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NUCLEAR PROPULSION FOR SHIPS

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CONTENTS

SCOPE The interests of both ship and reactor designers were considered in compiling this wide selection of book, unclassified report and journal references to the use of nuclear power for ship propulsion. Sources used were U.K. and U.S. reports abstracts, Nuclear Science Abstracts, Engineering Index (1948-56) Industrial Arts Index (1957 -), and the index to the "Information Bulletin." (429 references.) (auth)

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   pp.70-85, atomic propulsion of merchant ships.

2. BLAIR, C.
   The atomic submarine. Odhams, 1955. pp.224.

3. FAYRAM, R.A. and others
   Hazards evaluation for nuclear merchant ships.
   In: ***Advances in nuclear engineering:*** proceedings of the Second Nuclear Engineering and Science Congress, held at Philadelphia. 11-15 March, 1957. Vol.1, pp.470-5. New York, Pergamon Press, 1957.

4. MURPHY, C.P. and GATEWOOD, A.R.
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   Atomic energy in industry: 4th annual conference 26-28 October, 1955.

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8. NUCLEAR ENERGY RESEARCH BUREAU.
   What the new atomic submarine programme means to investors. New York, N.E.R.B., 28 February, 1958. pp.28. (N.E.R.B. report no. 81)
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9. RAYTHEON MANUFACTURING CO.
   Nuclear reactor data. 2nd ed. Waltham, Mass., 1956. pp.21.

   Basic data relating to all known nuclear reactors

10 UNITED STATES. Congress. Bills.
Hearing by the Committee on Merchant Marine and Fisheries, House of Representatives, [on] a bill authorizing the construction of a nuclear-powered merchant ship to promote the peacetime application of atomic energy, and for other purposes. 84th Cong., 1st session, (Washington, U.S. Govt Printing Office), 7 June, 1955. pp.22. (H.R.6243 and 6276)

11. UNITED STATES. Congress. Joint Committee on Atomic Energy.
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Preliminary economic report on the application of atomic power to merchant ships: pt. 1, mixed dry cargo ships; pt. 2, oil tanker ships, by W.J. Burns. April, 1956. pp.116.

14. AERE RP/M 53 U.K.A.E.A. ATOMIC ENERGY RESEARCH ESTABLISHMENT. Reactor Physics Division, Harwell.
Hazard from normal marine accidents to merchant ships propelled by nuclear-power plants, by B.T. Price. 28 December, 1954. pp.5.

Danger likely be acceptable unless there are at least 100 nuclear propelled ships operating in the world.

15. AGN 8 AEROJET-GENERAL NUCLEONICS, San Ramon, California.
Safety considerations for nuclear merchant ships, by R.A. Fayram and H.J. Schneider. 15 October, 1956. pp.32.

Summary of results of studies and estimation of the intensities of radioactive contamination of seawater after an accident to a hypothetical ship powered with a 60 MW reactor. Use of chelating agents to reduce dangers from contamination is considered.

16. IP 228 UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan.
Nuclear tanker economics, by H. Benford. July, 1957. pp.65.

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17 *Economics of nuclear ships*
CONNOLLY, T J and WILHELMSEN, J
Atomics and Nucl En , vol 9, no 5, May, 1958, pp 151-5

18 *Safety of nuclear ships in port*
FLETCHER P T
Atom, May, 1958, pp 10-6

19 *Nuclear power and ships*
RIGHTON, F G
Jt. Pan Nucl Mar Prop J , vol 2, no 1, April, 1958, pp 41-5

Considers advantages and disadvantages of nuclear propulsion for surface vessels and submersibles

20 *World progress with the atom since Geneva*
O'DONNELL A J
Jt Pan Nucl Mar Prop J , vol 2, no 1 April 1958, pp 46-51

Groups studying nuclear propulsion for shipping in various countries are outlined

21 *The nuclear propulsion of ships*
Beama J , vol 65, February, 1958 pp 36-7

22 *Atoms for nuclear ships a need for an economical plant*
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Shipp World, vol 138, no 3367, 8 January, 1958, pp 25-6

23 *Radiation hygiene aboard nuclear submarines*
EBERSOLE, J H
Amer Industr Hygiene Assoc Quart , vol 18, no 4, December, 1957, p 305

24 *Japanese nuclear tanker plans*
Shipp World vol 137, no 3356, 23 October, 1957, pp 341-2

25 *Prospects for nuclear propulsion*
PARKER F A and others
Mar Engng/Log vol 62, October, 1957, pp 91-2

26 *Safety measures for nuclear ships*
CROUCH, H F
Amer Soc Nav Engrs J , vol 69, August, 1957, p 565

27 *Ship propulsion*
GODWIN R P
Nucleonics vol 15 no 9, September 1957 pp 114-7

28 Tankers of the future?
Economist, vol 184, no 5947, 17 August, 1957, pp 561-3

29. *Nuclear-powered passenger-cargo ship.*
MACMILLAN, D.C.
Mar. J., vol.84, no.8, August, 1957, p.8.

30. *Nuclear energy for ship and submarine propulsion.*
DUNWORTH, J.V.
Financial Times Ann. Rev. British Ind., 1 July, 1957, pp.28-9.

31. *Nuclear navy paces U.S. atomic industry*
KENTON, J.E.
Nucleonics, vol.15, no.7, July, 1957, pp.66-71, 126.

32. *It's time to look at nuclear merchant ship safety.*
FAYRAM, R.A. and SCHNEIDER, H.J.
Nucleonics, vol.15, no.5, May, 1957, pp.109-11.

33. *Atomic energy in transport.* [In Russian]
SYRMAY, A.
Atomnaya En., vol.2, no4, April, 1957, p.395.

Includes graph showing the relation of freight costs to speed for the three cases 1) oil fuelled tanker 2) nuclear fuelled (steam turbine) tanker 3) nuclear fuelled (gas turbine) tanker.

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BOADLE, C.D.
Jt. Pan. Nucl. Mar. Prop. J., April, 1957, pp.5-27.

Includes: comments on types of reactors for ship propulsion and their safety

35. *American contracts for nuclear propulsion projects.*
Motor Ship, vol.37, March, 1957, p.531.

36. *The nuclear propulsion of ships.*
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37. *Japan plans atomic-powered marine.*
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38. *Navy's new nuclear look may shoot the moon for shipbuilding.*
Amer. Mach., vol.100, 8 October, 1956, p.100.

39. *Big shift is already on; navy's atomic fleet.*
Bsns Week, 15 September, 1956, p.154.

40. *Comparative costs for conventional and nuclear powered tanker.*
McMULLEN, J.J.
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41. *Atomic energy and propulsion.*
COCKCROFT, Sir JOHN
Atomics, vol.7, no.7, July, 1956, pp.241-7.

Possibility of harnessing atomic power to propel ships viewed from the engineering and economic standpoints.

42. *Nuclear power can be competitive.*
MADDOCKS, K
Mar. Engng Log, vol.61, July, 1956, pp.65-70.

43. *How will nuclear power affect you?*
Mar. Engng Log, vol.61, June, 1956, pp.92-5.

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Nucleonics, vol.14, no.6, June, 1956, pp.18B-19A.

45. *Outlook for nuclear merchant fleet.*
Nucleonics, vol.14, no.5, May, 1956, pp.73-6.

On question of economic feasibility, there are two divergent views in Government; Maritime Administration is highly optimistic as to chances for atomic tanker to be competitive in immediate future, whereas U S Navy is not so optimistic; considerations regarding need for new type of merchant ship propulsion, types of ships involved and design problems

46. *Nuclear propulsion.*
MADDOCK, K.
Mar. Engng, vol.61, March, 1956, p.70.

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RICKOVER, H G
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49. *Nuclear power plants for marine tanker service*
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Landbased plant information is used to give insight into possible use of atomic power for propulsion of marine tanker; economic comparison between nuclear and conventional fuels

50. *Development of a nuclear-powered merchant ship.*
Bull. Atomic Scient., vol.11, no.6, June, 1955, pp.229-30.

Details from the hearings held by the Joint Committee on Atomic Energy on 5 May 1955

51 *Prospects of utilization of atomic power plants in sea transport vessels* [In Russian]
PETROVSKII, N and KLEMENTEV, A
Morskoi Flot, vol.12, 1955, pp.16-7.

52. *Impact of nuclear power on submarines.*
KITTREDGE, G W
U.S. Naval Inst. Proc., vol.80, no.4, April, 1954, pp.419-25.

Development of submarines and submarine warfare is traced from World War 1 through adoption of snorkel and campaigns of World War 2 to show limitations of electric power plant and submerged speeds; with nuclear power plant of unlimited energy, cargo carrying submersibles, such as tankers of 10,000 to 15,000 tons as well as attack vessels is envisaged

53 *How economical is nuclear power for ships?*
Mar. Engng, vol 59, March, 1954, pp.39-40.

54. *Nuclear energy and sea power.*
STEELE, G P
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55 *Atomic power - where will it pay first?*
ROTH, E B
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56. *Atomic propulsion - with special reference to marine propulsion.*
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Inst Mar. Engrs Trans. vol.65, no.4, April, 1953, pp.105-12.
Amer Soc. Naval Engrs J., vol.65, no.4, November, 1953, pp.715-26.

Factors in conversion of nuclear reactors to produce propulsion power; estimated comparative fuel consumption figures for ships and submarines; present use of enriched reactors for specialised vessels is called "difficult to evisage"

57. *New fuel with a big future.*
Bsns Week, 14 March, 1953, p.94.

58. *Un project de navire atomique.*
DEVAUX, P
Nature (Paris), April, 1950, pp.102-4.

59. *Future developments in nuclear energy.*
GOODMAN, C
Nucleonics, vol.4, no.2, February, 1949, pp.2-16.

Possibility of application of nuclear power to submarines is among aspects considered

60. *Plan atomic power to drive warship.*
Northern Miner, vol.34, no.42, 6 January, 1949, p.18.

61. *Royal Navy and nuclear power.*
DANIEL, R.J.
Engineer, vol.185, no.4810, 2 April, 1948, pp.337-9.
no.4811, 9 April, 1948, pp.362-3.
Mar. Engr. vol.71, no.850, April, 1948, pp.169-70.
Engineering, vol.165, no.4292, 30 April, 1948, pp.428-31.

Problems considered under three main sub-headings including nuclear energy as a source of power in ships for propulsion and auxiliaries.

SECTION II : DESIGN AND EXPERIMENTAL DETAILS

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WESTINGHOUSE ELECTRIC CORPORATION
Atomic Power Division, Pittsburgh
Study of the ventilation requirements for power reactor compartments: naval reactor programme, by W.O. Passarelli.
14 May, 1951. pp.41.

Calculation of radioactivities and allowable leakage rates of reactor coolant Variables expressed so that the data calculated are in a general form and applicable to any thermal reactor system (provided the corrosion products in the reactor coolant are the same)

63. AECU 3596

GENERAL DYNAMICS CORPORATION, San Diego, California.
Calculation of effect of fuel burn-up on fuel and poison distribution in the marine reactor, by G. Hinman. 29 January, 1957.
pp.25.

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AMERICAN RADIATOR AND STANDARD SANITARY CORPORATION, Redwood City, California.
Ship design trend survey for the Atomic Energy Commission Maritime Reactors Branch, by D.L. Conklin and others.
13 June, 1957. pp.22.

65. ATC-54-12

AMERICAN TURBINE CORPORATION, New York.
Design study-60Mw closed cycle gas turbine nuclear power plant. December, 1954. pp.54.

Data based on the assumption that a graphite moderated enriched fuel reactor designed for conversion or breeding is employed

66. BSC-2054-11 (Rev.)

BETHLEHEM STEEL COMPANY, Quincy, Massachusetts
Annual progress report, 30 September, 1954 to 30 September, 1955: USAEC study agreement. 30 September, 1955. pp.41.

Design effort on a nuclear powered merchant vessel, nuclear powered distilling plant and a general survey of reactor types to determine applicability of each to marine propulsion

67. CF-54-8-236 (Del.)

OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY, Oak Ridge.
Homogeneous reactor for ship propulsion: reactor design and feasibility problem, by P.R.Clark and others. August, 1954.
pp.134.

68. JENER 43

JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH. Kjeller, Norway.
Atomic propulsion of merchant ships: short progress report for 1955 by the Kjeller Group. March, 1956. pp.20.

Vessels powered by thermal, heterogeneous, boiling (heavy or light) water moderated and cooled reactors are considered in these preliminary economic and technical feasibility studies The former shows that under certain conditions nuclear powered vessels may compete with conventionally powered vessels The technical studies have revealed a number of special problems relating to nuclear propulsion, but none that appears impossible

69. KAPL 552

KNOLLS ATOMIC POWER LABORATORY, Schenectady
The Genie Project: nuclear engineering course, by T. Trocki and others. 12 May, 1949. pp.14.

Early engineering design considerations for reactor cooling and heat transfer systems applicable to submarines are discussed

70. KAPL-M-RMM-2

KNOLLS ATOMIC POWER LABORATORY, Schenectady.
Shock and vibration in naval reactors, by R.M. Mains. 31 October, 1957. pp.43.

71. M 6159

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan.
Nuclear heat power systems for merchant ships, by H.A. Ohlgren and others. 4 December, 1956. pp.12.

72. NNSD-4 (Del.)

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, Newport News, Virginia.
Nuclear ship propulsion study; interim technical report. March, 1954. pp.20.

Comparison of weight and space requirements of another plant compared with a conventional oil-fired plant, and estimation of the preferred power range, if one exists, which favours a nuclear plant

73. NNSD-9 (Del.)

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, Newport News, Virginia.
Nuclear ship propulsion study. Interim technical report. 1 July, 1954. pp.37.

The application of a 102 Mw pressurized water reactor power plant to a C4-S1-A mariner merchant vessel is evaluated The ship, reactor and steam plant are described, methods of waste discharge are considered, and the effects of shield weight and core lifetime on ship operation discussed

74. NNSD-15 NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, Newport News, Virginia.
Nuclear ship propulsion study. Interim technical report no.3 covering period 1 July - 1 November, 1954, by J.B. Woodward. 1 November, 1954. pp.33.

Operation of the reference design nuclear ship propulsion plant was studied in all situations. Comparisons made between oil-fired and nuclear plants in steady-steaming performance, normal manoeuvring performance, startup and shutdown, refueling procedures, drydocking procedures, primary system maintenance, and engine department crew requirements. The effect of fission product transients on manoeuvrability and operation under emergency conditions are also discussed.

75. NNSD-NSPS-1002 NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, Newport News, Virginia.
Nuclear ship propulsion study project - analysis of temperature transients in pressurized water reactor systems, by J.B. Woodward. 1 July, 1955. pp.33.

76. NNSD-NSPS-1008 NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY, Newport News, Virginia.
Influence of shield configuration on cargo capacity of nuclear powered ships, by O.H. Kleeper. 16 January, 1956. pp.51.

77. NP 6414 ALL STATES DESIGN AND DEVELOPMENT COMPANY INC., Trenton.
Transient analysis of emergency cooling systems for submarine nuclear reactors, by H.A. Harrington and others. 1957. pp.127.

78. NP 6567 SWEDISH SHIPBUILDING RESEARCH FOUNDATION, Goteborg.
Atomic power for ship propulsion. A survey of available information. 1956. pp.20.

Types of atomic reactors for ships; weight and space requirements for atomic plant; operational control of the reactor machinery; renewal of fuel rods; problems of safety; schematic arrangements for 20,000 s.h.p. atomic machinery for a tanker; insurance of atomic powered ships; costs of atomic power; plans for atomic power ship propulsion by some of the major powers.

79. NRL-4668 NAVAL RESEARCH LABORATORY, Washington.
Naval Research Laboratory Research Reactor: pt.1, instrumentation tests at Oak Ridge National Laboratory, by C.W. Peters and others. 10 November, 1955. pp.18.

80. NRL-4729 NAVAL RESEARCH LABORATORY, Washington and BROOKHAVEN NATIONAL LABORATORY, Upton.
Naval Research Laboratory Research Reactor: pt.2, *reactivity measurements on a graphite and water reflected core,* by E.H. Bebbs and others. 27 March, 1956. pp.28.

81. TID 7539 — UNITED STATES ATOMIC ENERGY COMMISSION and MARITIME ADMINISTRATION.
Nuclear powered ship for American ship operators: a symposium held at Washington, 30 July, 1957. 30 July, 1957. pp.196.

Marine applications of nuclear power are discussed with regard to maritime regulations and marine insurance. The designs of the first nuclear merchant vessel and its pressurized water reactor are given. Other reactor designs proposed are boiling water, organic moderated and gas cooled reactors.

82. WAPD-152 — WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division, Pittsburgh.
Shock design notes, by C.M. Friedrich. July, 1956. pp.77.

Special problems in shock analysis in connection with nuclear power plant design for submarines are considered.

83. WAPD-CE-43 — WESTINGHOUSE ELECTRIC CORPORATION,
Atomic Power Division.
Design basis for reactor vessels, by B.F. Langer. 18 October, 1955. pp.14.

Basis of design of reactor pressure vessels for naval service.

84. WAPD-S5W-C-288 — WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Engineering report of S5W [attack type submarine reactor] condensate pot: calculations and results, by G.H. Hasley.
26 December, 1956. pp.12.

85. WAPD-S5W-TH (S)-352 — WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Result of investigation on recommendations concerning the SSN 585 [attack type submarine reactor] coolant pressurizing system contained in the report of the S5W fluid system review committee, by J.A. Logan. 7 January, 1957. pp.4.

86. WAPD-SFR-S.86 — WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
SSN578 [Submarine Fleet Reactor] coolant purification system; design description, by W.J. Sigley. 25 September, 1956. pp.29.

Includes: coolant purification system of SSN 579 [Submarine Fleet Reactor]. Equipment, components, piping, instruments, controls, protective devices, principles of operation, and safety precautions.

87. WAPD-TH-290 — WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Pressure drop through S3W Submarine Fleet Reactor bottom plate orifice model, by B.W. LeTourneau and R.D. Oldenkamp.
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89. *O.M.R. and ship propulsion.*
PAULSEN, F.R.
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90. *Ship propulsion by nuclear power: pt.1.*
ILLIES, K.
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91. *Design of the power plant for the first nuclear merchant ship.*
WHITELAW, R.L.
4th Nuclear Science & Engineering Conference, Chicago, 17-21 March, 1958, paper 69. pp.19.

92. *Reactor physics and core design for the merchant ship reactor.*
WOOD, P.M. and LEVINE, Z.
4th Nuclear Engineering and Science Conference, Chicago, 17-21 March, 1958, paper 96. pp.19.

93. *Propulsion of ships by steam turbine machinery [including propulsion by nuclear reactors].*
BROWN, T.W.F.
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94. *Guiding nuclear subs.*
Electronics, vol.31, no.10, 7 March, 1958, p.28.

95. *Some aspects of the design of a pressurized water, ship reactor.* [*In German*]
BACHMANN, H.G.
Atomkern En., vol.3, no.2, February, 1958, pp.53-5.

96. *100 ton reactor vessel for nuclear surface ship.*
Heat Engng, vol.33, no.1, January-February, 1958, pp.114-6.

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MacMILLAN, D.C.
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98. *Nuclear reactors for ship propulsion.* [*In Dutch*]
MUYSKEW, M.
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99. ***Nuclear ship propulsion: an analytical approach.***
BAUER, S.G. and KENDON, M.H.
Nucl. Engng, vol.2, no.21, December, 1957, pp.499-503.

100. ***Nuclear propulsion of ships.***
HINTON, Sir CHRISTOPHER and MOORE, R.V.
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Shipp. World, vol.137, no.3362, 4 December, 1957, pp.481-4.
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101. ***Fluid-fuel reactors for nuclear merchant ships.***
ELLIS, C.B.
Soc. Nav. Arch. Mar. Engrs, paper 11 for meeting 14-15 November, 1957. pp.17.
Shipbuild., vol.65, no.602, mid April, 1958, pp.281-6.

102. ***Some problems in the application of nuclear propulsion to naval vessels.***
RICKOVER, H.G. and others.
Soc. Nav. Arch Mar. Engrs, paper 12 for meeting 14-15 November, 1957. pp.18.
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103. ***Closed cycle boiling water reactor.***
SHAKELFORD, M.H. and MORRELL, R.C.
Mar. Engng/Log, vol.62, November, 1957, pp.88-9, 154.

Engineering and economic characteristics of a nuclear tanker powered by an AMF closed cycle, boiling water reactor.

104. ***Nuclear merchant ships:*** pt. 1, ***first U.S. ship nears the ways;*** pt. 2, ***advanced ship reactors;*** pt. 3, ***world wide efforts.***
Nucleonics, vol.15, no.11, November, 1957, pp.78-87.

105. ***Nuclear propulsion notes: details of the U.S. passenger/cargo ship.***
Mar. Engr, vol.80, no.974, November, 1957, p.408.

106. ***Nuclear merchant ship propulsion plant: status report.***
HASEK, C.W.
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107. ***Nuclear power trends.***
MOORE, W.T.
Amer. Soc. Mech. Engrs, paper 57-PWR-9, presented at A.S.M.E. Power Division Conference, Allentown, Pennsylvania, 21-23 October, 1957. pp.14.

Reviews types of U.S.A. reactors. Describes design for the first U.S. merchant ships.

108. ***Basic details of the first nuclear ship.***
MacMILLAN, D.C.
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109. *Design of the first nuclear plant.*
GRIMES, R P
Mar Engng/Log, vol.62, October, 1957, pp.88-90.

110. *Nuclear technology - ship propulsion design with gas turbines.* [*In German*]
ILLIES, K
Atomkern En., vol.2, no.10, October, 1957, pp.368-76.

111. *Ship propulsion with enclosed gas turbines and gas cooled reactors* [*In German*]
BAMMERT, K
Atomkern En., vol.2, no.10, October, 1957, pp.381-4.

112. *Special nuclear reactors for ships.* [*In German*]
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Atomkern En., vol.2, no.10, October, 1957, pp.385-90.

113 *Calder-Hall-type unit for tankers.*
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114. *The Soviet atomic icebreaker "Lenin."*
Shipb. Shipp. Rec., vol.90, no.11, 12 September, 1957, pp.342-3.

115. *Nuclear ship-propulsion with reactors of the gas-cooled, graphite-moderated type.*
Shipb. Shipp. Rec., vol.90, no.10, 5 September, 1957, pp.304-6, 313.

Adaptation of Calder Hall equipment for marine purposes is discussed

116. *Atomic engines for ships.* [*In Russian*]
LAKHANIN, V V
Atomnaya En., vol.3, no.9, September, 1957, pp.222-7.

117. *Nuclear propulsion of merchant ships.*
Motor Ship, vol.38, September, 1957, pp.273-7

Synopsis of papers presented at a conference on the nuclear propulsion of merchant ships Includes: "The nuclear powered passenger-cargo ship"; "Gas-cooled reactor concepts", and "The outlook for improvements in pressurized water reactors for marine propulsion"

118. *Hamburg Reactor Conference of The Study Group for the Promotion of the Application of Nuclear Energy in Shipbuilding and Ship Propulsion, 3-6 June, 1957.* [*In German*]
Atomkern. En., vol.2, no.8/9, August/September, 1957, pp.285-320.

Includes: developments in the field of power reactors; some aspects of light water moderated reactors for power applications; safety requirements on board a nuclear propelled tanker; does the handling of fuel elements present a problem in a nuclear propelled tanker; the work of the Atomic Energy Committee of the Shipbuilding Research Establishment in Sweden; the proceedings of the Japanese Research Committee for application of nuclear propulsion to shipping; special problems in reactor cooling; the influence of the cooling medium on the design of a power reactor; research on the radiation stability of reactor materials; problems in the automatic control of the Karlsruhe research reactor FR 2; electronic computations in reactor design

119. *Nuclear powered tanker at the design stage.*
Times Rev. Ind., August, 1957, p.45.

120. *The atomic ship shapes up.*
WINSLOW, R.K.
Newsweek, vol.50, 29 July, 1957, pp.53-6.

121. *Nuclear power for the propulsion of merchant ships.*
SMITH, S.L. and RICHARDS, J.E.
Instn of Engrs & Shipbldrs in Scotland, paper 1228, 25 June, 1957. pp.28.
Engineer, vol.204, no.5294, 12 July, 1957, pp.46-9.
Shipping Wld & Wld Shipb., vol.136, no.3339, 26 June, 1957, pp.615-6.
Mar. Engr (Lond.) vol.80, no.972, September, 1957, pp.327-31.
" " " " no.973, October, 1957, pp.383-5.
Shipbuild., vol.64, no.596, November, 1957, pp.627-33.
Jt. Pan. Nucl. Mar. Prop. J., vol.2, no.1, April, 1958, pp.26-40.

A review is first made of nuclear fuels and fuel costs, and types of reactor available. The prospects for the commercial application of nuclear power to ship propulsion are then considered and a study made of the permissible cost for a tanker of 47,000 tons d.w. Some considerations of the engineering problems and safety precautions conclude the paper.

122. *Application de l'energie nucleaire a la propulsion des navires marchands.*
CAHEN, G. and RICARD, J.P.
Assoc. Tech. Maritime et Aeronautique, paper read June, 1957, pp.30.

123. *Heavy-water marine reactor mooted.*
Times Rev. Ind., June, 1957, p.42.

124. *Nuclear G.T. marine propulsion unit.*
Oil Eng., vol.24, no.284, Mid April, 1957, pp.474-6.

Some considerations for a single-loop closed-cycle nuclear gas turbine particularly for merchant ships.

125. *Nuclear propulsion of merchant ships.*
Motor Ship, vol.38, April, 1957, pp.18-9.

Technical and economic study of atomic tankers prepared for Norwegian shipowners.

126. *Closed cycle gas turbine nuclear propulsion plants for merchant ships.*
GIBLON, R.P. and KURZ, G.H.
Shipb. Shipp. Rec., vol.89, 7 March, 1957, pp.303-5.
14 March, 1957, pp.345-7.
21 March, 1957, pp.376-8.
Shipbuilder, vol.64, April, 1957, pp.199-213.
Soc. Nav. Arch. Mar. Engrs, N.Y. Met. Sec., paper to January, 1957 meeting. pp.65.

Aspects considered include reversing methods, starting, and control systems. Reactor design is considered with a discussion on cooling, fuel elements, control rods, pressure vessels, arrangement of machinery, and safety.

127. *Problems of nuclear ship propulsion*
Nucl. Engng, vol.2, no.12, March, 1957, pp 93-5

Nuclear propulsion of ships cannot come about simply by the installation of a land based design in a sea-going craft Ship propulsion raises many issues which are not encountered in stationary power units; these concern basic design, detailed engineering and international collaboration

128. *20 000 s.h p. nuclear propulsion plant*
GIBLON, R P and KURZ, G H
Motor Ship, vol.37, March, 1957, pp.518-22.

Design study for closed cycle gas turbine propulsion plants described and details also given of reactor design

129. *Nuclear power for a tanker*
Mar. Engng, vol.80, February, 1957, pp.63-4

130. *Atomic propulsion for ships.*
Fairplay (Annual Bunkering number), 24 January, 1957, p 8.

Review of U S proposal for design and construction of a nuclear passenger and cargo ship having length of 595 ft beam of 68 ft and being powered by a pressurized water reactor providing 22,000 s h p Need for U K work is emphasised

131. *Research into atomic ships*
J. Comm., Shipbuild. & Engng Ed., 17 January, 1957, p 2

Mitsubishi Heavy Industries Company in Japan are preparing designs for two atomic-powered oil tankers, one of which will be a submarine of 20,000 tons d w with a length of 540 ft a beam of 69 ft , and a submerged speed of 22 knots Tests have determined the amount of water pressure the vessel's hull could stand and the safe depth to which she could dive with a full cargo of oil

132. *Nuclear propulsion. Reactor 'steam turbine proposed by DeLaval.*
Shipp. World, vol.136, 2 January, 1957, p.16.

Dry saturated steam generated in a heterogeneous boiling water reactor is condensed and slightly cooled in a heat exchanger The reactor shielding is such that the secondary steam generated in the heat exchanger is not radioactive ' This steam is collected in a drum which supplies the main turbine, turbogenerators, and turbo-feed pump, and these can be fed from a stand by boiler if the reactor has to be run at a reduced load

133. *Kernenergie fur schiffsantriebe*
ILLIES, K.
Atomwirts., vol.2, January, 1957, pp.5-9.

Work in Germany on a pressurized water reactor with geared steam turbine In the primary circuit water at 160 atm will be heated from 270-290°C and in the heat exchanger saturated steam at 42 atm will be produced for the secondary circuit

134. *Nuclear power-gas turbines or steam turbines?*
BAYLEY, F J.
Mech. World, vol.137, no.3450, January, 1957, pp.6-8.

135. *Application of nuclear energy in shipbuilding and ship propulsion.* [*In German*]
RICHTER, F.
Bremen Chamber of Ind. & Comm. J., no.11, 1957, p.6

136. *Construction of an atomic ice-breaker* [*In Russian*]
Sudostroenic, vol.23, no 1, 1957, pp.11-3.

137. *Nuclear propulsion plant for a tanker* [*In German*]
ILLIES, K
Hansa, vol.93, 22 December, 1956, pp.2458-61.

Design and layout of the propulsion machinery in the tanker Vessel has a length of 590 ft and a deadweight capacity of 22,000 tons Geared steam turbine provides a maximum of 10,000 s h p at 105 r p m , and the speed is 16 knots

138. *Possibilities for the application of atomic energy in industry and shipping.* [*In German*]
Hansa, vol.93, 22 December, 1956, pp.2456-8.

Description of pressurised-water reactor as used in the Nautilus Consideration of shielding, moderators, coolants, stresses and vibrations

139. *Marine plants for nuclear propulsion.* [*In Polish*]
NOCON, P.
Budownictwo Okretowa, vol.1, November-December, 1956, p.292.

Mention of Russian nuclear icebreaker, having three propellers all at the stern

140. *Nuclear reactors for power.*
LEPPERT, G.
Amer. Soc. Nav. Engrs J., vol.68, no.4, November, 1956, pp.633-46.

141. *Simple, safe, low-cost reactor.*
Mar. Engng, vol.61, November, 1956, pp.68-9.

A E C contracts with Ford Instrument Co to study closed cycle, gas cooled reactor for a tanker 707 ft long with a capacity of 38,000 tons d w

142. *Cheaper atom power for the sea.*
Bsns Week. 6 October, 1956, pp.187-8.

Ford Instrument Co to conduct research into closed-cycle gas cooled power reactors for oil tankers

143. *Nuclear propulsion: Escher Wyss closed-cycle gas turbine proposal.*
Shipp. World, vol.135, 26 September, 1956, pp.275-8.

144. *Atomic review: propulsion.*
Engineering, vol.182, no.4720, 24 August, 1956, pp.252-4.

145. *The liquid-metal-fuel reactor closed-cycle gas-turbine power plant.*
STOUGHTON, L.D and SHEEHAN, T.V.
Mech Engng, vol.78, no.8, August, 1956, pp.669-702.

Nuclear gas turbine power plants could be used for merchant vessels

146. *Metallurgy in atomic power.*
RICKOVER, H G.
Amer. Soc. Naval Engrs J., vol.68, no.3, August, 1956, pp.441-5.

Problems and work in use of metals in application of atomic energy to propulsion of ships

147. *The gas turbine in atomic energy.*
PERKINS, J E.B
Nucl. Pwr, vol.1, no.3, July, 1956, pp.108-13.

Includes: possibility of use in marine propulsion

148. *Nuclear gas turbines.*
Mech. Engng, vol.78, no.7, July , 1956, pp.606-12.

Includes: large gas-turbine reactor plants which could be used in ship propulsion

149. *Bids received for tanker nuclear power plant.*
Prod. Engng, vol.27, May, 1956, p.212.

Short article showing design of gas cooled reactor with a closed-cycle gas turbine power plant submitted by Ford Instrument Co

150. *Nuclear power for commercial vessels.*
MADDOCKS, K
Atomics, vol.7, no.5, May, 1956, pp.151-5, 166.
" " no.6, June, 1956, pp.197-201, 224.
" " no.8, August, 1956, pp.291-5.
" " no.9, September, 1956, pp.309-14.

Following a brief discussion on the principles of fission and reactor operation, five types of reactor suitable for marine use and one type suitable for fuel production, are described and illustrated The gas cooled reactor is selected as most suitable for marine propulsion and a proposed closed cycle gas turbine plant is analysed in some detail Various proposals for the use of nuclear power in specific ships are reviewed, and an economic analysis is made to compare a 30,000 ton d w tanker when operating with an oil fired steam turbine plant and when operating with a nuclear powered closed cycle helium turbine

151. *Atomic power for oil tankers: possible application in marine tanker vessels.*
Atomics, vol 7, no.3, March, 1956, pp.97-9, 110.

Technical summary of power plant and survey of economic features

152. *Survey of atomic power for marine propulsion.*
TACKETT, D E
Nav. Arch. Mar. Engrs. Soc. Bull., vol.11, no.1, February, 1956. pp.14.

A comprehensive summary of reactor theory and technology; kinetics and control, reactor materials, fuels, moderators, reflectors, coolants, control rods, shielding materials, and cladding of structural materials are considered

153. *A Rolls-Royce marine G T. proposal.*
Oil Eng., vol.23, no.271, January, 1956, p.360.

154. *Ships with atomic engine.* [*In Russian*]
ZVONKOV, V
Soviet Fleet, January, 1956. pp.8.

155. *Atomic propulsion for ships.*
DAHL, O
Shipb. Shipp. Rec., Int. Des. Equip. No., 1956, pp.6-8.

Announcement that Norway could adopt atomic ship propulsion at short notice, using Norwegian uranium if it became difficult to obtain oil Question of reactor design and construction is discussed with special reference to the question of protection

156. *Propelling ships by nuclear power: direct use of reactor coolant in gas turbine.*
Engineering, vol.180, no.4691, 23 December, 1955, pp.859-61.

Selects gas cooled reactor as the most suitable and then describes proposed closed-cycle gas-turbine plant supplied from a helium-cooled reactor Comparison of the economics of a cargo vessel powered by a nuclear reactor and by an oil fired steam-turbine plant

157. *Nuclear power for merchant vessels.*
JOHNSON C H and JOHNSON, P.V.
Soc. Nav. Arch. Mar. Engrs, paper December, 1955. pp.23.
Mar. Engng, vol.61, January, 1956, pp.34-41.
February, 1956, pp.74-8.

Description of the general characteristics of the various nuclear power plants and discussion of the possibility of each being used aboard a merchant vessel

158. *Nuclear power plants for ship-propulsion application.*
WITZKE, R L and HAVERSTICK, S A.
Elect. Engng (N.Y.), vol.74, no.2, February, 1955, pp.116-21.
Brit. Motor Ship, vol.35, no.413, August, 1954, pp.188-91.

Application of atomic power in C-4 Mariner class cargo vessel is analyzed; at present nuclear power cannot compete on strictly economic basis with conventional power plants; however, other factors such as weight, space, speed, and range considerations would also enter into any complete evaluation

159. ***Will nuclear fuels run merchant ships?***
CROUCH, H.F.
Amer. Soc. Naval Engrs J., vol.67, no.1, February, 1955, pp.113-20.

Development of "dual purpose" type reactor systems is suggested in place of submarine reactors, which are considered impractical; space and fuel requirements for large liners and cargo vessels, which could use approximately 25,000 s h p developed by nuclear plants; comparisons with present steam practice, questions of safety

160. ***Atomic power on shipboard - lets be practical.***
CROUCH, H.F.
Amer. Soc. Naval Engrs J., vol.66, no.2, May, 1954, pp.290-302.

Practical aspects of nuclear energy, particularly heat generating source, when applied to shipboard, including operation of nuclear reactor and nuclear fuel

161. ***Designing a submarine power plant***
KUYPER, W.W
Gen. Elect. Rev., vol.56, no.5, September, 1953, pp.26-7, 60.
Amer. Soc. Naval Engrs J., vol.66, no.1, February, 1954, pp.211-4.

Problems in application of nuclear power to submarine; reactor requirements; distinctions brought out between conventional power plants and components of nuclear system

UNITED STATES PATENT SPECIFICATION

162. 2,727,996 *A thermal neutron shield and method for making same,* by T. Rockwell and V.L. McKinney. 20 December, 1956.

Shield described is of low weight and bulk and is suitable for use in planes and ships Shield comprises a matrix of a malleable metal, such as zirconium or aluminium, in which is dispersed a refractory material, boron oxide or boron carbide, in pellet form A sheathing of aluminium or stainless steel is bonded to it

(2) LARGE SHIP REACTOR AND CARRIER VESSEL REACTOR

REPORTS

163. NP 6338 MINE SAFETY APPLIANCES COMPANY, Callery, Penna.
Progress report no. 40 for April and May, 1957, by W.J. Posey.
13 June, 1957. pp.26.

Includes: hydrodynamic testing of CVR flow channels

164. NP 6428

MINE SAFETY APPLIANCES COMPANY, Callery, Penna.
Progress report no. 41 for June and July, 1957, by W.J. Posey. 15 August, 1957. pp.15.

Includes: hydrodynamic testing of CVR flow channels

165. WAPD-A1W(FE)-291

WESTINGHOUSE ELECTRIC CORPORATION
Atomic Power Division, Pittsburgh.
Extrusion - preliminary evaluation, by A.F. Steeves. 8 March, 1956. pp.3.

Extrusion of zircaloy 2 ingots to evaluate the feasibility of extrusion as a potential means of cost reduction

166. WAPD-A1W(IM)-3

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Investigation of burnout heat flux in rectangular channels at 2000 p s.i.a., by H.S. Jacket and others. 5 December, 1955. pp.52.

167. WAPD-A1W(M)-71

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Second interim report on the corrosion behaviour of zircaloy-3, by S. Kass. 8 March, 1956. pp.21.

168. WAPD-A1W(M)-307

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
MTR A-33 pressure tube feasibility study, by M. Doumas and W.R. Gibson. 4 April, 1956. pp.13.

Details of pressure tube capable of proof testing up to 24 in long A1W sub-assemblies

169. WAPD-A1W(P)-82 and Addition.

WESTINGHOUSE ELECTRIC CORPORATION
Atomic Power Division.
Table of $\Gamma(\tau)$, by O.F. Swift. March, 1956. pp.44.
Addendum May, 1956. pp.12.

$\Gamma(\tau)$*, used in the inhour formula for computing reactivity, has been evaluated for approximately 2000 values of* τ *and six groups of delayed neutrons*

170. WAPD-A1W(PCh)-18

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Predicted A1W primary water conditions by Y. Soloman and P.E. Brown. December, 1955. pp.9.

Water conditions in a carbon steel carrier vessel reactor plant have been examined for a variety of operating conditions Three types of feed water have been considered: deaerated, de-oxygenated and non-deaerated Water conditions for component design, testing, and equipment specification are given.

171. WAPD-A1W(PCh)-46

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Investigation of unclad carbon steel for pressurizer applications, by P.E. Brown and K. Katz.
25 January, 1956. pp.69.

Corrosion test results for conditions simulating pressurizer operations to examine the possibility of using unclad carbon steel.

172. WAPD-A1W(PCh)-61

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Results of examination of carbon steel pipe and small heat exchanger removed from NRTF, by R.S. Gilbert.
1956. pp.10.

Examination of activity levels and corrosion.

173. WAPD-A1W(PCh)-89

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Additional test results covering effects on carbon steel of exposure to reactor irradiation and high temperature, high pressure water, by E. Lieberman. 1956. pp.8.

174. WAPD-A1W(PCh)-473

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Report on Nalco test III of the out-of-pile nucleate boiling programme, by R.T. Esper. pp.21.

Effects of nucleate boiling on zircaloy-2.

175. WAPD-A1W(RD)-366 (Rev.)

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Stress analysis of plate-type fuel sub-assemblies, by B.R. Teer and D.E. Nestler. December, 1957. pp.26.

176. WAPD-A1W-(RD)-526

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Ring spring tests, by W.W. Wise and others. 18 May, 1956. pp.18.

Tests to determine the suitability of ring springs for thermally actuated cluster clamping devices and for core clamping devices.

177. WAPD-A1W(RDM)-320

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
Request for technical design approval of the A1W core 1 support plate weldment and the A1W core 1 forged support plate for the purpose of obtaining manufacturing release, by G.W. Hardigg. 1 September, 1956. pp.9.

Also bound with this are:
The effect of repeated impact on the deformation of cruciform sections at room temperature and 600°C, by G Zibrotosky 14 May, 1956 pp 26
A1W support plate welding feasibility and distortion, by J V Marron and J F Gibbons 5 September, 1956 pp 6
Photoelastic study of sub-assembly, by C F Peck and R G Crum August, 1956 pp 8
Thermal stresses and distortions in the A1W core 1 support plate, by J J Lescisin August, 1956 pp 6

178. WAPD-A1W(RDM)-397

WESTINGHOUSE ELECTRIC CORPORATION
Atomic Power Division.
Control rod assembly misalignment study, by W.A. Kerr and J.J. Lescisin. 26 November, 1956. pp.8.

179. WAPD-RM-187

WESTINGHOUSE ELECTRIC CORPORATION.
Atomic Power Division.
CVR pressurizer simulator study, by W.M. Gajewski and J.N. Grace. July, 1953. pp.49.

The response of the primary coolant pressurizing systems to rapid changes in steam plant load is studied by means of analog computer techniques Results are plotted for a range of values of the pressurizer design parameters

(3) SUBMARINE ADVANCED REACTOR

REPORTS

180. KAPL 1726

KNOLLS ATOMIC POWER LABORATORY, Schenectady.
Development of zircaloy-clad, discrete burnable poison elements for S3G/S4G by G.F. McKittrick and W.A. Neisz. 15 June, 1957. pp.29.

181. KAPL-M-AJB-2

KNOLLS ATOMIC POWER LABORATORY.
Fabrication of the first two Y shaped rod extension billets, by A.J..Brown. 26 November, 1956. pp.14.

182. KAPL-M-AME-5

KNOLLS ATOMIC POWER LABORATORY.
S3G seal weld-unit cells to standpile housing, by R.L. Harris. 7 February, 1957. pp.10.

183. KAPL-M-AME-6

KNOLLS ATOMIC POWER LABORATORY.
S3G instrumentation welding, by R.L. Harris.
28 February, 1957. pp.12.

184. KAPL-M-AME-7

KNOLLS ATOMIC POWER LABORATORY.
S3G instrumentation brazing, by D.R. Hauprich.
15 March, 1957. pp.11.

185. KAPL-M-AMS-1

KNOLLS ATOMIC POWER LABORATORY.
Summary of STR-SAR system operating conditions and materials, by S.H. Towne. 15 April, 1954.
pp.16.

186. KAPL-M-AMS-7

KNOLLS ATOMIC POWER LABORATORY.
Initial isolation valve report; S.A.R. project,
by E.R. Hottenstein. 15 October, 1954. pp.27.

187. KAPL-M-CDM-2

KNOLLS ATOMIC POWER LABORATORY.
Three group method for calculation of high critical mass thermal reactors, by C.D. McKeregham.
25 August, 1953. pp.8.

188. KAPL-M-CME-1

KNOLLS ATOMIC POWER LABORATORY.
Hydrogen embrittlement of carbon steel,
by C.M. Erb. 13 July, 1955. pp.5.

189. KAPL-M-DWJ-5

KNOLLS ATOMIC POWER LABORATORY.
Airborne activity from the void space between the SAR reactor pressure vessel and inner wall of the primary shield tank, by D.W. Johnson. March, 1956.
pp.31.

190. KAPL-M-EJ-4

KNOLLS ATOMIC POWER LABORATORY.
Status report on S3G/S4G unit cell mechanical analysis, by E.B. Johansson. 24 August, 1956.
pp.19.

191. KAPL-M-EJ-5

KNOLLS ATOMIC POWER LABORATORY.
S4G unit cell shock analysis, by E.B. Johansson.
14 October, 1957. pp.94.

192. KAPL-M-EL-1

KNOLLS ATOMIC POWER LABORATORY.
S3G/S4G cold water accident analysis, by E. Lantz.
27 April, 1956. pp.34.

193. KAPL-M-ER-2

KNOLLS ATOMIC POWER LABORATORY.
Dose rates on the S3G/S4G boiler and primary coolant piping after shutdown, by E.J. Romesberg.
18 February, 1958. pp.31.

194. KAPL-M-FDJ-4

KNOLLS ATOMIC POWER LABORATORY. *SAR primary coolant impurity activation and demineralizer shielding*, by F.D. Judge. 1956. pp.23.

195. KAPL-M-FTB-1

KNOLLS ATOMIC POWER LABORATORY. *Special physics instrumentation for S3G*, by F.T. Burkett. 16 January, 1958. pp.11.

196. KAPL-M-JAM-1

KNOLLS ATOMIC POWER LABORATORY. *Thermocouple in-pile calibration for S3G*, by J.A. McCann. 4 January, 1956. pp.9.

197. KAPL-M-LBV-8

KNOLLS ATOMIC POWER LABORATORY. *An instrument to measure simulated temperatures in the S3G emergency cooling test loop*, by L.B. Vandenberg and L.A. Hagen. 8 June, 1956. pp.15.

198. KAPL-M-PGL-1

KNOLLS ATOMIC POWER LABORATORY. *Programme for alternate coextension process for reference SAR fuel elements*, by P.G. Lozier. 24 September, 1956. pp.6.

199. KAPL-M-PL-1

KNOLLS ATOMIC POWER LABORATORY. *Investigation of activation foils for S3G flux distribution measurements*, by P.G. Lacey and others. 21 March, 1957. pp.20.

200. KAPL-M-RAD-2

KNOLLS ATOMIC POWER LABORATORY. *Fuel element failure detection and location - estimate of sensitivity D/N system S3G*, by R.A. Dewes. 7 November, 1957. pp.30.

201. KAPL-M-RE-107A

KNOLLS ATOMIC POWER LABORATORY. *Preliminary observations of control housing natural convection flow*, by C.G. Lindquist. 10 December, 1955. pp.5.

202. KAPL-M-RES-32

KNOLLS ATOMIC POWER LABORATORY. *Heat losses from the S3G/S4G reactor pressure vessel, head, and mechanisms and ambient temperatures of the region under the top hat*, by H.F. Carkin and G.O. Mueller. 20 September, 1957. pp.38.

203. KAPL-M-ROF-1

KNOLLS ATOMIC POWER LABORATORY. *Welding of S3G zircaloy 2 instrumented fuel element mounting*, by R.J. Flint. 12 September, 1957. pp.11.

204. KAPL-M-SAT-2

KNOLLS ATOMIC POWER LABORATORY.
Inert tungsten-arc welding of S3G zircaloy channel sections, by S.A. Toftegaard. 14 November, 1956. pp.6.

205. KAPL-M-SAT-3

KNOLLS ATOMIC POWER LABORATORY.
Diffusion bonding of SAR, prototype instrumented fuel element transition joints, by S.A. Toftegaard. 15 March, 1957. pp.7.

206. KAPL-M-SAT-4

KNOLLS ATOMIC POWER LABORATORY.
Guided bend test as a means of qualifying butt welds in zircaloy 2 and 3, by S.A. Toftegaard. 5 April, 1957. pp.12.

207. KAPL-M-SMS-3

KNOLLS ATOMIC POWER LABORATORY.
Basic sub-cooled light water properties. 18 April, 1955. pp.13.

208. KAPL-M-SMS-5

KNOLLS ATOMIC POWER LABORATORY.
Valve operating system, by E.R. Hottenstein. 11 May, 1955. pp.31.

209. KAPL-M-SMS-6

KNOLLS ATOMIC POWER LABORATORY.
SAR radioactive accessibility investigative program, by V.L. Galezunas. 29 September, 1955. pp.23.

Due to proposed use of a carbon steel-water system in SAR, a program directed at solving the new accessibility program is outlined. Properties of the crud, rate of accumulation of radioactive material in components external to the reactor, effect of radioactive crud level in primary coolant water, effect of heat and radiation flux on deposition and release of radioactive crud, and removal of radioactive products from primary coolant water are the five main areas of investigation.

210. KAPL-M-SMS-10

KNOLLS ATOMIC POWER LABORATORY.
Solubility and flow characteristics of ammonium pentaborate columns, by E.L. Shirley and A.P. Walsh. 22 November, 1955. pp.22.

211. KAPL-M-SMS-12

KNOLLS ATOMIC POWER LABORATORY.
Emergency cooling test program, by A.J. Arker and D.E. Davidson. 6 December, 1956 pp.12.

212. KAPL-M-SMS-13

KNOLLS ATOMIC POWER LABORATORY.
Asteadystate dynamic analysis of the S3G/S4G natural circulation steam generator system, by J.C. Westmoreland. 9 January, 1956. pp.32.

213. KAPL-M-SMS-14

KNOLLS ATOMIC POWER LABORATORY. *A transient dynamic analysis of the S3G/S4G natural circulation steam generator system,* by J.C. Westmoreland. 9 January, 1956. pp.28.

214. KAPL-M-SMS-16

KNOLLS ATOMIC POWER LABORATORY. *Elimination of special gas requirements of S3G/S4G plant,* by A. Lagani. 9 February, 1956. pp.20.

215. KAPL-M-SMS-18

KNOLLS ATOMIC POWER LABORATORY. *Reactor pressure and isolation valve closures following a possible leak in the primary coolant system of S3G,* by C.W. Sorenson. 1 March, 1956. pp.40.

216. KAPL-M-SMS-23

KNOLLS ATOMIC POWER LABORATORY. *A preliminary analysis of the thermal states and thermal stresses in the S3G/S4G primary coolant system pressurizer during cold start-up,* by J.C. Westmoreland. 25 April, 1956. pp.33.

217. KAPL-M-SMS-28

KNOLLS ATOMIC POWER LABORATORY. *S3G main coolant system pressure drop and flow,* by D.R. Eifort and W.C. Smith. 8 June, 1956. pp.25.

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KNOLLS ATOMIC POWER LABORATORY
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KNOLLS ATOMIC POWER LABORATORY.
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KNOLLS ATOMIC POWER LABORATORY
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PPA 27 represents the new major design and change in the stress initiated by PPA 25 Geometry, volume, fuel and steel inventory in PPA 27 are the same as in PPA 25, but the 53% beryllium volume fraction of PPA 25 has been replaced by polyethylene, zirconium and aluminium PPA 28 was obtained by adding interstitial polyethylene and boron to PPA 27, and PPA 29 was obtained by adding interstitial fuel and peripheral boron to PPA 27

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KNOLLS ATOMIC POWER LABORATORY.
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349. KAPL-M-TOR-2

KNOLLS ATOMIC POWER LABORATORY.
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350. KAPL-M-WEC-2

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KNOLLS ATOMIC POWER LABORATORY.
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MINE SAFETY APPLIANCES COMPANY, Callery, Penna.
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Includes: tests on the 3000 Kw steam generator.

354. NP-5690

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Progress report no. 28 for April and May, 1955, by J.M. Mausteller. 21 June, 1955. pp.70.

Includes: tests on the 3000Kw steam generator.

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Progress report no. 29 for June and July, 1955, by J.W. Mausteller. 19 August, 1955. pp.53.

Includes: tests on the 3000Kw steam generator.

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MINE SAFETY APPLIANCES COMPANY, Callery, Penna.
Progress report no. 30 for August and September. 1955, by W.J. Posey. 11 October, 1955. pp.78.

Includes: tests on the 3000Kw steam generator.

357. NP-5840

MINE SAFETY APPLIANCES COMPANY, Callery, Penna.
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Includes: tests on the 3000Kw steam generator.

358. NP-5886

MINE SAFETY APPLIANCES COMPANY,
Callery, Penna.
Progress report no.32 for December and January, 1956, by W.J. Posey. 9 February, 1956. pp.72.

Includes: tests on the 3000Kw steam generator.

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MINE SAFETY APPLIANCES COMPANY,
Callery, Penna.
Progress report no. 33 for February and March, 1956, by W.J. Posey. 9 April, 1956. pp.57.

Progress of tests on models of the S2G steam generators and research into liquid metal system components. Study of water - NaK leaks.

360. NP-5935

MINE SAFETY APPLIANCES COMPANY,
Callery, Penna.
Nitrogen containing two per cent oxygen as a sodium system cover gas, by E.F. Batutis and others. 10 April, 1956. pp.22.

361. NP-5991

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Progress report no. 34 for April and May, 1956, by W.J. Posey. 11 June, 1956. pp.73.

Includes: tests on the 3000Kw steam generator.

362. NP-6037

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Removal of entrained gas from a sodium system, by K.R. Barker and J.W. Mausteller. 12 July, 1956. pp.14.

363. NP-6068

MINE SAFETY APPLIANCES COMPANY,
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Progress report no. 35 for June and July, 1956, by W.J. Posey. 9 August, 1956. pp.75.

Includes: tests on the 3000Kw steam generator.

364. NP-6132

MINE SAFETY APPLIANCES COMPANY,
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Progress report no. 36 for August and September, 1956, by W.J. Posey. 10 October, 1956. pp.70.

Includes: tests on the 3000Kw steam generator.

365. NP-6179

MINE SAFETY APPLIANCES COMPANY,
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Progress report no. 37 for October and November, 1956, by W.J. Posey. 13 December, 1956. pp.57.

Includes: tests on the 3000Kw steam generator.

366. NP-6209

MINE SAFETY APPLIANCES COMPANY,
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Includes: tests on the 3000Kw steam generator.

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MINE SAFETY APPLIANCES COMPANY,
Callery, Penna.
Test of proposed design S1G bellows in sodium, by G E. Kennedy and E.C. King. 22 December, 1955. pp.7.

368. NP-6260

MINE SAFETY APPLIANCES COMPANY,
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Progress report no. 39 for February and March, 1957, by W.J. Posey. 12 April, 1957. pp.38.

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MILLER, C.E.
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CREVER, F.E.
Franklin Inst. J., vol.273, June, 1957, pp.575-6.

371. *Troubles with atomic submarine "Seawolf".*
Metal Progr., vol.71, no.3, March, 1957, pp.92, 116.

Consideration of difficulties experienced in the cooling system.

372. *Seawolf runs afoul: navy's atomic submarine is tied up with heat exchanger troubles.*
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HORWAY, G.
Nucl. Engng, vol.1, no.6, September, 1956, pp.231-4.

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BRUGGEMAN, W.H.
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Recent advances in purity control are covered, emphasis being placed on results from the prototype SIR system as well as other unpublished data. Included are chemical and nuclear activation analysis of sodium, filtration data, and details of operation of cold traps and plugging indicators.

375. *Use of zirconium in liquid-sodium systems.*
BOWMAN, F.E. and CUBICCIOTTI, D.D.
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Control of impurities, namely oxygen, hydrogen and nitrogen which affect the attractive properties of zirconium.

376. *Seawolf launched for atomic power test run, features air conditioning and odor control.*
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378. *Atom sub launched into test ball.*
Engng News Record, vol.152, 1 April, 1954, p.26.

379. *Nuclear power plants for ship propulsion.*
CREVER, F.E. and TROCKI, T.
Elect. Engng (N.Y.), vol.73, no.4, April, 1954, pp.331-5.
Brit. Motor Ship, vol.35, no.411, June, 1954, pp.104-7.

Two prototype submarine atomic power plants are being developed: Submarine Thermal Reactor and Submarine Intermediate Reactor; fundamentals discussed and those of gas cooled reactor power plant.

380. *Sub. will be first - atomic power may be near.*
Compressed Air Mag., vol.59, no.1, January, 1954, pp.19-20.

Special structure 225 ft in diameter at Knolls Atomic Power Laboratory, near Schenectady, N.Y. in which tests will be conducted by General Electric Co. of prototype atomic power plant for submarine; two submarines, Nautilus and Seawolf will both be reactor driven, one by reactor to be tested in sphere, and other by Westinghouse STR unit.

381. *Keel laid for second atomic sub. USS Seawolf.*
Mar. Engng, vol.58, November, 1953, pp.59-60.

382. *Atom apple*
PHELPS, H.C.
Weld. Engr. vol.38, no.7, July, 1953, pp.23-6.

Construction details of 225 ft diameter 'Hortonsphere' which will hold prototype of new atomic energy submarine propulsion unit, contained in complete section of submarine hull, sphere is entirely supported from outside by 26 pipe columns; 3850 tons of steel plate used, welding operations described and rigid specification stressed

383. *Sphere is atom sub lab*
Engng News Record, vol.150, no.15, 9 April, 1953, pp 32-4.

Description of welded steel ball 225 ft diameter, erected near Schenectady, NY to be used as laboratory building to test power plant section of atomic submarine hull and will serve as protective device in precautionary measures against escape of fission products during preliminary submarine reactor tests

384. *Submarine reactor building.*
Mech. Engng, vol.75, no.1, January, 1953, pp.29.

Details of spherical design of SIR test building

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CLARK, P.M.
Amer. Soc. Mech. Engrs paper 52-A94 for meeting 30 November - 5 December, 1952. pp.10.

In developing nuclear power for submarine propulsion it was necessary to develop a pump capable of circulating approximately 400 g p m of liquid metal at temperatures up to 750°F and which could tolerate no leakage of liquid metal at shaft; two identical centrifugal pumps were built, pump design, seal development, and operational experience

386. *Reactor that even looks safe; experiments for navy's second atom-powered submarine*
Bsns Week, 8 November, 1952, p.76.

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(5) SUBMARINE THERMAL REACTOR AND "NAUTILUS"

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Report of NRL progress, Washington, June, 1956 pp.46

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389. UNITED STATES. Atomic Energy Commission. Naval Reactors Branch.
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ARGONNE NATIONAL LABORATORY, Lemont.
Critical studies with G.E. type fuel elements, by F.H. Martins and G.F. Helfrich.
August, 1953. pp.39.

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Development of scram-latch components for Mk.1 naval reactor, by D.R. Forry and others.
1 October, 1951. pp.33.

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Idaho Falls, Idaho.
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KNOLLS ATOMIC POWER LABORATORY, Schenectady.
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15 April, 1954. pp.16.

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