUNDATION FOR NUCLEAR PROPULSION OF MERCHANT SHIPS/ NASSAULAAN 13

THE HAGUE, NETHERLANDS

NORWAY

IFA	SEE KRE
JENER	JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH P.O. BOX 175 LILLESTROM, NORWAY IFA/INSTITUT FOR ATOMENERGI/ AND RCN /REACTOR CENTRUM NEDERLAND/
KRE	KJELLER RESEARCH ESTABLISHMENT /INSTITUT FOR ATOMENERGI/IFE KJELLER /NEAR LILLESTROM/, NORWAY
NAEC	NATIONAL ATOMIC ENERGY COUNCIL P.O. BOX 175 LILLESTROM, NORWAY
NORATOM	NORATOM A/S HOLMENVEIEN 20 VINDEREN OSLO, NORWAY
REDERIATOM	REDERIATOM /NUCLEAR RESEARCH GROUP OF NORWEGIAN SHIPOWNERS/ P.O. BOX 175 LILLESTROM, NORWAY

PAKISTAN

PAEC	PAKISTANI AT. EN. COMMISSION KARACHI 29, PAKISTAN

PERU

JCEA	JUNTA DE CONTROL DE ENERGIA ATOMICA AVENIDA NICOLAS DE PIEROLA 611 APT. 914 LIMA, PERU

POLAND

CAE	OFFICE OF GOVERNMENT HIGH COMMISSIONER

* * * * * * * * * * * * * * * * *

	FOR ATOMIC ENERGY PALACE OF CULTURE AND SCIENCE, 18TH FLOOR WARSAW, POLAND
INST. NUCL. RES.	INSTITUTE OF NUCLEAR RESEARCH WARSAW, POLAND

SPAIN

AQUARIUS	AQUARIUS COMPANY FORMED TO MANAGE PROJECTED IBERIAN DUAL-PURPOSE STATION
CENUSA	CENTRALES NUCLEARES S.A. C/O 1 HERMOSILLA MADRID 1, SPAIN
FECSA	FUERZAS ELECTRICAS DE CATALUNA S.A. MEMBER OF JOINT COMPANY FORMED TO BUILD THE CATALONIA POWER STATION.
FENOSA	FUERZAS ELECTRICAS DEL NORDESTE SA
HIFRANSA	SOCIEDAD HISPANO-FRANCESA D-ENERGIA NUCLEAR
HYDROELECTRICA	HYDROELECTRICA ESPANOLA SA
IBERDUERO	IBERDUERO ELECTRIC
JEN	MINISTERIO DE INDUSTRIA JUNTA DE ENERGIA NUCLEAR SERRANO 121 MADRID, SPAIN
NUCLENOR	CENTRALES NUCLEAR DEL NORTE S.A. MADRID, SPAIN
TECNATOM	TECNATOM S.A. VALLEHERMOSO 30 MADRID, SPAIN
UEM	UNION ELECTRICA MADRILENA S.A. AV. JOSE ANTONIO 4 MADRID, SPAIN

SWEDEN

AB-ATOM	A.B. ATOMENERGI

* * * * * * * * * * * * * * * * *

	LOVHOLMSVAGEN 7 STOCKHOLM 9, SWEDEN
ARC	SWEDISH ATOMIC RESEARCH COUNCIL DOBELNSGATAN 64 STOCKHOLM VA, SWEDEN
ASEA	ALLMANNA SVENSKA ELECTRISKA A,B, NUCLEAR POWER DEPARTMENT VASTERAS, SWEDEN
ATOM-ASEA	ATOM-ASEA CONSORTIUM, ASEA AND GOVERNMENT, TO TAKE OVER ASEA PROJECTS,
GOTAVERK	CHANTIERS DE CONSTRUCTION NAVALE DE GOTAVERKE GOTEBORG 8, SWEDEN /SWEDISH SHIPBUILDING RESEARCH FOUNDATION/
JOHNSON	JOHNSON INDUSTRIAL GROUP AXEL JOHNSON INSTITUTE FOR INDUSTRIAL RESEARCH NYNASHAMM, SWEDEN
KVS	SWEDISH STATE POWER BOARD NUCLEAR POWER DEPARTMENT KARDUANSMAKARGATAN 8 FACK STOCKHOLM 1, SWEDEN
OKAB	OSKARSHAMMSVERKETS KRAFTGRUPP AG GROUP OF PRIVATE AND MUNICIPAL UTILITIES, CENTRAL AND SOUTHERN SWEDEN
OKG	SEE OKAB
SWED STATE PB	SWEDISH STATE POWER BOARD FACK, STOCKHOLM 2 SWEDEN
SYNDKRAFT	SYDSVENSKA KRAFT AKTIEBOLAGET SOUTH SWEDEN POWER COMPANY

SWITZERLAND

AET	AZIENDA ELECTRICA TICINESE BELLINZONA, SWITZERLAND MEMBER ENERGIE NUCLEAIRE SA
ATOMKRAFT	ATOMELEKTRA A.G.

* * * * * * * * * * * * * * * * *

	FORCE ATOMIQUE S.A. PRIVATBANK + VERWALTUNGSGESELLSCHAFT BARENGASSE 29 ZURICH 1, SWITZERLAND
BBC	BROWN, BOVERI, AND CO. LTD. ATOMIC POWER DEPARTMENT BADEN, SWITZERLAND
BKW	BERNISCHE KRAFTWERKE A.G. 2 VIKTORIAPLATZ BERN, SWITZERLAND MEMBER OF SUISATOM
EIR	EIDGENOSSISCHE INSTITUT FUR REAKTORFORSCHUNG WURENLINGEN, AARGAU, SWITZERLAND FEDERAL INSTITUTE FOR REACTOR RESEARCH
ELECTRO-WATT	ELECTRO-WATT LTD. 16 TALACKER ZURICH, SWITZERLAND
ENUSA	ENERGIE NUCLEAIRE S.A. 10 AVENUE DE LA GARE LAUSANNE, SWITZERLAND
FCAE	FEDERAL COMMISSION FOR ATOMIC ENERGY EFFINGERSTRASSE 55 BERN, SWITZERLAND
MOTOR-COLUMBUS	MOTOR-COLUMBUS ELECTRICAL MANAGEMENT CO. LTD. 27, 5400 BADEN SWITZERLAND
NOK	NORDOSTSCHWEIZERISCHE KRAFTWERKE AG FORCES ELECTRIQUES DU NORD-EST DE LA SUISSE BADEN, SWITZERLAND
RAG	REACTOR A.G. WURENLINGEN/A.G. SWITZERLAND
SNA	SOCIETE NATIONALE POUR L ENCOURAGEMENT DE LA TECHNIQUE ATOMIQUE INDUSTRIELLE MEMBERS ARE ENUSA, THERMATON, AND SUISATOM.
SUISATOM	SUISATOM, S.A. BAHNHOFPLATZ 3

	ZURICH 1, SWITZERLAND
SULZER	SULZER BROTHERS, LTD. WINTERTHUR ZURICH, SWITZERLAND
THERMATOM	THERMATOM, S.A. ZURCHER STRASSE 9 WINTERTHUR ZURICH, SWITZERLAND

TAIWAN

POWER	TAIWAN POWER COMPANY
TAIPOWER	TAIPOWER CORPORATION

UNITED ARAB REPUBLIC

UAR AEE	UNITED ARAB REPUBLIC ATOMIC ENERGY ESTABLISHMENT INSHAS NR. CAIRO, EGYPT, UNITED ARAB REPUBLIC

UNION OF SOVIET SOCIALIST REPUBLICS

CENTRAL ATOMIC	CENTRAL ATOMIC ENERGY UTILIZATION BOARD USSR
KURCHATOV	KURCHATOV ATOMIC ENERGY INSTITUTE MOSCOW, USSR
MINISTRY USSR	MINISTRY OF POWER STATIONS USSR
USSR	SOVIET ATOMIC ENERGY COMMITTEE /STATE ATOMIC ENERGY COMMITTEE OF THE USSR COUNCIL OF MINISTERS/ STAROMONETNY PEREULOK 26 MOSCOW, U.S.S.R.

UNITED KINGDOM

AEA	UNITED KINGDOM ATOMIC ENERGY AUTHORITY 11 CHARLES II STREET LONDON S.W. 1

* * * * * * * * * * * * * * * * *

ENGLAND

AEI-JT	A.E.I. - JOHN THOMPSON NUCLEAR ENERGY CO. LTD RADBROKE HALL KNUTSFORD, CHESHIRE ENGLAND
AERE	ATOMIC ENERGY RESEARCH ESTABLISHMENT HARWELL DIDCOT, BERKSHIRE ENGLAND
APC	ATOMIC POWER CONSTRUCTION, LTD. 29 THEOBALDS ROAD LONDON W.C. 1, ENGLAND INTERNATIONAL COMBUSTION FAIREY ENG. RICHARDSONS-WESTGARTH
BABCOCK ENG. ELEC.	BABCOCK ENGLISH ELECTRIC NUCLEAR LTD. REORGANIZATION OF NDC. ENGLISH ELECTRIC BABCOCK + WILCOX LTD. TAYLOR WOODROW INDUSTRIAL REORGANIZATION CORP.
BAW LTD	BABCOCK AND WILCOX LTD ATOMIC ENERGY DEPARTMENT 209 EUSTON ROAD LONDON N.W. 1 ENGLAND SEE BABCOCK ENG. ELEC.
BNX	BRITISH NUCLEAR EXPORT EXECUTIVE ATOMIC POWER CONSTRUCTION LTD. THE NUCLEAR POWER GROUP NUCLEAR DESIGN AND CONSTRUCTION UK ATOMIC ENERGY AUTHORITY
CEGB	CENTRAL ELECTRICITY GENERATING BOARD BANKSIDE HOUSE SUMNER STREET LONDON S.E. 1 ENGLAND
DEHAV	DE HAVILLAND ENGINE CO. LTD. NUCLEAR POWER GROUP LEAVESDEN, HERFORDSHIRE ENGLAND
DER	DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT

* * * * * * * * * * * * * * * * *

	DOUNREAY THURSO, CAITHNESS SCOTLAND
EE	ENGLISH ELECTRIC CO. LTD. ATOMIC POWER DIVISION CAMBRIDGE ROAD WHETSTONE, NEAR LEICESTER ENGLAND SEE BABCOCK ENG. ELEC.
EE-BW	SEE NUCLEAR DESIGN AND CONSTRUCTION
EE-BW-TW	ENGLISH ELECTRIC, BABCOCK AND WILCOX, AND TAYLOR WOODROW ATOMIC POWER CONSTRUCTIONS LTD CAMBRIDGE ROAD WHETSTONE, NEAR LEICESTER ENGLAND
FAIREY	FAIREY ENGINEERING LTD. HESTON, MIDDLESEX ENGLAND MEMBER OF APC
FW	FOSTER WHEELER LTD. FOSTER WHEELER HOUSE 3 IXWORTH PLACE LONDON S.W. 3 ENGLAND
GEC	GENERAL ELECTRIC CO. LTD. OF ENGLAND ERITH, KENT ENGLAND
GEC-SC	G.E.C. AND SIMON-CARVES ATOMIC ENERGY CO. GENERAL ELECTRIC CO. LTD. OF ENGLAND /GEC/ SIMON-CARVES LTD. /SC/
HAG	HUMPHREYS AND GLASGOW LTD. POWER DIVISION 22 CARLISLE PLACE LONDON S.W. 1 ENGLAND
HS	HAWKER SIDDELEY NUCLEAR POWER CO. LTD. SUTTON LANE LANGLEY, NEAR SLOUGH BUCKINGHAMSHIRE ENGLAND
MITCHELL	MITCHELL ENGINEERING LTD.

	NUCLEAR POWER DIVISION 1 BEDFORD SQUARE LONDON W.C. 1 ENGLAND
NDC	NUCLEAR DESIGN AND CONSTRUCTION CO. WHETSTONE, LEICESTER UNITED KINGDOM ENGLISH ELECTRIC BABCOCK + WILCOX LTD TAYLOR-WOODROW REORGANIZED. SEE BABCOCK ENG. ELEC.
NPG	NUCLEAR POWER GROUP RADBROKE HALL KNUTSFORD, CHESHIRE ENGLAND
NPPC	NUCLEAR POWER PLANT CO. LTD. MEMBER OF NPG
RIO TINTO	RIO TINTO ZINC CORPORATION LTD. 6 ST. JAMES SQUARE LONDON, S.W. 1, ENGLAND
RR	ROLLS-ROYCE AND ASSOCIATES LTD. P.O. BOX 31 DERBY ENGLAND
SC	SIMON CARVES LTD. NUCLEAR POWER DIV. CHEADLE HEATH STOCKPORT, CHESHIRE ENGLAND
SSEB	SOUTH OF SCOTLAND ELECTRICITY BOARD EDINBURGH, SCOTLAND
TNPG	THE NUCLEAR POWER GROUP SEE NPG
TW	TAYLOR WOODROW CONSTRUCTION LTD. 345 RUISLIP ROAD SOUTHALL, MIDDLESEX, ENGLAND SEE BABCOCK ENG. ELEC.
UKAEA	UNITED KINGDOM ATOMIC ENERGY AUTHORITY 11 CHARLES II STREET LONDON S.W. 1

* * * * * * * * * * * * * * * * *

ENGLAND

UPC	UNITED POWER CO. LTD. MAGNET HOUSE KINGSWAY LONDON W.C. 2 ENGLAND
VICK	VICKERS NUCLEAR ENGINEERING LTD. VICKERS HOUSE WESTMINSTER LONDON S.W. 1 ENGLAND

WEST GERMANY

AEG	ALLGEMEINE ELECTRIZITATS GESELLSCHAFT AEG-HOCHHAUS FRANKFURT 70 GERMANY
AKB	SEE ATOMKRAFT-BAYERN
AKS	ARBEITSGEMEINSCHAFT KERNKRAFTWERKE STUTTGART STUTTGART, GERMANY
ALKEM	ALKEM KARLSRUHE, WEST GERMANY NUKEM DOW CHEMICAL INTERNATIONAL
APK	ARBEITSGEMEINSCHAFT PROJEKT KERNKRAFTWERK WIESMOOR 49 HORSTENER STRASSE HAMBURG-HARBURG, GERMANY
ATOMFORUM	DEUTSCHES GESELLSCHAFT FUR ATOMENERGIE E.V. WENZELGASSE 2 II BONN, GERMANY
ATOMKRAFT-BAYERN	GESELLSCHAFT FUR DIE ENTWICKLUNG DER ATOMKRAFT IN BAYERN M.B.H. BLUTENBURGSTRASSE 6 MUNICH 2, GERMANY
AVR	ARBEITSGEMEINSCHAFT DEUTSCHER ENERGIE- VERSORGUNGS UNTERNEHMEN ZUR VORBEREITUNG DER ERRICHTUNG EINES LEISTUNGSVERSUCHS- REAKTORS E.V.

* * * * * * * * * * * * * * * * *

	LUISSENSTRASSE 105 DUSSELDORF, GERMANY
BASF	BADISCHE ANILIN UND SODA FABRIK
BBC-KRUPP	CONSORTIUM BBC-KRUPP ARBEITSGEMEINSCHAFT CARL-REISS-PLATZ 1-5 MANNHEIM, GERMANY
BEWAG	BERLINER KRAFT UND LICHT BERLIN, GERMANY
CHEMISCHE WERKE	CHEMISCHE WERKE HULS AG
DEUTSCH BAW	DEUTSCH BABCOCK UND WILCOX-DAMPFKESSELWERKE ATOMABTEILUNG DUISBURGERSTRASSE 375 OBERHAUSEN, GERMANY
DEUTSCH WERFT	DEUTSCH WERFT A.G. HAMBURG 1, GERMANY /MEMBER OF GKSS/
ELECTROMARK	ELECTROMARK HAGEN
EVS	ENERGIE-VERSORGUNG SCHWABEN
GEA	ATOMKRAFT-BAYERN
GFK	GESELLSCHAFT FUR KERNFORSCHUNG M.B.H. 1 FRIEDRICHSPLATZ KARLSRUHE, GERMANY
GFR	GERMAN FEDERAL REPUBLIC /WEST GERMANY/ FEDERAL MINISTRY FOR NUCLEAR ENERGY AND WATER ECONOMY LUISENSTRASSE 46 BAD GODESBERG, GERMANY
GHH	GUTEHOFFNUNGSHUETTE STERKRADE AG 42 OBERHAUSEN RD POSTFACH, GERMANY
GKSS	GESSELLSCHAFT FUR KERNENERGIEVERTUNG IM SCHIFFBAU UND SCHIFFAHRT M.B.H. /COMPANY FOR THE UTILIZATION OF NUCLEAR ENERGY IN SHIPBUILDING AND NAVIGATION/ NORMANNENWEG 10 HAMBURG 6, GERMANY

* * * * * * * * * * * * * * * * *

HAMBURGISCHE	HAMBURGISCHE ELECTRICITATSWERKE AG 48 GERHART-HAUPTMANN-PLATZ 2000 HAMBURG 1 WEST GERMANY
HKG	HOCHTEMPERATUR-KERNKRAFTWERK GESELLSCHAFT MBH HAGEN, W. GERMANY
INTERATOM	INTERNATIONALE ATOMREAKTORBAU G.M.B.H. 506 BENSBERG/KOLN POSTFACH, GERMANY DEMAG, W.GERMANY NORTH AMERICAN AVIATION, U.S. DEUTSCH BABCOCK AND WILCOX
KBWP	KERNKRAFTWERK BADEN-WURTTEMBERG PLANNINGSGESELLSCHAFT M.B.H. STUTTGART-O, NECKARSTR, 121 GERMANY NOW KERNKRAFTWERK OBRIGHEIM G.M.B.H.
KERNKRAFTWERK LING	KERNKRAFTWERK LINGEN G.M.B.H. SUBSIDIARY OF VEW WITH AEG
KERNKRAFTWERK OBRIG	KERNKRAFTWERK OBRIGHEIM G.M.B.H. STUTTGART, GERMANY FORMERLY KBWP
KFA-JUELICH	KERNFORSCHUNGSANLAGE JUELICH JUELICH, GERMANY
KFK	KERNFORSCHUNGSZENTRUM KARLSRUHE KERNREAKTOR BAU- UND BETRIEBS-GESELLSCHAFT M.B.H. 5 WEBERSTRASSE KARLSRUHE, GERMANY
KKL	SEE KERNKRAFTWERK LINGEN
KKN	KERNKRAFTWERK NIEDERAICHBACH SEE KNK
KKO	SEE KERNKRAFTWERK OBRIGHEIM
KNK	KERNKRAFTWERK NIEDERAICHBACH G.M.B.H. NIEDERAICHBACH NUCLEAR STATION
KRB	KERNKRAFTWERK RWE-BAYERNWERK GMBH

* * * * * * * * * * * * * * * * *

	GUNDREMMINGEN, GERMANY KARLSRUHE, GERMANY
KSH	KERNENERGIEGESELLSCHAFT SCHLESWIG-HOLSTEIN
KWO	KERNKRAFTWERK OBRIGHEIM SEE KBWP
MAN	MASCHINENFABRIK AUGSBURG-NURNBERG A.G. NURNBERG, KATZWANGERSTR. 101 GERMANY
NORDWEST KRAFTWERK	NORDWESTDEUTSCHE KRAFTWERK A.G) HAMBURG, GERMANY
PREUSSENELEKTRA	PREUSSISCHE ELEKTRIZITATIS AG 10-12 PAPENSTEIG 3 HANOVER W. GERMANY
RWE	RHEINISCH WESTFALISCHES ELECTRIZITATSWERKE ESSEN, GERMANY
RWE-BAYERNWERK	KERNKRAFTWERK RWE-BAYERNWERK G.M.B.H. GUNDREMINGEN BAVARIA, GERMANY
SIEMENS	SIEMENS-SCHUCKERTWERKE A.G. ABTEILUNG REAKTORENTWICKLUNG WERNER-VON-SIEMENS-STRASSE 50 ERLANGEN, GERMANY
SKW	STUDIENGESELLSCHRAFT KERNKRAFTWERKE G.M.B.H. PEPENSTIEG 10-12 HANOVER, GERMANY
VAK	VEREINIGTE ELEKTRIZITATSWER WESTFALEN AG RWE BAYERNWERK A. G.
VEW	VEREINIGTE ELEKTRIZITATSWERK WESTFALEN A.G. JOINT ELECTRICITY SUPPLY GROUP
WIESMOOR	SEE APK

YUGOSLAVIA

ELEKTROSTO	ELEKTROSTOPANSTVO MACEDONIA ELECTRIC BOARD

* * * * * * * * * * * * * * * * *

FEDERAL NUCL	FEDERAL NUCLEAR ENERGY COMMISSION OF THE SOCIALIST FEDERAL REPUBLIC OF YUGOSLAVIA 29 KOSANCICEV VENAC PO BOX 353 BELGRADE, YUGOSLAVIA
UNO	YUGOSLAV INDUSTRIAL SYNDICATE

AQUEOUS HOMOGENEOUS REACTORS

AND

MOLTEN SALT HOMOGENEOUS REACTORS

DOMESTIC

* * * * * * * * * * * * * * * * *

NAME/OWNER	NUCLEAR HYDRAZINE PRODUCTION REACTOR /AGN
DESIGNER	AEROJET-GENERAL NUCLEONICS
LOCATION	STUDY, EXPERIMENTAL LOOP IN MTR /AGN-302 LOOP/
PURPOSE	CHEMONUCLEAR REACTOR, IN-REACTOR PRODUCTION OF HYDRAZINE
TYPE	HOMOGENEOUS SUSPENSION FUEL
POWER MWE(MWT)	0 175
COOLANT	ANHYDROUS LIQUID AMMONIA WITH 1 WT. PER CENT HYDRAZINE
MODERATOR	SUSPENSION FLUID
FUEL MATERIAL	URANIUM DIOXIDE PARTICLES SUSPENDED IN ANHYDROUS LIQUID AMMONIA
FUEL ENRICH.	93 PER CENT U-235
FUEL CHARGE	APPROX. 270 KG. URANIUM DIOXIDE
BURNUP(REFUEL)	RECYCLED FUEL PLUS ABOUT 0.58 POUND URANIUM DIOXIDE/DAY
NEUTRON FLUX	APPROX. 10 E+11
CONTROL	RODS
COOLANT TEMP.	INLET 100 F OUTLET 160 F
COOLANT PRESS.	750 PSIA
REACTOR VESSEL	SPHERICAL VESSEL 8 FT. DIA.
CONTAINMENT	CANYON TYPE SHIELDING, UNDERGROUND
REMARKS	URANIUM FUEL COMPOUNDS SOLUBLE IN LIQUID AMMONIA ARE BEING STUDIED. THE NUCLEAR HYDRAZINE PRODUCTION REACTOR CONCEPT DIRECTLY UTILIZES THE URANIUM FISSION PROCESS TO PRODUCE HYDRAZINE FROM LIQUID AMMONIA. BASIS FOR OPERATION IS A HOMOGENOUS SLURRY OF FINE URANIUM DIOXIDE PARTICLES SUSPENDED IN ANHYDROUS LIQUID AMMONIA. URANIUM DIOXIDE IS SEPARATED FOR RECYCLE TO THE REACTOR AND FUEL REPROCESSING WITH MAKE-UP FUEL ADDED AS REQUIRED. FIRST STUDIES CONSIDERED U

* * * * * * * * * * * * * * * * *

COMPOUND SUSPENDED IN AN AIR COOLANT /SMOKE-FUELED/. AGN, GENERAL TIRE + RUBBER, AND UNION CARBIDE WILL WORK AS A RESEARCH TEAM UNDER AN AEC CONTRACT IN FISSIOCHEMISTRY FIELD. NITROGEN FIXATION WITH NATURAL GAS OR COAL GASIFICATION PRODUCTS FOR FERTILIZER AND INTERMEDIATE CHEMICAL PRODUCTION WILL BE ONE AREA OF INVESTIGATION. PROJECT WILL INCLUDE DESIGN OF CHEMONUCLEAR LOOPS AND REACTORS AND THE DEVELOPMENT OF CERAMIC AND MIXED-CERAMIC-METAL FUELS. THE REACTOR WORK WILL TAKE PLACE AT UNION CARBIDES STERLING PARK FACILITIES.

REFERENCES

NUCLEAR REACTOR MAY MAKE CHEMICALS.
CHEM. AND ENG. NEWS 37, 46-7 /AUGUST 10, 1959/

NUCLEAR HYDRAZINE PROGRAM. FINAL TECHNICAL ENGINEERING REPORT, MARCH 22 1960-MARCH 22 1961
JH CUSACK, OTHERS
ASD-TR-61-7-840 /JULY 1961/

* * * * * * * * * * * * * * * * *

NAME/OWNER	LAPRE /LOS ALAMOS POWER REACTOR EXPERIMENT//AEC
DESIGNER	LOS ALAMOS SCIENTIFIC LABORATORY
OPERATOR	LOS ALAMOS SCIENTIFIC LABORATORY
LOCATION	LOS ALAMOS, N.M.
PURPOSE	POWER EXPERIMENT
TYPE	AQUEOUS HOMOGENEOUS, CIRCULATING FUEL
POWER MWE(MWT)	0 800 KWT
CRITICAL	1958. HAS BEEN DISMANTLED.
COOLANT	LIGHT WATER
MODERATOR	HYDROGEN IN FUEL SOLUTION
FUEL MATERIAL	URANIUM DIOXIDE IN AQUEOUS SOLUTION OF PHOSPHORIC ACID
FUEL ENRICH.	93.4 PER CENT U-235
FUEL CHARGE	6.5 KG. U-235
SPECIFIC POWER	250 KW/KG U-235
NEUTRON FLUX	THERMAL AVE. 1X10 E+13 FAST AVE. 6X10 E+13
CONTROL	MOVABLE SLEEVE OF BERYLLIUM OXIDE AND GRAPHITE
COOLANT TEMP.	INLET 400 F OUTLET 600 F
COOLANT PRESS.	INLET 700 PSI OUTLET 600 PSI
REACTOR VESSEL	CYLINDRICAL SS, GOLD INNER CLADDING
CONTAINMENT	SAFETY ENCLOSURE TANK, CARBON STEEL, COPPER LINED
REMARKS	TWO VERSIONS HAVE BEEN STUDIED, BOTH USING PHOSPHORIC ACID SOLUTIONS OF ENRICHED U AS FUEL. IN BOTH SYSTEMS THE HEAT EXCHANGER FOR POWER REMOVAL IS IN THE SAME PRESSURE VESSEL AS THE REACTING FLUID. FUEL SOLUTION CIRCULATION IS BY CONVECTION IN ONE VERSION AND BY FORCED CIRCULATION IN THE OTHER. IN THE CONVECTION FLOW PLANT THE ACID IS ABOUT 95 PER CENT STRENGTH,

* * * * * * * * * * * * * * * * *

WHILE IN THE FORCED CIRCULATION SYSTEM IT IS 50 PER CENT. PURPOSE OF THE EXPERIMENTS WAS TO DEVELOP HIGH PRESSURE SUPERHEATED STEAM FOR GOOD TURBINE UTILIZATION.

REFERENCES

THE LOS ALAMOS POWER REACTOR EXPERIMENT.
D FROMAN, ET AL.
PROC. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 3, 283-6 /1955/

THE FUEL SYSTEM URANIUM DIOXIDE-PHOSPHORIC ACID-WATER AND LOS ALAMOS POWER REACTOR EXPERIMENT II
BJ THAMER
SECOND U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 7, 54-6 /1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HRE /HOMOGENEOUS REACTOR EXPERIMENT//AEC
DESIGNER	OAK RIDGE NATIONAL LABORATORY
OPERATOR	OAK RIDGE NATIONAL LABORATORY
LOCATION	OAK RIDGE, TENNESSEE
PURPOSE	POWER EXPERIMENT
TYPE	AQUEOUS HOMOGENEOUS, TWO-REGION, CIRCULATING FUEL HRE-1 CRITICAL IN 1953 WAS LIGHT WATER COOLED. DISMANTLED IN 1954.
POWER MWE(MWT)	5 10
CRITICAL	1958, CLOSED OUT 1961
COOLANT	HEAVY WATER SOLUTION
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANYL SULFATE IN HEAVY WATER SOLUTION
FUEL ENRICH.	93 PER CENT U-235
FUEL CHARGE	4 KG. U-235
SPECIFIC POWER	1700 KW/KG FISSIONABLE MATERIAL
BURNUP(REFUEL)	/600 DAYS AT 5 MW/
CONTROL	NONE
COOLANT TEMP.	INLET 494 F OUTLET 572 F /CORE/ INLET 533 F OUTLET 539 F /BLANKET/
COOLANT PRESS.	2000 PSI
REACTOR VESSEL	SPHERICAL ZIRCALOY-2 CORE TANK WITHIN SS-CLAD CARBON STEEL PRESSURE VESSEL
CONTAINMENT	STEEL-LINED CONCRETE CELL
REMARKS	PRELIMINARY STUDIES OF BOILING HOMOGENEOUS SYSTEMS WERE BASED ON URANIUM TRIOXIDE-HEAVY WATER OR URANYL SULFATE SLURRIES AS FUEL, WITH HEAVY WATER AS COOLANT AND MODERATOR. SINGLE AND TWO-REGION DESIGNS WERE STUDIED. HRE-III, PROPOSED FOR INVESTIGATING THE THORIUM/U-233 CYCLE, HAS BEEN

* * * * * * * * * * * * * * * * *

CANCELED. FOSTER WHEELER HAS PROPOSED CONSTRUCTION OF AN AHR POWER BREEDER USING A BLANKET OF FERTILE MATERIAL SURROUNDING THE CORE.

REFERENCES

PRELIMINARY DESIGN AND FEASIBILITY STUDY OF A LARGE-SCALE BOILING SLURRY PLUTONIUM-POWER PRODUCER.
LC WIDDOES, OTHERS
CF-51-8-84 /1951/

BOILING HOMOGENEOUS REACTOR FOR PRODUCING POWER AND PLUTONIUM.
HF KARMACK, OTHERS
CF-54-8-238 /1954/

THE HOMOGENEOUS REACTOR EXPERIMENT, A CHEMICAL ENGINEERING PILOT PLANT.
SE BEALL, CE WINTERS
CHEM. ENG. PROG. 50, 256-63 /MAY 1954/

ULTIMATE HOMOGENEOUS REACTOR, REACTOR AND FEASIBILITY PROBLEM.
RA THOMAS, OTHERS
CF-54-8-239 /1954/

THE HOMOGENEOUS REACTOR TEST.
SE BEALL, JA SWARTOUT
PROC. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 3, 263-82 /1955/

CIVILIAN POWER REACTOR PROGRAM, PART III. STATUS REPORT ON AQUEOUS REACTORS, 1960.
TID-8518 /BOOK 3/

HRE-3 PRELIMINARY DESIGN SUMMARY AND REFERENCE REPORT.
RH CHAPMAN
CF-59-11-112 /1958/

PROPOSED MODIFICATIONS TO THE HRE CORE
CG LAWSON
CF-60-1-20 /JANUARY 1960/

HRE-II DESIGN REPORT
RH CHAPMAN
ORNL-TM-348 /MARCH 1964/

JANUARY 1969 BNWL-936

AQ. HOMOGENEOUS AND MOLTEN SALT REACTORS, DOMESTIC AD04

* * * * * * * * * * * * * * * * *

NAME/OWNER	MSRE /MOLTEN SALT REACTOR EXPERIMENT//AEC
DESIGNER	OAK RIDGE NATIONAL LABORATORY
OPERATOR	OAK RIDGE NATIONAL LABORATORY
LOCATION	OAK RIDGE, TENNESSEE
PURPOSE	ENGINEERING EXPERIMENT
TYPE	MOLTEN SALT FUELED, HOMOGENEOUS, SINGLE REGION, HIGH POWER DENSITY
POWER MWE(MWT)	0 10
CRITICAL	FULL POWER, ABOUT 7.5 MWT, MAY 1966
COOLANT	FUEL MIXTURE /LITHIUM FLUORIDE-BERYLLIUM FLUORIDE/
MODERATOR	GRAPHITE
FUEL MATERIAL	MOLTEN FLUORIDES, IN PER CENT, 65 LITHIUM-7 FLUORIDE, 21.1 BERYLLIUM FLUORIDE, 5 ZIRCONIUM FLUORIDE, 0.9 URANIUM FLUORIDE.
FUEL ENRICH.	25-30 PER CENT U-235 FIRST LOAD, LATER FULLY ENRICHED U FUEL, AND LATER ADDITION OF THORIUM
FUEL ASSEMBLY	CORE REGION IS 64 IN. HIGH, CONSISTING OF UNCLAD GRAPHITE-MODERATOR STRINGERS WITH 1140 VERTICAL CHANNELS FOR FUEL FLOW. EACH CHANNEL IS 1.2 IN. WIDE AND 0.4 IN. DEEP. A 1/4 IN. THICK CYLINDER OF INOR-8 SURROUNDS THE CORE TO DIRECT FLOW, DOWNWARD THROUGH ANNULUS BETWEEN CYLINDER AND REACTOR VESSEL. CYLINDER IS 68 IN. HIGH AND 56 IN. ID. FLOW IS THEN UPWARD THROUGH THE CHANNELS.
FUEL CHARGE	FUEL VOLUME IN CORE 25 CU. FT. 70.5 CU. FT. SYSTEM TOTAL
NEUTRON FLUX	THERMAL AVE. 1.5 E+13 PEAK 3.4 E+13
CONTROL	FLEXIBLE TUBES IN CANNED CYLINDRICAL SEGMENTS OF GADOLINIUM-ALUMINUM OXIDE /BEADS/, CLAD INSIDE AND OUT WITH INCONEL.
COOLANT TEMP.	INLET 1015 F OUTLET 1075 F
REACTOR VESSEL	INOR-8 ALLOY, VERTICAL GRAPHITE STRINGERS WITH

* * * * * * * * * * * * * * * * *

MILLED-IN FUEL CHANNELS. PRIMARY /FUEL/ LOOP IS SEALED IN STEEL CONTAINMENT VESSEL. COOLANT SALT IS IN 163 U-TUBES.

CONTAINMENT

CONTAINMENT CELL IS 24 FT. DIAM. AND 33 FT. DEEP. THERMAL SHIELD AROUND REACTOR IS A DOUBLE-WALLED SS TANK, ANNULUS FILLED WITH WATER AND CARBON STEEL BALLS. THE INNER WALL IS LINED WITH THERMAL INSULATION AND HEATERS.
PRESSURE-SUPPRESSION SYSTEM ADDED.

REMARKS

THE PLANT HAS PERFORMED WELL DURING TWO YEARS OF TEST OPERATION.
OAK RIDGE HAS PROPOSED A MOLTEN SALT BREEDER FOR CONSTRUCTION, A REFERENCE DESIGN FOR A 1000 MWE STATION HAVING BEEN COMPLETED. SEE AD07.
MSRE WAS REFULED WITH U-233 IN FALL OF 1968
IT WILL PROVIDE INFORMATION APPLICABLE TO A MOLTEN SALT THERMAL BREEDER OPERATING ON A THORIUM/U-233 CYCLE. 37 KG OF U-233 REPLACED THE U-235 STRIPPED FROM THE FUEL SALT ON-SITE.
MAPP UTILITIES WILL PARTICIPATE IN AN R+D AND FEASIBILITY STUDY OF THE MOLTEN SALT REACTOR LEADING TO CONSTRUCTION OF A DEMONSTRATION PLANT

REFERENCES

MOLTEN SALT BREEDER REACTOR.
HG MACPHERSON
CF-59-12-64 /REV./ /1960/

EXPERIMENTAL MOLTEN SALT FUELED 30 MW POWER REACTOR.
LC ALEXANDER, OTHERS
ORNL-2796 /MARCH 1960/

A 10 MWT MOLTEN-SALT REACTOR EXPERIMENT.
AL BOCH, OTHERS
TRANS. AMERICAN NUCLEAR SOC. 4, 331-2 /NOV. 1961/

THE MOLTEN SALT REACTOR EXPERIMENT.
AL BOCH, OTHERS
POWER REACTOR EXPERIMENTS, VOL. 1, P. 247-92
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA /1962/

MSRE, MOLTEN SALT REACTOR EXPERIMENT.
ES BETTIS, WB MCDONALD
NUCLEONICS 22, 66-70 /JAN. 1964/

MOLTEN SALT FAST REACTORS.

* * * * * * * * * * * * * * * * *

LG ALEXANDER
PROC. CONF. ON BREEDING, ECONOMICS, AND SAFETY IN LARGE FAST POWER REACTORS, ARGONNE NATIONAL LAB., OCTOBER 7-10, 1963,
ANL-6792 /P. 553-70/

FUEL PROPERTIES AND NUCLEAR PERFORMANCE OF FAST REACTORS FUELED WITH MOLTEN CHLORIDES.
PA NELSON, OTHERS
TRANS. AMERICAN NUCLEAR SOC. 8, 153-4 /JUNE 1965/

THE MOLTEN SALT REACTOR- AN INGREDIENT OF NUCLEAR PROGRESS.
FA SMITH
POWER REACTOR TECH. REACTOR FUEL PROCESS. 10, 6-16 /WINTER 1966-67/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PAR /PENNSYLVANIA ADVANCED REACTOR//WEST
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
PURPOSE	POWER DEMONSTRATION PROPOSAL
TYPE	AQUEOUS HOMOGENEOUS, CIRCULATING SOLUTION OR SLURRY FUEL, SINGLE REGION
POWER MWE(MWT)	80 /A/ 150 /B/ 550 /B/
CRITICAL	R+D
COOLANT	FUEL SOLUTION /A/ FUEL SLURRY /B/
MODERATOR	HEAVY WATER IN FUEL SOLUTION OR SLURRY REF. DESIGN 1, SLURRY
FUEL MATERIAL	A - URANYL SULFATE, HEAVY WATER SOLUTION B - URANIUM-THORIUM OXIDE, HEAVY WATER SUSPENSION
FUEL GEOMETRY	SOLUTION OR SLURRY
FUEL ENRICH.	93 PER CENT U-235
REACTOR VESSEL	SPHERICAL STEEL VESSEL 15 FT. DIA./ 6 IN. WALL THICKNESS
REMARKS	PAR THIRD ROUND PROPOSAL BY PENNSYLVANIA POWER AND LIGHT AND BALTIMORE GAS AND ELECTRIC WAS DROPPED IN 1958. AN EXTENDED R+D EFFORT WAS GRANTED BY AEC FOR JUSTIFICATION OF THE SYSTEM, WITH POSSIBLE CONSTRUCTION OF A DEMONSTRATION PLANT.
REFERENCES	PRELIMINARY SYSTEM ANALYSIS FOR THE PENNSYLVANIA ADVANCED REACTOR T GOGNIAT, OTHERS WCAP-433 /1956/ THE PAR HOMOGENEOUS REACTOR PROJECT. WE JOHNSON, OTHERS ASME PREPRINT 56-A-170 /1956/ THE PAR HOMOGENEOUS REACTOR PROJECT-PLANT DESIGN AND OPERATING PROBLEMS. WE JOHNSON, OTHERS PROC. AMERICAN POWER CONF. 19, 640-50 /1957/

JANUARY 1969 BNWL-936

AQ. HOMOGENEOUS AND MOLTEN SALT REACTORS, DOMESTIC AD05

* * * * * * * * * * * * * * * * *

PROPOSED 80,000 KILOWATT HOMOGENEOUS REACTOR PLANT
PROCESS AND PLANT DESCRIPTION.
DH FOX, ED.
WCAP-9 /1955/ DECLASSIFIED FEB. 1957

PAR HOMOGENEOUS UNIT.
JE KENTON
NUCLEONICS 15, 166 /SEPTEMBER 1957/

DESIGN CONSIDERATION FOR THE PAR SLURRY
HOMOGENEOUS PLANT.
ATOMIC ENERGY 9, 202-10 /1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	AQUEOUS HOMOGENEOUS REACTOR DESIGN /BAW
DESIGNER	BABCOCK AND WILCOX
PURPOSE	POWER AND SPACE HEAT
TYPE	AQUEOUS HOMOGENEOUS, TWO REGION.
POWER MWE(MWT)	100 KWE 400 KWT
CRITICAL	DESIGN STUDY
COOLANT	FUEL SOLUTION
MODERATOR	FUEL SOLUTION
FUEL MATERIAL	URANYL SULFATE IN LIGHT WATER SOLUTION
FUEL ENRICH.	SLIGHT
FUEL CHARGE	4.8 KG. U-235
BURNUP(REFUEL)	FUEL ADDITION 580 GM./YEAR FUEL REPLACEMENT AFTER 5 YEARS
CONTROL	AUTOMATIC BY POWER DEMAND
REMARKS	A CONCEPTIONAL DESIGN FOR A 150 MWE PLANT HAS BEEN COMPLETED. THIS CONCEPT IS A TWO-REGION REACTOR WITH A THORIA PELLET BLANKET.
REFERENCES	A DESIGN STUDY OF A LOW-POWER AQUEOUS HOMOGENEOUS BOILING REACTOR POWER PLANT. BA MONG, OTHERS BW-AED-502 /JUNE 1, 1955 DECL. APRIL 3, 1959/ SINGLE-FLUID TWO-REGION AQUEOUS HOMOGENEOUS REACTOR POWER PLANT, CONCEPTIONAL DESIGN AND FEASIBILITY STUDY. FINAL REPORT. NUCLEAR POWER GROUP, BABCOCK AND WILCOX CO. NPG-171 /JUNE 1957/

* * * * * * * * * * * * * * * * *

NAME/OWNER	MSBR /MOLTEN SALT BREEDER REACTOR/ ORNL
DESIGNER	OAK RIDGE NATIONAL LABORATORY
PURPOSE	POWER BREEDER DEVELOPMENT
TYPE	MOLTEN SALT HOMOGENEOUS REACTOR, TWO-REGION, TWO-FLUID SYSTEM. THERMAL BREEDER
POWER MWE(MWT)	1000 2225
CRITICAL	REFERENCE DESIGN
COOLANT	FUEL SALT
MODERATOR	GRAPHITE GRAPHITE REFLECTOR
FUEL MATERIAL	CORE. URANIUM FLUORIDE DISSOLVED IN LITHIUM-BERYLLIUM FLUORIDE SALTS. BLANKET. THORIUM FLUORIDE DISSOLVED IN LITHIUM-BERYLLIUM FLOURIDE SALTS.
FUEL GEOMETRY	GRAPHITE TUBES, CHANNELED, 3.5 IN. OD.
FUEL ASSEMBLY	CORE ASSEMBLY IS 12.5 FT. HIGH BY 10 FT. DIAM. COMPOSED OF 534 GRAPHITE FUEL ELEMENTS. FUEL FLOW IS UPWARD THROUGH PASSAGES IN OUTER REGION OF TUBE AND DOWNWARD THROUGH CENTRAL PASSAGE. AN 18-IN. THICK MOLTEN SALT BLANKET IS FORMED BY BLANKET SALT FILLING THE INTERSTICES OF HEXAGONAL MODERATOR BLOCKS SURROUNDING THE CORE.
SPECIFIC POWER	2.89 MWT/KG FISSILE
BURNUP(REFUEL)	ON-SITE FUEL RECYCLE PROCESSING
NEUTRON FLUX	THERMAL AVE. 6.7 E+14 FAST AVE. 12.1 E+14
COOLANT TEMP.	FUEL SALT INLET 1000 F OUTLET 1300 F BLANKET INLET 1150 F OUTLET 1250 F
REACTOR VESSEL	HASTELLOY-N CYLINDER 14 FT. DIAM. BY 19 FT. HIGH. SIDE WALLS 1.25 IN. THICK, HEADS 2.25 IN. THICK.
CONTAINMENT	REINFORCED CONCRETE REACTOR CELL, STEEL LINER. VAPOR-SUPPRESSION SYSTEM.
REMARKS	AN MSBR /PA/ DESIGN REFERS TO THE DIRECT REMOVAL

* * * * * * * * * * * * * * * * *

OF PROTACTINIUM FROM THE BLANKET STREAM IN THE BLANKET PROCESSING STEP. EXCEPT FOR THIS STEP THE PARAMETERS ARE THE SAME. ALTERNATIVE MSR DESIGNS ARE THE MSBR /PA-PB/, USING DIRECT CONTACT COOLING WITH MOLTEN LEAD AND PROTACTINIUM RECOVERY, THE SSCP /PA/ DESIGN FOR A SINGLE-STREAM CORE BREEDER WITH DIRECT REMOVAL OF PROTACTINIUM FROM THE FUEL STREAM, MOSEL /PA-PB/ WHICH IS AN EPITHERMAL BREEDER WITH DIRECT CONTACT COOLING WITH MOLTEN LEAD AND PROTACTINIUM REMOVED FROM FUEL STREAM, AND MSCR, A MOLTEN SALT CONVERTER REACTOR. SEE AD04.

REFERENCES

MOLTEN SALT CONVERTER REACTOR, DESIGN STUDY AND POWER COST ESTIMATES FOR A 1000 MWE STATION.
LG ALEXANDER, OTHERS
ORNL-TM-1060 /SEPT. 1965/

DESIGN STUDIES OF 1000-MWE MOLTEN SALT BREEDER REACTORS
PR KASTEN, OTHERS
ORNL-3996 /AUG. 1966/

AQUEOUS HOMOGENEOUS REACTORS

AND

MOLTEN SALT HOMOGENEOUS REACTORS

FOREIGN

* * * * * * * * * * * * * * * * *

NAME/OWNER	PHOEBUS/CEA, FRANCE
DESIGNER	CEA, FRANCE
LOCATION	GRENOBLE, FRANCE
PURPOSE	POWER EXPERIMENT
TYPE	AQUEOUS HOMOGENEOUS, CIRCULATING SLURRY FUEL, BOILING.
POWER MWE(MWT)	0 1
CRITICAL	R+D
COOLANT	LIGHT WATER FUEL SLURRY
MODERATOR	LIGHT WATER FUEL SLURRY
FUEL MATERIAL	URANIUM DIOXIDE IN GLASS MARBLES, SUSPENDED IN WATER
REMARKS	RESEARCH AND DEVELOPMENT PROJECT, PROTOTYPE REPORTEDLY UNDER CONSTRUCTION. BOILING SLURRY CONCEPT. SECOND PHASE OF THE RESEARCH PROGRAM IS TO BE THE STUDY OF A BOILING CYCLONE-REACTOR. PHOEBUS HAS A CYLINDRICAL CORE. LIQUID FUEL IS INJECTED TANGENTIALLY AT THE PERIPHERY OF THE CORE, AND A VORTEX FLOW MAINTAINED.
REFERENCES	IDEAS ON A PROJECT FOR A HOMOGENEOUS REACTOR, J BENEVISTE, OTHERS SECOND U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 415-20 /1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	SUS-POP /SUSPENSION POWER ONLY PILE/ /RCN-THE NETHERLANDS
DESIGNER	KEMA, THE NETHERLANDS
OPERATOR	KEMA
LOCATION	ARNHEIM, THE NETHERLANDS
PURPOSE	POWER EXPERIMENT
TYPE	AQUEOUS HOMOGENEOUS, CIRCULATING SLURRY FUEL
POWER MWE(MWT)	250 KWE
CRITICAL	SUB-CRITICAL SYSTEM IN OPERATION 1955
COOLANT	LIGHT WATER FUEL SLURRY
MODERATOR	LIGHT WATER FUEL SLURRY
FUEL MATERIAL	URANIUM DIOXIDE SUSPENSION IN WATER
FUEL ENRICH.	20 PER CENT U-235
CONTROL	BORON CARBIDE SHIM-SAFETY RODS IN THE REFLECTOR
REACTOR VESSEL	STAINLESS STEEL CYLINDER
CONTAINMENT	CONCRETE SHIELD
REMARKS	A SUBCRITICAL SYSTEM HAS BEEN IN OPERATION. THREE-PHASE PROGRAM HEAVY WATER SYSTEM, ENTAILING PRELIMINARY STUDY, DUTCH INDUSTRY STUDY, AND CONSTRUCTION, HAS BEEN INSTITUTED BY SEP WITH ASSISTANCE FROM KEMA, RCN AND U.S. INDUSTRY, REPLACING THE PRIMARY PROJECT. A SYSTEM USING A CIRCULATING FUEL OF THORIUM OXIDE AND URANIUM OXIDE SUSPENDED IN HEAVY WATER WAS STUDIED, AND IS CURRENTLY UNDER DEVELOPMENT. SEE KSTR.
REFERENCES	THE DESIGN OF A SMALL-SCALE PROTOTYPE OF A HOMOGENEOUS REACTOR FUELED WITH URANIUM OXIDE SUSPENSION. H DE BRUYN, OTHERS INTL CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 3, 116-20 /1955/

* * * * * * * * * * * * * * * * *

NAME/OWNER	KSTR /KEMA SUSPENSION TEST REACTOR/ KEMA-RCN-EUR, NETHERLANDS
DESIGNER	RCN-KEMA-SEP, THE NETHERLANDS
OPERATOR	REACTOR CENTRUM NEDERLAND
LOCATION	ARNHEIM, THE NETHERLANDS
PURPOSE	POWER EXPERIMENT
TYPE	AQUEOUS HOMOGENEOUS, SLURRY FUEL, PROTOTYPE
POWER MWE(MWT)	250 KW
CRITICAL	DESIGN AND CONSTRUCTION /SEE ALSO SUS-POP/
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER FUEL SLURRY BERYLLIUM OXIDE REFLECTOR
FUEL MATERIAL	URANIUM/THORIUM OXIDE SUSPENSION IN HEAVY WATER
FUEL ENRICH.	HIGH
CONTROL	UNDETERMINED
COOLANT TEMP.	250 C
REACTOR VESSEL	CYLINDRICAL SS VESSEL, CONED ENDS, 23 IN. LONG/11.05 IN. DIA. 18 LITERS CAPACITY
CONTAINMENT	DOUBLE CONTAINMENT. REACTOR SYSTEM IS IN STEEL COMPARTMENTS BACKED UP BY CONCRETE BIOLOGICAL SHIELD - THE FIRST CONTAINMENT - AND A CONCRETE REACTOR HALL - THE SECOND CONTAINMENT.
REMARKS	SUBCRITICAL REACTOR IN OPERATION, SECOND STEP /PROCESS/ REACTOR UNDER CONSTRUCTION. PART OF SEPS 3-PHASE PROGRAM /SEE SUS-POP/. THE SEP PROGRAM, WITH ASSISTANCE FROM KEMA, RCN, AND US INDUSTRY, LARGELY REPLACE KEMAS AHR DEVELOPMENT PROGRAM. SUSPENSION FLOW IS UPWARD THROUGH VESSEL
REFERENCES	DEVELOPMENT OF A 250 KW AQUEOUS HOMOGENEOUS SINGLE REGION SUSPENSION REACTOR. PJ KREYGER, OTHERS SECOND U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 427-30 /1958/

AQ. HOMOGENEOUS AND MOLTEN SALT REACTORS,FOREIGN AF03

* * * * * * * * * * * * * * * * *

KSTR. THE KEMA SUSPENSION TEST REACTOR,
NUCLEAR ENG. 8, 437-39 /DEC 1963/

THE AQUEOUS HOMOGENEOUS SUSPENSION REACTOR PROJECT
KEURING VAN ELECTROTECHNISCHE MATERIALEN, N.V.
ARNHEIM. GENEVA, 1964, A/CONF.28/P/635

THE HOMOGENEOUS SUSPENSION REACTOR PROJECT
JJ WEST
EURONUCLEAR 3 /2/, 89-92 /FEB, 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	DAVID POWER REACTOR /ASEA, SWEDEN
DESIGNER	ASEA, SWEDEN
PURPOSE	CONCEPT FOR POWER, DESIGN STUDY
TYPE	SLURRY FUEL HOMOGENEOUS.
CRITICAL	CONCEPT
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM THORIUM OXIDES IN HEAVY WATER, SLURRY
REMARKS	EXPERIMENTAL WORK IN PROGRESS NO RECENT INFORMATION.
REFERENCES	A BOILING SLURRY REACTOR CONCEPT. O. LINDSTROM, B. WIDELL ASEA RESEARCH, NO. 7, PP. 239-70 /1962/

JANUARY 1969 BNWL-936

AQ. HOMOGENEOUS AND MOLTEN SALT REACTORS,FOREIGN AF05

* * * * * * * * * * * * * * * * *

NAME/OWNER	MOSEL /MOLTEN SALT EPITHERMAL REACTOR//W GERMANY
DESIGNER	KFA, JUELICH, W. GERMANY
PURPOSE	POWER
TYPE	TWO-FLUID, TWO-REGION MOLTEN SALT REACTOR MODULAR CONSTRUCTION
POWER MWE(MWT)	500
CRITICAL	CONCEPTUAL DESIGN
COOLANT	BLANKET FLUID, INTERMEDIATE HEAT TRANSFER FLUID
FUEL MATERIAL	CORE, URANIUM DISSOLVED IN MOLTEN FLUORIDES BLANKET, THORIUM IN MOLTEN FLUORIDES SODIUM AND BERYLLIUM FLUORIDES
FUEL GEOMETRY	MOLTEN SALT MIXTURE
FUEL ASSEMBLY	FUEL CHANNEL DESIGNS INCLUDE PIPES OR PLATES PLATE-TYPE CORES COULD INVOLVE CONCENTRIC RINGS, SPIRALS, INVOLUTES, AND PLATES
SPECIFIC POWER	1-3 MW/KG
COOLANT TEMP.	550-640 C
REMARKS	A CONCEPTUAL DESIGN AND ECONOMIC STUDY FOR A TWO-FLUID, TWO-REGION REACTOR. POWER PLANT INCLUDES THE REACTOR, TURBINE GENERATOR, AND FUEL PROCESSING FACILITIES. CORE IS SEPARATED FROM THE SURROUNDING BLANKET BY A WALL. BLANKET SALT PASSES THROUGH THE CORE BEFORE FLOWING THROUGH THE BLANKET REGION INTERNAL DIRECT CONTACT COOLING, WITH LEAD AS THE COOLANT, AND INTERNAL COOLING WITH SEPARATE FUEL AND COOLANT ARE BEING STUDIED, AS WELL AS EXTERNAL COOLING WITH DIRECT CONTACT HEAT EXCHANGE.
REFERENCES	THE MOSEL REACTOR CONCEPT PR KASTEN GENEVA, 1964, PAPER =538 ATOMPRAXIS 10, 441-43 /1964/ THE MOSEL REACTOR CONCEPT PR KASTEN 3RD U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF.28/P/538

* * * * * * * * * * * * * * * * *

DESIGN CONCEPTS FOR THE CORE STRUCTURE OF A MOSEL
MOLTEN SALT EXPERIMENT REACTOR
PR KASTEN
NUCLEAR STRUCTURAL ENG, 2, 224-32 /1965/

COOLING CONCEPTS FOR A COMPACT MOSEL /MOLTEN
SALT/ REACTOR.
U GAT
NUCLEAR ENG, DESIGN 5, 113-22 /MARCH 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	SAWA/INST. NUCLEAR RESEARCH, POLAND
DESIGNER	INSTITUTE OF NUCLEAR RESEARCH, POLAND
PURPOSE	POWER BREEDER
TYPE	MOLTEN SALT HOMOGENEOUS, FAST BREEDER
POWER MWE(MWT)	1000
CRITICAL	CONCEPT
COOLANT	ALUMINUM CHLORIDE, BOILING, CLOSED CYCLE CIRCULATION
FUEL MATERIAL	CORE, PLUTONIUM TRICHLORIDE, MOLTEN BLANKET, URANIUM CHLORIDES, SODIUM OR POTASSIUM CHLORIDE AS DILUENT
FUEL ASSEMBLY	6000-LITER CORE
FUEL CHARGE	1000 KG, PLUTONIUM-239 4000 KG, URANIUM-238
SPECIFIC POWER	333 KW/LITER LIQUID SALT
COOLANT TEMP.	INLET 280 C /LIQUID/ OUTLET 800 C /VAPOR/
REMARKS	SODIUM CHLORIDE IN THE CORE COMPOSITION IS AN INACTIVE DILUENT. THE ALUMINUM CHLORIDE CIRCULATES IN A CLOSED CYCLE, THE VAPOR TRANSFERRING HEAT FROM CORE TO AN EXCHANGER OR TURBINE WITH CONDENSER. IT IS THEN RETURNED TO THE CORE IN LIQUID STATE.
REFERENCES	SALT-BOILING FAST REACTOR SAWA. M TAUBE, OTHERS INR-669/C /DEC. 1965/ CONCEPTS OF THE FUSED SALT REACTORS SAWA AND WARS. COMPILATION OF CHARACTERISTICS. M TAUBE, A KOWALEW KERNENERGIE 10, 184-6 /JUNE 1967/ NEW BOILING SALT FAST BREEDER REACTOR CONCEPTS. M TAUBE, OTHERS NUCLEAR ENG. DESIGN 5, 109-12 /1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	WARS/INST. NUCLEAR RESEARCH, POLAND
DESIGNER	INSTITUTE OF NUCLEAR RESEARCH, POLAND
TYPE	MOLTEN SALT FAST REACTOR
POWER MWE(MWT)	1000
CRITICAL	DESIGN
COOLANT	BOILING MERCURY
FUEL MATERIAL	CORE, PLUTONIUM TRICHLORIDE BLANKET URANIUM CHLORIDE SODIUM OR POTASSIUM CHLORIDE DILUENT
FUEL ASSEMBLY	MERCURY IS PUMPED INTO THE FUSED SALT TO GIVE A DISPERSED SYSTEM, AND IS HEATED TO BOILING TEMPERATURE.
SPECIFIC POWER	400 KW/LITER SALT
COOLANT TEMP.	INLET 600 C OUTLET 740 C
REACTOR VESSEL	TANK-TYPE VESSEL
REFERENCES	MERCURY-BOILING FUSED-SALT FAST REACTOR, WARS M TAUBE, OTHERS INR-706/C /APRIL 1966/ CONCEPT OF THE FUSED SALT REACTORS SAWA AND WARS. COMPILATION OF CHARACTERISTICS M TAUBE, A KOWALEW KERNENERGIE 10, 184-6 /JUNE 1967/ NEW BOILING SALT FAST BREEDER REACTOR CONCEPTS. M TAUBE, OTHERS NUCLEAR ENG. DESIGN 5, 109-12 /1967/

BOILING LIGHT WATER REACTORS

DOMESTIC

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD01

* * * * * * * * * * * * * * * * *

NAME/OWNER	PATHFINDER ATOMIC POWER PLANT/AEC,NSP
DESIGNER	ALLIS-CHALMERS MANUFACTURING CO.
OPERATOR	NORTHERN STATES POWER COMPANY
LOCATION	SIOUX FALLS, S. D. BIG SIOUX RIVER
PURPOSE	POWER DEMONSTRATION
TYPE	BWR, CONTROLLED RECIRCULATION, NUCLEAR SUPERHEAT
POWER MWE(MWT)	58.5 189
CRITICAL	MARCH 1964, CORE/BOILER/AND SUPER HEATER DEC. 1964 SEE REMARKS
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	BOILER, URANIUM DIOXIDE PELLETS 0.348 AND 0.310 IN. DIA. SUPERHEATER, URANIUM DIOXIDE-SS CERMET 0.020 IN. THICK
FUEL GEOMETRY	BOILER, RODS 72 IN. ACTIVE LENGTH SUPERHEATER, CONCENTRIC TUBES 71.5 IN. ACTIVE LENGTH
FUEL CLADDING	BOILER, ZIRCALOY-2 0.04 IN. THICK SUPERHEATER, SS. 0.006 IN. THICK
FUEL ENRICH.	BOILER, 2.2 AND 3.2 PER CENT U-235 SUPERHEATER, 93 PER CENT U-235
FUEL ASSEMBLY	BOILER, 81 RODS, 9X9, 96 ELEMENTS/LOADING SUPERHEATER, 2 FUELED CERMET TUBES, CONCENTRIC, 412 ELEMENTS/LOADING
FUEL CHARGE	BOILER 6560 KG. URANIUM SUPERHEATER 50 KG. U-235
SPECIFIC POWER	24 KW/KG U IN BOILER
BURNUP(REFUEL)	10,000 MWD/TON U FUEL LIFETIME AVE. 1.3 YEARS FOR SUPERHEAT, 9 MONTHS.
NEUTRON FLUX	THERMAL AVE. 4X10 E+13 /BOILER/

* * * * * * * * * * * * * * * * *

10 E+13 /SUPERHEATER/
FAST AVE. 2X10 E+14

CONTROL BORON-SS CONTROL RODS, CONTROLLED RECIRCULATION

COOLANT TEMP. INLET 360 F OUTLET 825 F

REACTOR VESSEL CYLINDRICAL, CARBON STEEL, SS LINED.

CONTAINMENT CYLINDRICAL STEEL VESSEL, HEMISPHERICAL TOP AND ELLIPSOIDAL BOTTOM, 50 FT. ID./120.5 FT. HIGH. ABOUT ONE-HALF BELOW GRADE.

REMARKS THE COOLANT IS CIRCULATED BY PUMPS LOCATED EXTERNALLY TO THE REACTOR VESSEL. WET STEAM GENERATED IN THE BOILING REGION PASSES THROUGH THE NUCLEAR SUPERHEATER FOR CONVERSION TO DRY STEAM FOR USE IN THE ELECTRICITY-GENERATING TURBINE.
THE SECOND SUPERHEAT FUEL LOADING WILL CONSIST OF LOW-ENRICHMENT URANIUM DIOXIDE PELLETS, CLADDING UNDETERMINED. THE BOILER ELEMENTS WILL PROBABLY BE UNCHANGED.
SCHEDULED SHUT-DOWN IN SEPT. 1967 SHOWED SEVERAL FAILED STEAM SEPARATOR NOZZLES. NORTHERN STATES POWER HAS SHUT DOWN THE REACTOR PERMANENTLY

REFERENCES

A CONTROLLED RECIRCULATION BOILING WATER REACTOR WITH NUCLEAR SUPERHEATER.
CB GRAHAM, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 74-8 /1958/

INTERIM FEASIBILITY REPORT, NUCLEAR SUPERHEATER FOR A CONTROLLED RECIRCULATION BOILING REACTOR.
ALLIS-CHALMERS
AECU-3704 /MAY 1958/

A CONTROLLED RECIRCULATION BOILING WATER REACTOR WITH NUCLEAR SUPERHEATER. PATHFINDER ATOMIC POWER PLANT FEASIBILITY REPORT.
ALLIS-CHALMERS
ACNP-5917 /AUGUST 1959/

PATHFINDER ATOMIC POWER PLANT SAFEGUARDS REPORT. PART II. LICENSE APPLICATION.
NORTHERN STATES POWER CO.
ACNP-5905 /JANUARY 15, 1962/

DESIGN AND CONSTRUCTION PRACTICE, PATHFINDER AND BONUS.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD01

* * * * * * * * * * * * * * * * *

W MITCHELL
POWER REACTOR TECHNOLOGY 7/3/, 276-312
/SUMMER 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	LA CROSSE BWR/DAIRYLAND POWER
DESIGNER	ALLIS-CHALMERS MANUFACTURING CO.
OPERATOR	DAIRYLAND POWER COOPERATIVE
LOCATION	GENOA, WISCONSIN MISSISSIPPI RIVER
PURPOSE	POWER DEMONSTRATION, 2ND ROUND.
TYPE	BWR, FORCED CIRCULATION, DIRECT CYCLE. SINGLE PASS, SINGLE ZONE
POWER MWE(MWT)	50 165
CRITICAL	JULY 1967. ON-LINE TARGET OCT. 1968.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.350 IN. DIA./1.05 IN. LONG
FUEL GEOMETRY	ROD 0.396 IN. OD./83 IN. ACTIVE LENGTH
FUEL CLADDING	STAINLESS STEEL TUBES 0.020 IN. WALL THICKNESS THICKNESS
FUEL ENRICH.	3.63 PER CENT U-235
FUEL ASSEMBLY	ROD BUNDLE 10/10, ZIRCONIUM AND SS SHROUDS 72 ASSEMBLIES/CORE SS SHROUDS OF INITIAL CORE WILL BE REPLACED PART WAY THROUGH CORE LIFE BY ZIRCONIUM SHROUDS. SHROUD SECTIONS ARE REMOVABLE.
FUEL CHARGE	8600 KG. URANIUM
BURNUP(REFUEL)	INITIAL CORE 12,700 MWD/T
NEUTRON FLUX	THERMAL AVE. 1.5 X 10 E+13
CONTROL	BORON CARBIDE PELLETS IN INCONEL TUBES CRUCIFORM SHEATHS OF SS CONTROLLED CIRCULATION
COOLANT TEMP.	INLET 285.6 F

* * * * * * * * * * * * * * * * *

COOLANT PRESS, INLET	1350 PSIA
REACTOR VESSEL	CYLINDRICAL STEEL VESSEL, HEMISPHERICAL ENDS SS LINING 0.188 IN. THICK 8.25 FT. ID/37 FT. HIGH, 4 IN. WALL THICKNESS WITH CLADDING SS INNER THERMAL SHIELD
CONTAINMENT	STEEL BUILDING, HEMISPHERICAL DOME LINED ABOVE-GRADE WITH 9-IN. CONCRETE. DOME IS UNLINED
REFERENCES	HAZARDS SUMMARY REPORT FOR CONSTRUCTION AUTHORIZATION OF THE LA CROSSE BOILING WATER REACTOR. ALLIS-CHALMERS MANUFACTURING CO. ACNP-62574 /OCTOBER 1962/ LA CROSSE BOILING WATER REACTOR, SAFEGUARDS REPORT FOR OPERATING AUTHORIZATION. ALLIS-CHALMERS ACNP-65544 /VOL. 1-2/ JULY 1965

* * * * * * * * * * * * * * * * *

NAME/OWNER	SUPERHEAT REACTOR STUDY /AC
DESIGNER	ALLIS-CHALMERS MANUFACTURING CO.
PURPOSE	POWER
TYPE	BWR NUCLEAR SUPERHEAT AND BWR SUPERHEAT-REHEAT DESIGNS.
POWER MWE(MWT)	400
CRITICAL	DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
REMARKS	AN INTEGRAL SUPERHEAT REACTOR ISR IS DESIGNED TO REACH STEAM AT 1450 PSIG AND 1000 F BY 3 PASSES THROUGH THE BOILER AND SUPERHEATER. A SUPERHEAT-REHEAT REACTOR SSR CONCEPT WOULD USE TWO REACTORS, THE STEAM BEING DEVELOPED IN A SUPER HEAT BWR AND REHEATED IN A SEPARATE SUPERHEAT REACTOR.
REFERENCES	APPLIED ATOMICS DEC. 11, 1963 P 6-7. NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	SUPERHEAT REACTOR FOR PROPULSION/AC
DESIGNER	ALLIS-CHALMERS MANUFACTURING CO.
PURPOSE	SHIP PROPULSION, SURFACE VESSEL
TYPE	BWR, NUCLEAR SUPERHEAT
POWER MWE(MWT)	175
CRITICAL	DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL GEOMETRY	RODS, ACTIVE LENGTH 7 FT.
FUEL ASSEMBLY	BOILER, 136 ELEMENTS SUPERHEATER /CENTRAL/, 343 ELEMENTS
CONTROL	RODS
REACTOR VESSEL	STEEL VESSEL 9.5 FT. ID./30 FT. LONG. WALL THICKNESS INCLUDING CLAD 5 IN.
CONTAINMENT	STEEL VESSEL PLUS LEAD SHIELDING.
REMARKS	FULL DESIGN STUDY HAS BEEN DONE FOR GIBBS AND COX, N. Y.
REFERENCES	NUCLEAR SUPERHEAT PROPULSION SYSTEM FOR A PASSENGER LINER. ALLIS-CHALMERS, ATOMIC ENERGY DIV. ACNP-6125, SUPPLEMENT 1. /1961/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD05

* * * * * * * * * * * * * * * * *

NAME/OWNER	ELK RIVER REACTOR/AEC
DESIGNER	ALLIS-CHALMERS MANUFACTURING CO.
OPERATOR	RURAL COOPERATIVE POWER ASSOCIATION
LOCATION	ELK RIVER, MINNESOTA MISSISSIPPI RIVER
PURPOSE	POWER DEMONSTRATION, 2ND ROUND
TYPE	BWR, NATURAL CIRCULATION, INDIRECT CYCLE, SEPARATE SUPERHEAT.
POWER MWE(MWT)	22 64
CRITICAL	NOV. 1962, FULL POWER FEB. 1964
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM-THORIUM OXIDE PELLETS 0.407 IN. DIA./0.500 IN. LONG
FUEL GEOMETRY	ROD, 5 FT. ACTIVE LENGTH
FUEL CLADDING	SS 0.410 IN. ID./0.020 IN. THICK
FUEL ENRICH.	4.3 PER CENT U-235 SPIKE ELEMENTS 5.23 PER CENT
FUEL ASSEMBLY	25 RODS 5X5 148 ASSEMBLIES/CORE SPIKE ASSEMBLIES 5.23 PER CENT ENRICHED WILL BE LOADED 640 DAYS AFTER STARTUP.
FUEL CHARGE	185 KG. URANIUM
SPECIFIC POWER	341 KW/KG U-235
BURNUP(REFUEL)	10,000 MWD/T FUEL REFUELED APRIL 1967 AVE. 8730 MWD/T
NEUTRON FLUX	THERMAL AVE. 1.55X10 E+13 FAST AVE. 4.8X10 E+13
CONTROL	BORON ALLOYED WITH SS CLADDING TUBES AS BURNABLE POISON. SS-BORON ALLOY RODS.
COOLANT TEMP.	INLET 450 F

* * * * * * * * * * * * * * * * *

COOLANT PRESS, INLET	940 PSIA
REACTOR VESSEL	STEEL SHELL, SS CLAD, UPRIGHT CYLINDER 7 FT. ID./ 25 FT. HIGH
CONTAINMENT	VERTICAL STEEL CYLINDER 74 FT. DIA./115 FT. HIGH.
REMARKS	SPIKE ASSEMBLIES WILL INCREASE CORE LIFE, AMOUNT IS NOT SPECIFIED.

REFERENCES

A PROPOSAL FOR A NUCLEAR STEAM GENERATING PLANT FOR THE RURAL COOPERATIVE POWER ASSOCIATION, ELK RIVER, MINNESOTA.
ACF IND. INC.
NP-7331 /1958/

ELK RIVER REACTOR QUARTERLY PROGRESS REPORT FOR JUNE, JULY, AUGUST 1959.
ALLIS-CHALMERS
ACNP-ERR-5 /1959/

FINAL HAZARDS REPORT FOR THE RCPA ELK RIVER REACTOR AT ELK RIVER, MINNESOTA, AND ADDITIONS AND CORRECTIONS TO FINAL HAZARDS REPORT FOR THE ELK RIVER REACTOR AT ELK RIVER, MINNESOTA.
WS FARMER, DG STRAWSON
TID-11734 /JULY 1960/

DESIGN PRACTICE: THE ELK RIVER REACTOR.
POWER REACTOR TECHNOLOGY 5, 33-47 /MARCH 1962/

NUCLEONICS REACTOR FILE NO. 18
ERR, ELK RIVER REACTOR
NUCLEONICS 21 /7/, /JULY 1963/ /FOLDOUT/

TECHNICAL SPECIFICATIONS FOR THE RCPA ELK RIVER REACTOR AT ELK RIVER, MINNESOTA.
ALLIS-CHALMERS MAF. CO.
TID-21059 /REVISED SEPT. 1,1961/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD06

* * * * * * * * * * * * * * * * *

NAME/OWNER	ZBSR /ZIRCONIUM BOILING-SUPERHEATING REACTOR//AI
DESIGNER	ATOMICS INTERNATIONAL
PURPOSE	POWER
TYPE	BOILING-SUPERHEATING, DIRECT CYCLE, FORCED CIRCULATION.
POWER MWE(MWT)	300 778
CRITICAL	STUDY
COOLANT	LIGHT WATER AND STEAM
MODERATOR	BOILER, LIGHT WATER SUPERHEATER, ZIRCONIUM HYDRIDE
FUEL MATERIAL	BOILER, URANIUM DIOXIDE PELLETS SUPERHEATER, URANIUM DIOXIDE SINTERED POWDER
FUEL GEOMETRY	ROD BOILER, 0.394 IN. DIA./0.396 IN. LONG SUPERHEATER, 0.403 IN. DIA.
FUEL CLADDING	BOILER, ZIRCALOY-2 TUBES, 0.450 IN. OD. SUPERHEATER, SS THIN-WALL TUBES
FUEL ENRICH.	BOILER, 2.53 PER CENT U-235 SUPERHEATER, 3.39 PER CENT U-235
FUEL ASSEMBLY	BOILER, 140-ROD BUNDLE, 12X12 WITH 4 CENTRAL RODS REMOVED. ZIRCALOY BOX CONTAINS 5 BUNDLES 84 ASSEMBLIES/BOILER SUPERHEATER, 7-ROD CLUSTER FITTED INTO A 1700-IN. DIA. FLOW CHANNEL IN MODERATOR LOG ASSEMBLY. 16 CHANNELS/LOG. 45 LOGS IN SUPERHEAT REGION
FUEL CHARGE	BOILER, 28,400 KG. URANIUM SUPERHEATER 12,500 KG. URANIUM
SPECIFIC POWER	19 KW/KG U
BURNUP(REFUEL)	10,000 MWD/MTU /BATCH/
CONTROL	BORON-SS RODS
COOLANT TEMP.	INLET 593 F OUTLET 600 F
COOLANT PRESS.	1550 PSIG

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD06

* * * * * * * * * * * * * * * * *

REACTOR VESSEL CARBON STEEL VESSEL 11 FT, 4 IN, DIA,/51 FT, HIGH, SS LINER,

REMARKS THE REACTOR CORE CONSISTS OF A CENTRAL SUPERHEAT REGION, AND A PERIPHERAL BOILING REGION, IN WHICH STEAM IS PRODUCED. THE BOILING REGION IS COOLED AND MODERATED BY LIGHT WATER, THE SUPERHEAT REGION CONSISTS OF ZIRCONIUM HYDRIDE MODERATOR LOG ASSEMBLIES, FUEL ASSEMBLIES AND CONTROL RODS, IT IS SEPARATED FROM THE BOILING REGION BY A FLOW BAFFLE, AND IS IN A STEAM ENVIRONMENT DURING OPERATION, A CONCEPT IN WHICH THE ZIRCONIUM HYDRIDE IS USED AS BOTH MODERATOR AND FUEL CLADDING MATERIAL WAS BRIEFLY INVESTIGATED, THE INTEGRAL FUEL-MODERATOR CONCEPT, AS WELL AS A 50-MWE CONCEPT,

REFERENCES EVALUATION OF ZIRCONIUM HYDRIDE AS MODERATOR IN INTEGRAL BOILING WATER-SUPERHEAT REACTORS,
JD GYLFE, OTHERS
NAA-SR-5943 /MARCH 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BWR DUAL PURPOSE STUDY/AMF-MITCHELL
DESIGNER	AMF-ATOMICS, MITCHELL ENG.
PURPOSE	POWER, DUAL PURPOSE
TYPE	BWR
POWER MWE(MWT)	25 110 COMBINED OUTPUT FROM NUCLEAR AND GEOTHERMAL WOULD BE 50 MWE
CRITICAL	STUDY
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	RODS
FUEL CLADDING	SS
FUEL ENRICH.	2.2 PER CENT U-235
FUEL ASSEMBLY	8X8 ROD ASSEMBLY IN ZIRCONIUM BOX
CONTROL	SILVER-INDIUM RODS
COOLANT TEMP.	476 F
REMARKS	A STUDY SUBMITTED TO ITALY-S LARDERELLO CO. ON THE FEASIBILITY OF INTEGRATING A BWR INTO THE LARDERELLO GEOTHERMAL STEAM GENERATING SYSTEM. COMPLETION OF STUDY IN 1962. AMF HAS DESIGNED A DUAL PURPOSE REACTOR FOR POWER AND WATER DESALINATION BASED ON THIS STUDY.
REFERENCES	NUCLEAR POWER FEB. 1962 P. 77. NEWS RELEASE. NUCLEONICS 21, 27/APRIL 1963/. NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	BWR-PWR STUDY/AMF
DESIGNER	AMF ATOMICS
PURPOSE	DUAL PURPOSE, POWER AND WATER DESALINATION.
TYPE	BWR-PWR, BOILING-SUPERHEATING.
POWER MWE(MWT)	110
CRITICAL	STUDY
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD
FUEL CLADDING	SS TUBES
FUEL ENRICH.	2.2 PERCENT U-235
FUEL ASSEMBLY	8X8 ROD ASSEMBLY, ZIRCONIUM BOX
CONTROL	RODS
REMARKS	THE REACTOR WOULD BE USED WITH A MULTISTAGE FLASH UNIT SUPPLIED BY AMF-S MAXIM DIVISION, AND WOULD DESALINIZE 10 MILLION GALLONS PER DAY WITH ABOUT 156,000 KWH/DAY OF ELECTRICITY. THE DUAL PURPOSE DESIGN IS AN OUTGROWTH OF AN AMF/UK-MITCHELL STUDY OF A BOILING-SUPERHEAT REACTOR FOR ITALY-S LARDERELLO COMPANY, WHICH WAS PROPOSED FOR USE IN COMBINATION WITH A GEOTHERMAL STEAM PLANT.
REFERENCES	NUCLEONICS WEEK, MARCH 7, 1963, P. 3. NEWS RELEASE.

* * * * * * * * * * * * * * * * *

NAME/OWNER	VMR /VARIABLE MODERATOR REACTOR/AM-STANDARD
DESIGNER	AMERICAN STANDARD CORP.
LOCATION	CRITICAL ASSEMBLY AT ADVANCED TECHNOLOGY LABS, CALIFORNIA
PURPOSE	POWER PROTOTYPE
TYPE	BWR, VARIABLE MODERATOR, DIRECT CYCLE, FORCED CIRCULATION. CALANDRIA /SHELL-AND-TUBE/ CORE STRUCTURE.
POWER MWE(MWT)	5-50
CRITICAL	R AND D
COOLANT	LIGHT WATER IN FUEL CHANNELS
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, SINTERED AND GROUND, 0.320 IN. DIA.
FUEL GEOMETRY	PINS, 0.353 IN. DIA., 50 IN. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY OR 348 SS
FUEL ENRICH.	2.2 PER CENT U-235
FUEL ASSEMBLY	HEXAGONAL 37 RODS 181 ASSEMBLIES/CORE
FUEL CHARGE	4590 KG. URANIUM DIOXIDE
BURNUP(REFUEL)	15,000 MWD/TU BATCH, 1/3 CORE PER YEAR
NEUTRON FLUX	THERMAL AVE. 3.1X10 E+13
CONTROL	MODERATOR LEVEL ADJUSTMENT, OR MODERATOR LEVEL ADJUSTMENT AND SOLUTION POISON.
COOLANT TEMP.	INLET 537 F OUTLET 545 F
COOLANT PRESS.	1000 PSIA OPERATING STEAM PRESSURE
REACTOR VESSEL	CYLINDRICAL A212-B STEEL, 304 SS CLAD, 6 FT. 4 IN. ID./ 14 FT. 6 IN. LONG.
REMARKS	PROPOSAL HAS BEEN MADE BY WOLVERINE ELEC. COOP.,

* * * * * * * * * * * * * * * * *

MICHIGAN, FOR A POWER PROTOTYPE BASED ON AMERICAN-STANDARD-S DESIGN STUDY OF VARIABLE MODERATOR REACTOR. A VMR IS UNDER STUDY AT BATTELLE MEMORIAL INSTITUTE. REACTOR CONCEPT PROPOSES AN ARRANGEMENT OF FUEL RODS IN CLUSTERS WHICH ARE SEPARATED FROM ONE ANOTHER BY RELATIVELY WIDE MODERATOR CHANNELS. THE COOLANT WATER IN THE CHANNELS IS SEPARATED FROM THE MODERATOR WATER OUTSIDE THE CLUSTERS BY A CALANDRIA DESIGN OF THE CORE STRUCTURE. LEVEL OF THE MODERATOR CAN BE ADJUSTED TO REGULATE AND CONTROL REACTIVITY.

REFERENCES

VARIABLE MODERATOR REACTOR DEVELOPMENT PROGRAM, QUARTERLY PROGRESS REPORT NO. 1, AUGUST 31, 1959, ATL-A-100 /1959/

HAZARDS SUMMARY REPORT FOR THE VMR CRITICAL ASSEMBLY EXPERIMENTS.
RA EGEN, OTHERS
BMI-1445 /JUNE 10, 1960/

TECHNICAL FEASIBILITY AND ECONOMIC POTENTIAL OF THE VARIABLE MODERATOR REACTOR, FINAL REPORT.
AMERICAN-STANDARD, ADV. TECHNOLOGY LABS.
ATL-A-109 /REV.1/ /DECEMBER 1960/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BORAX-4 /BOILING REACTOR EXPERIMENT-4/AEC
DESIGNER	ARGONNE NATIONAL LABORATORY
OPERATOR	ARGONNE NATIONAL LABORATORY
LOCATION	NATIONAL REACTOR TEST STATION, IDAHO
PURPOSE	POWER EXPERIMENT
TYPE	BWR
POWER MWE(MWT)	2 20
CRITICAL	1957, CORE REVISION 1958
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM-THORIUM DIOXIDE PELLETS 0.225 IN. DIA. BORAX-3 USED URANIUM-ALUMINUM ALLOY FUEL
FUEL GEOMETRY	PLATE
FUEL CLADDING	ALUMINUM-NICKEL ALLOY
FUEL ENRICH.	7 PERCENT U-235 /BORAX-3 ENRICHMENT WAS 90 PERCENT/
FUEL ASSEMBLY	EXTRUDED ALLOY PLATES WITH 2 1/2 IN. DIA. TUBULAR CAVITIES CONTAINING FUEL PELLETS, THERMALLY BONDED TO CLADDING WITH LEAD. 6 PLATES/ASSEMBLY 69 ASSEMBLIES/CORE
NEUTRON FLUX	THERMAL AVE. 5X10 E+13
COOLANT TEMP.	400 F
COOLANT PRESS.	300 PSIG
REMARKS	EARLY BORAX EXPERIMENTS USED METALLIC FUEL TO INVESTIGATE BWR STABILITY.
REFERENCES	DESIGN AND OPERATING EXPERIENCE OF A PROTOTYPE BOILING WATER POWER REACTOR. JR DIETRICH, OTHERS PROC. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 3, 56-60 /1958/

* * * * * * * * * * * * * * * * *

OPERATIONAL EXPERIENCE WITH BORAX POWER PLANT.
WH ZINN, OTHERS
NUCLEAR SCI. AND ENG. 1, 420-37 /OCTOBER 1956/

PERFORMANCE EVALUATION OF DIRECT CYCLE BOILING
WATER NUCLEAR POWER PLANTS BASED ON RECENT EBWR
AND BORAX DATA.
JM HARRER, OTHERS
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY 9, 264-85 /1958/

CIVILIAN POWER REACTOR PROGRAM. PART III. STATUS
REPORT ON THE BOILING WATER REACTOR TECHNOLOGY AS
OF 1959.
TID-8518 /5/ BOOK 5.

* * * * * * * * * * * * * * * * *

NAME/OWNER	BORAX-5 /BOILING REACTOR EXPERIMENT-5//AEC
DESIGNER	ARGONNE NATIONAL LABORATORY
OPERATOR	ARGONNE NATIONAL LABORATORY
LOCATION	NATIONAL REACTOR TEST STATION, IDAHO
PURPOSE	POWER EXPERIMENT, NUCLEAR SUPERHEAT DEMONSTRATION.
TYPE	BWR, FORCED OR NATURAL CIRCULATION, DIRECT CYCLE, NUCLEAR SUPERHEAT.
POWER MWE(MWT)	2 20
CRITICAL	1962, DRY SUPERHEATED STEAM PRODUCED OCTOBER 1963, REACTOR PHASED OUT OF SUPERHEAT PROGRAM 1965
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	BOILER, URANIUM DIOXIDE PELLETS 0.343 IN. DIA. SUPERHEATER, URANIUM DIOXIDE-SS CERMET
FUEL GEOMETRY	BOILER, RODS, 3/8 IN. DIA./24 IN. ACTIVE LENGTH SUPERHEATER, FLAT PLATE, 0.014 IN. THICK MEAT
FUEL CLADDING	BOILER, SS TUBES, WALL THICKNESS 0.015 IN. SUPERHEATER, SS CLADDING 0.008 IN. THICK
FUEL ENRICH.	BOILER, 10 PER CENT U-235 SUPERHEATER, 93 PER CENT U-235
FUEL ASSEMBLY	BOILER, 49 RODS, 7X7 SUPERHEATER, RIGID 4-PLATE ELEMENT 5 ELEMENTS/ASSEMBLY 12 ASSEMBLIES IN CENTRAL LOADING
NEUTRON FLUX	BOILER, 1.33X10 E+13 /AXIAL/,1.45X10 E+13 /RADIAL/ SUPERHEATER 1.30X10 E+13 /AXIAL/
CONTROL	BORAL, SS-CLAD RODS.
REACTOR VESSEL	CYLINDRICAL, CARBON STEEL 66 3/8 IN. ID. /16 FT. HIGH, SS LINED
CONTAINMENT	PIT, SHIELDED BY HIGH DENSITY CONCRETE
REMARKS	STEAM IS SUPERHEATED IN TWO PASSES, FLOWING DOWN

* * * * * * * * * * * * * * * * *

THROUGH FIRST-PASS ELEMENTS, THEN UPWARD THROUGH SECOND PASS. THREE SEPARATE CORE CONFIGURATIONS ARE POSSIBLE. BOILER-SUPERHEATER WITH CENTRAL SUPERHEAT, PURE BOILER, NO SUPERHEAT, AND BOILER WITH PERIPHERAL SUPERHEAT. DRY SUPERHEATED STEAM PRODUCED IN OCT. 1963.

REFERENCES

PRELIMINARY DESIGN AND HAZARDS REPORT, BOILING REACTOR EXPERIMENT V /BORAX-V/
ARGONNE NATIONAL LABORATORY
ANL-6120 /FEBRUARY 1960/

A NUCLEAR SUPERHEATING REACTOR-BORAX-V.
N NOVICK, OTHERS
SMALL AND MEDIUM POWER REACTORS, VOL. 1,PP. 111-25
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

DESIGN AND HAZARDS SUMMARY REPORT, BOILING REACTOR EXPERIMENT V /BORAX-V/.
ARGONNE NATIONAL LABORATORY
ANL-6302 /MAY 1961/

BORAX-V INTEGRAL NUCLEAR SUPERHEAT REACTOR EXPERIMENTS.
WR WALLIN, OTHERS
POWER REACTOR EXPERIMENTS, VOL. 2 PP. 9-26
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

BORAX-V A NUCLEAR SUPERHEAT REACTOR.
RE RICE, WR WALLIN
AMERICAN POWER CONFERENCE 26TH ANNUAL MEETING.
CHICAGO, APRIL 1964, CONF-504-2

* * * * * * * * * * * * * * * * *

NAME/OWNER	ALPR /ARGONNE LOW POWER REACTOR//AEC-ARMY
DESIGNER	ARGONNE NATIONAL LABORATORY
OPERATOR	COMBUSTION ENGINEERING, INC.
LOCATION	NATIONAL REACTOR TEST STATION, IDAHO
PURPOSE	PROTOTYPE PACKAGE POWER REACTOR
TYPE	BWR, NATURAL CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	250 KWE 3
CRITICAL	1958, DESTROYED BY EXPLOSION JANUARY 1961
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM-ALUMINUM-NICKEL ALLOY
FUEL GEOMETRY	PLATE, 3 7/8 IN. BY 3 7/8 IN. BY 34 1/2 IN.
FUEL CLADDING	ALUMINUM-NICKEL ALLOY, 0.035 IN. THICK
FUEL ENRICH.	91 PER CENT U-235
FUEL ASSEMBLY	9 PLATES/ASSEMBLY 40 ASSEMBLIES TO CORE
FUEL CHARGE	14 KG. U-235 IN 40-ELEMENT CORE, 21 KG. U-235 IN 60-ELEMENT CORE
SPECIFIC POWER	214 KW/KG U-235 IN 40-ELEMENT CORE
BURNUP(REFUEL)	APPROX. 20 PER CENT 3 YEAR LIFE. IN 60-ELEMENT CORE.
NEUTRON FLUX	THERMAL AVE. 7.5X10 E+12 FAST MAX. 3.28 X 10 E+12
CONTROL	BURNABLE POISON, BORON-10 IN ALUMINUM ATTACHED TO ASSEMBLY. 9 CONTROL RODS
COOLANT TEMP.	INLET 175 F OUTLET 420 F
COOLANT PRESS.	300 PSIG
REACTOR VESSEL	STEEL

* * * * * * * * * * * * * * * * *

CONTAINMENT CYLINDRICAL TANK-TYPE STRUCTURE, 38 FT, DIA./
48 FT, HIGH, GRAVEL SHIELDING FILL AROUND
PRESSURE VESSEL AND COMPONENTS.

REMARKS OPERATION 1958. EXPLOSION ON JANUARY 3, 1961
DESTROYED CORE, RESULTING IN THREE FATALITIES.
REACTOR HAS BEEN DISMANTLED.

REFERENCES DESIGN STUDY OF A NUCLEAR POWER PLANT FOR 100 KW
ELECTRIC AND 400 KW HEAT CAPACITY.
M TRESHOW, OTHERS
ANL-5452 /1957/

ARGONNE LOW POWER REACTOR. A PROTOTYPE DIRECT
CYCLE BOILING WATER REACTOR PACKAGE PLANT FOR
ELECTRIC POWER PRODUCTION AND SPACE HEATING.
CR BRAUN
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY 9, 244-54 /1958/

ABWR PL-1 REFERENCE DESIGN REPORT.
FJ STARON, LM JOHNSON
CEND-70 /JANUARY 1960/

DESIGN OF THE ARGONNE LOW POWER REACTOR /ALPR/
NR GRANT, OTHERS
ANL-6076 /MAY 1961/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EBWR/EXPERIMENTAL BOILING WATER REACTOR//AEC
DESIGNER	ARGONNE NATIONAL LABORATORY
OPERATOR	ARGONNE NATIONAL LABORATORY
LOCATION	LEMONT, ILLINOIS DES PLAINES RIVER
PURPOSE	POWER EXPERIMENT
TYPE	BWR, NATURAL CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	5 20 100 MWT MODIFICATION IN 1962
CRITICAL	1956 SHUT DOWN PERMANENTLY JUNE 1967
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	CORE 1, URANIUM-NIOBIUM-ZIRCONIUM ALLOY CORE 1A, URANIUM OXIDE IN ALUMINUM MATRIX SPIKE ELEMENTS URANIUM OXIDE IN ZIRCONIUM OR CALCIUM OXIDE MODIFICATION FOR PLUTONIUM-URANIUM OXIDE FUEL 1964
FUEL GEOMETRY	CORE 1, PLATES, THICK AND THIN, 4 FT ACTIVE LENGTH CORE 1A, FUELED ROD 5 FT. LONG AS SPIKE ELEMENTS
FUEL CLADDING	CORE 1, ZIRCALOY -2 0.020 IN. THICK CORE 1A, ZIRCALOY-2,
FUEL ENRICH.	CORE 1, 1.44 PER CENT U-235 CORE 1A, HIGH
FUEL ASSEMBLY	CORE 1, 6-PLATE ELEMENTS 114 ASSEMBLIES/CORE CORE 1A, 49-ROD ASSEMBLY
FUEL CHARGE	5600 KG. URANIUM /FIRST LOADING/
SPECIFIC POWER	CORE 1, 270 KW/KG U-235
NEUTRON FLUX	THERMAL AVE. /100 MWT/ 3X10 E+13
CONTROL	MOVABLE RODS
COOLANT TEMP.	INLET 130 F OUTLET 489 F

* * * * * * * * * * * * * * * * * * *

REACTOR VESSEL STEEL VESSEL 84 IN. ID., SS CLAD

CONTAINMENT CYLINDRICAL STEEL TANK 80 FT. DIA./119 FT. HIGH.

REMARKS ON NOVEMBER 15, 1962, THE EBWR REACHED 100 MWT. MODIFICATIONS INCLUDED ADDING 32 HIGHLY ENRICHED ELEMENTS TO THE CORE, ADDITION OF CONTROL RODS, APPROPRIATE PIPING AND VALVES. EBWR HAS BEEN SHUT DOWN AGAIN FOR FURTHER MODIFICATION LEADING TO FUELING WITH PLUTONIUM/URANIUM OXIDE. THE MIXED OXIDE FUEL WILL BE IN THE CENTER OF THE CORE, WITH ENRICHED URANIUM DIOXIDE ASSEMBLIES SURROUNDING IT.
FIRST SELF-SUSTAINING ACTION WITH PLUTONIUM FUEL ACHIEVED IN SEPT. 1965, WITH ELECTRICITY GENERATION IN OCT. 1966. FULL POWER OF 42 MWT WAS REACHED NOV. 11, 1966.

REFERENCES

THE EXPERIMENTAL BOILING WATER REACTOR /EBWR/
ANL-5607 /MAY 1957/

REACTORS ON-THE-LINE. EXPERIMENTAL BOILING WATER REACTOR,
NUCLEONICS 15, 52A-53A /JULY 1957/

HAZARDS EVALUATION REPORT ASSOCIATED WITH THE OPERATION OF EBWR AT 100 MW,
EA WIMUNC, JM HARRER
ANL-5781 /ADD/ /REV 1/ /OCTOBER, 1960/

MODIFICATION OF THE EXPERIMENTAL BOILING WATER REACTOR /EBWR/ FOR HIGH-POWER OPERATION.
JF MATOUSEK, COMP.
ANL-6552 /APRIL 1962/

HAZARDS SUMMARY REPORT ON THE EXPERIMENTAL BOILING WATER REACTOR /EBWR/
ANL-5781

* * * * * * * * * * * * * * * * *

NAME/OWNER	PL /PORTABLE LOW-POWER//AEC-U.S. ARMY
DESIGNER	COMBUSTION ENGINEERING, INC.
PURPOSE	POWER AND HEAT
TYPE	BWR, NATURAL CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	1 8.5
CRITICAL	DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL CLADDING	SS TUBES
FUEL ENRICH.	4.8 PER CENT U-235
FUEL ASSEMBLY	59 FUEL ELEMENTS, 3 POISON ELEMENTS/ASSEMBLY 24 ASSEMBLIES/CORE
REMARKS	PL IS ONE OF SEVERAL REACTORS IN THE ARMY-S BWR PROGRAM PROPOSED FOR INSTALLATION IN A SNOW TUNNEL AT BYRD STATION, ANTARCTICA. THE CORE CONTAINS 24 FUEL ASSEMBLIES, EACH COMPOSED OF 59 FUEL ELEMENTS AND THREE POISON ELEMENTS.
REFERENCES	PL FINAL DESIGN REPORT. VOL. IV. REACTOR DESIGN. COMBUSTION ENGINEERING INC. CEND-135 /VOL. 4/ /1961/ VOLUMES 1-5 ARE DATED JUNE 30, 1961.

* * * * * * * * * * * * * * * * *

NAME/OWNER	VBWR/VALLECITOS BOILING WATER REACTOR//GE-PACIFIC G + E
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	PACIFIC GAS + ELECTRIC CO.
LOCATION	PLEASANTON, CALIF.
PURPOSE	POWER PROTOTYPE
TYPE	BWR, NATURAL CIRCULATION, DIRECT CYCLE.
POWER MWE(MWT)	5 20
CRITICAL	1957, MODIFICATIONS 1960, PERMANENTLY SHUT-DOWN 1963
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE-SS MATRIX
FUEL GEOMETRY	PLATES, 2.950 IN. WIDE/37 IN. LONG. SOME RODS.
FUEL CLADDING	SS 0.005 IN. THICK
FUEL ENRICH.	90 PER CENT U-235
FUEL ASSEMBLY	6-9 PARALLEL PLATES/ASSEMBLY. 120 PLATES/CORE
FUEL CHARGE	25 KG. U-235
SPECIFIC POWER	1200 KW/KG U-235
NEUTRON FLUX	THERMAL AVE. 4.5X10 E+13
CONTROL	POISON PLATES, BORON-SS AND BORON CARBIDE
COOLANT TEMP.	INLET. VARIES OUTLET. 546 F
COOLANT PRESS.	INLET. 1000 PSIA
REACTOR VESSEL	CARBON STEEL, SS CLAD, 7 FT. OD., 3 1/2 IN. THICK
CONTAINMENT	PRESSURE-TIGHT, UPRIGHT CYLINDRICAL STEEL BUILDING 48 FT. DIA./100 FT. HIGH.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD15

* * * * * * * * * * * * * * * * *

REMARKS TEST FACILITY FOR THE DRESDEN REACTOR, AND A DEMONSTRATION PLANT. SUPERHEAT PROGRAMS WERE INVESTIGATED. SEE VESR. SEE ALSO SADE.

REFERENCES

REACTORS ON-THE-LINE. VBWR.
NUCLEONICS 16, INSERT, /FEBRUARY 1958/

GENERAL ELECTRIC VALLECITOS BOILING WATER REACTOR,
FINAL HAZARDS SUMMARY REPORT,
JL MURRAY, ED.
SG-VAL-2 /3RD ED/ /NOVEMBER 30, 1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	DRESDEN-1/COMMONWEALTH EDISON
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	COMMONWEALTH EDISON
LOCATION	MORRIS, ILLINOIS CONFLUENCE OF KANKAKEE AND DES PLAINES RIVERS
PURPOSE	POWER
TYPE	BWR, FORCED CIRCULATION, DUAL CYCLE
POWER MWE(MWT)	200 700
CRITICAL	1960
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.498 IN. DIA./0.625 IN. LONG.
FUEL GEOMETRY	ROD, 1/2 IN. DIA./106.5 IN. ACTIVE LENGTH FUEL ROD CONSISTS OF 4 FUEL SEGMENTS JOINED END-TO-END, WITH SPACER PLATES BETWEEN THE SEGMENTS.
FUEL CLADDING	ZIRCALOY-2, 0.030 IN. THICK
FUEL ENRICH.	1.5 PER CENT U-235
FUEL ASSEMBLY	SQUARE CHANNEL, 36 RODS, 6X6, 488 ASSEMBLIES/CORE FOURTH PARTIAL REFUELING APRIL-MAY 1967 106 ZIRCALOY-CLAD URANIUM DIOXIDE FUEL ASSEMBLIES IN 464-ASSEMBLY CORE, INCLUDING FOUR PLUTONIUM DIOXIDE RODS FROM REACTOR-PRODUCED PLUTONIUM.
FUEL CHARGE	51,500 KG.URANIUM
SPECIFIC POWER	11.50 MW/MTU
BURNUP(REFUEL)	10,000 MWD/TON BATCH REFUELING 10-30 PERCENT
NEUTRON FLUX	THERMAL AVE. 3.15X10 E+13 FAST /TYPICAL/ 1X10 E+14
CONTROL	MOVABLE POISON RODS, CADMIUM-SILVER ALLOY, SS CLAD

* * * * * * * * * * * * * * * * *

COOLANT TEMP. INLET 504.7 F OUTLET 546.4 F

COOLANT PRESS. INLET 1027.7 PSIG

REACTOR VESSEL CARBON STEEL, SS CLAD, 12 FT. 2 IN. ID.

CONTAINMENT STEEL SPHERE, 190 FT. DIA., ABOVE-GRADE INSULATED.

REMARKS SUBCOOLED WATER ENTERS AT THE BOTTOM OF THE REACTOR VESSEL AND FLOWS UPWARD THROUGH THE ASSEMBLIES, WHERE IT BOILS. THE STEAM-WATER MIXTURE FLOWS OUT AT THE TOP OF THE FUEL ASSEMBLIES AND IS DIRECTED TO THE REACTOR VESSEL OUTLET NOZZLES. EXTERNAL LOOPS HANDLE RECIRCULATION FLOW, THERE BEING NO RECIRCULATION OF THE CORE COOLANT WITHIN THE REACTOR VESSEL.

REFERENCES

PRELIMINARY HAZARDS SUMMARY REPORT FOR THE DRESDEN NUCLEAR POWER STATION.
G SEGE
GEAP-1044 /MAY 1, 1957

PRELIMINARY HAZARDS SUMMARY REPORT FOR THE DRESDEN NUCLEAR POWER STATION.
AMENDMENT NO. 1
GEAP-3009 /MAY 1, 1958/
AMENDMENT NO. 2 /DP EBRIGHT/
GEAP-3053 /AUGUST 22, 1958/
AMENDMENT NO. 3 /JL MURRAY, DP EBRIGHT/
GEAP-3076 /DECEMBER 23, 1958/
AMENDMENT NO. 4, PART I /DP EBRIGHT/
GEAP-3106 /FEBRUARY 1959/
AMENDMENT NO. 6 /DP EBRIGHT/
GEAP-3186 /JUNE 12, 1959/

DRESDEN ON-THE-LINE.
NUCLEONICS 17, INSERT. /DECEMBER 1959/

PERFORMANCE AND OPERATING EXPERIENCE OF THE DRESDEN NUCLEAR POWER STATION.
IL WADE
ASME PREPRINT 61-WA-268 /1961/

THE DRESDEN NUCLEAR POWER STATION.
POWER REACTOR TECHNOLOGY 4/4/, 56-68 /SEPT. 1961/

NUCLEAR INDUSTRY JUNE 1967 P. 19

* * * * * * * * * * * * * * * * *

NAME/OWNER	DRESDEN-2/COMMONWEALTH EDISON
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	COMMONWEALTH EDISON
LOCATION	MORRIS, ILLINOIS CONFLUENCE OF KANKAKEE AND DES PLAINES RIVERS
PURPOSE	POWER
TYPE	BWR, SINGLE CYCLE, FORCED CIRCULATION /2-LOOP/, INTERNAL STEAM SEPARATION.
POWER MWE(MWT)	715 2300
CRITICAL	CONTRACT AWARD FOR DRESDEN-2 AND -3, TARGET 1970, REFERENCE DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIA. /0.75 IN. LONG
FUEL GEOMETRY	ROD 144 IN. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY-2 TUBES 0.036 IN. WALL THICKNESS
FUEL ENRICH.	AVERAGE 2 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE 7X7, APPROX. 14 RODS HAVE REDUCED ENRICHMENT. ASSEMBLY ENCLOSED IN ZIRCALOY CHANNEL 724 ASSEMBLIES
BURNUP(REFUEL)	AVERAGE INITIAL 15000 MWD/T ANNUAL PROGRESSIVE PARTIAL BATCH
CONTROL	CRUCIFORM CONTROL BLADES, BORON CARBIDE POWDER IN SS TUBES TEMPORARY BORON-SS POISON CURTAINS
COOLANT TEMP.	INLET 530.4 F
COOLANT PRESS.	1000 PSIG
REACTOR VESSEL	ALLOY STEEL CYLINDER 6 1/8 IN. THICK, INNER SS CLADDING 7/32 IN. THICK
CONTAINMENT	PRESSURE-SUPPRESSION, CORE SPRAY SYSTEM.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD17

* * * * * * * * * * * * * * * * *

REMARKS

TOTAL CAPACITY OF THE DRESDEN NUCLEAR STATION
WILL BE 1800 MWE
CONTRACT FOR A THIRD REACTOR HAS BEEN AWARDED,
POWER 809 MWE/2300 MWT, TARGET 1970,
INTAKE CANAL FOR CONDENSER COOLING WATER EXTENDS
WEST FROM KANKAKEE RIVER AND DISCHARGE CANAL NORTH
TO ILLINOIS RIVER

REFERENCES

DRESDEN NUCLEAR POWER STATION UNIT 2
PLANT DESIGN AND ANALYSIS REPORT
NP-15538 /ND/ VOL. 1-2-3

DRESDEN NUCLEAR POWER STATION UNIT 3
PLANT DEISGN AND ANALYSIS REPORT
COMMONWEALTH EDISON CO.
DOCKET 50-249

* * * * * * * * * * * * * * * * *

NAME/OWNER	FITCHBURG GAS AND ELECTRIC PLANT/FITCHBURG G+E, FITCHBURG PAPER CO
DESIGNER	GENERAL ELECTRIC COMPANY
LOCATION	MASSACHUSETTS
PURPOSE	POWER AND PROCESS HEAT
TYPE	BWR, NATURAL CIRCULATION
POWER MWE(MWT)	28
CRITICAL	PROPOSAL. SEE REMARKS.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
CONTAINMENT	PRESSURE-SUPPRESSION
REMARKS	PLANT WOULD SUPPLY AN AVERAGE OF 140,000 POUNDS OF STEAM PER DAY FOR PROCESS HEAT. GE-S DECISION TO BUILD NO NUCLEAR STATIONS UNDER 50 MWE WILL CAUSE FITCHBURG G+E TO RE-EVALUATE ITS PROPOSAL.
REFERENCES	FORUM MEMO SEPT. 1963 P. 16 NEWS RELEASE.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD19

* * * * * * * * * * * * * * * * *

NAME/OWNER	SHOREHAM NUCLEAR STATION/LONG ISLAND LIGHTING CO.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	LONG ISLAND LIGHTING COMPANY
LOCATION	SHOREHAM, LONG ISLAND, NEW YORK LONG ISLAND SOUND
PURPOSE	POWER
TYPE	BWR, FORCED CIRCULATION, SINGLE CYCLE
POWER MWE(MWT)	523 1593
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.487 IN. DIAM.
FUEL GEOMETRY	ROD, 0.563 IN. OD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2, 0.032 IN. THICK
FUEL ENRICH.	AVE. 2.28 PER CENT U-235
FUEL ASSEMBLY	BUNDLE, 7X7, ZIRCALOY-4 CHANNELS 368 ASSEMBLIES/CORE
BURNUP(REFUEL)	AVE. 19,000 MWD/T
REACTOR VESSEL	STEEL CYLINDER 15 FT. 3 IN. ID/64 FT. 8 IN. LONG WALL THICKNESS 4 11/16 IN. SS LINING 1/8 IN. THICK
CONTAINMENT	STEEL-LINED CONCRETE STRUCTURE PRESSURE SUPPRESSION SYSTEM
REFERENCES	SHOREHAM NUCLEAR POWER STATION PRELIMINARY SAFETY ANALYSIS REPORT. LONG ISLAND LIGHTING CO. DOCKET 50-322, VOL. 1-3

BOILING LIGHT WATER REACTORS, DOMESTIC BD20

* * * * * * * * * * * * * * * * *

NAME/OWNER	BIG ROCK POINT STATION/CONSUMERS POWER CO.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	CONSUMERS POWER COMPANY
LOCATION	CHARLEVOIX, MICH. LAKE MICHIGAN
PURPOSE	POWER, PRODUCTION OF COBALT-60
TYPE	BWR, FORCED CIRCULATION, DIRECT CYCLE, HIGH POWER DENSITY
POWER MWE(MWT)	71 240 /SEE REMARKS/
CRITICAL	SEPT. 1962.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, 0.345 IN. DIA./0.019 IN. THICK
FUEL GEOMETRY	RODS /STACK OF CYL. PELLETS/, APPROX. 70 IN. ACTIVE LENGTH
FUEL CLADDING	SS TUBES, 0.043 IN. THICK JUNE 1967, SS-CLAD FUEL ELEMENTS, NEARLY ALL REPLACED BY ZIRCALOY-CLAD ELEMENTS
FUEL ENRICH.	3.2 PER CENT U-235
FUEL ASSEMBLY	144 RODS/ASSEMBLY, 12X12 56 ASSEMBLIES/CORE SEE REMARKS
FUEL CHARGE	11,700 KG. URANIUM
BURNUP(REFUEL)	10,000 REFUELED MAY 1966 MARCH 1968
CONTROL	CONTROL RODS CONTAINING BORON CARBIDE, CENTRAL AND PERIPHERAL BOTTOM-ENTERING, POISON CURTAIN BORATED SS, LIQUID POISON INJECTION.
COOLANT TEMP.	INLET 346 F
COOLANT PRESS.	1050 PSIA

* * * * * * * * * * * * * * * * *

REACTOR VESSEL CARBON STEEL, SS-CLAD, 30 FT. HIGH/106 IN. ID.

CONTAINMENT SPHERE, 130 FT. DIA., 103 FT. ABOVE-GRADE. EXTERNAL INSULATION OF CORK MASTIC COATING PROTECTED BY ACRYLIC RESIN.

REMARKS THE ASSEMBLY HAS 12 SMALLER DIA. FUEL RODS, 3 TO EACH CORNER, TO REDUCE POWER PEAKING. IN PHASE II OF THE R+D PROGRAM THE CORE SIZE WILL BE INCREASED TO 86 BUNDLES. PLANNED STEP-WISE APPROACH TO 240 MWT IS INDICATED.
ZIRCALOY-CLAD FUEL BUNDLES ARE BEING INSERTED INTO CORE TO REPLACE SS-CLAD FUEL.
FIRST COBALT INSERTION FOR LARGE-SCALE PRODUCTION OF COBALT-60 WAS MADE DURING THE MAY 1966 REFUEL.

REFERENCES

NEW BOILING WATER NUCLEAR PLANT /BIG ROCK POINT, MICHIGAN/,
MECH. ENG. 81, 80 /OCTOBER 1959/

FINAL HAZARDS SUMMARY REPORT FOR BIG ROCK POINT PLANT.
VOLUME I. PLANT TECHNICAL DESCRIPTION AND SAFEGUARD EVALUATION.
CONSUMERS POWER CO.
NP-11153 /VOL. I/ /NOVEMBER 1961/

HIGH POWER DENSITY DEVELOPMENT PROJECT. INTERIM REPORT. 300 MW/E/ HPD CONCEPTUAL DESIGN SUTDY.
GEAP-3967 /JUNE 22, 1962/

DESIGN PRACTICE. HUMBOLDT BAY AND BIG ROCK POINT.
W MITCHELL
POWER REACTOR TECHNOLOGY 7/1/, 70-84 /WINTER 1963 1964/

NUCLEAR INDUSTRY JUNE 1967 P. 19

* * * * * * * * * * * * * * * * *

NAME/OWNER	HUMBOLDT BAY PLANT/PACIFIC G+E
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	PACIFIC GAS + ELECTRIC CO.
LOCATION	EUREKA, CALIF. HUMBOLDT BAY
PURPOSE	POWER
TYPE	BWR, NATURAL CIRCULATION, SINGLE CYCLE
POWER MWE(MWT)	51 240 OPERATION AT 65 MWE IN 1968
CRITICAL	FEB. 1963
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.420 IN. DIA./0.6 IN. LONG, SINTERED SOLID CYLINDRICAL.
FUEL GEOMETRY	RODS, 79 IN. ACTIVE LENGTH
FUEL CLADDING	SS. SEE REMARKS
FUEL ENRICH.	2.6 PER CENT U-235
FUEL ASSEMBLY	49 RODS, 7X7 172 BUNDLES/CORE
FUEL CHARGE	13,840 KG. U /34,600 POUNDS URANIUM DIOXIDE/
SPECIFIC POWER	12.2 KW/KG
BURNUP(REFUEL)	10,000 MWD/TU BATCH, APPROX. 20 PER CENT LATER CORES 15,400 MWD/TU
NEUTRON FLUX	THERMAL AVE. 2X10 E+13 THERMAL MAX. 4X10 E+13 FAST AVE. 5X10 E+13
CONTROL	MOVABLE RODS CONTAINING BORON CARBIDE, BOTTOM DRIVEN AND PERIPHERAL. POISON CURTAIN BORATED SS. LIQUID POISIN INJECTION.
COOLANT PRESS.	1035 PSIA

* * * * * * * * * * * * * * * * *

REACTOR VESSEL	CARBON STEEL, SS CLAD, 42 FT. HIGH/120 IN. ID.
CONTAINMENT	PRESSURE-SUPPRESSION /DRY-WELL, SUPPRESSION CHAMBER AND POOL/.
REMARKS	DURING MARCH-APRIL 1968, 23 HIGH-EXPOSURE ASSEMBLIES WERE REPLACED BY LOW-EXPOSURE FUEL. 3/4 OF THE SS-CLAD ELEMENTS HAVE BEEN REPLACED BY ZIRCALOY-CLAD ELEMENTS, REMAINING TO BE REPLACED IN FALL OF 1968.
REFERENCES	PRELIMINARY HAZARDS SUMMARY REPORT. HUMBOLDT BAY POWER PLANT UNIT NO. 3. PACIFIC GAS + ELECTRIC CO. NP-7512 /APRIL 15,1959/
	PACIFIC GAS + ELECTRIC COMPANY FINAL HAZARDS SUMMARY REPORT, HUMBOLDT BAY POWER PLANT UNIT NO. 3. PACIFIC GAS + ELECTRIC CO. NP-14319 /SEPT. 1,1961/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BODEGA BAY ATOMIC PLANT/PACIFIC G+E
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	PACIFIC GAS + ELECTRIC CO.
LOCATION	BODEGA BAY, SONOMA COUNTY, CALIF.
TYPE	BWR, FORCED CIRCULATION, DIRECT CYCLE.
POWER MWE(MWT)	313 1000
CRITICAL	PROJECT HAS BEEN CANCELED.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	SS
FUEL ENRICH.	2.7 PER CENT U-235
FUEL ASSEMBLY	49 RODS, 7X7 529 ASSEMBLIES / CORE
FUEL CHARGE	67,000 KG. URANIUM
BURNUP(REFUEL)	15,000 MWD/TON U
CONTAINMENT	PRESSURE-SUPPRESSION, REINFORCED CONCRETE BUILDING
REMARKS	THE PROJECT HAS BEEN CANCELED BECAUSE OF SITING PROBLEMS.
REFERENCES	NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED AS OF JUNE 30, 1962. U. S. ATOMIC ENERGY COMMISSION TID-8200 /6TH REVISION/ /1962/ BODEGA BAY ATOMIC PARK, UNIT NUMBER 1, EXHIBIT C, PRELIMINARY HAZARDS SUMMARY REPORT, DECEMBER 28, 1962. PACIFIC GAS AND ELECTRIC CO. NP-12476 /1962/

BOILING LIGHT WATER REACTORS, DOMESTIC BD23

* * * * * * * * * * * * * * * * *

NAME/OWNER	NIAGARA MOHAWK NUCLEAR PLANT /NINE MILE POINT/ NIAGARA MOHAWK POWER CORP.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	NIAGARA MOHAWK POWER CORPORATION
LOCATION	OSWEGO, NEW YORK /NINE MILE POINT/ LAKE ONTARIO
PURPOSE	POWER
TYPE	BWR, FORCED CIRCULATION, SINGLE CYCLE
POWER MWE(MWT)	500 1538
CRITICAL	TARGET 1969.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 TUBES 0.5 IN. OD. WALL THICKNESS 0.03
FUEL ENRICH.	2.1 PER CENT U-235
FUEL ASSEMBLY	64-ROD ASSEMBLY, 8X8, ZIRCALOY-2 CHANNEL 500 ASSEMBLIES/CORE
FUEL CHARGE	95,400 KG. URANIUM
BURNUP(REFUEL)	15000 MWD/T BATCH, 20 PER CENT FIRST FUEL DISCHARGE SCHEDULED FOR JUNE 1969
CONTROL	BORON CARBIDE POWDER IN SS TUBES VARIABLE COOLANT RECIRCULATION FLOW.
COOLANT TEMP.	INLET 530 F
COOLANT PRESS.	INLET 1015 PSIA
REACTOR VESSEL	CYLINDRICAL STEEL VESSEL, HEMISPHERICAL HEADS 17 FT. 9 IN. ID/61 FT. 2 IN. HIGH BETWEEN HEADS WALL THICKNESS 7 IN. SS INNER CLADDING 1/4 IN. THICK

* * * * * * * * * * * * * * * * *

CONTAINMENT PRESSURE-SUPPRESSION STRUCTURE CONSISTING OF A DRYWELL CONTAINING THE REACTOR VESSEL AND FIVE RECIRCULATION LOOPS, AND SUPPRESSION POOL. REACTOR BUILDING IS REINFORCED CONCRETE HIGH-BAY STRUCTURE.

REMARKS CONTRACT FOR DESIGN AND CONSTRUCTION OF THE REACTOR, TURBINE GENERATOR AND RELATED EQUIPMENT AWARDED TO GE IN OCTOBER 1963.

REFERENCES PRELIMINARY HAZARDS SUMMARY REPORT, NINE MILE POINT NUCLEAR STATION, VOLS. I AND II, NIAGARA MOHAWK POWER CORP. APRIL 1964. DOCKET 50-220. /APRIL 1964/

FIRST SUPPLEMENT TO PRELIMINARY HAZARDS SUMMARY REPORT, NINE MILE POINT NUCLEAR STATION, NIAGARA MOHAWK POWER CORP. AUG. 1964 /EXHIBIT D, SUPP-1/

HAZARDS ANALYSIS BY THE DIVISION OF REACTOR LICENSING IN THE MATTER OF NIAGARA MOHAWK POWER CORPORATION 9-MILE POINT NUCLEAR STATION, OSWEGO
DIV. REACTOR LICENSING, AEC
TID-22438 /ND/

NINE MILE POINT NUCLEAR STATION.
PRELIMINARY HAZARDS SUMMARY REPORT
VOL. 1, 2, SUPPLEMENT 1
NIAGARA MOHAWK POWER CORP.
NP-15660
VOL.1, APRIL 1964
VOL.2, APRIL 1964
SUPPL. 1, AUG. 1964

BOILING LIGHT WATER REACTORS, DOMESTIC BD24

* * * * * * * * * * * * * * * * *

NAME/OWNER	OYSTER CREEK STATION-1/JERSEY CENTRAL P*L
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	JERSEY CENTRAL POWER AND LIGHT CO.
LOCATION	OYSTER CREEK, N. J., FORKED RIVER /BARNEGAT BAY/
PURPOSE	POWER
TYPE	BWR DIRECT CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	515 1600
CRITICAL	DELAYED DUE TO CRACKS IN PRESSURE VESSEL, TARGET 1969
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 TUBES 0.502 IN. OD/0.034 IN. THICK
FUEL ENRICH.	2.1 PER CENT U-235
FUEL ASSEMBLY	64-ROD ASSEMBLY, 8X8, ZIRCALOY-2 CHANNEL 532 ASSEMBLIES/CORE
FUEL CHARGE	486 POUNDS URANIUM DIOXIDE/ASSEMBLY
BURNUP(REFUEL)	15000 MWD/T PARTIAL BATCH 25 PER CENT, SCATTER PATTERN
CONTROL	CRUCIFORM BLADES, BORON CARBIDE POWDER IN SS BORON-SS POISON CURTAINS
COOLANT TEMP.	301 F
COOLANT PRESS.	1000 PSIG
REACTOR VESSEL	STEEL CYLINDER 17 FT. 9 IN. ID/61 FT. 2 IN. BETWEEN HEADS, CYLINDER CONTAINS CORE, STEAM SEPARATORS AND DRIERS.
CONTAINMENT	PRESSURE-SUPPRESSION SYSTEM CONSISTING OF DRYWELL

* * * * * * * * * * * * * * * * *

AND PRESSURE-ABSORPTION STRUCTURE. DRYWELL ENCLOSES REACTOR VESSEL, PUMPS, PIPING, CONTROL ROD DRIVES.
ABSORPTION CHAMBER IS A TOROIDAL STEEL SHELL ENCLOSED IN REINFORCED CONCRETE VAULT, OUTSIDE OF AND BELOW DRYWELL AND PARTIALLY FILLED WITH WATER.
CONTAINMENT STRUCTURE IS REINFORCED CONCRETE, PARTIALLY BELOW-GRADE.

REFERENCES

APPLICATION TO U. S. ATOMIC ENERGY COMMISSION FOR REACTOR CONSTRUCTION PERMIT AND OPERATING LICENCES, OYSTER CREEK NUCLEAR POWER PLANT UNIT PART B, PRELIMINARY SAFEGUARDS SUMMARY REPORT, MARCH 1964.
JERSEY CENTRAL POWER + LIGHT CO.
DOCKET 50-219
NP-14365 /ND/

OYSTER CREEK
NUCLEAR ENG. 10, 225-28 /JUNE 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BONUS /BOILING NUCLEAR SUPERHEAT//AEC, PRWRA
DESIGNER	GENERAL NUCLEAR ENGINEERING CORPORATION
OPERATOR	PUERTO RICO WATER RESOURCES AUTHORITY
LOCATION	PUNTA HIGUERA, PUERTO RICO CARIBBEAN SEA
PURPOSE	POWER DEMONSTRATION
TYPE	BWR, FORCED CIRCULATION, NUCLEAR SUPERHEAT PRESSURE TUBE
POWER MWE(MWT)	16.5 50
CRITICAL	APRIL 1964 PROJECT TO BE TERMINATED /1968/
COOLANT	LIGHT WATER AND STEAM.
MODERATOR	LIGHT WATER REFLECTOR, LIGHT WATER
FUEL MATERIAL	CENTRAL BOILER, URANIUM DIOXIDE PELLETS 0.445 IN. DIA. SUPERHEATER, URANIUM DIOXIDE PELLETS 0.5 IN. DIA.
FUEL GEOMETRY	BOILER, SEGMENTED ROD 0.50 IN. OD., 54 IN. ACTIVE LENGTH SUPERHEATER, ROD 54.6 IN. ACTIVE LENGTH
FUEL CLADDING	BOILER, ZIRCALOY-2 TUBES 0.025 IN. WALL THICKNESS SUPERHEATER INCONEL 0.018 IN. THICK
FUEL ENRICH.	BOILER, 2.4 PER CENT U-235 WITH NATURAL U IN 4 CENTRAL ELEMENTS SUPERHEAT, 3.25 PER CENT U-235
FUEL ASSEMBLY	BOILER, 32 TUBES, 64 ASSEMBLIES. SUPERHEAT, 32 RODS, 32 ASSEMBLIES IN PRESSURE TUBES
FUEL CHARGE	BOILER, 2.81 TONS U SUPERHEAT, 1.79 TONS U
SPECIFIC POWER	BOILER, 13.2 TMW/TON U SUPERHEAT, 7.25 TMW/TON U
BURNUP(REFUEL)	BOILER, 12,900 MWD/MTU

* * * * * * * * * * * * * * * * *

	SUPERHEATER, 13,000 MWD/MTU
CONTROL	BORON-SS RODS, GRAVITY SCRAM. CRUCIFORM RODS IN BOILER SECTION AND SLAB RODS BETWEEN BOILER-SUPERHEATER, PLUS CHEMICAL SHIM.
COOLANT TEMP.	BOILER 540 F SUPERHEAT 900 F
COOLANT PRESS.	950 PSIG
REACTOR VESSEL	CARBON STEEL CYLINDER 7 FT. ID./26 FT. 6 IN. HIGH AVERAGE THICKNESS 3 1/8 IN. INNER SS CLADDING 1/4 IN. THICK
CONTAINMENT	HEMISPHERICAL STEEL SHELL WELDED TO CYLINDRICAL STEEL WALL, LOW-PRESSURE, HOUSES THE ENTIRE PLANT. CYLINDRICAL CONCRETE OUTER WALL. BUILDING IS 107 FT. ABOVE GROUND.
REMARKS	HEMISPHERICAL STEEL SHELL 166 FT. 8 IN. DIA., 13/32 IN. THICK, CONCRETE MAT, HOUSES ENTIRE PLANT. LOW-PRESSURE DESIGN, 5 PSIG INTERNAL PRESSURE. ASSEMBLIES ARE ARRANGED IN FOUR GROUPS AROUND THE SQUARE BOILER ZONE. THE FUEL ROD IS SURROUNDED BY A STAINLESS STEEL TUBE TO FORM THE STEAM COOLANT ANNULUS, AND THIS IS SURROUNDED BY A STAINLESS STEEL PRESSURE TUBE TO PROVIDE A THERMAL INSULATING GAP BETWEEN THE COOLANT TUBE AND THE WATER MODERATOR. DESIGN HAS BEEN EXTRAPOLATED TO A LARGE CENTRAL STATION INTEGRAL NUCLEAR SUPERHEAT STEAM PLANT. GNEC IS DESIGNING AN ANNULAR SUPERHEAT ELEMENT TO REPLACE THE TUBULAR ELEMENTS OF THE FIRST CORE LOADING.
REFERENCES	BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION. PRELIMINARY DESIGN STUDY AND HAZARDS SUMMARY REPORT. VOL. II. REFERENCE DESIGN. VOL. III. ALTERNATE DESIGN STUDIES. VOL. IV. PRELIMINARY HAZARDS SUMMARY REPORT. PRWRA, GENERAL NUCLEAR ENG. TID-8524 /JUNE 1960/ NUCLEAR SUPERHEAT. THE BONUS REACTOR. POWER REACTOR TECHNOLOGY 3, 68-74 /SEPTEMBER 1960/ BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION TECHNICAL SPECIFICATIONS. F BEVILACQUA

* * * * * * * * * * * * * * * * *

GNEC-214 /OCTOBER 26, 1962/

BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION,
SUPPLEMENTARY STUDY, EXTRAPOLATION TO LARGE
CENTRAL STATION INTEGRAL NUCLEAR SUPERHEAT PLANT,
GENERAL NUCLEAR ENG.
PRWRA-GNEC-4 /ND/

BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION,
FINAL SUMMARY DESIGN REPORT,
PRWRA, GENERAL NUCLEAR ENG,
PRWRA-GNEC-6 /FEB, 1, 1962/

BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION,
FINAL HAZARD SUMMARY REPORT,
PRWRA, GENERAL NUCLEAR ENG,
PRWRA-GNEC-5 /FEB, 1, 1962/

DESIGN AND CONSTRUCTION PRACTICE, BONUS,
POWER REACTOR TECHNOLOGY 7/3/, 292-312
/SUMMER 1964/

BOILING NUCLEAR SUPERHEATER /BONUS/ POWER STATION
PUNTA HIGUERA SITE NEAR RINCON, PUERTO RICO
PROJECT COMPLETION REPORT
OAK RIDGE OPERATIONS OFFICE
ORO-649 /JUNE 1966/

BOILING NUCLEAR SUPERHEATER BONUS POWER STATION
FINAL HAZARDS SUMMARY REPORT
PRWRA-GNEC-5 /REV/ FEB. 1, 1962, REV. NOV. 15,1965

AEC NEWS RELEASE L-151 /JULY 1, 1968/

BOILING LIGHT WATER REACTORS, DOMESTIC BD26

* * * * * * * * * * * * * * * * *

NAME/OWNER	NUSU /NUCLEAR SUPERHEAT/
DESIGNER	GENERAL NUCLEAR ENG. CORP., COMBUSTION ENG.
PURPOSE	POWER
TYPE	BWR, DIRECT CYCLE, FORCED CIRCULATION, NUCLEAR SUPERHEAT
POWER MWE(MWT)	200 633
CRITICAL	DESIGN
COOLANT	LIGHT WATER AND STEAM
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, ANNULAR, 1.114 IN. DIA./ 0.20 IN. THICK
FUEL GEOMETRY	BOILER, ANNULAR RODS SUPERHEATER, DOUBLE-ANNULAR RODS
FUEL CLADDING	BOILER, SS INNER AND OUTER, 0.020 IN. THICK SUPERHEATER, OUTER SS, INTERMEDIATE HASTELOY X, INNER HASTELOY X
FUEL ENRICH.	BOILER, 4.5 PER CENT U-235 SUPERHEATER 2.4 PER CENT U-235
FUEL ASSEMBLY	BOILER, 42-ROD ASSEMBLY, HEXAGONAL 30 ASSEMBLIES/CORE SUPERHEATER, 18-ROD ASSEMBLY, HEXAGONAL 61 ASSEMBLIES/CORE
FUEL CHARGE	32.5 SHORT TONS URANIUM
SPECIFIC POWER	16.4 MW/T URANIUM
BURNUP(REFUEL)	BATCH, 1/3 CORE
CONTROL	BORON-SS RODS
REACTOR VESSEL	CARBON STEEL CYLINDER, HEMISPHERICAL HEADS, 11 FT. 6 IN. ID. AND 15 FT. 2 IN. HIGH, SS INNER CLADDING
CONTAINMENT	CYLINDRICAL CONCRETE STRUCTURE, HEMISPHERICAL STEEL DOME, CARBON STEEL SHELL. PRESSURE-SUPPRESSION SYSTEM.
REMARKS	DESIGN STUDY OF AN INTEGRAL BOILING-SUPERHEATING

* * * * * * * * * * * * * * * * *

DESIGN WITH A TWO-REGION CORE. BOTH BOILING AND SUPERHEATING OCCUR IN THE SUPERHEAT REGION, WHICH IS FUELED WITH DOUBLE ANNULAR FUEL ELEMENTS. STEAM IS SUPERHEATED ON THE INTERNAL SURFACES OF THE ELEMENT, AND BOILING OCCURS ON THE EXTERNAL SURFACE WHICH IS IN CONTACT WITH THE LIQUID COOLANT WATER. SURROUNDING BOILER REGION IS FUELED WITH SINGLE-ANNULAR ELEMENTS. BOILING OCCURS ON BOTH INNER AND OUTER SURFACES. LIQUID COOLANT FLOW IS TWO-PASS, THE BOILER SECTION AND THE BOILER PART OF THE SUPERHEAT SECTION BEING HYDRAULICALLY IN SERIES.

REFERENCES

DIRECT CYCLE BOILING WATER REACTOR WITH INTEGRAL NUCLEAR SUPERHEAT.
GENERAL NUCLEAR ENGINEERING CORP.
GNEC-212 /JAN. 1962/

A 200 MWE BOILER-SUPERHEATER REACTOR, PRELIMINARY DESIGN.
GENERAL NUCLEAR ENG.
GNEC-136 /OCT. 1960/

BOILING LIGHT WATER REACTORS, DOMESTIC BD27
* * * * * * * * * * * * * * * * *

NAME/OWNER	PILGRIM STATION/BOSTON-ED.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	BOSTON EDISON
LOCATION	PLYMOUTH, MASSACHUSETTS CAPE COD BAY
PURPOSE	POWER
TYPE	BWR, FORCED CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	625 1912
CRITICAL	APPLICATION FOR CONSTRUCTION PERMIT 1967 TARGET 1971
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIAM.
FUEL GEOMETRY	ROD 0.562 IN. OD
FUEL CLADDING	ZIRCALOY-2 0.032 IN. THICK
FUEL ENRICH.	AVE. 2.18 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7, ZIRCALOY-4 CHANNEL 580 ASSEMBLIES/CORE
BURNUP(REFUEL)	AVE. 19,000 MWD/T
CONTROL	CRUCIFORM RODS, BORON CARBIDE IN SS TUBES
COOLANT PRESS.	1000 PSIG
REACTOR VESSEL	STEEL VESSEL APPROX. 64 FT. 8 IN. HIGH, 18 FT. 8 IN. ID SS CLAD 1/8 IN. THICK MIN.
CONTAINMENT	DOUBLE PRESSURE-SUPPRESSION SYSTEM, WHICH INCLUDES A DRYWELL AND PRESSURE-SUPPRESSION CHAMBER, PLUS A SECOND UNDERGROUND CHAMBER AND POOL SURROUNDING THE REACTOR BUILDING, TO WHICH THE LATTER IS VENTED. THE SECOND CHAMBER IS VENTED TO THE STACK.
REMARKS	TYPE SELECTION IN FEBRUARY 1965.

* * * * * * * * * * * * * * * * *

REFERENCES PILGRIM NUCLEAR POWER STATION
DESIGN AND ANALYSIS REPORT
BOSTON EDISON CO.
DOCKET 50-293 /1967/

BOILING LIGHT WATER REACTORS, DOMESTIC BD28

* * * * * * * * * * * * * * * * *

NAME/OWNER	SURFSIDE/ASDA, N.Y. SMALL UNIFIED REACTOR FACILITY WITH SYSTEMS FOR ISOTOPES, DESALTING, ELECTRICITY
DESIGNER	AMF ATOMICS /HITTMAN ASSOCIATES/
OPERATOR	ATOMIC AND SPACE DEV. AUTHORITY
LOCATION	LONG ISLAND SOUND, NEW YORK
PURPOSE	POWER, DESALINATION, ISOTOPE PRODUCTION.
TYPE	BWR, PRESSURE TUBE
POWER MWE(MWT)	2.5 33
CRITICAL	DESIGN AND CONSTRUCTION CONTRACT AWARDED TO HITTMAN ASSOC. OCTOBER 1968.
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	ZIRCALOY TUBE 27 IN. LONG/0.440 IN. DIA.
FUEL ENRICH.	4-5 PER CENT U-235
FUEL ASSEMBLY	37-TUBE BUNDLE. 82 ELEMENTS WILL BE CONTAINED IN THE ZIRCALOY PRESSURE TUBES, EITHER SINGLY OR IN CLUSTERS. TARGET MATERIALS CAN BE INSERTED INDEPENDENT OF THE REFUELING.
REMARKS	SURFSIDE WILL PRODUCE 2500 KWE NET, 1-MILLION GPD OF WATER, AND NEUTRONS FOR AN EQUIVALENT OF 400,000 CURIES PER YEAR OF COBALT-60
REFERENCES	NUCLEONICS WEEK JULY 22, 1965 P. 1-2 NEWS RELEASE WATER DESALINATION REPORT OCT. 13, 1966 P. 1 NEWS RELEASE NUCLEONICS WEEK OCT. 31, 1968. NUCLEAR INDUSTRY MARCH 1967 A. 60

* * * * * * * * * * * * * * * * *

NAME/OWNER	DEEP-POOL REACTOR/AEC
DESIGNER	AEC-BECHTEL
PURPOSE	WATER DESALINATION, PROCESS HEAT
TYPE	BWR
POWER MWE(MWT)	400
CRITICAL	CONCEPTUAL DESIGN
COOLANT	DEMINERALIZED LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	ZIRCALOY-2
FUEL ENRICH.	2.75 PER CENT U-235 INITIAL
FUEL ASSEMBLY	SQUARE ASSEMBLY 120 ASSEMBLIES/CORE ACTIVE HEIGHT 6 1/2 FT.
FUEL CHARGE	25,000 KG. URANIUM
BURNUP(REFUEL)	20,000 MWD/T
CONTROL	BORON CARBIDE POWDER IN INCONEL TUBES
COOLANT TEMP.	INLET 200 F OUTLET 270 F
COOLANT PRESS.	77 PSIA
REACTOR VESSEL	150 FT. DEEP TANK OF HIGH-PURITY WATER IN WHICH REACTOR CORE IS LOCATED. CARBON STEEL, 11 FT. DIA.
CONTAINMENT	STEEL-LINED CONCRETE PIT, 100 FT. BELOW-GRADE TO 50 FT. ABOVE-GRADE. CONTROLLED VENTILATION CONCEPT
REMARKS	DESIGN CONCEIVED BY AEC CHICAGO OPERATIONS OFFICE AND DEVELOPED BY BECHTEL IN A 6-MONTH DESIGN STUDY THE REACTOR FURNISHES POWER FOR A 50 MGD SEA-WATER CONVERSION PLANT

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD29

* * * * * * * * * * * * * * * * *

REFERENCES

DEEP-POOL REACTOR FOR WATER DESALTING
BECHTEL CORP.
COO-283 /1965/

CONCEPTUAL DESIGN OF A REACTOR FOR USE IN
DESALINATION.
US AEC CHICAGO OPERATIONS OFFICE
COO-278 /OCT. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	MILLSTONE POINT STATION/CONNECTICUT L + P, HARTFORD ELECTRIC, WESTERN MASSACHUSETTS ELEC.
DESIGNER	GENERAL ELECTRIC COMPANY
LOCATION	WATERFORD, CONNECTICUT LONG ISLAND SOUND
PURPOSE	POWER
TYPE	BWR, DIRECT CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	550 2011
CRITICAL	CONSTRUCTION. TARGET 1969
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIA.
FUEL GEOMETRY	RODS, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 0.036 IN. THICK, 0.570 IN. OD.
FUEL ENRICH.	AVE. 2.07 PER CENT U-235
FUEL ASSEMBLY	7X7 ROD BUNDLE, ZIRCALOY-4 CHANNEL 580 ASSEMBLIES
BURNUP(REFUEL)	AVE. 15,000 MWD/T
CONTROL	CRUCIFORM RODS, BOTTOM ENTRY. BORON CARBIDE CONTROL MATERIAL TEMPORARY POISON CURTAINS
COOLANT PRESS.	1000 PSIG
REACTOR VESSEL	CYLINDER, 18 FT. 8 IN. ID/64 FT. 8 IN. LONG
CONTAINMENT	STEEL AND REINFORCED CONCRETE STRUCTURE. PRESSURE-SUPPRESSION SYSTEM.
REMARKS	CONTRACT AWARD 1965
REFERENCES	MILLSTONE NUCLEAR POWER STATION. DESIGN AND ANALYSIS REPORT CONNECTICUT LIGHT + POWER CO., HARTFORD ELECTRIC LIGHT CO., WESTERN MASSACHUSETTS ELECTRIC CO.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD30

* * * * * * * * * * * * * * * * *

NP-16147 /ND/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD31

* * * * * * * * * * * * * * * * *

NAME/OWNER	ISRAELI BWR STUDY/US-ISRAEL JOINT BOARD
DESIGNER	KAISER ENGINEERS/CATALYTIC CONSTRUCTION CO.
PURPOSE	POWER AND DESALINATION
TYPE	BWR DIRECT CYCLE, FORCED RECIRCULATION INTERNAL STEAM SEPARATION
POWER MWE(MWT)	250 1250
CRITICAL	ENGINEERING AND ECONOMIC FEASIBILITY STUDY
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD 0.570 IN. DIA., 12 FT. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY-2
FUEL ENRICH.	SLIGHT
FUEL ASSEMBLY	49-ROD BUNDLE 7X7, ZIRCALOY-4 CHANNEL MODULAR, STACKED, CORE IS BUILT UP OF MODULES CONSISTING OF ONE CONTROL BLADE AND FOUR FUEL ASSEMBLIES
BURNUP(REFUEL)	SCATTER, ANNUAL, 20 PER CENT
CONTROL	BORON CARBIDE PELLETS IN STAINLESS STEEL, CRUCIFORM, CONTROL OF RECIRCULATION RATE.
CONTAINMENT	PRESSURE-SUPPRESSION, DRYWELL IS A STEEL PRESSURE VESSEL VENTING INTO A TOROIDAL SUPPRESSION POOL.
REMARKS	SEE ALSO PWR STUDY HD45. THE 100 MGD DESALTING FACILITY WOULD BE A MULTI-STAGE FLASH DISTILLATION PLANT
REFERENCES	ENGINEERING FEASIBILITY, ECONOMIC STUDY FOR DUAL PURPOSE ELECTRIC POWER-WATER DESALTING PLANT, KAISER ENG., CATALYTIC CONSTR, REPORT NO. 66-I-RE /JAN. 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	QUAD CITIES NUCLEAR STATION/IOWA-ILLINOIS E+G CORDOVA STATION
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	COMMONWEALTH EDISON
LOCATION	CORDOVA, ILLINOIS ON MISSISSIPPI RIVER
PURPOSE	POWER
TYPE	BWR, DIRECT CYCLE, FORCED CIRCULATION, TWO-REACTOR STATION
POWER MWE(MWT)	800 2255 PER REACTOR
CRITICAL	TARGET NO,1, 1970 NO,2, 1971
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIAM.
FUEL GEOMETRY	ROD, ACTIVE LENGTH 144 IN., 0.570 IN. OD
FUEL CLADDING	ZIRCALOY-2, 0.036 IN. THICK
FUEL ENRICH.	2 PER CENT U-235
FUEL ASSEMBLY	7X7 ROD BUNDLE, ZIRCALOY-4 CHANNELS 724 BUNDLES/CORE
BURNUP(REFUEL)	AVE. 15,000 MWD/T
CONTROL	RODS, BOTTOM ENTRY, BORON CARBIDE IN SS
COOLANT TEMP.	INLET 530.4 F
COOLANT PRESS.	1000 PSI
REACTOR VESSEL	CYLINDER 21 FT. DIAM/69 FT. LONG
CONTAINMENT	PRESSURE-SUPPRESSION, REACTOR BUILDING
REMARKS	OPTION ON SECOND UNIT FOR SITE
REFERENCES	UTILITIES COLLABORATE ON 1618-MW NUCLEAR STATION,

BOILING LIGHT WATER REACTORS, DOMESTIC BD32

* * * * * * * * * * * * * * * * *

EL MICHELSON
ELECTRICAL WORLD 168, 32-3 /JULY 17, 1967/

QUAD CITIES STATION UNIT 1, PLANT DESIGN ANALYSIS,
COMMONWEALTH EDISON CO.
DOCKET 50-254

* * * * * * * * * * * * * * * * *

NAME/OWNER	MONTICELLO NUCLEAR STATION/NORTHERN STATES POWER
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	NORTHERN STATES POWER
LOCATION	MONTICELLO, MINNESOTA /NW OF MINNEAPOLIS/
PURPOSE	POWER
TYPE	BWR, FORCED CIRCULATION SINGLE CYCLE
POWER MWE(MWT)	500 AFTER CORE REPLACEMENT IN 1973, 545 MWE
CRITICAL	TARGET 1970, FULL POWER NOV. 1970
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	INDUCED DRAFT COOLING TOWERS ARE PROVIDED FOR OPERATION DURING PERIODS OF LOW STREAM-FLOW
REFERENCES	NUCLEAR INDUSTRY APRIL 1966 P. 39 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	BROWNS FERRY NUCLEAR STATION/TVA TVA NUCLEAR STATION
DESIGNER	GENERAL ELECTRIC CO.
OPERATOR	TENNESSEE VALLEY AUTHORITY
LOCATION	BROWNS FERRY, LIMESTONE VALLEY, ALABAMA WHEELER RESERVOIR /TENNESSEE RIVER/
PURPOSE	POWER
TYPE	BWR, SINGLE CYCLE, FORCED CIRCULATION THREE-REACTOR STATION APPLICATION FOR NO.3 JULY 1967
POWER MWE(MWT)	1100 3290 /PER REACTOR/
CRITICAL	TARGET NO. 1, 1970 NO. 2, 1971 NO. 3, 1972
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLET 0.488 IN. DIAM.
FUEL GEOMETRY	ROD 0.562 IN. OD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 TUBES 0.032 IN. THICK
FUEL ENRICH.	2.19 PER CENT U-235
FUEL ASSEMBLY	BUNDLE, 7X7, ZIRCALOY-4 SPACERS, ZIRCALOY-4 CHANNELS. 764 ASSEMBLIES/CORE
BURNUP(REFUEL)	19000 MWD/T ANNUAL, BATCH FUEL REMOVED FROM UNIT 1 AT FIRST BATCH RELOADING WILL BE INSTALLED IN UNIT 3 AS PART OF INITIAL LOADING.
CONTROL	SS TUBES WITH BORON, TEMPORARY CURTAINS.
CONTAINMENT	COMMON, ZONED, SECONDARY CONTAINMENT, UNITS INDEPENDENT OF EACH OTHER, REINFORCED CONCRETE, PRIMARY CONTAINMENT, STEEL PRESSURE VESSEL WITH

* * * * * * * * * * * * * * * * *

ASSOCIATED PRESSURE-SUPPRESSION CHAMBER.

REMARKS APPROVAL IS BEING SOUGHT FOR AN UNDERGROUND DIFFUSER PIPE COOLING SYSTEM FOR DISCHARGE WATER.

REFERENCES

BROWNS FERRY NUCLEAR POWER STATION,
TENNESSEE VALLEY AUTHORITY. DESIGN AND
ANALYSIS REPORT.
TENNESSEE VALLEY AUTHORITY
NP-16251 /VOL. 1-2/, 1966

TVA-S FIRST NUCLEAR PLANT
CP PALO, DB WEAVER
POWER ENG. 71, 38-42 /APRIL 1967/

BROWNS FERRY NUCLEAR POWER STATION, UNIT 3
TENNESSEE VALLEY AUTHORITY
DOCKET 50-296-1

* * * * * * * * * * * * * * * * *

NAME/OWNER	VERMONT YANKEE/VERMONT YANKEE NUCLEAR POWER CORP.
DESIGNER	GENERAL ELECTRIC CO.
OPERATOR	VERMONT YANKEE NUCLEAR POWER CORP.
LOCATION	BRATTLEBORO, VERMONT CONNECTICUT RIVER
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	514 1600
CRITICAL	TARGET 1971
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	APPLICATION FOR CONSTRUCTION PERMIT NOV. 1966 CONSTRUCTION PERMIT GRANTED DEC. 1967. PLANT ID DESIGNED FOR ONCE-THROUGH COOLING, BUT AN OPEN- OR CLOSED-CYCLE COOLING TOWER SYSTEM WILL BE REQUIRED.
REFERENCES	NUCLEONICS WEEK AUG. 11, 1966 P. 1-2 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	PEACH BOTTOM 2 - 3/PHILADELPHIA ELECTRIC /DELAWARE VALLEY UTILITIES/
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	DELAWARE VALLEY UTILITIES ATLANTIC CITY ELECTRIC PHILADELPHIA ELECTRIC
LOCATION	PEACH BOTTOM, YORK COUNTY, PENNA. CONOWINGO DAM
PURPOSE	POWER
TYPE	BWR, SINGLE CYCLE, FORCED CIRCULATION TWO-REACTOR UNIT
POWER MWE(MWT)	1000 3295 PER REACTOR
CRITICAL	TARGET NO. 1, 1971 NO. 2, 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIAM.
FUEL GEOMETRY	ROD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2, 0.562 IN. OD. AND 0.032 IN. THICK
FUEL ENRICH.	AVE. 2.19 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7 ZIRCALOY-4 CHANNELS 764 ASSEMBLIES/CORE
CONTROL	CRUCIFORM RODS, BORON CARBIDE, VARIATION OF COOLANT FLOW, TEMPORARY POISON CURTAINS
REACTOR VESSEL	STEEL VESSEL 20 FT. 11 IN. ID, 72 FT. LONG. CORE SPRAY SYSTEM
CONTAINMENT	REINFORCED CONCRETE AND STEEL SUPERSTRUCTURE WITH METAL SIDING. SEPARATE CONTAINMENT FOR EACH REACTOR, HOUSED IN SEPARATE BUILDINGS. PRESSURE SUPPRESSION PRIMARY CONTAINMENT
REMARKS	SERVICE WATER TO BE PUMPED FROM CONOWINGO DAM AND

* * * * * * * * * * * * * * * * *

DISCHARGED TO SOUTH OF STATION.

REFERENCES

PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1-2-3
PEACH BOTTOM ATOMIC POWER STATION UNITS 2 AND 3
PHILADELPHIA ELECTRIC CO.
DOCKET 50-277 AND 50-278

* * * * * * * * * * * * * * * * *

NAME/OWNER	DAVIDS ISLAND STA./CONSOLIDATED EDISON CO. ORANGE + ROCKLAND UTILITIES
DESIGNER	GENERAL ELECTRIC COMPANY
LOCATION	DAVIDS ISLAND, LONG ISLAND SOUND, N.Y.
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	1000
CRITICAL	TARGET 1978
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD
FUEL CLADDING	ZIRCALOY TUBES
FUEL ENRICH.	2.2 PER CENT U-235
FUEL ASSEMBLY	ROD BUNDLE 764 BUNDLES/CORE
BURNUP(REFUEL)	1ST CYCLE 11,517 MWD/T EQUIL. CORE 33,000 MWD/T
REFERENCES	NEWS RELEASES

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD38

* * * * * * * * * * * * * * * * *

NAME/OWNER	JAMES A. FITZPATRICK STA./POWER AUTHORITY STATE OF NEW YORK /PASNY/
DESIGNER	GENERAL ELECTRIC COMPANY
LOCATION	NINE MILE POINT, NEW YORK LAKE ONTARIO
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	800 /DATA REFERS TO EASTON 750 MWE DESIGN SEE REMARKS
CRITICAL	TARGET 1973-74
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD, 0.562 IN. OD, 144 IN. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY-2 0.032 IN. THICK
FUEL ENRICH.	2.20 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7 ZIRCALOY-4 CHANNEL 548 ASSEMBLIES/CORE
REACTOR VESSEL	VESSEL 18 FT 2 IN. ID/69 FT. 2 IN. HIGH
CONTAINMENT	REINFORCED CONCRETE AND STEEL BUILDING, METAL SIDING. PRESSURE-SUPPRESSION
REMARKS	NIAGARA MOHAWK HAS DROPPED ITS PROPOSED EASTON STATION BECAUSE OF DELAYS IN GETTING APPROVAL AND ASSIGNED ITS CONTRACTS WITH GE TO PASNY. PART OF THE NINE MILE POINT SITE WILL BE SOLD TO PASNY. THE REACTOR HAS BEEN UPDATED TO 800 MWE.
REFERENCES	EASTON NUCLEAR STATION PRELIMINARY SAFETY ANALYSIS REPORT NIAGARA MOHAWK POWER CORP. DOCKET 50-300 /1968/

BOILING LIGHT WATER REACTORS, DOMESTIC BD39

* * * * * * * * * * * * * * * * *

NAME/OWNER	BURNS HARBOR STATION/NIPSCO BAILEY STATION-3
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	NORTHERN INDIANA PUBLIC SERVICE CO /NIPSCO/
LOCATION	DUNE ACRES, NEAR GARY, INDIANA ON LAKE MICHIGAN
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	800
CRITICAL	CONSTRUCTION 1968 TARGET 1972
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
REFERENCES	NUCLEONICS WEEK JAN. 19, 1967 P. 1 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	HIGH POWER DENSITY BWR
DESIGNER	GENERAL ELECTRIC COMPANY
PURPOSE	POWER
TYPE	BWR, HIGH POWER DENSITY
POWER MWE(MWT)	600 1915
CRITICAL	CONCEPTUAL DESIGN
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.373 IN. OD
FUEL GEOMETRY	ROD, 144 IN. ACTIVE LENGTH, 0.428 IN. DIAM.
FUEL CLADDING	ZIRCALOY-2, 0.027 IN. THICK
FUEL ENRICH.	2.66 PER CENT U-235
FUEL ASSEMBLY	BUNDLE, 9X9, ZIRCALOY-4 CHANNELS CORNER RODS OF BUNDLES HAVE SMALLER DIMENSIONS FOUR BUNDLES SURROUND A CRUCIFORM CONTROL ROD 368 BUNDLES/CORE CORE DIAMETER 136.8 IN. ROD SPACING IS BY A GRID OF WIRES
BURNUP(REFUEL)	20,000 MWD/T BATCH, 8 MONTHS
CONTROL	SS TUBES WITH BORON CARBIDE, CRUCIFORM RODS. TEMPORARY BORON CARBIDE POISON CURTAINS.
REFERENCES	600 MWE HIGH POWER DENSITY BWR CORE - CONCEPTUAL DESIGN. FINAL REPORT. DR MILLER, OTHERS GEAP-4974 /FEB. 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BELL STATION/N.Y. STATE ELECTRIC + GAS CO. CAYUGA LAKE
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	N.Y. STATE ELECTRIC + GAS CO.
LOCATION	CAYUGA LAKE, NEAR ITHACA, NEW YORK
PURPOSE	POWER
TYPE	BWR, SINGLE CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	800 2400
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.488 IN. DIAM.
FUEL GEOMETRY	ROD 0.562 IN. OD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 0.032 IN. THICK
FUEL ENRICH.	AVE. 2.23 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7 ZIRCALOY-4 CHANNELS 560 ASSEMBLIES/CORE
FUEL CHARGE	273,000 LBS. URANIUM DIOXIDE
BURNUP(REFUEL)	19,000 MWD/TU
CONTROL	CRUCIFORM ROD, BORON CARBIDE IN SS TUBES, BOTTOM ENTRY. TEMPORARY POISON CURTAINS.
COOLANT PRESS.	1005 PSIG
REACTOR VESSEL	VERTICAL CYLINDER 18 FT. 2 IN. ID, 69 FT. 4 IN. LONG, WALL 5 17/32 IN. THICK STEEL.
CONTAINMENT	PRESSURE-SUPPRESSION PRIMARY CONTAINMENT SYSTEM. STEEL-LINED CONCRETE CYLINDRICAL STRUCTURE
REMARKS	SERVICE WATER FROM CAYUGA LAKE WILL BE RETURNED

* * * * * * * * * * * * * * * * *

TO LAKE VIA CIRCULATING WATER DISCHARGE SYSTEM.

REFERENCES BELL STATION, PRELIMINARY SAFETY ANALYSIS REPORT, NEW YORK STATE ELECTRIC AND GAS CORP, DOCKET 20-319, VOL. 1-2

* * * * * * * * * * * * * * * * *

NAME/OWNER	BRUNSWICK STATION/CAROLINA POWER + LIGHT CO. CAPE FEAR STATION
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	CAROLINA POWER + LIGHT COMPANY
LOCATION	CAPE FEAR RIVER, N. CAROLINA TIDAL ESTUARY
PURPOSE	POWER
TYPE	BWR, SINGLE CYCLE FORCED CIRCULATION. 3-REACTOR STATION
POWER MWE(MWT)	800 2436 PER REACTOR
CRITICAL	CONTRACT JAN. 1968 TARGET NO.1, 1973 NO.2, 1974 NO.3, 1975
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.487 IN. DIAM.
FUEL GEOMETRY	ROD 0.563 IN. OD, 144 IN. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY-2 0.032 IN. THICK
FUEL ENRICH.	AVE. 2.25 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7 ZIRCALOY-4 CHANNEL 560 ASSEMBLIES/CORE
FUEL CHARGE	AVE. 19,000 MWD/T
CONTROL	RODS, BORON CARBIDE IN SS
REACTOR VESSEL	STEEL CYLINDER 837 IN. HIGH, 218 IN. ID. WALL THICKNESS 5 17/32 MIN. SS CLADDING 1/8 IN. THICK
CONTAINMENT	STEEL-LINED CONCRETE STRUCTURE. PRESSURE SUPPRESSION SYSTEM.
REMARKS	COOLING WATER INTAKE IN THE WALDEN CREEK AREA AND DISCHARGE IN THE VICINITY OF PRICE CREEK.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS. DOMESTIC BD42

* * * * * * * * * * * * * * * * *

REFERENCES BRUNSWICK STEAM ELECTRIC PLANT UNITS 1 + 2.
PRELIMINARY SAFETY ANALYSIS REPORT
CAROLINA POWER + LIGHT CO.
DOCKET 50-324, 50-325 /1968/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD43

* * * * * * * * * * * * * * * * *

NAME/OWNER	COOPER NUCLEAR STATION/CONSUMERS PUBLIC POWER, IOWA LIGHT + POWER	
DESIGNER	GENERAL ELECTRIC COMPANY	
LOCATION	BROWNVILLE, NEBRASKA MISSOURI RIVER	
PURPOSE	POWER	
TYPE	BWR, FORCED CIRCULATION, SINGLE CYCLE, HIGH POWER DENSITY	
POWER MWE(MWT)	780	2381
CRITICAL	TARGET 1972	
COOLANT	LIGHT WATER	
MODERATOR	LIGHT WATER	
FUEL MATERIAL	URANIUM DIOXIDE PELLETS	
FUEL GEOMETRY	RODS	
FUEL CLADDING	ZIRCALOY	
CONTAINMENT	PRESSURE-SUPPRESSION SYSTEM	
REFERENCES	COOPER NUCLEAR STATION, PRELIMINARY SAFETY ANALYSIS REPORT, CONSUMERS PUBLIC POWER DISTRICT DOCKET 50-298 /19680	

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD44

* * * * * * * * * * * * * * * * *

NAME/OWNER	DUANE ARNOLD STATION/IOWA ELECTRIC LIGHT + POWER
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	IOWA ELECTRIC LIGHT + POWER COMPANY
LOCATION	PALO, IOWA CEDAR RIVER
PURPOSE	POWER
TYPE	BWR, 2-REACTOR STATION. UNIT 2 NOT OPTIONED TO GE
POWER MWE(MWT)	550 PER REACTOR
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	CONTRACT AWARD FEB, 1968, CLOSED-CIRCUIT COOLING TOWERS WILL BE USED
REFERENCES	NEWS RELEASES

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDWIN I. HATCH NUCLEAR PLANT/GEORGIA POWER CO.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	GEORGIA POWER COMPANY
LOCATION	BAXLEY, GEORGIA ALTAMAHA RIVER
PURPOSE	POWER
TYPE	BWR, FORCED CONVECTION CIRCULATION
POWER MWE(MWT)	800 2436
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.487 IN. DIAM.
FUEL GEOMETRY	ROD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 TUBES 0.563 IN. OD.
FUEL ENRICH.	2.23 PER CENT U-235
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7 ZIRCALOY-4 CHANNELS 560 ASSEMBLIES/CORE
BURNUP(REFUEL)	FIRST CORE AVE. 20,000 MWT/TU
CONTROL	CRUCIFORM RODS, BORON CARBIDE IN SS TUBES. BOTTOM ENTRY. TEMPORARY POISON CURTAINS.
COOLANT PRESS.	1020 PSIA
REACTOR VESSEL	CORE SHROUD IS A STAINLESS STEEL CYLINDER AROUND THE CORE. VESSEL IS A VERTICAL CYLINDRICAL STEEL SHELL, 18 FT. 2 IN. ID BY 69 FT. 4 IN. LONG, WALL THICKNESS 5 17/32 IN.
CONTAINMENT	PRESSURE-SUPPRESSION PRIMARY CONTAINMENT SYSTEM, REACTOR BUILDING.
REMARKS	CONTRACT AWARDED IN DEC. 1967 WITH OPTION ON

* * * * * * * * * * * * * * * * *

SECOND REACTOR.
A COOLING TOWER SYSTEM IS PROVIDED FOR IN THE DESIGN.

REFERENCES

EDWIN I. HATCH NUCLEAR PLANT,
PRELIMINARY SAFETY ANALYSIS REPORT VOL. 1-4
DOCKET 50-321 /MAY 1968/

* * * * * * * * * * * * * * * * *

NAME/OWNER	IBSHR /INTEGRAL BOILING SUPERHEATING REACTOR/WEST
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
PURPOSE	POWER
TYPE	BWR, NUCLEAR SUPERHEAT, PRESSURE TUBE
POWER MWE(MWT)	310 820
CRITICAL	DESIGN STUDY
COOLANT	BOILING REGION, LIGHT WATER SUPERHEAT REGION, LIGHT WATER STEAM
MODERATOR	GRAPHITE
FUEL MATERIAL	BOILING REGION URANIUM DIOXIDE PELLETS .354 IN. DIAM. SUPERHEAT REGION URANIUM DIOXIDE PELLETS .370 IN. DIAM.
FUEL GEOMETRY	ROD .400 IN. OD
FUEL CLADDING	BOILING REGION ZIRCALOY 0.021 IN. THICK, GAS GAP SUPERHEAT REGION SS 0.015 IN. THICK
FUEL ENRICH.	LOW FUEL ASSEMBLIES WITH DIFFERENT ZONES OF ENRICHMENT WERE STUDIED
FUEL ASSEMBLY	BOILING REGION 85-ROD BUNDLE, 2 ASSEMBLIES/PRESSURE TUBE 256 ASSEMBLIES SUPERHEAT REGION 55-ROD BUNDLE, 2 ASSEMBLIES/PRESSURE TUBE 240 ASSEMBLIES ACTIVE CORE HEIGHT 16 FT.
FUEL CHARGE	51,935 KG URANIUM
BURNUP(REFUEL)	BOILING REGION AVE. 16,500 MWD/MT SUPERHEAT REGION AVE. 16,000 MWD/MT
CONTROL	RODS, BORON CARBIDE
COOLANT TEMP.	BOILING REGION

* * * * * * * * * * * * * * * * *

	INLET 602.5 F OUTLET 613.2 F
	SUPERHEAT REGION
	INLET 613.2 F OUTLET 1000 F
COOLANT PRESS.	BOILING REGION 1785 PSIA SUPERHEAT REGION 1670 PSIA
REACTOR VESSEL	SS VESSEL 26.6 FT. ID. 32.25 FT. HIGH WALL 1.125 IN. THICK
CONTAINMENT	PRESTRESSED CONCRETE CYLINDER 88 FT. ID/92 FT. OD. 139 FT. HIGH VAPOR SUPPRESSION SYSTEM
REMARKS	BOILING PRESSURE TUBES LOCATED CENTRALLY IN SQUARE LATTICE, SURROUNDED BY SUPERHEAT REGION WITH PRESSURE TUBES ALSO IN SQUARE LATTICE
REFERENCES	GRAPHITE MODERATED INTEGRAL BOILING AND SUPER-HEATING PRESSURE TUBE REACTOR, WESTINGHOUSE ELECTRIC CORP. WCAP-1674 /DEC. 1, 1960/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD47

* * * * * * * * * * * * * * * * *

NAME/OWNER	PHILADELPHIA ELECTRIC STA./PHILADELPHIA ELECTRIC
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	PHILADELPHIA ELECTRIC COMPANY
LOCATION	UNDETERMINED
PURPOSE	POWER
TYPE	BWR, TWO-REACTOR STATION
POWER MWE(MWT)	1065 PER REACTOR
CRITICAL	TARGET NO. 1, 1975 NO. 2, 1977
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, DOMESTIC BD48

* * * * * * * * * * * * * * * * *

NAME/OWNER	ENRICO FERMI-2/DETROIT EDISON
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	DETROIT EDISON COMPANY
LOCATION	MONROE, MICHIGAN LAGOONA BEACH
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	1135
CRITICAL	TARGET 1974
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER

BOILING LIGHT WATER REACTORS

DOMESTIC

BOILING LIGHT WATER REACTORS

FOREIGN

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF01

* * * * * * * * * * * * * * * * *

NAME/OWNER	GAMMA PROJECT/DANATOM, DENMARK
DESIGNER	DANATOM, DENMARK
LOCATION	KARLBY KLINT, DJURSLAND, JUTLAND
PURPOSE	POWER
TYPE	BWR, INTERNAL STEAM SEPARATION, SINGLE CYCLE
POWER MWE(MWT)	200 667
CRITICAL	DESIGN-TO BE BUILT
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS , FUEL SEGMENTS OF PELLETS, EACH SEGMENT CLAD WITH ZIRCALOY-2, ARE JOINED TO FORM A FUEL ROD.
FUEL CLADDING	ZIRCALOY-2
FUEL ENRICH.	1,9 PERCENT U-235
FUEL ASSEMBLY	15X15 ARRAY WITH SOME RODS OMITTED 89 ELEMENTS/CORE
CONTROL	SPECTRAL SHIFT CONTROL HAS BEEN PROPOSED FOR STUDY
COOLANT TEMP.	INLET 530 F OUTLET 485 F WITH BOILING SYSTEM 520 F AND 476 F WITH BOILING SYSTEM PRESSURE IS REDUCED.
CONTAINMENT	PRESSURE-SUPPRESSION
REMARKS	REVISED DESIGN, /GAMMA 2/ IS FOR A SINGLE CYCLE SYSTEM.
REFERENCES	GAMMA, A 200MW BOILING WATER REACTOR POWER STATION. DANATOM DANATOM-04-61 /AUGUST 1961/ GAMMA II-A 200MW BOILING WATER REACTOR POWER STATION. A REVISION. DANATOM

* * * * * * * * * * * * * * * * *

DANATOM-03-62 /JUNE 1962/

HEAVY WATER REACTOR WILL BOIL.
A WILLIAMS
POWER ENG, 72, 78-80 /NOV, 1968/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF02

* * * * * * * * * * * * * * * * * *

NAME/OWNER	TARAPUR STATION/INDIA
DESIGNER	GENERAL ELECTRIC CO.-U.S.
LOCATION	TARAPUR, INDIA ARABIAN SEA
PURPOSE	POWER, STATES OF BUJARAT AND MAHARASHTRA
TYPE	BWR, DUAL CYCLE, FORCED CIRCULATION, INTERNAL STEAM SEPARATION TWO-REACTOR STATION
POWER MWE(MWT)	190 660 PER REACTOR
CRITICAL	NO. 1 FUELED DEC. 1967 NO. 2 FUELED JAN. 1968
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD, 0.541 IN. OD., ACTIVE LENGTH 12 FT.
FUEL CLADDING	ZIRCALOY-2, 28 MILS THICK
FUEL ENRICH.	AVE. 2.25 PER CENT URANIUM-235
FUEL ASSEMBLY	6X6 ROD ASSEMBLY, ZIRCALOY CHANNEL 284 ASSEMBLIES
FUEL CHARGE	87,870 LBS. URANIUM
CONTROL	RODS
REACTOR VESSEL	STEEL, SS CLAD, 12 FT. ID./53.9 FT. HIGH 5.375 IN. WALL THICKNESS
CONTAINMENT	PRESSURE-SUPPRESSION, STEEL DRYWELL. SPHERICAL STRUCTURE, 65 FT. DIA., NECK 23FT. DIA., TOTAL HEIGHT 96.5 FT. BOTH REACTORS ARE HOUSED IN A COMMON BUILDING BUT EACH REACTOR AND ITS ACCESSORIES ARE ENCLOSED IN A SEPARATE DRY-WELL VENTING INTO ITS OWN PRESSURE-SUPPRESSION CHAMBER.
REMARKS	FIRST FUEL LOADING WILL BE ENRICHED URANIUM, THE POSSIBILITY IS BEING CONSIDERED OF OPERATING THE PLANT, SUBSEQUENT TO FIRST LOADING, ON

* * * * * * * * * * * * * * * * *

PLUTONIUM-ENRICHED NATURAL URANIUM FUEL. A SMALL-SCALE PROTOTYPE VERSION OF THE TARAPUR BWR IS CURRENTLY BEING DESIGNED BY INDIAN SCIENTISTS AND WILL BE BUILT AT THE TROMBAY ATOMIC ENERGY ESTABLISHMENT. INTENDED PRIMARILY FOR R+D, THE 20 MWE CAPACITY WOULD, HOWEVER, BE FED TO THE BOMBAY POWER GRID.

REFERENCES TARAPUR ATOMIC POWER STATION
M. N. CHAKRAVARTI, M. R. SRINIVASAN
3RD U.N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF.28/P/745

* * * * * * * * * * * * * * * * *

NAME/OWNER	GARIGLIANO NUCLEAR STATION/SENN, ITALY PUNTA FIUME
DESIGNER	GENERAL ELECTRIC CO.-U.S.
OPERATOR	SENN, ITALY
LOCATION	PUNTA FIUME /GARIGLIANO/, ITALY GARIGLIANO RIVER
PURPOSE	POWER /US-EURATOM PROGRAM/
TYPE	BWR, FORCED CIRCULATION, DUAL CYCLE
POWER MWE(MWT)	150 500
CRITICAL	JUNE 1963, SEE REMARKS
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, SINTERED, 0.456 IN. DIA.
FUEL GEOMETRY	RODS, ACTIVE LENGTH 106.5 IN.
FUEL CLADDING	ZIRCALOY-2, 0.019 IN. THICK SEE REMARKS
FUEL ENRICH.	2.7 PER CENT U-235
FUEL ASSEMBLY	81 RODS, 9X9 208 ASSEMBLIES IN CORE
FUEL CHARGE	97,750 LBS. URANIUM
BURNUP(REFUEL)	13,000 MWD/TON /BATCH, 20 PER CENT/
CONTROL	CONTROL BLADES, TUBES FILLED WITH BORON CARBIDE POWDER. OPERATION IS FROM BELOW THE REACTOR VESSEL.
COOLANT TEMP.	INLET 190.5C
COOLANT PRESS.	71.3 ATM. ABS.
REACTOR VESSEL	CARBON STEEL CYLINDER, SS CLAD 141 IN. ID./5 IN. THICK /INCLUDING CLAD//444 1/4 IN. LONG/
CONTAINMENT	SPHERE, 160 FT. DIA., CARBON STEEL, APPROX.

* * * * * * * * * * * * * * * * *

0.94 IN. THICK

REMARKS

TRIAL OPERATIONS WERE DISCONTINUED IN SEPTEMBER 1963 BECAUSE OF MECHANICAL BREAKDOWN, OPERATION RESUMED IN 1964. REFUELED NOV.-DEC. 1965, WITH ONE-HALF OF SS-CLAD FUEL REPLACED BY ZIRCONIUM CLAD FUEL.
SENN PLANS A SECOND REACTOR AT THE SITE.

REFERENCES

THE GARIGLIANO NUCLEAR POWER STATION.
M COVINO
NUCLEAR POWER 7, 65-7 /FEBRUARY 1962/

FINAL HAZARD SUMMARY REPORT FOR THE GARIGLIANO NUCLEAR POWER STATION.
SOCIETA ELETTRONUCLEARE NAZIONALE /SENN/, ITALY
APED-4022 /1962/

GARIGLIANO NUCLEAR POWER PLANT.
R LEPORE, OTHERS.
3RD UN INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY PAPER NO. 737 /1964/

GARIGLIANO NUCLEAR POWER PLANT
EURATOM BULLETIN NO. 4, P. 4-12 /DEC. 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	JPDR /JAPAN POWER DEMONSTRATION REACTOR//JAERI
DESIGNER	GENERAL ELECTRIC CO.-U.S.
OPERATOR	JAERI, JAPAN
LOCATION	TOKAI-MURA, JAPAN
PURPOSE	POWER DEMONSTRATION, SHIP PROPULSION R+D
TYPE	BWR, NATURAL CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	12.5 45
CRITICAL	AUG. 1963, ON-LINE OCT. 1963
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE CYLINDERS, SINTERED
FUEL GEOMETRY	HOLLOW TUBES.
FUEL CLADDING	SS
FUEL ENRICH.	3.1 PER CENT U-235
FUEL ASSEMBLY	36-ROD ASSEMBLY. EACH ROD CONSISTS OF 2 FUEL SEGMENTS 72 ASSEMBLIES/CORE
BURNUP(REFUEL)	12,000 MWD/TON U /324 DAYS FIRST CORE/
REMARKS	RESEARCH AND DEVELOPMENT IS IN PROGRESS ON JPDR-2, A MODIFIED VERSION OF THE GE DESIGN. SEE BF15.
REFERENCES	NUCLEAR POWERED TANKER DESIGN AND ECONOMIC ANALYSIS, DIRECT CYCLE BOILING WATER REACTOR. GEAP-3294 /DEC. 1959/ REACTOR DESIGN REPORT FOR JPDR. DA VERNIER, J JACOBSON GEAP-3767 /1961/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF05

* * * * * * * * * * * * * * * * *

NAME/OWNER	DODEWAARD NUCLEAR STATION/GKN SEP BWR
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	NV GEMEENSCHAPPELIJKE KERNENERGIECENTRALE NEDERLAND /GKN/ JOINT NETHERLANDS NUCLEAR POWER STATION
LOCATION	DOODEWAARD, THE NETHERLANDS /BETUWE DISTRICT/ WAAL RIVER
PURPOSE	POWER
TYPE	BWR DIRECT CYCLE, NATURAL CIRCULATION
POWER MWE(MWT)	50 165
CRITICAL	1968
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS-ANNULAR
FUEL CLADDING	ZIRCALOY-2 OR STAINLESS STEEL.
FUEL ENRICH.	2.5 PER CENT U-235
FUEL ASSEMBLY	36-ROD ASSEMBLY 156 ELEMENTS/CORE
FUEL CHARGE	13000 KG. URANIUM
SPECIFIC POWER	36.3 KW/LITER OF CORE VOLUME
BURNUP(REFUEL)	13,000 MWD/TU
CONTROL	SS TUBES CONTAINING BORON CARBIDE
REACTOR VESSEL	CYLINDRICAL VESSEL 3 M. ID./11 M. LONG, STEEL WITH SS LINING. VESSEL CONTAINS CORE AND SUPPORT STRUCTURE, STEAM-WATER SEPARATOR, AND STEAM DRIER. WALL THICKNESS 80 MM CLAD THICKNESS 4 MM
CONTAINMENT	REACTOR BUILDING, PRESSURE-SUPPRESSION SYSTEM.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF05

* * * * * * * * * * * * * * * * *

REMARKS SEP ENGINEERS WORKING WITH GE WILL DO PRELIMINARY DESIGN, SCOPING, AND ECONOMIC STUDIES. EURATOM HAS EAR-MARKED CONSTRUCTION FUNDS FOR THE PROJECT.

REFERENCES THE DUTCH NUCLEAR POWER PLANT PROJECT.
JS TERPSTRA
EURATOM BULLETIN NO. 4, 28-9 /DEC. 1963/

DODEWAARD NUCLEAR POWER STATION
P MOSTERT
EURONUCLEAR 3, 37-40 /JAN. 1966/

THE FIRST NETHERLANDS NUCLEAR STATION
ENERGIE NUCLEAIRE 10, 293-96 /SEPT. 1968/

* * * * * * * * * * * * * * * * *

NAME/OWNER	SIMPEVARP REACTOR/OKAB, SWEDEN OSKARSHAMM NUCLEAR POWER STATION
DESIGNER	ASEA, SWEDEN
OPERATOR	OSKARSHAMMSVERKETS KRAFTGRUPP AB /OKAB/, SWEDEN
LOCATION	OSKARSHAMM, SIMPEVARP PENINSULA, SWEDEN ON BALTIC COAST
PURPOSE	POWER
TYPE	BWR DIRECT CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	400 1250
CRITICAL	CONSTRUCTION, TARGET AUGUST 1970
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 10.5 MM DIAM.
FUEL GEOMETRY	ROD, 12.25 MM OD, 3650 MM LONG
FUEL CLADDING	ZIRCALOY-2 0.8 MM THICK
FUEL ENRICH.	2.5 PER CENT U-235, ZONED
FUEL ASSEMBLY	64-ROD BUNDLE, SQUARE LATTICE, ZIRCALOY ENVELOPES 448 ASSEMBLIES/CORE
FUEL CHARGE	80 TONS URANIUM
BURNUP(REFUEL)	20,000 MWD/T ANNUAL, ONE-HALF CHARGE
CONTROL	CRUCIFORM RODS WITH BORON CARBIDE COOLANT FLOW REGULATION
COOLANT TEMP.	160 C
REACTOR VESSEL	STEEL VESSEL 17.4 M LONG, 5.0 M ID, WALL THICKNESS 120 MM INCLUDING 5 MM SS CLAD.
CONTAINMENT	PRESTRESSED CONCRETE ENCLOSING REACTOR, SERVICE AND EQUIPMENT AUXILIARIES, OUTER STEEL LINING. PRESSURE-SUPPRESSION SYSTEM. REACTOR BUILDING A GAS-TIGHT CONCRETE STRUCTURE.

* * * * * * * * * * * * * * * * *

REMARKS CONTRACT AWARD TO ASEA IN JULY 1965.
CONSTRUCTION SCHEDULED FOR SPRING 1966.
TARGET 1970

REFERENCES OSKARSHAMM NUCLEAR POWER STATION
EURONUCLEAR 2, 382-3 /AUG, 1965/

SWEDEN-S LARGEST NUCLEAR POWER STATION
ENGINEERING 200, 141 /JULY 30, 1965/

LA CENTRALE NUCLEAIRE D-OSKARSHAMN
O GIMSTEDT, S SANDSTROM
ENERGIE NUCLEAIRE 9, 298-302 /AUG-SEPT, 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	IBR /INTEGRAL BOILING REACTOR/AEA, UNITED KINGDOM.
DESIGNER	UK AEA
PURPOSE	SHIP PROPULSION
TYPE	BWR, DIRECT OR INDIRECT CYCLE, PRESSURE TUBE.
POWER MWE(MWT)	60
CRITICAL	CONCEPT
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	PINS
FUEL CLADDING	SS OR ZR TUBES
FUEL ENRICH.	5 PER CENT U-235
FUEL ASSEMBLY	FUEL PINS CLUSTERED AROUND CENTRAL BURNABLE POISON PIN, AND MOUNTED WITH IN A ZIRCONIUM-NIOBIUM ALLOY SHROUD.
REMARKS	THE AEA HAS STUDIED THIS CONCEPT, AND THE BELGIUM CONCEPT VULCAIN, IN THEIR SHIP PROPULSION PROGRAM. TWO VERSIONS OF THE IBR WERE BEING INVESTIGATED. INDIRECT CYCLE, IN WHICH THE TUBES CONTAINING THE FUEL ELEMENTS ARE CLOSED AND INTERCONNECTED TO FORM A CIRCUIT THROUGH WHICH HIGH PRESSURE WATER IS PUMPED AS AN INTERMEDIATE IN THE MAIN COOLANT, AND DIRECT CYCLE, IN WHICH THE TUBES CONTAINING THE FUEL ARE OPEN AT THE ENDS THE COOLANT FLOWING DIRECTLY OVER THE FUEL. BOILING TAKES PLACE IN THE CORE. THE PRIMARY COOLANT PUMP, STEAM SEPARATORS AND PRESSURIZER ARE ALL WITHIN THE REACTOR VESSEL.
REFERENCES	THE U. K. ATOMIC ENERGY AUTHORITYS NUCLEAR SHIP CONCEPTS. NUCLEAR ENG. 8, 88-9 /MARCH 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	ULYANOVSK ATOMIC POWER STATION/CENTRAL ATOMIC ENERGY UTILIZATION BOARD, USSR,
DESIGNER	USSR
OPERATOR	CENTRAL ATOMIC ENERGY UTILIZATION BOARD
LOCATION	MELEKESS /ULYANOVSK REGION/ USSR VOLGA RIVER
PURPOSE	POWER
TYPE	BWR, DIRECT CYCLE
POWER MWE(MWT)	70 250
CRITICAL	1965
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	NIOBIUM-ZIRCONIUM ALLOY
FUEL ENRICH.	1.5 PER CENT U-235
FUEL ASSEMBLY	91 FUEL RODS, HEXAGONAL 187 ASSEMBLIES/CORE
FUEL CHARGE	26 TONS ENRICHED URANIUM
SPECIFIC POWER	9.6 KW/KG ENRICHED URANIUM
NEUTRON FLUX	THERMAL AVE. 3X10 E+13
CONTROL	CONTROL RODS
COOLANT TEMP.	236-310 C
COOLANT PRESS.	32-100 KG/SQ. CM.
REACTOR VESSEL	CYLINDER, BOILER PLATE STEEL 11.2 M. HIGH, 3.8 M. DIA. 10 CM. THICK
REMARKS	THE COOLANT WATER FLOWS INTO AN ANNULUS BETWEEN THE STEEL PRESSURE VESSEL WALL AND THE

* * * * * * * * * * * * * * * * *

CORE, FLOWS DOWNWARD, PASSES OVER THE FUEL ELEMENTS IN THE CORE FROM THE BOTTOM TO THE TOP, LEAVES THE REACTOR AND GOES TO THE STEAM GENERATORS.

REFERENCES

DOUBLE WATER CIRCUIT POWER REACTORS IN THE USSR.
SA SKORTSOV
SOVIET J. ATOMIC ENERGY 5, 1107-19
/SEPTEMBER 1958/

VOL. I. POWER REACTORS. PP. 73-5
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1959.

* * * * * * * * * * * * * * * * *

NAME/OWNER	BELOYARSK STATION/MINISTRY OF POWER, USSR, PROJECT-1		
DESIGNER	USSR		
OPERATOR	MINISTRY OF POWER STATIONS		
LOCATION	BELOYARSK URALS, USSR,		
PURPOSE	POWER		
TYPE	BWR, NUCLEAR SUPERHEAT, PRESSURE TUBE, 2-REACTOR STATION,		
POWER MWE(MWT)	94 200	286 560	/BELOYARSK-1/ /BELOYARSK-2/
CRITICAL	BELOYARSK-1, 1964 BELOYARSK-2, 1967		
COOLANT	LIGHT WATER AND STEAM		
MODERATOR	GRAPHITE		
FUEL MATERIAL	URANIUM-MOLYBDENUM ALLOY		
FUEL GEOMETRY	ANNULAR /HOLLOW/ CYLINDERS, 600 CM, LONG,		
FUEL CLADDING	SS INNER AND OUTER		
FUEL ENRICH,	BELOYARSK-1, 1,5 PER CENT U-235 BELOYARSK-2, 3,0 PER CENT 1-235		
FUEL ASSEMBLY	6 CYLINDERS, HEXAGONAL 750 BOILING REGION 268 STEAM COOLED /SECONDARY STEAM/		
FUEL CHARGE	15,880 KG, URANIUM		
SPECIFIC POWER	3,2 KW/KG ENRICHED URANIUM		
BURNUP(REFUEL)	BELOYARSK-1, 4000 MWD/T BELOYARSK-2, 10000 MWD/T		
NEUTRON FLUX	MAX, 2X10 E+13		
CONTROL	CONTROL RODS		
COOLANT TEMP,	INLET 300 C	OUTLET 340 C	
COOLANT PRESS,	150 ATM,		

* * * * * * * * * * * * * * * * *

REACTOR VESSEL CYLINDER, CARBON STEEL, 9.6 M. HIGH, 9.0 M. DIA.

CONTAINMENT NONE OTHER THAN REACTOR HALL.

REMARKS SECOND REACTOR USES ANNULAR ELEMENTS WITH LARGER ANNULI BUT SAME OD, AND 3 PER CENT ENRICHED URANIUM.
A THIRD PLANT IS PLANNED FOR THE COMPLEX, USING 5 PER CENT ENRICHED FUEL FOR 1000 MWE AND 2220 MWT

REFERENCES

URANIUM-GRAPHITE REACTORS WITH SUPERHEATED STEAM FOR ELECTRIC POWER STATIONS.
NA DOLLEZHAL
SOV. J. ATOMIC ENERGY 5, 1085-1106
/SEPTEMBER 1958/

STEAM COOLED POWER REACTOR EVALUATION-BELOYARSK /URAL/ REACTOR.
GENERAL ELECTRIC COMPANY, HANFORD
HW-67473 /APRIL 1961/

EXPERIMENTAL UNIFLOW STEAM SUPERHEATING REACTOR INSTALLATION OF THE FIRST ATOMIC POWER PLANT.
VV KOLOGOV, OTHERS
FTD-TT-61-340 /1962/ /TRANSLATION/

URANIUM GRAPHITE POWER REACTOR WITH DIRECT FEEDING OF STEAM TO TURBINES.
NA DOLLEZHAL, OTHERS
FTD-TT-61-342 /1962/ /TRANSLATION/

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

OPERATION OF THE FIRST NUCLEAR POWER PLANT IN THE WORLD.
GN USHAKOV, OTHERS.
ATOMNAYA ENERGIYA 16,484-8 /1964/
AEC-TR-6463 /TRANSLATION/

IV KURCHATOV BELOYARSK NUCLEAR POWER PLANT.
PI ALESHCHENKOV, VM SHUVALOV
ATOMNAYA ENERGIYA 16,489-96 /1964/
AEC-TR-6462 /TRANSLATION/

START-UP AND PILOT OPERATION OF THE FIRST UNIT OF THE BELOYARSK NUCLEAR POWER STATION AFTER I.V. KURCHATOV.

* * * * * * * * * * * * * * * * *

AN GRIGORYANTS, OTHERS
3RD N.N. INTL. CONF. ON THE PEACEFUL USES OF
ATOMIC ENERGY, 1964, A/CONF. 28/P/308

WORLD-S POWER REACTORS 1966, CHART.
NUCLEAR ENGINEERING APRIL 1966

* * * * * * * * * * * * * * * * *

NAME/OWNER	KAHL EXP. HIGH TEMPERATURE REACTOR/RWE AND BAYERN, RWE-1, VAK REACTOR
DESIGNER	GE/AEG, US AND W. GERMANY
OPERATOR	VERSUCHSATOMKRAFTWERK KAHL GMBH /VAK/, W. GERMANY RWE AND BAYERNWERK AG
LOCATION	KAHL-AM-MAIN, W. GERMANY MAIN RIVER
PURPOSE	POWER EXPERIMENT
TYPE	BWR, NATURAL CIRCULATION, INDIRECT CYCLE. FORCED CIRCULATION CAN BE ADDED AT A LATER DATE. SUPERHEAT WILL BE ADDED.
POWER MWE(MWT)	15 60
CRITICAL	NOV. 1960, FULL POWER DEC. 1961
FUEL MATERIAL	URANIUM DIOXIDE SINTERED PELLETS, 0.5 IN. DIA./ 0.63 IN. LONG
FUEL GEOMETRY	ROD, ACTIVE LENGTH 29.9 IN.
FUEL CLADDING	ZIRCALOY, 0.85 MM. WALL THICKNESS
FUEL ENRICH.	2.3-2.6 PER CENT U- 235 /1ST CORE, 4 ZONE ENRICHMENT/
FUEL ASSEMBLY	72 RODS, TWO LAYERS, 6X6 88 ASSEMBLIES/CORE
FUEL CHARGE	5545KG. URANIUM
BURNUP(REFUEL)	8800 MWD/T BY ZONES
NEUTRON FLUX	THERMAL AVE. 1.5X10 E+13
CONTROL	RODS, 2 PER CENT ENRICHED BORIDED SS
COOLANT TEMP.	286C
COOLANT PRESS.	1000 PSIG
REACTOR VESSEL	STEEL CYLINDER DOMED ENDS, 27 FT. 9 IN. HIGH, 8 FT. ID. CLAD. SS.
CONTAINMENT	CYLINDER, DOMED ENDS, 106 FT. HIGH, 45 FT. DIA.

* * * * * * * * * * * * * * * * *

REMARKS A PROVISION HAS BEEN MADE FOR DOUBLING THE DESIGN POWER. SECOND TURBOSET MAY BE OPERATED IN DIRECT CYCLE. AEG WILL DEVELOP THE CONCEPT IN A STUDY OF A SUPERHEAT STEAM PLANT /SEE RWE-BAYERNWERK AG STATION/. AEG HAS ALSO ANNOUNCED THAT A PROTOTYPE SUPERHEAT REACTOR WITH A CAPACITY OF 100 MWT WILL BE CONSTRUCTED NEAR KAHL, WITH COMPLETION SCHEDULED FOR 1968.

REFERENCES

THE KAHL NUCLEAR POWER STATION.
HJ BRUCHNER
NUCLEAR POWER 6, 67-70 /MARCH 1961/

COMMISSIONING KAHL-S 15 MW BWR.
R KUHNEL, R MISENTA
NUCLEAR ENGINEERING 7, 407-14 /OCTOBER 1962/

THE 15 EMW NUCLEAR POWER STATION WITH BOILING WATER REACTOR AT KAHL/MAIN /FEDERAL REPUBLIC OF GERMANY/.
HJ BRUCHNER
SYMP. ON SMALL AND MEDIUM POWER REACTORS, PAPER SMPR/19
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, SEPTEMBER 5-9, 1960.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF11

* * * * * * * * * * * * * * * * *

NAME/OWNER	KRB NUCLEAR STATION/KRB, W. GERMANY RWE-BAYERNWERK
DESIGNER	ALLGEMEINE ELECTRIZITATS GESELLSCHAFT, /AEG/
OPERATOR	KERNKRAFTWERK RWE-BAYERNWERK GMBH /KRB/
LOCATION	GUNDREMINGEN, BAVARIA, W. GERMANY /ON DANUBE/
PURPOSE	POWER US-EURATOM
TYPE	BWR, DUAL CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	237 801
CRITICAL	1966
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD 3,30 M. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY-2 0,889 IN. THICK, 14,29 MM. OD.
FUEL ENRICH.	AVE. 2,24 PER CENT U-235
FUEL ASSEMBLY	36-ROD BUNDLE, 6X6 IN ZIRCALOY-4 CHANNEL 89 FUEL ELEMENT CELLS MAKE UP THE CORE. EACH CELL CONSISTS OF 4 ELEMENTS WITH A CENTRAL CONTROL ROD. 12 SINGLE ELEMENTS ARE ARRANGED ON THE PERIPHERY OF THE CORE. TOTAL RODS 13,248
FUEL CHARGE	53 TONS URANIUM DIOXIDE
BURNUP(REFUEL)	16,500 MWD/TU ANNUAL 90 ELEMENTS/YEAR
CONTROL	CRUCIFORM RODS, BORON CARBIDE ABSORBER MATERIAL, POISON CURTAINS.
COOLANT TEMP.	INLET 266 C
COOLANT PRESS.	71,3 ATM. ABS.
REACTOR VESSEL	STEEL VESSEL 3,71 M. ID., 16,5 M. HIGH,

* * * * * * * * * * * * * * * * *

WALL THICKNESS 121 MM.
SS CLAD 7 MM. THICK

CONTAINMENT CONCRETE SHELL, AIR GAP, AND STEEL CONTAINMENT.
STEEL STRUCTURE IS 30 M. ID., 60 M. HIGH, WITH
WALL THICKNESS 13.5/26.5 MM.
CONCRETE SHELL THICKNESS 38 CM.
WIDTH OF AIR GAP 15 CM.

REMARKS THE REACTOR IS A DEVELOPMENT OF THE US. GE.
DESIGNED RWE-1 REACTOR.

REFERENCES

THE GENERAL ELECTRIC COMPANY 100 MEGAWATT NATURAL
CIRCULATION BOILING WATER REACTOR POWER PLANT.
GENERAL ELECTRIC CO., APED
TID-15057 /1960/

THE 150 MWE ATOMIC POWER STATION WITH AN
EVAPORATING REACTOR, DESIGNED BY AEG.
E MOLDOVANYI
ENERGIA ES ATOMTECH. /HUNGARY/ 15, 139-43
/MARCH 1962/

THE NUCLEAR POWER STATION GUNDREMINGEN OF THE
KERNKRAFTWERK RWE-BAYERNWERK GMBH.
K PENSTER
BRENNSTOFFE-WAERME-KRAFT 16,227-30 /MAY 1964/

THE GUNDREMMINGEN NUCLEAR POWER PLANT.
I DESFOSSES, OTHERS.
EURATOM BULLET IN NO. 4,26-27 /DEC. 1963/

KRB GUNDREMMINGEN NUCLEAR POWER STATION
R JAERSHKY, R TAURIT
EURONUCLEAR 3, 212-26 /MAY 1966/

GUNDREMMINGEN NUCLEAR POWER PLANT.
R JAERSCHKY /AEG/
ATOM. STROM. 12, 103-6 /SEPT-OCT 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BWR STUDY/AEG, DEUTSCH WERFT, W. GERMANY
DESIGNER	AEG, W. GERMANY
PURPOSE	SHIP PROPULSION
TYPE	BWR
POWER MWE(MWT)	STUDY. NO RECENT INFORMATION
CRITICAL	STUDY
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REMARKS	DEUTSCHE WERFT AG HAS ANNOUNCED PLANS TO BUILD A FREIGHTER OF AT LEAST 45,000 TONS TO BE POWERED BY A BWR. STUDY AND DEVELOPMENT OF THE PLANS WAS DONE IN COOPERATION WITH AEG.
REFERENCES	ENERGIE NUCLEAIRE, JULY-AUGUST 1962, P. 296 NEWS RELEASE.

* * * * * * * * * * * * * * * * *

NAME/OWNER	LINGEN BWR/KERNKRAFTWERK LINGEN GMBH VEW STATION
DESIGNER	AEG, W. GERMANY
OPERATOR	KERNKRAFTWERK-LINGEN, W. GERMANY
LOCATION	DORTMUND-EMS CANAL, NORTH OF MUENSTEN, WESTPHALIA
PURPOSE	POWER
TYPE	BWR INDIRECT CYCLE, OIL-FIRED SUPERHEAT.
POWER MWE(MWT)	240 514
CRITICAL	MAY 1968 COMMERCIAL OPERATION OCT. 1968
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	ZIRCALOY-2 TUBES, 14.3 MM OD.
FUEL ENRICH.	AVE. 2.2 PER CENT U-235
FUEL ASSEMBLY	36-ROD CLUSTER, SQUARE ZIRCALOY CASING 284 ASSEMBLIES/CORE
FUEL CHARGE	32.2 TONS URANIUM
BURNUP(REFUEL)	AVE. 1ST CORE 16,500 MWD/TU
CONTROL	CRUCIFORM RODS, BORON CARBIDE IN SS
REACTOR VESSEL	STEEL CYLINDER 13.5 M HIGH/3.6 M ID. WALL 90 MM THICK, SS CLAD 6 MM THICK. FORGED RING STRUCTURE
CONTAINMENT	STEEL VESSEL
REMARKS	A JOINT PROJECT FOR A 240 MWE PLANT USING THE AEG-SUPPLIED 160 MWE BWR REACTOR WITH A 90 MWE OIL-FIRED SUPERHEATER. COOLING WATER WITHDRAWN FROM CANAL AND RETURNED TO RIVER

* * * * * * * * * * * * * * * * *

AT JUNCTION WITH THE CANAL.

REFERENCES

THE LINGEN NUCLEAR POWER STATION
O DEUBLEIN
ATOMWIRTSCHAFT 10, 162-9 /APRIL 1965/

LINGEN A SURVEY OF THE KWL PLANT.
O DEUBLEIN
NUCLEAR ENG. 13, 929-45 /NOV. 1968/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF14

* * * * * * * * * * * * * * * * *

NAME/OWNER	CANDU-BLW /CANDU-BOILING LIGHT WATER//AECL GENTILLY NUCLEAR STATION
DESIGNER	AECL, HYDRO-QUEBEC, CANADA
LOCATION	POINTE-AUX-ROCHES, NEAR GENTILLY AND BECANCOUR, QUEBEC, CANADA ST. LAWRENCE RIVER
PURPOSE	POWER PROTOTYPE
TYPE	BWR, HEAVY WATER MODERATED, DIRECT CYCLE, VERTICAL PRESSURE TUBE /CALANDRIA/,
POWER MWE(MWT)	500 803 PROTOTYPE 250 MWE
CRITICAL	PROTOTYPE CONSTRUCTION TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	HEAVY WATER, HEAVY WATER REFLECTOR,
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD 0.78 IN. DIAM, 19.5 IN. LONG SEE REMARKS
FUEL CLADDING	ZIRCALOY-4, 0.023 IN. WALL THICKNESS
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	18-ELEMENT BUNDLES 10 BUNDLES/CHANNEL, STACKED 308 CHANNELS
FUEL CHARGE	101.9 TON URANIUM
SPECIFIC POWER	24 W/G URANIUM
BURNUP(REFUEL)	ON-LOAD, WEEKLY
CONTROL	HORIZONTAL BOOSTER RODS OF ENRICHED URANIUM ZIRCALOY TUBES WITH HELIUM-3 AS ABSORBER ELEMENTS SOLUBLE POISON ADDITION OR REMOVAL FROM MODERATOR
COOLANT TEMP.	520 F
COOLANT PRESS.	OUTLET 980 PSIA

* * * * * * * * * * * * * * * * *

REACTOR VESSEL SS VERTICAL CYCLINDER 30 FT. DIA./ 23 FT. HIGH. CALANDRIA TUBES ZIRCALOY-2, AND PRESSURE TUBES A ZIRCONIUM-NIOBIUM ALLOY.

CONTAINMENT REINFORCED CONCRETE SHELL 100 FT. DIA., 182 FT. HIGH, HOUSING REACTOR VESSEL, VAULT, OTHER EQUIPMENT.

REMARKS A FUEL CONFIGURATION DESIGNATED TUBE-IN-SHELL WAS CONSIDERED, CONSISTING OF A MASSIVE ELEMENT PENETRATED BY COOLANT TUBES. COOLANT WOULD FLOW THROUGH THE TUBES AND ALSO THROUGH ANNULUS BETWEEN THE ELEMENT AND THE PRESSURE TUBE. CLADDING WOULD BE A SHELL STRUCTURE.
JAPAN PLANS DEVELOPMENT OF AN ADVANCED CONVERTER BASED ON CANDU-BLW, WITH PROTOTYPE CONSTRUCTION IN 1969.

REFERENCES

QUEBEC WILL GET CANDU-BLW REACTOR.
CANADIAN CHEM. PROCESSING 49, 57-62 /MAY 1965/

SECOND-GENERATION CANDU
NUCLEAR ENG. 10, 301-2 /AUG. 1965/

NUCLEAR CANADA JUNE 1966 P. 3-4
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER JAPCO TSURUGA STATION/JAPAN ATOMIC POWER CO.

DESIGNER GENERAL ELECTRIC COMPANY

OPERATOR JAPAN ATOMIC POWER CO. /JAPCO/

LOCATION TSURUGA, JAPAN. ON SEA OF JAPAN.

TYPE BWR, FORCED CIRCULATION, HIGH POWER DENSITY

POWER MWE(MWT) 310

CRITICAL CONSTRUCTION 1966, TARGET 1970

COOLANT LIGHT WATER

MODERATOR LIGHT WATER

REMARKS RESEARCH AND DEVELOPMENT, MODIFICATION OF THE GE JPDR-1 REACTOR.

REFERENCES RESEARCH AND DEVELOPMENT OF JPDR-2
A FORCED CIRCULATION, HIGH POWER DENSITY BOILING WATER REACTOR.
J MIIDA, K MOCHIZUKI
NIPPON GENSHVIYOKU GAKKAISHI 6, 350-5 /JUNE 1964/

NUCLEONICS WEEK OCT. 7, 1965 P. 2
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	FUKUSHIMA NUCLEAR STATION/TOKYO ELECTRIC POWER CO.
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	TOKYO ELECTRIC POWER CO., JAPAN
LOCATION	FUKUSHIMA, NORTHERN HONSHU, JAPAN
TYPE	BWR, TWO-REACTOR STATION
POWER MWE(MWT)	NO. 1, 440 NO. 2, 760
CRITICAL	NO. 1, 1970 NO. 2, 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL ENRICH.	LOW
REMARKS	CONTRACT FOR NO. 2 STATION IN JAN. 1968
REFERENCES	NEWS RELEASES

* * * * * * * * * * * * * * * * *

NAME/OWNER	SANTA MARIA DE GARONA STATION/NUCLENOR, SPAIN
DESIGNER	GENERAL ELECTRIC CO.
OPERATOR	CENTRALES NUCLEARES DEL NORTE SA /NUCLENOR/ SPAIN
LOCATION	SANTA MARIA DE GARONA, SPAIN NEAR BURGOS
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	440 1481
CRITICAL	TARGET 1970. CONSTRUCTION PERMIT GRANTED
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	ROD
REACTOR VESSEL	CYLINDER COMPOSED OF FORGED STEEL RINGS. 5.5 M. OD. WALL THICKNESS 120-150 MM.
REFERENCES	NEWS RELEASES.

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF18

* * * * * * * * * * * * * * * * *

NAME/OWNER	MUEHLBERG STATION/BKW, SWITZERLAND
DESIGNER	GENERAL ELECTRIC CO., BROWN BOVERI
OPERATOR	BERNISCHE KRAFTWERK, SWITZERLAND /BERNESE POWER COMPANY/
LOCATION	MUEHLBERG, AAR RIVER, BERNE, SWITZERLAND
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	300
CRITICAL	CONSTRUCTION, TARGET 1971
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REFERENCES	MUEHLEBERG NUCLEAR POWER STATION OF THE BERNESE POWER COMPANY WP AUER BROWN BOVERI REV, 54, 51-68 /FEB-MAR, 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	TWISTED TAPE BWR/W. GERMANY, FRANCE VORTEX FLOW BWR
DESIGNER	AEG /W. GERMANY/ AND SNECMA /FRANCE/
PURPOSE	POWER
TYPE	BWR, HIGH POWER DENSITY
POWER MWE(MWT)	600 1800
CRITICAL	FEASIBILITY STUDY
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 12.5 MM. DIAM.
FUEL GEOMETRY	ROD 14.4 MM. OD. ACTIVE LENGTH 3.66 M.
FUEL CLADDING	ZIRCALOY-2 0.9 MM. THICK
FUEL ENRICH.	SLIGHT
FUEL ASSEMBLY	49-ROD BUNDLE, 7X7, SQUARE ZIRCALOY-2 BOX. 592 ASSEMBLIES/CORE METAL BANDS OF ZIRCALOY-2, 0.2 MM. THICK, ARE TWISTED BETWEEN THE FUEL RODS TO ROTATE THE STEAM-WATER FLOW ALONG THE ASSEMBLY.
FUEL CHARGE	117,250 KG. URANIUM
BURNUP(REFUEL)	22,500 MWD/TU BATCH, 20 PER CENT
CONTROL	RODS
REACTOR VESSEL	STEEL CYLINDER
REMARKS	A PROTOTYPE TWISTED TAPE ASSEMBLY HAS BEEN TESTED IN THE KAHL-VAK BWR.
REFERENCES	TWISTED TAPE BOILING WATER REACTOR, FINAL REPORT JULY 1965-SEPT. 1966 AEG, SNECMA EUR-3651 /SEPT. 15, 1967/ BOILING WATER REACTOR WITH TWISTED TAPES BETWEEN THE FUEL RODS. J VOLLRADT

BOILING LIGHT WATER REACTORS, FOREIGN BF19

* * * * * * * * * * * * * * * * *

ATOMWIRT, ATOMTECH, 12, 595-601 /DEC, 1967/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF20

* * * * * * * * * * * * * * * * *

NAME/OWNER	CHOGOKU ELECTRIC STATION/CHOGOKU ELECTRIC POWER CO
DESIGNER	HITACHI LTD /JAPAN/
OPERATOR	CHOGOKU ELECTRIC POWER COMPANY /JAPAN/
LOCATION	SHIMANE PENINSULA, NEAR HIROSHIMA, JAPAN
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	500
CRITICAL	CONSTRUCTION TARGET 1971 OPERATION 1975
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
REFERENCES	NEWS RELEASES

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF21

* * * * * * * * * * * * * * * * *

NAME/OWNER	WUERGASSEN STATION/PREAG, W.GERMANY
DESIGNER	AEG /W.GERMANY/
OPERATOR	PREUSSEN ELEKTRA AG /PREAG/, W.GERMANY
LOCATION	NEAR HOXTRA, UPPER WESER RIVER, W.GERMANY
PURPOSE	POWER
TYPE	BWR, DIRECT CYCLE, FORCED CIRCULATION
POWER MWE(MWT)	612 1912
CRITICAL	TARGET 1972
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	PIN
FUEL ENRICH.	2.6 PER CENT U-235
FUEL ASSEMBLY	49-PIN BUNDLE 444-ELEMENT CORE
FUEL CHARGE	86 TONS URANIUM DIOXIDE
BURNUP(REFUEL)	27,500 MWD/T
REACTOR VESSEL	CYLINDRICAL PRESSURE VESSEL
CONTAINMENT	SPHERICAL CONTAINMENT. VAPOR-SUPPRESSION DESIGN. CONTAINMENT BUILDING DOUBLE-WALL, PRESSURE AND GAS TIGHT.
REFERENCES	STADE AND WURGASSEN. NUCLEAR ENG. 12, 756-7 /OCT. 1967/

JANUARY 1969 BNWL-936

BOILING LIGHT WATER REACTORS, FOREIGN BF22

* * * * * * * * * * * * * * * * *

NAME/OWNER	RHINGALS BWR/SWEDISH STATE POWER BOARD
DESIGNER	ATOM-ASEA AND JOHNSON GROUP, SWEDEN
LOCATION	RHINGALS, SWEDEN
PURPOSE	POWER
TYPE	BWR
POWER MWE(MWT)	750 2270
CRITICAL	TARGET 1973
COOLANT	LIGHT WATER
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	ROD, 12.25 MM AND 11.75 MM OD
FUEL CLADDING	ZIRCALOY-2
FUEL ASSEMBLY	64-ROD BUNDLE, 8X8, ZIRCALOY BOX 648 ASSEMBLIES/CORE
FUEL CHARGE	130 TONS URANIUM DIOXIDE
BURNUP(REFUEL)	FIRST CORE AVE. 18,600 MWD/TU 20 PER CENT EQUILIBRIUM CORE 26,800 MWD/MTU ANNUALLY
CONTROL	RODS, BORON CARBIDE
REACTOR VESSEL	STEEL CYLINDER 5.95 M ID/21.0 M HIGH WALL 145 MM THICK, SS LINER 5 MM THICK
CONTAINMENT	CONCRETE AND STEEL CONTAINMENT STRUCTURE PRESSURE SUPPRESSION
REMARKS	CONTRACT AWARD JULY 1968
REFERENCES	RHINGALS NUCLEAR ENG. 13, 838-9 /OCT. 1968/

CAVITY (GAS CORE) REACTORS

DOMESTIC

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD01

* * * * * * * * * * * * * * * * *

NAME/OWNER GASEOUS FUEL REACTOR STUDY/BURNS AND ROE

DESIGNER BURNS AND ROE INC.

PURPOSE SPACE PROPULSION

TYPE GASEOUS FUEL

POWER MWE(MWT) 30

CRITICAL STUDY

COOLANT HELIUM

MODERATOR GRAPHITE REFLECTOR

FUEL MATERIAL URANIUM HEXAFLUORIDE, GASEOUS FUEL WITH BROMINE TRIFLUORIDE ADDED.

REMARKS A GASEOUS CORE REACTOR USING URANIUM HEXAFLUORIDE AS FUEL AND HELIUM AS AN INTERNAL COOLANT PROPOSED FOR SPACE PROPULSION UNIT. CORE CHANNELS ARE OF ALUMINUM DOUBLE TUBE WALL. URANIUM HEXAFLUORIDE IS INSIDE THE ALUMINUM TUBES, HELIUM IS IN THE ANNULUS. COOLANT FLOW IS BY NATURAL CIRCULATION. THERE IS A GRAPHITE REFLECTOR.

REFERENCES GASEOUS-FUEL REACTOR.
S BARON
NUCLEONICS 16, 128, 130-33 /AUGUST 1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GASEOUS CORE REACTOR STUDY/GE
DESIGNER	GENERAL ELECTRIC COMPANY FLIGHT PROPULSION LAB.
PURPOSE	SPACE PROPULSION
TYPE	GASEOUS /PLASMA/ FUEL
CRITICAL	STUDY
MODERATOR	PROPELLANT
FUEL MATERIAL	FISSIONABLE MATERIAL IN A PLASMA STATE
REMARKS	FEASIBILITY STUDY OF A CAVITY REACTOR. THE FISSIONABLE MATERIAL EXISTS IN THE GASEOUS /PLASMA/ STATE. THE MODERATING PROPELLANT IS HEATED BY FISSIONABLE FUEL AND FLOWS OUT AN EXHAUST NOZZLE TO PRODUCE THRUST. FUEL AND PROPELLANT ARE SEPARATED BY HYDRODYNAMIC METHODS.
REFERENCES	A GASEOUS-CORE NUCLEAR ROCKET UTILIZING HYDRODYNAMIC RETENTION OF FISSIONABLE MATERIAL. J GREY PRESENTED AT THE ARS SEMI-ANNUAL MEETING, JUNE 8-11, 1959, SAN DIEGO, CALIFORNIA, /1959/ CAVITY REACTOR CRITICAL EXPERIMENT JH LOFTHOUSE, OTHERS GEMP-473 ANS TRANS. 9, 340 /1966/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD03

* * * * * * * * * * * * * * * * *

NAME/OWNER	GASEOUS CORE REACTOR STUDY/LASL
DESIGNER	LOS ALAMOS SCIENTIFIC LABORATORY
PURPOSE	DIRECT ELECTRIC POWER, FEASIBILITY STUDY
TYPE	GASEOUS /PLASMA/ FUEL
MODERATOR	GRAPHITE /HEAVY WATER BLANKET/
FUEL MATERIAL	FISSIONABLE GAS, URANIUM-235 OR PLUTONIUM-239
REMARKS	THE REACTOR IS A GRAPHITE CYLINDER FILLED WITH A FISSIONABLE GAS /FISSION-PLASMA REACTOR/. ENERGY RELEASED IN THE FISSION PULSE INDUCES A CURRENT IN A COIL WRAPPED AROUND THE GRAPHITE CYLINDER. THE HEAVY WATER BLANKET SURROUNDS THE GRAPHITE.
REFERENCES	PLASMA REACTOR PROMISES DIRECT ELECTRIC POWER. S. A. COLGATE, RL AAMODT NUCLEONICS 15, 50-55 /AUGUST 1957/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD04

* * * * * * * * * * * * * * * * *

NAME/OWNER GASEOUS CORE REACTOR STUDY-2/LEWIS RESEARCH CENTER
WHEEL-FLOW GASEOUS CORE REACTOR

DESIGNER NASA LEWIS RESEARCH CENTER

PURPOSE ROCKET PROPULSION CONCEPTUAL STUDY

TYPE GASEOUS FUEL, COAXIAL FLOW

MODERATOR GRAPHITE OR HEAVY WATER

FUEL MATERIAL FISSIONABLE GAS, URANIUM-235 OR PLUTONIUM-239

REMARKS GASEOUS FUEL IS IN A CAVITY REGION SURROUNDED BY A REFLECTOR-MODERATOR REGION. CYLINDRICAL GEOMETRY WAS STUDIED AS BEING MORE APPLICABLE THAN SPHERICAL FOR ROCKET USE. FUEL REGION IS CENTRALLY LOCATED IN CAVITY REGION, EXTENDING ENTIRE LENGTH OF THE CAVITY. FUEL IS CONTAINED BY FLOW THROUGH VORTEX TUBES, BY MEANS OF SEPARATE COAXIAL STREAMS IN WHICH FUEL FLOW IS AT LOW VELOCITY RELATIVE TO THE PROPELLANT, AND BY USE OF MAGNETIC FORCES TO CONFINE THE FUEL TO A PARTICULAR REGION. STUDY IS OF A CAVITY REACTOR WITH FUEL AND CAVITY REGIONS COMPLETELY ENCLOSED BY A REFLECTOR-MODERATOR 100 CM. THICK.

REFERENCES

TWO-DIMENSIONAL CRITICALITY CALCULATIONS OF GASEOUS-CORE CYLINDRICAL-CAVITY REACTORS.
RE HYLAND, OTHERS /LEWIS RESEARCH CENTER/
NASA-TN-D-1575 /MARCH 1963/

WHEEL-FLOW GASEOUS CORE REACTOR CONCEPT.
JC EVVARD
NASA-TN-D-2951 /NOV. 1965/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD05

* * * * * * * * * * * * * * * * *

NAME/OWNER	NUCLEAR LIGHT BULB/UAC, NASA
DESIGNER	UNITED TECHNOLOGY CENTER DIVISION UNITED AIRCRAFT CORP.
PURPOSE	ROCKET PROPULSION
TYPE	GASEOUS FUEL, VORTEX FLOW, VERY HIGH TEMPERATURE
CRITICAL	STUDY
COOLANT	NEON GAS
FUEL MATERIAL	VAPORIZED URANIUM PLUTONIUM FUEL ALSO STUDIED
FUEL GEOMETRY	TRANSPARENT UNIT /BULB/ OF FUSED SILICA OR SINGLE-CRYSTAL BERYLLIA TO CONTAIN THE FUEL VAPOR.
FUEL ASSEMBLY	A COMPLETE ENGINE CONSISTS OF 7 UNIT CAVITIES, STRUCTURAL GRID, MODERATOR REGIONS, FUEL INJECTION DEVICES ETC. WITHIN PRESSURE SHELL. VOLUME OF A UNIT CAVITY IS 24.2 CU. FT. NEON COOLANT GAS IS INJECTED TANGENT TO THE TRANSPARENT WALL TO DRIVE THE VORTEX.
CONTAINMENT	VESSEL IS FILAMENT-WOUND GLASS PRESSURE-SHELL. FOUR CONFIGURATIONS WERE STUDIED
REMARKS	BOTH THE NUCLEAR LIGHT BULB ENGINE AND AN OPEN-CYCLE ENGINE ARE BEING STUDIED. IN THE OPEN-ENGINE SYSTEM, SEEDED HYDROGEN PROPELLANT IS INJECTED AT THE PERIPHERAL WALL OF THE CAVITY TO DRIVE THE VORTEX, HEAT BEING TRANSFERRED TO THE CAVITY PROPELLANT BY RADIATION.
REFERENCES	STUDIES OF SPECIFIC NUCLEAR LIGHT BULB AND OPEN-CYCLE VORTEX STABILIZED GASEOUS NUCLEAR ROCKET ENGINES. GH MCLAFFERTY, OTHERS NASA-CR-1030 /APRIL 1968/ OPEN-CYCLE AND LIGHT-BULB TYPES OF VORTEX-STABILIZED GASEOUS NUCLEAR ROCKETS. JW CLARK, OTHERS J. SPACECRAFT + ROCKETS 5/8/, 941-7 /AUG. 1968/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD06
* * * * * * * * * * * * * * * * *

NAME/OWNER	GASEOUS CORE REACTOR POWER STATION STUDY/PURDUE
DESIGNER	PURDUE UNIVERSITY
PURPOSE	CENTRAL STATION POWER
TYPE	GASEOUS /CAVITY/ CORE, FORCED CIRCULATION OF FUEL
POWER MWE(MWT)	1000 2800
CRITICAL	DESIGN
COOLANT	GASEOUS FUEL MIXTURE SECONDARY SYSTEM, WATER
MODERATOR	EXTERNAL HEAVY WATER REFLECTOR
FUEL MATERIAL	CORE, URANIUM HEXAFLUORIDE IN FLUORINE-HELIUM MIX. BLANKET, THORIUM DIOXIDE-HEAVY WATER SOLUTION
FUEL GEOMETRY	GAS
FUEL ENRICH.	100 PER CENT
FUEL ASSEMBLY	CORE IS A SPHERICAL CAVITY 243 CM. RADIUS. GASEOUS FUEL CIRCULATES THROUGH CORE AND PRIMARY COOLANT LOOPS BY BLOWERS REFLECTOR IS SEPARATED FROM CORE CAVITY BY THE PRESSURE VESSEL, AND FROM THE EXTERNAL BLANKET BY AN ALUMINUM SPHERICAL STRUCTURE. BLANKET ENCLOSED BY OUTER ALUMINUM STRUCTURE.
NEUTRON FLUX	EPITHERMAL SPECTRUM
COOLANT TEMP.	CORE 1040 F BLANKET 250 F
COOLANT PRESS.	CORE 860 PSIA BLANKET 30 PSIA
REACTOR VESSEL	THICK ALUMINUM HOLLOW SPHERE 140 FT. DIA., 1 IN. THICK. INNER BONDED ALUMINA LINING. REFLECTOR AND BLANKET ARE SPHERICAL ALUMINUM STRUCTURES
CONTAINMENT	STEEL SPHERE BIOLOGICAL AND BLAST SHIELDS, CONCRETE, IRON.
REMARKS	PLANT INCLUDES ON-SITE FUEL PROCESSING FACILITIES.

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD06

* * * * * * * * * * * * * * * * *

MODIFIED FLUORIDE VOLATILITY PROCESS FOR CORE MATERIAL AND CONVENTIONAL THOREX PROCESS FOR BLANKET MATERIAL

REFERENCES

DESIGN AND EVALUATION OF A 1000 MWE CENTRAL STATION POWER PLANT WITH A CIRCULATING FUEL GASEOUS CORE REACTOR, A STUDY CARRIED OUT AS PART OF THE FIRST GRADUATE NUCLEAR ENGINEERING DEISGN SEMINAR, JUNE 15-AUG. 7, 1964
FG ARCELLA, OTHERS
TID-22225 /ND/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD07

* * * * * * * * * * * * * * * * *

NAME/OWNER	GLOW PLUG REACTOR
DESIGNER	DOUGLAS AIRCRAFT CO.
PURPOSE	SPACE PROPULSION
TYPE	GASEOUS CORE REACTOR
CRITICAL	PRELIMINARY DESIGN STUDY
COOLANT	COOLANT-PROPELLANT GAS IS HYDROGEN
MODERATOR	SEE REMARKS
FUEL MATERIAL	URANIUM HEXAFLUORIDE /GASEOUS/
FUEL ASSEMBLY	CORE CONSISTS OF INDIVIDUAL CONCENTRIC TUBES, WITH GASEOUS FUEL IN THE INSIDE TUBES AND THE COOLANT-PROPELLANT FLOWING THROUGH THE TUBE ANNULI. TUBE WALL MATERIAL STUDIED WERE SAPPHIRE, FUSED SILICA, AND MAGNESIA OPTICAL CRYSTALS. FUSED SILICA WAS SELECTED FOR THE THERMAL STUDY.
REMARKS	PARALLEL, CROSS-FLOW, AND COMBINATIONS WERE STUDIED. TUBES ARE COOLED REGENERATIVELY BY THE ENTERING COOLANT-PROPELLANT GAS, WHICH THEN PASSES THROUGH THE SURROUNDING MODERATOR-REFLECTOR, IS SEEDED, AND IS DIRECTED PAST THE OUTSIDE TUBES WHERE IT IS HEATED BY THERMAL RADIATION FROM THE FUEL TO THE REQUIRED DISCHARGE TEMPERATURE.
REFERENCES	CONCEPTUAL DESIGN OF THE GLOW PLUG GASEOUS CORE REACTOR FA ROSS, RJ HALL NP-15906 /NOV. 15, 1963/

JANUARY 1969 BNWL-936

CAVITY (GAS CORE) REACTORS, DOMESTIC CD08

* * * * * * * * * * * * * * * * *

NAME/OWNER	GAS-CORE NUCLEAR ROCKET/AEROJET-GENERAL
DESIGNER	AEROJET-GENERAL
PURPOSE	ROCKET PROPULSION
TYPE	GASEOUS CORE REACTOR
POWER MWE(MWT)	14,400 MWT
CRITICAL	REFERENCE DESIGN
COOLANT	COOLANT-PROPELLANT HYDROGEN GAS
MODERATOR	BERYLLIUM OXIDE REFLECTOR
FUEL MATERIAL	URANIUM-233 DUST
FUEL CHARGE	24.1 KG, URANIUM-233
REACTOR VESSEL	SPHERICAL VESSEL OF TITANIUM ALLOY WITH RADIAL SPACING CARRYING HYDROGEN FOR COOLING
REMARKS	TOTAL THRUST 405,000 LB.
REFERENCES	GAS-CORE NUCLEAR ROCKET ENGINE EE DUKE, WJ HOUGHTON J SPACECRAFT ROCKETS 4, 1592-7 /DEC 1967/

CAVITY (GAS CORE) REACTORS

FOREIGN

* * * * * * * * * * * * * * * * *

NAME/OWNER	GASEOUS CORE REACTOR EXPERIMENT/USSR
DESIGNER	USSR
OPERATOR	USSR
PURPOSE	EXPERIMENT, SPACE PROPULSION
TYPE	GASEOUS FUEL
CRITICAL	GROUND-BASED EXPERIMENT OPERATED
MODERATOR	BERYLLIUM /GRAPHITE REFLECTOR/
FUEL MATERIAL	URANIUM HEXAFLUORIDE, GASEOUS
FUEL CLADDING	FUEL CHANNELS ARE ALUMINUM
FUEL ENRICH.	90 PER CENT URANIUM-235
REMARKS	GROUND-BASED EXPERIMENT IS REPORTED TO BE IN OPERATION.
REFERENCES	EXPERIMENTAL REACTOR WITH GASEOUS FISSIONABLE SUBSTANCE /URANIUM HEXAFLUORIDE/. IK KIKOIN, OTHERS. SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9 /PART2/. 528-34 /1958/
	SOVIET EXPERIMENTAL URANIUM HEXAFLUORIDE REACTOR. REVIEW OF SOVIET LITERATURE. AID WORK ASSIGNMENT NO. 16. LIBRARY OF CONGRESS. AEROSPACE INF. DIV., WASHINGTON D. C. NP-12239 /OCTOBER 18, 1962/

GAS COOLED REACTORS

DOMESTIC

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCRE-1 /GAS COOLED REACTOR EXPERIMENT-1//AEC
DESIGNER	AEROJET-GENERAL NUCLEONICS
OPERATOR	AEROJET-GENERAL NUCLEONICS
LOCATION	NATIONAL REACTOR TEST STATION /NRTS/ IDAHO
PURPOSE	POWER EXPERIMENT, MOBILE PLANT /SEE ML-1/
TYPE	GCR
POWER MWE(MWT)	0 2
CRITICAL	CRITICAL EXPERIMENT OPERATION 1960, DISCONTINUED 1962
COOLANT	NITROGEN
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE DISPERSED IN SS /CERMET FUEL/
FUEL GEOMETRY	CONCENTRIC CYLINDERS OR PLATES ALTERNATE PINS
FUEL CLADDING	SS
FUEL ASSEMBLY	TUBE PLATES ALTERNATE 19-PIN CLUSTERS
REMARKS	A SOLID-MODERATED EXPERIMENT MAY BE CONSTRUCTED. A SECOND FUEL ELEMENT DESIGN CONSISTED OF HIGHLY ENRICHED URANIUM DIOXIDE PELLETS CONTAINED IN A LONG TUBLAR CAN /PIN/, A 19-PIN HEXAGONAL CLUSTER FORMING AN ELEMENT. THE USE OF URANYL NITRATE INSTEAD OF URANIUM DIOXIDE IN THE CERMET MATRIX WAS ALSO STUDIED.
REFERENCES	ARMY GAS COOLED REACTOR SYSTEMS PROGRAM. GCRE-I HAZARDS SUMMARY REPORT. ADDENDUM III. AEROJET-GENERAL NUCLEONICS DO-28506 /ADD. 3/ /MAY 1960/ ARMY GAS COOLED REACTOR SYSTEMS PROGRAM. FINAL SUMMARY REPORT OF THE GAS COOLED REACTOR EXPERIMENT -1. AEROJET-GENERAL NUCLEONICS IDO-28598 /OCT. 1963/.

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCRE-2 /GAS COOLED REACTOR EXPERIMENT-2//AEC
DESIGNER	AEROJET-GENERAL NUCLEONICS
PURPOSE	PROPOSED AS BACK-UP EXPERIMENT FOR GCRE-I
TYPE	GCR, SOLID HOMOGENEOUS CORE
CRITICAL	REFERENCE DESIGN, DEVELOPMENT.
COOLANT	NITROGEN
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM CARBIDE OR URANIUM DIOXIDE DISPERSED IN GRAPHITE
FUEL GEOMETRY	HEXAGONAL GRAPHITE ELEMENT
FUEL CLADDING	SILICON CARBIDE COATING, NICKEL-BASE ALLOY CAN
FUEL ASSEMBLY	HEXAGONAL FUELED GRAPHITE ELEMENT CONTAINING 19 COOLANT TUBES
REMARKS	A SOLID-MODERATED EXPERIMENT MAY BE CONSTRUCTED.
REFERENCES	CONCEPTUAL DESIGN AND FEASIBILITY STUDY FOR THE GAS COOLED REACTOR EXPERIMENT-II. GA LINDENBERGER IDO-25530 /REV./ /1959/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD03

* * * * * * * * * * * * * * * * *

NAME/OWNER	ML-1 /MOBILE LOW-POWER-1//AEC,ARMY
DESIGNER	AEROJET-GENERAL NUCLEONICS
OPERATOR	US ARMY
LOCATION	NATIONAL REACTOR TEST STATION /NRTS/ IDAHO DEVELOPMENT AT FT. BELVOIR, VA.
PURPOSE	PROTOTYPE FOR FIELD POWER GENERATING UNIT.
TYPE	GCR, CLOSED CYCLE, PRESSURE TUBE, MOBILE,
POWER MWE(MWT)	330 KWE 3.3
CRITICAL	1961, TRIAL POWER RUN OCT. 1962, POWER OPERATION 1963,
COOLANT	NITROGEN, LATER, AIR
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE AND URANIUM / BERYLLIUM OXIDE PELLETS
FUEL GEOMETRY	PINS 1.72 IN. OD./32 IN. LONG, ACTIVE LENGTH 22 IN
FUEL CLADDING	HASTELLOY-X 0.241 IN. OD. TUBES, 0.030 IN. THICK
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	19-PIN BUNDLES. INNER 6 PINS, ENRICHED URANIUM DIOXIDE. OUTER 12, URANIUM DIOXIDE DILUTED WITH BERYLLIUM OXIDE. CENTRAL PIN IS VOID. ELEMENTS ARE INSULATED. 61 ELEMENT/CORE, CONTAINED IN PRESSURE TUBES
FUEL CHARGE	49 KG. U-235
BURNUP(REFUEL)	1ST CORE LIFETIME 3000 HRS.
NEUTRON FLUX	THERMAL AVE. 1.9X10 E+12 FAST AVE. 1.7X10 E+13
CONTROL	BURNABLE POISON LINER IN EACH FUEL ELEMENT AND CONTROL BLADES.
COOLANT TEMP.	INLET 791 F OUTLET 1200 F

* * * * * * * * * * * * * * * * *

COOLANT PRESS.	INLET 313 PSIA OUTLET 289 PSIA
REACTOR VESSEL	STEEL VESSEL 80 IN. HIGH/31 IN. DIA.
CONTAINMENT	SHIELD TANK CONTAINING 2 PER CENT BORIC ACID SOLUTION AROUND THE CORE. RADIAL SHIELDING MATERIALS.
REMARKS	THE AEC-ARMY NUCLEAR PROGRAM WAS DISCONTINUED, WITH PHASE-OUT OF ML-1, POWER CONVERSION FUNDING CONTINUING TO JUNE 1966.

REFERENCES

ARMY GAS COOLED REACTOR SYSTEMS PROGRAM.
PRELIMINARY HAZARDS SUMMARY REPORT FOR THE ML-1
NUCLEAR POWER PLANT.
IDO-28537 /APRIL 1959/

ARMY GAS COOLED REACTOR SYSTEMS PROGRAM. THE ML-1
DESIGN REPORT.
IDO-28550 /MAY 1960/

ARMY GAS COOLED REACTOR SYSTEMS PROGRAM.
CONCEPTUAL DESIGN STUDY, 3000 KWE MOBILE NUCLEAR
POWER PLANT.
HC CARNEY, JR.
AGN-TM-383 /APRIL 1961/

ML-1 CRITICAL EXPERIMENTS.
DA DINGEE, JW RAY
MND-C-2487 /P. 203-22/ /1961/

ARMY GAS COOLED SYSTEMS PROGRAM. FINAL HAZARDS
SUMMARY REPORT FOR THE ML-1 NUCLEAR POWER PLANT.
AEROJET-GENERAL NUCLEONICS
IDO-28560 /VOL. 1/ /NOVEMBER 1960/
IDO-28560 /VOL. 2, SUPPLEMENT 1/ /SEPTEMBER 1961/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HDMR /HIGH DENSITY MODERATOR REACTOR/AEC-ARMY
DESIGNER	AEROJET-GENERAL NUCLEONICS
PURPOSE	MOBILE POWER PLANT STUDY FOR ARMY
TYPE	GCR, CLOSED CYCLE /REGENERATIVE BRAYTON CYCLE/.
POWER MWE(MWT)	500 KWE 3.34
CRITICAL	CONCEPTUAL DESIGN
MODERATOR	YTTRIUM HYDRIDE, NICKEL-BERYLLIUM OXIDE REFLECTOR
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	PINS, 0.35 IN. DIA., 16-IN. ACTIVE LENGTH
FUEL CLADDING	HASTELLOY-X, 0.020 IN. THICK
FUEL ENRICH.	48 PER CENT U-235
FUEL ASSEMBLY	INDIVIDUAL PINS. 1157 TO CORE + 578 MOD. PINS /SOME PINS CONTAIN URANIUM OXIDE FUEL AND SOME CONTAIN YTTRIUM HYDRIDE.
FUEL CHARGE	108 KG. U-235
NEUTRON FLUX	THERMAL AVE. 1.4X10 E+4
CONTROL	DRUM-TYPE ELEMENTS IN REFLECTOR
COOLANT TEMP.	INLET 934 F OUTLET 1400 F
COOLANT PRESS.	500 PSIA
REACTOR VESSEL	SS PRESSURE VESSEL. TUNGSTEN TOP SHIELD PLUS TUNGSTEN IN THE LOWER ENDS OF THE FUEL PINS FOR SHIELDING. TUNGSTEN, SURROUNDING CORE RADIALLY AS PRIMARY-GAMMA SHIELD.
CONTAINMENT	LEAD OUTSIDE THE TUNGSTEN SHIELD. OVERALL PACKAGE. 109.5 IN. LONG, 109 IN. WIDE, 90 IN. HIGH
REMARKS	CONCEPTUAL DESIGNS CONSIDERED WERE FOR VARIOUS THERMODYNAMIC CYCLES, MODERATORS, AND GAS COOLANTS HDMR EVOLVED AS THE OPTIMIUM POWER PLANT.
REFERENCES	ARMY GAS COOLED REACTOR SYSTEMS PROGRAM. STUDY OF

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD04

* * * * * * * * * * * * * * * * *

MOBILE GAS-COOLED NUCLEAR POWER PLANTS.
VOLUME I. PLANT DESCRIPTION.
VOLUME II. ANALYSIS
VOLUME III. APPENDIXES.
AEROJET-GENERAL NUCLEONICS
DO-28584 /VOLS. 1,2,3/ /1962/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD05

* * * * * * * * * * * * * * * * *

NAME/OWNER	ARGONNE TUNGSTEN REACTOR/AEC
DESIGNER	ARGONNE NATIONAL LABORATORY
PURPOSE	ROCKET PROPULSION, FEASIBILITY STUDY.
TYPE	GCR, UNMODERATED, FAST REACTOR
COOLANT	GAS /HYDROGEN/
FUEL MATERIAL	URANIUM DIOXIDE IN TUNGSTEN MATRIX
FUEL CLADDING	TUNGSTEN
REMARKS	DESIGN IS BEING CONSIDERED AS A BACKUP FOR KIWI-NERVA FUELED GRAPHITE REACTORS
REFERENCES	REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, FEBRUARY 1964, ARGONNE NATIONAL LAB. ANL-6860 /MARCH 15, 1964/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD06

* * * * * * * * * * * * * * * * *

NAME/OWNER	CHEMONUCLEAR REACTOR STUDY-1/BNL CARBON DIOXIDE CRACKING
DESIGNER	BROOKHAVEN NATIONAL LABORATORY
OPERATOR	CONCEPTUAL DESIGN.
PURPOSE	CHEMONUCLEAR PRODUCTION AND POWER.
TYPE	GCR, CHEMONUCLEAR PLANT
POWER MWE(MWT)	171 571
CRITICAL	CONCEPTUAL DESIGN
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, GRAPHITE AXIAL AND RADIAL REFLECTORS.
FUEL MATERIAL	URANIUM DIOXIDE DISPERSED IN ALUMINUM FOIL.
FUEL GEOMETRY	FOIL
FUEL CLADDING	NONE
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	FOIL SPACED BY A SYSTEM OF SCREENING AND ROD-SPACERS COMPOSED OF SAP. CORE IS 19 FT. DIA., 19 FT. HIGH
FUEL CHARGE	559 KG. U-235
BURNUP(REFUEL)	50,000 MWD/TON U /45 DAYS/
CONTROL	POISON RODS INSERTED AXIALLY
COOLANT TEMP.	650 F
COOLANT PRESS.	500 PSI
REACTOR VESSEL	SPHERICAL, 33 FT. DIA.
REMARKS	CONCEPT FOR THE USE OF FISSION-FRAGMENT ENERGY TO SUPPLY THE HEAT OF REACTION TO CRACK CARBON DIOXIDE TO CARBON MONOXIDE. CHEMICAL OUTPUT OF THE REACTOR WOULD BE 1220 TONS OF CARBON DIOXIDE PER DAY, USING 129 MW OF THE TOTAL REACTOR POWER OF 700 MW.
REFERENCES	DESIGN OF AN EXTERNALLY MODERATED, FIXED-FUEL

* * * * * * * * * * * * * * * * *

CHEMONUCLEAR REACTOR.
DA GOELLNER
AMERICAN NUCLEAR SOC. TRANS. 5/2/, 436 /NOV, 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	CHEMONUCLEAR REACTOR STUDY-2/BNL OZONE GENERATION
DESIGNER	BROOKHAVEN NATIONAL LABORATORY
PURPOSE	OZONE GENERATION.
TYPE	GCR, CHEMONUCLEAR REACTOR
POWER MWE(MWT)	39
CRITICAL	CONCEPTUAL DESIGN
COOLANT	OXYGEN GAS FROM AIR SEPARATION PLANT
MODERATOR	GRAPHITE, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM DISPERSED IN PALLADIUM FOIL, 2.5 MICRONS THICK
FUEL ENRICH.	93.5 PER CENT U-235
FUEL ASSEMBLY	HONEYCOMB CONFIGURATION IN EACH SUBASSEMBLY, WHICH IS 3 IN./3 IN. WITH 0.04 IN. WALL THICKNESS. ALUMINUM STRUCTURAL MATERIAL.
FUEL CHARGE	100 KG. U-235
BURNUP(REFUEL)	CORE OPERATION 635 FULL-POWER DAYS
CONTROL	ABSORBING RODS, AXIAL INSERTION
COOLANT TEMP.	INLET -4 F OUTLET 32 F
COOLANT PRESS.	300 PSIG
REMARKS	GAS-PHASE OZONE PROCESS USES FISSION FRAGMENT ENERGY FOR GENERATING OZONE FROM OXYGEN. THE OXYGEN STREAM ACTS AS COOLANT, CHEMICAL REACTANT, AND PROCESS MEDIUM.
REFERENCES	DESIGN AND ECONOMIC STUDY OF A GAS-PHASE CHEMONUCLEAR OZONE PROCESS. M BELLER, OTHERS BNL-8281 /1964/ NUCLEAR APPLICATIONS 1, 322-6 /AUG. 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EBOR /EXPERIMENTAL BERYLLIUM OXIDE REACTOR//AEC
DESIGNER	GENERAL ATOMICS DIV. GENERAL DYNAMICS NOW GULF GENERAL ATOMIC
OPERATOR	GENERAL DYNAMICS, TEST OPERATION
LOCATION	NATIONAL REACTOR TEST STATION /NRTS/ IDAHO
PURPOSE	PROTOTYPE
TYPE	GCR, DIRECT CYCLE
POWER MWE(MWT)	0 10
CRITICAL	SEE REMARKS
COOLANT	HELIUM
MODERATOR	BERYLLIUM OXIDE
FUEL MATERIAL	URANIUM DIOXIDE/BERYLLIUM OXIDE PELLETS, 0.33 IN. DIA./0.43 IN. LONG.
FUEL GEOMETRY	PINS, ACTIVE LENGTH 76 IN.
FUEL CLADDING	HASTELLOY-X TUBES 0.020 IN. WALL THICKNESS
FUEL ENRICH.	70 PER CENT U-235
FUEL ASSEMBLY	19-PIN ELEMENT. EACH CORE ELEMENT IS A STACK OF BERYLLIUM OXIDE SQUARE-ANNULAR BLOCKS WITH PINS INSERTED INSIDE THE CORE ELEMENT LINER. THE CENTER PIN CONTAINS ONLY BERYLLIUM OXIDE. 36 CORE ELEMENTS, IN SHROUD TUBES IN THE BERYLLIUM OXIDE MODERATOR BLOCKS.
FUEL CHARGE	100 KG. U-235
BURNUP(REFUEL)	100,000 MWD/T
NEUTRON FLUX	THERMAL AVE. 4.8X10 E+12 FAST AVE. 3.1X10 E+13
CONTROL	CRUCIFORM RODS, BURNABLE POISON
COOLANT TEMP.	INLET 750 F OUTLET 1300 F
COOLANT PRESS.	1120 PSIA
REACTOR VESSEL	LOW ALLOY STEEL CYLINDRICAL SHELL 34 FT. HIGH,

* * * * * * * * * * * * * * * * *

	13 FT. OD., 5 1/4 IN. THICK
CONTAINMENT	REACTOR IS LOCATED IN A VAULT WITH CONCRETE WALLS AND BOTTOM, COVERED WITH REMOVABLE CONCRETE SLABS.
REMARKS	THE EBOR PROJECT HAS BEEN DROPPED BECAUSE OF WANING INTEREST IN BERYLLIUM OXIDE AS A MODERATOR AND EBOR-S TARDINESS IN GETTING INTO OPERATION.

REFERENCES

MARITIME GAS COOLED REACTOR PROGRAM. MGCR PROTOTYPE PRELIMINARY DESIGN. VOL. I.
GENERAL DYNAMICS
GA-1612 /VOL. I/ /DECEMBER 1960/

THERMAL DESIGN OF THE MGCR CORE.
JT ROGERS, R KATZ
GAMD-1542 /AUGUST 4, 1960/

MARITIME GAS COOLED REACTOR PROGRAM. A REVIEW OF THE MARITIME GAS COOLED REACTOR PROGRAM.
KA TRICKETT
GA-2603 /DECEMBER 1961/

THE EXPERIMENTAL BERYLLIUM OXIDE REACTOR.
WC MOORE
ASME PREPRINT 61-WA-225 /1961/

EXPERIMENTAL BASES FOR THE DESIGN OF EBOR.
WC MOORE
POWER REACTOR EXPERIMENTS, VOL. 1, P. 79-101
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

MGCR AS A LAND BASED ELECTRIC PLANT.
F DE HOFFMANN, WT FURGERSON
GA-1516 /SEPT. 6, 1960/

NUCLEONICS WEEK JAN. 5, 1967 P. 4
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	HTGR /HIGH TEMP. GCR/PHILADELPHIA ELECTRIC CO. PEACH BOTTOM REACTOR
DESIGNER	GENERAL ATOMICS DIV. GENERAL DYNAMICS NOW GULF GENERAL ATOMIC
OPERATOR	PHILADELPHIA ELECTRIC COMPANY
LOCATION	PEACH BOTTOM, PENNA.
PURPOSE	POWER PROTOTYPE
TYPE	GCR, HIGH TEMPERATURE.
POWER MWE(MWT)	40 115
CRITICAL	1967
COOLANT	HELIUM
MODERATOR	GRAPHITE, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM/THORIUM CARBIDE DISPERSED IN GRAPHITE, PELLETS
FUEL GEOMETRY	ROD ACTIVE LENGTH 7.5 FT.
FUEL CLADDING	PELLETS ARE CARBON COATED. GRAPHITE CAN, GRAPHITE SLEEVE.
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	VENTED FUEL ELEMENT. FUEL COMPACT IN GRAPHITE SLEEVE, UPPER AND LOWER REFLECTOR SECTIONS. TOTAL LENGTH 12 FT. 804 FUEL ELEMENTS CORE, CLOSE-PACKED
FUEL CHARGE	220 KG. URANIUM + 1450 KG. THORIUM
SPECIFIC POWER	AVE. 800 KW/KG U-235
BURNUP(REFUEL)	75,000 MWD/T URANIUM + THORIUM /80 PERCENT PLANT LOAD, 36 MONTHS
NEUTRON FLUX	THERMAL AVE. 4X10 E+13
CONTROL	RODS, BOTTOM MOUNTED
COOLANT TEMP.	INLET 660 F OUTLET 1380 F
REACTOR VESSEL	CARBON STEEL 14 FT. ID. / 37 FT. HIGH. WALL

* * * * * * * * * * * * * * * * *

THICKNESS 2 1/2 IN.

REMARKS

A THREE-YEAR DEVELOPMENT PROGRAM ON THE HTGR CONCEPT IS BEING CONDUCTED BY GD FOR ESADA /NEW YORK/. ADVANCED REACTOR DEVELOPMENT ASSOCIATES /ARDA/ HAS CONTRACTED WITH GENERAL DYNAMICS TO STUDY A 250 MW/E/ HTGR. MEMBERS OF OF ARDA ARE WESTERN UTILITY GROUPS. A 1000 MWE ADVANCED REACTOR PLANT IS BEING STUDIED /SEE TARGET/

REFERENCES

HTGR-UNDERLYING PRINCIPLES AND DESIGN.
P FORTESCU, OTHERS
NUCLEONICS 18, 86-90 /JANUARY 1960/

THE HTGR, AN ADVANCED HIGH TEMPERATURE GAS COOLED GRAPHITE MODERATED REACTOR.
CL RICKARD
PROC. SYMP. ON GAS COOLED REACTORS, PHILADELPHIA, FEBRUARY 1960, FRANKLIN INSTITUTE. /1960/

APPLICATION OF PHILADELPHIA ELECTRIC COMPANY FOR CONSTRUCTION PERMIT AND CLASS 104 LICENSE. PEACH BOTTOM ATOMIC POWER STATION. PART A. GENERAL INFORMATION. PART B.
PRELIMINARY HAZARDS SUMMARY REPORT. VOLUME I.
PLANT DESCRIPTION AND SAFEGUARDS ANALYSIS.
VOLUME II.
SITE AND ENVIRONMENTAL INFORMATION.
PHILADELPHIA ELECTRIC COMPANY
NP-9115 /JULY 1960/

GAS COOLED REACTORS.
POWER REACTOR TECHNOLOGY 5, 60-70 /JUNE 1962/

STATUS OF THE HIGH TEMPERATURE GAS-COOLED REACTOR.
T LE CLAIR
POWER APP. AND SYSTEMS NO. 62, P. 371-75 /OCTOBER 1962/

HIGH TEMPERATURE GAS-COOLED REACTORS.
F DE JOFFMANN, CL RICKARD
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA 1964, A/CONF.28/P/213

* * * * * * * * * * * * * * * * *

NAME/OWNER	FORT ST. VRAIN NUCLEAR STATION/PSC, COLORADO COLORADO HTGR
DESIGNER	GULF GENERAL ATOMIC
OPERATOR	PUBLIC SERVICE CO. OF COLORADO
LOCATION	PLATTEVILLE, COLORADO, NORTH OF DENVER FT. ST. VRAIN
PURPOSE	POWER DEMONSTRATION.
TYPE	GCR, HIGH TEMPERATURE
POWER MWE(MWT)	330 837
CRITICAL	TARGET 1973
COOLANT	HELIUM
MODERATOR	GRAPHITE GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM AND THORIUM CARBIDE COATED WITH PYROLYTIC CARBON AND SILICON CARBIDE
FUEL GEOMETRY	HEXAGONAL GRAPHITE ELEMENTS, 14 IN. ACROSS FLATS, 31 IN. HIGH, CONTAINING FUEL PARTICLES IN CHANNELS NON-VENTED
FUEL ASSEMBLY	1482 HEXAGONAL GRAPHITE ELEMENTS STACKED IN 247 VERTICAL COLUMNS. ACTIVE CORE IS 15 1/2 FT. HIGH AND 19 1/2 FT. DIAM OF 37 FUEL REGIONS, 31 HAVE 7 COLUMNS OF ELEMENTS AND 6 HAVE 5 COLUMNS OF ELEMENTS
SPECIFIC POWER	1200 KW/KG
BURNUP(REFUEL)	100,000 MWD/T 1/6 CORE PER YEAR
NEUTRON FLUX	THERMAL AVE. 5X10 E+13
CONTROL	RODS, BORON CARBIDE
COOLANT TEMP.	INLET 760 F OUTLET 1400 F
COOLANT PRESS.	700 PSIA
REACTOR VESSEL	PRESTRESSED CONCRETE VESSEL ENCLOSES COMPLETE NUCLEAR STEAM SUPPLY SYSTEM, CARBON STEEL LINER

* * * * * * * * * * * * * * * * *

	IS 3/4 IN. THICK AND HELIUM-TIGHT. SPACE BETWEEN CONCRETE AND LINER IS PRESSURIZED WITH HELIUM. VESSEL IS 31 FT. DIAM. AND 75 FT. HIGH
CONTAINMENT	REACTOR BUILDING
REMARKS	THE PROPOSAL BY ROCHESTER G+E FOR THE HTGR WAS DROPPED. PSC OF COLORADO WILL BUILD THE PLANT IN ITS SYSTEM UNDER THE AEC ADVANCED CONVERTER PROGRAM. PLANNING INCLUDES A SECOND NUCLEAR UNIT AT THE SAME LOCATION WITH A CAPACITY OF 600-700 MWE, TO BE COMPLETED IN 1975 OR 1976 INDUCED DRAFT COOLING TOWER PROVIDED FOR.
REFERENCES	NUCLEAR INDUSTRY DEC. 1965 P. 15 NEWS RELEASE PUBLIC SERVICE COMPANY OF COLORADO PLANT, CONCEPTUAL DESIGN REPORT. GENERAL DYNAMICS CORP., GENERAL ATOMICS DIV. GA-6802 /NOV. 15, 1965/ 330 MWE FORT ST. VRAIN HIGH TEMPERATURE GAS COOLED REACTOR A HABUSH, AM HARRIS NUCLEAR ENG. DESIGN 7, 312-21 /1968/ FORT ST. VRAIN NUCLEAR GENERATING STATION. PRELIMINARY SAFETY ANALYSIS REPORT. PUBLIC SERVICE CO. COLORADO DOCKET-50-267 /1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	TARGET /THERMAL ADVANCED REACTOR GAS-COOLED EXPLOITING THORIUM// GD-AEC
DESIGNER	GENERAL ATOMIC DIV. GENERAL DYNAMICS NOW GULF GENERAL ATOMIC
PURPOSE	REFERENCE DESIGN, POWER, FUEL RECYCLE.
TYPE	GCR, ADVANCED REACTOR.
POWER MWE(MWT)	1000 2270
CRITICAL	REFERENCE DESIGN
COOLANT	HELIUM
MODERATOR	GRAPHITE AND BERYLLIUM OXIDE, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM/THORIUM CARBIDE COATED PELLETS /PYROCARBON COATING/
FUEL GEOMETRY	CYLINDERS
FUEL CLADDING	GRAPHITE SLEEVE, BERYLLIUM OXIDE SPINES. 4.53 IN. DIA./20 FT. LONG
FUEL ENRICH.	HIGH
FUEL ASSEMBLY	SINGLE ELEMENT EXTRUDED GRAPHITE BODY WITH FUEL PARTICLES LOOSELY PACKED IN COLUMNS WITHIN THE BODY OF THE ELEMENT, AND BERYLLIUM OXIDE AS AN ELEMENT SPINE MATERIAL, AND AN INTERNAL FISSION TRAP ASSEMBLY. 5,489 ELEMENTS.
FUEL CHARGE	2374 KG. U-235, 86,330 KG.THORIUM
BURNUP(REFUEL)	6-YEAR FUEL LIFE /BATCH 1/6 PER YEAR/
CONTROL	RODS IN GRAPHITE GUIDE TUBES.
COOLANT TEMP.	INLET 720 F OUTLET 1470 F
COOLANT PRESS.	INLET 450 PSIA
REACTOR VESSEL	PRESTRESSED CONCRETE HEXAGONAL VESSEL, INNER CYLINDRICAL DIA. 56 FT. 6 IN. / 40 FT. HIGH. INNER SS INSULATION, NEXT MILD STEEL CONCRETE LINER, COOLING COILS WITH WATER CIRCULATION, AND CONCRETE IN DIRECT CONTACT WITH LINER AND COOLING

* * * * * * * * * * * * * * * * *

COILS.

CONTAINMENT A SECONDARY, CONVENTIONAL, LARGE LOW-PRESSURE CONTAINMENT STRUCTURE HAS BEEN EXAMINED. THE PRE-STRESSED CONCRETE REACTOR STRUCTURE, AS PER THE REFERENCE DESIGN, IS LOCATED WITHIN A METAL LEAK COLLECTOR WITHIN A CONVENTIONAL BUILDING.

REMARKS PLANT DESIGN AND DEVELOPMENT, UNDER CONTRACT TO AEC, IS BASED ON HTGR CONCEPT. GAS COOLING FOR A FAST REACTOR HAS BEEN REPORTRD AT THE 3RD GENEVA CONFERENCE, CONCEPT IS UNDER INVESTIGATION AT GEN. DYNAMICS. SEE HELIUM COOLED FAST REACTOR, DD-27.

REFERENCES

A CONCEPTUAL DESIGN OF A 1000-MWE HIGH TEMPERATURE GAS-COOLED REACTOR.
RM FRYER
ANS TRANSACTIONS, JUNE 1964. ABSTRACT.

DESIGN STUDY REPORT FOR TARGET, A 1000-MWE HIGH TEMPERATURE GAS-COOLED REACTOR.
GENERAL ATOMICS DIV., GENERAL DYNAMICS CORP.
GA-4706 /NOV. 1964/

* * * * * * * * * * * * * * * * * *

NAME/OWNER	HTRE-3 /HEAT TRANSFER REACTOR EXPERIMENT-3//AEC-USAF
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	GENERAL ELECTRIC COMPANY
LOCATION	NATIONAL REACTOR TEST STATION /NRTS/ IDAHO
PURPOSE	AIRCRAFT PROPULSION EXPERIMENT
TYPE	GCR, DIRECT CYCLE, HORIZONTAL CONFIGURATION.
POWER MWE(MWT)	0 32
CRITICAL	HTRE-3 1958, POWER TESTS 1960-1961
COOLANT	AIR /SEE REMARKS/
MODERATOR	ZIRCONIUM HYDRIDE /SEE REMARKS/
FUEL MATERIAL	URANIUM DIOXIDE IN NICKEL-CHROMIUM MATRIX
FUEL GEOMETRY	ROD
FUEL CLADDING	NICKEL-CHROMIUM ALLOY
FUEL ENRICH.	93.4 PER CENT U-235
FUEL ASSEMBLY	FUEL-MODERATOR UNIT, SINGLE FUEL CARTRIDGE 150 UNITS/CORE
REMARKS	THE SERIES HAS INVOLVED 2 REACTOR CONCEPTS, WATER-MODERATED AND ZIRCONIUM-HYDRIDE MODERATED REACTORS. HTRE-1 WAS WATER MODERATED AND THE CORE STRUCTURE WATER COOLED. HTRE-2 WAS A MECHANICALLY MODIFIED HTRE-1. HTRE-3 HAD SIMILAR CONFIGURATION BUT WAS MODERATED WITH SOLID ZIRCONIUM HYDRIDE AND THE CORE STRUCTURE WAS AIR-COOLED. THE REACTOR WAS TESTED WITH 2 J-47 ENGINES IN PARALLEL AT A 32.4 MW POWER LEVEL. THE CORE WAS COMPOSED OF AIR FLOW TUBES SURROUNDED BY A HEXAGONAL MODERATOR TUBE, EACH FLOW TUBE CONTAINING A SINGLE FUEL CARTRIDGE OF ENRICHED URANIUM DIOXIDE IN A NICKEL-CHROMIUM MATRIX. THE REACTOR OPERATED IN A HORIZONTAL POSITION. THE PROJECT HAS BEEN DISCONTINUED, BUT GE IS CARRING OUT CONVERSION STUDIES TO A NUCLEAR MERCHANT SHIP POWER PLANT. PROJECT IS DESIGNATED 630-A.
REFERENCES	ANP HTRE-S FULFILL TEST GOALS.

GAS COOLED REACTORS, DOMESTIC DD12

* * * * * * * * * * * * * * * * *

G THORNTON, B BLUMBERG
NUCLEONICS 19, 45-51 /JANUARY 1961/

* * * * * * * * * * * * * * * * * * *

NAME/OWNER	630-A NUCLEAR STEAM GENERATOR/GENERAL ELECTRIC CO.
DESIGNER	GENERAL ELECTRIC COMPANY
LOCATION	CRITICAL EXPERIMENT NRTS, IDAHO
PURPOSE	SHIP PROPULSION
TYPE	GCR CALANDRIA /MARK 5A/ TUBE-TYPE /MARK 5B/
POWER MWE(MWT)	27,300 SHP 60.4 /MARK 5B/ PLUS POWER FOR SHIP AUX. NEEDS SEE REMARKS
CRITICAL	NUCLEAR MOCKUP 1962
COOLANT	HELIUM
MODERATOR	LIGHT WATER INNER REFLECTOR BERYLLIUM OXIDE OUTER REFLECTOR GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE PELLET OR VIBRATORY COMPACTED POWDER
FUEL GEOMETRY	ROD, 0.357 IN. OD., 42.0 IN. ACTIVE LENGTH LONG /4.184 IN. OD. STACKED IN CARTRIDGES. ACTIVE LENGTH 27.5 IN.
FUEL CLADDING	INCOLOY, 0.015 IN. THICK /COLLAPSIBLE/ OR SS STUDIED/
FUEL ENRICH.	6 PER CENT U-235
FUEL ASSEMBLY	27-ROD BUNDLE IN INCOLOY OR SS SHELL. 216 ELEMENTS DISPERSED AROUND AND SUPPORTED FROM 91 MODERATOR TUBES EXTENDING DOWNWARD FROM SHIELD PLUG. HEXAGONAL PATTERN.
FUEL CHARGE	393 POUNDS U-235
SPECIFIC POWER	375 KW/KG
BURNUP(REFUEL)	SEE REMARKS
CONTROL	TOP-MOUNTED BORATED SS RODS, IN CENTER OF FUEL ELEMENTS AND BETWEEN ELEMENTS

* * * * * * * * * * * * * * * * *

COOLANT TEMP. INLET 553 F OUTLET 1200 F

COOLANT PRESS. 830 PSIA

REACTOR VESSEL STEEL CYLINDER, FLANGED, 16 FT. 3 1/2 IN. HIGH

CONTAINMENT LOW-CARBON STEEL PRESSURE VESSEL ENCLOSING ENTIRE REACTOR - SHIELD PLUG, BOILER, PRESSURE VESSEL, GAS CIRCULATORS, MODERATOR COOLING SYSTEM, INNER SHIELD ASSEMBLY,
12 1/2 FT. DIA., 39 FT. HIGH

REMARKS MARK 1, 2, AND 3 DESIGNS FOR A 27,300 SHP NUCLEAR STEAM GENERATOR WERE 85-CELL AIR-COOLED SYSTEMS USING NICKEL ALLOY CLAD CONCENTRIC FUEL RINGS AND FULLY ENRICHED FUEL. MARK-4 WAS A 55-CELL CLOSED CYCLE SYSTEM. MARK-5 IS EITHER A CALANDRIA TYPE /5A/ OR TUBE-TYPE /5B/ SYSTEM. THE REACTOR-SHIELD-PLUG ASSEMBLY IS THE INTEGRAL UNIT.
IN A REDESIGN FOR A 106 MW PLANT INCORPORATED INTO A BRAYTON CYCLE, FUEL LOADING WOULD BE 1.362 E4 POUNDS OF URANIUM DIOXIDE, 3.23 PER CENT ENRICHED, FOR A BURNUP OF 31,000 MWD/T AND AN OPERATING LIFE OF 6.37 YEARS

REFERENCES

630A MARITIME NUCLEAR STEAM GENERATOR SCOPING STUDY.
GENERAL ELECTRIC CO., FLIGHT PROPULSION LABORATORY
GEMP-108 /DECEMBER 1961/

630A MARITIME NUCLEAR STEAM GENERATOR. PROGRESS REPORT NO. 4.
GENERAL ELECTRIC CO., FLIGHT PROPULSION LABORATORY
GEMP-175 /JANUARY 31, 1963/

THE 630A CRITICAL EXPERIMENT. DESCRIPTION AND EXPERIMENTAL RESULTS.
GD PINCOCK, RE WOOD
TRANS. AMERICAN NUCLEAR SOC. 6/1/, 85-6 JUNE 1963/

630A MARITIME NUCLEAR STEAM GENERATOR SCOPING STUDY . SUMMARY REPORT.
GENERAL ELECTRIC CO., FLIGHT PROP. LAB. DEPT.
GEMP-107 /1962/

DESCRIPTION OF A 10,000 SHP 630A MARITIME NUCLEAR STEAM GENERATOR.
GENERAL ELECTRIC CO., ADV. TECHNOLOGY SERVICES
GEMP-239 /SEPT. 30, 1963/

* * * * * * * * * * * * * * * * *

THE 630A MARINE REACTOR.
NUCLEAR ENG. 9. 50-53 /FEB. 1964/

630A-MARITIME NUCLEAR STEAM GENERATOR.
STATUS REPORT NO. 1
GENERAL ELECTRIC CO., ADV. TECHNOLOGY SERVICES
GEMP-231 /SEPT. 12, 1963/

630A MARK-5 MARITIME NUCLEAR STEAM GENERATOR
STATUS REPORT
GEMP-342 /FEB. 26, 1965/

630A MARK-4 MARITIME NUCLEAR STEAM GENERATOR
SUMMARY REPORT
GEMP-341 /FEB. 26, 1965/

DESIGN OF A MARINE NUCLEAR POWER PLANT UTILIZING
THE DIRECT BRAYTON CYCLE.
BS GATHY /US COAST GUARD ACADEMY/
NAVAL ENG. J. 79, 887-95 /DEC. 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCHWR /GAS COOLED HEAVY WATER-MODERATED REACTOR/ EAST COAST, FLORIDA WEST COAST NUCLEAR GROUP
DESIGNER	GENERAL NUCLEAR ENGINEERING CORPORATION
OPERATOR	TAMPA ELECTRIC CO., FLORIDA POWER CORP.
LOCATION	POLK COUNTY, FLORIDA
PURPOSE	POWER PROTOTYPE
TYPE	GCR, VERTICAL PRESSURE TUBE
POWER MWE(MWT)	50 153.4
CRITICAL	PROJECT DROPPED IN JUNE 1961
COOLANT	CARBON DIOXIDE
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE IN BERYLLIUM MATRIX, PELLETS 0.500 IN. DIA.
FUEL GEOMETRY	ROD
FUEL CLADDING	SS 0.015 IN. THICK /BERYLLIUM CLADDING STUDIED/
FUEL ENRICH.	2.05 PER CENT U-235
FUEL ASSEMBLY	19-ROD CLUSTER ASSEMBLIES IN VERTICAL PRESSURE TUBES, 6-12 BUNDLES/PRESSURE TUBE 208 PRESSURE TUBES /ZIRCALOY-INSULATED/
FUEL CHARGE	20.3 SHORT TONS URANIUM DIOXIDE
BURNUP(REFUEL)	10,000 MWD/TON U
CONTROL	CONTROL RODS, HORIZONTAL BLADES
COOLANT TEMP.	INLET 550 F OUTLET 1050 F
COOLANT PRESS.	500 PSI
REACTOR VESSEL	SS PRESSURE VESSEL 0.75 IN. THICK/13 FT. OD. /24 FT. HIGH
CONTAINMENT	STEEL, CYLINDRICAL, 118.5 FT. HIGH/87 FT. DIA.
REMARKS	NEW PROPOSALS FOR STUDY INCLUDE A HEAVY-WATER,

* * * * * * * * * * * * * * * * *

NATURAL URANIUM REACTOR, WHICH WAS REFUSED BY THE AEC. EVALUATION STUDY DONE BY GNEC AND AEPSC INCLUDED A HEAVY WATER-MODERATED GCR, COLD PRESSURE TUBE DESIGN FOR 1630 MWT AND 480 MWE. FUEL WOULD BE BERYLLIUM-CLAD URANIUM DIOXIDE, NATURAL OR SLIGHTLY ENRICHED, WITH A BURNUP OF ABOUT 5000 MWT/MTU.

REFERENCES

INTERIM REFERENCE DESIGN. GAS COOLED, HEAVY WATER MODERATED, PRESSURE TUBE REACTOR PROTOTYPE /GCPTR/
GENERAL NUCLEAR ENG.
GNEC-74 /SEPTEMBER, 1958/

PRELIMINARY HAZARDS SUMMARY REPORT, VOL. II. DESCRIPTION OF REACTOR AND PLANT.
FLORIDA WEST COAST NUCLEAR GROUP
GEH-24950 /DECEMBER 1959/

APPLICATION FOR USAEC LICENSES BY FLORIDA WEST COAST NUCLEAR GROUP.
PART A , GENERAL INFORMATION.
PART B. PRELIMINARY HAZARDS SUMMARY REPORT.
VOLUME 1. CHARACTERISTICS OF SITE AND ENVIRONMENT.
VOLUME 2. DESCRIPTION OF REACTOR AND PLANT.
VOLUME 3. HAZARDS EVALUATION.
AMERICAN ELEC. POWER SERVICE CORP., GENERAL NUCLEAR ENG.
NP-8251 /DECEMBER 7, 1959/

HEAVY WATER MODERATED REACTORS EVALUATION STUDY.
AMERICAN ELECTRIC POWER SERVICE CORP., GEN. NUCLEAR ENG.
NP-12344 /VOLS. 1,2,3/ /OCT. 15, 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EGCR /EXPERIMENTAL GAS COOLED REACTOR//AEC
DESIGNER	KAISER ENG./ACF INDUSTRIES
OPERATOR	TENNESSEE VALLEY AUTHORITY
LOCATION	OAK RIDGE, TENNESSEE
PURPOSE	POWER AND EXPERIMENT
TYPE	GCR
POWER MWE(MWT)	22 85
CRITICAL	TERMINATED. SEE REMARKS
COOLANT	HELIUM
MODERATOR	GRAPHITE, VERTICAL CHANNELS.
FUEL MATERIAL	URANIUM DIOXIDE HOLLOW CYLINDERS 3/4 IN. LONG 0.707 IN. OD. 36 PELLETS PER ROD + 2 MAGNESIA PELLETS.
FUEL GEOMETRY	ROD, ACTIVE LENGTH 27 IN.
FUEL CLADDING	SS THIN-WALL TUBE 0.020 IN. WALL THICKNESS
FUEL ENRICH.	2.46 PER CENT U-235
FUEL ASSEMBLY	7 TUBES PER ASSEMBLY, GRAPHITE SLEEVE 1650 ASSEMBLIES/CORE EACH FUEL CHANNEL CONTAINS 6 ASSEMBLIES.
FUEL CHARGE	12.23 TONS URANIUM
BURNUP(REFUEL)	10,000 MWD/TU BATCH, FUEL SHUFFLING
NEUTRON FLUX	THERMAL AVE. 0.78X10 E+13
CONTROL	SS-BORON CARBIDE RODS, TOP-MOUNTED
COOLANT TEMP.	INLET 510 F OUTLET 1043 F
COOLANT PRESS.	INLET 313.7 PSIA OUTLET 303.4 PSIA
REACTOR VESSEL	CARBON STEEL VESSEL 20 FT. ID. / 45 FT. HIGH PLATE 2 3/4 IN. THICK, SS INNER TEMPERATURE BARRIER.
CONTAINMENT	STEEL CYLINDER 114 FT. DIA./216 FT. HIGH, 147 FT.

* * * * * * * * * * * * * * * * * * *

ABOVE-GRADE, WITH A STEEL VESSEL SURROUNDING THE REACTOR COMPLEX.

REMARKS

CORE IS A VERTICAL CYLINDER OF MONOLITHIC GRAPHITE AND CONTROL RODS. HELIUM COOLANT FLOW IS FROM THE BOTTOM OF THE CORE TO THE TOP, WHERE IT ENTERS TWO SEPARATE LOOPS EACH HAVING ITS OWN HEAT EXCHANGER AND BLOWER. FUEL DEVELOPMENT PROGRAM WILL INCLUDE WORK IN UC, SILICON CARBIDE COATINGS, AND OTHER CERAMIC FUELS. A 750 MWE VERSION OF THE PLANT HAS BEEN EVALUATED BY TVA, WESTINGHOUSE, AND THE EGCR WILL BE TERMINATED, WITH APPROXIMATELY 57-MILLION EXPENDED TO DATE.

REFERENCES

EXPERIMENTAL GAS COOLED REACTOR PRELIMINARY HAZARDS SUMMARY REPORT.
KAISER ENG.
ORO-196 /MAY 1959/

EXPERIMENTAL GAS COOLED REACTOR PRELIMINARY PROPOSAL.
KAISER ENG. AND ALLIS-CHALMERS MFG. CO.
AECU-4701 /AUGUST 1959/

EGCR-DESCENDENT OF CALDER HALL
WF BANKS
NUCLEAR ENG. 6, 28-32 /JANUARY 1961/

EXPERIMENTAL GAS COOLED REACTOR FINAL HAZARDS SUMMARY REPORT. VOLUME I. DESCRIPTION AND HAZARDS EVALUATION.
ORO-586 /VOL. I/ /1962/

REVISIONS TO EXPERIMENTAL GAS COOLED REACTOR FINAL HAZARDS SUMMARY REPORT.
VOL. 1. DESCRIPTION AND HAZARDS EVALUATION.
OAK RIDGE OPERATIONS OFFICE, AEC
ORO-586 /VOL. 1, SUPPL. 1/ /APRIL 1965/

AEC NEWS RELEASE J-4 /JAN. 7, 1966/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD17
* * * * * * * * * * * * * * * * *

NAME/OWNER	UHTREX/ULTRA HIGH TEMP. REACTOR EXP/AEC LOS ALAMOS TURRET REACTOR
DESIGNER	LOS ALAMOS SCIENTIFIC LABORATORY
OPERATOR	LOS ALAMOS SCIENTIFIC LABORATORY
LOCATION	LOS ALAMOS, N. M.
PURPOSE	POWER EXPERIMENT, EXTENSION OF TURRET
TYPE	GCR, HIGH TEMPERATURE, REVOLVING CORE, UNCLAD FUEL
POWER MWE(MWT)	3
CRITICAL	1968
COOLANT	HELIUM
MODERATOR	GRAPHITE GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM CARBIDE-GRAPHITE
FUEL GEOMETRY	EXTRUDED HOLLOW CYLINDERS 1 IN. OD. BY 5.5 IN. LONG
FUEL CLADDING	NONE PYROLYTIC GRAPHITE COATING
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	FOUR FUELED CYLINDERS POSITIONED END-TO-END IN HORIZONTAL FUEL CHANNELS BORED RADIALLY THROUGH THE HOLLOW GRAPHITE CORE CYLINDER. 312 RADIAL CHANNELS
SPECIFIC POWER	450 W/G U-235
BURNUP(REFUEL)	10-50 PER CENT ON-LOAD 1-6 ELEMENTS DAILY SEE REMARKS
NEUTRON FLUX	THERMAL 2.4X10 E+13
CONTROL	BORON CARBIDE AND BORON-SS RODS, ARTICULATED
COOLANT TEMP.	INLET 1600 F OUTLET 2400 F
COOLANT PRESS.	500 PSIA

* * * * * * * * * * * * * * * * *

REACTOR VESSEL SPHERICAL PRESSURE VESSEL
CARBON STEEL 13.5 FT. OD., 1.75 IN. WALL.
INTERNAL INSULATION.

CONTAINMENT CONCRETE STRUCTURE, STEEL-LINED.
DIVIDED INTO SEPARATELY SHIELDED REACTOR CELL, WITH PRIMARY LOOP AND FUEL LOADING EQUIPMENT, FUEL-DISCHARGE ROOM, GAS CLEANUP ROOM, TWO GAS-CLEANUP PIPING ROOMS

REMARKS THE REACTOR CORE IS A VERTICAL GRAPHITE CYLINDER FABRICATED FROM 5 NESTED, CONCENTRIC, HOLLOW CYLINDERS. TAPERED PLUG IN CENTER OF CORE IS SLOTTED ON ONE SIDE TO RECEIVE SPENT FUEL ELEMENTS AND BORED AT THE BOTTOM FOR THE COOLANT INLET CHANNEL. CHANNELS RUN RADIALLY FROM THE CENTER OF THE CORE TO ITS OUTSIDE EDGE, FUEL ELEMENTS BEING LOADED AT THE PERIPHERY AND DISCHARGED IN THE CENTER. THE CORE ROTATES ON ITS AXIS FOR REFUELING. HELIUM COOLANT ENTERS AT THE BOTTOM

REFERENCES TURRET. A HIGH TEMPERATURE GAS CYCLE REACTOR PROPOSAL.
RP HAMMOND, OTHERS
LA-2198 /JANUARY 23, 1958/

A PRELIMINARY STUDY OF THE TURRET EXPERIMENT - AN OPERATING TEST OF UNCLAD FUEL AT HIGH TEMPERATURES
RP HAMMOND, JP CODY
LA-2303 /MARCH 1959/
NUCLEONICS 17, 106-9 /DECEMBER 1959/

ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT /UHTREX/ HAZARD REPORT
LOS ALAMOS SCIENTIFIC LAB.
LA-2689 /MARCH 1962/

UHTREX
POWER REACTOR TECHNOLOGY 9, 51-63 /WINTER 1965-6/

* * * * * * * * * * * * * * * * *

NAME/OWNER PROJECT ROVER/NUCLEAR ROCKET//AEC-NASA
PHOEBUS

DESIGNER LOS ALAMOS SCI. LAB./WESTINGHOUSE ELECTRIC CORP.

OPERATOR LOS ALAMOS SCI. LAB. /KIWI/

LOCATION JACKASS FLATS, NEVADA /NEVADA TEST SITE/

PURPOSE NUCLEAR ROCKET PROPULSION

TYPE GCR

POWER MWE(MWT) PHOEBUS 5000 MWT

CRITICAL KIWI 1959-1961
NRX 1964
NERVA FULL POWER TEST MARCH 3, 1966
POWER RUN, PHOEBUS 1B, FOR 30 MINUTES AT 1500 MWT IN FEB. 1967
NRX-A6 /EXP. NERVA-1/ STARTUP IN DEC. 1967. FUEL GAS EXIT TEMPERATURES APPROACHING 4500 R. PHOEBUS 2A INTERMEDIATE POWER RUN IN 1968, FOLLOWED IN TWO WEEKS, JUNE 1968, BY POWER RUN LASTING 32 MIN., REACHING POWER LEVEL OF 4000 MWT FOR 12.5 MIN. AND PEAKING AT 4200 MWT. DESIGN POWER IS 5000 MWT AND 250,000 LB. THRUST.

COOLANT GASEOUS HYDROGEN

MODERATOR GRAPHITE

FUEL MATERIAL URANIUM CARBIDE DISPERSED IN GRAPHITE

REMARKS PHOEBUS-2 TESTS IN 1968 ARE END OF PROGRAM BEGUN IN 1964. NEXT STEP WOULD BE DEVELOPMENT OF A FLIGHT-READY ENGINE WITH A SPECIFIC IMPULSE OF ABOUT 825 SEC. A SATURN V WITH A NUCLEAR THIRD STAGE COULD LAND ABOUT TWICE THE EQUIPMENT ON THE MOON AS THE ALL-CHEMICAL VERSION AND EXTEND EXPLORATION TIME FOR MANNED MISSIONS.

REFERENCES
NUCLEAR ROCKETS. LOS ALAMOS PROJECT ROVER.
RE SCHREIBER
NUCLEONICS 16,70-2 /JULY 1958/

A REVIEW OF PROJECT ROVER
RE SCHREIBER
IRE TRANS. NUCLEAR SCI. NS-9, 16-20 /JAN. 1962/

* * * * * * * * * * * * * * * * *

PHOEBUS MAY YIELD 268-POUND REACTOR.
FG MC GUIRE
MISSILES AND ROCKETS 12, 16-17 /APRIL 8, 1963/

REVIEW OF SOLID CORE NUCLEAR ROCKETS.
FC SCHWENK
IEEE TRANS. NUCLEAR SCIENCE NS-12 , 160-168
/FEB. 1965/

THE NERVA NUCLEAR ROCKET REACTOR PROGRAM.
WESTINGHOUSE ENG. 25, 66-75 /MAY 1965/

NUCLEAR INDUSTRY SEPT. 1966 P. 19-22
NEWS RELEASE

NUCLEONICS WEEK NOV. 30, 1967 P. 4
NEWS RELEASE

AND PHOEBUS -GINS ARISE
NEW SCIENTIST JUNE 27, 1968 P. 692-4

* * * * * * * * * * * * * * * * *

NAME/OWNER	NGE/NUCLEAR GAS ENGINE//AEC
DESIGNER	OAK RIDGE NATIONAL LABORATORY
OPERATOR	STUDY
PURPOSE	SHIP PROPULSION
TYPE	GCR, CLOSED CYCLE, DIRECT COUPLING TO RECIPROCATING ENGINE
POWER MWE(MWT)	1.5 OR 20,000 SHP 60
CRITICAL	STUDY
COOLANT	NITROGEN OR HELIUM
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS, 24 IN. LONG
FUEL CLADDING	SS CAPSULES
FUEL ASSEMBLY	7 CAPSULES/ASSEMBLY IN FUEL CHANNELS, 5 ASSEMBLIES/CHANNEL 665 ASSEMBLIES / CORE
CONTROL	RODS
REACTOR VESSEL	CARBON STEEL, 14 FT. DIA./23 FT. HIGH/8 IN. THICK
CONTAINMENT	CARBON STEEL 26 FT. OD./32 FT. HIGH/3/8 IN. THICK
REMARKS	A PRELIMINARY STUDY HAS BEEN DONE OF A RECIPROCATING ENGINE COUPLED TO A GAS COOLED REACTOR, SIMILAR TO GCR-2 BUT WITH A SMALL CORE.
REFERENCES	DESIGN CONSIDERATION FOR HIGH PRESSURE GAS COOLED REACTORS WITH SMALL CORES. OAK RIDGE NATIONAL LAB. ORNL-CF-58-7-55 /SEPTEMBER 1958/ A NUCLEAR GAS ENGINE FOR MARINE PROPULSION. OAK RIDGE NATIONAL LAB. ORNL-CF-58-9-12 /SEPTEMBER 1958/ PROC. 1958 NUCLEAR MERCHANT SHIP SYMPOSIUM, AUGUST 1958.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD19

* * * * * * * * * * * * * * * * *

TID-7563 /JANUARY 1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PBRE /PEBBLE BED REACTOR EXPERIMENT/ /ORNL
DESIGNER	OAK RIDGE NATIONAL LABORATORY
PURPOSE	POWER EXPERIMENT
TYPE	GCR, PEBBLE-BED
CRITICAL	POSTPONED IN 1962
COOLANT	HELIUM
MODERATOR	GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM/THORIUM OXIDE, OR URANIUM/THORIUM CARBIDE IN GRAPHITE
FUEL GEOMETRY	SPHERES, 1.5 IN. OD.
FUEL CLADDING	GRAPHITE COATING
FUEL ENRICH.	2.91 PER CENT U-235
FUEL ASSEMBLY	11,700 FUELED SPHERES/CORE
FUEL CHARGE	17.2 KG. U-235
SPECIFIC POWER	3000 KW/KG U-235
BURNUP(REFUEL)	130,000 MWD/TON EXPOSED FUEL RECYCLED TO TOP, ADDITION AND/OR REMOVAL BY GRAVITY FLOW AT POWER.
CONTROL	CONTROL BLADES, LOCATED IN REFLECTOR
COOLANT TEMP.	INLET 550 F OUTLET 1250 F
COOLANT PRESS.	500 PSIA
REACTOR VESSEL	CORE. GRAPHITE REFLECTED CYLINDER 2 1/2 FT. DIA./ 4 FT. HIGH PRESSURE VESSEL. CARBON STEEL CYLINDER 9.5 FT. OD. 20 FT. HIGH/2.5 IN. THICK
CONTAINMENT	SHIELDED COMPARTMENTS, SECONDARY CONTAINMENT BUILDING.
REMARKS	BASIC DESIGN WAS CONCIEVED BY FARRINGTON DANIELS, A TWO-REGION THERMAL BREEDER DESIGN, STUDY PROJECT BY SANDERSON AND PORTER, WAS TURNED

* * * * * * * * * * * * * * * * *

OVER TO ORNL FOR RESEARCH AND DEVELOPMENT, SPHERICAL GRAPHITE FUEL PELLETS WERE EVALUATED, FIRST PHASE STUDY, PBRE, 5 MWT, SECOND PHASE, CONCEPTUAL DESIGN, 330 MWE, 800 MWT CENTRAL STATION, RADIAL FLOW, DOWNFLOW AND UPFLOW STUDIES, LARGE CORE WITH AXIAL FLOW SELECTED FOR DEVELOPMENT. PBRE PROPOSED FOR INSTALLATION IN HRE-2 FACILITY HAS BEEN POSTPONED.

REFERENCES

PRELIMINARY DESIGN OF A 10 MWT PEBBLE-BED REACTOR EXPERIMENT.
OAK RIDGE NATIONAL LAB.
CF-60-10-63 /NOVEMBER 1960/

DESIGN STUDY OF A PEBBLE-BED REACTOR POWER PLANT.
AP FRAAS, OTHERS
CF-60-12-5 /REV./ /MAY 1961/

CONCEPTUAL DESIGN OF THE PEBBLE-BED REACTOR EXPERIMENT.
OAK RIDGE NATIONAL LAB.
ORNL-RM-201 /MAY 1962/

DANIELS EXPERIMENTAL POWER PILE DESIGN PROPOSAL.
MONN-188 /BOOKS 1 AND 2/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR STUDY, SPACE PROPULSION/THIOKOL
DESIGNER	THIOKOL CHEMICAL CORPORATION
PURPOSE	SPACE PROPULSION
TYPE	GCR, PEBBLE-BED
POWER MWE(MWT)	175
COOLANT	HYDROGEN
MODERATOR	GRAPHITE, LATERAL BERYLLIUM OXIDE REFLECTOR
FUEL MATERIAL	FUELED GRAPHITE PELLETS, VARIABLE DIAMETERS
FUEL GEOMETRY	PEBBLES
FUEL ASSEMBLY	CORE STRUCTURE, CYLINDRICAL GRAPHITE SEPARATORS ENCLOSING FUEL PELLETS /COMPARTMENTED/, FUELED SPHERES HAVE DIFFERENT DIAMETERS FOR DIFFERENTIAL LOADING.
CONTROL	ROTATING ELEMENTS, BORON-CONTAINING DRUMS IN REFLECTOR.
COOLANT TEMP.	INLET 25 F OUTLET 4200 F
COOLANT PRESS.	INLET 400 PSI OUTLET 100 PSI
REACTOR VESSEL	GRAPHITE CYLINDER /CORE/ 5 FT. X 5 FT.
REMARKS	A PARALLEL-PLATE CORE IS ALSO DISCUSSED. THE PEBBLE-BED CORE STRUCTURE CONSISTS OF CYLINDRICAL GRAPHITE SEPARATORS ENCLOSING THE FUEL PELLETS. DIFFERENTIAL RADIAL LOADING PREVENTS INCREASING POWER DENSITY AT CORE CENTER AND REDUCES FLOW THROUGH THE LATERAL REFLECTOR. THIOKOL HAS SET UP A UNIT FOR RESEARCH AND DEVELOPMENT IN NUCLEAR PROPULSION FOR SPACE AT PARSIPANNY-TROY HILLS, NEW JERSEY. THEY ARE PRIME CONTRACTORS IN AN AIR FORCE CONTRACT /WITH GM AND NUCLEAR DEVELOPMENT CORP./ FOR A NUCLEAR PROPULSION SYSTEM STUDY.

REFERENCES

PEBBLE-BED REACTOR LOOKS OKAY FOR NUCLEAR SPACE VEHICLES.
MM LEVOY, JJ NEWGARD
SAE JOURNAL 68, 46-50 /JUNE 1960/

NUCLEAR SPACE VEHICLES USING PEBBLE-BED REACTORS.

* * * * * * * * * * * * * * * * *

MM LEVOY, JJ NEWGARD
NP-8586 /1960/

PEBBLE-BED NUCLEAR REACTORS FOR SPACE VEHICLE PROPULSION.
MM LEVOY, JJ NEWGARD
AERO/SPACE ENGINEERING 19, 54-8 /APRIL 1960/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR-3 /GAS COOLED REACTOR-3/
DESIGNER	OAK RIDGE NATIONAL LABORATORY TENNESSEE VALLEY AUTHORITY COMBUSTION ENGINEERING CORP. WESTINGHOUSE ELECTRIC CORP.
PURPOSE	ADVANCED DESIGN STUDY
TYPE	GCR, ADVANCED EGCR TYPE
POWER MWE(MWT)	750 1908
CRITICAL	STUDY
COOLANT	HELIUM
MODERATOR	GRAPHITE, HEXAGONAL COLUMNS
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.97 IN. OD./0.74 IN. ID. 1 IN. LONG STACKED ON A THIN CERAMIC TUBE.
FUEL GEOMETRY	RODS 18.9 FT. ACTIVE LENGTH /TWO RODS/
FUEL CLADDING	SS 0.015 IN. THICK
FUEL ENRICH.	3 PER CENT U-235
FUEL ASSEMBLY	7-ROD CLUSTERS, GRAPHITE SLEEVES THROUGH THE MODERATOR BLOCKS. 1062 FUEL CHANNELS
FUEL CHARGE	218,000 LB URANIUM DIOXIDE
BURNUP(REFUEL)	20,000 MWD/T 4-STEP PER CORE LIFETIME.
CONTROL	RODS, TOP-MOUNTED
COOLANT TEMP.	INLET 577 F OUTLET 1150 F
COOLANT PRESS.	420 PSIA
REACTOR VESSEL	SPHERICAL STEEL VESSEL 52 FT. 6 IN. ID., 4 IN. THICK WALLS.
CONTAINMENT	STEEL-LINED REINFORCED CONCRETE BUILDING.
REMARKS	A STUDY TO EVALUATE THE FUTURE POTENTIAL OF GAS COLLED REACTORS OF THE EGCR TYPE.
REFERENCES	THE ORNL GCR-3, A 750-MWE GAS-COOLED CLAD-FUEL

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD22

* * * * * * * * * * * * * * * * *

REACTOR POWER PLANT. A JOINT DESIGN STUDY.
M BENDER, WR GALL
ORNL-3353 /JAN. 28, 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PBR /PEBBLE BED REACTOR//SANDERSON + PORTER
DESIGNER	SANDERSON AND PORTER
PURPOSE	POWER
TYPE	GCR, PEBBLE-BED
POWER MWE(MWT)	125 350
CRITICAL	CONCEPTUAL DESIGN
COOLANT	HELIUM
MODERATOR	GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM/THORIUM DIOXIDE IN GRAPHITE. BLANKET THORIUM DIOXIDE IN GRAPHITE
FUEL GEOMETRY	SPHERES 1 1/2 IN. DIA. BLANKET 3/4 IN. DIA.
FUEL CLADDING	NONE
FUEL ASSEMBLY	7 VERTICAL FUEL CHANNELS CONTAIN CORE ELEMENTS, BLANKET ELEMENTS IN ANNULAR RING FORMED BY THE CORE CHANNEL STRUCTURE AND THE THERMAL SHIELD. 228,600 SPHERES/CORE 2,370,000 SPHERES/BLANKET
NEUTRON FLUX	THERMAL AVE. 2.2X10 E+14
CONTROL	RODS, TOP-DRIVEN
COOLANT TEMP.	INLET 550 F OUTLET 1250 F
COOLANT PRESS.	965 PSIA
REACTOR VESSEL	CARBON STEEL CYLINDER
CONTAINMENT	CONTAINMENT VESSEL TO HOUSE PRIMARY SYSTEM, CONVENTIONAL STRUCTURE FOR SECONDARY SYSTEM.
REMARKS	HELIUM FLOW IS DOWNWARD THROUGH CORE AND BLANKET IN PARALLEL. THE FUEL CHANNELS ARE 6 GRAPHITE CYLINDERS, BORED AXIALLY WITH AN OBROUND HOLE 31 IN./37 IN. FORMING A CENTRAL CHAMBER.
REFERENCES	DESIGN AND FEASIBILITY STUDY OF A PEBBLE-BED REACTOR-STEAM POWER PLANT. PART I. PLANT DESIGN. SANDERSON + PORTER, ALCO PRODUCTS

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD23

* * * * * * * * * * * * * * * * *

NYO-8753 VOL. I /MAY 1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	TORY/AEC
DESIGNER	UNIVERSITY OF CALIFORNIA RADIATION LABORATORY
OPERATOR	UNIVERSITY OF CALIFORNIA RADIATION LABORATORY
LOCATION	NEVADA TEST SITE
PURPOSE	PROJECT PLUTO /NUCLEAR RAMJET/ EXPERIMENT
TYPE	GCR, DIRECT CYCLE, HIGH TEMPERATURE, UNCLAD FUEL.
POWER MWE(MWT)	150 TORY-2C 600
CRITICAL	ZERO POWER, DEC. 1960 TORY-2C, 1964 PLUTO PROGRAM DISCONTINUED
COOLANT	AIR
MODERATOR	BERYLLIUM OXIDE, GRAPHITE REFLECTOR
FUEL MATERIAL	BERYLLIUM-URANIUM OXIDE
FUEL GEOMETRY	HEXAGONAL TUBES 4 IN. LONG
FUEL CLADDING	NONE
FUEL ENRICH.	HIGH
FUEL ASSEMBLY	HEXAGONAL BUNDLES CONTAINED IN UNFUELED BERYLLIUM OXIDE STRUCTURAL ELEMENT, WITH AIR-COOLED HASTELLOY TUBE AT EACH CORNER OF ELEMENT. APPROX. 100,000 FUEL ELEMENTS/CORE
CONTROL	GRAPHITE CYLINDERS WITH BORON STEEL /ROTATING/ AND LINEAR RODS
REMARKS	TORY-2-A-1 HAD A CYLINDRICAL CORE 45 INCHES LONG BY 32 INCHES DIAMETER. THE RAMJET CONSISTS OF AN INLET DIFFUSER, A SINGLE-PASS STRAIGHT-THROUGH HEAT EXCHANGER /THE REACTOR/, AND AN EXHAUST NOZZLE.
REFERENCES	SUMMARY REPORT ON HIGH TEMPERATURE BERYLLIUM-OXIDE CRITICAL EXPERIMENTS. RG FINKE UCRL-6329 /1961/

* * * * * * * * * * * * * * * * *

NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1961, TID-8200 /11TH REVISION/ /1964/

THE PLUTO PROGRAM, HL REYNOLDS /LAWRENCE RADIATION LAB./ UCRL-6923 /MAY 17, 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR STUDY, PROCESS HEAT/US BU-MINES
DESIGNER	UNITED STATES BUREAU OF MINES
PURPOSE	PROCESS HEAT FOR GASIFICATION OF COAL
TYPE	GCR, PEBBLE-BED, INDIRECT CYCLE
POWER MWE(MWT)	750
COOLANT	HELIUM
MODERATOR	GRAPHITE
FUEL GEOMETRY	PEBBLES
REMARKS	A NONNUCLEAR SYSTEM TO SERVE AS A PROTOTYPE HAS BEEN DESIGNED AND CONSTRUCTED. CONCEPT IS FOR A HELIUM-COOLED REACTOR /HELIUM ABOVE 1000 F/ TO HEAT STEAM. SUITABILITY OF HELIUM-GRAPHITE SUSPENSIONS AS REACTOR COOLANTS IS BEING INVESTIGATED.
REFERENCES	HIGH TEMPERATURE SYSTEMS FOR NUCLEAR PROCESS HEAT. JP MC GEE TID-7564 /P. 305/ /1958/ INDIRECT CYCLE NUCLEAR REACTOR SYSTEM TO FURNISH PROCESS HEAT. RC DALZELL, JP MCGEE CHEM. ENG. PROG. 55, SYMP. SERIES =22, 111-18 /1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR-MHD/WESTINGHOUSE
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
PURPOSE	POWER-CONCEPT
TYPE	GCR, NUCLEAR FUELED MHD PLANT, CLOSED CYCLE.
POWER MWE(MWT)	600
CRITICAL	STUDY
COOLANT	HELIUM
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM CARBIDE-GRAPHITE
FUEL GEOMETRY	ANNULAR RODS
FUEL CLADDING	NONE
FUEL ENRICH.	SLIGHT
FUEL ASSEMBLY	ANNULAR ELEMENTS POSITIONED IN FUEL CHANNELS
BURNUP(REFUEL)	/ON-LOAD REFUELING/
COOLANT TEMP.	INLET 1690 F OUTLET 2500 F
COOLANT PRESS.	25-50 PSIA
REACTOR VESSEL	CORE, RIGHT CYLINDER OF GRAPHITE MODERATOR AND REFLECTOR PIERCED BY VERTICAL FUEL CHANNELS.
REMARKS	UTILIZATION OF FISSION PRODUCTS FROM UNCLAD FUEL FOR GAS IONIZATION. SYSTEM CONSISTS OF THE REACTOR, AN MHD GENERATOR, MHD COMPRESSOR, REGENERATOR, COOLER, POSSIBLY A D.C. TO A.C. CONVERTER.
REFERENCES	MHD POWER GENERATION BY NONTHERMAL IONIZATION AND ITS APPLICATION TO NUCLEAR ENERGY CONVERSION. EJ STERNGLASS, OTHERS NUCLEAR ENERGY, MARCH 1963, P. 60-66.

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR FAST REACTOR STUDY/GGA HELIUM COOLED FAST BREEDER
DESIGNER	GULF GENERAL ATOMIC
PURPOSE	POWER, POSSIBLY DESALINATION
TYPE	GCR, FAST BREEDER
POWER MWE(MWT)	415 1093
CRITICAL	REFERENCE DESIGN
COOLANT	HELIUM /CARBON DIOXIDE STUDIED/
MODERATOR	NONE
FUEL MATERIAL	URANIUM/PLUTONIUM OXIDE PELLETS, CORED, 0.5 IN. LONG. RADIAL BLANKET URANIUM DIOXIDE
FUEL GEOMETRY	ROD 46 IN. LONG UPPER AND LOWER BLANKET SECTIONS EACH 18 IN.
FUEL CLADDING	HASTELLOY CANS 0.44 IN. OD., 12.5 MILS THICK SPACING BY RIBS
FUEL ASSEMBLY	BUNDLES 100 RODS/BOX, ACTIVE LENGTH 116.5 CM. 213 BOXES, SQUARE PITCH GRID-PLATE IS EGG-CRATE STRUCTURE
FUEL CHARGE	1770 KG. FISSILE
SPECIFIC POWER	0.62 MWT/KG FISSILE
BURNUP(REFUEL)	100,000 MWD/T
CONTROL	MOTION OF POISON ELEMENTS, FUEL, OR BOTH
COOLANT TEMP.	INLET 300 C OUTLET 600 C SEE REMARKS
COOLANT PRESS.	1000 PSIA SEE REMARKS
REACTOR VESSEL	PRESTRESSED CONCRETE CYLINDER, FLAT ENDS, INNER STEEL LINING FACED WITH INSULATING MATERIAL, ADJACENT BUILT-IN WATER COILS. VESSEL CONTAINS CORE, CIRCULATORS, STEAM GENERATORS, MAIN COOLANT

* * * * * * * * * * * * * * * * *

DUCTING, ROD-DRIVE MECHANISMS.

CONTAINMENT CONCRETE-LINED PIT

REMARKS CARBON DIOXIDE COOLANT AND CARBIDE FUELS WERE ALSO STUDIED.
REPRESENTATIVE DESIGNS INCLUDE A 463 MWE PLANT WITH HELIUM COOLANT, OXIDE FUEL, WORKING PRESSURE 1000 PSI, INLET 300 C AND OUTLET 596 C, AND A 1364 MWE PLANT WITH CARBON DIOXIDE COOLANT, CARBIDE FUEL, WORKING PRESSURE 2000 PSI, INLET 340 C AND OUTLET 615 C. STUDY UNDER AEC SPONSORSHIP.
APPLICATION TO WATER DESALINATION IS CONSIDERED.
GENERAL ATOMICS HAS ANNOUNCED THE DEVELOPMENT OF GAFRE /GENERAL ATOMICS FAST REACTOR EXPERIMENT/ WITH EAST CENTRAL NUCLEAR GROUP.
A JOINT PROGRAM WITH SWITZERLAND WILL STUDY GAS-COOLED FAST BREEDERS, WITH RESEARCH PERFORMED DURING 1968 AT THE SWISS FEDERAL INSTITUTE FOR
WITH A GROUP OF 21 UTILITIES, GGA IS ENGAGED IN A 2-YEAR R+D PROGRAM FOR A GAS COOLED FAST REACTOR OR EXP. FACILITY, TO INCLUDE CORE DESIGN AND DEVELOPMENT, SYSTEM COMPONENT DEVELOPMENT, AND SAFETY ANALYSIS, WHICH WILL COMPLEMENT THE SWISS PROGRAM.

REFERENCES

GAS COOLING FOR FAST REACTORS.
P. FORTESCUE, OTHERS
3RD UN INTL. CONF. PEACEFUL USES ATOMIC ENERGY, GENEVA, 1964, A/CONF. 28/P 694

DEVELOPMENT OF THE GAS-COOLED FAST REACTOR CONCEPT
P. FORTESCUE, R.T. SHANSTROM, H. FRENCH
NUCLEONICS 23 /5/, 56-60 /MAY 1965/

STUDY OF A GAS-COOLED FAST BREEDER REACTOR. INITIAL STUDY, CORE DESIGN ANALYSIS AND SYSTEM DEVELOPMENT PROGRAM. FINAL SUMMARY REPORT.
GENERAL ATOMIC DIV. GENERAL DYNAMICS
GA-5537 /AUG. 15, 1964/

DEVELOPMENT OF THE GAS-COOLED FAST REACTOR CONCEPT
P FORTESCUE, RT SHANSTROM
FAST REACTOR TECHNOLOGY, NATIONAL TOPICAL MEETING APRIL 26-28, 1965. AMERICAN NUCLEAR SOCIETY.
ANS-100 /P.89-98/

* * * * * * * * * * * * * * * * *

NAME/OWNER	MMPPR /MULTIPURPOSE MILITARY PORTABLE POWER REACTOR.
DESIGNER	AEROJET-GENERAL NUCLEONICS
PURPOSE	MILITARY POWER REQUIREMENTS.
TYPE	GCR, AIR OR SUPERHEATED STEAM COOLANT, PRESSURE TUBE, PORTABLE PLANT.
POWER MWE(MWT)	1
CRITICAL	DESIGN
COOLANT	AIR OR SUPERHEATED STEAM, SEE REMARKS
MODERATOR	LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	PIN
FUEL CLADDING	HASTELLOY X
FUEL ENRICH.	MODERATE
FUEL ASSEMBLY	19-PIN BUNDLE
CONTROL	BLADES
COOLANT TEMP.	1000 F MAX. WITH BRAYTON CYCLE 1200 F
COOLANT PRESS.	500 PSI
REACTOR VESSEL	ALUMINUM TANK, 8 FT. DIA./8 FT. HIGH, OUTER LEAD SHIELDS TO FORM AN ANNULUS FOR CIRCULATION OF BORATED WATER.
CONTAINMENT	SHIELD TANKS, SAND BAGS.
REMARKS	A DUAL-LOOP PLANT UTILIZING THE LOEFFLER OR THE BRAYTON CYCLE, CONVENTIONAL SUPERHEATED-STEAM POWER-CONVERSION EQUIPMENT. A DIRECT-STEAM-CYCLE PLANT USES THE SAME GAS-COOLED REACTOR, BUT IS COOLED BY SUPERHEATED STEAM WHICH IS USED DIRECTLY AS THE TURBINE WORKING FLUID. PLANT IS DESIGNED FOR TRANSPORTATION TO REMOTE AREAS IN A TOTAL OF 25 PACKAGES.
REFERENCES	DESIGNED, THE PORTABLE POWER REACTOR.

* * * * * * * * * * * * * * * * *

S. LUCHTER /AEROJET-GENERAL NUCLEONICS/
MECH. ENG. 87, 32-35 /JUNE 1965/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD29

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR FAST REACTOR STUDY-1/ORNL
DESIGNER	OAK RIDGE NATIONAL LABORATORY
PURPOSE	POWER
TYPE	GCR, INDIRECT CYCLE, FAST REACTOR
POWER MWE(MWT)	1080 2500
CRITICAL	CONCEPTUAL DESIGN
COOLANT	HELIUM
MODERATOR	STEEL REFLECTOR
FUEL MATERIAL	URANIUM/PLUTONIUM DIOXIDE BLANKET, DEPLETED URANIUM DIOXIDE
FUEL GEOMETRY	PIN 0.25 IN. DIA., 72 IN. LONG + 15 X 2 IN. AXIAL BLANKET. RADIAL BLANKET PINS 0.92 IN. DIA., 8.5 FT. LONG
FUEL CLADDING	SS
FUEL ASSEMBLY	CORE, 421-PIN BUNDLE, CYLINDRICAL STEEL ALLOY CONTAINER 9.763 IN. OD. 154 ASSEMBLIES BLANKET, RADIAL, 9 IN. OD. 102 ASSEMBLIES
BURNUP(REFUEL)	SHUT DOWN
CONTROL	RODS
COOLANT TEMP.	INLET 500 F OUTLET 1150 F
COOLANT PRESS.	1016 PSI
REACTOR VESSEL	PRESTRESSED CONCRETE SPHERE 44 FT. ID., 11 FT. WALL THICKNESS, LINED.
CONTAINMENT	REINFORCED CONCRETE CYLINDER 100 FT. ID., 154.5 FT HIGH, WALL THICKNESS 4.5 FT.
REMARKS	TWO SYSTEMS WERE STUDIED, HELIUM-COOLED INDIRECT CYCLE WITH CONVENTIONAL STEAM CYCLE, AND SULFUR DIOXIDE COOLED DIRECT CYCLE SYSTEM WITH A DIRECT RANKINE CYCLE /SEE DD30/.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD29

* * * * * * * * * * * * * * * * *

A CARBON DIOXIDE-COOLED SYSTEM WAS BRIEFLY REVIEWED.

REFERENCES GAS COOLED FAST REACTOR CONCEPTS.
OAK RIDGE NATIONAL LAB.
ORNL-3642 /SEPT. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR FAST REACTOR STUDY-2/ORNL
DESIGNER	OAK RIDGE NATIONAL LABORATORY
PURPOSE	POWER
TYPE	GCR, FAST REACTOR, DIRECT RANKINE CYCLE
POWER MWE(MWT)	3168
CRITICAL	CONCEPTUAL DESIGN
COOLANT	SULFUR DIOXIDE /SUPERCRITICAL/
MODERATOR	CYLINDRICAL STEEL REFLECTOR.
FUEL MATERIAL	CORE, URANIUM/PLUTONIUM DIOXIDE BLANKET, DEPLETED URANIUM DIOXIDE OXIDES COMPACTED BY VIBRATORY METHODS
FUEL GEOMETRY	PIN 72-IN. ACTIVE LENGTH + 15 X 2 IN. AXIAL BLANKET. RADIAL BLANKET LARGER DIA.
FUEL CLADDING	HASTELLOY-X SEAMLESS TUBING 1/4 IN. OD.
FUEL ASSEMBLY	CORE, 577-PIN ASSEMBLY, CYLINDRICAL CONTAINER 135 FUEL ASSEMBLIES 114 RADIAL BLANKET ASSEMBLIES
CONTROL	RODS, BOTTOM ENTRY
COOLANT TEMP.	OUTLET 910 F
COOLANT PRESS.	INLET 1350 PSIA OUTLET 1200 PSIA
REACTOR VESSEL	CORE VESSEL 17 FT. ID., 8 IN. WALL THICKNESS, CARBON STEEL CYLINDER, SS LINER ABOVE CORE. PRIMARY VESSEL MAY BE PRESTRESSED CONCRETE. ANNULAR SPACE BETWEEN CORE VESSEL AND PRIMARY /COOLANT/ VESSEL.
CONTAINMENT	SPHERICAL SHELL, ALL-METAL RECOMMENDED. CENTRAL SHELL HOUSING THE REACTOR IS CONNECTED TO 5 IDENTICAL SURROUNDING SHELLS /REGENERATOR-CONDENSER-PUMP SYSTEM/. EACH SHELL IS 80 FT. DIA. WITH WALLS ABOUT 1 3/8 IN. THICK. SHELLS ARE SEALED FROM THE REACTOR SHELL AND FROM EACH OTHER.
REMARKS	CORE COOLANT IS IN THE SUPERCRITICAL PHASE.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, DOMESTIC DD30

* * * * * * * * * * * * * * * * *

REACTOR SUPPLIES 910 F, 1200 PSIA SUPERCRITICAL SULFUR DIOXIDE TO TWO 500-MW TURBING GENERATORS. TURBINES EXHAUST THROUGH REGENERATORS TO SURFACE CONDENSERS AND CONDENSED LIQUID IS PUMPED BACK TO THE REACTOR THROUGH REGENERATORS WHICH PRE-HEAT REACTOR FEED TO 234 F AND 800 PSI.
PRESSURE IS INCREASED BY A FEED PUMP TO 1405 PSIA AT 238 F.

REFERENCES

GAS COOLED FAST REACTOR CONCEPTS
OAK RIDGE NATIONAL LAB.
ORNL-3642 /SEPT. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	CHEMONUCLEAR REACTOR STUDY-3/BNL NITROGEN FIXATION
DESIGNER	BROOKHAVEN NATIONAL LABORATORY
TYPE	GCR
POWER MWE(MWT)	1500
COOLANT	NITROGEN-OXYGEN MIXTURE 1/2 BY VOLUME.
MODERATOR	GRAPHITE GRAPHITE WITH BORON REFLECTOR
FUEL MATERIAL	URANIUM-ALUMINUM ALLOY
FUEL GEOMETRY	HONEYCOMB FOIL
FUEL ENRICH.	FULL
FUEL ASSEMBLY	FOIL ARRANGED IN HEXAGONS
FUEL CHARGE	839 KG U-235
CONTROL	RODS
COOLANT TEMP.	INLET 485 F OUTLET 1075 F
COOLANT PRESS.	1000 PSI
REACTOR VESSEL	PRESTRESSED CONCRETE PRESSURE VESSEL, SPHERICAL
REMARKS	REACTOR PRODUCES ELECTRIC POWER FOR ELECTROLYTIC HYDROGEN PRODUCTION FROM WATER. AMMONIA IS PRODUCED BY CONVENTIONAL CATALYTIC COMBINATION WITH ATMOSPHERIC NITROGEN. PROCESS DESIGN CONSISTS OF REACTOR SYSTEM, POWER CYCLE, AND CHEMICAL PRODUCTION PLANT.
REFERENCES	DUAL CYCLE CHEMONUCLEAR NITROGEN FIXATION PROCESS. M BELLER, OTHERS CHEM. ENG. PROGRESS 63, 51-55 /APRIL 1967/

GAS COOLED REACTORS

FOREIGN

* * * * * * * * * * * * * * * * *

NAME/OWNER	HTGR /HIGH TEMP. GAS-COOLED REACTOR/AAEC,AUSTRALIA
DESIGNER	AAEC-AUSTRALIA
PURPOSE	POWER REACTOR STUDY
TYPE	GCR, HIGH TEMPERATURE, PEBBLE-BED
POWER MWE(MWT)	500
CRITICAL	FEASIBILITY STUDY
COOLANT	CARBON DIOXIDE
MODERATOR	BERYLLIUM OR BERYLLIUM OXIDE
FUEL MATERIAL	/THORIUM-PLUTONIUM/ OXIDE-BERYLLIUM OXIDE PEBBLES ABOUT 1 IN. DIA. A PLUTONIUM/THORIUM/BERYLLIUM SYSTEM IS BEING STUDIED.
FUEL GEOMETRY	PEBBLES
FUEL CLADDING	BERYLLIA COATING
FUEL ENRICH.	FISSILE-FERTILE-MODERATOR RATIO 1-10-2000
SPECIFIC POWER	1.3 MW/KG FUEL
BURNUP(REFUEL)	CONTINUOUS, ON-LOAD. PARTIALLY SPENT FUEL RECIRCULATED.
COOLANT TEMP.	INLET 350 C OUTLET 700-800 C
COOLANT PRESS.	35 ATM. /515 PSI/
REMARKS	SYSTEM INVESTIGATION, FUEL ELEMENTS STUDIES. MOST PROMISING ELEMENTS INCORPORATE BERYLLIUM, URANIUM, AND THORIUM. CERMET FUELS, BERYLLIUM OXIDE MATRIX ELEMENTS ARE UNDERGOING IRRADIATION STUDIES. CONCEPT DEVELOPMENT TARGET IS 1980 A 500 MWE REACTOR HAS BEEN EVALUATED
REFERENCES	TENTH ANNUAL REPORT, 1961-1962 AUSTRALIAN ATOMIC ENERGY COMMISSION 1962 HIGH TEMPERATURE GAS-COOLED REACTOR FEASIBILITY STUDY.

* * * * * * * * * * * * * * * * *

ENGINEERING DESIGN AND ANALYSIS OF A BERYLLIA
MODERATED PEBBLE-BED REACTOR.
DR EBELING, JE HAYES
MECH. CHEM. ENG. TRANS. 119-37 /MAY 1967/

THE AUSTRALIAN HIGH TEMPERATURE GAS-COOLED REACTOR
FEASIBILITY STUDY.
WH ROBERTS
J. NUCLEAR MATERIALS 14, 29-40 /1964/
PROC. 1ST. INTL. CONF. BERYLLIUM OXIDE, AUSTRALIA.
OCT. 1963

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF02

* * * * * * * * * * * * * * * * *

NAME/OWNER	BRAZILIAN POWER REACTOR/CEN, BRAZIL
DESIGNER	NOT SELECTED
LOCATION	PARATI, BRAZIL /MAMBUCABA RIVER/
PURPOSE	POWER
TYPE	GCR WAS PROPOSED. NO CURRENT INFORMATION.
POWER MWE(MWT)	150
REMARKS	ON COMPLETION OF STUDY, CEN WILL INVITE PUBLIC BIDS FOR CONSTRUCTION.
REFERENCES	APPLIED ATOMICS JUNE 13,1962, P. 8-9

* * * * * * * * * * * * * * * * *

NAME/OWNER	CZECHOSLOVAKIA ATOMIC POWER STATION/CZECH.SOC.REP.
DESIGNER	USSR
OPERATOR	CZECH.SOC.REP.
LOCATION	BOHUNICE, CZECH.
PURPOSE	POWER
TYPE	GCR, HEAVY WATER MODERATED, PRESSURE TUBE /CALANDRIA/
POWER MWE(MWT)	150 590
CRITICAL	NO.1 1969 /CONSTRUCTION/ NO.2 1974
COOLANT	CARBON DIOXIDE
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD 4 MM. DIA./4.0 M. LONG /WIRE/
FUEL CLADDING	MAGNESIUM-BERYLLIUM ALLOY 0.45 MM. THICK
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	CLUSTER OF THIN FUEL RODS SUSPENDED AT TOP. EACH CLUSTER IS IN A MAGNESIUM ALLOY SHIELD TUBE. 150-200 RODS/ELEMENT.
FUEL CHARGE	25,400 KG. URANIUM
SPECIFIC POWER	23.2 KW/KG URANIUM
BURNUP(REFUEL)	3000 MWD/TON /CONTINUOUS/
CONTROL	RODS, SHIM-SAFETY AND REGULATING, GRAVITY DROP
COOLANT TEMP.	INLET 100 C OUTLET 425 C
COOLANT PRESS.	60 ATM.
REACTOR VESSEL	STEEL VESSEL. IN IT IS MOUNTED AN ALUMINUM TANK CONTAINING THE MODERATOR WITH ALUMINUM TUBES CONTAINING FUEL ELEMENTS, AND FOR COOLANT CIRCULATION.

* * * * * * * * * * * * * * * * *

REMARKS PLANS CALL FOR A 4-REACTOR STATION AT THIS SITE.
A 150-MWE STATION IS PROPOSED FOR THIS SITE.

REFERENCES ROD FUEL ELEMENT FOR A GAS-COOLED HEAVY WATER REACTOR.
PI KHRISTENKO, OTHERS
SECOND UN INTL. CONF. PEACEFUL USES ATOMIC ENERGY
6, 370-78 /1958/

A HEAVY WATER POWER REACTOR WITH GAS COOLING.
AI ALIKHANOV, OTHERS
J. NUCLEAR ENERGY II, VOL. 3, 77-82 /1956/

ENGINEERING AND ECONOMIC ASPECTS OF CONSTRUCTION OF AN ATOMIC POWER STATION IN CZECHOSLOVAKIA.
A SEVCICK
SECOND UN INTL. CONF. PEACEFUL USES ATOMIC ENERGY
8, 322-8 /1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BETA/DANATOM, DENMARK
DESIGNER	DANATOM-DENMARK
PURPOSE	POWER
TYPE	GCR
POWER MWE(MWT)	175 574
CRITICAL	DESIGN STUDY
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	NATURAL URANIUM
FUEL GEOMETRY	ROD, 29.2 MM. DIA. /1.15IN.//28.8 IN. LONG
FUEL CLADDING	MAGNOX, FINNED.
FUEL ASSEMBLY	RODS IN GRAPHITE SLEEVES, LOCATED IN VERTICAL COOLANT CHANNELS IN CYL. GRAPHITE STRUCTURE. 9 ELEMENTS / CHANNEL 3176 FUEL CHANNELS / CORE
BURNUP(REFUEL)	3000-4500 MWD/T
NEUTRON FLUX	THERMAL MAX. 3.26X10 E+13 THERMAL AVE. 1.74X10 E+13
CONTROL	RODS, SAFETY AND SHIM, BORON-STEEL
COOLANT TEMP.	INLET 190 C OUTLET 380 C
COOLANT PRESS.	156.5 PSIA
REACTOR VESSEL	PRESSURE VESSEL 68 FT. 8 1/2 IN. ID. SPHERE, LOW-C STEEL
REMARKS	VERTICAL COOLANT CHANNELS ARE LOCATED WITHIN THE CYLINDRICAL GRAPHITE STRUCTURE, THE CARBON DIOXIDE FLOWING IN THE ANNULAR SPACE BETWEEN THE GRAPHITE SLEEVES AND THE FUEL RODS. AFTER PASSING THROUGH THE HEAT EXCHANGERS, THE COOLANT GAS IS RETURNED TO THE REACTOR.
REFERENCES	BETA, A 175 MW GAS COOLED NUCLEAR REACTOR POWER STATION. A PRELIMINARY DESIGN STUDY.

* * * * * * * * * * * * * * * * *

DANATOM
DANATOM-01-60 /MARCH 1960/

BETA, DANATOMS 175 MW DESIGN STUDY,
NUCLEAR ENG, 5, 264-5 /JUNE 1960/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF05

* * * * * * * * * * * * * * * * *

NAME/OWNER	NEUBRANDENBERG STATION/EAST GERMANY
DESIGNER	USSR
OPERATOR	E GERMANY
LOCATION	NEUBRANDENBERG, EAST GERMANY
PURPOSE	POWER EXPERIMENT
TYPE	GCR, HEAVY WATER MODERATED, PRESSURE TUBE /CALANDRIA/
POWER MWE(MWT)	70 300
CRITICAL	1964
COOLANT	CARBON DIOXIDE
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL ENRICH.	SLIGHT
REMARKS	NO RECENT INFORMATION. STATION REPORTEDLY TO BE EQUIPPED WITH TWO 70 MW/E/ REACTORS BY 1965.
REFERENCES	A HEAVY WATER, GAS COOLED REACTOR. AI ALIKHANOV, OTHERS J. NUCLEAR ENERGY 3, PART 2, 77-82 /AUGUST 1956/

* * * * * * * * * * * * * * * * *

NAME/OWNER	G-1 /GRAPHITE-REACTOR 1/CEA, FRANCE
DESIGNER	CEA-FRANCE
OPERATOR	CEA-EDF
LOCATION	MARCOULE, FRANCE
PURPOSE	PLUTONIUM PRODUCTION, CENTRAL STATION POWER PROTOTYPE
TYPE	GCR, HORIZONTAL CONFIGURATION
POWER MWE(MWT)	17 38
CRITICAL	1956
COOLANT	AIR
MODERATOR	GRAPHITE-HORIZONTAL CHANNELS
FUEL MATERIAL	NATURAL URANIUM CAST BARS /SLUGS/
FUEL GEOMETRY	RODS 26 MM. DIA./100 MM. LONG
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY
FUEL ASSEMBLY	37 SLUGS IN ONE SHEATH 2 ELEMENTS PER CHANNEL 1337 HORIZONTAL CHANNELS.
FUEL CHARGE	100 TONS URANIUM
NEUTRON FLUX	THERMAL AVE. 1.55X10 E+12 FAST AVE. 2X10 E+12
CONTROL	VERTICAL CONTROL RODS /BORON CARBIDE/ AND NEUTRON ABSORBER ELEMENTS.
COOLANT TEMP.	INLET 20 C OUTLET 200 C
REACTOR VESSEL	THERMAL AND BIOLOGICAL SHIELDS, NO PRESSURE VESSEL
REMARKS	THE AIR-COOLED G-1 REACTOR HAS THREE AIR CIRCIUTS FOR COOLING THE FUEL ELEMENTS, THERMAL SHIELD, AND FRONT AND REAR FACES. THE PRIMARY DIRECT CIRCUIT MAINTAINS THE URANIUM CLADDING AT A MAXIMUM 275 C.
REFERENCES	THE G-1 REACTOR D MARTIN

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF06

* * * * * * * * * * * * * * * * *

ENERGIE NUCLEAIRE 5, 221-5 /JUNE 1963/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF07

* * * * * * * * * * * * * * * * *

NAME/OWNER	G-2, G-3/CEA-ELECTRICITE DE FRANCE
DESIGNER	CEA-FRANCE
OPERATOR	CEA-EDF
LOCATION	MARCOULE, FRANCE
PURPOSE	PLUTONIUM PRODUCTION, POWER
TYPE	GCR
POWER MWE(MWT)	32 200 /UPRATED TO 240 /
CRITICAL	G-2 1959, G-3 1962
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE WITH HORIZONTAL CHANNELS
FUEL MATERIAL	NATURAL U METAL, SOME CENTRAL RODS URANIUM-ALUMINUM ALLOY, 15-20 CHANNELS LOADED WITH THORIUM
FUEL GEOMETRY	RODS 28.2 CM. LONG/2.8 AND 3.1 CM./PERIPHERAL/DIA.
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY 1.5 MM. THICK, FINNED
FUEL ASSEMBLY	FINNED-CLAD RODS, 28 ELEMENTS/CHANNEL 1200 FUEL CHANNELS
FUEL CHARGE	110 TONS URANIUM
SPECIFIC POWER	1.82 KW/KG
BURNUP(REFUEL)	400 MWD/TON /ON-LOAD REFUELING/
NEUTRON FLUX	THERMAL MAX. 2.8 X10 E+13 FAST AVE. 1.2X10 E+13
CONTROL	BORON CARBIDE RODS, STEEL CLADDING, NO BURNABLE POISON
COOLANT TEMP.	333-307 C
COOLANT PRESS.	15 KG/SQ. CM.
REACTOR VESSEL	PRESTRESSED CONCRETE HORIZONTAL CYLINDER, DISKED ENDS, MASSIVE BASE. 33.6 M. LONG /14 M.ID.
CONTAINMENT	REACTOR BUILDING-CONVENTIONAL.

* * * * * * * * * * * * * * * * *

REMARKS

BOTH G-2 AND G-3 HAVE BEEN UP-RATED TO 30-37 MWE AND 240 MWT, G-3 IS EXPECTED TO PRODUCE 40 MW FOR THE FRENCH NATIONAL GRID.

REFERENCES

DESCRIPTION OF REACTORS G-2 AND G-3,
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES
OF ATOMIC ENERGY 8, 334-55 /1958/

THE WORLDS REACTORS, G-2 AND G-3,
NUCLEAR ENG. /INSERT/ /DECEMBER 1959/

THE G-2 AND G-3 INDUSTRIAL COMPLEXES,
L MAILLARD
ENERGIE NUCLEAIRE 5, 226-30 /JUNE 1963/

DIRECTORY OF NUCLEAR REACTORS, VOL. I, POWER
REACTORS, P. 151
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1959

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF08

* * * * * * * * * * * * * * * * *

NAME/OWNER	EL-4 /EAU LOURDE/ CEA-FRANCE MONT D ARREE CENTRALE NUCLEAIRE
DESIGNER	CEA-FRANCE
OPERATOR	CEA-FRANCE
LOCATION	MORLAIX, BRITTANY, FRANCE /NEAR BRENNILIS/
PURPOSE	POWER, CONTRIBUTION TO EURATOM ORGEL PROJECT, /PROTOTYPE/
TYPE	GCR, HEAVY WATER MODERATED HORIZONTAL PRESSURE TUBE
POWER MWE(MWT)	75 250
CRITICAL	DECEMBER 1966, FULL POWER SUMMER 1967, REACTOR DOWN IN JAN, 1968 BECAUSE OF CRACKS IN HEAT EXCHANGER, EXPECTED BACK ON-LINE BY END OF 1968,
COOLANT	CARBON DIOXIDE, FORCED CIRCULATION
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 13 MM DIAM,
FUEL GEOMETRY	ROD, 40 CM, LONG/11 MM, DIA,
FUEL CLADDING	SS-THIN, LATER CORES BERYLLIUM, IRON-ALUMINUM OR ZIRCONIUM ALLOYS
FUEL ENRICH,	FIRST CORE 1,4 PERCENT U-235, LATER NATURAL URANIUM
FUEL ASSEMBLY	19-ROD CLUSTER, GRAPHITE SLEEVE, 9 ELEMENTS /CHANNEL
SPECIFIC POWER	35 W/G URANIUM DIOXIDE
BURNUP(REFUEL)	10,000 MWD/TON /ON-LOAD REFUELING/
CONTROL	GAS RODS AND SOLUBLE POISON
COOLANT TEMP,	INLET 260 C OUTLET 475-500 C
COOLANT PRESS,	870 PSI
REACTOR VESSEL	MOLYBDENUM-STAINLESS STEEL HORIZONTAL CYLINDER,

* * * * * * * * * * * * * * * * *

5.5 M. BETWEEN END PLATES, 4 M. ID., 30 MM. WALL THICKNESS. ZIRCALOY-2 FUEL TUBES JOINED TO END PLATES

CONTAINMENT PRESTRESSED CONCRETE CYLINDER 46 M. ID, 44 M. HIGH
WALL THICKNESS 2.36 IN.
SPHERICAL DOME 60 CM. THICK

REMARKS PRESSURE TUBES ARE ZIRCALLOY, THERMALLY INSULATED FROM THE HOT GAS PASSING THROUGH THEM, COLD HEAVY WATER MODERATOR IS CONTAINED IN A VESSEL RIGIDLY CONNECTED TO THE POWER TUBES BY A LEAK-PROOF JUNCTION. THE HORIZONTAL CHANNELS ARE ACCESSIBLE FROM BOTH ENDS, THE FUEL ELEMENTS BEING MOVED ALONG THE LENGTH OF THE CHANNEL DURING IN-PILE LIFE. A SCALED-UP 500 MWE PLANT HAS BEEN STUDIED AS A REFERENCE DESIGN. AMONG THE COOLANTS STUDIED BRIEFLY WAS A SUSPENSION OF GRAPHITE IN CARBON DIOXIDE GAS. EL-5 AS PLANNED WILL BE A 300 MWE PLANT WITH ITHE SAME BASIC CHARACTERISTICS AS EL-4.
A 600 MWE PLANT HAS BEEN EVALUATED.
CEA, WITH SULZER, IS STUDYING A HEAVY WATER GCR WITH VERTICAL CHANNELS INTEGRATED IN A PRESTRESSED CONCRETE VESSEL, AND WITH SIEMENS A HEAVY WATER BWR, ALSO WITH A PRESTRESSED CONCRETE VESSEL.

REFERENCES

EL-4, CHOICE OF PRINCIPAL PARAMETERS.
B BAILLY DU BOIS, R. NAUDET
SPM-620 /MARCH 1960/ IN FRENCH
AEC-TR-4194 /TRANSLATION/

EL-4- AN ADVANCED NATURAL URANIUM REACTOR.
NUCLEAR ENG. 8, 312-316 /SEPTEMBER 1963/

HEAVY WATER MODERATED GAS-COOLED REACTORS.
B BAILLY DU BOIS, OTHERS
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA 1964, VOL. 5, P. 343-49

EL-4 AND THE FRENCH HEAVY WATER/GAS LINE.
R. CARLE, R. GIBRAT
NUCLEAR ENG. 10, 171-174 /MAY 1965/

THE FRENCH NUCLEAR POWER STATION EL-4
JC BRISSET
INTL. CONF. CANADIAN NUCLEAR ASSOCN.
PREPRINT 65-CNA-212
CONF-650515-6

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF08

* * * * * * * * * * * * * * * * *

EL-4 FEATURES AND CONSTRUCTION PROBLEMS
R CARLE, P SCHULHOFF
3RD UN INTL. CONF. PEACEFUL USES ATOMIC ENERGY
VOL. 5, 350-6 /1964/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF09

* * * * * * * * * * * * * * * * *

NAME/OWNER	BRENDA/SNECMA AND CEA, FRANCE PILE CHAUD
DESIGNER	SOCIETE NACIONALE D-ETUDES ET DE CONSTRUCTION DE MOTEURS D-AVIATION /SNECMA/
LOCATION	CADARACHE, FRANCE
PURPOSE	AIRCRAFT PROPULSION PROTOTYPE
TYPE	GCR
POWER MWE(MWT)	1
CRITICAL	INITIAL CONSTRUCTION ONLY. DROPPED IN 1958
COOLANT	GAS
MODERATOR	BERYLLIUM OXIDE, GRAPHITE OR WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL CLADDING	CERAMIC
REFERENCES	NUCLEAR POWER 4,82 /APRIL 1959/ NEWS RELEASE J. NUCLEAR MATERIALS 14, 46-7 /1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-1/ELECTRICITE DE FRANCE
DESIGNER	CEA, ELECTRICITE DE FRANCE
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	CHINON, FRANCE LOIRE RIVER
PURPOSE	POWER
TYPE	GCR, TWO-REGION CORE.
POWER MWE(MWT)	68 300
CRITICAL	1959
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM-MOLYBDENUM ALLOY
FUEL GEOMETRY	HOLLOW RODS 54CM. LONG/1.4 AND 3.5 CM. DIA.
FUEL CLADDING	MAGNESIUM-ALUMINUM ALLOY 1.8 MM. THICK, FINNED 1.8 MM. THICK, RADIAL FINS
FUEL ASSEMBLY	15 CARTRIDGES /CHANNEL 1148 CHANNELS
FUEL CHARGE	140,000 KG. URANIUM
SPECIFIC POWER	2.1 KW/KG
BURNUP(REFUEL)	3000 MWD/TON
NEUTRON FLUX	THERMAL AVE. 1.6X10 E+13 FAST MAX. 3.3X10 E+13
CONTROL	SHIM-SAFETY RODS, REGULATING RODS, NO BURNABLE POISON
COOLANT TEMP.	INLET 140 C OUTLET 335 C
COOLANT PRESS.	25 KG/SQ. CM.
REACTOR VESSEL	STEEL CYLINDER, HEMISPHERICAL ENDS. 10CM. THICK/22.80 LONG, 10M. DIA.
CONTAINMENT	STEEL SPHERE 55 M. DIA.

* * * * * * * * * * * * * * * * *

REMARKS FIRST REACTOR OF THE 3-REACTOR CHINON NUCLEAR POWER STATION. REACTOR HAS A TWO-REGION CORE WITH COMPACT CENTER, MORE WIDELY SPACED PERIPHERY. COMMERCIAL OPERATION 1963.

REFERENCES THE CHINON NUCLEAR POWER PLANT EDF-1 AND EDF-2
M ROUX
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES
OF ATOMIC ENERGY 8,356-79 /1958/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-2/ELECTRICITE DE FRANCE
DESIGNER	CEA, ELECTRICITE DE FRANCE
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	CHINON, FRANCE LOIRE RIVER
PURPOSE	POWER
TYPE	GCR
POWER MWE(MWT)	195 785
CRITICAL	AUGUST 1964 HAS BEEN DOWN SINCE NOV. 1967 BECAUSE OF LEAK IN FUEL ROD.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS, HEXAGONAL
FUEL MATERIAL	URANIUM HOLLOW CYLINDERS
FUEL GEOMETRY	HOLLOW RODS, 52.8 CM. LONG/2.4 AND 4.3 CM. DIA.
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY CANS, GRAPHITE SLEEVE. /FINNED CANS/
FUEL ASSEMBLY	FINNED HOLLOW ROD, 12 ELEMENTS/CHANNEL 2660 CHANNELS.HEX.SUBASSEMBIES 36 CHANNELS EACH
FUEL CHARGE	250.000 KG.URANIUM
SPECIFIC POWER	3.1 KG/KW
BURNUP(REFUEL)	3000 MWD/TON
NEUTRON FLUX	THERMAL AVE. 1.7X10 E+13 FAST MAX. 3.5X10 E+13
CONTROL	SHIM-SAFETY AND REGULATING RODS
COOLANT TEMP.	INLET 195 C OUTLET 365 C
COOLANT PRESS.	25 KG/SQ. CM.
REACTOR VESSEL	SPHERE OF WELDED STEEL PLATES 18.3 M.DIA./10.6CM.

* * * * * * * * * * * * * * * * *

	THICK
CONTAINMENT	NONE
REMARKS	2ND STATION OF THE 3-REACTOR CHINON NUCLEAR POWER STATION.
REFERENCES	THE CHINON NUCLEAR POWER PLANT EDF-1 AND EDF-2, M ROUX SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 8, 356-79 /1958/
	FIRST STEPS TOWARD CONVENTIONAL NUCLEAR POWER. JP ROUX, C. BIENVENU J. BRIT. NUCLEAR ENERGY SOC. 1/3/, 235-59 /JULY 1962/
	NUCLEAR POWER STATION EDF-2,EDF-3,AND EDF-4 C BIENVENU, OTHERS THIRD U. N. INTL. CONF. PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF.28/P/38

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-3/ELECTRICITE DE FRANCE
DESIGNER	ELECTRICITE DE FRANCE
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	CHINON, FRANCE LOIRE RIVER
PURPOSE	POWER
TYPE	GCR
POWER MWE(MWT)	480
CRITICAL	MARCH 1966 DOWN SINCE NOV. 1967 DUE TO LEAK IN HEAT EXCHANGER. OPERATION MID-1968 AT 320 MWE.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM-MOLYBDENUM ALLOY TUBE
FUEL GEOMETRY	HOLLOW RODS
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY, FINNED
FUEL ASSEMBLY	FINNED TUBE 2700 CHANNELS
FUEL CHARGE	400 TONS URANIUM
SPECIFIC POWER	1.1 MWE/TON
REACTOR VESSEL	PRESTRESSED CONCRETE
REMARKS	3RD STATION OF THE CHINON NUCLEAR POWER COMPLEX CONSTRUCTION WAS STARTED IN 1961.
REFERENCES	THE DEVELOPMENT IN FRANCE OF THE REACTOR SYSTEM NATURAL URANIUM-GRAPHITE-CARBON DIOXIDE EXPERIENCE ACQUIRED, FUTURE PROSPECTS. J HOROWITZ, JP ROUX BULL, INFORM. SCI. TECH. /PARIS/ NO.76,3-11 /OCT. 1963/ NUCLEAR POWER STATIONS EDF-2,EDF-3,AND EDF-4. C BIENVENU, OTHERS

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF12

* * * * * * * * * * * * * * * * *

3RD U. N. INTL. CONF. PEACEFUL USES OF ATOMIC
ENERGY, GENEVA, 1964, A/CONF.28/P/38

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-4/ELECTRICITE DE FRANCE SAINT LAURENT DES EAUX
DESIGNER	ELECTRICITE DE FRANCE
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	LOIR-ET-CHER, NORMANDY, FRANCE LOIRE RIVER
PURPOSE	POWER
TYPE	GCR INTEGRATED DESIGN, TWO-REACTOR STATION
POWER MWE(MWT)	500 1650 PER REACTOR
CRITICAL	NO.1, 1968 NO.2, 1970
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM ALLOY
FUEL GEOMETRY	HOLLOW ROD 43 MM. OD./23 MM. ID.
FUEL CLADDING	GRAPHITE SLEEVE, ZIRCALOY CAN.
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	43,110 FUEL ELEMENTS 2,874 FUEL CHANNELS
FUEL CHARGE	445 TONS URANIUM
CONTROL	RODS
COOLANT TEMP.	INLET 217 C OUTLET 400 C
COOLANT PRESS.	384 PSI
REACTOR VESSEL	PRE-STRESSED CONCRETE VERTICAL CYLINDER. THE HEAT EXCHANGER IS ALSO LOCATED INSIDE THE PRESSURE VESSEL.
REMARKS	CONSTRUCTION. TARGET FOR NO. 1 REACTOR 1968. PLANS HAVE INCLUDED STUDY OF THE INTEGRATED CONCEPT OR

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF13

* * * * * * * * * * * * * * * * *

MONOBLOC DESIGN.

REFERENCES

NUCLEAR POWER STATIONS EDF-2, EDF-3, AND EDF-4.
C BIENVENU, OTHERS.
3RD U. N. INTL. CONF. PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964. A/CONF.28/P/38

NEW DESIGN OF REACTOR COMPLEX AND OF LOADING MECHANISM.
ORNL-TN-82 /TRANSLATION OF PAPER FROM CANNES SYMPOSIUM, 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-5/EDF-CEA, FRANCE BUGEY-1
DESIGNER	CEA, FRANCE
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	BUGEY, NEAR LYONS, FRANCE
PURPOSE	POWER AND EXPERIMENTAL FACILITY
TYPE	GCR
POWER MWE(MWT)	500 2400
CRITICAL	TARGET 1971
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM TUBES
FUEL GEOMETRY	ANNULAR ELEMENT INTERNAL AND EXTERNAL COOLING
FUEL CLADDING	MAGNESIUM ALLOY INNER AND OUTER CLADDING
FUEL ENRICH.	NATURAL
REACTOR VESSEL	PRESTRESSED CONCRETE
REMARKS	PLANNED WORK ON ANNULAR METAL ELEMENTS IS IN PROCESS /PROJECT INCA-INCORPORE ANNULAR/. THE CARBON DIOXIDE CIRCUIT WILL BE WITHIN THE CONCRETE VESSEL AND COMPLETELY INDEPENDENT OF STEAM AND WATER LOOPS. BUGEY-1 WILL BE THE FIRST OF FIVE UNITS
REFERENCES	PROPRIETE INDUSTRIELLE NUCLEAIRE NO. 9 /5-15-64/, VOL. 7, P. 14. NEWS RELEASE BUGEY-1 NUCLEAR POWER STATION. ME ROBERT, MP LAUNAY BULL. INFORM. ATEN NO. 61, 21-33 /SEPT-OCT. 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	VANDELLOS NUCLEAR STATION/FRANCE-SPAIN CATALONIA STATION
DESIGNER	SOCIA /INDATOM AND SEEN, FRANCE/
OPERATOR	SOCIEDAD HISPANO-FRANCESCA DE ENERGIA NUCLEAR SA /HIFRENSA/, FRANCE-SPAIN
LOCATION	VANDELLOS, SPAIN /TARRAGONA/ ON MEDITERRANEAN COAST
PURPOSE	POWER
TYPE	GCR DUPLICATE OF FRENCH EDF-4
POWER MWE(MWT)	500 1667
CRITICAL	CONSTRUCTION PERMIT JULY 1968. TARGET 1972.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM-MOLYBDENUM ALLOY
FUEL GEOMETRY	ANNULAR ELEMENT
FUEL CLADDING	ZIRCONIUM-MAGNESIUM ALLOY
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	SINGLE ELEMENT
FUEL CHARGE	500 TONS URANIUM
NEUTRON FLUX	2.3 E+13
COOLANT PRESS.	26.5 ATM.
REACTOR VESSEL	PRESTRESSED CONCRETE VESSEL 28.5 M OD 19.0 M ID 50 M HIGH HEAT EXCHANGER IS BELOW CORE WITHIN THE VESSEL
REMARKS	NEGOTIATIONS WERE CONCLUDED IN OCTOBER 1966 AND CONTRACTS SIGNED AT END OF YEAR. CONSTRUCTION START JANUARY 1967.

* * * * * * * * * * * * * * * * *

PART OF THE ELECTRICITY WILL BE EXPORTED TO THE FRENCH GRID.

REFERENCES APPLIED ATOMICS OCT. 7,1964 P.12-13
NEWS RELEASE

FRENCH REACTOR FOR SPAIN.
NUCLEAR ENG. 9,393 /NOV.1964/

THE FRENCH-SPANISH STATION VANDELLOS.
INDUSTRIES ATOMIQUES NOV. 1966 P. 79-80

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDF-RWE STATION ELECTRICITE DE FRANCE AND W. GERMANY RWE
DESIGNER	SIEMENS /W. GERMANY/ AND GAAA /FRANCE/
LOCATION	RHINE RIVER, FRENCH SIDE
PURPOSE	POWER
TYPE	GCR, GRAPHITE MODERATED
POWER MWE(MWT)	500
CRITICAL	PLANNED NO RECENT INFORMATION
COOLANT	GAS
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE
FUEL ENRICH.	NATURAL
REACTOR VESSEL	PRESTRESSED CONCRETE
REMARKS	AGREEMENT ON JOINT PROJECT HAS BEEN REACHED. THERE IS ALSO A TENTATIVE PLAN FOR A HEAVY-WATER MODERATED GCR TO BE BUILT LATER ON THE GERMAN SIDE OF THE RIVER.
REFERENCES	NUCLEONICS WEEK DEC.17,1964 P.1-2 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	BEERSHEBA STATION/ISRAEL
DESIGNER	ISRAEL, FRENCH ASSISTANCE
LOCATION	NEGEV DESERT NEAR BEERSHEBA, ISRAEL
PURPOSE	PILOT POWER, RESEARCH
TYPE	GCR, HEAVY WATER MODERATED
CRITICAL	TARGET 1964-5
COOLANT	CARBON DIOXIDE
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL ENRICH.	NATURAL
REMARKS	REPORTEDLY UNDER CONSTRUCTION. NO RECENT INFORMATION.
REFERENCES	NUCLEONICS 19,26/FEB. 1961/ NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	LATINA/SIMEA, ITALY
DESIGNER	NPPC /UK/ AND AGIP NUCLEARE /ITALY/
OPERATOR	SIMEA, ITALY
LOCATION	LATINA, ITALY
PURPOSE	POWER
TYPE	GCR
POWER MWE(MWT)	200 705
CRITICAL	DEC. 1963
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	URANIUM METAL RODS, 29.3 MM. DIA./914.4 MM. LONG
FUEL CLADDING	MAGNOX CANS, 2 MM. THICK, GRAPHITE SLEEVE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	SPIRAL FINNED ELEMENT, 8 ELEMENTS/CHANNEL 2929 FUEL CHANNELS
FUEL CHARGE	268 TONS URANIUM
SPECIFIC POWER	2.62 KW/KG URANIUM
CONTROL	BORON STEEL RODS
COOLANT TEMP.	INLET 180 C OUTLET 390 C
REACTOR VESSEL	PRESSURE VESSEL 20.35 M. DIA.
CONTAINMENT	CONCRETE BUILDING
REMARKS	ELECTRICITY PRODUCTION IN MAY 1963. FUEL IS COMPOSED OF NATURAL URANIUM METAL RODS IN MAGNOX CANS. THE ELEMENT WILL BE THE POLYZONAL SPIRAL TYPE, WITH SPIRAL FINS AND AXIAL FLOW SEPARATORS OR SPLITTERS.
REFERENCES	FOR BASIC DESIGN SEE CALDER

* * * * * * * * * * * * * * * * *

LATINA.
NUCLEAR ENG. 4, 329-40 /OCTOBER 1959/

LATINA NUCLEAR POWER STATION. COMMISSIONING AND
INITIAL OPERATING EXPERIENCE
A BERTINI, OTHERS
3RD UN INTL. CONF. PEACEFUL USES ATOMIC ENERGY
VOL. 5, 38-46 /1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	TOKAI ATOMIC STATION/JAPCO, JAPAN
DESIGNER	GEC-SC, UNITED KINGDOM
OPERATOR	JAPAN ATOMIC POWER CO.
LOCATION	TOKAI-MURA, JAPAN PACIFIC COAST
PURPOSE	POWER
TYPE	GCR
POWER MWE(MWT)	150 570
CRITICAL	1965, POWER PRODUCED NOV. 1965 COMMERCIAL OPERATION AT 120 MWE EARLY 1966
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS, HOLLOW, 40.8 MM. OD./23.7 MM.ID./714 MM.LONG
FUEL CLADDING	MAGNOX CAN-OUTSIDE CANNING ONLY. GRAPHITE SLEEVE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	FINNED MAGNOX CANNED ELEMENTS, 8/CHANNEL 2048 CHANNELS
FUEL CHARGE	187 TON URANIUM
SPECIFIC POWER	3.14 KW/KG URANIUM
NEUTRON FLUX	THERMAL AVE. 2X10 E+13
CONTROL	RODS, TOP-MOUNTED
COOLANT TEMP.	INLET 203 C OUTLET 390 C
COOLANT PRESS.	205 PSIG
REACTOR VESSEL	SPHERICAL PRESSURE VESSEL, 62 FT.ID./3 1/4 IN. THICK
REMARKS	A HOLLOW FUEL ELEMENT, CANNED ON THE OUTSIDE ONLY, HAS BEEN ADOPTED FOR THE TOKAI PLANT. THE CAN IS

* * * * * * * * * * * * * * * * *

SEALED AT EACH END BY END PLUGS, IS LONGITUDINALLY FINNED WITH HELICAL SWIRLERS, AND IS SUPPORTED INSIDE A GRAPHITE SLEEVE.

REFERENCES FOR BASIC DESIGN SEE CALDER

JAPANS FIRST NUCLEAR POWER STATION,
PA LINDLEY, OTHERS
NUCLEAR POWER 5, 104-13 /MARCH 1960/

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCR STUDY/FAPIG. JAERI. JAPAN
DESIGNER	FIRST ATOMIC POWER INDUSTRY GROUP JAPAN ATOMIC ENERGY RESEARCH INST.
PURPOSE	POWER
TYPE	GCR, HIGH TEMPERATURE, DIRECT CYCLE
POWER MWE(MWT)	9.9 31
CRITICAL	DESIGN
COOLANT	HELIUM
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM CARBIDE COATED WITH CARBON, DISPERSED IN GRAPHITE. THORIUM CARBIDE MAY BE USED.
FUEL GEOMETRY	ROD, 6.0 CM. OD./150 CM. LONG
FUEL CLADDING	GRAPHITE SHEATH
FUEL ASSEMBLY	RODS, DOUBLE GRAPHITE SHEATH 400 ELEMENTS
BURNUP(REFUEL)	APPROX. 30 MONTHS
NEUTRON FLUX	THERMAL AVE. 5.15 10+13
COOLANT TEMP.	INLET 488 C OUTLET 754 C
COOLANT PRESS.	30 KG/SQ. CM.
REACTOR VESSEL	PRESSURE VESSEL
REMARKS	DEVELOPMENTAL STUDIES.
REFERENCES	ON NUCLEAR DESIGN OF THE SEMI-HOMOGENEOUS, HIGH-TEMPERATURE, GAS-COOLED REACTOR. SIGERU YASUKAWA ET AL. JAERI-1049 /MARCH 1963//IN JAPANESE/ CONCEPTUAL DESIGN OF A POWER STATION USING A /EXPERIMENTAL/ SEMIHOMOGENEOUS HIGH-TEMPERATURE GAS COOLED REACTOR. FIRST ATOMIC POWER IND. GROUP, TOKYO. FAPIG /TOKYO/ 27/2/, 91-120 /AUG. 1963/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF20

* * * * * * * * * * * * * * * * *

/IN JAPANESE/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF21

* * * * * * * * * * * * * * * * *

NAME/OWNER	EDEYRN STATION/CEGB, UNITED KINGDOM
DESIGNER	NOT SELECTED
OPERATOR	CENTRAL ELECTRIC GENERATING BOARD, U.K.
LOCATION	CAERNARVONSHIRE, WALES
PURPOSE	POWER
TYPE	GCR
CRITICAL	PLANNED
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
REMARKS	PLANNED
REFERENCES	FOR BASIC DESIGN SEE CALDER

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF22

* * * * * * * * * * * * * * * * *

NAME/OWNER	CALDER HALL/ATOMIC ENERGY AUTHORITY UNITED KINGDOM
DESIGNER	UK AEA
OPERATOR	UK AEA
LOCATION	CALDER HALL, CUMBERLAND, ENGLAND
TYPE	GCR /4-REACTOR STATION/
POWER MWE(MWT)	45 235
CRITICAL	1956-1958 /A1,1956,A2,1956,B3,1958,B4,1958/
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	SOLID RODS, CYLINDRICAL 2.92 CM. DIA/101.5CM. LONG
FUEL CLADDING	MAGNESIUM ALLOY /MAGNOX/ CAN, 0.8 MM. THICK
FUEL ASSEMBLY	SOLID RODS IN MAGNESIUM ALLOY CAN. 6 ELEMENTS/CHANNEL, HELICAL FINS /RODS LOADED ONE ON TOP OF THE OTHER/ 1696 VERTICAL FUEL CHANNELS
FUEL CHARGE	127 TON URANIUM
SPECIFIC POWER	1.38 KW/KG U
NEUTRON FLUX	THERMAL AVE. 6.02 E+12 FAST AVE 2.14 E+13
CONTROL	RODS, BORON STEEL IN SS, TOP-MOUNTED
COOLANT TEMP.	INLET 140 C OUTLET 336 C
COOLANT PRESS.	INLET 7.03 KG/SQ.CM.OUTLET 6.7 KG/SQ. CM.
REACTOR VESSEL	STEEL CYLINDER, ELLIPSOID ENDS 11.25 M.ID. /21.65 M. HIGH, 5.08 CM. THICK
CONTAINMENT	BIOLOGICAL SHIELD AND REACTOR BUILDING
REMARKS	THE HEAT OUTPUT OF EACH REACTOR HAS BEEN INCREASED TO 220 MW.
REFERENCES	SYMPOSIUM ON CALDER WORKS NUCLEAR POWER PLANT.

* * * * * * * * * * * * * * * * *

J. BRIT. NUCLEAR ENERGY CONF. 2, 41-291 /1957/

COMMISSIONING AND OPERATION OF A STATION, CALDER WORKS. H. G. DAVEY
J. BRIT. NUCLEAR ENERGY CONF. 3, 101-8/APRIL 1958/

DESIGN OF GAS-COOLED, GRAPHITE MODERATED REACTORS
DR POULTER, ED.
OXFORD UNIV. PRESS, N. Y. 1963

* * * * * * * * * * * * * * * * *

NAME/OWNER	CHAPEL CROSS/ATOMIC ENERGY AUTHORITY, U.K.
DESIGNER	UK AEA
OPERATOR	UK AEA
LOCATION	CHAPEL CROSS, DUMFRIESCHIRE, SCOTLAND
PURPOSE	PLUTONIUM PRODUCTION, POWER
TYPE	GCR-CALDER HALL DESIGN
POWER MWE(MWT)	35 235-240 4-REACTOR STATION
CRITICAL	1959-1960 /4TH REACTOR MARCH 1960/ DOWN /1968/ DUE TO MASSIVE FUEL MELTING.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS 2.92 CM. DIA./101.5 CM. LONG
FUEL CLADDING	MAGNOX 0.8 MM. THICK REMOVABLE GRAPHITE SLEEVES IN REACTORS 2,3, AND 4
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	SOLID CYLINDRICAL RODS, MAGNOX CAN, FINNED 6 ELEMENTS/CHANNEL 1696 FUEL CHANNELS
FUEL CHARGE	127 TON URANIUM
SPECIFIC POWER	1.36 KW/KG U
CONTROL	RODS BORON STEEL IN SS, TOP-MOUNTED
COOLANT TEMP.	OUTLET 340 C
REMARKS	HEAT OUTPUT OF EACH REACTOR WAS INCREASED TO 220 MW IN MARCH, 1961
REFERENCES	CHAPEL CROSS, NUCLEAR ENG. 4, 250-2 /JUNE 1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	WINDSCALE AGR/ATOMIC ENERGY AUTHORITY, U.K.
DESIGNER	UK AEA
OPERATOR	UK AEA
LOCATION	WINDSCALE, CUMBERLAND, ENGLAND
PURPOSE	POWER PROTOTYPE
TYPE	GCR, HIGH TEMPERATURE
POWER MWE(MWT)	33 105
CRITICAL	AUGUST 1962
COOLANT	CARBON DIOXIDE /HELIUM STUDIED AS ALTERNATE/
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, SINTERED, 0.400 IN. DIA./ 0.40 IN. LONG
FUEL GEOMETRY	PENCILS
FUEL CLADDING	SS CANS 0.015 IN. THICK RIBBED
FUEL ENRICH.	2.5 PER CENT U-235
FUEL ASSEMBLY	MARK 2 FUEL, 21-ELEMENT /PENCIL/ CLUSTER IN GRAPHITE SLEEVE /3FT. LONG/, FUEL ELEMENT ASSEMBLY IS COMPOSED OF 2 CLUSTERS, FUEL ELEMENT STRINGER /ACTIVE LENGTH 14 FT. 5 IN./ IS MADE UP OF 4 ASSEMBLES. 253 FUEL CHANNELS /197 IN USE/
FUEL CHARGE	290 KG. U-235
SPECIFIC POWER	350 KW/KG U-235
BURNUP(REFUEL)	10,000 MWD/TON U /CONTINUOUS-DURING OPERATION/
NEUTRON FLUX	THERMAL AVE. 1.49X10 E+13
CONTROL	BORON STEEL RODS
COOLANT TEMP.	INLET 250-325 C OUTLET 500-575 C
COOLANT PRESS.	270 PSIG
REACTOR VESSEL	CYLINDER 21 FT. ID./54 FT. HIGH, DOUBLE-SHELL

* * * * * * * * * * * * * * * * *

CONSTRUCTION

CONTAINMENT STEEL HEMISPHERICAL TOP, TRUNCATED-CONE LOWER HALF

REMARKS ZERO-ENERGY EXPERIMENT /HERO/ CRITICAL IN FEBRUARY 1962. BERYLLIUM CLADDING, PLANNED FOR FIRST CORE, WILL NOT BE USED. IN THE BERYLLIUM DESIGN, THERE WERE 36 FUEL ELEMENT RODS PER CLUSTER, AND THREE SUCH CLUSTERS PER BERYLLIUM ELEMENT SUBASSEMBLY. COOLANT FLOW IS UPWARD INTO A COLLECTOR BOX ABOVE THE CORE. PRESSURE VESSEL IS OF DOUBLE-SHELL CONSTRUCTION, THE INNER SHELL CONTAINING THE HOT GAS AND THE OUTER SHELL OPERATING AT THE COOLER INLET GAS TEMPERATURE. FULL POWER OPERATION IN FEBRUARY 1963, WITH ELECTRICITY SUPPLIED TO THE NATIONAL GRID.
AGR-S WILL BE IN OPERATION AT DUNGENESS-B /1970/, HINKLEY POINT-2 /1973/, HUNTERSTON-B /1973/.

REFERENCES

DESIGN CONCEPT OF THE AGR.
RV MOORE
ELEC. REVIEW 169, 774-92/NOVEMBER 17, 1961/

THE DESIGN OF GAS-COOLED, GRAPHITE-MODERATED REACTORS.
DR POULTER, ED.
OXFORD UNIV. PRESS, N. Y. 1963.

AGR
NUCLEAR ENG. 6,151-58 /APRIL 1961/

SYMPOSUIM ON THE ADVANCED GAS-COOLED REACTOR,
BRITISH NUCLEAR ENERGY SOC. J. 2/2/ 95-294
/APRIL 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	DUNGENESS-B/CEGB, UNITED KINGDOM AGR-2
DESIGNER	ATOMIC POWER CONSTRUCTION LTD., UK. AGR-2 DESIGN BY UK AEA
OPERATOR	CENTRAL ELECTRIC GENERATING BOARD
LOCATION	KENT, ENGLAND
PURPOSE	POWER
TYPE	GCR, ADVANCED HIGH TEMPERATURE TWO-REACTOR STATION
POWER MWE(MWT)	600 PER REACTOR
CRITICAL	TARGET 1971 DELAYS DUE TO CONSTRUCTION AND DESIGN PROBLEMS
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, SINTERED, 0.57 IN. DIA.
FUEL GEOMETRY	PINS 0.57 IN. DIA./40 IN. LONG
FUEL CLADDING	SS CANS 0.015 IN. WALL THICKNESS
FUEL ENRICH.	1.47-1.76 PER CENT U-235
FUEL ASSEMBLY	CLUSTERS, 18 PENCILS/CLUSTER, GRAPHITE SLEEVE, 3-RING CLUSTER 8-ELEMENT STRINGERS, 465 CHANNELS /412 AT EQUILIBRIUM/ ACTIVE CORE HEIGHT 27 FT.
BURNUP(REFUEL)	18000-20000 MWD/T CONTINUOUS ON-LOAD AXIAL SHUFFLING
CONTROL	RODS
COOLANT TEMP.	INLET 320 C OUTLET 675 C
COOLANT PRESS.	450 PSI
REACTOR VESSEL	PRESTRESSED CONCRETE CYLINDER, INNER SEAL OF WATER

* * * * * * * * * * * * * * * * *

COOLED MILD STEEL MEMBRANE. VESSEL HOUSES CORE, GAS CIRCULATORS, AND BOILERS. INNER PRESSURE SHELL SEPARATES CORE FROM BOILER.

CONTAINMENT SINGLE CONCRETE BUILDING HOUSES BOTH REACTORS AND OTHER PLANT EQUIPMENT. REACTOR CENTERS ARE 160 FT. APART.

REMARKS APC-S ADVANCED GCR DESIGN WAS SELECTED FOR THE SECOND COMPLEX AT DUNGENESS STATION. EURATOM PARTICIPATION HAS BEEN EXTENDED TO MARCH, 31, 1970.

REFERENCES

ADVANCED GAS-COOLED REACTORS-AN ASSESSMENT. RV MOORE, JT THORN. BRITISH NUCLEAR ENERGY SOC. J. 2/2/, 97-111 /APRIL 1963/

DUNGENESS-B AGR REACTOR POWER STATION ATOM NO. 7, P. 168-74 /SEPT. 1965/

MAIN DESIGN FEATURES OF DUNGENESS-B NUCLEAR ENG. 10, 347 /SEPT. 1965/

DUNGENESS-B AGR NUCLEAR POWER STATION CEGB, LONDON NP-15473 /ND/

DUNGENESS B. ADVANCED GAS COOLED REACTOR POWER STATION. EP DUFFY NUCLEAR ENG. 12, 524-28 /JULY 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BERKELEY/CENTRAL ELECTRIC GENERATING BOARD, U.K.
DESIGNER	AEI-JOHN THOMPSON, U.K.
OPERATOR	CENTRAL ELECTRIC GENERATING BOARD
LOCATION	BERKELEY, GLOUCESTERSHIRE, ENGLAND
PURPOSE	POWER
TYPE	GCR,CALDER-TYPE
POWER MWE(MWT)	138 560 TWO-REACTOR STATION
CRITICAL	APRIL-MAY 1962
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD 1.1 IN. DIA./19 IN. LONG
FUEL CLADDING	MAGNOX, HELICAL FINS
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	U SLUGS IN MAGNOX TUBES, 24 IN. LONG 13 ELEMENTS/CHANNEL /STACKED/ 3265 FUEL CHANNELS
FUEL CHARGE	231 TONS U
SPECIFIC POWER	2.4 KW/KG URANIUM
BURNUP(REFUEL)	3000 MWD/T AVE. ON-LOAD, PARTIAL 10 CHANNELS/WEEK
NEUTRON FLUX	THERMAL AVE. 9.6X10 E+12 CORE CENTER 1.7X10 E+13
CONTROL	RODS, BORON IN STEEL, TOP-MOUNTED
COOLANT TEMP.	OUTLET 345 C
COOLANT PRESS.	139 PSIA /INLET/
REACTOR VESSEL	CYLINDER, 50 FT. DIA., 3-IN. THICK STEEL.

* * * * * * * * * * * * * * * * *

80 FT HIGH AND 50 FT HIGH /2-REACTORS/

CONTAINMENT REACTOR BUILDING

REMARKS BOTH REACTORS IN OPERATION IN APRIL-MAY 1962. BERKELEY BEGAN PRODUCING 6000 KWE ON THE NO. 1 GENERATOR IN JUNE 1962.

REFERENCES SEE CALDER

REACTORS ON-THE-LINE. NO. 10. BERKELEY. NUCLEONICS 12. /FACING PAGE 36/ /DECEMBER 1961/

BERKELEY CONSTRUCTION. SECTION DRAWINGS NUCLEAR ENG. 8,157-163 /MAY 1963/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF27

* * * * * * * * * * * * * * * * *

NAME/OWNER	DRAGON/ATOMIC ENERGY AUTHORITY, U.K. AND EUROPEAN NUCLEAR ENERGY AGENCY /ENEA/
DESIGNER	ATOMIC ENERGY RESEARCH ESTABLISHMENT, U.K.
OPERATOR	UK AERE
LOCATION	WINFRITH HEATH, ENGLAND
PURPOSE	POWER EXPERIMENT
TYPE	GCR, HIGH TEMPERATURE, CERAMIC SYSTEM
POWER MWE(MWT)	0 20
CRITICAL	AUG. 1964, POWER OUTPUT 20 MWT APRIL 1966
COOLANT	HELIUM
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM-THORIUM CARBIDES, SINTERED COMPACTS WITH GRAPHITE COATING
FUEL GEOMETRY	ANNULAR ROD, 6 FT. LONG
FUEL CLADDING	GRAPHITE TUBES
FUEL ASSEMBLY	FUEL-MODERATOR ELEMENTS. CLUSTERS OF HEXAGONAL GRAPHITE TUBES CONTAINING GRAPHITE FUEL BOXES WITH ANNULAR FUEL INSERTS. 37 ASSEMBLIES/CORE. /CENTRAL AND PERIPHERAL ZONES/ SEE REMARKS
SPECIFIC POWER	1.4 MW/KG
BURNUP(REFUEL)	100,000 MWD/TON CAPABILITY
CONTROL	RODS, BORON CARBIDE IN SS TUBES
COOLANT TEMP.	INLET 350 C OUTLET 750 C
COOLANT PRESS.	300 PSIA
REACTOR VESSEL	CYLINDER, CONICAL TOP 350 CM. DIA.
CONTAINMENT	INNER STEEL SHELL, OUTER CONTAINMENT BUILDING OF SEALED CONCRETE.
REMARKS	DRAGON IS A JOINT UNDERTAKING BY UK AND ENEA

* * * * * * * * * * * * * * * * *

/OF OECD/. HELIUM COOLANT FLOW IS UP THROUGH THE FUEL ELEMENT ASSEMBLIES, OVER SURFACES OF GRAPHITE CLADDING TUBES, AND WITH IN THE PASSAGES FORMED BY SPACER RIDGES ON THE GRAPHITE TUBES. PRELIMINARY STUDIES OF 1000 MWT REACTORS ARE BEING PERFORMED. HOT CRITICAL EXPERIMENT /ZENITH/ OPERATIONAL IN 1959. FUEL LOADING FOR DRAGON IN MARCH 1964. PROJECT WAS EXTENDED TO 1967 TO PROVIDE FOR THE DESIGN OF A POWER PRODUCTION PROTOTYPE, AND A FINAL DESIGN HAS BEEN COMPLETED FOR A 540 MWE REACTOR WHICH WOULD PRODUCE COOLANT GAS AT A TEMPERATURE OF 750 C. THIS TEMPERATURE MIGHT BE RAISED TO 850 C WITH LITTLE DESIGN CHANGE, MAKING IT POSSIBLE TO LINK THE SYSTEM DIRECTLY WIT- A GAS TURBINE. PARTNERS IN THE DRAGON PROJECT ARE EURATOM MEMBER STATES PLUS AUSTRIA, BRITAIN, DENMARK, NORWAY, SWEDEN AND SWITZERLAND. DURING MAINTENANCE SHUTDOWN IN OCT. 1966 MOST OF THE ORIGINAL FUEL CHARGE WAS REPLACED. SECOND FUEL CHARGE CONTAINS NEWLY-DEVELOPED COATED FUEL PARTICLES, PLUTONIUM-BEARING FUELS, DIRECTLY COOLED FUEL COMPACTS, AND FUEL SAMPLES FROM THTR /W. GERMANY/ AND OAK RIDGE. START-UP IN JAN. 1967.

REFERENCES

HIGH TEMPERATURE GAS-COOLED REACTOR PROJECT.
THE ENGINEER, 415-17 /MARCH 1959/

RESEARCH AND DEVELOPMENT ASPECTS OF THE DRAGON REACTOR EXPERIMENT.
LR SHEPHERD, PJ MARIEN
POWER REACTOR EXPERIMENTS VOL. I, PP. 13-47
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

THE DRAGON REACTOR.
POWER REACTOR TECHNOLOGY 6 /1/, 74-80
/DECEMBER 1962/

THE DRAGON REACTOR DEVELOPMENT AND DESIGN OF THE HTGC.
GE LOCKETT, RAU HUDDLE
NUCLEAR POWER 5,112-17 /FEB. 1960/

HOW DOES THE DRAGON PROJECT STAND.
P CAPRIOGLIO, M DE BACCI
EURATOM 3,20-23 /SEPT. 1964/

APPLIED ATOMICS AUG. 17, 1966 P. 2-3
NEWS RELEASE

CHEM. + ENG. NEWS OCT. 17, 1966 P. 79

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF27

* * * * * * * * * * * * * * * * *

NEWS RELEASE

APPLIED ATOMICS FEB. 15, 1967 P. 4
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	TRAWSFYNYDD/CENTRAL ELECTRIC GENERATING BOARD, U.K
DESIGNER	ATOMIC POWER CO., U.K.
OPERATOR	CEGB
LOCATION	MERIONETHSHIRE, WALES LAKE TRAWSFYNYDD /RESERVOIR/
PURPOSE	POWER
TYPE	GCR, CALDER TYPE
POWER MWE(MWT)	250 870 /TWO-REACTOR STATION/
CRITICAL	NO. 1 SEPT. 1964, ON-LINE JAN. 1965 NO. 2 DEC. 1964
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD 1 1/8 IN. DIA.
FUEL CLADDING	MAGNOX, LONGITUDINAL SPIRAL
FUEL ASSEMBLY	9 ELEMENTS/CHANNEL /STACKED/ 3720 FUEL CHANNELS
FUEL CHARGE	280 TONS URANIUM
SPECIFIC POWER	3.11 KW/KG URANIUM
BURNUP(REFUEL)	4500 MWD/TON U ON-LOAD
CONTROL	BORON STEEL RODS
COOLANT TEMP.	OUTLET 392 C
COOLANT PRESS.	240 PSIG
REACTOR VESSEL	STEEL SPHERE 61 FT. ID., 3 1/2 IN. PLATE THICKNESS
REMARKS	ON-LINE IN JANUARY 1965.
REFERENCES	FOR BASIC DESIGN SEE CALDER
	TRAWSFYNYDD

* * * * * * * * * * * * * * * * *

NUCLEAR ENG. 6,12-23 /JAN. 1961/

THE APC-S DESIGN FOR TRAWSFYNYDD
NUCLEAR ENG. 4, 289-90 /JULY, AUGUST, SEPTEMBER, 1959/

TRAWSFYNYDD DESIGN FEATURES,
NUCLEAR ENERGY ENG. 13, 489-95 /OCTOBER 1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HINKLEY POINT-1/CENTRAL ELECTRIC GEN. BOARD, U.K.
DESIGNER	ATOMIC POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	HINKLEY POINT, SOMERSET, ENGLAND BRISTOL CHANNEL
PURPOSE	POWER
TYPE	GCR, CALDER TYPE
POWER MWE(MWT)	250 971
CRITICAL	NO. 1, 1964, POWER TO GRID FEB. 1965 NO. 2, OCT. 1964, POWER 1966
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD 1 1/8 IN. DIA. /36 IN. LONG
FUEL CLADDING	MAGNOX, FINNED
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	8 ELEMENTS/CHANNEL /STACKED/ 4500/ FUEL CHANNELS
FUEL CHARGE	376 TONS URANIUM
BURNUP(REFUEL)	MINIMUM 3000 MWD/TON
NEUTRON FLUX	THERMAL MAX. 3X10 E+13 FAST MAX. 3.6X10 E+13
CONTROL	RODS, BORON STEEL
COOLANT TEMP.	INLET 180 C OUTLET 375 C
COOLANT PRESS.	200 PSIA
REACTOR VESSEL	BOILER PLATE STEEL SPHERE, 67 FT. DIA.
CONTAINMENT	REACTOR BUILDING
REMARKS	CEGB WILL BUILD A SECOND STATION AT SITE.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF29

* * * * * * * * * * * * * * * * *

A PROPOSAL BY TNGP IS FOR AN ADVANCED GAS-COOLED REACTOR.
SEE DF40

REFERENCES FOR BASIC DESIGN SEE CALDER

HINKLEY POINT
NUCLEAR ENG. 3, 286 /JULY 1958/

HINKLEY POINT NUCLEAR POWER STATION
D REED
NUCLEAR ENERGY SEPT. 1965 P. 272-83

* * * * * * * * * * * * * * * * *

NAME/OWNER	SIZEWELL/CENTRAL ELECTRIC GENERATING BOARD, U.K.
DESIGNER	ATOMIC POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	ALDEBURGH, SUFFOLK COAST, ENGLAND
PURPOSE	POWER
TYPE	TWIN MAGNOX GCR
POWER MWE(MWT)	290 948 PER REACTOR
CRITICAL	NO. 1 REACTOR DEC. 1965 NO. 2 REACTOR EARLY 1966
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD, 42 IN. ACTIVE LENGTH
FUEL CLADDING	MAGNOX, POLYZONAL HELICALLY FINNED
FUEL ASSEMBLY	7 RODS/CHANNEL /STACKED/ 3800 FUEL CHANNELS
FUEL CHARGE	321 TONS URANIUM
SPECIFIC POWER	2.96 KW/KG URANIUM
BURNUP(REFUEL)	ON-LOAD
CONTROL	RODS, STEEL WITH BORON STEEL INSERTS
COOLANT TEMP.	INLET 214 C OUTLET 410 C
COOLANT PRESS.	279 PSIA
REACTOR VESSEL	STEEL SPHERES 63 FT. 6 IN. ID., 4.125 IN. THICK
CONTAINMENT	SINGLE REACTOR BUILDING TO HOUSE BOTH REACTORS.
REMARKS	CONSTRUCTION
REFERENCES	FOR BASIC DESIGN SEE CALDER

* * * * * * * * * * * * * * * * *

SIZEWELL NUCLEAR POWER STATION.
BRITISH POWER ENG. 2/2/, 86-6 /JANUARY 1961/

SIZEWELL NUCLEAR POWER STATION.
HS ARMS, OTHERS
NUCLEAR POWER 6, 61-81 /SEPTEMBER 1961/

FROM HINKLEY TO SIZEWELL.
NUCLEAR ENG. 6, 364-70 /SEPT. 1961/

BRITAIN-S SEVENTH NUCLEAR POWER STATION
ENGINEERING 200, 70 /JULY 16, 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HUNTERSTON-A/S. SCOTLAND ELECTRICITY BOARD
DESIGNER	GENERAL ELECTRIC CO. LTD., SIMON CARVES, U.K.
OPERATOR	S. SCOTLAND ELECTRICITY BOARD
LOCATION	AYRSHIRE /WEST KILBRIDE/ SCOTLAND FIRTH OF CLYDE
PURPOSE	POWER
TYPE	GCR, TWO-REACTOR STATION
POWER MWE(MWT)	150 530 PER REACTOR
CRITICAL	NO. 1 SEPT. 1963 NO. 2 APRIL 1964
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS 1.15 IN. DIA./24 IN. LONG
FUEL CLADDING	MAGNOX, POLYZONAL AXIAL FINNED GRAPHITE SLEEVE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	10 RODS/CHANNEL /STACKED/ 3288 FUEL CHANNELS
FUEL CHARGE	251 TONS URANIUM
SPECIFIC POWER	2.13 KW/KG URANIUM
BURNUP(REFUEL)	APPROX. 2100 MWD/TON /ON-POWER, BOTTOM LOAD/
NEUTRON FLUX	THERMAL MAX. 1.35X10 E+13
CONTROL	RODS, BORON STEEL
COOLANT TEMP.	INLET 400 F OUTLET 735 F
COOLANT PRESS.	150 PSI
REACTOR VESSEL	STEEL SPHERE 70 FT. ID. AND 3 IN. THICK WALL
CONTAINMENT	REACTOR BUILDING

* * * * * * * * * * * * * * * * *

REMARKS STATION ON-LINE IN JUNE 1964
HUNTERSTON-B WILL BA A 1250 MWE TWIN-REACTOR AGR,
SEE DF46

REFERENCES FOR BASIC DESIGN SEE CALDER

GAS COOLED REACTOR FOR THE SOUTH OF SCOTLAND
ELECTRICITY BOARD.
PJ GRANT
NUCLEONICS 16, 108-13 /MAY 1958/

HUNTERSTON, MOST POWERFUL ATOMIC STATION.
ENGINEERING 198, 386-7 /SEPT. 25, 1964/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF32

* * * * * * * * * * * * * * * * *

NAME/OWNER	DUNGENESS-A/CEGB, UNITED KINGDOM
DESIGNER	THE NUCLEAR POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	KENT, ENGLAND STRAIT OF DOVER
PURPOSE	POWER
TYPE	GCR, CALDER TYPE
POWER MWE(MWT)	275 840 /TWO-REACTOR STATION/
CRITICAL	NO. 1 REACTOR JUNE 1965 NO. 2 REACTOR OCT. 1965
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	ROD, 1.10 IN. DIA./38.3 IN. LONG
FUEL CLADDING	MAGNOX
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	7 ELEMENTS/CHANNEL /STACKED/ 3932 CHANNELS
FUEL CHARGE	300 TONS URANIUM
SPECIFIC POWER	2.78 KW/KG URANIUM
CONTROL	RODS
COOLANT TEMP.	INLET 250 C OUTLET 410 C
REACTOR VESSEL	MILD STEEL SPHERICAL VESSEL.
CONTAINMENT	BUILDING WITH VAULT FOR REACTOR PRESSURE VESSEL
REMARKS	AGR HAS BEEN SELECTED FOR THE SECOND COMPLEX AT DUNGENESS. SEE DF25
REFERENCES	DUNGENESS NUCLEAR POWER STATION

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF32

* * * * * * * * * * * * * * * * *

RD VAUGHAN, OTHERS
NUCLEAR POWER 6, 76-96 /APRIL 1961/
RD VAUGHAU, OTHERS
NUCLEAR POWER 6, 76-96 /APRIL 1961/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF33

* * * * * * * * * * * * * * * * *

NAME/OWNER	OLDBURY/CENTRAL ELECTRIC GENERATING BOARD, U.K.
DESIGNER	THE NUCLEAR POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	OLDBURY-ON-SEVERN, GLOUCESTERSHIRE, ENGLAND SEVERN ESTUARY
PURPOSE	POWER
TYPE	GCR, CALDER TYPE 2-REACTOR STATION
POWER MWE(MWT)	300 834
CRITICAL	1967 OPERATION OF NO. 1 REACTOR DELAYED DUE TO LEAKAGE OF COOLANT GAS THROUGH REACTOR VESSEL INSULATION.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS, 1.10 IN. OD. /38.3 IN. LONG
FUEL CLADDING	MAGNOX, SPIRAL FINS
FUEL ASSEMBLY	8 ELEMENTS/CHANNEL /STACKED/ 3308 CHANNELS 3320 FUEL CHANNELS
FUEL CHARGE	293 TONS URANIUM
SPECIFIC POWER	2.85 KW/KG URANIUM
BURNUP(REFUEL)	4500 MWD/TON U
CONTROL	RODS, TOP-SUSPENDED
COOLANT TEMP.	INLET 245 C OUTLET 410 C
COOLANT PRESS.	364.3 PSIA
REACTOR VESSEL	PRESTRESSED CONCRETE VERTICAL CYLINDER 77 FT. ID., 60 FT. INNER HEIGHT, END SLABS 22 FT. THICK, WALL THICKNESS 15 FT.

* * * * * * * * * * * * * * * * *

	MILD STEEL LINER
CONTAINMENT	REACTOR BUILDING
REMARKS	EACH REACTOR AND ITS BOILERS ARE WITHIN A CONCRETE PRESSURE VESSEL /INTEGRAL DESIGN/. CARBON DIOXIDE COOLANT FLOWS FROM BLOWERS BUILT INTO THE PRESSURE VESSEL BELOW THE FOUR BOILERS, WHICH ARE ARRANGED SYMMETRICALLY AROUND THE CORE. FLOW IS UPWARD THROUGH THE CORE.
REFERENCES	FOR BASIC DESIGN SEE CALDER
	OLDBURY, FIRST U. K. CONCRETE PRESSURE VESSEL. NUCLEAR ENG. 7, 446-8 /NOVEMBER 1962/
	OLDBURY DESIGN APPRAISAL. NUCLEAR POWER 7, 44-50 /NOVEMBER 1962/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF34

* * * * * * * * * * * * * * * * *

NAME/OWNER	BRADWELL/CENTRAL ELECTRIC GENERATING BOARD, U.K.
DESIGNER	THE NUCLEAR POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	BRADWELL-ON-SEA, ESSEX, ENGLAND
PURPOSE	POWER
TYPE	GCR, CALDER TYPE
POWER MWE(MWT)	150 538 /2-REACTOR STATION/
CRITICAL	NO. 1, 1961 NO. 2, 1962.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS, 1.155 IN. DIA. /3.3 FT. LONG /3 FT. ACT. LENGTH/
FUEL CLADDING	MAGNOX, RADIAL FINS
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	8 ELEMENTS/CHANNEL /STACKED/ 2837 CHANNELS
FUEL CHARGE	241 TONS URANIUM
SPECIFIC POWER	2.20 KW/KG URANIUM
BURNUP(REFUEL)	3000-4500 MWD/TON U
NEUTRON FLUX	THERMAL AVE. 1.59X10 E+13 CORE CENTER 1.7X10 E+13
CONTROL	RODS, BORON STEEL
COOLANT TEMP.	INLET 180 C OUTLET 390 C
REACTOR VESSEL	MILD STEEL SPHERE, 66 FT. 9 IN. DIA., 3 AND 4 IN. THICK
CONTAINMENT	REACTOR BUILDING
REMARKS	POWER OPERATION IN NOVEMBER 1962

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF34

* * * * * * * * * * * * * * * * *

REFERENCES

BRADWELL NUCLEAR POWER STATION.
NUCLEAR POWER 7, 78-105 /APRIL 1962/

BRADWELL A HARD-WON ACHIEVEMENT
NUCLEAR ENG. 8, 164-67 /MAY 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	WYLFA/CENTRAL ELECTRIC GENERATING BOARD, U.K.
DESIGNER	ATOMIC POWER GROUP, U.K.
OPERATOR	CEGB
LOCATION	WYLFA HEAD, N. W. WALES /ANGLESEY ISLAND/ IRISH SEA COAST
PURPOSE	POWER
TYPE	GCR-CALDER TYPE, ONCE-THROUGH BOILER
POWER MWE(MWT)	590 1870 /2-REACTOR STATION/
CRITICAL	CONSTRUCTION CONTRACT AWARDED 1964. TARGET 1969.
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE, VERTICAL CHANNELS
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	RODS 1.10 IN. DIA./42 IN. LONG
FUEL CLADDING	MAGNOX, HERRINGBONE FINNED
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	8 ELEMENTS/CHANNEL /STACKED/ 6150 FUEL CHANNELS
FUEL CHARGE	595.4 TONS URANIUM
SPECIFIC POWER	3.16 KW/KG URANIUM
BURNUP(REFUEL)	ON-LOAD
CONTROL	RODS, BORON STEEL OR MILD STEEL
COOLANT TEMP.	INLET 247 C OUTLET 414 C
COOLANT PRESS.	400 PSIA
REACTOR VESSEL	PRESTRESSED CONCRETE, SPHERICAL INNER SHAPE 11 FT. THICK WALL
CONTAINMENT	REACTOR BUILDING
REMARKS	UPC CONTRACT FOR REACTOR NO. 1 WAS CANCELLED AND

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF35

* * * * * * * * * * * * * * * * *

CONTRACT FOR 2-REACTOR STATION AWARDED TO APG IN FEB. 1964.

REFERENCES WYLFA NUCLEAR POWER STATION
NUCLEAR ENG. 10 /7/, 139-54 /APRIL 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	WEISMOOR STATION/APK, W. GERMANY
DESIGNER	NOT SELECTED. SEE REMARKS.
LOCATION	WEISMOOR, W. GERMANY
PURPOSE	POWER
TYPE	GCR-ADVANCED TYPE
POWER MWE(MWT)	40
CRITICAL	PROJECT HAS BEEN CANCELED
REMARKS	PROPOSALS FROM UK FOR AN AGR WERE SUBMITTED, AND STUDY CONTRACT WAS MADE WITH GUTTEHOFFNUNGSHUTTE STERKRADE AG AND US GA. SITE WAS TO HAVE BEEN WEISMOOR A PROPOSAL BY GHH FOR A GAS TURBINE HTGR HAS BEEN ACCEPTED BY KSH FOR A SITE NEAR HAMBURG. SEE DF43.
REFERENCES	NEWS RELEASES

* * * * * * * * * * * * * * * * *

NAME/OWNER	AVR PEBBLE BED REACTOR/AVR, W. GERMANY
DESIGNER	BBC-KRUPP, W. GERMANY
OPERATOR	AVR, WEST GERMANY
LOCATION	JUELICH, W. GERMANY
PURPOSE	POWER EXPERIMENT, PROTOTYPE FOR 150 MWE PLANT.
TYPE	GCR, HIGH TEMPERATURE, PEBBLE BED
POWER MWE(MWT)	15 46
CRITICAL	AUGUST 1966
COOLANT	NEON-HELIUM /PROBABLY PURE HELIUM WILL BE USED/
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM, THORIUM CARBIDE PEBBLES
FUEL GEOMETRY	SMALL SPHERICAL PEBBLES 6 CM. DIA.
FUEL CLADDING	MACHINED GRAPHITE SHELLS, GRAPHITE PLUG.
FUEL ENRICH.	20 PER CENT U-235
FUEL ASSEMBLY	GRAPHITE-CLAD PEBBLES 100,000 PEBBLES/CORE
BURNUP(REFUEL)	/ON-LOAD/
CONTROL	CONTROL OF THE COOLANT GAS- NO RODS EXCEPT SHUT-DOWN
COOLANT TEMP.	INLET 200 C OUTLET 850 C
COOLANT PRESS.	10 ATM.
CONTAINMENT	DESIGN WORK IS IN PROGRESS ON PRESTRESSED CONCRETE PRESSURE VESSELS FOR LARGE UNITS. CONCTRUCTION EXPECTED BY 1967.
REMARKS	THE GCR PEBBLE-BED REACTOR CONCEPT WAS STUDIED BY FARRINGTON DANIELS, AND A FURTHER DEVELOPMENT BY WINNETT BOYD WAS DESIGNATED THE DANIELS-BOYD NUCLEAR STEAM GENERATOR, WHICH USED LOW-ENRICHMENT URANIUM CARBIDE WAFERS IN A POROUS GRAPHITE SHEATH FOR THE PRODUCTION OF 400 MW E.

* * * * * * * * * * * * * * * * *

THE CONCEPT WAS STUDIED FURTHER BY WINNETT BOYD IN ASSOCIATION WITH ARTHUR D. LITTLE, AS WELL AS BY SANDERSON AND PORTER AND THE OAK RIDGE LABORATORY. THE AVR PROJECT AT JULICH WAS DESIGNED AND DEVELOPED BY BBC/KRUPP OF MANNHEIM. THE USAEC HAS REQUESTED FUNDS IN ITS CONSTRUCTION AUTHORIZATION BILL FOR A COOPERATIVE PROGRAM WITH THE AVR PROJECT. AEC WOULD DEVELOP AND HAVE FABRICATED A COATED-PARTICLE REACTOR CORE FOR IRRADIATION IN THE AVR PEBBLE-BED REACTOR. A EURATOM CONTRACT WAS SIGNED IN 1964
A LONG-TERM DEVELOPMENT PROGRAM FOR THE PEBBLE-BED CONCEPT INCLUDES THE 15 MW E PLANT AS A FIRST STAGE, A SECOND STAGE REACTOR ALSO 15 MW E BUT CYCLING THE HIGH-TEMPERATURE HELIUM DIRECTLY TO A GAS TURBINE, AND A 150 MW E REACTOR AS THE FINAL STAGE, WITH A TARGET DATE OF 1970.
THE REACTOR FAMILY HAS BEEN DESIGNATED THORIUM-HOCHTEMPERATUR REAKTOR /THTR/.
DESIGN STUDY FOR A 200 MWE FULL-SCALE THTR WILL BE DONE IN COOPERATION WITH EURATOM.

REFERENCES

DANIELS EXPERIMENTAL POWER PILE DESIGN PROPOSAL.
MONN-188 /BOOKS I AND II

PRELIMINARY DESIGN OF A 10 MW/T/ PEBBLE-BED REACTOR EXPERIMENT.
OAK RIDGE NATIONAL LAB.
CF-60-10-63 /NOVEMBER 1960/

DESIGN STUDY OF A PEBBLE-BED REACTOR POWER PLANT.
AP FRAAS, OTHERS
DEVELOPED BY BBC/KRUPP OF MANNHEIM.
A GERMAN CONSORTIUM HOCHTEMPERATUR-KERNKRAFTWERK GESELLSCHAFT HAS BEEN FORMED TO SPONSOR DEVELOP-MENT OF A 300 MWE HIGH-TEMPERATURE THORIUM REACTOR /THTR/, WITH CONSTRUCTION TARGETED FOR 1969 AND OPERATION IN 1974. THE DESIGN, BY BBC/KRUPP AND JUELICH RESEARCH CENTER UNDER EURATOM CONTRACT, WILL BE EXTRAPOLATED TO COMMERICAL SCALE.
BBC/KRUPP IS EXPECTED TO MAKE A FORMAL BID TO THE CONSORTIUM. SEE DF44.
NUCLEONICS 14, 34-51 /MARCH 1956/

BOYD-S ACTIVE CIRCUIT GAS REACTOR.
CANADIAN CHEM. PROCESSING 43, 54-6 /MAY 1959/

SPECIAL FEATURES OF THE BROWN BOVERI-KRUPP REACTOR
O MACHNIG, OTHERS
NUCLEAR POWER 6, 63-6 /MARCH 1961/

* * * * * * * * * * * * * * * * *

THE AVR HIGH TEMPERATURE GAS-COOLED REACTOR.
HW SCHMIDT
PREPRINT PAPER NO. 31, ENGINEERS JOINT COUNCIL,
NEW YORK, /1962/

HIGH TEMPERATURE REACTOR DEVELOPMENT BY BBC/KRUPP
R SCHULTEN, O MACHNIG
ATOMPRAXIS 4, 117-122 /APRIL 1963/

ENERGY OUT OF PEBBLES
P SCHULTEN
EURATOM 4, 44-48 /JUNE 1965/

THE PEBBLE BED REACTOR. GERMANY-S HIGH TEMPERATURE
GAS-COOLED PROJECT.
NUCLEAR ENG. 10, 333-34 /SEPT. 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	KNK NUCLEAR STATION/ATOMKRAFT-BAYERN, W. GERMANY NIEDERAICHBACH STATION / BAYERNWERK REACTOR
DESIGNER	SIEMENS, W. GERMANY
OPERATOR	KERNKRAFTWERK NIEDERAICHBACH GMBH
LOCATION	NIEDERAICHBACH, BAVARIA, W. GERMANY /ON ISAR RIVER
PURPOSE	POWER PROTOTYPE
TYPE	HEAVY WATER MODERATED, GCR, PRESSURE TUBE
POWER MWE(MWT)	100
CRITICAL	CONSTRUCTION 1966, TARGET 1970
COOLANT	CARBON DIOXIDE
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	RODS
FUEL CLADDING	SS 0.25 MM. THICK
FUEL ENRICH.	1.1 PER CENT U-235
FUEL ASSEMBLY	19-ROD BUNDLE 1404 ELEMENTS IN 351 CHANNELS
SPECIFIC POWER	6.6 KW/KG
BURNUP(REFUEL)	11,600 MWD/T ON-LOAD
NEUTRON FLUX	4.5 E+13
COOLANT TEMP.	550 C
COOLANT PRESS.	880 PSI
CONTAINMENT	DOUBLE CONTAINMENT
REMARKS	THE SIEMENS DESIGN STUDY WAS COMMISSIONED BY AKB, FABWERKE HOECHST, AND BAVARIAN GOVERNMENT. IT HAS BEEN DECIDED THAT BAYERNWERKE WILL UNDERTAKE THE PROJECT ALONE, WITH CONSTRUCTION TO START IN 1965. KNK /KERNKRAFTWERK NIEDERAICHBACH/ GMBH HAS BEEN FORMED TO CONSTRUCT THE PLANT, AND WILL TAKE OVER

* * * * * * * * * * * * * * * * *

THE OPERATION AFTER FIVE YEARS.

REFERENCES

NUCLEAR POWER STATION WITH HEAVY WATER MODERATED PRESSURE TUBE REACTOR FOR HIGH TEMPERATURES.
W KELLER, HANS-JOACHIM PRESUSS
SIEMENS-Z, 37, 302-4 /APRIL 1963/

THE AKB PROJECT FOR A GAS-COOLED HEAVY WATER POWER REACTOR.
W KELLER
ATOMWIRTSCHAFT 8, 645-54 /DEC. 1963/

NIEDERAICHBACH NUCLEAR POWER STATION.
EURONUCLEAR 2, 281-3 /JUNE 1965/

NUCLEAR INDUSTRY DEC. 1965 P. 22
NEWS RELEASE

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF39

* * * * * * * * * * * * * * * * *

NAME/OWNER	FRUSS/POLAND
PURPOSE	POWER, FOR SUPERHEATING SUPERCRITICAL STEAM.
TYPE	GCR, PRESSURE TUBE
POWER MWE(MWT)	1000
CRITICAL	DESIGN
COOLANT	GAS
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL ENRICH.	NATURAL
REFERENCES	FRUSS - 1000 MWE NATURAL U GAS-COOLED GRAPHITE MODERATED PRESSURIZED REACTOR FOR SUPERCRITICAL STEAM PARAMETERS. J. LOPUSZYNSKI /POLISH ACAD. SCI., INST. NUCLEAR RES, WARSAW/ PAN-543/IX/JULY 1964/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF40

* * * * * * * * * * * * * * * * *

NAME/OWNER	HINKLEY POINT-B/CEGB, GT. BRITAIN
DESIGNER	THE NUCLEAR POWER GROUP-UK
OPERATOR	CENTRAL ELECTRIC GENERATING BOARD, GT. BRITAIN
LOCATION	HINKLEY POINT, SOMERSET, ENGLAND BRISTOL CHANNEL
PURPOSE	POWER
TYPE	AGR /ADVANCED GCR/ TWO-REACTOR STATION
POWER MWE(MWT)	626 1504 /PER REACTOR/
CRITICAL	CONSTRUCTION. TARGET 1972
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.60 IN. DIAM.
FUEL GEOMETRY	PIN
FUEL CLADDING	SS
FUEL ENRICH.	LOW
FUEL ASSEMBLY	36-PIN BUNDLE, GRAPHITE SLEEVE. 8 ELEMENTS LINKED TO FORM STRINGER ACTIVE CORE HEIGHT 27.2 FT CORE IS GRAPHITE STACK CONTAINING 308 FUEL CHANNELS.
FUEL CHARGE	122.5 TONS URANIUM
BURNUP(REFUEL)	18,000 MWD/T WHOLE CHANNEL DISCHARGE, ON-LOAD
CONTROL	RODS
COOLANT TEMP.	INLET 310 C OUTLET 665 C
COOLANT PRESS.	34 KG/SQUARE CM.
REACTOR VESSEL	VERTICAL CYLINDER, PRESTRESSED CONCRETE, 62 FT. ID AND 63.5 FT. HIGH INNER SURFACE INSULATED AND COOLED.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF40

* * * * * * * * * * * * * * * * *

REMARKS REACTOR UNITS ARE COMBINED IN A SINGLE COMPLEX, BOTH BEING SERVED BY THE SAME REFUELING MACHINE. BOILERS ARE IN AN ANNULUS SURROUNDING THE CORE.

REFERENCES HINKLEY POINT B, SURVEY OF DESIGN AND CONSTRUCTION
NUCLEAR ENG. 13, 652-68 /AUG. 1968/

HINKLEY POINT B
ENGINEER 223, 220-1 /FEB. 10, 1967/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF41

* * * * * * * * * * * * * * * * *

NAME/OWNER	FESSENHEIM STATION/EDF, FRANCE
DESIGNER	EDF, CEA, SCHNEIDER GROUP /FRANCE/
OPERATOR	ELECTRICITE DE FRANCE
LOCATION	FESSENHEIM, FRANCE RHINE RIVER
PURPOSE	POWER
TYPE	GCR, TWO-REACTOR STATION
POWER MWE(MWT)	740 PER REACTOR
CRITICAL	CONSTRUCTION AUTHORIZED, TARGET 1972
COOLANT	CARBON DIOXIDE
MODERATOR	GRAPHITE
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	HOLLOW ROD, EDF-3 TYPE
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY
FUEL ENRICH.	NATURAL
REACTOR VESSEL	PRESTRESSED CONCRETE
REFERENCES	THE FRENCH NATURAL-URANIUM GRAPHITE-MODERATED GAS-COOLED NUCLEAR POWER STATIONS. C BIENVENU, B SAITCEVSKY ANS TRANS. 10, 315 /JUNE 1967/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF42

* * * * * * * * * * * * * * * * *

NAME/OWNER	GCFR /GAS-COOLED FAST REACTOR/ UK AEA
DESIGNER	UK ATOMIC ENERGY AUTHORITY
PURPOSE	POWER BREEDER
TYPE	GAS-COOLED FAST REACTOR, PEBBLE-BED
POWER MWE(MWT)	1000 2380
CRITICAL	STUDY
COOLANT	HELIUM
MODERATOR	GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM/PLUTONIUM OXIDE PEBBLES, DOUBLE COATING OF PYROLYTIC CARBON AND SILICON CARBIDE. BLANKET, URANIUM DIOXIDE PEBBLES /AXIAL/ URANIUM DIOXIDE PINS /RADIAL/
FUEL GEOMETRY	PEBBLES RADIAL BLANKET, PINS
FUEL CLADDING	SLEEVE OF SS GAUZE AND INNER SLEEVE OF SILICON CARBIDE WITH MACHINED-IN ORIFICES, FORMING ANNULUS FOR FUEL PEBBLES. RADIAL BLANKET, THIN SS CANS.
FUEL ENRICH.	20 AND 26 PER CENT PLUTONIUM
FUEL ASSEMBLY	CORE IS A PEBBLE BED DISPOSED AS AN ANNULUS WITH COOLANT FLOWING RADIALLY FROM OUTER TO INNER SURFACE, THE ANNULAR CONTAINER BEING FORMED BY TWO CONCENTRIC SLEEVES. RADIAL BLANKET ASSEMBLIES ARE HEXAGONAL BUNDLES OF FUEL PINS HOUSED IN AN EGGCRATE STRUCTURE. EACH ASSEMBLY RECEIVES AN INDIVIDUAL COOLANT SUPPLY
FUEL CHARGE	1978 KG EQUIV. PLUTONIUM-239
BURNUP(REFUEL)	80,000 MWD/T OFF-LOAD, MONTHLY
CONTROL	RODS, BORON CARBIDE
COOLANT TEMP.	INLET 300 C OUTLET 1000 C
COOLANT PRESS.	750 PSI
REACTOR VESSEL	PRESTRESSED CONCRETE VESSEL

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF42

* * * * * * * * * * * * * * * * *

REFERENCES

A GAS-COOLED FAST REACTOR USING COATED PARTICLE FUEL.
CP GRATTON, OTHERS
J. BRITISH NUCLEAR ENERGY SOC. 7/3/, 233-42 /1968/

* * * * * * * * * * * * * * * * *

NAME/OWNER	KSH REACTOR/KSH, W. GERMANY GEESTACHT GAS TURBINE REACTOR
DESIGNER	GUTEHOFFNUNGSHUTTE STERKRADE AG /GHH/, W. GERMANY
OPERATOR	KERNKRAFTWERK SCHLESWIG-HOLSTEIN GMBH /KSH/
LOCATION	GEESTACHT-TESPERHUDE ON ELBE RIVER, W. GERMANY NEAR HAMBURG
PURPOSE	POWER PLUS DESALINATION OR DISTRICT HEATING
TYPE	GCR, HIGH TEMPERATURE, DIRECT CYCLE
POWER MWE(MWT)	25
CRITICAL	CONSTRUCTION TO START IN FALL 1969.
COOLANT	HELIUM
MODERATOR	GRAPHITE GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM-THORIUM PELLETS COATED WITH SILICON CARBIDE
FUEL GEOMETRY	TUBES
FUEL CLADDING	GRAPHITE TUBES 3.27 M LONG, 8.9 CM THICK
FUEL ASSEMBLY	ELEMENT CONSISTS OF A CYLINDRICAL GRAPHITE TUBE FILLED WITH FUEL PARTICLES AND A CENTRAL GRAPHITE ROD. 633 ELEMENTS/CORE
CONTROL	BORON CARBIDE RODS
REACTOR VESSEL	STEEL VESSEL 10 M LONG, 4 M ID, 85 MM THICK WALLS
CONTAINMENT	NO SAFETY CONTAINMENT
REMARKS	REACTOR TO BE COUPLED TO A HELIUM TURBINE. A 300 MWE DESIGN STUDY HAS BEEN DONE.
REFERENCES	THE GEESTACHT GAS TURBINE HTGR CLOSED CYCLE GAS TURBINE. NUCLEAR ENG. 12, 542 /JULY 1967/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF44

* * * * * * * * * * * * * * * * *

NAME/OWNER	THTR /THORIUM HIGH TEMP. REACTOR/ HKG, W. GERMANY
DESIGNER	BBC/KRUPP, W. GERMANY
OPERATOR	HOCHTEMPERATUR-KERNKRAFTWERK GESELLSCHAFT HKG
LOCATION	POSSIBLE SITES ARE HAGEN AND DORTMUND
PURPOSE	POWER PROTOTYPE
TYPE	GCR, HIGH TEMPERATURE, PEBBLE-BED
POWER MWE(MWT)	300
CRITICAL	CONSTRUCTION TARGET 1969, OPERATION 1974
COOLANT	HELIUM
MODERATOR	GRAPHITE. GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM AND THORIUM CARBIDE SPHERICAL PARTICLES
FUEL GEOMETRY	SPHERES /PEBBLES/
FUEL CLADDING	GRAPHITE SPHERES 6 CM. DIAM. CONTAINING FUEL SPHERES.
FUEL ENRICH.	92 PER CENT U-235
FUEL ASSEMBLY	CYLINDRICAL CAVITY WITH CONICAL BOTTOM IN A GRAPHITE AND CARBON STRUCTURE CONTAINS THE FUELED SPHERES. INITIAL CORE 650,000 SPHERES CORE IS 5.6 M. DIAM. AND 5.1 M. HIGH
BURNUP(REFUEL)	ON-LINE, CONTINUOUS
COOLANT TEMP.	INLET 262 C OUTLET 750 C
COOLANT PRESS.	40 ATM.
REACTOR VESSEL	PRESTRESSED CONCRETE
REMARKS	DESIGN WILL BE EXTRAPOLATED TO COMMERCIAL SCALE. THTR IS A DEVELOPMENT OF THE AVR JUELICH REACTOR. SEE DF37.
REFERENCES	THTR HIGH TEMPERATURE REACTOR PROTOTYPE. ENGINEER AUG. 11, 1967 P. 204-5

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF44

* * * * * * * * * * * * * * * * *

CONCEPTUAL DESIGN STUDY FOR A 1000 MWE HIGH
TEMPERATURE PEBBLE-BED REACTOR.
W KERSTING
NUCLEAR ENG. DESIGN 7, 345-66 /1968/

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF45

* * * * * * * * * * * * * * * * *

NAME/OWNER	SEATON-CAREW STATION/CEGB, GT. BRITAIN HARTLEPOOL STATION
DESIGNER	TENDERS INVITED
LOCATION	HARTLEPOOL, ENG. /N.E. COAST/
PURPOSE	POWER
TYPE	GCR, TWO-REACTOR STATION
POWER MWE(MWT)	625 PER REACTOR
CRITICAL	TARGET NO.1, 1973 NO.2, 1974
REACTOR VESSEL	PRESTRESSED CONCRETE
REMARKS	HAS BEEN APPROVED CONTRACT PLACED WITH BABCOCK ENGLISH ELECTRIC NUCLEAR LTD.

JANUARY 1969 BNWL-936

GAS COOLED REACTORS, FOREIGN DF46

* * * * * * * * * * * * * * * * *

NAME/OWNER	HUNTERSTON-B/S. SCOTLAND ELECTRICITY BOARD
DESIGNER	THE NUCLEAR POWER COMPANY, U.K. /NPC/
OPERATOR	SOUTH OF SCOTLAND ELECTRICITY BOARD
LOCATION	HUNTERSTON, SCOTLAND FIRTH OF CLYDE
TYPE	AGR /ADVANCE GCR/, TWO-REACTOR STATION
POWER MWE(MWT)	625 1500 PER REACTOR
CRITICAL	TARGET 1973
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	PIN 1039 MM LONG, 15.25 MM DIAM.
FUEL CLADDING	SS
FUEL ENRICH.	SLIGHT
FUEL ASSEMBLY	8 ELEMENTS/CHANNEL 308 FUEL CHANNELS
FUEL CHARGE	122.5 TONS URANIUM
BURNUP(REFUEL)	18,000 MWD/T ON-LOAD
REACTOR VESSEL	PRESTRESSED CONCRETE VESSEL FOR EACH REACTOR.
CONTAINMENT	SINGLE CONTAINMENT BUILDING
REMARKS	APPROVAL RECEIVED JULY 1967. CONTRACT AWARD OCT. 1967
REFERENCES	NEWS RELEASES
	HUNTERSTON-B NUCLEAR ENG. 12, 924-25 /DEC. 1967/

HEAVY WATER MODERATED REACTORS

DOMESTIC

* * * * * * * * * * * * * * * * *

NAME/OWNER	SSCR /SPECTRAL SHIFT CONTROLLED REACTOR//AEC-BAW
DESIGNER	BABCOCK AND WILCOX
PURPOSE	POWER PROTOTYPE
TYPE	PWR, SPECTRAL SHIFT REACTOR
POWER MWE(MWT)	330 1074
CRITICAL	REFERENCE DESIGN
COOLANT	HEAVY WATER - LIGHT WATER
MODERATOR	HEAVY WATER - LIGHT WATER
FUEL MATERIAL	URANIUM DIOXIDE POWDER, COMPACTED
FUEL GEOMETRY	RODS, SWAGED, CORE ACTIVE HEIGHT 107 IN.
FUEL CLADDING	ZIRCALOY-2 TUBES 0.025 IN. THICK, ALTERNATE SS.
FUEL ENRICH.	3.33 PER CENT U-235 AVERAGE
FUEL ASSEMBLY	ZONE LOADING, 220-ROD ASSEMBLY, 72 ASSEMBLIES 188-ROD ASSEMBLY WITH CENTRAL CONTROL-ROD BLADE, 25 ASSEMBLIES. 130-ROD, TRIANGULAR, PARTIAL ELEMENTS, 12 ASSEMBLIES TOTAL 109 FUEL ASSEMBLIES
FUEL CHARGE	40,325 KG. URANIUM
BURNUP(REFUEL)	16780 MWD/MTU 790-DAY INTERVALS
CONTROL	COMPOSITION OF COOLANT-MODERATOR MIXTURE, CONTROL AND POISON RODS.
COOLANT TEMP.	INLET 542F OUTLET 590F
COOLANT PRESS.	2140 PSIA
REACTOR VESSEL	STEEL CYLINDER 13 FT. OD./29 FT. HIGH, SS INNER CLAD.
CONTAINMENT	SPHERE, 125 FT. DIA.
REMARKS	VARIATIONS OF THE REFERENCE DESIGN INCLUDE CORE WITH SS CLADDING, NUCLEAR PLANTS OF 154-458 MWE

* * * * * * * * * * * * * * * * *

WITH ZIRCALOY-2 CLAD CORES, ALTERNATES USING SS CLADDING, AND A PLANT WITH A REACTOR CORE OF THORIUM OXIDE AND RECYCLED U-233 OXIDE CLAD IN ZIRCALOY. BURNS + ROE HAS STUDIED A DESALINIZATION-POWER PLANT FOR THE N.Y. ATOMIC RESEARCH AND DEVELOPMENT AUTHORITY WITH CONCENTRATION ON AN SSCR WITH THORIUM AS THE FERTILE FUEL. OTHER INTERESTS INCLUDE A PROPOSAL FOR A KEY WEST, FLORIDA, DESALINIZATION PLANT, LOS ANGELES DEPT. OF WATER AND POWER, AND SIERRA PACIFIC POWER, THE LATTER FOR A PLANT ON WALKER LAKE NEAR RENO, NEVADA.

REFERENCES

THORIUM AND URANIUM FUEL CYCLES FOR SPECTRAL SHIFT CONTROLLED PRESSURIZED WATER REACTORS.
GK RHODE, MC EDLUND
ANS THIRD ANNUAL MEETING, JUNE 1957
PAPER 4-1 /1957/

THE SPECTRAL SHIFT CONTROL REACTOR DESIGN AND ECONOMIC STUDY.
D MARS, D GANS, JR.
BAW-1241 /DECEMBER 1961/

THE SPECTRAL SHIFT CONTROL REACTOR /A VARIATION OF PWR/.
MC EDLUND
SMALL AND MEDIUM POWER REACTORS, VOL.1, P. 165-78
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1961.

SPECTRAL SHIFT CONTROL REACTOR.
J COUGHLIN
ASME PREPRINT 61-PWR-6 /1961/

SPECTRAL SHIFT REACTOR.
POWER REACTOR TECH. 5/4/, 81-6 /SEPTEMBER 1962/

WATER COOLED THORIUM REACTORS
HS BARRINGER
TID-7650 /P. 172-93/ /1962/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED02

* * * * * * * * * * * * * * * * *

NAME/OWNER	HWOCR /HEAVY WATER ORGANIC COOLED REACTOR/
DESIGNER	COMBUSTION ENGINEERING BABCOCK + WILCOX ATOMICS INTERNATIONAL
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED, ORGANIC COOLED, PRESSURE TUBE
POWER MWE(MWT)	500 1550
CRITICAL	DESIGN PROJECT HAS BEEN CANCELED.
COOLANT	ORGANIC LIQUID, SANTOWAX OMP
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE OR URANIUM METAL
FUEL GEOMETRY	ROD 0.513 IN. OD. /31 RODS/ AND 0.313 IN. /7 RODS/
FUEL CLADDING	SAP TUBE 0.010 AND 0.016 IN. THICK
FUEL ENRICH.	INITIAL 1.25 PER CENT U-235 OR NATURAL.
FUEL ASSEMBLY	37-ROD ASSEMBLY. 5 ELEMENTS/PRESSURE TUBE /STACKED/ 600 PRESSURE TUBES PRESSURE TUBES HAVE AN INNER LINER OF SAP, A GAS GAP, AND AN OUTER TUBE OF ZIRCALOY-2.
FUEL CHARGE	246,000 LBS. URANIUM DIOXIDE-98.7 TONS URANIUM
SPECIFIC POWER	15.7 MW/MTU IN ENRICHED FUEL DESIGN.
BURNUP(REFUEL)	20,000 MWD/MT NATURAL FUEL 5000 MWD/MT
COOLANT TEMP.	INLET 536F OUTLET 760F
COOLANT PRESS.	28.1 KG/SQ. CM.
REACTOR VESSEL	HEAVY WATER TANK, VERTICAL PRESSURE TUBES
CONTAINMENT	STEEL SPHERE
REMARKS	REFERENCE DESIGN HAS BEEN DEVELOPED FOR ECONOMIC

EVALUATION AND APPRAISAL. JOINT R+D WILL BE PERFORMED ON THE CONCEPT BY CE AND AI, WITH ASSISTANCE FROM DUPONT, UNDER AEC CONTRACT A PRELIMINARY CONCEPTUAL DESIGN FOR A 1000 MWE STATION HAS BEEN DONE BY CE AND AI.

REFERENCES

ORGANIC COOLED, HEAVY WATER MODERATED REACTOR POWER PLANT CONCEPTUAL DESIGN AND EVALUATION, VOL. II, REFERENCE PLANT DESIGN.
COMBUSTION ENG., NUCLEAR DIV.
CEND-175 /VOL. I AND II/ /MARCH 1963/

HEAVY WATER ORGANIC COOLED REACTOR 1000 MWE NUCLEAR POWER PLANT, PRELIMINARY CONCEPTUAL DESIGN.
VOL. 2, PLANT DESCRIPTION
COMBUSTION ENG., ATOMICS INTERNATIONAL

HEAVY WATER ORGANIC COOLED REACTOR, 500 MWE NUCLEAR DEMONSTRATION PLANT DESIGN.
ATOMICS INTERNATIONAL, COMBUSTION ENGINEERING
AI-CE-MEMO-25 /MARCH 29, 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HWCTR/HEAVY WATER COMPONENTS TEST REACTOR/AEC
DESIGNER	E.I. DUPONT DE NEMOURS AND CO. INC.
OPERATOR	E.I. DUPONT DE NEMOURS AND CO. INC.
LOCATION	SAVANNAH RIVER, GEORGIA
PURPOSE	FUEL ELEMENT TESTING, POWER REACTOR CONDITION
TYPE	HEAVY WATER COOLED AND MODERATED, PRESSURE VESSEL
POWER MWE(MWT)	0 60
CRITICAL	MARCH 1962. SHUT DOWN 1965
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	ZIRCONIUM-ORALLOY
FUEL GEOMETRY	TUBES 2.3 IN. OD./1.96 IN. ID./9FT. 5 IN. LONG TARGETS WITH BORON ALONG AXIS
FUEL CLADDING	ZIRCALOY-2 0.015 IN. THICK. ZIRCALOY-2 HOUSING TUBES
FUEL ENRICH.	93 PER CENT U-235 IN DRIVER TUBES
FUEL ASSEMBLY	DRIVER ELEMENTS /24/ ON OUTSIDE OF CORE, CENTER OCCUPIED BY ELEMENTS UNDER TEST. /36 POSITIONS AVAILABLE/. TEST ELEMENTS /1ST CHARGE/ ARE NATURAL U TUBES 2.06 IN. OD. AND 1.467 IN. ID. WITH 110 LB. NATURAL U/ELEMENT. /12 POSITIONS AVAILABLE/
BURNUP(REFUEL)	OPERATING LIFE 33 MONTHS
CONTROL	RODS, SS WITH BORON, GRAVITY DROP. /BURNABLE POISON-BORON/
COOLANT TEMP.	INLET 214C OUTLET 239C
COOLANT PRESS.	1000 PSI
REACTOR VESSEL	CARBON STEEL, SS LINED, CYLINDRICAL, REMOVABLE TOP
CONTAINMENT	PRESTRESSED REINFORCED CONCRETE /BELOW GRADE/ AND

* * * * * * * * * * * * * * * * *

CARBON STEEL /ABOVE GRADE/. CYLINDRICAL BUILDING 70 FT. DIA./125 FT. HIGH.

REMARKS

HEAVY WATER FLOW IS DOWN THE FUEL ASSEMBLIES, DISCHARGING AT THE BOTTOM OF THE FUEL HOUSINGS, THEN UPWARD THROUGH THE MODERATOR SPACE AND OUT NEAR THE TOP OF THE CORE. STEAM IS DISCHARGED TO TO THE ATMOSPHERE. PROVISION HAS BEEN MADE IN THE DESIGN FOR INSTALLATION OF ISOLATED COOLANT LOOPS FOR AS MANY AS 6 OF THE TEST FUEL POSITIONS, THE TWO CURRENTLY IN USE ARE FOR A LIQUID HEAVY WATER-COOLED ISOLATED LOOP, AND A BOILING HEAVY WATER-COOLED ISOLATED LOOP.
OPERATION WAS TERMINATED AFTER A 33-MONTH PERIOD. THE HWCTR HAS BEEN PLACED ON STAND-BY, AND WILL NOT BE FITTED FOR AN ORGANIC COOLANT.

REFERENCES

A PRELIMINARY EVALUATION OF GAS COOLING OF POWER REACTORS MODERATED BY HEAVY WATER.
RC HOLMES, OTHERS
DP-307 /AUGUST 1958/

HEAVY WATER COMPONENTS TEST REACTOR. SAVANNAH RIVER PLANT. PLANS AND ESTIMATE.
DP-412 /OCTOBER 1959/

HWCTR. THE SAVANNAH RIVER COMPONENTS TEST REACTOR.
NUCLEAR ENG. 5, 221-2 /MAY 1960/

FINAL HAZARDS EVALUATION OF THE HEAVY WATER CRITICAL TEST REACTOR /HWCTR/
LM ARNETT, OTHERS
DP-600 /DEC. 1962/

* * * * * * * * * * * * * * * * *

NAME/OWNER	HEAVY WATER REACTOR STUDY-1/DU PONT
DESIGNER	E. I. DUPONT DE NEMOURS AND CO., INC.
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED AND COOLED, COLD PRESSURE TUBE
POWER MWE(MWT)	491 1838
CRITICAL	STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE FUSED, COMPACTED, SWAGED WITH ZIRC-2 TUBES
FUEL GEOMETRY	COAXIAL TUBES /MASSIVE, FULL-LENGTH/ 3 CONCENTRIC
FUEL CLADDING	ZIRCALOY-2 0.02 IN. THICK. DIA. OF TUBES AT OUTER CLADDING 3.792 IN.
FUEL ENRICH.	1.19 PER CENT U-235
FUEL ASSEMBLY	FUEL BUNDLE /COAXIAL TUBES/ /15FT. LONG/ 226 FUEL POSITIONS
FUEL CHARGE	27.1 TONS URANIUM
SPECIFIC POWER	68 MW/MTU
BURNUP(REFUEL)	14,000 MWD/MTU SHUT-DOWN
CONTROL	RODS
COOLANT TEMP.	INLET 260C OUTLET 310C
COOLANT PRESS.	1730 PSIA
REMARKS	ECONOMIC STUDIES
REFERENCES	AN EVALUATION OF HEAVY WATER MODERATED POWER REACTOR DF BABCOCK, OTHERS. DP-830 /JUNE 1963/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED05

* * * * * * * * * * * * * * * * *

NAME/OWNER	HEAVY WATER REACTOR STUDY-2/DU PONT
DESIGNER	E. I. DUPONT DE NEMOURS AND CO., INC.
OPERATOR	STUDY
PURPOSE	SEA-WATER DISTILLATION
TYPE	HEAVY WATER MODERATED AND COOLED, VERTICAL PRESSURE TUBES
POWER MWE(MWT)	550 3500
CRITICAL	STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE COMPACTED SWAGED WITH ZIRC-2 TUBES
FUEL GEOMETRY	CONCENTRIC TUBES /COAXIAL TUBES/-3, DIA. OUTER CLAD TUBES 3.7 IN. OD.
FUEL CLADDING	ZIRCALOY-2
FUEL ENRICH.	1.2 PER CENT U-235
FUEL ASSEMBLY	3 COAXIAL TUBES 7 1/2 FT. LONG 420 ASSEMBLIES
FUEL CHARGE	APPROX. 63 TONS URANIUM
BURNUP(REFUEL)	15000 MWD/MTU INTERIM 1/3 REPLACEMENT
CONTROL	RODS, TOP-MOUNTED CONTROL, GRAVITY SAFETY
COOLANT TEMP.	320C
COOLANT PRESS.	1700 PSI
REACTOR VESSEL	SS TANK, WELDED-IN PRESSURE TUBES
CONTAINMENT	CONVENTIONAL LOW-LEAKAGE STEEL SHELL
REMARKS	PRIMARY COOLANT SYSTEM /8 LOOPS/, COOLANT DISTRIBUTION TO PRESSURE TUBES BY HEADERS AND PIG TAILS. ALL PRIMARY PIPING AND EQUIPMENT IS CARBON STEEL. STUDY IS FOR APPLICATION TO SEA-WATER DISTILLATION PLANT.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED05

* * * * * * * * * * * * * * * * *

REFERENCES

HEAVY WATER REACTORS FOR SEA-WATER DISTILLATION PLANTS.
DS ST.JOHN, OTHERS.
DP-866 /JAN. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER HEAVY WATER REACTOR STUDY-3/DU PONT

DESIGNER E. I. DUPONT DE NEMOURS AND CO., INC.

PURPOSE SEA WATER DISTILLATION-STUDY

TYPE HEAVY WATER MODERATED, ORGANIC COOLED, PRESSURE TUBES /COLD/

POWER MWE(MWT) 2660 8300

CRITICAL STUDY

COOLANT ORGANIC LIQUID

MODERATOR HEAVY WATER

FUEL MATERIAL URANIUM CARBIDE

FUEL GEOMETRY CONCENTRIC TUBES, 10 FT. LONG. OUTER TUBE, CLAD, 3.20 IN. DIA.

FUEL ASSEMBLY CONCENTRIC TUBES
1400 ASSEMBLIES

BURNUP(REFUEL) 8500 MWD/TON ON-LINE, 1 POSITION AT A TIME

CONTROL RODS

COOLANT TEMP. INLET 280C OUTLET 380C

COOLANT PRESS. 300 PSI

REACTOR VESSEL CALANDRIA, ALUMINUM TUBES, TUBE SHEET AND SHELL. AXIAL AND RADIAL THERMAL SHIELDS ARE ANNULAR CARBON STEEL TANKS.

CONTAINMENT CONVENTIONAL STEEL VESSEL, INNER CONCRETE SHADOW SHIELD.

REMARKS THE PRESSURE TUBES OF ZIRCONIUM-NIOBIUM ALLOY ARE LINED WITH A DIFFUSION BARRIER. AN 0.120-IN. ANNULUS OF INERT GAS IS PROVIDED BETWEEN THE PRESSURE TUBE AND THE CALANDRIA TUBE. IN THE OPTIMUM FUEL ASSEMBLY DESIGN, THERE MAY BE A SOLID CENTRAL ROD INSTEAD OF A SMALL DIA. TUBE. PROTOTYPE PLANT DESIGN IS ON 3500 MWT.

REFERENCES HEAVY WATER REACTORS FOR SEA WATER DISTILLATION PLANTS.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS. DOMESTIC ED06

* * * * * * * * * * * * * * * * *

DS ST.JOHN, OTHERS,
DP-866 /JAN. 1964/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED07

* * * * * * * * * * * * * * * * *

NAME/OWNER	HEAVY WATER REACTOR STUDY-4/DU PONT
DESIGNER	E. I. DUPONT DE NEMOURS AND CO., INC.
PURPOSE	POWER, U-233/THORIUM FUEL CYCLE.
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE
POWER MWE(MWT)	981
CRITICAL	STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	THORIUM METAL WITH 1.5 PER CENT U-233 AND THORIUM BLANKET
FUEL GEOMETRY	TUBES, BLANKET THORIUM SLUGS
FUEL ASSEMBLY	CONCENTRIC TUBES AND BLANKET SOLID ELEMENTS, 678 FUEL POSITIONS
FUEL CHARGE	103 TONS THORIUM + 1540 KG, U-233
CONTROL	RODS
COOLANT TEMP.	INLET 264C OUTLET 304C
COOLANT PRESS.	500 PSI A
REMARKS	U-233 THORIUM FUEL CYCLE STUDY, CONCEPT. FURTHER DEVELOPMENT IS PROPOSED TO THE AEC.
REFERENCES	THORIUM-FUELED HEAVY WATER MODERATED POWER REACTORS DF BABCOCK ET AL. DP-864 /1963/ HEAVY WATER REACTORS FOR BREEDING WITH THORIUM DS ST.JOHN, JW WADE NUCLEONICS 22,54-57 /SEPT. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PRTR /PLUTONIUM RECYCLE TEST REACTOR/ /AEC
DESIGNER	GENERAL ELECTRIC COMPANY
OPERATOR	PACIFIC NORTHWEST LAB., BATTELLE MEMORIAL INST.
LOCATION	HANFORD, RICHLAND, WASHINGTON COLUMBIA RIVER
PURPOSE	POWER, PLUTONIUM RECYCLE DEMONSTRATION
TYPE	HEAVY-WATER MODERATED AND COOLED, PRESSURE TUBE /CALANDRIA/
POWER MWE(MWT)	0 70
CRITICAL	DECEMBER 1960
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	FIRST CORE URANIUM DIOXIDE WITH PLUTONIUM-ALUMINUM SPIKE ASSEMBLIES. LATER, UNIFORM LOADING WITH PLUTONIUM/URANIUM DIOXIDE.
FUEL GEOMETRY	RODS 0.504 IN. DIA./7 FT. 4 IN. LONG. MARK 2 CONCENTRIC TUBES.
FUEL CLADDING	ZIRCALOY-2 0.030 IN. THICK
FUEL ASSEMBLY	19-ROD ASSEMBLIES, 85 PROCESS TUBES. CORE 1, 52 URANIUM DIOXIDE ASSEMBLIES 33 SPIKE ELEMENTS 1963, 44 URANIUM/PLUTONIUM OXIDE ELEMENTS 22 ALUMINUM-PLUTONIUM /TEST/ AND 19 URANIUM DIOXIDE /TEST/ ELEMENTS.
SPECIFIC POWER	15 KW/KG URANIUM DIOXIDE
BURNUP(REFUEL)	URANIUM DIOXIDE ELEMENTS 5000-8000 MWD/T PLUTONIUM-ALUMINUM ELEMENTS 50 PER CENT
NEUTRON FLUX	THERMAL AVE. 8.3X10 E+13 /RADIAL/ FAST AVE. 2.7X10 E+13 /RADIAL
CONTROL	MODERATER LEVEL, SHIM CONTROL BY ABSORBER ELEMENTS
COOLANT TEMP.	INLET 478F OUTLET 530F
COOLANT PRESS.	1050 PSIG

* * * * * * * * * * * * * * * * *

REACTOR VESSEL	ALUMINUM CALANDRIA TANK CONTAINING THE MODERATOR WITH FUEL CHANNELS AND PROCESS TUBES MOUNTED VERTICALLY. PROCESS TUBES ARE ZIRCALOY-2 WITH GAS-GAP THERMAL INSULATIONS.
CONTAINMENT	ALL-WELDED STEEL CYLINDER, HEMISPHERICAL TOP, 80 FT. DIA. AND 120 FT. HIGH
REMARKS	THERE ARE 85 FUEL CHANNELS, VERTICALLY MOUNTED WITHIN THE CALANDRIA. THE INNER PROCESS TUBE IS OF ZIRCALOY-2 AND CONTAINS THE FUEL ELEMENTS. INITIAL LOADING CONTAINED TWO TYPES OF ELEMENTS. THE MARK I ELEMENT IS A 19-ROD CLUSTER ASSEMBLY. THE MARK II ELEMENT IS COMPOSED OF A ROD SURROUNDED BY TWO CONCENTRIC ANNULAR RINGS IN ZIRCALOY-2 CLADDING. HEAVY WATER FLOWS VERTICALLY UPWARD WITHIN THE PROCESS TUBES. SHUTDOWN IN JUNE 1962 FOR REFUELING.

REFERENCES

THE PLUTONIUM RECYCLE PROGRAM, A RESUME OF THE CONCEPT, PROGRAM, AND FACILITIES.
HANFORD ATOMIC PROD. OPN.
HW-50700 /JUNE 12, 1957/

THE PLUTONIUM RECYCLE TEST REACTOR FINAL SAFEGUARDS ANALYSIS.
NG WITTENBROCK, OTHERS
HW-61236 /OCTOBER 1959/

THE PLUTONIUM RECYCLE TEST REACTOR.
POWER REACTOR TECHNOLOGY 3,53-57 /JUNE 1960/

MEASURED PHYSICS PARAMETERS, DESIGN FEATURES, AND OPERATING CHARACTERISTICS OF PRTR.
JR TRIPLETT, RE PETERSON
POWER REACTOR EXPERIMENTS VOL. 2, PP. 213-26
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED09

* * * * * * * * * * * * * * * * * * *

NAME/OWNER	PHWR STUDY/GNEC-AEPSC
DESIGNER	GENERAL NUCLEAR ENGINEERING CORPORATION
PURPOSE	STUDY
TYPE	HEAVY WATER MODERATED, VERTICAL PRESSURE TUBE /COLD/
POWER MWE(MWT)	489 1850
CRITICAL	STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.23 IN. ID. AND 0.500 IN. OD.
FUEL GEOMETRY	HOLLOW RODS
FUEL CLADDING	ZIRCONIUM-NIOBIUM ALLOY 0.015 IN. THICK
FUEL ENRICH.	1.43 PER CENT U-235
FUEL ASSEMBLY	19-ROD BUNDLE, 4.5 FT. LONG, 4 BUNDLES ARE STACKED END TO END IN EACH OF THE 560 ZIRCONIUM-NIOBIUM PRESSURE TUBES. 560 FUEL POSITIONS
FUEL CHARGE	51.4 METRIC TONS URANIUM
SPECIFIC POWER	35.5 MW/TON U
BURNUP(REFUEL)	19,700 MWD/MTU /ON-LINE REFUELING/
CONTROL	BALL COLUMNS, HYDRAULICALLY ACTUATED BORON SS
COOLANT TEMP.	INLET 257 C OUTLET 302 C
COOLANT PRESS.	1760 PSIA
REACTOR VESSEL	SS 22 FT. 4 IN. DIA./21 FT. HIGH HEAVY WATER TANK, 1.25 IN. WALL THICKNESS.
CONTAINMENT	SPHERICAL STEEL SHELL, 165 FT. DIA.
REMARKS	STUDY MADE FOR ECNG
REFERENCES	HEAVY WATER MODERATED REACTORS EVALUATION STUDY.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED09

* * * * * * * * * * * * * * * * *

AMERICAN ELECTRIC POWER SERVICE CORP. AND GENERAL
NUCLEAR ENGINEERING CORP., EAST CENTRAL NUCLEAR
GROUP INC.
NP-12344 /OCT. 15,1962. VOL. 1,2 AND 3.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED10

* * * * * * * * * * * * * * * * *

NAME/OWNER	BHWR STUDY/GNEC-AEPSC
DESIGNER	GENERAL NUCLEAR ENGINEERING CORPORATION
PURPOSE	POWER
TYPE	HEAVY WATER COOLED AND MODERATED, BWR, PRESSURE TUBE
POWER MWE(MWT)	1697
CRITICAL	STUDY
COOLANT	BOILING HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, CORED, CYLINDRICAL, 0.50 IN. OD./0.20 IN. ID.
FUEL GEOMETRY	ROD
FUEL CLADDING	ZIRCONIUM-NIOBIUM TUBES, 0.015 IN. WALL THICKNESS
FUEL ENRICH.	1.352 PER CENT U-235
FUEL ASSEMBLY	19-ROD BUNDLES, 4 BUNDLES /ACT, LENGTH 18 FT./ IN EACH ZIRCONIUM-NIOBIUM ALLOY PRESSURE TUBE 700 PRESSURE TUBES IN CORE
FUEL CHARGE	77.5 TONS URANIUM DIOXIDE
SPECIFIC POWER	24.8 MW/TON U
BURNUP(REFUEL)	19,620 MWD/MTU /ON-POWER, FUEL SHUFFLING/
CONTROL	HY-BALL COLUMNS
COOLANT PRESS.	1100 PSIA
REACTOR VESSEL	24-FT. DIA. VESSEL, PENETRATED BY PRESSURE TUBES, /STAINLESS STEEL/
CONTAINMENT	SPHERICAL STEEL SHELL, 160 FT. DIA.
REMARKS	STUDY FOR ECNG. CORE CONSISTS OF 700 PRESSURE TUBES SURROUNDED BY MODERATOR, THE HOT BOILING COOLANT IS INSULATED FROM THE MODERATOR AND PRESSURE TUBE BY 4 ANNULI OF STAGNANT HEAVY WATER LOCATED INSIDE THE PRESSURE TUBE BETWEEN THE FUEL

* * * * * * * * * * * * * * * * *

BUNDLE AND THE TUBE.

REFERENCES HEAVY WATER MODERATED REACTORS EVALUATION STUDY.
AMERICAN ELECTRIC POWER SERVICE CORP., GENERAL
NUCLEAR ENG. CORP.
NP-12344 /OCT. 15, 1962/ VOL. 1,2 AND 3.

* * * * * * * * * * * * * * * * *

NAME/OWNER	HEAVY WATER REACTOR STUDY/ORNL BOILING LIGHT WATER COOLED
DESIGNER	OAK RIDGE NATIONAL LABORATORY
PURPOSE	POWER AND WATER DESALINIZATION
TYPE	HEAVY WATER MODERATED, LIGHT WATER COOLED, VERTICAL PRESSURE TUBE /CALANDRIA/.
POWER MWE(MWT)	8333
CRITICAL	REFERENCE DESIGN
COOLANT	BOILING LIGHT WATER
MODERATOR	HEAVY WATER, GRAPHITE REFLECTOR.
FUEL MATERIAL	URANIUM DIOXIDE, VIBRATORY COMPACTED RINGS ABOUT 0.6 IN. THICK
FUEL GEOMETRY	2 CONCENTRIC TUBES 4.326 IN. OD./72 IN. LONG
FUEL CLADDING	ZIRCALOY-2 0.020 IN. THICK
FUEL ASSEMBLY	STRING OF ELEMENTS IN EACH TUBE, ACTIVE CORE LENGTH 28.5 FT. 1308 PRESSURE TUBES
FUEL CHARGE	747 TONS URANIUM
BURNUP(REFUEL)	7000 MWD/MTU FUEL SHUFFLING 10 ELEMENTS/DAY
COOLANT TEMP.	INLET 464 F OUTLET 486 F
COOLANT PRESS.	INLET 720 PSIA OUTLET 620 PSIA
REACTOR VESSEL	CUBICAL ALUMINUM-CLAD STEEL CALANDRIA VESSEL, 34 FT. ON SIDE, CONTAINING COLD MODERATOR AND GRAPHITE REFLECTOR. ALUMINUM CALANDRIA TUBES, GAS-GAP INSULATION FROM PRESSURE TUBES.
CONTAINMENT	SEPARATE CYLINDRICAL BUILDING FOR EACH REACTOR OF A COMPLEX STATION. DOUBLE CONTAINMENT, WITH ZONE BETWEEN THE TWO BARRIERS AT A NEGATIVE PRESSURE.
REMARKS	REFERENCE DESIGN PREPARED FOR A DUAL PURPOSE FACILITY USING THREE 8333 MWT REACTORS AND PRODUCING 2-BILLION GAL. WATER/DAY. PLANT DESIGNS WERE PREPARED FOR ORNL BY SARGENT AND LUNDY FOR A

* * * * * * * * * * * * * * * * *

25000 MWT STATION AND A 3500 MWT REACTOR.

REFERENCES

A LARGE DESALINIZATION REACTOR BASED ON CURRENT TECHNOLOGY.
I SPIEWAK
NUCLEONICS 21, 64, 66, 68 /JULY 1963/

SALINE WATER CONVERSION POWER REACTOR PLANTS
SARGENT AND LUNDY /FOR OAK RIDGE NATIONAL LABORATORY/
SL-1998 /JANUARY 11, 1963/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PARR SHOALS PLANT / CVNPA CVTR, CAROLINAS-VIRGINIA TUBE REACTOR
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
OPERATOR	CAROLINAS-VIRGINIA NUCLEAR ASSOCIATES /CVNA/
LOCATION	PARR SHOALS, S. C.
PURPOSE	POWER DEMONSTRATION, PROTOTYPE
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE /U-TUBE/
POWER MWE(MWT)	17 56
CRITICAL	MARCH 1963 CLOSED DOWN IN FALL OF 1967
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.43 IN. DIA./0.636 IN. LONG /OUTER ZONE/ AND 0.53 IN. /INNER/
FUEL GEOMETRY	RODS, ACTIVE LENGTH 95.4 IN.
FUEL CLADDING	ZIRCALOY-4 0.0215 IN. THICK + ZIRCALOY-4 WIRE WRAPPING
FUEL ENRICH.	OUTER ZONE, 2.0 PER CENT U-235 INNER ZONE, 1.5 PER CENT U-235
FUEL ASSEMBLY	19-ROD BUNDLE /HEX-COOLANT-FLOW BAFFLE AROUND BUNDLE/ 72 FUEL ASSEMBLIES /1 ASSEMBLY IN EACH END OF U-TUBE/ 36 PRESSURE TUBES /ZIRCALOY-4 INSIDE CORE, SS OUTSIDE/
FUEL CHARGE	3280 KG. URANIUM
BURNUP(REFUEL)	8404 MWD/TON U /INITIAL CORE AVE./ CYCLIC REFUELING
CONTROL	RODS, BORON-SS AND SS
COOLANT TEMP.	INLET 505 F OUTLET 541 F
COOLANT PRESS.	1500 PSIA

* * * * * * * * * * * * * * * * *

REACTOR VESSEL SS MODERATOR TANK WITH HEAVY WATER, UPRIGHT CYLINDER.

CONTAINMENT RIGHT VERTICAL CYLINDER, FLAT BASE, HEMISPHERICAL DOME, STEEL-LINED REINFORCED CONCRETE, 58 FT. ID. AND 114 FT. HIGH

REMARKS COLD TUBE DESIGN, IN WHICH THE PRESSURE TUBE IS INSULATED FROM THE HIGH TEMPERATURE CIRCULATING FLUID. PHYSICS TESTS, MAINTENANCE SHUT-DOWN IN JUNE-JULY 1964, POSSIBLE POWER PRODUCTION TARGET JULY 1964. A LARGE PLANT DESIGN HAS BEEN DEVELOPED.

REFERENCES

CAROLINAS-VIRGINIA TUBE REACTOR REFERENCE DESIGN II WESTINGHOUSE ELECTRIC CORP., STONE + WEBSTER ENG. CORP.
CVNA-40 /DECEMBER 16, 1959/

CVTR-PRESSURE-TUBE REACTOR.
PG DEHUFF
WESTINGHOUSE ENGR. 31, 98-102 /JULY 1961/

CAROLINAS-VIRGINIA NUCLEAR POWER ASSOCIATES.
FINAL HAZARDS SUMMARY REPORT. PART B. LICENSE APPLICATION.
CVNA-90 /1962/

CAROLINAS-VIRGINIA PRESSURE TUBE REACTOR.
NUCLEAR ENERGY, PP. 424-7, NOVEMBER 1962

DESIGN PRACTICE. THE CAROLINAS-VIRGINIA TUBE REACTOR.
POWER REACTOR TECH. 6, 63-81 /FALL 1963/

THE CAROLINAS-VIRGINIA TUBE REACTOR.
NUCLEONICS 23, 50-51 /MAY 1965/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, DOMESTIC ED13
* * * * * * * * * * * * * * * * *

NAME/OWNER	CVNA REACTOR/WEST-CAROLINAS-VIRGINIA NUCLEAR ASSOC CVNA
DESIGNER	WESTINGHOUSE ELECTRIC CORPORATION
PURPOSE	DESIGN STUDY, POWER
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE, COLD TUBE U-TUBE
POWER MWE(MWT)	300 1136 AS IN CASE IV
CRITICAL	DESIGN
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.5 IN. DIA.
FUEL GEOMETRY	RODS, 0.54 IN. OD. BY 16.03 FT. ACTIVE LENGTH
FUEL CLADDING	ZIRCALOY
FUEL ENRICH.	SEE REMARKS
FUEL ASSEMBLY	37-ROD CLUSTER /SEE REMARKS/, 5 ELEMENTS PER PRESSURE TUBE 384 PRESSURE TUBES IN REACTOR
SPECIFIC POWER	14.8 MWT/MTU
COOLANT TEMP.	INLET 488 F OUTLET 570.8 F
COOLANT PRESS.	1480 PSIA
REACTOR VESSEL	SS MODERATOR TANK, VERTICAL CYLINDER.
REMARKS	FOUR CASES WERE STUDIED. CASE 1, USING NATURAL URANIUM DIOXIDE FUEL IN 19-ROD CLUSTERS. CASE 2, ENRICHED URANIUM DIOXIDE IN 19-ROD CLUSTERS. CASE 3, NATURAL FUEL IN 37-ROD CLUSTERS. AND CASE 4, ENRICHED FUEL IN 37-ROD CLUSTERS. PRIMARY SYSTEM PRESSURE IS 1000 PSIA FOR THE NATURAL URANIUM SYSTEMS, TO MINIMIZE THE WALL THICKNESS OF THE PRESSURE TUBES AND FUEL-ROD CLADDING
REFERENCES	CAROLINAS-VIRGINIA TUBE REACTOR, LARGE PLANT STUDY WESTINGHOUSE ELEC. CORP. RG MC GRATH, ED.

CVNA-184 /JUNE 1963/

HEAVY WATER REACTORS. LARGE PLANT STUDIES.
POWER REACTOR TECHNOLOGY 7, 401-6 /FALL 1964/

HEAVY WATER MODERATED REACTORS

FOREIGN

* * * * * * * * * * * * * * * * *

NAME/OWNER	NPD-2/AECL, ONTARIO HYDRO, CANADA NUCLEAR POWER DEMONSTRATION-2
DESIGNER	CGE-CANADA
OPERATOR	ONTARIO HYDRO
LOCATION	DES JOACHIMS, ONTARIO, CANADA OTTAWA RIVER
PURPOSE	POWER DEMONSTRATION
TYPE	HEAVY WATER MODERATED AND COOLED, HORIZONTAL TO BE CONVERTED TO BOILING HEAVY WATER IN 1968
POWER MWE(MWT)	20 83
CRITICAL	APRIL 1962
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 2.38 CM. DIA./2.11 CM. LONG
FUEL GEOMETRY	ROD 0.6 IN. DIAM. 19.5 IN. LONG
FUEL CLADDING	ZIRCALOY-2 TUBES 0.015 IN. WALL THICKNESS.
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	7-ROD BUNDLE, WIRE-WRAP SPACING 9 BUNDLES/CHANNEL 132 CHANNELS
FUEL CHARGE	15,000 KG. URANIUM
SPECIFIC POWER	5.55 KW/KG. URANIUM
BURNUP(REFUEL)	5400 MWD/T
NEUTRON FLUX	THERMAL AVE. 2.6X10 E+13 FAST AVE. 1.6X10 E+13
CONTROL	1 BOOSTER ROD. ADJUSTABLE MODERATOR LEVEL.
COOLANT TEMP.	INLET 530 F OUTLET 485 F WITH BOILING SYSTEM, 520 AND 476 F
COOLANT PRESS.	INLET 78 KG/SQ.CM. OUTLET 72 KG/SQ.CM.

* * * * * * * * * * * * * * * * *

WITH BOILING SYSTEM, PRESSURE IS REDUCED

REACTOR VESSEL CALANDRIA /TUBE-IN-SHELL SYSTEM/. CALANDRIA TUBES ARE ALUMINUM, PRESSURE TUBES ARE ZIRCALOY-2. HORIZONTAL CYLINDER, ALUMINUM, DOUBLE-WALLED.

CONTAINMENT REACTOR VAULT, CONCRETE

REMARKS A 68 MWE REACTOR HAS ALSO BEEN STUDIED. A DESIGN FOR AN OFF-THE-SHELF CONCEPT, HWR-80, HAS BEEN MADE.
NPD WAS SHUT DOWN IN MARCH 1968 FOR CONVERSION TO AN EXPERIMENTAL BOILING SYSTEM. FUEL AND STEAM CONDITIONS ARE UNCHANGED.

REFERENCES

THE CANADIAN NPD-2 POWER STATION.
IN MACKAY
SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 8, 313-21 /1958/

DESIGN OF NPD AND CANDU
IL WILSON
AECL-799 /PAPER NO. 11/ /1959/

NPD ON THE LINE. REACTOR FILE NO. 13.
NUCLEONICS 20. /FACING P. 46/ /NOVEMBER 1962/

NPD-2, CANADA-S PROTOTYPE POWER REACTOR.
A WYATT
NUCLEAR ENERGY, MAY 1962, PP. 192-201

UPRATED NPD OR HWR-80
JL OLSEN
AECL-1599 /PP. 43-53/ /SEPTEMBER 1962/

HEAVY WATER MODERATED NATURAL URANIUM POWER REACTORS.
JL GRAY, OTHERS
AECL-1646 /OCTOBER 1962/

HWR- OFF-THE-SHELF DESIGN FOR NUCLEAR POWER.
DAB CHASE
CANADIAN NUCLEAR TECHNOLOGY 1 /6/, 31-8 /1962/

NUCLEAR POWER DEMONSTRATION GENERATING STATION. FINAL HAZARDS REPORT.
CANADIAN GENERAL ELECTRIC CO.
AECL-1813 /AUG. 1963/

HEAVY WATER REACTOR WILL BOIL

HEAVY WATER MODERATED REACTORS, FOREIGN EF01

* * * * * * * * * * * * * * * * *

A WILLAIMS
POWER ENG, 72, 78-80 /NOV, 1968/

HEAVY WATER MODERATED REACTORS, FOREIGN EF02

* * * * * * * * * * * * * * * * *

NAME/OWNER	ONTARIO HYDRO/ONTARIO HYDRO, AECL, CANADA PICKERING NUCLEAR GENERATING STATION
DESIGNER	AECL AND ONTARIO-HYDRO, CANADA
OPERATOR	HYDROELECTRIC POWER COMM. OF ONTARIO /ONTARIO-HYD/
LOCATION	FAIRPORT, LAKE ONTARIO, CANADA
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED AND COOLED, HORIZONTAL PRESSURE TUBE, HOT, 2-REACTOR STATION
POWER MWE(MWT)	508 1742 /PER REACTOR/ TWO-REACTOR STATION
CRITICAL	NO.1 TARGET 1971 NO.2 TARGET 1972 PLANT HAS BEEN DELAYED ABOUT A YEAR BY STRIKES AND EQUIPMENT PROCUREMENT PROBLEMS. PICKERING 3 AND 4 HAVE BEEN AUTHORIZED
COOLANT	HEAVY WATER PRESSURIZED
MODERATOR	HEAVY WATER, COLD, HEAVY WATER REFLECTOR
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS 0.6 IN. DIA. OVER CLAD
FUEL CLADDING	ZIRCALOY TUBES 0.41 MM. WALL THICKNESS
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	28-ROD BUNDLE 12 BUNDLES/CHANNEL 390 CHANNELS
FUEL CHARGE	105 TONS URANIUM DIOXIDE
SPECIFIC POWER	18.8 KW/KG
BURNUP(REFUEL)	8000 MWD/T
NEUTRON FLUX	THERMAL MAX. 1X10 E+14
CONTROL	RODS
COOLANT TEMP.	INLET 249 C OUTLET 293 C

* * * * * * * * * * * * * * * * *

COOLANT PRESS.	1285 PSIA
REACTOR VESSEL	HORIZONTAL SS CALANDRIA WITH ZIRCALOY TUBES ROLLED INTO SS END FITTINGS. COOLANT TUBE BORE IS 10 CM.
CONTAINMENT	VERTICAL REINFORCED CONCRETE CYLINDER, ELLIPSOID DOME, ELASTOMER LINER. CALANDRIA VAULT. PRESSURE-RELEASE SYSTEM. INDIVIDUAL BUILDINGS WILL HOUSE THE TWO REACTORS. THE CONTAINMENT SYSTEM DEPENDS ON PRESSURE REDUCTION BY MEANS OF A LARGE VACUUM BUILDING, TO WHICH ALL REACTORS ARE CONNECTED BY DUCTWORK. THE BUILDING WILL BE PERMANENTLY EXHAUSTED TO 1 PSIA. A TANK CONTAINING 350,000 CU. FT. WATER AT TOP OF THE VACUUM BUILDING WILL PROVIDE A DOUSING SPRAY IF THE PRESSURE RISES ABOVE 6.2 PSIA
REMARKS	ZIRCONIUM-NIOBIUM ALLOY MAY BE USED FOR PRESSURE TUBES. COOLANT TUBE ID. WILL BE INCREASED FROM 8.26 CM /DOUGLAS PT/ TO ABOUT 10 CM AND NO. OF TUBES REDUCED BY ABOUT 1/3. AN ALTERNATE 22-ROD BUNDLE MAY BE DEVELOPED FOR LATER LOADINGS.

REFERENCES

POWER REACTOR DEVELOPMENT EVALUATION. A SUMMARY REPORT BY A COMMITTEE OF AECL STAFF. AECL-1730 /MAY 1,1963/

STUDIES OF CANDU-TYPE REACTORS IN THE 500 MWE RANGE.
IL WILSON, CE BEYNON, OTHERS
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964. A/CONF.28/P/6

DESIGN PARAMETERS FOR 500 MW CANDU REACTOR.
IL WILSON, CE BEYNON, OTHERS
CANADIAN NUCLEAR TECHNOLOGY 3/4/,38-42 /FALL 1964/

THE PICKERING NUCLEAR GENERATING STATION
CE BEYNON
AECL-2214 /APRIL 1965/

HEALTH PHYSICS MAY 1966 P. 725-6
NEWS NOTE

PROGRESS REPORT ON THE PICKERING GENERATING STATION
WG MORRISON
AECL-2558 /AUG. 1966/

* * * * * * * * * * * * * * * * *

MULTI-UNIT ASPECTS OF THE PICKERING GENERATING STATION.
WG MORISON
HEAVY WATER POWER REACTORS, PROC. SYMPOSIUM, VIENNA, SEPT. 1967 P. 267-84
IAEA, VIENNA, 1968

* * * * * * * * * * * * * * * * *

NAME/OWNER	CANDU/AECL, CANADA DOUGLAS POINT
DESIGNER	AECL, ONTARIO-HYDRO, CANADA
OPERATOR	HYDROELECTRIC POWER COMM. OF ONTARIO /ONTARIO-HYD/
LOCATION	DOUGLAS POINT, LAKE HURON, ONTARIO, CANADA
PURPOSE	POWER AND COBALT-60 PRODUCTION.
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE /HORIZONTAL/, CALANDRIA
POWER MWE(MWT)	220 688
CRITICAL	OCT. 1966, FULL POWER JAN. 1967
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 14.24 MM.DIA./20 MM. LONG 24 PER ROD.
FUEL GEOMETRY	ROD 0.6 IN. DIA. OVERCLAD, 19.5 IN. LONG
FUEL CLADDING	ZIRCALOY-2 TUBES 0.017 IN. THICK, 0.6 IN. OD
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	19-ROD BUNDLES. 12 BUNDLES/FUEL CHANNEL 306 FUEL CHANNELS 3091 FUEL BUNDLES IN 2 FUEL ZONES
FUEL CHARGE	42,000 KG NATURAL U
SPECIFIC POWER	15.8 KW/KG NATURAL U
BURNUP(REFUEL)	8400 MWD/TU 5 BUNDLES/DAY ON-LOAD
NEUTRON FLUX	THERMAL AVE. 1.8 E+14 FAST AVE. 1.6 E+14
CONTROL	REGULATING AND BOOSTER RODS. CHANGE IN MODERATOR LEVEL, CHEMICAL SHIM
COOLANT TEMP.	INLET 480 F OUTLET 560 F

* * * * * * * * * * * * * * * * *

COOLANT PRESS. INLET 1480 PSI OUTLET 1310 PSI

REACTOR VESSEL CALANDRIA, A HORIZONTAL SS CYLINDER 19 FT. 8 IN. ID, 16 FT. 8 IN. LONG. WALL THICKNESS 1 IN. PRESSURE TUBES ARE ZIRCALOY-2, 306 TUBES PASSING THROUGH THE CALANDRIA.

CONTAINMENT STEEL AND CONCRETE VAULT.
REACTOR BUILDING A CONCRETE CYLINDER WITH HEMISPH. DOME OF 0.5 IN. STEEL. BUILDING IS 130 FT. ID, 140 FT. HIGH, CONCRETE WALLS 4 FT. THICK. ELASTOMER LINER

REMARKS COOLANT FLOW IS IN OPPOSITE DIRECTIONS IN ADJACENT TUBES. BOILING CORES FOR THE CANDU CONCEPT HAVE ALSO BEEN STUDIED, AS WELL AS A REACTOR OF INTERMEDIATE SIZE. ONTARIO HYDRO IS CONSIDERING A COMPLEX OF FOUR 450 MWE CANDU-TYPE REACTORS, WITH PRESSURE-SUPPRESSION SYSTEM.
PRODUCED A PRACTICAL DESIGN FOR AN 1800 MW NUCLEAR POWER PLANT, HWR-1800, BASED ON CANDU.
FOUR OF THE 306 FUEL CHANNELS HAVE BEEN LOADED WITH COBALT TOWARD THE SUPPLY OF INDUSTRIAL-GRADE COBALT-60.

REFERENCES

BASIC CONSIDERATIONS IN THE DESIGN OF A FULL SCALE HEAVY WATER AND NATURAL URANIUM POWER REACTOR.
WB LEWIS
AECL-785 /MARCH 28, 1959/

STATUS REPORT ON THE DOUGLAS POINT PROJECT.
DLS BATE
AECL-1599 /P. 54-68/ /SEPTEMBER 1962/

HEAVY WATER MODERATED NATURAL URANIUM POWER REACTORS.
JL GRAY, OTHERS
AECL-1646 /OCTOBER 1962/

DOUGLAS POINT NUCLEAR GENERATING STATION.
ATOMIC ENERGY OF CANADA LTD.
AECL-1596 /OCTOBER 1962/

DESIGN AND COST ESTIMATE OF A MULTIPLE UNIT HEAVY WATER MODERATED AND COOLED NUCLEAR POWER PLANT.
NL WILLIAMS /CANADIAN GENERAL ELECTRIC CO., LTD./
CANADIAN NUCLEAR ASSOCIATION-INTERNATIONAL

* * * * * * * * * * * * * * * * *

CONFERENCE, MONTREAL, MAY 1963
NUCLEAR ENG. 8, 343 /SEPTEMBER 1963/ ABSTRACT

DOUGLAS POINT. THE CANDU REACTOR.
CE BEYNON
AECL-1807 /P. 25-30/ /1963/

THE WORLD-S REACTORS NO. 37 CANDU /DOUGLAS POINT/
NUCLEAR ENG. 9, 289-294 /+INSET/ /AUG. 1964/

DOUGLAS POINT, A PRE-CRITICAL REPORT.
CANADIAN NUCLEAR TECH. 5, 19-33 /SEPT-OCT. 1966/

DOUGLAS POINT.
ENGINEERING 203, 255-9 /FEB. 17, 1967/

DOUGLAS POINT. FACT SHEET CANDU-PHW-200.
DOUGLAS POINT NUCLEAR POWER STATION.
CANADIAN NUCLEAR TECHNOLOGY NOV-DEC 1967 P. 30-33

* * * * * * * * * * * * * * * * *

NAME/OWNER	WR-1 /WHITESHELL REACTOR-1/AECL, CANADA
DESIGNER	CANADIAN GENERAL ELECTRIC CO.
OPERATOR	AECL
LOCATION	WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT, PINAWA, MANITOBA, CANADA
PURPOSE	ENGINEERING TEST REACTOR, REACTOR FUELS AND MATERIALS
TYPE	HEAVY WATER MODERATED, ORGANIC COOLED, PRESSURE TUBE /CALANDRIA/
POWER MWE(MWT)	40-60
CRITICAL	NOV. 1965
COOLANT	TERPHENYL
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	ROD TYPE 1, LENGTH 75.1 CM. TYPE 2, LENGTH 42.84 CM.
FUEL CLADDING	TYPE 1, SAP 1.43 CM. ID. TYPE 2, ZIRCONIUM-NIOBIUM ALLOY 1.384 CM. ID.
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	TYPE 1, 18-ELEMENT BUNDLE 3 BUNDLES/CHANNEL TYPE 2, 18-ELEMENT BUNDLE 5 BUNDLES/CHANNEL
BURNUP(REFUEL)	AVE. 5000 MWD/T OFF-POWER
NEUTRON FLUX	THERMAL AVE. 5.59 E+13
CONTROL	PRIMARILY BY VARIATION IN MODERATOR LEVEL AND TEMPERATURE.
COOLANT TEMP.	INLET 640 F OUTLET 700 F
COOLANT PRESS.	OUTLET 165 PSI
REACTOR VESSEL	VERTICAL SS CALANDRIA, 5 M. HIGH, 2.7 M. ID,

* * * * * * * * * * * * * * * * * *

WALL 1.27 CM. THICK.

CONTAINMENT NO CONTAINMENT. STEEL AND CONCRETE SHIELDING.

REMARKS THE OCDRE PROJECT WAS DROPPED IN FAVOR OF AN ORGANIC TEST REACTOR, THE WR-1
CANADIAN GE HAS PROPOSED A DESIGN FOR THE HEAVY WATER MODERATED, ORGANIC COOLED PROTOTYPE FOR JEN -SPAIN- DON. THE 106.5 MWT REACTOR CONSISTS OF A CALANDRIA, 132 FUEL CHANNELS, CENTRAL TEST CHANNEL, SHUT-DOWN SHIELDS, AND A TOP ROTATING DECK PLATE.

REFERENCES

THE OCDRE PROGRAM.
WM CAMPBELL
AECL-945 /OCTOBER 1959/

THE ORGANIC-COOLED HEAVY-WATER MODERATED REACTOR SYSTEM.
KH CAMPBELL
AECL-1807 /P. 68-73/ /1963/

WR-1 TYPE REACTOR PROPOSED FOR SPAIN-S DON
DBA CHASE P. ENG. /CAN. GENERAL ELECTRIC CO/
CANADIAN NUCLEAR TECHNOLOGY FALL 1965 P. 42-43

WR-1 DESIGN DETAILS
CANADIAN NUCLEAR TECHNOLOGY NOV-DEC 1967 P. 34-5

* * * * * * * * * * * * * * * * *

NAME/OWNER	ESSOR /ESSAI ORGEL//EURATOM DEMAG AG, DEUTSCH B+W, AI
DESIGNER	GAAA, INTERATOM, MONTECATINI
PURPOSE	COMPONENTS TESTING FOR ORGEL
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE
POWER MWE(MWT)	0 35
CRITICAL	FULL POWER EARLY 1968
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM ALLOY FEED FUEL. SEE REMARKS.
FUEL GEOMETRY	PLATES CURVED AND MOUNTED TO FORM 3-PART TUBULAR ELEMENT 150 CM. LONG.
FUEL CLADDING	ALUMINUM
FUEL ENRICH.	93 PER CENT U-235
FUEL ASSEMBLY	BR-2 TYPE ELEMENTS, 16 CHANNELS SURROUNDING THE EXPERIMENTAL OR ORGEL ZONE. 17-PLATE ELEMENTS IN 44 FUEL EMPLACEMENTS, 20 OF WHICH ARE SUPPLEMENTARY. THE CENTRAL OR ORGEL ZONE HAS 12 CHANNELS, EACH WITH INDEPENDENT COOLANT LOOP.
BURNUP(REFUEL)	4 ELEMENTS / MONTH
NEUTRON FLUX	10 E+14
CONTROL	RODS
COOLANT TEMP.	INLET 47 C
REACTOR VESSEL	CENTRAL ZONE COMPARTMENT AN ALUMINUM VESSEL. VERTICAL SS TANK CONTAINING HEAVY WATER, WITH EXTENSIONS IN THE LOWER PART FOR PASSAGE OF THE ORGEL CHANNELS-ZIRCALOY CALANDRIA TUBES, SINTERED SAP PRESSURE TUBES, GAS INSULATED.
CONTAINMENT	CYLINDRICAL SHELL 45 M. DIA.
REMARKS	TEST REACTOR IN THE EURATOM ORGEL PROGRAM FOR TESTING COOLANT CHANNEL ASSEMBLY, PRESSURE TUBE,

* * * * * * * * * * * * * * * * *

THERMAL INSULATION, CALANDRIA TUBE, CONNECTIONS, FUEL ELEMENTS. ECO /EXPERIENCE CRITIQUE ORGEL/ DESIGNED BY DUTCH NERATOOM IS UNDER CONSTRUCTION AT ISPRA CENTER IN ITALY. ECO WILL USE U METAL RODS IN ALUMINUM CANS, DIPHENYL COOLANT AND HEAVY WATER MODERATOR.

REFERENCES

DESCRIPTION OF A SPECIFIC TEST REACTOR FOR STUDYING THE ORGEL SYSTEM.
C CHASSIGNET, OTHERS
POWER REACTOR EXPERIMENTS, VOL. II, PP. 183-212
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962

ESSOR, SPECIFIC TEST REACTOR FOR HEAVY WATER REACTOR CONCEPTS DEVELOPED BY EURATOM.
JC LENY, OTHERS
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, 1964
A/CONF. 28/P/78

THE ORGEL PROJECT
JC LENY, S ORLOWSKI
NUCLEAR ENG. 10, 96-100 /MARCH 1965/

* * * * * * * * * * * * * * * * *

NAME/OWNER	ORGEL /ORGANIQUE EAU LOURDE//EURATOM
DESIGNER	REF. DESIGN BELGONUCLEAIRE, INDATOM, SIEMENS /SEE ALSO ESSOR/
PURPOSE	POWER
TYPE	HEAVY WATER MOD. ORGANIC COOLED-PRESSURE TUBE /CALANDRIA/
POWER MWE(MWT)	250 759
CRITICAL	DEVELOPMENT
COOLANT	TERPHENYLS
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM CARBIDE
FUEL GEOMETRY	PENCILS OR TUBULAR ELEMENTS, 2.34 CM. OD.
FUEL CLADDING	SAP 0.13 CM. THICK
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	REFERENCE FUEL IS A 19-ROD BUNDLE
SPECIFIC POWER	24 MW/T
BURNUP(REFUEL)	8900 MWD/TON
NEUTRON FLUX	THERMAL MAX. 6.9X10 E+13
COOLANT TEMP.	INLET 265 C OUTLET 400 C
COOLANT PRESS.	16 KG/SQ.CM.
REACTOR VESSEL	VERTICAL CYLINDER-SS-CONTAINING COLD HEAVY WATER, ZIRCALOY CALANDRIA TUBES, SAP PRESSURE TUBES, GAS INSULATED. /VERTICAL CALANDRIA TUBES/
REMARKS	ESSOR, THE HEAVY WATER REACTOR DESIGNED BY GAAA AND INTERATOM, IS AN EXPERIMENTAL REACTOR FOR ORGEL, EURATOM-S DEVELOPMENT OF THE ORGANIC CONSTRUCTION AT ISPRA. DESIGNED BY DUTCH NERATOOM, IS UNDER WAY AT ISPRA CENTER IN ITALY. ECO WILL USE U METAL RODS IN AL CANS, DIPHENYL COOLANT AND HEAVY WATER MODERATOR. EXPO, THE EXPONENTIAL EXPERIMENT, IS ALSO UNDER

* * * * * * * * * * * * * * * * *

STUDY FOR AN ORGEL PROTOTYPE, A THORIUM OXIDE FUELED REACTOR HAS BEEN STUDIED AS COMPARISON TO THE URANIUM CARBIDE SYSTEM.

REFERENCES

ORGEL-A EUROPEAN CONCEPT.
JC LENY
NUCLEAR ENG. 6. 508-12 /DECEMBER 1961/

DESIGN CRITERIA, ENGINEERING FEATURES, EXPERIMENTAL PROGRAM FOR THE ECO REACTOR.
P BONNAURE, OTHERS
ENERGIA NUCLEARE 9 /9/. 529-34 /SEPTEMBER 1962/

EXPERIENCE CRITIQUE ORGEL /ECO/
NUCLEAR ENG. 8.440-41 /DEC. 1963/

LE PROJET ORGEL
NEUE TECHNIK /NT/ NO. 10, 1963 P. 585-96

THE ORGEL PROJECT
JC LENY, S ORLOWSKI
NUCLEAR ENG. 10, 96-100 /MARCH 1965/

WHAT IS ORGEL - A BRIEF RECAP.
EURATOM 4, 49-54 /JUNE 1965/

PERFORMANCE OF AN ORGEL REACTOR FUELED WITH THORIUM.
E LAFONTAINE, OTHERS
HEAVY WATER POWER REACTORS, PROC. SYMPOSIUM, VIENNA, SEPT. 1967 P. 409-28
IAEA, VIENNA, 1968

* * * * * * * * * * * * * * * * *

NAME/OWNER	VULCAIN / BELGONUCLEAIRE-UK AEA
DESIGNER	BELGONUCLEAIRE-UKAEA
LOCATION	SEE REMARKS
PURPOSE	SHIP PROPULSION
TYPE	PWR, SPECTRAL SHIFT
POWER MWE(MWT)	20 65 /FOR 20,000 SHP/
CRITICAL	CONSTRUCTION, DEVELOPMENT, SEE REMARKS
COOLANT	HEAVY WATER-LIGHT WATER.
MODERATOR	HEAVY WATER-LIGHT WATER.
FUEL MATERIAL	URANIUM DIOXIDE PELLETS, 7.5 MM. DIA.
FUEL GEOMETRY	PINS, 3 FT. 8 3/4 IN. ACTIVE LENGTH
FUEL CLADDING	SS
FUEL ENRICH.	6 PER CENT U-235
FUEL ASSEMBLY	181-PIN ASSEMBLY. HOLLOW INCOMPLETE HEXAGONAL, WITH CENTRAL ZIRCALOY TUBE AS GUIDE FOR SHUT-OFF ROD. NO SHROUDS. 18 ASSEMBLIES IN CORE
FUEL CHARGE	1283 KG. URANIUM
BURNUP(REFUEL)	40,000-45,000 MWD/T 3 YEARS
NEUTRON FLUX	THERMAL AVE. 3X10 E+13
CONTROL	SPECTRAL SHIFT, BORON-SS RODS
COOLANT PRESS.	2100 PSI
REACTOR VESSEL	STEEL VESSEL 6 FT. 4 IN. ID., 153 IN. HGIH. POSSIBLY SS INNER CLADDING.
CONTAINMENT	STEEL SPHERE 25 FT. DIA., 1 1/8 IN. THICK. SECONDARY CONCRETE SHIELDING.
REMARKS	THE VULCAIN PROGRAM INCLUDED CONSTRUCTION AT CEN OF A ZERO-POWER REACTOR VENUS /VULCAIN EXPERIMENT

* * * * * * * * * * * * * * * * * *

NUCLEAR STUDY/, CRITICAL IN APRIL 1964 AND ENDED IN MARCH 1966. THE BR-3 REACTOR WAS MADE AVAILABLE TO THE VULCAIN PROGRAM AND MODIFIED TO OPERATE WITH A VULCAIN CORE, REACHING POWER IN DEC. 1966. SEE BR-3/VULCAIN, HF01

REFERENCES

PROJECT VULCAIN, DESCRIPTION AND PRINCIPAL CHARACTERISTICS.
VN-61-305 /BELGONUCLEAIRE, 1961/

THE VULCAIN PROJECT AND ITS DEVELOPMENT PROCESSES.
P MALDAGUE
ATOMWIRTSCHAFT 7, 317-21 /JUNE 1962/

THE VULCAIN REACTOR.
PE MALDAGUE
POWER REACTOR EXPERIMENTS, VOL. 2, P. 253-73
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1962.

THE U. K. ATOMIC ENERGY AUTHORITY-S NUCLEAR SHIP CONCEPTS.
NUCLEAR ENG. 8, 88-9 /MARCH 1963/

THE VULCAIN CORE POWER EXPERIMENT.
J STORRER
GENEVA 1964, A/CONF.28/P/515

CENTRE DE L-ENERGIE NUCLEAIRE
ANNUAL REPORT 1966
NP-17126

* * * * * * * * * * * * * * * * *

NAME/OWNER	RAPP/RAJASTHAN ATOMIC POWER PROJECT//INDIA.
DESIGNER	CANADIAN GENERAL ELECTRIC
LOCATION	RANA PRATAP SAGAR, RAJASTHAN STATE, INDIA RESERVOIR SITE
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE /CALANDRIA/ TWO-REACTOR STATION
POWER MWE(MWT)	200 PER REACTOR
CRITICAL	TARGET NO. 1, OCT. 1970 TARGET NO. 2, 1972
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	RODS
FUEL ENRICH.	NATURAL
REMARKS	CANADA WILL SUPPLY HALF THE FUEL FOR THE FIRST CHARGE. STATION WILL CONSIST OF TWO 200 MWE PLANTS RAPP-1 AND RAPP-2.
REFERENCES	FOR GENERAL DESIGN PARAMETERS SEE CANDU

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF09

* * * * * * * * * * * * * * * * *

NAME/OWNER	KALPAKKAM STATION / INDIA MAPP PROJECT /MADRAS ATOMIC POWER STATION/
LOCATION	KALPAKKAM, NEAR MADRAS, INDIA
PURPOSE	POWER
TYPE	CANDU-PHR TYPE TWO-REACTOR STATION
CRITICAL	PLANNED. NO. 1 TARGET 1972
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL ENRICH.	NATURAL
REMARKS	TWO CANADIAN-TYPE PRESSURIZE HEAVY WATER REACTORS ARE PROJECTED FOR THE SITE. INDIA IS UNDERTAKING CONSTRUCTION OF THE MAPP PROJECT DESIRING TO PROCEED WITHOUT FOREIGN ASSISTANCE. DETAILED DESIGN IS IN PROGRESS
REFERENCES	NUCLEAR CANADA MARCH, 1968 P, 5-6 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	HALDEN REACTOR/JENER, NORWAY AND OEEC
DESIGNER	JENER, NORWAY
OPERATOR	EUROPEAN NUCLEAR ENERGY AGENCY
LOCATION	HALDEN, NORWAY
PURPOSE	PROCESS STEAM
TYPE	HEAVY WATER MODERATED AND COOLED BWR
POWER MWE(MWT)	0 20
CRITICAL	1959
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE, FIRST CORE URANIUM METAL WITH URANIUM DIOXIDE SPIKE ELEMENTS,
FUEL GEOMETRY	RODS 25 MM. DIA./2.4 M. LONG
FUEL CLADDING	SS. FIRST CORE FINNED ALUMINUM
FUEL ENRICH.	SLIGHT. FIRST CORE NATURAL URANIUM.
FUEL ASSEMBLY	316 RODS/CORE. PROVISION FOR 325
NEUTRON FLUX	THERMAL PEAK 3X10 E+13
CONTROL	SHIM AND SCRAM RODS, CADMIUM TUBES, SS CLAD
COOLANT PRESS.	400 PSI
REACTOR VESSEL	CLAD STEEL CYLINDER 2.7 M. DIA./476 CM. HIGH.
CONTAINMENT	FACILITY IS CONSTRUCTED IN A CAVE WITH THE REACTOR IN A DEEP PIT IN THE FOUNDATION. REACTOR HALL IS 28 M./10 M./11.4 M. HIGH.
REMARKS	SECOND CORE OPERATION MARCH 1962. PROPOSED CONVERSION TO SPECTRAL SHIFT CONTROL. INTEREST IS IN APPLICATION TO AN OCEANOGRAPHIC RESEARCH VESSEL. A 3-YEAR RESEARCH PROGRAM WILL BE DEVOTED TO LONG-TERM TESTING OF FUEL ELEMENTS, EXPERIMENTAL CHEMISTRY, DEVELOPMENT OF INSTRUMENTATION. PARTICIPANTS WILL INCLUDE

* * * * * * * * * * * * * * * * *

UK AEA, NORWEGIAN INST. FOR ATOMENERGI, DANISH AND FINNISH AEC, RCN /NETHERLANDS/, AB-ATOMENERGI /SWEDEN/, AND US AEC. FULL DESIGN OUTPUT OF 20 MWT /ON SECOND FUEL CHARGE/ HAS BEEN USED TO PROVIDE PROCESS STEAM FOR NEARBY PAPER AND PULP MILLS /JANUARY 1964/
THE DEVELOPMENT PROGRAM HAS BEEN EXTENDED TO DECEMBER 1969 AND WILL INCLUDE ON-LINE COMPUTER CONTROL OF THE REACTOR, AND THORIUM PHYSICS INVESTIGATIONS.

REFERENCES

THE HALDEN BOILING WATER REACTOR.
N HIDLE, O DAHL
HPR-2 /1958/

HALDEN BWR
NUCLEAR ENG. 4. 106-12 /MARCH 1959/

* * * * * * * * * * * * * * * * *

NAME/OWNER	KANUPP/KARACHI NUCLEAR POWER PROJ./PAKISTAN AEC
DESIGNER	CANADIAN GENERAL ELECTRIC
LOCATION	KARACHI AREA, PAKISTAN /PARADISE POINT/
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED AND COOLED. HORIZONTAL PRESSURE TUBE, INTEGRAL DESIGN
POWER MWE(MWT)	125
CRITICAL	TARGET 1970
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS
FUEL GEOMETRY	RODS
FUEL CLADDING	ZIRCALOY
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	19-ELEMENT BUNDLE 2288 FUEL BUNDLES/CORE 11 BUNDLES/FUEL CHANNEL
BURNUP(REFUEL)	ON-LOAD
REACTOR VESSEL	INTEGRAL CALANDRIA/DUMP-TANK SURROUNDED BY A LIGHT WATER THERMAL SHIELD. CALANDRIA IS SS 16 FT. 6 IN. BY 16 FT. 4 IN. FUEL CHANNELS ARE ZIRCONIUM ALLOY.
CONTAINMENT	PRESTRESSED CONCRETE CYLINDRICAL BUILDING 115 FT. ID/120 FT. HIGH, WALLS 4.5 FT. THICK HEMISPHERICAL DOME, ELASTOMER LINING. THE REACTOR VAULT IS A SEALED, STEEL-LINED, REINFORCED CONCRETE STRUCTURE FILLED WITH LIGHT WATER IN WHICH THE CALANDRIA CONTAINING THE MODERATOR IS IMMERSED.
REMARKS	CANADIAN CONSTRUCTION OF THE NUCLEAR POWER PLANT HAS BEEN APPROVED. THE UNITIZED SYSTEM COMBINES CALANDRIA AND DUMP TANK IN A SINGLE UNIT.
REFERENCES	PAKISTAN TURNKEY CONTRACT FOR CGE

* * * * * * * * * * * * * * * * *

CANADIAN NUCLEAR TECHNOLOGY 4, 23-24 /SUMMER 1965/

KANUPP DESIGN DETAILS
CANADIAN NUCLEAR TECHNOLOGY 4, 24 /SUMMER 1965/
KARACHI NUCLEAR POWER PROJECT, PROGRESSIVE
CONSTRUCTION AND DESIGN FEATURES
RC JOHNSTON
HEAVY WATER POWER REACTORS, PROC. SYMPOSIUM,
VIENNA, SEPT, 1967, P. 113-23
IAEA, VIENNA, 1968

DEVELOPMENT IN REACTOR BUILDING DESIGN FOR CANDU-
TYPE NUCLEAR POWER PLANTS.
RL WILLIAMSON, WP RAFFERTY
ENGINEERING JOURNAL 50, 41-48 /OCT, 1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	DON / JEN, CENUSA-SPAIN
DESIGNER	AI /UNITED STATES/-JEN
OPERATOR	CENTRALES NUCLEARES SA /CENUSA/
PURPOSE	POWER PROTOTYPE
TYPE	HEAVY WATER MODERATED, ORGANIC COOLED, CALANDRIA,
POWER MWE(MWT)	30 106.5
CRITICAL	DESIGN, PROJECT DROPPED
COOLANT	SANTOWAX OMP
MODERATOR	HEAVY WATER, HEAVY WATER REFLECTOR
FUEL MATERIAL	URANIUM CARBIDE PELLET 12.7 MM. DIA.
FUEL GEOMETRY	ROD, 2895.6 MM. ACTIVE LENGTH
FUEL CLADDING	SAP 0.5 MM. THICK, FINNED
FUEL ENRICH.	1.7 PER CENT U-235
FUEL ASSEMBLY	19-ROD CLUSTER, SAP SHROUD TUBE, 138 ELEMENTS/CORE
FUEL CHARGE	12230 KG. URANIUM
SPECIFIC POWER	8.2 KW/KG U
BURNUP(REFUEL)	8000 MWD/MTU
CONTROL	RODS, STEEL TUBES FILLED WITH BORON CARBIDE
COOLANT TEMP.	INLET 299 C OUTLET 343 C
REACTOR VESSEL	ALUMINUM CALANDRIA STRUCTURE FOR THE HEAVY WATER, PROCESS TUBES ARE SAP IN CORE REGION, SS AND CARBON STEEL IN THE REST.
CONTAINMENT	CONVENTIONAL BUILDING, LEAK TIGHT.
REMARKS	CONCEPTUAL DESIGN BY AI HAS BEEN COMPLETED. FINAL PLANS WILL BE DEVELOPED BY JEN, CONSTRUCTION TARGET WAS 1965. PROJECT HAS BEEN DROPPED IN FAVOR OF FAST REACTOR DEVELOPMENT.

* * * * * * * * * * * * * * * * *

REFERENCES

ORGANIC COOLED HEAVY WATER MODERATED POWER REACTOR STUDY,
BL HOFFMAN
TID-7575 /P, 108/ /MARCH 1959/

THE 22ND PROJECT,
L PALACOIS, G VELARDE /JEN, MADRID/
PREPRINT /OTTOWA/
CANADIAN NUCLEAR ASSOC., 1962

THE DON PROJECT,
F PASCUAL, L PALACOIS, MK SANDERS
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF. 28/P/601

SAFETY FEATURES OF THE DON REACTOR CONCEPT,
A ALONSO, BL HOFFMAN,
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964, A/CONF. 28/P/495

DEVELOPMENT OF THE DON PROJECT
EURONUCLEAR 2, 283-4 /JUNE 1965/

NUCLEONICS WEEK JUNE 1, 1967 P, 8
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	AGESTA REACTOR STATION/STATE POWER, AB-ATOMENERGI, CITY OF STOCKHOLM, SWEDEN
DESIGNER	ASEA-AB ATOMENERGI R/3-ADAM
OPERATOR	STATE POWER BOARD, SWEDEN
LOCATION	AGESTA, SWEDEN LAKE MAGELUNGEN
PURPOSE	POWER AND DISTRICT HEATING
TYPE	HEAVY WATER MODERATED AND COOLED PWR
POWER MWE(MWT)	10 65
CRITICAL	JULY 1963, FULL POWER MARCH 1964 DOWN IN 1968 BECAUSE OF PIN-HOLE CORROSION OF FUEL CLADDING, WITH SOME RELEASE OF RADIOACTIVITY TO HEAVY WATER SYSTEM. BACK ON-LINE OCT. 1, 1968 WITH FUEL ELEMENTS OF NEW DESIGN
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 17 MM. DIA./733 MM. LONG
FUEL GEOMETRY	ROD COMPOSED OF 3 ELEMENTS SCREWED TOGETHER, 3 M. LONG
FUEL CLADDING	ZIRCALOY-2 TUBE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	19-ROD BUNDLE. 4 BUNDLES MAKE UP THE FUEL ELEMENT, IN ZIRCALOY PROTECTIVE CAN. 140 ELEMENTS/CORE NEW CORE HAS 84 ASSEMBLIES OF NEW DESIGN
FUEL CHARGE	18 TON URANIUM DIOXIDE
BURNUP(REFUEL)	5000 MWD/T
CONTROL	RODS, HYDRAULIC OPERATION, SILVER-INDIUM-CADMIUM IN SS CLADDING
COOLANT TEMP.	INLET 400 F OUTLET 430 F

* * * * * * * * * * * * * * * * *

COOLANT PRESS.	495 PSIG
REACTOR VESSEL	STEEL VESSEL, INNER SS CLADDING, 4.5 M. DIA. AND 6 M. HIGH
CONTAINMENT	CAVERN, LINED WITH CONCRETE AND WELDED STEEL PLATE
REMARKS	THE PROJECT DEVELOPED FROM TWO DESIGN STUDIES, DESIGNATED R-3 AND ADAM. IN THE ADAM CONCEPT DEVELOPED BY ASEA FOR HOUSE HEATING PURPOSES, PRESSURE VESSEL WAS FILLED WITH HEAVY WATER. COOLANT ENTERED THE REACTOR VESSEL BY 8 PIPES THROUGH THE BOTTOM, FLOWED UPWARD THROUGH THE MODERATOR, AND WAS TURNED DOWNWARD BETWEEN THE THERMAL SHIELD AND THE VESSEL WALL. IT WAS THEN DISTRIBUTED TO THE FUEL ELEMENTS THROUGH A SPACE BETWEEN THE GRID PLATE AND THE BOTTOM ALUMINUM CASTING. AFTER PASSING THE FUEL RODS THE HEAVY WATER ENTERED THE UPPER PLENUM AND LEFT THE REACTOR. A FUEL ELEMENT WAS COMPOSED OF 19 ALUMINUM CANS CONTAINING FUEL PELLETS. THERE WERE 168 ELEMENTS IN THE CORE. IN THE R-3 CONCEPT DEVELOPED BY AB-ATOMENERGI FOR POWER AND HEAT PRODUCTION, THE FUEL ELEMENT CONTAINED FIVE SUBASSEMBLIES OR BUNDLES COMPOSED OF 19 INDIVIDUAL FUEL RODS IN A SUPPORTIVE SHROUD OF ZIRCALOY-2. EACH FUEL ROD WAS BUILT UP OF URANIUM DIOXIDE PELLETS ENCASED IN A ZIRCALOY-2 CAN. COOLANT FLOW WAS UPWARD THROUGH THE FUEL ELEMENT SHROUDS, THEN DOWNWARD THROUGH THE MODERATOR AND BOTTOM REFLECTOR REGIONS TO THE OUTLET NOZZLES. THE AGESTA PWR HAS A CYLINDRICAL CORE CONTAINING 140 ELEMENTS SECURED TO THE LID OF REACTOR PRESSURE VESSEL. ELEMENTS PENETRATE BOTTOM CORE PLATE INTO COOLANT PLENUM. COOLANT FLOW IS FROM THE INLET PLENUM UPWARD THROUGH ELEMENTS, DOWNWARD IN THE MODERATOR SPACE BETWEEN THE ELEMENTS. THERE IS A PROVISION FOR RAISING THE REACTOR OUTPUT TO 125 MWT BY MEANS OF A MORE POWERFUL CORE AND ADDED HEAT EXCHANGERS /STAGE II/.
REFERENCES	R/3-ADAM. SWEDISH NUCLEAR HEAT-ELECTRIC STATION. NUCLEAR ENG. 5, 202-5 /MAY 1960/ DESCRIPTION OF THE AGESTA PLANT, /BOOK IN PREPARATION. NEW TECHNIQUE /NT/ 12,713, 1963/ THE AGESTA REACTOR.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF13

* * * * * * * * * * * * * * * * *

B MC HUGH
NUCLEAR ENERGY SEPT. 1964 P. 252-261

THE SWEDISH AGESTA POWER REACTOR
FA ABADIE-MAUMERT
ENERGIE NUCLEAIRE 7, 330-32 /SEPT.-OCT. 1965/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF14

* * * * * * * * * * * * * * * * *

NAME/OWNER	MARVIKEN POWER STATION/STATE POWER BOARD, SWEDEN
DESIGNER	ASEA, AB ATOMENERGI, SWEDEN
OPERATOR	STATE POWER BOARD, SWEDEN
LOCATION	MARVIKEN, SWEDEN /NORKOPINGS BAY AREA/
PURPOSE	PROTOTYPE, POWER AND SPACE HEAT
TYPE	HEAVY WATER MODERATED AND COOLED BWR, DIRECT CYCLE, NATURAL CIRCULATION, INTEGRAL NUCLEAR SUPERHEAT
POWER MWE(MWT)	200
CRITICAL	CONSTRUCTION TARGET 1968
COOLANT	HEAVY WATER AND STEAM
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 12.5 MM. DIA. /BOILING/ AND 11.5 MM. DIA. /SUPERHEATING/
FUEL GEOMETRY	ROD
FUEL CLADDING	BOILER ZIRCALOY-2 SUPERHEATER CHROMIUM-NICKEL STEEL
FUEL ENRICH.	BOILER 1.3 PER CENT U-235 SUPERHEATER 1.5 PERCENT
FUEL ASSEMBLY	36-ROD CLUSTERS IN BOILING REGION. 48-ROD CLUSTERS IN SUPERHEATING REGION. 147 BOILING CHANNELS, NON-INSULATED SHROUDS 32 SUPERHEAT CHANNELS, INSULATED SHROUDS SUPERHEAT CHANNELS WILL BE EMPTY DURING FIRST YEAR OF OPERATION.
SPECIFIC POWER	18 KW/KG URANIUM
BURNUP(REFUEL)	13000 MWD/T — ON-LOAD FOR BOILING ELEMENTS. SHUT-DOWN FOR SUPER HEAT ELEMENTS.
CONTROL	RODS
COOLANT TEMP.	INLET 120 C OUTLET

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF14

* * * * * * * * * * * * * * * * *

BOILING 263 C
SUPERHEAT 475 C

COOLANT PRESS. INLET 49.5 ATM.

REACTOR VESSEL CARBON-MANGANESE STEEL VESSEL 26 M HIGH, 5 M DIAM. MODERATOR TANK SEPARATING MODERATOR FROM BOILING CIRCUIT

CONTAINMENT CIRCULAR WALLS AND PRESSURE-SUPPRESSION CONTAINMENT OF PRESTRESSED CONCRETE.

REMARKS A REDESIGN OF THE ORIGINAL PROPOSAL WAS DONE UNDER PROJECT BASHFUL, WHICH WAS CONCERNED WITH A NATURAL CIRCULATION DIRECT CYCLE PLANT. THE ORIGINAL PROPOSAL WAS FOR A 100 MWE BWR. ADVANCED DESIGN ENVISAGES THE GENERATION OF SUPERHEATED STEAM TO PRODUCE 204 MWE, BUT IT COULD PRODUCE 160 MWE OPERATING WITH SATURATED STEAM. PLUTONIUM FUELS WILL BE STUDIED. THE PROJECT HAS BEEN RENAMED MARVIKEN-K. SWEDISH PARLIAMENT HAS APPROVED CONSTRUCTION OF A 200 MWE STATION. PRELIMINARY WORK IS REPORTEDLY IN PROGRESS ON AN ENLARGED REACTOR, BASHFUL-1000 OF THE MARVIKEN TYPE.

REFERENCES

BF-4. SUMMARY REPORT /PRE-PROJECT/ CONCERNING BASHFUL AB. ATOMENERGI REPORT, MAY 1962
NEUE TECH. /NT/ 4/12/. 713 /1963/

THE DEVELOPMENT WORK LEADING UP TO THE MARVIKEN NUCLEAR POWER STATION.
PH MARGEN
NEUE TECH. /NT/ 4/12/. 699-714 /1963/

HEAVY WATER STEAM IN DIRECT CYCLE-MARVIKEN
R NILSEN
NUCLEAR ENG. 11. 456-60 /JUNE 1966/

* * * * * * * * * * * * * * * * *

NAME/OWNER	PHWR /PRESSURIZED HEAVY WATER REACTOR/ AB-ATOMENERGI, SWEDEN
DESIGNER	AB-ATOMENERGIE, SWEDISH JOHNSON CO.
PURPOSE	POWER REACTOR STUDY.
TYPE	HEAVY WATER MODERATED AND COOLED, CROSS-FLOW
POWER MWE(MWT)	250-400 1200
CRITICAL	CONCEPT
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM /LATER PLUTONIUM-ENRICHED URANIUM/
FUEL GEOMETRY	ROD
FUEL CLADDING	ZIRCONIUM
FUEL ENRICH.	1.5 PER CENT U-235
FUEL ASSEMBLY	SINGLE ELEMENT - NO CLUSTERING
FUEL CHARGE	APPROX. 33.7 TONS URANIUM
SPECIFIC POWER	35.6 KG/KG U
REACTOR VESSEL	CYLINDRICAL, 36 M. DIA./50 M. HIGH
REMARKS	CONCEPT IS BASED ON A CROSS-FLOW REGIME, WITH THE FUEL ELEMENTS LAID ACROSS THE PATH OF THE COOLANT FLOW, PROVIDING DIRECT CONTACT BETWEEN FUEL AND HEAVY WATER. PHWR-400 IS AN INVESTIGATION OF CONCEPT AS A POSSIBLE CHOICE FOR FULL-SCALE INSTALLATION FOR 1970 SERVICE. FULL-SCALE REACTOR EVALUATION HAS BEEN DONE BY NORDSTJERNAN GROUP IN COLLABORATION WITH AB ATOMENERGIE AND US WESTINGHOUSE. A FINAL REPORT ON THE FEASIBILITY OF A 250 MW PLANT HAS BEEN COMPLETED FOR AB ATOMENERGIE BY WESTINGHOUSE, BECHTEL, JOHNSON CO. THE FEASIBILITY OF BUILDING A PHWR IN MADRAS STATE, INDIA, IS BEING STUDIED BY JOHNSON CO. AND INDIA-S AEC.
REFERENCES	APPLIED ATOMICS, MAY 16, 1962, P. 11-12.

* * * * * * * * * * * * * * * * *

NAME/OWNER	SULZER PROJECT/FEDERAL INST. TECH., SWITZERLAND
DESIGNER	SULZER BROTHERS, SWITZERLAND
OPERATOR	FEDERAL INSTITUTE OF TECHNOLOGY, SWITZERLAND
LOCATION	ZURICH, SWITZERLAND LIMMAT RIVER
PURPOSE	POWER AND DISTRICT HEAT
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBE
POWER MWE(MWT)	6-8 30
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER, GRAPHITE REFLECTOR
FUEL MATERIAL	URANIUM METAL
FUEL GEOMETRY	HOLLOW RODS
FUEL CLADDING	ZIRCALOY
FUEL ENRICH.	NATURAL /OUTER ANNULAR RING 1 PER CENT U-235/
FUEL ASSEMBLY	INDIVIDUAL FUEL TUBE IS BONDED ON THE INSIDE TO A ZIRCALOY PRESSURE TUBE, 13 MM. ID. EIGHT TUBE ELEMENTS, WITH AN OUTER THIN ZIRCALOY SHEATH, ARE HOUSED IN AN OUTER CASING TUBE, SEPARATED FROM THE HOT URANIUM SURFACE BY INSULATION. 88 ELEMENTS/CORE
CONTROL	RODS
REACTOR VESSEL	MODERATOR TANK, THIN-WALLED ALUMINUM, OPEN AT TOP GRAPHITE REFLECTOR BELOW AND AT SIDES, THERMAL SHIELDS, AND CYLINDRICAL BIOLOGICAL SHIELD OF CONCRETE WHICH CAN SERVE AS PRESSURE VESSEL. THERMAL SHIELD IS WATER-COOLED.
CONTAINMENT	UNDERGROUND CONSTRUCTION.
REFERENCES	SULZER PROJECT FOR A PROTOTYPE HEAVY WATER POWER REACTOR FOR LOCATION IN AN UNDERGROUND CAVERN. P DE HALLER, AF FRITZSCHE SECOND U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY 9, 16-35 /1958/

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF16

* * * * * * * * * * * * * * * * *

REPORT ON THE CONSTRUCTION OF A NUCLEAR HEAT AND POWER STATION FOR THE DISTRICT HEATING STATION OF THE FEDERAL INSTITUTE OF TECHNOLOGY.
SULZER BROS.
NP-7945 /N.D./

* * * * * * * * * * * * * * * * *

NAME/OWNER	EXPERIMENTAL POWER PLANT LUCENS/SNA, SWITZERLAND
DESIGNER	SULZER BROTHERS, SWITZERLAND
OPERATOR	SNA, SWITZERLAND
LOCATION	LUCENS, SWITZERLAND
PURPOSE	POWER EXPERIMENT
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE TUBES /CALANDRIA/
POWER MWE(MWT)	6-7 30
CRITICAL	1966
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM-CHROMIUM ALLOY
FUEL GEOMETRY	ROD, 17 MM. DIA./650 MM. LONG. 4 SEGMENTS/ROD
FUEL CLADDING	MAGNESIUM-ZIRCONIUM ALLOY, FINNED, 1.75 MM. THICK
FUEL ENRICH.	0.96 PER CENT U-235
FUEL ASSEMBLY	7-ROD ELEMENT /GRAPHITE SUPPORT IN THE PRESSURE TUBE, INTO WHICH RODS ARE INSERTED/ CORE IS CYLINDRICAL WITH 2 CONCENTRIC ZONES. 73 ELEMENTS
FUEL CHARGE	5640 KG. URANIUM
SPECIFIC POWER	12 KW/KG U
CONTROL	RODS, TUBULAR, SILVER-CADMIUM ALLOY CLAD WITH SS, GAS-COOLED
COOLANT TEMP.	INLET 221 C OUTLET 384 C
COOLANT PRESS.	60 ATM.
REACTOR VESSEL	MODERATOR VESSEL ALUMINUM CYLINDER, ZIRCALOY PRESSURE TUBES
CONTAINMENT	CAVERN CONSTRUCTION, BIOLOGICAL SHIELD.
REMARKS	SNA IS SPONSORING THE PROJECT, WHICH HAS REPLACED

HEAVY WATER MODERATED REACTORS, FOREIGN EF17

* * * * * * * * * * * * * * * * *

THE PROPOSAL CONSIDERED BY SNA MEMBERS THERMATOM, ENUSA AND SUISATOM FOR A REACTOR OF SULZER DESIGN. THE CORE IS DIVIDED INTO TWO AREAS BY THE PITCH OF THE FUEL ELEMENTS. THE PRESSURE TUBES ARE OF ZIRCALOY-2. COOLANT FLOWS DOWN THE INSIDE OF THE TUBE AND PASSES UP OVER THE FUEL ELEMENT PROPER.

REFERENCES

LUCENS. SWITZERLAND-S EXPERIMENTAL PRESSURE TUBE REACTOR.
NUCLEAR ENG. 7, 449-51 /NOVEMBER 1962/

THE EXPERIMENTAL NUCLEAR PLANT AT LUCENS.
P DE HALLER, W HELBLING
ENERGIC NUCLEAIRE 5, 501-11 /NOV. 1963/

THE NUCLEAR EXPERIMENTAL STATION AT LUCENS.
P VERSTRAETE
INDUSTRIES ATOMIQUES 3/4 , 55-67 /1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	SGHWR /STEAM GENERATING HWR/AEA, UNITED KINGDOM
DESIGNER	U.K. ATOMIC ENERGY AUTHORITY
OPERATOR	U.K. ATOMIC ENERGY AUTHORITY
LOCATION	WINFRITH HEATH, DORSET, ENGLAND
PURPOSE	POWER PROTOTYPE
TYPE	HEAVY WATER MODERATED, LIGHT WATER COOLED, DIRECT CYCLE PRESSURE TUBE, /CALANDRIA/
POWER MWE(MWT)	100 294
CRITICAL	FULL POWER JAN. 1968
COOLANT	LIGHT WATER, BOILING
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 0.57 IN. DIAM.
FUEL GEOMETRY	ROD, ACTIVE LENGTH 144 IN.
FUEL CLADDING	ZIRCALOY-2 CAN 0.028 IN. WALL THICKNESS
FUEL ENRICH.	1.4 PER CENT U-235
FUEL ASSEMBLY	36-ELEMENT CLUSTER
FUEL CHARGE	21.41 TON U
BURNUP(REFUEL)	12,000 MWD/T ON-LOAD
CONTROL	VARIATION IN HEAVY WATER LEVEL, BORIC ACID INJECTION FOR QUICK SHUTDOWN AND REACTIVITY ADJUSTMENT. EMERGENCY CORE SPRAY BY MEANS OF CENTRAL SPARGE PIPE IN CORE.
COOLANT TEMP.	INLET 527 F OUTLET 538 F
COOLANT PRESS.	INLET 970 PSI
REACTOR VESSEL	ALUMINUM-MAGNESIUM ALLOY MODERATOR TANK MOUNTED INSIDE WATER-FILLED SHIELD TANKS. ALUMINUM-MAGNESIUM CALANDRIA TUBES, ZIRCALOY IN-CORE PRESSURE TUBES.

* * * * * * * * * * * * * * * * *

CONTAINMENT THICK REINFORCED CONCRETE SHIELD AROUND REACTOR, STEAM DRUMS AND PRIMARY DRUMS, SECONDARY CONTAINMENT ENCLOSES WHOLE OF MAIN BUILDING. WALLS ARE STEEL-LINED.

REMARKS PROTOTYPE CONSTRUCTION WAS STARTED IN MAY, 1963. THE UK HAS BEEN STUDYING THIS REACTOR CONCEPT SINCE 1958. BRITAIN-S INDUSTRIAL CONSORTIA WILL COLLABORATE AND SHARE IN DESIGN AND DEVELOPMENT OF THE PROJECT. TECHNICAL COLLABORATION WILL ALSO BE CARRIED ON WITH CANADA AND SWEDEN. LOW-LEVEL FORCED-DRAFT COOLING TOWERS WILL BE USED DEISGN FOR A LARGE-SCALE DUAL PURPOSE REACTOR HAS BEEN DEVELOPED.

REFERENCES

SYMPOSIUM ON PRESSURE TUBE WATER REACTORS. BRITISH NUCLEAR ENERGY SOCIETY, RISLEY, LANCS., ENGLAND, JULY 1962.

THE SGHWR PROTOTYPE REACTOR.
A FIRTH, JER HOLMES
NUCLEAR ENG. 9,46-9 /FEB. 1964/

GENERAL DESIGN OF THE STEAM GENERATING HEAVY WATER REACTOR.
S FAWCETT, OTHERS
THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, 1964. A/CONF.28/P/129

THE STEAM GENERATING HEAVY WATER REACTOR
H CARTWRIGHT
TRG REPORT 1246 R /1966/

SGHWR. A DARK HORSE COMPETITOR
H CARTWRIGHT
NUCLEONICS 24, 60-63 /SEPT. 1966/

BRITAIN-S HEAVY WATER REACTOR,
ENGINEERING 204, 411-15 /SEPT. 15, 1967/

WINFRITH SGHWR
NUCLEAR ENG. 13/144/ P. 416-25 /1968/

STEAM GENERATING HEAVY WATER REACTOR
UK AEA
BROCHURE ISSUED FEB. 1968

A LARGE-SCALE DUAL-PURPOSE PLANT FOR WATER/POWER PRODUCTION.

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF18

* * * * * * * * * * * * * * * * *

DW CLELLAND
DESALINATION 2, 215-19 /1967/

* * * * * * * * * * * * * * * * *

NAME/OWNER	R-1 AND R-2 / USSR
DESIGNER	USSR
PURPOSE	POWER CONVERTER-CONCEPT DEVELOPMENT
TYPE	HEAVY WATER MODERATED, ORGANIC COOLED, PRESSURE TUBE.
POWER MWE(MWT)	500 1600
CRITICAL	CONCEPTUAL DESIGNS R-1 AND R-2
COOLANT	ORGANIC LIQUID
MODERATOR	HEAVY WATER-GRAPHITE REFLECTOR.
FUEL MATERIAL	R-1 NATURAL URANIUM METAL R-2 URANIUM DIOXIDE
FUEL GEOMETRY	R-1 RODS R-2 TUBES
FUEL CLADDING	MAGNESIUM-BERYLLIUM ALLOY
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	R-1 THICK-WALLED ANNULAR URANIUM, 680 CENTRAL CHANNELS 356 PERIPHERAL CHANNELS R-2 TUBULAR CLUSTERS 580 CENTRAL CHANNELS 290 PERIPHERAL CHANNELS
FUEL CHARGE	R-1 100 TONS URANIUM R-2 120 TONS
BURNUP(REFUEL)	R-2 9000 MWD/T
COOLANT TEMP.	INLET 230 C OUTLET 300 C
REMARKS	THE R-1 DESIGN HAS A HIGH PLUTONIUM PRODUCTION RATE, AND R-2 A HIGH URANIUM FUEL BURNUP. MATERIAL FOR THE PRESSURE TUBES IS NOT SPECIFIED.
REFERENCES	NATURAL URANIUM HEAVY-WATER-MODERATED ORGANIC-COOLED POWER CONVERTER REACTOR. A ALICHANOV, OTHERS THIRD U. N. INTL. CONF. ON THE PEACEFUL USES OF ATOMIC ENERGY, MAY 1964, A/CONF.28/P/877

* * * * * * * * * * * * * * * * *

NAME/OWNER	MZFR/MEHR-ZWECK-FORSCHUNGS REAKTOR//MINISTRY ATOMIC POWER, W. GERMANY
DESIGNER	SIEMENS, W. GERMANY
OPERATOR	GESELLSCHAFT FUR KERNFORSCHUNG MBH SOCIETY FOR NUCLEAR RESEARCH
LOCATION	KARLSRUHE RESEARCH CENTER, KARLSRUHE, W. GERMANY
PURPOSE	POWER PROTOTYPE
TYPE	HEAVY WATER MODERATED AND COOLED, PRESSURE VESSEL
POWER MWE(MWT)	50 200
CRITICAL	DECEMBER 1967, FULL POWER DOWN IN 1968 DUE TO LEAKAGE OF HEAVY WATER INTO BOILER DURING FUEL RECHARGE.
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE PELLETS 1.04 MM. DIA.
FUEL GEOMETRY	ROD 1,864 MM. ACTIVE LENGTH
FUEL CLADDING THICKNESS	ZIRCALOY-2 0.6 MM. THICK TUBE
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	37-ROD BUNDLE TWO ELEMENTS STACKED IN FUEL CHANNEL 242 ELEMENTS/CORE
FUEL CHARGE	13570 KG. URANIUM DIOXIDE
BURNUP(REFUEL)	ON-LOAD
NEUTRON FLUX	THERMAL AVE. 1.2X10 E+14
CONTROL	ABSORBER RODS, CADMIUM-INDIUM-SILVER, PLUS VARIATION IN THE MODERATOR TEMPERATURE
COOLANT TEMP.	INLET 252 C OUTLET 280 C
COOLANT PRESS.	1280 PSIA
REACTOR VESSEL	CYLINDER 13.45 FT. ID., CONTAINING A SECOND

* * * * * * * * * * * * * * * * *

SUSPENDED VESSEL HOLDING THE MODERATOR. VESSEL IS PERFORATED BY SHROUD TUBES INSULATED BY LAYERS OF STAGNANT WATER.

CONTAINMENT SPHERICAL STEEL BUILDING 98.4 FT. DIA., 23 FT. ABOVE GROUND.

REMARKS RESEARCH AIMS ARE TO TEST NATURAL URANIUM REACTOR FUEL ELEMENTS UNDER OPERATING CONDITIONS, IN-PILE LOOP RESEARCH ON COOLANTS, MATERIALS TESTING, THORIUM, U-233 FUEL CYCLE, ISOTOPE PRODUCTION, PRODUCTION OF FISSILE MATERIAL, NUCLEAR SUPERHEAT, NEW CONSTRUCTION DESIGNS. MZFR IS A MODIFICATION OF THE SIEMENS SNDR-16/SIEMENS NATURAL DEUTERIUM REACTOR/

REFERENCES

THE SIEMENS MULTIPURPOSE REACTOR DESIGN.
A ZEIGLER
NUCLEAR POWER 6, 71-4 /MARCH 1961/

APPLIED ATOMICS FEB. 16, 1966 P. 11
NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	MITSUBISHI HEAVY WATER REACTOR/MITSUBISHI ATOMIC POWER IND, INC., JAPAN
DESIGNER	MITSUBISHI ATOMIC POWER IND. INC., JAPAN
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED/COOLED, PWR, PRESSURE TUBE, CLOSED CYCLE
POWER MWE(MWT)	345 1163
CRITICAL	DESIGN STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER REFLECTOR, LIGHT AND HEAVY WATER
FUEL GEOMETRY	RODS
FUEL CLADDING	ZIRCALOY TUBES
FUEL ENRICH.	NATURAL PLUS DEPLETED URANIUM
FUEL ASSEMBLY	47,500 RODS/CORE 500 LONGITUDINAL PRESSURE TUBES, COLD
BURNUP(REFUEL)	8000 MWD/TU
NEUTRON FLUX	THERMAL AVE. 1.2 X 10 E+4
CONTROL	RODS, MODERATOR POISON
COOLANT PRESS.	102 ATM.
REFERENCES	DESIGN STUDY OF PRESSURIZE HEAVY WATER COOLED POWER REACTOR, MASA-TOSHI YOKOSUKA /MITSUBISHI AT, POWER IND./ GENSHIRYOKU HATSUDEN 8, 51-61 /SEPT. 1964/

* * * * * * * * * * * * * * * * *

NAME/OWNER	YUGOSLAV REACTOR
DESIGNER	UNO /YUGOSLAVIA/ AND ASEA /SWEDEN/
PURPOSE	POWER
TYPE	HEAVY WATER MOD. AND COOLED, BWR
POWER MWE(MWT)	200-400
CRITICAL	DEVELOPMENT. TARGET 1971-72
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
REMARKS	AN AGREEMENT BETWEEN ASEA AND UNO ON REACTOR DEVELOPMENT HAS BEEN SIGNED.
REFERENCES	BUSINESS ATOMICS REPORT MARCH 16, 1966 P. 4 NEWS RELEASE

* * * * * * * * * * * * * * * * *

NAME/OWNER	VENTURE/CANADIAN GENERAL ELECTRIC
DESIGNER	CANADIAN GENERAL ELECTRIC CO. LTD., CANADA
PURPOSE	300
TYPE	HEAVY WATER MODERATED/COOLED VERTICAL PRESSURE TUBE
CRITICAL	DESIGN
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL GEOMETRY	PENCIL
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	BUNDLES, STACKED IN FUEL CHANNELS
BURNUP(REFUEL)	ON-LOAD, SINGLE FACE
CONTROL	DIGITAL COMPUTER CONTROLS MODERATOR LEVEL, ABSORBER AND CONTROL RODS.
REACTOR VESSEL	CALANDRIA A VERTICAL WELDED SS TANK ZIRCALOY-2 CALANDRIA TUBES ZIRCALOY-2 FUEL CHANNELS INTERSPACE BETWEEN TUBE FILLED WITH CARBON DIOXIDE
CONTAINMENT	PRESTRESSED CONCRETE BUILDING, FREE-STANDING, LINED WITH RESIN.
REMARKS	A TWO-REACTOR UNIT /600 MWE/ MAY BE CONSIDERED FOR LOCATION ON A RIVER IN EAST-CENTRAL CANADA
REFERENCES	DESIGN DETAILS OF THE CGE VERTICAL HEAVY WATER PRESSURE TUBE REACTOR. SOME FACTORS INFLUENCING THE DESIGN. NL WILLIAMS HEAVY WATER POWER REACTORS, PROC. SYMPOSIUM, VIENNA, SEPT. 1967 P. 233-43 IAEA, VIENNA, 1968

JANUARY 1969 BNWL-936

HEAVY WATER MODERATED REACTORS, FOREIGN EF24

* * * * * * * * * * * * * * * * *

NAME/OWNER	ARGENTINE MZFR/ARGENTINE AEC ATUCHA STATION
DESIGNER	SIEMENS, W. GERMANY
OPERATOR	CNEA, ARGENTINA
LOCATION	ATUCHA, ARGENTINA
PURPOSE	POWER
TYPE	HEAVY WATER MODERATED PWR
POWER MWE(MWT)	300 1100
CRITICAL	CONSTRUCTION. TARGET 1972
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM DIOXIDE
FUEL GEOMETRY	ROD 11.9 MM. OD
FUEL CLADDING	ZIRCALOY-2
FUEL ENRICH.	NATURAL
FUEL ASSEMBLY	36-ROD BUNDLE
BURNUP(REFUEL)	8,000 MWD/T RADIAL SHUFFLING ON-LOAD
COOLANT TEMP.	OUTLET 305.4 C
COOLANT PRESS.	117 KG/SQ. CM.
REACTOR VESSEL	VESSEL 5360 MM. ID.
CONTAINMENT	SPHERICAL STRUCTURE.
REFERENCES	STEAM GENERATING AND OTHER HEAVY WATER REACTORS. NUCLEAR ENG. 13, 521-2 /MAY 1968/

* * * * * * * * * * * * * * * * *

NAME/OWNER	BHWR/CZECHOSLOVAKIA
PURPOSE	POWER
TYPE	HEAVY WATER BWR, NATURAL CIRCULATION, DIRECT CYCLE
POWER MWE(MWT)	500
CRITICAL	STUDY
COOLANT	HEAVY WATER
MODERATOR	HEAVY WATER
FUEL MATERIAL	URANIUM
FUEL ENRICH.	NATURAL
	CONTINUOUS, ON-LOAD.
REACTOR VESSEL	PRESTRESSED CONCRETE VESSEL PRESSURE-DAMPING SYSTEM
REFERENCES	A 500 MW BHWR-TYPE NUCLEAR PLANT M JOVANIC, L MOJOVIC NUKL. ENERG. 5 /4/, 7-15 /1967/