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Vol. 7

2

CHEMISTRY—SEPARATION PROCESSES
FOR PLUTONIUM AND URANIUM

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BIBLIOGRAPHY ON NUCLEAR REACTOR FUEL REPROCESSING AND WASTE DISPOSAL

Volume 7

Surveys (General)

T. F. Connolly

Oak Ridge National Laboratory
operated by
Union Carbide Corporation

United States Atomic Energy Commission
Division of Technical Information

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PROCESSING OF NUCLEAR REACTOR FUELS – A BIBLIOGRAPHY

Introduction

This volume includes Section 7.0 of eight sections of a bibliography on nuclear reactor fuel reprocessing and waste disposal. The collection will be a unit, and cross references are made between volumes. The decimal coding of headings is designed for ease of cross referencing, filing, expansion, and for future use in an automatic microfilm viewer-printer now being developed.

Cutoff points are somewhat arbitrary: overlapping into the area of feed materials, for example, is kept to a minimum, even though fuel reprocessing and fuel refabrication can be a continuous operation. Continuous on-site reprocessing of aqueous reactor fuels is only lightly covered.

Section 1.0, Chemistry and Physics of Important Elements, contains many references to separation methods and conditions, particularly on a laboratory scale. Cross references to that section from Sections 2.0, 3.0, and 6.0 – to each of which it may be considered as peripheral – would be too numerous to be included and should be assumed for each element. Special tests or uses (e.g., as construction materials or reagents in standard processes) are treated in the appropriate sections.

The complete collection includes about 7000 abstracts, nearly all from Nuclear Science Abstracts, representing books, bibliographies, symposia, journals, and contractors' topical reports. Most of the material dates from the 1955 Geneva Conference to the present. A serious lack is material from progress reports, and a program for the detailed abstracting and indexing of progress reports is therefore under way at ORNL (with the helpful cooperation of the Cataloging Section of the AEC-DTI Extension).

TABLE OF CONTENTS

SURVEYS (GENERAL) 7.00

	Code	Page
CHEMISTRY AND ENGINEERING	7.01	7.01
CHEMISTRY	7.01.01	7.01
ENGINEERING	7.01.02	7.03
COSTS	7.02	7.04
DECISIVE FACTORS	7.02.01	7.04
METHODS OF COST ANALYSIS	7.02.02	7.07
ESTIMATDD FUTURE COSTS	7.02.03	7.08
SMALL PLANTS	7.02.04	7.10
GENERAL	7.02.05	7.10
FULL CYCLE	7.03	7.13
BURNUP AND POISONING	7.03.01	7.14
BURNUP CALCULATION	7.03.02	7.16
GENERAL	7.03.03	7.17
PLUTONIUM	7.03.04	7.21
THORIUM	7.03.05	7.22
FUEL AND FUEL ELEMENTS	7.04	7.23
AQUEOUS	7.04.01	7.23
CERAMIC	7.04.02	7.24
GENERAL	7.04.03	7.24
GLASS	7.04.04	7.26
DISPERSED FUELS	7.04.05	7.27
LIQUID METAL	7.04.06	7.28
MODERATORS AND POISONS	7.04.07	7.30
PLUTONIUM	7.04.08	7.30
OTHER SOLID FUELS	7.04.09	7.32
UO_2	7.04.10	7.33
INFORMATION SOURCES	7.05	7.35
INTERNATIONAL CO-OPERATION	7.06	7.37
PROCESSES AND METHODS	7.07	7.41
AQUEOUS PROCESS	7.07.01	7.41
GENERAL	7.07.02	7.42
AQUEOUS FUELS	7.07.03	7.48
CONTINUOUS PROCESSING	7.07.04	7.49
BREEDING	7.07.05	7.49

SURVERYS (GENERAL) 7.00

CHEMISTRY AND ENGINEERING 7.01

See also, under CHEMISTRY AND PHYSICS OF IMPORTANT ELEMENTS,

GENERAL--Surveys (1.18.03).

CHEMISTRY 7.01.01

15085

CHEMICAL PROCESSES. J. M. Kay (Imperial Coll. of Science and Tech., [London]). J. Brit. Nuclear Energy Conf. 4, 131-44(1959) Apr.

Second Geneva conference papers on the more important processes peculiar to the nuclear energy industry are discussed in three parts; production of nuclear materials; processing of fuel from thermal reactors; and processing of concentrated fissile materials. (T.R.H.)

CHEMISTRY OF NUCLEAR POWER. J. K. Dawson and G. Long. London, George Newnes, Ltd., 1959. 214p.

The subjects discussed in this volume are: the role of the chemist in the atomic energy industry, raw materials, fission and the fission products, new heavy elements, separation processes, handling of radioactive materials, water-cooled nuclear reactors, gas-cooled reactor systems, disposal of radioactive wastes, and future applications. (W.L.H.)

7171

CHEMICAL-TECHNOLOGICAL PROBLEMS IN THE UTILIZATION OF ATOMIC ENERGY. Karl Winnacker (Farbwerke Hoechst AG, Frankfurt am Main). Chem. Ing. Tech. 31, 301-9(1959) May. (In German)

The peaceful use of atomic energy presents the chemist and chemical industry with new and extensive problems which concern not only production of the fuel and moderator, manufacture of the fuel elements and preparation of the spent atomic fuel, but also the development of new radiation-resistant materials. Furthermore, it makes possible new methods for chemical and technical processes using radioactive fission products; the decontamination of effluent gas and water also produces chemical problems. (auth)

19990 NP-7866

European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.

CHEMICAL PROCESS FLOWSHEETS. Technical Report No. 49, Chapter 140. E. Detilleux, M. Lang, E. L. Nicholson, and A. Redon. [1959]. 55p. $12.30 (ph), $4.50(mf) OTS.

The chemical aspects of the Eurochemic radiochemical processing plant are discussed in detail. Material and activity balances for the two alternative processes of 700 and 350 kg per day are presented. Flowsheets for head end, extraction, tail-end treatments, solvent recovery, and acid recovery are presented. (W.L.H.)

19036 NP-7775

European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.

BASIC CHEMISTRY. Technical Report No. 38, Chapter 120. Sten Ahrland. 1959. 33p. $6.30(ph), $3.00(mf) OTS.

An attempt is made to expound the basic chemistry of the different reprocessing steps chosen for the Eurochemic plant. In some cases alternatives are given when the exact reaction courses are unknown. (C.J.G.)

European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.

RECENT DEVELOPMENTS IN AQUEOUS REPROCESSING OF IRRADIATED URANIUM. Technical Report No. 15. Sten Ahrland. Oct. 1, 1958. 12p. $3.30(ph), $2.40(mf) OTS.

See also Technical Report No. 10 (NP-7667).

A summary of recent developments in aqueous reprocessing of irradiated U is presented. General trends are discussed as well as recent work on dual-temperature scrub and extracting agents such as amines. In addition, a discussion of organic ion exchangers for Pu tail-end treatment is presented along with the use of inorganic ion exchangers such as silica gel and other hydrous oxides for Pu and U separations. Consideration is also given to substituting U(IV) for Fe(II) as a reducing agent for Pu(IV), and the possibility of decreasing the number of extraction cycles is examined. It is suggested that the dual-temperature scrub merits closer investigation as does waste recycling, anion exchange purification of Pu, and the use of amines as extracting agents. (J.R.D.)

CHEMISTRY AND ENGINEERING 7.01

CHEMISTRY 7.01.01

CHEMICAL PROBLEMS IN THE HARNESSING OF NUCLEAR ENERGY. R. Walti. Sulzer Tech. Rev. (Switz.) 40, No. 3, 55-8(1958).

The exploitation of nuclear energy not only poses physical, metallurgical and design problems, but chemical questions also arise over the whole range of reactor engineering. They begin with the search for minerals containing fissile substances and end with "purification," i.e. the treatment of exhausted elements. (auth)

6187 ✓

CHEMICAL ASPECTS OF NUCLEAR POWER. 1. CHEMISTRY AND METALLURGY. F. S. Martin (A.E.R.E., Harwell). Atomics 8, 127-30, 147(1957) Apr.

Some aspects of the collaboration between chemistry and metallurgy in the nuclear industry are briefly discussed. (B.J.H.)

15157

THE CHEMICAL PROBLEMS OF THE NUCLEAR INDUSTRY. Robert Sartorius (Commissariat à l'Énergie Atomique, Paris). p.9-18 of "Journées d'Information sur l'Énergie Nucléaire, 14-15-16 Janvier 1957." Documents, Suppl. to No. 114. France, Commissariat General á la Productivité. 1957. 203p. (In French)

Chemistry must furnish to the nuclear industry its primary materials and it must process the irradiated fuel elements. The constituents of a reactor are listed and the chemical processing required for each is summarized. The new techniques developed include solvent extraction and ion exchange. The special characteristics of a plant treating radioactive materials are briefly described. (J.S.R.)

5282 ✓ AERE-CE/R-1382

Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.

THE PREPARATION AND PROPERTIES OF URANIUM, PLUTONIUM, THORIUM AND THE FISSION PRODUCT CHLORIDES. D. Bradley. 1954. Decl. Nov. 21, 1956. 46p.

SOVIET RADIOCHEMISTRY. A. N. Murin (USSR). Atomnaya Energiya 3, 11, pp. 454-464, 1957.

This is a brief historical review of the development of radio-chemistry in Russia. Matters mentioned include co-precipitation techniques for neptunium, plutonium and americium, mixed crystals, solvent extraction of trans-plutonium elements, ion exchange separation of uranium and thorium; chromatographic separation of trans-uranium elements; analytical methods for uranium, general chemistry of uranium and thorium, determination of protactinium by zirconium amygdalate; separation of neptunium and plutonium, extraction of americium from fission product solutions, chemical properties of plutonium, americium and curium; fission and fission products.

INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, Geneva, 1955. PROCEEDINGS. New York, United Nations, 1955-56. 16 v. $130. (On microcards, $70.) Individual volumes may be purchased separately. For prices see below.)

This is the definitive and unabridged text of the reports and proceedings of the International Conference on the Peaceful Uses of Atomic Energy, held at Geneva, August 8-20, 1955.

Titles of the 16 volumes are: 1—The World's Requirements for Energy: The Role of Nuclear Power, $8; 2—Physics: Research Reactors, $8; 3—Power Reactors, $7.50; 4—Cross-Sections Important to Reactor Design, $7.50; 5—Physics of Reactor Design, $9; 6—Geology of Uranium & Thorium, $9; 7—Nuclear Chemistry and the Effects of Irradiation, $10; 8—Production Technology of the Materials Used for Nuclear Energy, $10; 9—Reactor Technology and Chemical Processing, $10; 10—Radioactive Isotopes and Nuclear Radiations in Medicine, $8; 11—Biological Effects of Radiation, $8; 12—Radioactive Isotopes and Ionizing Radiations in Agriculture, Physiology, and Biochemistry, $9; 13—Legal, Administrative, Health, and Safety Aspects of Large Scale Use of Nuclear Energy, $7; 14—General Aspects of the Use of Radioactive Isotopes; Dosimetry, $6.50; 15—Applications of Radioactive Isotopes and Fission Products in Research and Industry, $7.50; 16—Record of the Conference (an overall report on the sixty technical sessions of the conference). $5.

CHEMISTRY AND ENGINEERING 7.01

CHEMISTRY 7.01.01

6506 A/CONF.15/P/307
THE CHEMICAL PROCESSING OF IRRADIATED FUELS FROM THERMAL REACTORS. G. R. Howells, T. G. Hughes, D. R. Mackey, and K. Saddington (United Kingdom Atomic Energy Authority, Sellafield, Cumb., Eng.). 49p.

The chemical plants located at the Windscale Works of the U.K. Atomic Energy Authority are designed to process natural or near-natural uranium fuels discharged from thermal reactors. The purpose is to separate the uranium and plutonium in pure forms from the associated fission products and from one another. This is accomplished by the use of solvent extraction methods after dissolution of the fuel rods in nitric acid. The organic solvents used at different stages of the process are dibutoxytetraethylene glycol ("Butex") and tributyl phosphate diluted with kerosene. The pure uranyl nitrate solution is returned to the Springfields Works for further treatment prior to re-enrichment

ENGINEERING 7.01.02

THE NUCLEAR HANDBOOK. O. R. Frisch. London, George Newnes Limited, 1958. 650p.

This is a reference book in the field of nuclear physics. The volume is divided into 19 sections: concepts in nuclear physics, radiation effects and protection, elements and isotopes, natural radioactivity, materials, vacuum, particle accelerators, x-rays and gamma rays, neutrons, fission products and transuranic elements, reactors, chemistry, ion chambers and computers, electronics, deflection techniques and magnetic materials, cloud and bubble chambers, nuclear emulsions, and nuclear reactions. (W.L.H.)

7144
THE ROLE PLAYED BY CHEMICAL INDUSTRY IN NUCLEAR ENERGY. Robert Sartorius. pp. 201-29 in "Proceeding of the Scientific Congress, Nuclear Sessions, July 2-6, 1956, 3rd. Electronic-Nuclear International Review." Rome, National Committee for Nuclear Research, 1956. 447p. (In French)

The chemical processing of uranium, as well as moderators and structural materials, is reviewed. The new chemical techniques, such as ion exchange resins and solvent extraction, are described. Remote-controlled plant installations for the processing of radioactive materials are discussed. (J.S.R.)

17479
TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY. A Supplement to Nuclear Science and Engineering, Volume 1, Number 1, June 1958. New York, Academic Press, Inc., 1958. 192p.

The programs and technical summaries of the papers presented at the national meeting of the American Nuclear Society at Los Angeles June 2-5, 1958, are presented. Papers are included on reactor theory, kinetics, and engineering, corrosion, metallurgy, chemistry and processing, shielding, etc. (W.D.M.)

10133
ADVANCES IN CHEMICAL ENGINEERING. VOLUME I. Thomas B. Drew and John W. Hoopes, Jr., eds. New York, Academic Press Inc., 1956. 448p.

Review articles are presented on the following: boiling of liquids; fluid mechanics, mixing, and heat transfer in non-Newtonian materials; theory of diffusion; turbulence in thermal and material transport; mechanically aided liquid extraction; automatic computer in manufacturing operations; and radiation effects on chemical and biological processes. (C.W.H.)

NUCLEAR ENGINEERING HANDBOOK. First Edition. Harold Etherington, ed. New York, McGraw-Hill Book Company, Inc., 1958. 1872p.

This handbook is divided into fourteen major sections. These sections include: mathematical data and general tables; nuclear data; mathematics; nuclear physics; experimental techniques; reactor physics; radiation and radiological protection; control of reactors; fluid and heat flow; reactor materials; chemistry and chemical engineering; nuclear power plant selection; mechanical design and operation of reactors; and isotopes. (W.L.H.)

5676
ADVANCES IN NUCLEAR ENGINEERING. VOLUME I. John R. Dunning and Bruce R. Prentice, eds. New York, Pergamon Press, 1957. 530p.

Papers are presented on manufacture, production, recovery, and economics of nuclear fuels, spent fuel processing, plant containment concepts and design, plant components, waste disposal, protection and safety measures, and radiation processing. (M.H.R.)

CHEMISTRY AND ENGINEERING 7.01

ENGINEERING 7.01.02

NUCLEAR CHEMICAL ENGINEERING. Manson Benedict and Thomas H. Pigford. New York, McGraw-Hill, 1957. 594 p. $9.50.

"This text describes the materials of importance in nuclear reactors and the novel processes which have been developed to concentrate, purify, and separate these materials." Preface.

CHEMICAL PROCESSING AND EQUIPMENT; Selected Reference Material. U. S. Atomic Energy Commission. (AECD-5276) Washington, Government Printing Office, 1955. 302 p. $2 (paper). Also published by McGraw-Hill Book Co., New York. $6.

Describes the chemical processing of reactor fuel elements at the Idaho Chemical Processing Plant.

COSTS 7.02

See also, under FISSION PRODUCT, POISON, AND RADIOISOTOPE REMOVAL,

COSTS (2.13),

and,

under FISSIONABLE MATERIAL--RECOVERY,

RECOVERY OF IRRADIATED TH AND U--Costs (3.02.06),

and,

under WASTE TREATMENT AND DISPOSAL--Costs (8.01).

DECISIVE FACTORS 7.02.01

WHICH FOR MINIMUM FUEL COST—ZIRCALOY OR STAINLESS CLAD? Norman Beecher (National Research Corp., Cambridge, Mass.) and Manson Benedict (Massachusetts Inst. of Tech., Cambridge). Nucleonics 17, No. 7, 64-7; 100(1959) July.

Costs were compared, based on recent AEC prices, for Zircaloy-2 and stainless steel cladding in a pressurized water reactor. Zircaloy-2 offers a lower fuel cost for burnups > 12,000 Mwd/ton. Nomenclature, basic prices, and other data are listed. (A.C.)

PRINCIPAL ECONOMICAL QUESTIONS CONCERNING THE PROCESSING OF IRRADIATED FUELS. Jiří Beránek (Chemical Project, Prague). Jaderná energie 5, 117-23(1959). (In Czech.)

The influence of the principal factors on the economic efficiency of the processing of irradiated fuels was evaluated. The influence of burnout is discussed, and the necessary conditions for economical reprocessing are set. For a given system of reactors the costs of different fuel cycles are analyzed. The minimum economical capacity of a processing plant is set out, and the influence of the transport distance from the power stations to the plant is determined. (auth)

23046 TID-7559(Pt.1)(Paper 1)
Division of Reactor Development, AEC.
FUEL CYCLE DEVELOPMENT. Clark Goodman.
Paper 1 of FUEL ELEMENTS CONFERENCE HELD AT GATLINBURG, TENNESSEE, MAY 14-16, 1958.
8p.

Nuclear power costs are discussed in terms of three general areas: capital costs, operating costs, and fuel cycle costs. The general features of the fuel cycle development program are outlined and a few of the important problems this program is expected to solve are discussed. Among the many problems to be solved are the fuel lifetime, cost reduction in chemical processing and waste disposal, cost reduction in fabrication, and the development of Pu and U^{233} as fuels for power reactors. (W.D.M.)

8722 CRCE-695
Atomic Energy of Canada Ltd. Chalk River Project. Chalk River. Ont.
CONTRIBUTION TO POWER COST BY SHEATHING MATERIALS. J. Y. Glass. Dec. 1957. 26p. (AECL-547). $1.00(AECL)

The contribution to power cost by three fuel sheathing materials, aluminum-nickel alloy. Zircaloy-2, and stainless steel, was estimated. Uranium oxide. in pellet form, was considered as the fuel material. Since aluminum-nickel alloys are not as corrosion resistant to high temperature water as is Zircaloy-2. a method is presented to determine the corrosion resistance such alloys would have to have to compete economically with the Zircaloy-2 as sheathing materials. The results of this study show that if Zircaloy-2 sheathing material can be purchased for a price of $50 per pound of tubing, then Al-Ni alloy sheathing should have a corrosion resistance life of at least 630 days in the reactor (average power density—12.8 Mw/t of UO_2) to compete economically with the Zircaloy-2. (auth)

COSTS 7.02

DECISIVE FACTORS 7.02.01

8723 DL-33 (Rpt: UNCLASSIFIED)
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
URANIUM OXIDE FUEL OF LOW COST. W. B. Lewis. Apr. 1958. 18p. (AECL-568). $0.50(AECL).

In the United States and Canada it seems reasonable to set the dividing line between high and low cost fuel at 1.5 mill/kwh. To achieve this as the total fuelling cost including both supply and charges on the inventory of fabricated fuel requires careful planning. Dense sintered UO_2 is promising because it withstands high burn-up such as 10.000 Mwd/t without swelling and it retains fission product gases fairly well. It is also chemically stable in water at high temperature but it is a bad conductor of heat, and is liable to crack under thermal shock. This cracking has not been found troublesome in round rods clad in a firm sheath. The poor thermal conductivity, however, limits the diameter of such round rods if the central temperature is to be kept well below the melting point. Recent experiments have shown, nevertheless, that rod diameters of 0.6 to 0.9 in. may be practicable. even for large power reactors. In such large sizes the costs of fabricating sintered pellets and of cladding even in costly Zircaloy need not be prohibitive. Experience even on a small scale of hundreds or a few thousand pounds of oxide has resulted in total costs of little over $30 per lb of UO_2. Moreover for large power (200 Mwe) reactors taking advantage of heavy water as moderator and coolant it is possible to achieve a burn-up yield of 8,000 Mwd/t of uranium and a total fuelling cost of 1.5 mill/kwh if the fuel costs $26/lb of UO_2. Even with Zircaloy cladding this seems within reach and in a few years with fabrication on a larger scale $20/lb of UO_2 is in prospect. Experiments are in progress on the retention of fission product gases and if these sustain the present promise it will be possible to adopt simpler and cheaper techniques of fuel cladding. Moreover recent results with aluminum-nickel alloys suggest that these might replace the more costly Zircaloy, but an example is given showing that this may not reduce the over-all fuelling costs. Adjusting the reactor design to minimize total costs may increase the power rating and raise the fuel costs. but at the same time fuel burn-up may be extended and with the cheaper fuel in prospect the total fuelling costs may be held at about 1.0 mill/kwh from natural uranium oxide without any reprocessing. (auth)

11030
BLENDING VS. REENRICHMENT FOR SLIGHTLY ENRICHED URANIUM. Presented at Nuclear Engineering and Science Conference, held at Chicago, March 17 to 21, 1958. Preprint 2, Session 18. Donald Kallman and John E. Brennan (Babcock and Wilcox Co.). New York, American Institute of Chemical Engineers, 1958. 11p.

The economic aspects of blending irradiated fuels with highly enriched uranium and the reenrichment of irradiated, but decontaminated, uranium to obtain slightly enriched uranium fuels are considered. It is concluded that blending with highly enriched uranium may be permanently practiced in place of reenrichment at the diffusion plant because the difference in cost may be small and the flexibility greater. (J.S.R.)

GENERAL ECONOMICS OF CHEMICAL REPROCESSING FOR SOLVENT EXTRACTION PROCESSING. F. L. Culler May 1, 1957. p. 1108-32 of SYMPOSIUM ON THE REPROCESSING OF IRRADIATED FUELS HELD AT BRUSSELS, BELGIUM, MAY 20-5, 1957. 1165p. (TID-7534 (Bks. 1-3))

Results of economic studies are reported from seven facilities using Redox, Purex, or the ICPP Process. It was concluded that the reprocessing plant cost may be relatively insensitive to the type chemical process, and that the important variables in unit cost may be chemical plant capacity and fuel burnup.

7523
ON THE LOCATION OF NUCLEAR POWER STATIONS. Marcello Quojani. pp. 273-84 in "Proceeding of the Scientific Congress, Nuclear Sessions, July 2-6, 1956, 3rd. Electronic-Nuclear International Review." Rome, National Committee for Nuclear Research, 1956. 447p. (In Italian)

The primary considerations in the location of nuclear power stations are that the station be in proximity to the center of an electrical system and that it be near large available sources of water. Other important considerations are ease of disposing of spent fuels, population in the area, and geological and meteorological factors. (J.S.R.)

BATCH VERSUS CONTINUOUS PROCESSING. C. E. Dryden and J. M. Frame (General Electric Co., Schenectady, N. Y.). Chem. Eng. Progr. 52, 371-4(1956) Sept.

Batch vs. continuous methods of fuel processing for a nuclear reactor are compared for the purpose of developing a criterion for selection of the method for lowest power cost. (T.R.H.)

COSTS 7.02

DECISIVE FACTORS 7.02.01

14726 A/CONF.15/P/439
Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.
ECONOMICS OF UNIRRADIATED PROCESSING PHASES OF URANIUM FUEL CYCLES. J. P. Murray, F. S. Patton, R. F. Hibbs, and W. L. Griffith. 25p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

Expanding reactor programs present industrial opportunities in their fuel processing phases. This paper considers the manufacture of unirradiated uranium fuel materials, including the conversion of uranium hexafluoride to uranium metal, uranium dioxide, etc.; their subsequent fabrication into fuel elements; and the processing and recycle of accrued scrap. The intent is to offer potential processors an insight into operational and economic parameters associated with such enterprises. Process flow cycles and detailed economic analyses have been prepared for the following reactor fuels: (1) Uranium alloy (1.87% uranium-235) containing 2% zirconium, considered as fuel for the Consumers Public Power Reactor. (A cost analysis for 1.87% uranium-235 nonalloyed uranium is also presented.) The initial reactor charge is 30,000 kg uranium, and annual steady-state requirements are 21,000 kg uranium as slugs, 0.455 in. O.D. × 12 in. The initial charge would remain in the reactor 435 days. (2) Slugs of dense fired uranium dioxide (1.8% to 2.1% uranium-235) for a hypothetical reactor. The initial reactor charge is 200,000 lb of uranium dioxide and the annual steady state requirements are 50,000 lb of uranium dioxide as slugs. The initial charge plus 25% of the annual make-up would be made in one year. The relative economics of a small processing plant supporting only the Consumers Public Power Reactor and a larger plant (six fold capacity) of versatile design such that many types of fuels could be processed were appraised. Unit processing costs for the larger versatile plant (or "Job Shop") were found to be approximately one-half as great. The advantage of the "Job Shop" in a period of limited demands and diversified fuels, arises from its approach to large scale, continuous processing and the attendant more favorable distribution of fixed costs and those variable costs not directly proportional to throughput. For every kilogram of uranium-zirconium alloy produced as finished slugs, approximately 0.5 kg of remeltable scrap is recycled and additional scrap containing approximately 0.4 kg uranium is processed through chemical recovery facilities. Correspondingly, for every kilogram of uranium dioxide produced as slugs, approximately 1.2 kg of uranium is recycled. The unit cost in "Job Shop" of nonalloyed uranium slugs was found to be about three-fourths of the cost of the uranium-zirconium alloy slugs, and the cost of uranium dioxide slugs was about two-thirds the cost of the uranium-zirconium slugs. All unit costs were about one-tenth greater at a 70% production level than at 100% utilization of facilities, and about twice as costly at 25% utilization. Uranium processing cost variables over the assay range of 0.7115% to 95% uranium-235 were reviewed. Included were the following topics: (1) The relationship of "lists of uranium cost versus uranium-235 assay" to the extent of salvage processing. (2) The costs of health physics protective measures for different uranium-235 assays. (3) The costs of nuclear safety protective measures for different uranium-235 assays. (4) Cost relationships for fuel fabrication facilities, scrap processing facilities, and irradiated fuel element processing facilities being at the same or different sites. (5) Reduction of traffic with gaseous diffusion plants by blending uranium recovered from irradiated fuel processing facilities with other available enriched uranium to achieve a desired uranium-235 content. (auth)

23065 TID-7579(p.34-44)
Office of Operations Analysis and Forecasting, AEC.
REDUCTION OF FUEL CYCLE COSTS THROUGH OPTIMIZATION. Allen V. Butterworth. 11p.

Some of the possibilities for the reduction of fuel cycle cost through optimum use of present technology are considered. The discussion is directed toward the determination of the optimum fuel cycle, i.e., the fuel cycle which provides the lowest cost of nuclear power. Such a fuel cycle may be significantly different from the fuel cycle which results in the lowest fuel cycle cost. (W.D.M.)

EFFECT OF FUEL DILUENT ON REPROCESSING COSTS. Archie M. Larson, Jr. (Internuclear Co., Clayton, Mo.). Nucleonics 14, No. 10, 80 & 82(1956) Oct.

There are only two major factors affecting the reprocessing costs for fully enriched fuel elements. The most important of these is the degree by which the enriched U fuel is diluted with alloying and cladding material. The other factor is the type of diluent material used. (W.L.H.)

COSTS 7.02

DECISIVE FACTORS 7.02.01

Effect of fuel diluent on reprocessing costs. Archie M. Larson, Jr. (Internuclear Co., Clayton, Mo.) Nucleonics 14, 10, p. 80-2 (1956).

The reprocessing cost of U^{235} fuel is calcd. as a function of wt. of Al diluent in fuel element. The cost rises from 1 unit for no Al to approx. 100 units for 99% Al.

6890 CEI-79
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
A PRELIMINARY COST ESTIMATE FOR FUEL RECYCLING. H. K. Rae, D. H. Charlesworth, A. R. Bancroft, F. G. Crouch, G. E. Haddeland, E. Mizzan, A. J. Mooradian, and E. E. Winter. Oct. 1955. 239p. (AECL-418). $3.50(OTS).

A fuel cycle consisting of storage, disassembly, chemical desheathing, dissolving, TBP extraction, denitration, reduction to oxide or metal, fuel-element fabrication and waste disposal for both U and Pu fuels has been studied. Processing costs are estimated in dollars per pound of U, dollars per gram of Pu, and cents per gram of fission products. The total recycling costs for a DR-37 type of fuel cycle are calculated. On the ten-reactor scale (100 electrical Mw per reactor) with two Pu recycles and using

7202 ✓ A/CONF.15/P/54
ECONOMICS OF ENRICHMENT AND OF THE USE OF PLUTONIUM AND U-233. N. L. Franklin, J. M. Hill, and J. C. C. Stewart (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.), and C. A. Rennie (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 18p.

A standard for comparison, the gas-cooled reactor using natural uranium metal fuel is adopted. A brief survey of the cost structure of power produced from such a reactor is given. The effect of the fuel cycle and the reactor size upon the expected reactivity performance using natural uranium fuel is discussed. The cost structure in the production of enriched uranium is reviewed and a typical cost enrichment curve is deduced for the range 0.5 to 2.0 Co. Typical fuel element costs, inventory costs, and repurchase values are presented. The general principles of the use of plutonium in place of uranium 235 are considered for conditions of total plutonium recycle and for plutonium-natural uranium fuels. The major differences between such

8727 ✓
FACTORS AFFECTING FUEL CYCLE COST. J. W. Ullmann (Oak Ridge National Lab., Tenn.). pp. 210-21 in "Progress in Nuclear Energy. Series III. Process Chemistry. Volume 2."

The components of over-all fuel cost are analyzed, and the effects of several parameters are discussed. (auth)

METHODS OF COST ANALYSIS 7.02.02

NUCLEAR PLANT ESTIMATING DIFFICULT. J. J. Kearney. Elec. World 150, 72-5(1958) Nov. 17.

All of the various capital and operating costs for a nuclear power plant, particularly fuel costs, vary somewhat from similar costs for a conventional plant. Besides the type of fuel used, its preparation, and disposal of its waste products, the fact that enriched nuclear fuel cannot be bought or sold in the open market, and under most licensing arrangements the user is responsible for the fissionable material, there are other factors which are responsible for these complexities. The cost of nuclear fuel is considered, and a flow chart is given indicating all the various steps in a typical fuel cycle. (auth)

4071 CF-53-5-172(Rev.)
Oak Ridge National Lab., Tenn.
COST ESTIMATE CHECK LIST FOR A NEW PROJECT. W. G. Stockdale. Nov. 25, 1957. 18p. Contract [W-7405-eng-26]. $3.30(ph OTS); $2.40(mf OTS).

An itemized list for capital and operating cost is presented to be used as a guide in estimating costs for a new project. The availability of cost indices, to relate the value used from listed cost to a current basis, is included. (W.L.H.)

7094 ✓
NEW STATISTICAL METHOD RAPIDLY DETERMINES OPTIMUM PROCESS CONDITION. S. I. Neuwirth and L. M. Naphtall (Polytechnic Inst. of Brooklyn, N. Y.). Chem. Eng. 64, No. 6, 238-42(1957) June.

A statistical method is presented for determining optimum process conditions by taking the steepest slope path to the summit. (W.L.H.)

COSTS 7.02

METHODS OF COST ANALYSIS 7.02.02

5306 RMO-3000
Grand Junction Operations Office, AEC
A METHOD FOR PRESENTATION OF COST ESTIMATES AND PROCESS ECONOMICS AS RECOMMENDED BY THE ATOMIC ENERGY COMMISSION. John Klemenic. July 26, 1956. 25p.

12546 CF-56-7-49
Oak Ridge National Lab., Tenn.
HRP-BP: A MATHEMATICAL ANALYSIS OF THE HRT BLANKET PROCESSING PLANT. William L. Carter. July 16, 1956. Decl. Mar. 13, 1957. 21p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

A mathematical analysis of the solid-liquid separation step for the HRT blanket processing facility is presented. (auth)

7270 A/CONF.15/P/2028
THE ECONOMICS OF FAST POWER REACTOR NUCLEAR FUEL. O. D. Kazachkovskii(Kazachkovsky), (U.S.S.R.) 20p.

The methods for calculating the fuel component in the cost structure of power produced by fast power reactors are defined. Account is taken of the many factors which determine the peculiarities of fast reactor operation. All considerations are made in relation to $Pu-U^{238}$ closed cycles. (W.D.M.)

ESTIMATED FUTURE COSTS 7.02.03

9471 CF-59-2-57
Oak Ridge National Lab., Tenn.
THE NUCLEAR FUEL CYCLE: PROSPECTS FOR REDUCING ITS COST. W. L. Albrecht. Feb. 20, 1959. 15p. Contract W-7405-eng-26. $3.30(ph), $2.40(mf) OTS.

Nuclear fuel cost of 1.25 mills/kwh would make nuclear power competitive with conventional power in low-cost coal areas if capital and operating costs can be brought to within about 10 percent of those of coal-fired plants. Substantial decreases in fuel fabrication cost are anticipated by 1970; other costs in the fuel cycle are expected to remain about the same as at present. Unit costs and irradiation levels that would be needed to give a fuel cost of 1.25 mills/kwh are believed to be attainable by 1970. (auth)

20987 CF-59-9-51
Oak Ridge National Lab., Tenn.
ESTIMATE OF POTENTIAL FUEL REPROCESSING, REVISION NO. 29—PART A. J. W. Ullmann. Sept. 15, 1959. 9p. $1.80(ph), $1.80(mf) OTS.

The power and estimated reprocessing load are tabulated for existing and proposed United States and United States-built reactors of 10 kw or greater thermal power. (auth)

8782 CF-58-11-69
Oak Ridge National Lab., Tenn.
RADIOCHEMICAL REPROCESSING COSTS IN AN EXPANDING NUCLEAR ECONOMY. C. E. Guthrie. Nov. 20, 1958. 20p. Contract [W-7505-Eng-26]. $3.30 (ph), $2.40(mf).

For presentation at the 1959 Nuclear Congress, Cleveland, April 5-10, 1959.

An analysis of reprocessing costs as a function of plant size indicates that reasonable (0.35 mills/kwh) costs may be attained by private industry around 1970. It could be advantageous to stockpile spent fuel during the early years rather than build small plants to process the fuel as discharged. (auth)

CHEMICAL PROCESSING FOR NUCLEAR ENERGY. ITS PROBLEMS AND IMPORTANCE. D. A. Collins and J. S. Nairn (United Kingdom Atomic Energy Authority, Sellafield, Cumb., Eng.). Nuclear Eng. 3, 191-7(1958) May.

Improvements in fuel element economy lead to more chemically intractable fuel in even more intractable canning. All this leads to more complex chemical separation problems associated with spent fuel reprocessing. In assessing the economic gain from changes, either in the type of fuel or the type of chemical reprocessing, it is necessary to consider the significance of the change in each stage of the fuel cycle: initial fabrication of the fuel element, irradiation in reactor, chemical processing, reenrichment, and refabrication of fuel element. Economic reprocessing demands a high use factor of the facilities, employing a large-scale power reactor system and adequate standardization of fuels. (W.D.M.)

8874
LOOK FOR NUCLEAR FUEL REPROCESSING BY '65. Frank R. Bruce (Oak Ridge National Lab., Tenn.). Chem. Eng. 64, No. 7, 202, 204, 206(1957) July.

The economics of processing spent power reactor fuels are discussed. (W.L.H.)

ESTIMATED FUTURE COSTS 7.02.03

11444 CF-59-1-13
Oak Ridge National Lab., Tenn.
FUEL CYCLE COSTS IN A GRAPHITE MODERATED SLIGHTLY ENRICHED FUSED SALT REACTOR. C. E. Guthrie. Jan. 9, 1959. 7p. Contract [W-7405-eng-26]. $1.80(ph), $1.80(mf) OTS.

A fuel cycle economic study has been made for a 315-Mwe graphite-moderated slightly enriched fused-salt reactor. Fuel cycle costs of less than 1.5 mills may be possible for such reactors operating on a ten-year cycle even when the fuel is discarded at the end of the cycle. Recovery of the uranium and plutonium at the end of the cycle reduces the fuel cycle costs to ~1 mill/kwh. Changes in the waste storage cost, reprocessing cost or salt inventory have a relatively minor effect on fuel cycle costs. (auth)

13651 ✓
PRODUCTIVE USES OF NUCLEAR ENERGY. REPORTS ON THE NUCLEAR ENERGY AND THE U. S. FUEL ECONOMY, 1955-1980. Perry D. Teitelbaum. Washington, National Planning Association. 1958. 198p. $3.00.

The fuel economy of the United States in the years from 1955 to 1980 is analyzed. The study is not confined to electric power, but includes other applications of nuclear energy, such as process heat and propulsion. The competitive interrelationships likely to prevail in the fuel economy are emphasized. The general order of the contribution of nuclear energy to the fuel and energy requirements is assessed over the next several decades. The necessity for public and private policies for coal, oil, gas, and nuclear energy is stressed. (J.S.R.)

THE COST OF NUCLEAR ENERGY IN 1957. James A. Lane (Oak Ridge National Lab., Tenn.). Energia nuclear (Madrid) 1, No. 4, 13-22(1957) Oct.-Dec. (In Spanish)

An examination is made of the present situation with respect to the economics of nuclear power, with the object of investigating whether the kilowatt price of nuclear power plants can be reduced. The cost of the fuel is also considered. The future economic competition of nuclear power plants with conventional fuels is also discussed. (J.S.R.)

8365 ✓ ORNL-2279(Del.)
Oak Ridge National Lab., Tenn.
THE EFFECT OF THE RADIOCHEMICAL REPROCESSING INDUSTRY'S GROWTH ON SPENT REPROCESSING COSTS. C. E. Guthrie. June 19, 1957. Decl. with deletions Apr. 1, 1958. 23p. Contract W-7405-eng-26. $4.80(ph OTS); $2.70(mf OTS).

An economic study of radiochemical reprocessing has been made to determine the means by which reasonable reprocessing costs (less than 0.75 mill/kwh) can be attained at the earliest possible date. It is assumed that the fuel is 2% enriched uranium irradiated to 4000 Mwd/ton. In a free economy, in which plants must be built to reprocess the fuel with minimum delay, reasonable reprocessing costs will not be attained until the nuclear power capacity reaches 80,000 Mw (heat), which is expected in about 1971. Reasonable reprocessing costs can be attained in a single plant from a nuclear capacity of 28,000 Mw (heat), which may be available around 1967, if the reactor operator does not have to pay use charges on the spent fuel. Several support programs by which the government could maintain reasonable radiochemical reprocessing costs in the projected economy prior to 1971 have been investigated. The government could support fuel recovery costs with the least expense by supplying the process development, and repurchasing and stockpiling spent reactor fuels until a single economical reprocessing plant can be built by private industry. (auth)

5998 ✓ A/CONF.15/P/206
LONG-RUN TRENDS IN CONVENTIONAL AND NUCLEAR POWER COSTS AND THEIR IMPLICATIONS FOR CANADA. J. Davis (British Columbia Electric Co. Ltd., Vancouver) and S. W. Clarkson (Atomic Energy of Canada Ltd., Chalk River, Ont.). 29p. (AECL-616). $0.25(AECL)

Most studies which have attempted to forecast the role of nuclear power have been deficient in one important respect: a static rather than a dynamic approach has been used. In this study distance, in the sense of power losses and transmission line costs, is taken into account. The time element has also been considered. Technological improvements in hydro, conventional, and nuclear plants are given their proper weighting. Capital costs and interest rates are considered. (W.D.M.)

COSTS 7.02

ESTIMATED FUTURE COSTS 7.02.03

5999 ✓ A/CONF.15/P/207
THE ECONOMIC ENVIRONMENT FOR NUCLEAR POWER IN CANADA. J. L. Olsen, E. C. Savage, et al. (Canadian General Electric Co. Ltd., Peterborough, Ont.). 18p. (AECL-617). $0.25(AECL).

The energy reserves (coal, oil, gas, and hydro) of Canada are discussed in regard to their location and cost of transportation. The energy requirements of the major regions of Canada for the next ten years are reviewed. Assuming a price drop in natural uranium oxide fuel, a 25% plant efficiency, and identical operating and maintenance charges, capital costs which would meet the competitive threshold in each of the areas are given. (W.D.M.)

SMALL PLANTS 7.02.04

CAPITAL AND OPERATING COST INFORMATION ON SEVERAL EXISTING U. S. NUCLEAR FUEL PROCESSING PLANTS. J. L. Schwennesen. May 1, 1957. p.1133-53 of SYMPOSIUM ON THE REPROCESSING OF IRRADIATED FUELS HELD AT BRUSSELS, BELGIUM, MAY 20-5, 1957. 1165p. (TID-7534(Bks. 1-3))

Four relatively small Plants that have processed irradiated reactor fuels are discussed. These include the Hot Semiworks located at the Hanford Atomic Products Operation near Richland, Washington; the Idaho Chemical Processing Plant (ICPP) located at the National Reactor Testing Station near Idaho Falls, Idaho; and the Metal Recovery Plant and the Thorex Pilot both located at the Oak Ridge National Laboratory. Although these Plants have many common features (principally with respect to basic process solvent extraction chemistry), they differ in many ways with regard to capacity; the size, shape, and composition of fuels that can be handled; the number of auxiliaries associated with each Plant; the amount of process equipment installed and so forth. 5 references.

1306
A CONCEPTUAL DESIGN AND COST STUDY FOR CHEMICALLY PROCESSING IRRADIATED REACTOR FUELS. Sidney M. Stoller (Vitro Corp. of America, New York). Chem. Eng. Progr. 52, Symposium Ser. No. 19, 131-41 (1956).

A conceptual design study conducted to establish costs of construction and operation of a small-scale chemical-processing facility is reported. This facility is designed to operate as a centrally located plant, equipped to handle, as feed, fuel elements of different compositions and of different enrichments. Discussion of the costs, as well as the effect on cost of changes in individual process variables, is included. A description of the conceptual design, giving general principles to be followed in setting up design criteria for a commercial reprocessing facility of this type, including discussion of layout, process equipment, and auxiliary services, is included. (auth)

GENERAL 7.02.05

4168
AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1960. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-SIXTH CONGRESS, FIRST SESSION ON AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1960, FEBRUARY 7, 27; MARCH 23, 24, 25; APRIL 13, 14, 15, AND MAY 8, 1959. Washington, D. C., Joint Committee on Atomic Energy, 1959. 706p.

Authorizing legislation for various projects involving nuclear research under contract to the United States Atomic Energy Commission for the fiscal year 1960 is presented. Cost summaries are presented for these various projects. The advances made by various research projects are discussed. (C.J.G.)

20776
ECONOMICS OF THE PRODUCTION OF RADIOISOTOPES IN NUCLEAR REACTORS. Pavel Kovanic (Ústav jaderného výzkumu ČSAV, Prague) and Milan Kulka (Tesla Liberec n. p., závod Přemyšlení). Jaderná energie 5, 227-32(1959). (In Czech.)

The possibilities of the production of radioisotopes in thermal nuclear reactors in dependence on the degree of enrichment of fuel and on the design of the reactor are evaluated. Approximate economic evaluation of the production of radioisotopes in different types of reactors on the basis of the number of radioactive nuclei produced, without detailed analysis of specific activities obtained, is made. The most advantageous type of a reactor is a reactor with highly enriched fuel, with removable reflector, with a possibility of changing easily the form of the reactor core, with a great excess of reactivity, and with a great space around the reactor core, which space is either empty or filled with water. (auth)

COSTS 7.02

GENERAL 7.02.05

4169
ECONOMIA DELL' ENERGIA ATOMICA. RASSEGNA BIBLIOGRAFICA E DI DOCUMENTAZIONE. [Economics of Atomic Energy: Bibliographic and Reference Survey. Third Edition.] Rome, Banca Nazionale del Lavore, 1959. 104p.

A bibliography of the most important publications in the world on the economics of atomic energy utilization is presented. The publications of international organizations are listed. The listing is arranged according to country. Information as to the availability of the literature is given. (J.S.R.)

23052 TID-7559(Pt.1)(Paper 13)
American-Standard. Atomic Energy Div., Mountain View, Calif.
THE ECONOMICS OF NUCLEAR POWER GENERATION. David P. Herron and William R. Holman. Paper 13 of FUEL ELEMENTS CONFERENCE HELD AT GATLINBURG, TENNESSEE, MAY 14-16, 1958. 23p.

Capital costs and fuel-cycle costs for nuclear power are examined to determine the costs existing today and the probable future trend. Particular emphasis is given to the effects of enrichment, fuel type and cladding, core design, and reactor type. (auth)

2474
MINIMIZING FUEL-PROCESSING COSTS. Allan M. Poindexter (AMF Atomics, Greenwich, Conn.). Nucleonics 17, No. 11, 162; 164; 166; 168(1959) Nov.

The price policy of the Atomic Energy Commission for fuel reprocessing is given. Expressions are derived for optimum batch weight and minimum variable reprocessing cost ($/kg U). (C.J.G.)

20993 NP-7853
European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.
PRELIMINARY COST ESTIMATES. Technical Report No. 47, Chapter 600. O. Jenne, E. Lüscher, M. Lung, F. Marcus, and A. Redon. [195?]. 5p. $1.80(ph), $1.80(mf) OTS.

Cost estimates are presented for a 100 ton per year radiochemical processing plant and for a 350 kg U per day pilot plant. (W.L.H.)

1181 HW-62362
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
UNCLASSIFIED RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT AND THE DIVISION OF RESEARCH, SEPTEMBER 1959. L. H. McEwen, comp. Oct. 10, 1959. 42p. Contract AT(45-1)-1350. OTS.

Reactor research and development are summarized under the following programs: plutonium recycle, basic swelling, gas cooled power reactor, maritime gas cooled reactor, nondestructive fuel testing, fixation of radioactive wastes, and radiation effects on metals. (W.D.M.)

FINANCING NUCLEAR ENERGY PROGRAMMES AND RELATIONS BETWEEN THE STATE AND INDUSTRY. Paris, Organisation for European Economic Co-Operation, 1959. 54p.

This study concerns the financing of nuclear energy programs by public financing (including national budget allocations), contributions from private industry, and the relationship between industry and the state for each individual country. The countries under discussion are Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. (C.J.G.)

ESTIMATES OF NUCLEAR ENERGY PRODUCTION IN EUROPE, 1958–1965. NATIONAL PROGRAMMES. BASIS FOR CALCULATING CAPITAL COSTS—COST FACTORS. Paris, Organisation for European Economic Co-Operation, 1959. 45p.

A summary of estimates of nuclear energy production in Europe for the period 1958-59 is presented with respect to installed nuclear capacity, nuclear fuel requirements, costs of meeting these requirements, and capital investment necessary for the building of nuclear power stations. Data on the possibility of projecting these estimates up to 1975 are presented. The programs of O.E.E.C. countries are summarized. A discussion of basic technical assumptions adopted for the estimate of fuel requirements and costs is presented in detail. Various cost factors in the generation of electricity are analyzed. (C.J.G.)

7
THE SIGNIFICANCE OF POWER PRODUCTION FROM NUCLEAR ENERGY FOR THE FUTURE REQUIREMENTS OF ITALY. Mario Bruni (La Centrale

COSTS 7.02

GENERAL 7.02.05

Finanziaria Generale S. p. A.) and Agostino Dalla Verde (Società Idroellettrica Piemonte). Atomwirtschaft 4, 368-73(1959) Sept. (In German)

Because of experience with the construction of hydroelectric stations in Italy, the high investment costs of nuclear power stations do not seem to cause unusual financial problems for private industry. The costs are a disadvantage, however, as nuclear power stations are less suitable for peak loads. A comparison of hydroelectric and nuclear power capacities shows that nuclear power can contribute 6000 Mw of installed capacity to the energy requirements in 1975, provided that nuclear power becomes competitive. (auth)

8875 ✓

NUCLEAR FUEL REPROCESSING. ITS STATUS AND DIRECTION. Edward L. Anderson, Jr. (Atomic Energy Commission, Washington). Chem. Eng. Progr. 53, No.6, 19-22 (1957) June.

The economics of nuclear fuel reprocessing is discussed. (T.R.H.)

5337 ✓

THE PROCESSING OF IRRADIATED NUCLEAR FUELS. E. Pohland Atomwirtschaft 3, 385-8(1958) Oct. (In German)

A brief survey is made of the processing of irradiated fuels. The separation methods, purification of uranium and plutonium, and the disposal of waste products are considered. The economic problems with respect to government processing plants and industrial processing plants are discussed. (J.S.R.)

REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 1, No. 1. Lemont, Argonne National Laboratory, 1958. 38p. Available from U. S. Government Printing Office for $0.55.

Commercial Aspects of Fuel Processing. An AEC price list is presented for plutonium produced in private reactors. The price paid for plutonium varies as a function of Pu^{240} content. The construction and operating costs are given for a hypothetical chemical processing plant running at full capacity for 300 days/year. Storage of fuel elements from various types of reactors is discussed. A flowsheet is given of the Darex Process for processing stainless steel fuels by dissolution in dilute aqua regia. Various other processes are discussed for processing fuels consisting of other alloys.

5817 ✓ CRCE-676

Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.

A PRELIMINARY DESIGN AND COST ESTIMATE FOR A DUAL-PURPOSE PROCESSING PLANT. D. H. Charlesworth. Nov. 1956. 28p. (AECL-424).

A preliminary design and cost estimate have been prepared for a dual-purpose processing plant capable of processing 1500 lb of U or 8.09 Kg of Pu, as Pu-Al alloy, daily. Dissolving facilities are not included. The estimated capital cost of the plant is $3,750,000. Daily operating costs are $4,370 when processing U and $4,320 when processing Pu fuel. It is estimated that the integration of U and Pu processing by the use of the same process equipment for both types of fuels results in a saving of 21% in capital cost and 28% in operating cost as compared to the use of separate facilities. (auth)

4663 AMF-GR-4-55

American Machine and Foundry Co. General Engineering Lab., Greenwich, Conn.

NUCLEAR FUEL COST FOR THE AMF CLOSED CYCLE BOILING WATER REACTOR. Franz S. Holzer. June 17, 1955. Decl. Feb. 13, 1957. 19p. (ER-6842; G-3608). $3.30(ph OTS); $2.40(mf OTS).

An estimate was made of the cost of the nuclear fuel and of the value of the total fuel inventory for the 22-Mw closed cycle boiling water reactor. Based on reasonable design objectives and economy in fabrication and reprocessing of fuel elements, the nuclear fuel cost would be 0.707 mils per KWH of heat or 1.86 mils per KWH of electricity. The total fuel inventory would be about $1,400,000. An alternate core design was also considered in order to obtain an upper limit of the costs. These upper limits are 1.59 mils per KWH of heat, 4.2 mils per KWH of electricity, and a total inventory of $1,750,000. The target design is based on a natural U core with fully enriched U at the center. (B.J.H.)

958 CF-55-3-31

Oak Ridge National Lab., Tenn.

CHEMICAL PROCESSING AND FUEL COSTS FOR THE REVISED THERMAL BREEDER REACTOR. E. D. Arnold. Mar. 3, 1955. Decl. Sept. 26, 1958. 8p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

The procedure for processing the blanket of the reactor is described, including the removal of high cross section fission products. An estimate of the process rate is given along with an estimate of operating cost and the fixed investment. (J.R.D.)

COSTS 7.02

GENERAL 7.02.05

6021 A/CONF.15/P/1446
ECONOMIC ASPECTS OF THE UNITED KINGDOM NUCLEAR POWER PROGRAMME. J. C. Duckworth (Central Electricity Generating Board, London) and E. Hywel Jones (South of Scotland Electricity Board, Glasgow). 16p.

The projected United Kingdom nuclear power program over the next eight to nine years is briefly reviewed. Generation costs for the nuclear stations under construction are given and compared with those for typical modern conventional stations which will be completed at about the same time. Nuclear generation costs for stations in the remainder of the program are estimated. Factors influencing costs are described, including life of the plant and methods of minimizing fuel costs by control of fuel replacement. The development of the U.K. electricity generating system, in the light of the costs given, is described. Future developments are considered, particularly the influence of pumped storage, conventional fuel fired super-heating, the trend of nuclear fuel costs, and the variation in available load factors. (auth)

4356 TID-7581
Division of Nuclear Materials Management, AEC.
AEC AND CONTRACTOR SS MATERIALS MANAGEMENT MEETING, MAY 25-28, 1959, [GERMANTOWN, MARYLAND]. 228p. OTS.

The papers prepared and presented by the Atomic Energy Commission and Contractor Personnel are presented. The meeting covered a broad range of problems encountered in the AEC and SS Materials Management work. (W.L.H.)

9618 ✓ CF-53-6-173
Oak Ridge National Lab., Tenn.
ECONOMICS OF CHEMICAL PROCESSING FOR A URANIUM-233 BREEDER. Don E. Ferguson and John P. Sanders. June 18, 1953. Decl. Mar. 12, 1957. 25p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70(mf OTS).

FUEL CYCLE 7.03

FAST OXIDE BREEDER. FUEL CYCLE AND COST. J. K. Davidson, R. S. Miller, and D. J. Smith (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucleonics 17, No. 1, 88-93(1959) Jan.

The fast breeder is of long-range interest because it is based on one of the two fuel systems (a thermal reactor with Th–U^{233} cycle is the other) that can produce more fissionable material than it uses. The oxide-fuel cycle (UO_2–PuO_2) in a fast breeder is of particular interest because it appears possible to arrive at a fuel-cycle cost low enough to make this system of short-range interest as well. The reactor, economic analysis, and fuel-cycle development are considered. (L.T.W.)

THE FAST OXIDE BREEDER–THE FUEL CYCLE. J. K. Davidson, W. O. Haas, Jr., J. L. Mewherter, R. S. Miller, and D. J. Smith. July 1, 1957. 98p. (KAPL-1757)

The development of a fast breeder fuel cycle based on a core fuel consisting of mixed UO_2 and PuO_2 is described. Purex-type process flowsheets, material balances, operating schedules, cost schedules, and a plant layout are presented, and the laboratory- and plant-scale process and equipment demonstrations are described. A cost estimate based on a demonstration of the process including the unique plant equipment gives a total fuel cycle cost of 2.04 mils/kw-hr and a net fuel cycle cost of 1.53 mils/kw-hr (0.3 breeding gain assumed).

7235 ✓ A/CONF.15/P/961
BREEDING AND CONVERSION PROCESSES IN HIGH-TEMPERATURE REACTORS. H. Wundt (Brown, Boveri & Cie. AG., Mannheim, Ger. and Fried. Krupp, Mannheim, Ger.). 39p.

The reactor design considered is a one-region reactor containing only fissile and fertile materials besides the graphite moderator and reflector. Since the maximum enrichment available to most countries is 20%, the conversion process involves both U^{233} and Pu^{239}. The two initial moderating ratios of the fertile materials are taken as independent parameters, and for 60 combinations of these the time behavior of k_∞ is worked out which shows the most desirable charging schedule for new fuel and possible burnup times. (W.D.M.)

FUEL CYCLE 7.03

9788 ✓ ANL-LB-SL-1053
Argonne National Lab., Lemont, Ill.
EFFECT OF PROCESSING LOSSES ON BREEDING GAIN AND DOUBLING (CONVERTING) TIME FOR EBR-II AND PBR REACTORS. I. G. Dillon. May 8, 1956. Decl. Mar. 9, 1957. 4p. Contract [W-31-109-eng-38]. $1.80(ph OTS); $1.80(mf OTS).

BURNUP AND POISONING 7.03.01

3153 ✓ NAA-SR-Memo-3651
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
BURNUP OF OMR FUEL ELEMENTS, HB-1 AND HT-1. G. D. Calkins. Mar. 13, 1959. 4p. OTS.

Preliminary results from Battelle, on the first OMR Fuel Elements, indicate that the maximum burnup was ~0.22 at. % U for the high burnup element and 0.20 at. % U for the heat transfer element. In both cases, the maximum burnup occurred at the edge of the fuel plate facing the center of the reactor core at an area about one-half to two-thirds down the length of the fuel plate from the outlet or upper end. (auth)

FUEL CYCLES; IRRADIATION AND THERMAL STABILITY. J. H. Kittel (Argonne National Lab., Lemont, Ill.). p.182-88 of PROCEEDINGS OF THE 1957 FAST REACTOR INFORMATION MEETING HELD AT CHICAGO, ILL., NOVEMBER 20-21, 1957.

In general, fast reactors operate at higher heat fluxes, higher fuel temperatures, and higher burnups than do most thermal reactors. For economical operation and efficient breeding, the expected lifetime must be relatively long, on the order of at least 2 at. % burnup, or 20,000 Mwd/t of fuel. The present status of information obtained in the U. S. on irradiation and thermal effects on fast reactor fuels is reviewed. The data which are presently available have been obtained principally in connection with the development of EBR-I, EBR-II, Fermi Reactor, and the Fast Oxide Breeder (KAPL). (W.D.M.)

HEAVY ELEMENT ISOTOPIC BUILDUP. J. W. Ullmann. May 1, 1957. p. 1080-1107 of SYMPOSIUM ON THE REPROCESSING OF IRRADIATED FUELS HELD IN BRUSSELS, BELGIUM, MAY 20-5, 1957. 1165p. (TID-7534(Bks. 1-3))

The transmutation products of elements of atomic number 90 and higher produced by irradiation and recycle of U, Pu, and Th are considered. The concentration of by-product isotopes produced in irradiated fuels from thermal reactors was studied. The effects of these isotopes on reactor operation and radiochemical processing is discussed. 11 references.

5994 KAPL-M-ELW-10
Knolls Atomic Power Lab., Schenectady, N. Y.
ISOTOPIC SHIELDED POISON BURNOUT. E. L. Wachspress. Nov. 1, 1959. 7p. Contract W-31-109-Eng-52. OTS.

Equations are derived for the burnout of a shielded burnable poison consisting of a homogeneous isotopic mixture. Calculations are given for europium. (W.D.M.)

3248 ✓ CF-56-1-162
Oak Ridge National Lab., Tenn.
PROCESSING REQUIREMENTS, BUILDUP OF FISSION PRODUCT ACTIVITY, AND LIQUID RADIOCHEMICAL WASTE VOLUMES IN A PREDICTED NUCLEAR POWER ECONOMY. H. R. Zeitlin, E. D. Arnold, and J. W. Ullmann. Jan. 30, 1956. 18p. Contract [W-7405-Eng-26] $3.30(ph OTS); $2.40(mf OTS).

1564 ✓
FISSION-PRODUCT BUILDUP IN LONG-BURNING THERMAL REACTORS. W. L. Robb, J. B. Sampson, Jr., R. Stehn, and J. K. Davidson (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucleonics 13, No. 12, 30-3(1955) Dec.

Poisoning by fission products in thermal reactors is evaluated from data on fission yields and cross sections of U^{235}. The effect of fission-product gas removal on the fission product poisoning for U^{235} is shown. The distribution of fission product poisoning by elements is also tabulated. (B.J.H.)

THE POTENTIAL SIMPLIFICATION OF REACTOR REPROCESSING BY THE PROPER CHOICE OF REACTOR SYSTEMS AND BY THE REMOVAL OF ONLY THE SERIOUS FISSION PRODUCT POISONS. Robert P. Schuman and Arthur D. Tevebaugh. Dec. 11, 1950. Changed from SECRET Feb. 8, 1956. 33p. (KAPL-M-RPS-5; MEMO-RPS-5)

The poisoning effects of the fission products and capture products for U^{233} and U^{235} thermal reactors are investigated, and certain fluid reactor systems that would lend themselves to simplified reprocessing and probably to simplified design for power breeder reactors are discussed.

FUEL CYCLE 7.03

BURNUP AND POISONING 7.03.01

11002 ✓ TID-10066
North American Aviation, Inc., Downey, Calif.
LONG TERM IRRADIATION OF NUCLEAR FUELS. E. R. Cohen and R. H. Sehnert. Sept. 15, 1954. Decl. Mar. 1, 1957. 49p. Contract AT-11-1-gen-8. $0.40(OTS).

With the objective of reducing fuel fabrication and chemical processing and thus the cost of power from nuclear reactors, it has been proposed that nuclear fuels be exposed to irradiations as high as 15,000 mwd/ton. Such exposures correspond to almost complete burnout of the original U^{235} contents of uranium fuels. A study is made of the changes in heavy isotope concentrations as well as the build-up of fission product poisons in fuel elements and the corresponding changes in local and effective reactivity as a function of irradiation exposure. Original uranium enrichments of 0.7115, 0.978, 1.46, and 1.94 weight per cent of U^{235} have been studied. The fuel is considered loaded into reactors operating at 300°K with initial conversion ratios varying in increments of 0.1 from 0.6 to 1.0. Changes in reactivity, fractional burnup of U^{235} and buildup of Pu^{239}, Pu^{240}, and Pu^{241} are presented over the range of parameters and interpreted for specific reactor objectives. (auth)

11007 DEGIS-23(R)
United Kingdom Atomic Energy Authority. Industrial Group H. Q., Risley, Lancs, England.
BIBLIOGRAPHY ON PLUTONIUM BUILD-UP IN REACTORS. B. Yates and G. I. Maughan, comps. Sept. 10, 1959. 13p. BIS.

The production of plutonium by neutron irradiation of uranium in a reactor and its subsequent effect on the reactivity of the reactor are considered in this bibliography. A selection of 62 unclassified references to reports, books, and journal articles are listed. Sources searched were U.K.A.E.A. abstracts index, Nuclear Science Abstracts, Chemical Abstracts (1940-56), and Science Abstracts "A" (1940-57). (auth)

1661 ✓ ORNL-2127(Pt. II(Vol. 3))
Oak Ridge National Lab., Tenn.
URANIUM-235 FISSION-PRODUCT PRODUCTION AS A FUNCTION OF THERMAL NEUTRON FLUX, IRRADIATION TIME, AND DECAY TIME. II. SUMMATIONS OF INDIVIDUAL CHAINS, ELEMENTS, AND THE RARE-GAS AND RARE-EARTH GROUPS. J. O. Blomeke and Mary F. Todd. Nov. 3, 1958. 361p. Contract W-7405-eng-26. $5.00(OTS).

Levels of fission products resulting from thermal fission of U^{235} in reactor fuels were compared over a wide range of reactor operating conditions and decay times. Values of approximately 300 fission products are presented in graphical form together with gross totals of their activities, radiation powers, and thermal neutron poisoning. The gamma spectrum is further broken into four groups of specified energy ranges, which are suitable for use in shielding design. Tabulation of these properties is arranged as to chain or mass number, element, and as to the rare-gas and rare-earth groups. (A.C.)

8946 ORNL-2869
Oak Ridge National Lab., Tenn.
THERMAL AND RESONANCE ABSORPTION CROSS SECTIONS OF THE U^{233}, U^{235}, AND Pu^{239} FISSION PRODUCTS. E. A. Nephew. Mar. 1, 1960. 50p. Contract W-7405-eng-26. OTS.

The absorption cross section of the fission product aggregate of U^{233}, U^{235}, and Pu^{239} was calculated as a function of irradiation and the degree of flux thermalization. Attention was given to the resonance integral of the fission products in the range of 0 to 100 ev. The saturation characteristics of the individual fission products which determine the composition of the fission product aggregate are calculated for fluxes with different epithermal contents. The parameter P used to specify the degree of flux thermalization represents the fraction of fissions due to the neutrons in the 1/E portion of the flux. By summing over the individual fission products, a resulting thermal cross section and an energy distributed resonance integral were obtained for the fission product aggregate of the three fuels as a function of P and F where F is the fractional burnup of the fuel. For F = 0 and T = 1000°K, the effective thermal cross sections are calculated to be 37, 43, and 54 barns per fission for U^{233}, U^{235}, and Pu^{239}, respectively. At the same conditions, the excess resonance integrals below 100 ev are calculated to be 134, 172, and 266 barns per fission for U^{233}, U^{235}, and Pu^{239}, respectively. By grouping the individual fission products which have similar saturation characteristics, it was possible to designate four pseudoelements which when taken together yield the same total thermal cross section and resonance integral as that of the fission product aggregate over the range of P and F values considered. Multigroup cross sections were computed and are listed for each pseudoelement for use in a 32-group code. Thermal group cross sections are listed for each pseudoelement for neutron temperatures between 69 and 2704°F. (auth)

FUEL CYCLE 7.03

BURNUP CALCULATION 7.03.02

6009
VALIDITY OF THE B_1 METHOD FOR FUEL CYCLE ANALYSIS. S. A. Hasnain and Raymond L. Murray (North Carolina State Coll., Raleigh). Nuclear Sci. and Eng. 6, 455-6(1959) Nov.

The method for burnup analysis for fixed fuel thermal reactors makes use of two simplifications, (a) separability of flux in space and time and (b) representation of flux by the bare-equivalent flux shape. It was proposed to establish the conditions for validity of these approximations and to extend the analysis by the use of additive corrections to the burnup functions. For large reactors the correction is shown to be unimportant. (B.O.G.)

9135
CALCULATING BURNOUT EFFECTS. Arthur W. Banister and Raymond L. Murray (North Carolina State Coll., Raleigh). Nucleonics 15, No. 6, 129-33(1957) June.
A simple way to analyze the effect of fuel burnup and distributed poisons in a thermal reactor is given. The technique involves an interactive solution of the critical diffusion equation that describes the reactor after fuel burnup or fission product buildup has occurred. Perturbation terms are transposed to the right-hand side of the equation and with approximations the equation becomes inhomogeneous. Complementary and particular solutions which give the new flux distribution are found and, by applying boundary conditions, the perturbed critical condition is obtained. (T.R.H.)

2577 AERE-CE/R-2615
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
HOMOGENEOUS AQUEOUS POWER REACTORS CORE FLUID PROCESSING RATES. R. G. Tongue and T. R. Jenkins. Sept. 1958. 42p. (HARD(B)/P-13). $0.84 (BIS).

Neutron poisons can be removed from homogeneous aqueous reactors by many types of processes. The equilibrium value of neutron capture cross-section of the total poisons depends on the rate of processing. Methods are given for calculating equilibrium poison levels for various types, combinations, and rates of processing. Numerical examples illustrate the methods for a reference power reactor system. (auth)

4719 NYO-2131
Massachusetts Inst. of Tech., Cambridge.
FUEL CYCLES IN NUCLEAR REACTORS. [Period covered]: September 1957 – August 1959. Raymond T. Shanstrom, Manson Benedict, and Charles T. McDaniel. 396p. Contract AT(30-1)-2073. OTS.

Contents of this report submitted as a thesis by Raymond T. Shanstrom.

A new IBM 704 computer code, FUELCYC, was developed for studying the effect on the fuel cycle of different methods of scheduling replacement of fuel and movement of control poisons. Four alternate fuel scheduling methods were built into the code and provision is made for the addition of other methods. The fueling techniques available in the code are: (1) "Batch," the replacement of the entire fuel charge at one time, with uniform control poisoning during the irradiation; (2) "Inout," the progressive shifting of fuel rods from inner positions to outer positions; (3) "Outin," the progressive shifting of fuel rods from outer positions to inner positions; and (4) "Graded," the periodic replacement of the most irradiated fuel rod among different local groups of rods. FUELCYC is designed for the study of fuel cycles in large power reactors with azimuthal symmetry, which are fueled with U^{235}, U^{238}, and the higher nuclides in their irradiation chains. It is a two-dimensional code in which neutron leakage occurs from two energy groups and neutron absorptions are allowed in the thermal group and also in one of four resonance groups for each fuel nuclide. Local properties are homogenized into cells. FUELCYC calculates the criticality factor, the flux distribution, the power density distribution, the burnup, the fuel cycle cost, and other properties during the life history of the fuel, taking into account the buildup and decay of nuclides in the fuel irradiation chains. An iterative method for solution of the flux distribution was developed which converges even for very coarse mesh spacings, and allows a typical fuel cycle problem to be solved, with good accuracy, in from three to five minutes. (auth)

5617
FUEL BURN-UP IN NUCLEAR REACTORS. B. L. Ioffe and L. B. Okun. Soviet J. Atomic Energy 4, 529-44(1956).

A method is described of calculating fuel burn-up in nuclear reactors, taking into account the capture and multiplication of neutrons while slowing down. In the calculations, account is taken of the burn-up of U^{235} and the build-up and burn-up of Np^{239}, Pu^{239}, Pu^{240}, Pu^{241} and of the fission fragments. (auth)

FUEL CYCLE 7.03

BURNUP CALCULATION 7.03.02

15463 CRFD-835
Atomic Energy of Canada Ltd., Chalk River, Ont.
$\int kd\theta$ IN FUEL IRRADIATIONS. J. A. L. Robertson. Apr. 1959. 27p. (AECL-807). $1.00(AECL).

The parameter, $\int kd\theta$, is being increasingly used to describe the condition of reactor fuels under irradiation. The mathematical derivation of the equations by which the parameter can be measured, for simple geometries, is provided. Some of the possible applications are discussed; by way of illustration, three numerical examples are included. (auth)

7476 BNL-3368
Brookhaven National Lab., Upton, N. Y.
FISSION PRODUCT CONCENTRATIONS IN FLUID REACTOR FUELS WITH CONTINUOUS PROCESSING. Allen M. Eshaya. 1956. 10p. $1.80(ph OTS); $1.80 (mf OTS).

The mathematical relationships relating the concentrations of fission products to the rates of removal were derived by Dwyer on the basis that no nuclide changes concentration as the fuel goes through the cycle. This analysis takes into account the changes in concentration which occur in a given volume element of fuel as it proceeds through the cycle. The relationship between the removal rates of successive nuclides in a given chain is introduced as a parameter. (A.C.)

7198 A/CONF.15/P/37
PROBLEMS OF FUELLING IN INDUSTRIAL CALDER HALL TYPE REACTORS. R. R. Gallie and H. H. Gott (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and F. C. W. Colmer (Central Electricity Generating Board, London). 33p.

The two main problems treated are the utilization of the initial fuel charge and the prediction of the statistical relation between bursts and burn-up and to draw the correct conclusions from this prediction. It is clear, however, that this prediction is largely a problem of the accumulation of operating experience and initial estimates are not likely to be precise. Attention is drawn to the practical problems, although the treatment is largely mathematical. (W.D.M.)

16091 IDO-14472
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
ICPP INPUT MEASUREMENT PROGRAM. F. H. Tingey and J. E. Rein. May 25, 1959. 49p. Contract AT(10-1)-205. $7.80(ph), $3.30(mf) OTS. (PTR-368).

The measurement of residual fissionable material in spent reactor fuel elements requires specialized equipment, methods, and control procedures. As a result of processing a variety of fuels at ICPP an integrated measurement generation, control and interpretation system has evolved which provides highly precise measurements from which plant material balances are constructed. (auth)

REACTOR FUEL CYCLE ANALYSIS BY SERIES METHODS. Raymond L. Murray, S. A. Hasnain, and A. L. Mowery, Jr. (North Carolina State College, Raleigh). Nuclear Sci. and Eng. 6, 18-25(1959) July.

An analytical method is developed for determining the properties of a power or converter reactor as a function of time during the operating cycle. Account is taken of the space-dependent fuel consumption and production by the fundamental flux distribution. Average isotopic compositions, reactivity, isotopic power distribution, and cycle life are expressed in terms of "burnup" functions. These may be evaluated by the use of series involving tabulated flux averages over the core. (auth)

GENERAL 7.03.03

See also, under WASTE TREATMENT AND DISPOSAL, SURVEYS AND BIBLIOGRAPHIES--Future Problems (8.06.08).

6327 TID-7583(p.56-85)
[General Electric Co. Hanford Atomic Products Operation, Richland, Wash.].
MEASUREMENTS. K. M. Harmon and R. A. Schneider. 30p.

Hanford plans for the measurement of the nuclear materials content of non-production fuels are presented. A comparison of the expected reliability of calculated and measured values which will be obtained at various points in the over-all fuel cycle is made. Some of the key factors in the problem of reconciling values obtained at the various points are discussed. (auth)

FUEL CYCLE 7.03

GENERAL 7.03.03

21737
(i) OPTIMIZATION OF FUEL CYCLES. P. R. J. French and C. S. Lowthian (A.E.I.-John Thompson Nuclear Energy Co., Ltd., Knutsford, Cheshire, Eng.). J. Brit. Nuclear Energy Conf. 4, 198-202(1959) July.

A simplified chain of long term changes in fuel composition with irradiation is considered, through an investigation of the physical parameters involved in the complementary design optimization of lattice parameters and fuel cycle. The investigation is based on a reactor operated on a 'once-through' equilibrium fuel cycle such that each region of the reactor contains, at any time, fuel elements whose irradiation periods are evenly distributed over the range from zero to the limiting irradiation at which fuel is discharged. A relationship is obtained between the burn-up of the fissionable content of the fuel and the initial distribution of neutrons between thermal and epithermal capture. The effect on fuel life of enrichment is considered together with the possible allocation of reactivity to increasing either reactor output or fuel life. It is indicated how, for a particular design, the ultimate generation cost can be influenced by the allocation of reactivity. (auth)

23053 TID-7559(Pt.1)(Paper 15)
Argonne National Lab., Lemont, Ill.
MANUFACTURING METHODS FOR THE EXPERIMENTAL BREEDER REACTOR MARK I AND MARK II FUEL LOADINGS. A. B. Shuck. Paper 15 of FUEL ELEMENTS CONFERENCE HELD AT GATLINBURG, TENNESSEE, MAY 14-16, 1958. 22p.

The EBR-II fuel cycle, the reactor core subassembly, and fuel element are described. The proposed methods for manufacturing the U^{235} fueled Mark I loading and the U-Pu fueled Mark II loadings are described in some detail. The initial loadings will be made using a simulated equilibrium fissium alloy. These will be manufactured by non-remote methods but using the same operational sequences as the recycle material. The recycle loadings will be pyrometallurgically processed, refabricated, and reassembled by remote control in a special facility under construction adjacent to the reactor. A brief description of this plant and the remote control process is given. (auth)

246
BLENDING VS. REENRICHMENT FOR SLIGHTLY ENRICHED URANIUM. Donald Kallman and John E. Brennan (Babcock and Wilcox Co., New York). Chem. Eng. Progr. 55, Symposium Ser. No. 23, 31-4(1959).

Blending with highly enriched uranium may permanently be practiced in place of reenrichment at the diffusion plant because the difference in cost may be small and the flexibility greater. The economics of both methods are compared relative to first-core loading and fuel-cycle costs. (auth)

22155
URANIUM-233. FORMATION IN REACTORS. PURIFICATION CYCLE. André Chesné (École de Physique et de Chimie Industrielles, Paris). Énergie nucléaire 1, 177-84(1959) July-Aug. (In French)

The irradiation of Th^{232} in a reactor gives rise to the formation of U^{233}, Pa^{233}, and fission products. In order to utilize the untransformed Th^{232} as a fertile material and U^{233} as a fissionable material, it is necessary to eliminate foreign elements capable of absorbing neutrons and gamma emitters which complicate their handling. The most favorable experimental conditions for the chemical treatment are defined. The process includes the solution of metallic thorium, decontamination of uranium, separation of uranium and thorium, reextraction of uranium, concentration and purification, and recovery of Pa^{233}. (tr-auth)

3475 TID-7557(p.35-50)
Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.
FUEL RECYCLING IN POWER REACTORS.
R. Berman, L. S. Mims, S. Siegel, and R. J. Beeley. p.35-50 [of] FIFTH INTERNATIONAL CONGRESS AND EXHIBITION OF ELECTRONICS AND ATOMIC ENERGY, ROME, ITALY, JUNE 16-30, 1958. (U. S. Papers). 16p.

Two fuel recycle concepts are discussed. The role of pyroreprocessing vs. aqueous reprocessing of the fuel is examined for each concept. In the uranium-plutonium cycle the general problems of reactivity and isotope buildup are examined as functions of the reactor design parameters. An investigation of a large organic-moderated reactor, operating on the plutonium recycle with natural-uranium feed, is described in some detail. The problems of designing a thorium-uranium recycle reactor are discussed for various neutron energy levels.

FUEL CYCLE 7.03

GENERAL 7.03.03

21738

(ii) OPTIMIZATION OF FUEL CYCLES. P. J. Grant, W. Oswald, and P. D. D. Russell (The General Electric Co., Ltd., Erith, Kent, Eng.). J. Brit. Nuclear Energy Conf. 4, 203-9(1959) July.

Economic factors affecting the choice of fuel cycles for nuclear power stations are discussed. The usefulness of the concept of neutron economy is examined and economic effects of changes in the use of neutrons with changes in the degree of enrichment of the fuel are considered briefly. The prices of the nuclear fuels are discussed. The optimization of the fuel cycle of a gas-cooled, graphite moderated reactor fuelled with natural uranium is discussed in some detail. (auth)

21739

OPERATIONAL PROBLEMS ASSOCIATED WITH FUEL CYCLING. J. C. C. Stewart and N. L. Franklin (U.K.A.E.A. Industrial Group, Risley, Lancs, Eng.). J. Brit. Nuclear Energy Conf. 4, 210-16(1959) July.

The uncertainties which exist in fuel performance are examined in relation to the physics and reactivity control of the reactor, the metallurgical lifetime of the fuel cycle which is external to the reactor. The requirements for processing fuel elements with a range of plutonium contents and depletions are given. (C.J.G.)

434 CF-58-10-34

Oak Ridge National Lab., Tenn.

ESTIMATE OF POTENTIAL FUEL REPROCESSING, REVISION NO. 25—PART A. J. W. Ullmann. Oct. 2, 1958. 8p. Contract W-7405-eng-26. $1.80(ph OTS); $1.80(mf OTS).

The power and estimated reprocessing load is tabulated for existing and proposed United States and United States built reactors of 10 kw or greater thermal power.

Oak Ridge National Lab., Tenn.

ESTIMATE OF POTENTIAL FUEL REPROCESSING, REVISION NO. 28—PART A. J. W. Ullmann. June 25, 1959. 9p. Contract [W-7405-eng-26]. $1.80(ph), $1.80(mf) OTS.

A tabulation containing information on the power of existing and proposed U. S. and U. S.-built reactors of 10 kw or greater thermal power is presented. Estimated fuel reprocessing loads for irradiated fuels are also included. (auth)

20311 AERE-R-2938

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.

RADIOISOTOPE DATA. R. A. Allen, R. J. Millett, and D. B. Smith. May 1959. 164p. $1.12(BIS).

Data on generally available radioactive materials and associated short-lived isotopes are reported. Calculated yields after various times of irradiation are quoted. Half life, decay scheme, other isotopes produced, target material, production processes, and cross sections are given. Preliminary sections include information on health regulations, radioactive standards, and a table of K factors. (C.J.G.)

NUCLEAR FUEL CYCLES. Nuclear Eng. 4, 113-17 (1958) Mar.

The papers on long term reactivity changes, theory of once-through fuel cycles, perturbations due to fuel cycles, optimization of fuel cycles, neutron economy, and operational problems presented at the Symposium on Nuclear Fuel Cycles arranged by the Institute of Physics in collaboration with the British Nuclear Energy Conference on Jan. 22 and 23 are summarized. The cycling of fuel in graphite-moderated power reactors is discussed. (W.D.M.)

REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 1, No. 4. Lemont, Argonne National Laboratory, 1958. 33p. Available from U. S. Government Printing Office for $0.55.

The fuel cycle program is reviewed, and the development of more efficient U^{233}, U^{235}, natural uranium, and plutonium fuels is outlined, together with use of fuels at higher temperature, increased burn-up, and reduction of fuel element production costs. In the Euratom program, the U. S. proposes to reprocess fuels provided by the U. S. to users in the Euratom countries. Details of this program are reviewed. Mechanical and chemical methods for decladding are considered, including pulverizers, sawing methods, and various chemical dissolution procedures. Fuel processing is examined, including Purex and Redox improvements and modifications, studies of organophosphorus and organonitrogen extractants, precipitation processes, and ion exchange. In addition, continued development in uranium hexafluoride volatility processes and pyro-

FUEL CYCLE 7.03

GENERAL 7.03.03

13463 ✓ CF-58-7-86
Oak Ridge National Lab., Tenn.
EFFECT ON POWER COST OF SUBSTITUTING ALUMINUM FOR ZIRCONIUM FUEL CLADDING IN A BOILING WATER REACTOR. W. L. Albrecht. July 24, 1958. 7p. Contract [W-7405-Eng-26]. $1.80(ph OTS); $1.80(mf OTS).

The substitution of Al-clad for Zr-clad fuel necessitates reducing the operating temperature. The amount of saving that must be made in fabrication and chemical reprocessing to overcome the cost of operating at reduced thermal efficiency is estimated for a boiling water reactor. (auth)

REACTOR FUEL CYCLES. J. J. Syrett. Chem. Weekblad 54, 223-6(1958).

The point, channel, and bulk discharge methods of charging reactor fuels in power reactors are compared from the economic aspects. Special emphasis is placed on the possible operating methods for a natural uranium reactor on a "once-through" fuel cycle, in which fuel is rejected after irradiation. (auth)

14186 ✓
NUCLEAR TECHNICS: PHYSICS, TECHNOLOGY, REACTORS. PART IV. Wolfgang Riezler and Wilhelm Walcher, eds. Stuttgart, B. G. Teubner Verlagsgesellschaft, 1958. pp. 481-640. (In German)

Part IV continues its discussion of reactors and completes the section on reactor theory by discussing reactor statistics and fuel cycles. Reactor measuring techniques and heat problems are considered. (J.S.R.)

FUEL ELEMENT EXAMINATION FACILITY FOR THE PLUTONIUM RECYCLE TEST REACTOR(PRTR). W. S. Kelly (General Electric Co., Richland, Wash.). p.109-19 in "Proceedings of the Seventh Hot Laboratories and Equipment Conference."

A facility is described which will permit the examination, immediately upon discharge, of fuel elements and process tubes irradiated in the Plutonium Recycle Test Reactor (PRTR). Located in the floor of the reactor hall, the facility will be provided with optical equipment to view, photograph, and measure the fuel elements and process tubes, and handling equipment to move the elements past the viewers. Directed air-cooling through the fuel element cooling channels will be provided to prevent damage resulting from self heating during examination. (auth)

16664 ✓ A/CONF.15/P/1197
CYCLES DE COMBUSTIBLES. PRODUCTION D'URANIUM, PROGRAMME DE CENTRALES ELECTRIQUES ET EFFORT FINANCIER CORRESPONDANT. (Fuel Cycles. Production of Uranium and the Central Electric Program and Related Financial Effort.)
J. Andriot and J. Gaussens (Commissariat à l'Énergie Atomique, Paris). 64p.

A number of different possible programs for nuclear power stations of various types are presented. These programs are established in relation to the use of uranium and thorium in amounts similar to those that shall probably be produced in France during the next fifteen years. As it is possible to draw plans for nuclear power stations in which several processes exist simultaneously, an unlimited number of variations being possible this survey is limited to successive analysis of the results obtained by use of only one of each of the following three systems: natural uranium–graphite, natural uranium–heavy water, and enriched uranium–pressurized light water. All schemes are considered as assemblages of these three simple systems. The effects of plutonium recycling are also considered for each system. The electric power installed and the capacity of stations situated up-stream and down-stream have been calculated by this method and an attempt has been made to establish the sum to be invested during the fifteen years necessary for the launching of the programs scheduled. A table of timing for the investments groups the results obtained. Considering the fact that French capital shall not be unlimited during the coming years, this way of presenting the results seems to be interesting. (auth)

9483
DOUNREAY. PART II. Nuclear Eng. 2, 286-93(1957) July.

The Dounreay Materials Testing Reactor and Dounreay Fast Reactor, their fuel cycles, chemical separation schemes, fuel element manufacture, effluent disposal, and fuel element examination are described. (T.R.H.)

FUEL CYCLE 7.03

GENERAL 7.03.03

7228 A/CONF.15/P/311
THEORETICAL ASPECTS OF FUEL CYCLING IN INDUSTRIAL CALDER HALL TYPE REACTORS. S. E. Lewis (Nuclear Power Plant Co., Ltd., Knutsford, Ches, Eng.) and C. S. Lowthian (AEI-John Thompson Nuclear Energy Co., Ltd., Knutsford, Ches., Eng.). 23p.

A basic theory of once-through fuel cycles is developed, which considers the variation of reactivity with fuel irradiation. It is shown how values of the fuel life can be obtained for various simple cycles and how these lives are a function of the reactivity which is allocated to life rather than to reactor heat output. The effect of the allocation of reactivity on the total generation cost of electricity is discussed. The concept of an equilibrium state is considered, in which the fuel cycle is so arranged that the over-all reactivity of the reactor does not vary with further irradiation. The reactivity at any specific point within the reactor is, however, a function of the fuel cycle adopted and it is

PLUTONIUM 7.03.04

5660 DEGIS-41(R)
United Kingdom Atomic Energy Authority. Development and Engineering Group. Library and Information Dept., Risley, Lancs, England.
BIBLIOGRAPHY ON PLUTONIUM FUELLING AND CYCLING. G. I. Maughan, comp. 11p. BIS.

A bibliography on the use of plutonium as a nuclear reactor fuel is presented. Included are 65 unclassified references to reports, books, and journal articles from U.K.A.E.A. Abstracts Index (1953 to date), Nuclear Science Abstracts (1953 to 58), and Engineering Index (1953 to 58). (J.R.D.)

SOME PROBLEMS OF PLUTONIUM FUEL CYCLES. M. Taube (Inst. of Nuclear Research, Warsaw). Nukleonika 3, 561-73(1958). (In Polish)

The role of nuclear fuel in fixing the costs of energy production in nuclear power stations is discussed. Classifications of types of fuel cycles and material balances for such cycles are given for the case of plutonium fuel. The specific power of the fuel and its connection with fuel cycles are characterized. (tr-auth)

14876 HW-58000
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PLUTONIUM RECYCLE PROGRAM. Annual Report, Fiscal Year, 1958. S. Goldsmith, ed. Nov. 11, 1958. 117p. Contract W-31-109-Eng-52. $2.75(OTS).

The work performed by the Hanford Laboratories on the Plutonium Recycle Program during fiscal year 1958 is described. Fuel Cycle Analysis: Studies were directed toward establishing a value for plutonium as fuel for thermal reactors. The fuel cycles studied considered sets of variables as determined by (1) single pass or steady state type of recycle, (2) "batch" or "graded" schemes for charging the fuel into the reactor, (3) "spike" or uniform enrichment methods, and (4) fuel processing methods. Physics: In addition to the physics work associated with the fuel cycle analysis, work was performed dealing with calculating effective cross sections, diffusion theory, measurements of lattice parameter, and measurements of plutonium cross sections. Fuel Element Technology: Studies were made on both ceramic and metallic core fuels. Methods of core fabrication, core cladding, and fuel element assembly were developed for a variety of fuel types. Efforts were concentrated on fuel elements of a rod clustered design and a three-component nested tubular design. Chemical Processing Technology: Research and development studies were continued on several chemical processing schemes in order to develop the design requirements for a preferred, completely integrated plutonium recycle system. Aqueous and pyrochemical methods were investigated for processing Pu fuels. It was found that Zr-2 fuel jackets could be dissolved in stainless steel equipment with ammonium fluoride solutions. A mixture of ammonium fluoride and ammonium nitrate was found to be as effective as ammonium fluoride alone for dissolving Zr-2 fuel jackets. This mixture has added advantages of simplifying the off-gas handling problem and also dissolving the tin along with the Zr. It was found that the passive oxide film formed on the Zr-2 cladding when it is exposed to high temperature water can be destroyed by exposing the Zr-2 to an anhydrous melt of $NH_4F \cdot 2HF$ at temperatures as low as 25°C. Major Experimental Facilities: Construction of two major experimental facilities was started. The Plutonium Fabrication Pilot Plant (PFPP) is designed to investigate a variety of fabrication methods for plutonium-bearing fuel elements. The Plutonium Recycle Test Reactor is heavy water moderated and cooled and contains 85 verti-

FUEL CYCLE 7.03

PLUTONIUM 7.03.04

cal pressure tubes. The reactor will have the experimental flexibility necessary to investigate a wide range of physics variables and fuel element designs associated with plutonium recycle. Detailed design of the reactor continued during the fiscal year. (For preceding period see HW-52000.) (W.D.M.)

9168 CF-60-2-34
Oak Ridge National Lab., Tenn.
A STUDY OF THE FUEL VALUE OF PLUTONIUM.
S. Jaye, L. L. Bennett, and M. P. Lietzke. Feb. 11, 1960. 90p. OTS.

The fuel value of mixtures of plutonium isotopes has been calculated for five thermal reactors (Yankee, Dresden, Hallam, GCR-II, Carolinas-Virginia). Plutonium with very high Pu^{239} content may be utilized economically in any of the reactors; its value varies from $8.1 to $16.5 per gram depending on the reactor. The use of once-recycle plutonium mixed with natural uranium is economical only in reactors with good neutron economy. The value of twice-recycle plutonium mixed with natural uranium was less than $5 per gram in four of the five reactor types studied. Fuel-cost calculations indicate that future reductions in fuel fabrication and handling charges will reduce fuel costs less than 1 mill/Ekwh if the annual fuel inventory charges are increased from 4 to 8%. The calculated fuel values for plutonium were not significantly affected by the use of projected-cost rather than present-cost estimates. (auth)

12899 RPI-12(AECL)
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
REACTIVITY AND FUEL BALANCE IN RECYCLED PLUTONIUM REACTORS. M. F. Duret. Oct. 24, 1955. 30p.

Equations are developed for expressing the nuclear characteristics of reactor cores containing natural U, recycled Pu, and up to three stages of depleted U. The initial reactor charge would be natural U which is processed for Pu and fission product removal as reactivity demands. Both the depleted U and separated Pu are recharged to the reactor. Depleted U would be discarded when Pu^{240} concentrations became excessive. (D.E.B.)

6029 A/CONF.15/P/1727
ANALYTICAL AND ECONOMIC INVESTIGATION OF PLUTONIUM PRODUCTION IN NUCLEAR POWER REACTORS. Andras Leval, Imre Kovâts, and Gergely Bûki (Budapest Technical Univ.). 45p.

A brief survey of the cost analysis of nuclear power plants is given. The evaluation of plutonium production is based on physical and economic factors of a very heterogeneous character. When attaining different burnup levels, the value of the extracted plutonium can be determined with reference to the time of production. The burnup level at which it is economical to extract the plutonium is established. (W.D.M.)

THORIUM 7.03.05

9424 BNL-483(p.36-45)
American-Standard. Atomic Energy Div., Mountain View, Calif.
SURVEY OF Th-U^{233} TECHNOLOGY. A. Ottenberg. p.36-45 [of] THORIUM-U^{233} SYMPOSIUM, SPONSORED BY THE UNITED STATES ATOMIC ENERGY COMMISSION AT BROOKHAVEN NATIONAL LABORATORY, JANUARY 9-10, 1958. 10p.

Physics data and the problems of reactor design, control, and fuel cycle, including processing and fabrication, are presented for the Th-U^{233} fuel cycle. The Los Alamos U^{233} processing flowsheet is included along with a diagram of nuclear reactions occurring in the neutron irradiation of Th. A flowsheet is presented for the Thorex process along with the long and short time cooling schemes for irradiated Th prior to Thorex processing. (W.L.H.)

9418 BNL-483(p.6-8)
Brookhaven National Lab., Upton, N. Y.
THE THORIUM CYCLE. F. T. Miles. p.6-8 [of] THORIUM-U^{233} SYMPOSIUM, SPONSORED BY THE UNITED STATES ATOMIC ENERGY COMMISSION AT BROOKHAVEN NATIONAL LABORATORY, JANUARY 9-10, 1958. 3p.

The thorium cycle is discussed beginning with the separation of thorium from its ores through the chemical separation of Th, Pa, and U^{233} and the recycle of the recovered Th. The in-pile production scheme for U^{233} from Th is presented. (W.L.H.)

FUEL CYCLE 7.03

THORIUM 7.03.05

6028✓ A/CONF.15/P/1642
STUDY OF FUEL CYCLES WITH REFERENCE TO A POWER PROGRAMME. M. Dayal, S. R. Paranjpe, N. B. Prasad, and B. Singh (Atomic Energy Establishment, Trombay, India). 14p.

As the thorium reserves of India are much larger than the uranium reserves, any large-scale nuclear power program has to be based ultimately on the thorium–U^{233} cycle. However, special fissile material will be required to start this cycle, and therefore a beginning has to be made with natural uranium reactors. These reactors will convert some U^{238} to plutonium, which may be used in the second generation of power reactors. These may either be fast reactors where U^{233} can be produced from thorium in the outer blanket with some net breeding gain or thermal reactors producing slightly less U^{233} than the plutonium consumed. This will then be the starting point for the third generation

FUEL AND FUEL ELEMENTS 7.04

AQUEOUS 7.04.01

21724 IGIS-54(RD/R)
United Kingdom Atomic Energy Authority. Industrial Group H.Q., Risley, Lancs, England.
A BIBLIOGRAPHY ON BOILING WATER REACTORS. G. I. Maughan. Apr. 1, 1959. 36p. $0.49(BIS).

A wide selection of book, report, and periodical references on heterogeneous boiling water reactors compiled from Nuclear Science Abstracts, 1948 to Feb. 1959, and Engineering Index, 1950 to 1957, is given. (J.E.D.)

LA-2043
Los Alamos Scientific Lab., N. Mex.
THE PROPERTIES OF PHOSPHORIC ACID SOLUTIONS OF URANIUM AS FUELS FOR HOMOGENEOUS REACTORS. B. J. Thamer, R. M. Bidwell, H. M. Busey, R. A. Clark, S. H. Cox, L. A. Geoffrion, R. P. Hammond, G. E. Meadows, B. J. Melton, R. H. Perkins, J. R. Phillips, M. G. Redman, J. D. Rogers, A. Sesonske, L. R. Sitney, E. O. Swickard, W. R. Wykoff, and J. B. Zorn. Mar. 6, 1956. 59p. Contract W-7405-Eng-36. $0.40(OTS).

Data secured up to March 1956 are given on the properties of $UO_3-H_3PO_4-H_2O$ solutions that might be suitable for use in homogeneous reactors. Included is information on solubility, radiation stability, vapor pressure, thermal expansion of the liquid phase, and corrosion. Sufficient U solubility in the system $UO_3-H_3PO_4-H_2O$ is readily obtainable with as little as 2 or 3M H_3PO_4. Adequate U solubility in the system $UO_2-H_3PO_4-H_2O$ requires the use of concentrated H_3PO_4, but these solutions have the advantages of low vapor pressure and low equilibrium pressure of radiolytic H_2 and O_2. A brief discussion is given of feasible methods of reprocessing phosphate fuel solutions with the use of only inorganic reagents. (auth)

FUEL AND FUEL ELEMENTS 7.04

FLUID FUEL REACTORS. James A. Lane, H. G. MacPherson, and Frank Maslan, eds. Reading, Mass., Addison-Wesley Publishing Company, Inc., 1958. 999p. $11.50.

A summary of the work done in the United States on fluid fuel reactors is presented. The first part deals with the aqueous homogeneous reactor; most of this work was done at ORNL, with some phases of the work (on slurries) at Westinghouse Atomic Power Division and some work on phosphate solutions at LASL. The second part deals with the fused salt system, which was investigated primarily at ORNL. The third part deals with the bismuth–uranium system, investigated at BNL. The development of aqueous homogeneous reactors is discussed. The nuclear characteristics of one and two region homogeneous reactors are summarized. The properties and technology of aqueous fuel solutions are treated. The integrity of metals in homogeneous reactor media is reviewed. Core and blanket chemical processing is summarized. Design, construction, and costs are discussed. Under molten–salt reactors, chemical aspects of fuels, construction materials, nuclear characteristics, heat-transfer systems, and conceptual designs are considered. The aircraft reactor experiment is summarized. Reactor physics for liquid metal reactor design are reviewed. The composition, properties, and chemical processes of liquid metal fuels are discussed. The metallurgy of construction materials is discussed. Engineering studies of the LMFR are summarized. Two-fluid and single-fluid LMFR designs are compared. Conceptual designs are compared. Conceptual designs of liquid metal fuel gas-cooled reactors, molten plutonium fuel reactors, and liquid metal-uranium oxide slurry reactors are discussed. (W.D.M.)

FUEL AND FUEL ELEMENTS 7.04

CERAMIC 7.04.02

FUEL ELEMENTS FOR GAS COOLED REACTORS. M. Becker. Atomkernenergie 4, 244-7(1959) June. (In German)

The high gas temperatures planned for future gas-cooled power reactors make the development of new types of fuels necessary. Only a slight increase in temperature would be expected in the transition from uranium fuel rods to uranium tubes or plates. The transition to ceramic fuels offers the possibility of a greater temperature increase. The canning materials must have sufficient high-temperature strength and corrosion resistance. The metals and ceramic materials with these properties are discussed. For the highest temperatures, graphite is probably most suitable. (auth)

THE FUTURE OF CERAMICS AS NUCLEAR FUEL. 2. DEVELOPMENT OF THE NEW FUELS. Peter Murray (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Power 4, No. 37, 89-94(1959) May.

Data on materials being developed to replace metal fuels are reviewed. Ceramics with nuclear potential such as uranium dioxide, uranium monocarbide, and dispersed fuels are discussed. (A.C.)

17107 BMI-1282
Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF CERMET FUEL ELEMENTS. Stan J. Paprocki, Donald L. Keller, George W. Cunningham, and Donald E. Kizer. Aug. 11, 1958. Decl. Sept. 26, 1958. 16p. Contract W-7405-eng-92. $3.30(ph OTS); $2.40(mf OTS).

Fabrication techniques for making metal-ceramic fuel elements containing 60 to 90 vol. % of UN or UO_2 in a Type 302B stainless steel matrix were investigated. A hot press-forging procedure was most successful for fabricating fuel cores with a density of 90 per cent of theoretical or better. This procedure consisted of sealing the cold-pressed core compacts in stainless steel picture-frame packs, heating to 1900°F, and pressing to a total reduction in thickness of 35%.

GENERAL 7.04.03

6058 CF-59-12-64(Rev.)
Oak Ridge National Lab., Tenn.
MOLTEN-SALT BREEDER REACTORS. H. G. MacPherson. Jan. 12, 1960. 25p. OTS.

The problems involved in building a molten-salt thermal-breeder reactor are reviewed, and it is concluded that the most feasible construction is an externally-cooled reactor with the fuel salt passing through the reactor core in graphite tubes. A reactor with 15% of the core volume occupied by fuel salt and 5% occupied by fertile salt would have a net breeding ratio of about 1.06. The specific power is about 3.0 Mw(th) per kg of U^{233}, U^{235}, and Pa in the entire reactor and chemical processing system. The resulting doubling time is 13 full-power years. The cost of the fuel cycle for a 1000-Mw(e) station with this breeding performance is estimated to be 1.2 mills/kwhr. The performance in terms of material utilization is an output of 1.18 Mw(e) per kg of U^{233}, U^{235}, and Pa, and 3.2 Mw(e) per metric ton of Th. The latter figure could be increased by a factor of two at a sacrifice of 0.01 in breeding ratio. (auth)

18740 TID-8507
Division of Reactor Development, AEC.
REPORT OF THE FLUID FUEL REACTORS TASK FORCE TO THE DIVISION OF REACTOR DEVELOPMENT, UNITED STATES ATOMIC ENERGY COMMISSION. Feb. 1959. 192p. $1.75(OTS).

A relative comparison is presented of the fluid fuel reactor concepts (aqueous homogeneous, molten salt, and liquid metal fuel) to determine the: (a) present state of development and technical feasibility; (b) technical feasibility of breeding; (c) potential power cost in mills per kwh in a system optimized for power production; and (d) research and development program necessary to produce a reactor capable of achieving the cost potential for each concept. The molten salt reactor has the highest probability of achieving technical feasibility. This is largely due to the use of a solution fuel and the availability of a suitable container material (INOR-8). (W.D.M.)

FUEL AND FUEL ELEMENTS 7.04

GENERAL 7.04.03

14027 ✓
CURRENT TRENDS IN REACTOR FUELS. 1. PROGRESS REPORT ON SOLID FUELS. Nucleonics 17, No. 5, 100-3(1959) May.

Rising operating temperatures and lowering costs sum up the aims of reactor technologists. The first problem was underlined at the First International Symposium on nuclear fuel elements. By the symposium papers it was evident that development work is strongly directed toward fuel materials—both core and cladding—that will provide long life at high temperature. Highlights of the discussions on high-temperature materials as well as those on operating experience in the U.S. and abroad and on the part played by fuel cycle costs in the cost of nuclear power are presented. (A.C.)

13057✓
FUEL ELEMENTS. A. G. Samoilov and V. S. Volkov. Atomnaya Energ. 6, 261-76(1959) Mar. (In Russian)

The preparation of fuel elements and their performance in various reactors are analyzed on the basis of data presented at the Second Geneva Conference. (tr-auth)

19995 NP-7872
European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.
FUEL ELEMENT INVESTIGATION COMPILATION OF DATA. Report ED-C Rev., Chapter 110. 1959. 24p. $4.80(ph), $2.70(mf) OTS.

A compilation of fuel element data from Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland is presented. Comments concerning production plans for each country are included. (J.R.D.)

PRODUCTION OF PLUTONIUM 239. Harrison S. Brown and Herbert L. Anderson. British Patent 815,641. July 1, 1959.

A graphite- and heavy-water-moderated reactor is described in which Pu^{239} and U^{233} can be produced. The liquid UF_6 fuel is circulated through a graphite moderator. The circulation system has means for heat removal and bleeding or adding UF_6. The UF_6 removed is continuously processed for Pu and fission product separation. (T.R.H.)

FUSED OXIDE REACTOR FUELS. S. W. Mayer, W. S. Ginell, and D. E. McKenzie (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). Nuclear Sci. and Eng. 2, No. 1, Suppl., 126-8(1959) June.

The present status and an outline of the work on an investigation of fused oxide fuels for power breeder reactors are given. The fuels, which consist of solutions of U and Th oxides in molten phosphates, have low vapor pressures, low solidification temperatures, and radiation damage resistance. The major component of the fuel is $NaPO_3$ which exists in the melt as long chains of oxygen-linked PO_4 tetrahedra. Several promising melt compositions are listed. Preliminary heat transfer calculations based on a cross flow, in-line tube bank heat exchanger for a 100 Mw reactor are summarized. Preliminary nuclear calculations were carried out on the basis of a $Th^{232}-U^{233}$ cycle for both a single region and a dual region reactor. (W.D.M.)

81 ✓ AERE-C/M-198
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
THE POSSIBILITY OF FUSED FLUORIDE FUEL SYSTEMS FOR HOMOGENEOUS REACTORS. PART I. GENERAL INTRODUCTION AND THE SYSTEM $NaF-PbF_2-UF_4$. J. K. Dawson and A. E Truswell. Feb. 1954. Decl. July 21, 1958. 8p. (RCTC/P-6).

A literature survey has revealed a number of possible binary and ternary combinations of metallic fluorides of low neutron cross section which should be investigated for low-melting eutectics and for uranium tetrafluoride solubility so that their value as working fluids in homogeneous reactors may be assessed. There is appreciable miscibility of UF_4 with the $NaF-PbF_2$ eutectic at temperatures in the region of 500°C. Thermal analyses have shown that the ternary eutectic lies at 472°C and 16 mol. % UF_4. (auth)

FUEL CYCLES; FUEL ELEMENT DESIGN. W. N. McDaniel (Atomic Power Development Associates, Inc., Detroit). p.149-54 of PROCEEDINGS OF THE 1957 FAST REACTOR INFORMATION MEETING HELD AT CHICAGO, ILL., NOVEMBER 20-21, 1957.

Considerations which enter into the design of fixed fast reactor fuel elements and subassemblies are discussed. The likenesses and differences in the ANL and APDA design approaches are compared. (W.D.M.)

FUEL AND FUEL ELEMENTS 7.04

GENERAL 7.04.03

17798
NEW MATERIALS FOR REATORS. D. Tytgat. Bull. Inform. Assoc. belge develop. pacifique energie atomique No. 12, 15-20(1958) Jan. (In French)
A summary is presented on the characteristics of fuels, claddings, and moderators used in thermal reactors.

NEW FUEL ELEMENT IN WHICH THE DANGER OF AN ATOMIC EXPLOSION WOULD BE LESSENED. (to United Kingdom Atomic Energy Authority). German Patent DAS 1030 475. Atompraxis 4, 477(1958). (In German)

21214 AEC-tr-3764
LIQUID FISSION MATERIALS. [PART] I. Th. van der Plas. Translated for Oak Ridge National Lab. from RCN Bull. 2, 142-6(1958). 16p. $3.30(ph), $2.40(mf) JCL.
A review of the general types of fluid reactor fuels is presented. In addition, some of the principal non-mechanical problems to be solved in the development of fluid fuels are discussed. Solutions to these problems are not presented. Liquid metals, molten salts, and solutions in water are examined. (J.R.D.)

2226 TID-3064
Technical Information Service Extension, AEC.
ENRICHED URANIUM FUEL MATERIALS: A BIBLIOGRAPHY OF UNCLASSIFIED LITERATURE. Gifford A. Young, comp. Aug. 1956. 37p. $0.30(OTS).
Unclassified reports on processing of enriched UF_6 into U metal, U-base alloys, UO_2, and UO_2SO_4 for use as reactor fuels are annotated. Recovery of enriched U scrap, methods of isotopic analysis, health physics, criticality problems, and materials management are emphasized. A few references to papers presented at the Geneva Conference, 1955, and other nonreport literature are included. 254 references. (auth)

GLASS 7.04.04

SILICA-URANIUM FUEL SYSTEMS. W. M. Cashin (General Electric Co., Schenectady N. Y.). J. Am. Ceram. Soc. 42, 328-9(1959) July.
Presented are the irradiation results on two uranium-silica systems: a uranium oxide-Vycor-brand glass system and a 10% uranium oxide glass prepared by melting. The glasses were irradiated up to 15% depletion of the uranium at temperatures up to the softening points with no appreciable loss of fission-product gases. Included is an outline of a procedure for impregnating leached, unfired Vycor-brand glass with uranium. Rare gas release from specimens is discussed. (auth)

14999 A/CONF.15/P/440
Rensselaer Polytechnic Inst., Troy, N. Y. and Owens-Corning Fiberglas Corp. Research Center, Newark, Ohio.
GLASS FIBERS IN NUCLEAR REACTOR TECHNOLOGY. P. Harteck, S. Dondes, and J. W. Michener. 6p. $0.50(OTS).
Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.
A novel technique of incorporating fissionable and fertile material, homogeneously dispersed, in mineral or glass fibers, appears to have definite advantages for use in nuclear reactor fuel elements. To date, incorporation of 10% uranium-235 oxide by weight has been readily achieved. Radiation stability studies were made of these fibers, examining the effect of fiber diameter, tensile strength, and surface effects. Fibers of 1 to 5 μ diameter were shown to be excellent sources of fission fragments for utilization in the irradiation synthesis of chemicals, i.e., the nitrogen fixation process. Fibers of over 10 μ in diameter are being considered as matrices of fuel elements for power and materials test nuclear reactors. Some of the advantages of dispersing fissionable, including uranium-233, uranium-235 and plutonium-239, and fertile, including uranium-238 and thorium-232, material in glass fibers are; large surface area per unit, high chemical and thermal stability, adaptability to variations in composition, versatility in possible structural forms, and adaptability to simplified chemical reprocessing procedures. (auth)

FUEL ELEMENTS OF URANIUM GLASS FOR NUCLEAR REACTORS. (to Siemens-Schuckertwerke AG., Germany). German Patent DAS 1033 807. Atompraxis 4, 477(1958). (In German)

FUEL AND FUEL ELEMENTS 7.04

DISPERSED FUELS 7.04.05

14110 ✓
NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). British Patent 809,061. Feb. 18, 1959.
A reactor utilizing fluidized U powder as fuel is presented. The U powder is fluidized by He. Both a graphite- and a water-moderated version are offered. (T.R.H.)

5533 ✓ NMI-1223
Nuclear Metals, Inc., Concord, Mass.
ALLOY DISPERSION FUEL ELEMENTS. J. Paul Pemsler. Nov. 17, 1959. 27p. Contract AT(30-1)-1565. OTS.
A survey was made of potential dispersion alloy fuel elements consisting of a uranium-containing, fissile, intermetallic phase dispersed in a non-fissile matrix. The intermetallic compounds considered were those of uranium with iron, nickel, aluminum, copper, bismuth, and silicon. Alloys were formed by melting mixtures of the constituents. On the basis of microstructure, oxidation resistance, and workability, the systems uranium-type 304 stainless steel and U–80 Ni, 20 Cr were chosen for detailed study. Techniques for extrusion of these alloys were developed. Six alloy compositions were fabricated with enriched uranium for irradiation studies. (auth)

8321 ✓ TID-7564(p.193-215)
Sanderson and Porter, New York.
A HIGH TEMPERATURE-GAS CYCLE PEBBLE BED REACTOR FOR CENTRAL STATION USE. S. T. Robinson and R. F. Benenati. p.193-215 [of] INFORMATION MEETING ON GAS-COOLED POWER REACTORS, OAK RIDGE NATIONAL LABORATORY, OCTOBER 21-22, 1958. 23p.
A high-temperature gas cycle Pebble Bed Reactor is described together with the specific design and economics of a 125 Mwe central station power plant. The nuclear characteristics of the system are presented together with a discussion of fuel cycles, fuel element types, and development problems. (auth)

17749 AECU-3828
Illinois Inst. of Tech., Chicago. Armour Research Foundation.
THE ARMOUR DUST FUELED REACTOR (ADFR). Quarterly Progress Report No. 2 For the Period May 21, 1958 to August 21, 1958. W. E. Loewe and D. Krucoff. 23p. ARF Project A-115. Contract AT(11-1)-603. $4.80(ph OTS); $2.70(mf OTS).
Study of the ADFR concept included experimental work on fuel dust suspension stability and redispersibility, erosion, and dust deposition using the fuel dust circulation loop. Some theoretical work was done in the areas of reactor safety and breeding. (For preceding period see AECU-3827.) (auth)

9429 TID-7546(p.231-42)
Sylvania-Corning Nuclear Corp., Bayside, N. Y.
RECENT DEVELOPMENTS IN DISPERSION TYPE FUEL ELEMENTS. Bernard Kopelman. p.231-42 [of] FUEL ELEMENTS CONFERENCE, PARIS, NOVEMBER 18-23, 1957. 12p.
Considerable interest has centered around dispersion type fuel elements because they offer possibilities of performance not readily achievable in solid homogeneous fuels. Among these advantages are the possibilities of operation at high temperatures, high burn-ups, and the ability to withstand various corrosion conditions. A wide variety of dispersant fuel materials are described as well as matrix materials to contain the fuel. The important factors governing the selection of both fuel and matrix are discussed. Descriptions are given of the various techniques for preparing the fuel particles, including those for uranium oxide. In addition, descriptions are given of various combinations of fuel and matrix which have been studied and the results obtained therefrom. Because of the wide variety of possible fuel materials, as well as matrices in which these fuels can be dispersed, it is suggested that there is hardly a solid reactor fuel whose requirements cannot be met by the use of the dispersant type fuel. (auth)

1121 ✓
DISPERSION-TYPE HEAT-EMITTING ELEMENTS. Veber and Girsh. Vsesoyuz. Sbornik Met. Yader. Energ. i Deistv. Obluchen. Mater. Moscow. Metallurgizdat, 298-318(1956). (Translated from Referat. Zhur. Met. No. 1, 1957, p.200).
A description of methods of preparation and utilization of heterogeneous mixtures, consisting of the fissionable phase dispersed in a continuous matrix made of non-fissionable material (pure metal or alloy), as heat-emitting elements for reactors with elevated specific loads. Problems concerning the concentration and particle size of the fissionable material, and the radiational damage to dispersion systems are examined.

FUEL AND FUEL ELEMENTS 7.04

DISPERSED FUELS 7.04.05

9406 KAPL-1909
Knolls Atomic Power Lab., Schenectady, N. Y.
IRRADIATION BEHAVIOR OF DISPERSION FUELS. D. W. White, A. P. Beard, and A. H. Willis. Oct. 1, 1957. 54p. Contract W-31-109-Eng-52. ([KAPL-P-1849]). $1.50 (OTS).

The dispersion fuel concept offers a method for minimizing irradiation-induced property changes in nuclear fuel systems by localizing fission damage into regulated domains within the system. The system is thereby provided with a structural framework, or matrix, whose properties are relatively unaffected by the dynamic and impurity effects of fission fragments. Dispersion-type fuel systems whose irradiation behavior has been, or is being, investigated in the United States are listed. The extent of property retention in a dispersion fuel alloy is dependent on the materials selected for the fuel-bearing and matrix phases and on their microstructural arrangement in the alloy. The consequences of varying the materials and fuel-phase particle size and volume fraction are discussed. From experimental observations it is shown that, by proper control of these parameters within the bounds of existing technology, the dispersion concept does provide improvement in property retention over alternate alloy design concepts. (auth)

12477 ✓ KAPL-1525
Knolls Atomic Power Lab., Schenectady, N. Y.
FABRICATION OF URANIUM-RICH URANIUM–MAGNESIUM DISPERSION FUELS BY POWDER HOT PRESSING. R. N. Honeyman. Apr. 26, 1956. Decl. Apr. 11, 1957. 21p. Contract W-31-109-eng-52. $0.30(OTS).

A dispersion-type fuel element of U in a Mg matrix irradiated in the MTR previously has been shown to sustain exceptionally high burnup compared to the solid U fuel slugs now used. This report describes the development of a hot-pressing, powder metallurgy process for consolidating these materials into fully dense compacts with spherical U particles, uniformly dispersed throughout the Mg matrix. (auth)

LIQUID METAL 7.04.06

21817 ✓ BNL-554
Brookhaven National Lab., Upton, N. Y.
NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT [FOR] OCTOBER 1–DECEMBER 31, 1958. F. Maslan, ed. 71p. $2.00(OTS).

Work is reported on the mixing, fluidity, dissolution rates, fission product removal, corrosion, etc., of LMFR fuel. General activities reported on include reactor theory, experimental reactor physics, heat transfer, radiochemical technology, mechanical engineering, special radioisotope development, radiochemical analysis, and hot laboratory operations. (For preceding period see BNL-536.) (W.D.M.)

227 ✓
THE CHEMISTRY OF FISSION PRODUCTS IN A MOLTEN METAL NUCLEAR FUEL. Allen M. Eshaya and Richard H. Wiswall (Brookhaven National Lab., Upton, N. Y.). Trans. N. Y. Acad. Sci. 21, 668-81(1959) June.

Methods of removing fission products from a U–Bi fuel solution are discussed. The solubility of Xe^{135} in a liquid fuel composed of uranium (600 to 1000 ppm), zirconium (100 to 300 ppm), magnesium (50 to 1000 ppm), and bismuth was determined to be 2.5×10^{-8} moles Xe/mole Bi-atm at 500°C. Tests on graphite capsules filled with U–Bi fuel and irradiated for 15 days at an average flux of 2×10^{12} neutrons/cm^2-sec indicate that both Xe^{133} and I^{131} have a strong tendency to concentrate at or near the liquid metal-graphite boundary. Similar graphite capsules of 3 concentric graphite layers of 1.5 mm thickness containing U–Bi were irradiated for 15 days and then equilibrated at 500°C for 75, 15, and 5 hours. The 75-hr equilibration resulted in a uniform distribution throughout the three layers. Significant differences in second and third layer concentrations existed at 15 hours; at 5 hours a concentration difference was noted between the first and second layers. The Xe^{131} concentration in liquid Bi was found to increase upon the addition of ThO_2 particles. The constancy of the equilibrium constants of Ce, La, Nd, Sm, U, and Zr were tested and correlated with the thermodynamic properties of $MgCl_2$–NaCl–KCl and Mg–Bi. From this correlation the separation factor, ratio of the distribution coefficient of a fission product element to that of U, was determined. Infinite dilution values were determined for Ce, Li, Mg, Na, and U in bismuth. (C.J.G.)

FUEL AND FUEL ELEMENTS 7.04

LIQUID METAL 7.04.06

1130 BAW-1048
Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.
CHEMICAL PROCESSING METHODS AND ECONOMICS FOR VARIOUS LIQUID METAL FUEL REACTORS.
R. D. Pierce, W. E. Miller, and H. E. Zellnik. Mar. 1958. 91p. Contract AT(30-1)-1940. OTS.

The economic factors related to chemical processing of the fuel and blanket from liquid bismuth fuel reactors are described and evaluated. Cost data are presented as a function of pertinent reactor parameters, permitting the estimation of costs for any particular reactor and mode of operation. Costs are presented for on- and off-site processing for single- and two-region reactors. Processes are considered for solutions and slurries of both oxides and intermetallic compounds. Technical details useful in interpreting and evaluating cost data are presented in the appendices. These costs are as general as possible, and are essentially independent of other parts of the reactor system. Therefore they are useful in estimating the over-all power cores. (auth)

THE BEHAVIOR OF FISSION PRODUCTS IN MOLTEN FLUORIDE REACTOR FUELS. Mark T. Robinson, William A. Brooksbank, Jr., Samuel A. Reynolds, Henry W. Wright, and Thomas H. Handley (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng. 4, 288-96 (1958) Sept.

Observations are reported on the behavior of several fission product elements in molten $NaF-ZrF_4-UF_4$ fuels, irradiated in capsule experiments, forced-convection in-pile loop experiments, and in the Aircraft Reactor Experiment (ARE). The rare gases were observed to escape readily from the fuels in dynamic tests, although in static tests the rate of escape is very low. Ruthenium and niobium deposit on the Inconel walls of the fuel container, probably as metals. Other fission products studied (Sr, Zr, La, Ce) appear to remain in the fuel. The results obtained are entirely consistent with theoretical predictions. It is suggested that the observed noble metal deposit may serve to reduce corrosion of metals by molten fluoride fuels. The unsatisfactory nature of Cs^{137} as a fission monitor in such fuels is reported and the use of Zr^{95} as a substitute is discussed. (auth)

MOLTEN PLUTONIUM FUEL DEVELOPMENT (METALLURGY). R. M. Bidwell (Los Alamos Scientific Lab., N. Mex.). p.172-8 of PROCEEDINGS OF THE 1957 FAST REACTOR INFORMATION MEETING HELD AT CHICAGO, ILL., NOVEMBER 20-21, 1957.

The Los Alamos work on liquid Pu as a reactor fuel has been primarily concerned not with the element itself, but with certain low-melting alloys. The most promising fuel alloys to date have been the eutectics of Pu with Fe, Co, and Ni. Phase diagrams are given for the three systems. For a large power station reactor, a more dilute Pu melt would be desirable from a heat transfer point of view. For this reason the Pu–Mg monotectic at 85 at. % Mg was investigated. Compatibility tests with W, Mo, Ta, and Nb are reviewed, and the TiPu (tipping plutonium) apparatus is described. (W.D.M.)

7329 LA-2112
Los Alamos Scientific Lab., N. Mex.
A MOLTEN PLUTONIUM FUELED REACTOR CONCEPT—LAMPRE. R. M. Kiehn, A. S. Coffinberry, and L. D. P. King. Jan. 1957. 14p. Contract W-7405-eng-36. $0.20(OTS).

A brief discussion is given of the concept known as Los Alamos Molten Plutonium Reactor Experiment (LAMPRE). A preliminary design is given for the purpose of illustration. The detailed design will be the subject of a later report. (auth)

Problems of Liquid-Metal Fuelled Reactors, B.R.T.FROST. Nuclear Eng. 1, 8, 9 Nov 1956 p 334-9, Dec p 373-7. Nov: Comparison of liquid-fuelled with solid-fuelled systems; types of liquid metal fuel; methods of fuel containment; use of fuel in thermal systems and in fast system; liquid metal fuels for breeder blankets; chemical processing of fuel. Dec: Bismuth systems discussed with reference to mass transfer, penetration and corrosion of graphite; corrosion of reactor constructional materials.

FUEL AND FUEL ELEMENTS 7.04

LIQUID METAL 7.04.06

FLUID FUEL REACTORS WITH URANIUM–BISMUTH. F. T. Miles, D. W. Bareis, O. E. Dwyer, D. H. Gurinsky, I. Kaplan, R. J. Teitel, and C. Williams. Jan. 1952. Decl. Dec. 15, 1955. 14p. (BNL-1072; LFR-4)

U–Bi solutions or dispersions of USn_3 in liquid Bi–Pb–Sn are proposed as fluid fuels for a power breeder or converter. A simple and effective chemical process based on the extraction of liquid metal with fused salts will remove fission products in a concentrated form for use or storage. A process for the continuous separation of U^{233} from Th in the blanket is described. Several design possibilities are discussed.

United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
LIQUID METAL FUELLED REACTORS. A BIBLIOGRAPHY OF PUBLISHED AND UNCLASSIFIED REPORT LITERATURE. G. L. Cooper and A. Potter. Oct. 1956. 27p. (AERE-Inf/Bib-106).

The bibliography is divided into three parts. Part I gives the general references to liquid metal fuelled reactor (LMFR) systems considered from the physics and engineering aspects. Part II is devoted to the processing of core and blanket. Part III deals with the general technology of the materials concerned. There are 111 references to report and published literature.

MODERATORS AND POISONS 7.04.07

15370 ✓ WAPD-A1W(NRM)-214
Westinghouse Electric Co. Bettis Plant, Pittsburgh.
LITERATURE SURVEY ON SELECTED ALLOYS CONTAINING METALLIC POISONS. A. B. Thomas, D. G. Freas, and E. S. Byron. June 1958. Decl. Mar. 24, 1959. 35p. Contract AT-11-1-GEN-14. $6.30(ph), $3.00(mf) OTS.

A literature search was made for information on metallic elements suitable for use as burnable poisons. The search was concerned primarily with availability, cost, alloy preparation and fabrication, phase diagrams, and corrosion resistance. The alloy systems are arranged in alphabetical order. (A.C.)

7467 A/CONF.15/P/2325
CHEMISTRY, PHYSICS AND NUCLEAR PROPERTIES OF A NEW DEUTERATED BERYLLIUM COMPLEX TO BE USED AS A MODERATOR. M. A. Rollier (Univ. of Cagliari, Sardinia). 17p.

The theoretical values of the nuclear parameters of a new moderating material are discussed. The chemical synthesis of this deuterated beryllium complex is described, and the limits of its applications in research and power reactors are sketched. Radiation damage experiments on the new material are under way and their significance is appraised. (auth)

5618 ✓
BERYLLIUM PHYSICS REACTOR. A. K. Krasin and B. G. Dubovsky. Soviet J. Atomic Energy 4, 605-7(1956).

In order to study the physical properties of a Be-moderated reactor, such a reactor was put into operation at the USSR atomic electric power station. The parameters of this reactor are listed. (B.J.H.)

PLUTONIUM 7.04.08

22513 ✓
PLUTONIUM–CERIUM–COPPER ALLOYS. A. S. Coffinberry (to U. S. Atomic Energy Commission). U. S. Patent 2,886,504. May 12, 1959.

A low melting point plutonium alloy useful as fuel in a homogeneous liquid metal fueled nuclear reactor is described. Vessels of tungsten or tantalum are useful to contain the alloy which consists essentially of from 10 to 30 atomic per cent copper and the balance plutonium and cerium, with the plutonium not in excess of 50 atomic per cent.

FUEL HANDLING AND PROCESSING. W. R. Martini (Los Alamos Scientific Lab., N. Mex.). p.179-81 of PROCEEDINGS OF THE 1957 FAST REACTOR INFORMATION MEETING HELD AT CHICAGO, ILL., NOVEMBER 20-21, 1957.

Present research at Los Alamos on handling liquid fuels in a reactor and means of reprocessing molten Pu alloys is intended to result in better realization of the high burnup potentialities of fast reactors. All of the work in this field at LASL is in a very preliminary or exploratory stage, so only an indication of the type of experiments underway is given. (W.D.M.)

FUEL AND FUEL ELEMENTS 7.04

PLUTONIUM 7.04.08

16200 ✓ CF-58-12-24
Oak Ridge National Lab., Tenn.
FUEL VALUE OF PLUTONIUM — PRELIMINARY REPORT. Paul R. Kasten. Dec. 5, 1958. 29p. Contract [W-7405-eng-26]. $4.80(ph), $2.70(mf) OTS.

Preliminary results were obtained on the value that commercially pure Pu (95% Pu^{235} and 5% Pu^{240}) has when used as nuclear fuel. The fuel value of Pu was taken to be such that the optimum Pu-fueled reactors have the same fuel costs as the optimum U-fueled reactors. For a given Pu value, that U enrichment which gave the minimum fuel cost was termed the optimum enrichment. This same procedure was used for the Pu-fueled reactors. For a given Pu value, the fuel cost was calculated as a function of Pu enrichment. That enrichment which gave minimum fuel cost was termed the optimum Pu enrichment. The fuel cost of the optimum U-fueled reactors was then plotted against the assumed Pu value. The same was done for the Pu-fueled reactors. The value of Pu corresponding to the crossing point of these curves was termed the fuel value. (W.L.H.)

PLUTONIUM-CERIUM ALLOY. A. S. Coffinberry (to U. S. Atomic Energy Commission). U. S. Patent 2,867,530. Jan. 6, 1959.

An alloy is presented for use as a reactor fuel. The binary alloy consists essentially of from about 5 to 90 atomic per cent cerium and the balance being plutonium. A complete phase diagram for the cerium-plutonium system is given.

6630 ✓
PLUTONIUM-CERIUM-COBALT AND PLUTONIUM-CERIUM-NICKEL ALLOYS. Arthur S. Coffinberry (to U. S. Atomic Energy Commission). U. S. Patent 2,901,345. Aug. 25, 1959.

New plutonium-base ternary alloys useful as liquid reactor fuels are described. The alloys consist of 10 to 20 atomic percent cobalt with the remainder plutonium and cerium in any desired proportion, with the plutonium not in excess of 88 atomic percent; or, of from 10 to 25 atomic percent nickel (or mixture of nickel and cobalt) with the remainder plutonium and cerium in any desired proportion, with the plutonium not in excess of 86 atomic percent. The stated advantages of these alloys over unalloyed plutonium for reactor fuel use are a lower melting point and a wide range of permissible plutonium dilution.

14876 HW-58000
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
PLUTONIUM RECYCLE PROGRAM. Annual Report, Fiscal Year, 1958. S. Goldsmith, ed. Nov. 11, 1958. 117p. Contract W-31-109-Eng-52. $2.75(OTS).

The work performed by the Hanford Laboratories on the Plutonium Recycle Program during fiscal year 1958 is described. Fuel Cycle Analysis: Studies were directed toward establishing a value for plutonium as fuel for thermal reactors. The fuel cycles studied considered sets of variables as determined by (1) single pass or steady state type of recycle, (2) "batch" or "graded" schemes for charging the fuel into the reactor, (3) "spike" or uniform enrichment methods, and (4) fuel processing methods. Physics: In addition to the physics work associated with the fuel cycle analysis, work was performed dealing with calculating effective cross sections, diffusion theory, measurements of lattice parameter, and measurements of plutonium cross sections. Fuel Element Technology: Studies were made on both ceramic and metallic core fuels. Methods of core fabrication, core cladding, and fuel element assembly were developed for a variety of fuel types. Efforts were concentrated on fuel elements of a rod clustered design and a three-component nested tubular design. Chemical Processing Technology: Research and development studies were continued on several chemical processing schemes in order to develop the design requirements for a preferred, completely integrated plutonium recycle system. Aqueous and pyrochemical methods were investigated for processing Pu fuels. It was found that Zr-2 fuel jackets could be dissolved in stainless steel equipment with ammonium fluoride solutions. A mixture of ammonium fluoride and ammonium nitrate was found to be as effective as ammonium fluoride alone for dissolving Zr-2 fuel jackets. This mixture has added advantages of simplifying the off-gas handling problem and also dissolving the tin along with the Zr. It was found that the passive oxide film formed on the Zr-2 cladding when it is exposed to high temperature water can be destroyed by exposing the Zr-2 to an anhydrous melt of $NH_4F \cdot 2HF$ at temperatures as low as 25°C. Major Experimental Facilities: Construction of two major experimental facilities was started. The Plutonium Fabrication Pilot Plant (PFPP) is designed to investigate a variety of fabrication methods for plutonium-bearing fuel elements. The Plutonium Recycle Test Reactor is heavy water moderated and cooled and contains 85 vertical pressure tubes. The reactor will have the experi-

FUEL AND FUEL ELEMENTS 7.04

PLUTONIUM 7.04.08

mental flexibility necessary to investigate a wide range of physics variables and fuel element designs associated with plutonium recycle. Detailed design of the reactor continued during the fiscal year. (For preceding period see HW-52000.) (W.D.M.)

7139 A/CONF.15/P/1203
"PROSERPINE," A HOMOGENEOUS CRITICAL EXPERIMENT WITH PLUTONIUM. J. Bertrand, P. Bonnaure, C. Clouet d'Orval, J. Corpel, J. de Lemare, P. Lecoustey, I. Prevot, R. Roche, M. Sauve, J. Tachon, and G. Vendryes (Commissariat à l'Énergie Atomique, Paris). 54p.

"Proserpine" is a zero power reactor which uses plutonium as a sulfate solution in light water. The main features of its design are directed towards minimizing the critical mass and towards safety in connection with contamination hazards. The core, beryllium oxide reflector, control devices, and fissile material circuits are described in detail. The experimental criticality studies are discussed. (W.D.M.)

6829
PLUTONIUM–THORIUM ALLOYS. F. W. Schonfeld (to U. S. Atomic Energy Commission). U. S. Patent 2,904,429. Sept. 15, 1959.

New plutonium-base binary alloys useful as liquid reactor fuel are described. The alloys consist of 50 to 98 at.% thorium with the remainder plutonium. The stated advantages of these alloys over unalloyed plutonium for reactor fuel use are easy fabrication, phase stability, and the accompanying advantage of providing a means for converting Th^{232} into U^{233}.

OTHER SOLID FUELS 7.04.09

IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Harold Montague Finniston and Oliver Sidney Plail (to United Kingdom Atomic Energy Authority). British Patent 809,671. Mar. 4, 1959.

A reactor fuel element design is offered. A uranium rod electroplated with Co, Fe, or Ni is encased in Al, Mg, Al–Mg, or Be. The electroplated layer is heated in Ar at 650°C to cause diffusion with the U. After canning, another heat treatment at 500°C for 3 hr causes interdiffusión of the plating with the can. (T.R.H.)

SILICON-MODIFIED URANIUM–ALUMINUM ALLOYS FOR FOREIGN REACTOR APPLICATIONS. W. C. Thurber and R. J. Beaver (Oak Ridge National Lab., Tenn.). Am. Inst. Mining Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser. 5, No. 7, 57-62(1958).

The addition of small amounts of silicon to uranium–aluminum alloys suppresses the formation of UAl_4 producing striking changes in the fabrication qualities of the fuel material. The effects of silicon additions on uranium–aluminum alloys in the range of compositions (40 to 50 wt. % U) required for applications where the U^{235} isotopic enrichment is limited to 20% are discussed in terms of casting, billet rolling, and composite fuel-plate fabrication. Particular attention is directed toward the control of the dog-bone and effects in roll-bonded fuel plates and component assembly problems peculiar to the novel materials combinations employed. Data are also presented on the mechanical and physical properties of modified uranium–aluminum alloys. (auth)

944 NP-6980
Sylvania-Corning Nuclear Corp., Bayside, N. Y.
BIBLIOGRAPHY OF SOLID FUEL ELEMENTS. (306 Annotated References). Helen C. Friedemann, comp. [1958]. 64p.

Available from Sylvania-Corning Nuclear Corp. ($1.00).

9442 TID-7546(p.549-53)
Division of Research, AEC.
URANIUM COMPOUNDS FOR NEW HIGH-TEMPERATURE FUELS. E. Epremian. p.549-53 [of] FUEL ELEMENTS CONFERENCE, PARIS, NOVEMBER 18-23, 1957. 5p.

The trend in nuclear reactors is toward higher temperature operation, and, since uranium and its lower alloys suffer a gross swelling at elevated temperatures due to the accumulation of fission gases, solid fuels in reactors of the future will utilize higher alloy content or, alternatively, consist of uranium compounds. An exploratory program is now in progress to study various compounds as potential high-temperature fuels. Following a review of the desirable characteristics of such a material, the information available to date is summarized and discussed. The materials being studied include uranium carbides, silicides, nitride, sulfide, beryllide, and others. It is too early to state which, if any, of these materials will compare favorably with UO_2, which appears to be the best high-temperature fuel at the present time. (auth)

OTHER SOLID FUELS 7.04.09

14277

REACTOR CORE MATERIALS. Technical Progress Reviews, Vol. 1, No. 3. Columbus, Battelle Memorial Institute, 1958. 60p. Available from U. S. Government Printing Office, Washington for $0.55.

A quarterly review of significant developments in the field of solid reactor core materials with emphasis on physical and mechanical properties, fabrication, radiation damage, metallurgy, and corrosion is presented. It is intended to provide readers with a convenient condensed source of information to keep abreast of developments in a general way. (W.D.M.)

FUEL ELEMENT CONCEPTS. C. M. Ladd (Atomic Power Development Associates, Inc., Detroit). p.257-62 of PROCEEDINGS OF THE 1957 FAST REACTOR INFORMATION MEETING HELD AT CHICAGO, ILL., NOVEMBER 20-21, 1957.

The fuel element concepts that have evolved from the programs at ANL, APDA, and KAPL are: (1) variations of the shell and tube radiator design using a sodium thermal bond; (2) the sodium-bonded flat plate radiator design; (3) the sodium-bonded pin element design used by ANL; (4) the metallurgical bonded plate subassembly proposed by BMI for the APDA Core II program; and (5) the gas-bonded pin element design studied by KAPL. The advanced fuel element designs developed by these three projects are discussed. (W.D.M.)

ORNL-2602
Oak Ridge National Lab., Tenn.
DEVELOPMENT OF SILICON-MODIFIED 48 Wt. % U-Al ALLOYS FOR ALUMINUM PLATE-TYPE FUEL ELEMENTS. W. C. Thurber and R. J. Beaver. Mar. 23, 1959. 53p. Contract W-7405-eng-26. $1.50(OTS).

The casting procedures, mechanical working characteristics, composite fuel plate fabrication, and fuel element assembly methods for a nominal 48 wt. % U-3 wt. % Si-Al alloy are examined. It was found that localized clad thinning, resulting from "dogboning" of the fuel alloy, is essentially eliminated in composite plates when this alloy is used in combination with 5154 Al frames and 1100 Al covers. However, fuel component dimensions are difficult to maintain within commonly accepted tolerances in the brazing process because of the marked differences in the thermal expansion of the fuel alloy and the containment materials. The mechanical properties, irradiation studies, corrosion testing, pneumatic pressure testing, and chemical reprocessing of the Si-modified alloy are also discussed. (auth)

6814 A/CONF.15/P/1583
ANALYSIS OF THE FUEL ELEMENTS USED IN REACTOR RA 1. R. Zucal and J. Toni (Comisión Nacional de Energía Atómica, Buenos Aires). 8p.

The uranium content in the fuel elements for the "RA-1" reactor varies from between 30 and 40% of uranous-uranic oxides in the central area to 1% at the ends. In view of the heterogeneous nature of the samples, the determinations must be made on a fraction of an over-all weighing operation, in such a way as to obtain results which are representative of a given section of the element. A study was made of the determination of uranium and of silicon, chromium, iron, and magnesium, constituents of the aluminum alloy. (auth)

UO_2 7.04.10

12308

FUEL ELEMENTS TODAY AND TOMORROW—SOME CURRENT DEVELOPMENTS. G. B. Greehough (United Kingdom Atomic Energy Authority, Sellafield, Cumb., Eng.). Nuclear Power 4, No. 36, 92-6(1959) Apr.

A summary is presented of the symposium held in New York on Jan. 28-29, 1959, which was jointly organized by Columbia University and the Sylvania-Corning Nuclear Corporation. In the immediate future the best bet is metallic fuels, in 5-10 years UO_2 in metallic cans, and in the more distant future, graphite cladding. (W.D.M.)

8383 CRL-51
Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.
URANIUM DIOXIDE—A PROMISING NUCLEAR FUEL. O. J. C. Runnalls. Jan. 1958. 35p. (AECL-553). $1.00 (AECL).

A Metallurgy Seminar to be presented at the Univ. of Toronto, Jan. 24, 1958 and at McMaster Univ., Feb. 20, 1958.

It is probable that several large natural uranium power reactors, moderated and cooled with heavy water, will be built in Ontario by 1980. The problem of selecting a fuel for such reactors has been intensively studied during the past two years. As a result, it is suggested that uranium dioxide clad in a zirconium alloy will meet the required specifications of corrosion resistance, irradiation stability and economic fabrication costs. A diversified experimental program has been established to develop cheap fabrication techniques and to determine the operating limits of uranium dioxide when irradiated in water at temperatures up to 300°C. (auth)

FUEL AND FUEL ELEMENTS 7.04

UO_2 7.04.10

7732 DL-34
Atomic Energy of Canada Ltd., Chalk River, Ont.
URANIUM DIOXIDE. W. B. Lewis. Dec. 1, 1958. 7p. (AECL-733). $0.20(AECL).
Presented at the American Nuclear Society Meeting, Detroit, Dec. 8, 1958.

A general discussion of uranium dioxide as the emerging preferred reactor fuel is presented. The reasons for the preference are given as well as the greatest shortcoming of UO_2, that of low heat conductivity. In addition, the problem of burn-up is considered, and courses of action leading to its solution are given. It is pointed out that progress in the field of atomic power is held back by limited technology, and to make solid progress it is necessary to probe and probe again. Careful cross-checks should be arranged between laboratories for establishing measurements. (J.R.D.)

STAINLESS STEEL–URANIUM DIOXIDE FUEL COMPONENTS FOR ARMY PACKAGE POWER REACTOR. J. E. Cunningham and R. J. Beaver (Oak Ridge National Lab., Tenn.). Am. Inst. Mining Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser. 5, No. 7, 29-40 (1958).

The design, manufacture, and operation characteristics of the fuel components developed for the Army Package Power Reactor are discussed. The technological factors, such as compatibility, corrosion resistance, and irradiation behavior, which led to the selection of UO_2 as the fuel dispersant, B_4C as the burnout poison, and austenitic stainless steel as the cladding and matrix material, are reviewed. The main features of the component engineered for service in power-producing reactors of compact-core design and high-performance characteristics are described. Highly enriched fuel in the form of a refractory oxide is dispersed in a metallic matrix to maximize the heat-transfer surface available for each gram of U-235. It is contained in a stainless steel jacket to afford corrosion protection and retain the highly poisonous by-products of fission. The use of a burnout poison to facilitate control and prolong the life of the heavy-investment fuel component is discussed. Specifications covering the material, dimensional, thermal, and nuclear characteristics of the product are tabulated. The fabricational procedures developed and adopted for manufacturing the component are fully presented. This includes incorporation of the UO_2 and B_4C into stainless steel compacts by powder-metallurgy techniques, methods for preparing composite fuel plates by roll cladding, and assembly and joining the thin plates into an integral unit by brazing with a nickel-base alloy. The fabrication problems associated with composition, chemical stability, homogeneity, fragmentation of the oxide and carbide particles, as well as sensitization, bond integrity, and the braze-joint design are discussed in detail. Quality control measures adopted to produce components within dimensional tolerance on a pilot-plant basis are described. These long-life fuel components are inexpensive to produce and their performance to date in the environment of pressurized-water and organic media has been excellent. The irradiation performance of the stainless steel–UO_2 materials combination under various degrees of burn-up as well as pertinent mechanical-property data are presented. A cost analysis is made on the over-all fuel cycle. (auth)

9438 TID-7546(p.432-41)
[United Kingdom Atomic Energy Authority.] Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
URANIUM DIOXIDE AS A REACTOR FUEL. P. Murray, S. F. Pugh, and J. Williams. p.432-41 [of] FUEL ELEMENTS CONFERENCE, PARIS, NOVEMBER 18-23, 1957. 10p.

The preparation, properties, and some aspects of the behavior under irradiation of nonstoichiometric uranium dioxide are described. An attempt is made to relate the changes observed under irradiation with the differences in physical and mechanical properties. (M.H.R.)

9435 TID-7546(p.384-401)
Atomic Energy of Canada Ltd. [Chalk River Project], Chalk River, Ont.
PRODUCTION OF URANIUM DIOXIDE FOR CERAMIC FUELS. L. C. Watson. p.384-401 [of] FUEL ELEMENTS CONFERENCE, PARIS, NOVEMBER 18-23, 1957. 18p.
Also issued separately as CRL-45 (AECL-515).

INFORMATION SOURCES 7.05

16130 ✓ TID-4000(4th Ed.)
Technical Information Service Extension, AEC.
AVAILABILITY LISTING OF REPORTS ABSTRACTED IN NUCLEAR SCIENCE ABSTRACTS. June 1959. 492p. $5.00(OTS).

A listing in alpha-numeric order of all reports which were abstracted in Nuclear Science Abstract (NSA), Vols. 1 through 12, and the two volumes of Abstracts of Declassified Documents (ADD) which preceded NSA is presented. The report number, the corresponding NSA or ADD volume and abstract number, and a brief notation regarding the latest known availability are given. Prices and types of copy available are also included. (J.R.D.)

5262 ✓ TID-3529(1st Rev.)
Technical Information Service Extension, AEC.
REPROCESSING OF IRRADIATED FISSION REACTOR FUEL AND BREEDING MATERIAL. A Literature Search. James M. Jacobs, comp. Jan. 1960. 41p. OTS.

A listing is presented of selected unclassified reports received by Technical Information Service Extension since TID-3312, Reprocessing of Irradiated Fission Reactor Fuel and Breeding Materials, was prepared. The listing contains 363 references. (J.R.D.)

WEBER, JOHN. The technical reports program of the Technology Division of the Office of Technical Services. *American Documentation*, v. 9, no. 4, Oct. 1958: 308-311.

Details of this program are given by one or two paragraphs under the following major headings: History, purpose of the Technology Division, size of the OTS collection and type of reports acquired, operations relating to PB and AEC reports, demand for reports, OTS trust fund, indexes and catalogs of OTS material, where reports can be seen and how ordered, liaison with other U.S. agencies, and mechanization (none as of the time the paper was prepared). Presented before the American Documentation Institute, Chicago, November 1957.

11692 ✓ TID-3312
Technical Information Service, AEC.
REPROCESSING OF IRRADIATED FISSION REACTOR FUEL AND BREEDING MATERIALS. AN ANNOTATED BIBLIOGRAPHY OF SELECTED REPORT LITERATURE. James M. Jacobs, comp. Nov. 1958. 121p. $2.75(OTS).

A total of 713 annotated references to the unclassified report literature is presented. Subject, author, and report number and availability indexes are included. (auth)

9564 ✓ TID-4000(3rd Ed.)
Technical Information Service Extension, AEC.
AVAILABILITY LIST OF USAEC REPORTS. June 1958. 467p. $3.00(OTS).

A list is presented of Atomic Energy Commission reports that have been abstracted in Nuclear Science Abstracts (NSA), Volumes 1 through 11, and in the two volumes of its predecessor, Abstracts of Declassified Documents (ADD). The best known available source for each report is given, including references for those reports which have appeared in the journal literature. A list is included of non-AEC reports that have appeared in these abstract journals (NSA and ADD). No special effort has been made to determine availability of non-AEC items, but such information is given when known. Added information in this edition includes many cross references from primary and secondary report numbers, references to full versions of reports from deleted or condensed versions, and prices as of the date of this publication. (C.H.)

8236 ✓ TID-4550(4th. Rev.)
Technical Information Service Extension, AEC.
WHAT'S AVAILABLE IN THE UNCLASSIFIED ATOMIC ENERGY LITERATURE. Jan. 1958. 63p.

Available free of charge (TISE).

This publication explains what unclassified atomic energy research information is available, how to locate and use this information, and how this information may be obtained. Assistance in locating, obtaining, and using fully the information announced in abstract journals, indexes, bibliographies, and other informational guides issued by the U. S. Atomic Energy Commission is given. The report codes used by the Atomic Energy Commission and its contractors are explained, and their uses in bibliographic control of information are discussed. The major sources of information developed in the national nuclear energy program are listed. Complete instructions are given on how to obtain

INFORMATION SOURCES 7.05

13649 ✓ TID-3085
Technical Information Service Extension, AEC.
NUCLEAR SCIENCE AND TECHNOLOGY. A Selective Bibliography. May 1958. 248p. $4.00(OTS).

This annotated bibliography contains 1619 selected references to United States Atomic Energy Commission reports, technical books, and articles in technical journals. Author and report number indexes with availability information are included. (auth)

HOW AND WHERE TO LOOK IT UP. A Guide to Standard Sources of Information. Robert W. Murphey. New York, McGraw-Hill Book Company, Inc., 1958. 730p.

A systematic organization of the major works of information is presented. An introductory chapter discusses reference works and their use. The basic types of reference sources are listed and described. The final part of the book lists reference books for people, places, and things. (J.S.R.)

SELECTED READINGS ON ATOMIC ENERGY, UNITED STATES ATOMIC ENERGY COMMISSION. Washington, Atomic Energy Commission, 1958. 77p. Available from U. S. Government Printing Office, Washington for $0.25.

An annotated bibliography on the subject of atomic energy from material published to March 15, 1958, is given. Publications of the AEC and its contractors and other official publications are listed. Books are grouped in the following categories: general, economic, social and political, and scientific and technical. The scientific and technical category is subdivided into physics, chemistry, biology and medicine, and engineering and metallurgy. Other items covered are: periodicals, books for young people, teaching aids, where to obtain research and development reports, official AEC depository libraries, AEC geology—mineralogy depository libraries, and atoms for peace libraries. (M.H.R.)

5808
TECHNICAL LITERATURE OF 1957. A CLASSIFIED GUIDE FOR RAPID REFERENCE TO THE PRINCIPAL ARTICLES OF THE YEAR. Nuclear Eng. 3, No. 23, 70-7 (1958) Feb.

The technical literature of 1957 on nuclear power development and reactor engineering is reviewed. In addition to published literature, selections from the monthly lists of unclassified documents printed by the U.K.A.E.A. are given. (J.E.D.)

6594 ✓ AERE-Lib/L-1
Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England.
SOURCES OF INFORMATION IN ATOMIC ENERGY. L. J. Anthony. Nov. 23, 1956. 19p.

BIBLIOGRAPHIES OF INTEREST TO THE ATOMIC ENERGY PROGRAM.

Compiled by Hugh E. Voress. (U. S. Atomic Energy Commission. TID-3043-Revised) 1958. Available from Office of Technical Services, Department of Commerce, Washington 25, D. C.

12634 TID-85(1st Rev.)
Technical Information Service Extension, AEC.
REPORT NUMBER SERIES USED BY THE TECHNICAL INFORMATION SERVICE IN CATALOGING REPORTS. Charlotte F. Chesnut and Frances E. Stratton, comps. Sept. 1957. 115p. $3.00(OTS).

A comprehensive list is presented of all research and development report number series used in cataloging reports located in the files of the Technical Information Service Extension, AEC. An alphabetical list is included for each series, identified in each case with the agency using the series to number the reports which it issues. Also included is an alphabetical list of agencies, with a list for each agency of the codes which it has used in numbering reports. (C.H.)

466 ✓
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
SOURCES OF INFORMATION IN ATOMIC ENERGY. L. J. Anthony. July 31, 1957. 28p. (AERE-Lib/L1(2nd Ed.)).

Sources of information on research and development in the field of atomic energy are listed. The availability of British, American, and Canadian reports and abstracts of articles on atomic energy and allied subjects appearing in scientific and technical journals is discussed. Sources of Russian information are reviewed. Atomic energy projects in other countries which may provide information are included. A list of published sources of information on atomic energy is appended.

5915
ATOMIC POWER FOR PEACE. VOLUME 5. GLOSSARY OF COMMON ATOMIC TERMS. W. J. Vogt. Johannesburg, Union of South Africa, Atomic Power Review, 1956. 36p.

INFORMATION SOURCES 7.05

Oak Ridge National Lab., Tenn.
BIBLIOGRAPHY—NUCLEAR REACTOR FUEL PROCESSING. H. E. Goeller. Mar. 12, 1957. 14p. Contract (W-7405-eng-26). (CF-57-3-153).

The references of this bibliography have been grouped into the following categories: general surveys; economic studies; design studies; hazards; waste disposal; equipment; plant decontamination; process data-general; process data-uranium-aluminum; process data-uranium-zirconium; process data-uranium-stainless steel; process data-thorium; and process data-high temperature.

2 AERE-READING LIST-3
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
A LIST OF BRITISH BOOKS AND PERIODICALS ON ATOMIC ENERGY. N. Skeats, comp. July 1958. 22p.

This list supersedes AERE-Inf/Bib-100 (May 1956) and Addenda (January 1957).

A list of British books and periodicals on atomic energy including sections on reactors, nuclear and atomic physics, quantum theory and wave mechanics, isotopes, instrumentation, radiochemistry, and radiation hazards is presented. The list of books includes both popular expositions and advanced texts written for the specialist. (W.D.M.)

PROVISIONAL GLOSSARY ON ATOMIC ENERGY. United Nations Secretariat, Department of Conference Services. (Terminology Bulletin No. 115). New York, United Nations, 1955. 291 p. $1.50.

Gives English, French, Spanish, and Russian equivalents of scientific and technical terms used in atomic energy; terms are arranged in parallel columns.

REACTOR FUEL PROCESSING. Argonne National Laboratory. (Technical Progress Review). For sale by Government Printing Office, Washington 25, D. C Yearly subscription, $2 domestic, $2.50 foreign; single copies, $0.55. Published quarterly.

A quarterly review of progress in the field of reactor fuel processing, edited by personnel of the Chemical Engineering Division of Argonne National Laboratory. Prepared at the request of the Division of Information Services of the U. S. Atomic Energy Commission.

ATOMIC ENERGY COMMISSION RESEARCH REPORTS FOR SALE BY OFFICE OF TECHNICAL SERVICES. Available from Office of Technical Services, Department of Commerce, Washington 25, D. C. Free.

This list of AEC research reports offered for sale by the Office of Technical Services is revised from time to time. Reports are arranged by subject categories and are identified by report number, title, paging and date. The sales price of each report is also given.

AN INTERNATIONAL BIBLIOGRAPHY ON ATOMIC ENERGY. Atomic Energy Commission Group, United Nations Department of Security Council Affairs. N. Y., United Nations, 1949–53. 2 volumes and supplements.

Vol. 1. Political, Economic and Social Aspects, compiled by Israel Light and Robert W. Frase. Annotated list of 854 items, arranged topically, including material in several languages. Includes documents, books, pamphlets, magazines, and audio-visual aids. (Document 1949. IX. 1. Vol. I. Rev. 2, March 28, 1949.) 45 p. $0.50.

Vol. 1. Supplement No. 1: Works dealing with political, economic, and social aspects of atomic energy, published in the English and Russian languages between March 1949 and July 1950. (Document 1950. IX. 2.) 22 p. $0.25.

Vol. 1. Supplement No. 2: Works dealing with political, economic, and social aspects of atomic energy, published between July 1950 and December 1952. (Document 1953. IX. 1.) 31 p. $0.30.

INTERNATIONAL CO-OPERATION 7.06

See also, under HAZARDS AND PROTECTION,

LIMITS AND STANDARDS--Standards and Units (4.01.07.02),

SHIPPING AND HANDLING OF RADIOACTIVE MATERIAI --Legal Aspects (4.02.05).

13330 ✓ CF-59-5-5
Oak Ridge National Lab., Tenn.
EUROCHEMIC ASSISTANCE PROGRAM: STATUS REPORT AS OF APRIL 1, 1959. E. L. Nicholson. May 5, 1959. 22p. Contract [W-7405-eng-26]. $4.80 (ph), $2.70(mf) OTS.

The status of the Eurochemic Plant, Mol, Belgium, is summarized, and the Eurochemic organization is given. The anticipated United States assistance through June 1959 is listed. (auth)

INTERNATIONAL CO-OPERATION 7.06

16089 ✓ CF-58-11-51(Rev.1)(Del.)
Oak Ridge National Lab., Tenn.
TRIP REPORT—EUROCHEMIC COMPANY ASSISTANCE—HANFORD ATOMIC PRODUCTS OPERATION SPENT FUEL PROCESSING TECHNOLOGY.
E. M. Shank. June 23, 1959. 21p. $3.30(ph), $2.40 (mf) OTS.

Information obtained from HAPO during visit by M. K. Twichell, UCNC, and E. M. Shank, ORNL, is given. Included are the tentative procedures for obtaining and transmitting information to the Eurochemic company. Discussions are given on pulsed columns, corrosion, pulse generators, centrifuges, valves, in-line instrumentation, evaporators, resin column design, off-gas processing, solvent recovery, liquid-waste handling, process control, equipment decontamination, criticality, radiation protection, diluent, and solvent stability, backmixing in a pulsed column, and use of 40% TBP in the purex flowsheet. (auth)

European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.
FUEL ELEMENT INVESTIGATION—COMPILATION OF DATA. Report ED-C. Apr. 3, 1959. 25p. $4.80(ph), $2.70(mf) OTS.

A compilation of estimation quantities of spent fuels from each subscribing country for inclusion in the Eurochemic processing load is presented. Also included are data on types of fuel, enrichment, and probable delivery period. From these data charts are developed which graphically present projected processing loads. (J.R.D.)

4555 CF-58-12-124
Oak Ridge National Lab., Tenn.
UNITED STATES ATOMIC ENERGY COMMISSION ASSISTANCE PROGRAM TO THE EUROCHEMIC COMPANY, MOL, BELGIUM. E. M. Shank. Dec. 31, 1958. 25p. Contract [W-7405-eng-26]. $4.80(ph OTS); $2.70 (mf OTS).

The United States Atomic Energy Commission program of assistance to the European Company for the Chemical Processing of Irradiated Fuels ("Eurochemic"), Mol, Belgium, is presented. Included are: background, formation, purpose, and structure of the Company; basic design considerations and a brief description of the proposed plant; present status of the design; the AEC assistance authority and procedure; tabulation of the assistance required by Eurochemic; and a list of participating organizations and members.

1865 AECL-717
Atomic Energy of Canada Ltd., Chalk River, Ont.
THE DEBATE IN THE HOUSE OF COMMONS ON THE ATOMIC ENERGY ESTIMATES FOR 1958–1959.
Sept. 3, 1958. 19p. $0.50(AECL).

Activities of Atomic Energy of Canada Limited are reviewed and objectives of that organization are outlined. Activities in the fields of fundamental research, applied research, and the development of nuclear power programs are discussed. The possibility of supplying uranium to other countries is considered. Future support of the Canadian government in the development of peaceful uses of atomic energy is discussed. (C.H.)

501 NP-6993
Organization for European Economic Co-operation, Paris.
FIRST REPORT ON THE ACTIVITIES OF THE AGENCY PRESENTED TO THE CONSULTATIVE ASSEMBLY OF THE COUNCIL OF EUROPE. Sept. 1958. 81p.

The general organization and initial activities of the European Nuclear Energy Agency are reviewed for the six months' period starting with the official creation of the Agency. Activities include a survey of methods for European cooperation in the field of experimental and prototype reactors, the organization of the Eurochemic Company for the chemical processing of irradiated fuels, enactment of an agreement for the joint operation of the Norwegian boiling water reactor, a survey of the possibilities of producing heavy water in Iceland, proposals for liberalizing international trade in nuclear materials, a survey of existing training facilities in Europe, the drafting of basic health standards for all European countries, drafting an agreement on the liabilities of operators of nuclear plants, the formation of estimates of the production and requirements of Europe in energy during the next few years, and arranging a European conference for the Spring of 1959 to discuss industrial prospects in the field of nuclear energy. (C.H.)

5664
THE ATOMIC RESEARCH CENTER-KARLSRUHE. Karlsruhe-Collective Purpose of State and Economy. Siegfried Balke, H. Veit, and K. Winnaker. The Makeup of the Construction and Management Company. R. Greifeld, O. Haxel, and G. Ritter. Site Selection. J. Steffens and F. Gutberlet. Atomwirtschaft 2, 391-401(1957) Dec. (In German)

INTERNATIONAL CO-OPERATION 7.06

11210 ✓
ATOMIC ENERGY IN ITALY IN 1958: POLITICAL-ECONOMIC PROBLEMS OVERSHADOW PROGRESS. Stelio Villani. Atomwirtschaft 3, 196-8(1958) May. (In German)

The development of nuclear energy in Italy is overshadowed by economic arguments between the champions of private enterprise and those of state monopoly, since it has been recognized that in an industrialized country the utilization of atomic energy will be of vital future importance. Italian atomic research was continued after the war, especially in the field of applied research and atomic engineering, at CISE, Milan, which was started by both private and official groups. (auth)

REPORT OF THE FBI [FEDERATION OF BRITISH INDUSTRIES] CONFERENCE ON NUCLEAR ENERGY HELD AT EASTBOURNE, 10-12 APRIL 1958. London, Federation of British Industries, 1958. 194p. $2.10.

Topics included in the proceedings are: the impact of nuclear energy upon industry; nuclear energy and the world's fuel and power requirements; financial and investment aspects, including home and overseas markets; survey of reactor types; radioisotopes and their uses; new materials for nuclear engineering; reactor instrumentation; and fabrication and processing of fuel elements. (J.H.M.)

13120 NP-7579
Joint Establishment for Nuclear Energy Research, Kjeller, Norway.
SEVENTH ANNUAL REPORT, JULY 1957–JUNE 1958 OF THE NETHERLANDS'–NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH. 32p.

The seventh annual report (July 1, 1957, to June 30, 1958) of the Netherlands–Norwegian Joint Establishment for Nuclear Energy Research is presented. The work of the Establishment is supported by the governments of the Netherlands and Norway and by private industry. Progress in the various departments is summarized, and a financial statement is included. (W.D.M.)

THE INTERNATIONAL ATOMIC ENERGY AGENCY. International Review Service. New York, 1957. 48 p. $2.50.

A review of the origin and development of the IAEA to January 1957. Text of the statute is reprinted as an appendix.

7330 ✓ NP-6311
Organization for European Economic Co-operation, Paris.
EXPERIMENTAL REACTORS: PROPOSALS FOR THEIR CO-OPERATIVE DEVELOPMENT IN EUROPE. Mar. 1957. 34p.

Some general remarks are included on the aims and principles of a program for the development of reactors in Europe. Reactor types recommended for development include boiling reactors, liquid-metal fuelled reactors, homogeneous aqueous reactors, test reactors, and fast breeder reactors. The advantages and problems of these reactors are briefly considered. Types not recommended for development are listed with the reasons for their exclusion. The framework for common activities is also discussed. (B.J.H.)

INTERNATIONAL ATOMIC POLITICS. Bertrand Goldschmidt (Commissariat à l'Énergie Atomique, Paris). p.177-84 of "Journées d'Information sur l'Énergie Nucléaire, 14-15-16 Janvier 1957." Documents, Suppl. to No. 114. France, Commissariat General à la Productivité. 1957. 203p. (In French)

The history of the development of atomic energy is composed of two phases: the first, that of atomic secrets, was from 1943 to 1954, and the second, that of controlled international agreements, was initiated in 1954. The atomic alliance of the Anglo-Saxon countries, the Baruch Plan, and the failure of secret policies during this first period are discussed. The new American policies calling for an international agency of atomic energy initiated the second phase. Parallel to this development, bilateral agreements for the peaceful use of atomic energy were made with friendly governments. The International Atomic Energy Agency, its agreements, and extent of control are discussed. The possible role of Euratom in international atomic policies is reviewed. (J.S.R.)

INTERNATIONAL COLLABORATION. Basilio Focaccia. pp. 21-31 in "Atti del Congresso Scientifico. Volume I. Sezione Nucleare, Giugno 1957." (In Italian)

The utilization of nuclear energy presents many complex problems, and the development of international collaboration is necessary for their solution. The growth of international organizations whose purpose is coöperation in the establishment of atomic energy utilization is discussed with emphasis on EURATOM.

INTERNATIONAL CO-OPERATION 7.06

THE INTERNATIONAL ATOMIC ENERGY AGENCY. (Department of State Publication 6477. International Organization and Conference Series, I, 33). Washington, Government Printing Office, 1957. 12 p. $0.15.

General description of history, activities, and future of the IAEA.

STATUTE. BETWEEN THE UNITED STATES OF AMERICA AND OTHER GOVERNMENTS DONE AT THE HEADQUARTERS OF THE UNITED NATIONS. October 26, 1956. International Atomic Energy Agency. (Department of State Treaties and other International Act Series, 3873) Washington, Government Printing Office, 1957. 132 p. $0.50.

STATUTE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Hearings before the Senate Committee on Foreign Relations and the Senate members of the Joint Committee on Atomic Energy. U. S. Congress. 85th Cong., 1st Sess. May 10, 14, 15, and 20, 1957. Washington, Government Printing Office, 1957. 258 p.

12116 ✓ NP-6825
Joint Establishment for Nuclear Energy Research, Kjeller, Norway.
SIXTH ANNUAL REPORT FOR JULY 1956—JUNE 1957 OF THE NETHERLANDS'-NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH. 31p.

A summary of the main activities of the Joint Establishment for Nuclear Energy Research is given covering the following: the operation of JEEP, isotopes, chemistry, metallurgy, reactor engineering, studies on nuclear propulsion, physics, health physics, Technical Information Service, JENER reactor courses, building program, international cooperation, personnel and accounts, and attendance at international conferences. (For preceding period see NP-6321.) (M.H.R.)

5441 ✓
COMMERCIAL AND INTERNATIONAL DEVELOPMENTS IN ATOMIC ENERGY. PROCEEDINGS OF A MEETING FOR MEMBERS AND GUESTS HELD SEPTEMBER 27–29, 1955 AT SHERATON-PARK HOTEL, WASHINGTON, D. C. A FORUM REPORT—NO. 7. Edwin Wiggin, ed. New York, Atomic Industrial Forum, Inc., 1956. $8.50.

The texts of 67 papers on commercial and international developments in atomic energy given at a meeting in Washington, D. C. in September, 1955, are given. General categories considered are reactors, reactor safety, radiation and radioisotopes, business opportunities, government activities, international activities, and the Geneva conference. A pictoral supplement on the first U. S. trade fair on atomic energy is appended. (D.E.B.)

NUCLEAR ENERGY IN WESTERN EUROPE AND UNITED STATES POLICY. Klaus E. Knorr. Princeton, Center of International Studies, Princeton University, 1956. 35 p.

A discussion of EURATOM and OEEC, with their implications for Western Europe and the United States.

WORLD DEVELOPMENT OF ATOMIC ENERGY; with Special Supplements on U. S. Bilateral Agreements and the U. N. Geneva Conference. Atomic Industrial Forum. New York, 1955. 151 p. $5.

Gives information on the organization and administration of atomic energy programs of countries that are working in the field. Information, for the most part, is based on replies received by the Forum in response to requests to the governments concerned for official information regarding atomic energy programs. Raw materials position, uranium production, research, international cooperation, nuclear power program, etc., are covered.

6705 ✓ A/CONF.15/P/2487
RADIATION PROTECTION IN INDUSTRY—CONTRIBUTION OF THE I. L. O. (International Labour Organization.) 25p.

Policies adopted by the International Labor Organization to assure radiation protection in industry are reviewed. The increasing use of ionizing radiations, both x radiation and radioisotopes, by industry influenced the revision of the Model Code of Safe Regulations for Industrial Establishments. Some of the aspects of the organization and administration of radiation protection in industry are discussed. (C.H.)

5195 A/CONF.15/P/2457
[Columbia Univ., New York].
THE ROLE OF ATOMIC ENERGY IN THE PROMOTION OF INTERNATIONAL COLLABORATION. I. I. Rabi. 3p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

A brief survey is presented of the international cooperation which made a success of the First Geneva Conference and which has initiated many international scientific meetings since that time. The policy of the United States in this respect is discussed. (J.S.R.)

INTERNATIONAL CO-OPERATION 7.06

7191 A/CONF.15/P/2424
THE CANADA-INDIA REACTOR: AN EXERCISE IN INTERNATIONAL CO-OPERATION. W. B. Lewis (Atomic Energy of Canada, Ltd., Chalk River, Ont.) and H. J. Bhabha (Dept. of Atomic Energy, Bombay). 6p.

Canada and India are coöperating in the construction of a research and engineering test reactor of the NRX type to operate at 40 Mw(th). A brief description of the reactor located at Trombay is given, and the essential differences with NRX discussed. The costs of the project are shared equally by Canada and India under the Colombo Plan. (W.D.M.)

6027 A/CONF.15/P/1624
A STUDY OF THE CONTRIBUTION OF ATOMIC ENERGY TO A POWER PROGRAMME IN INDIA. H. J. Bhabha (Atomic Energy Commission, India) and N. B. Prasad (Atomic Energy Establishment, Trombay, India). 27p.

A detailed comparison is made of the relative economics of a conventional thermal power station with an atomic power station of a capacity between 150 and 300 Mw, at a typical location. In view of the need to base the ultimate power production on thorium rather than uranium, possible power programs are discussed in which thorium progressively replaces uranium as feed material, and the effect of different rates of plutonium and U^{233} production on the rate of growth of installed capacity is calculated. The relative costs to the economy as a whole of a given increase in electric power production based on conventional thermal or nuclear power programs are estimated, including the capital investment required for the mining of the fuel and its treatment, its transport, and the capital investment in power stations. (auth)

DEVELOPMENT OF INTERNATIONAL COLLABORATION IN THE PEACEFUL USES OF ATOMIC ENERGY. Paul R. Jolles (International Atomic Energy Agency, Vienna). 20p.

Various types and methods of international collaboration in the field of the peaceful uses of atomic energy are described which have developed in recent years, the inter-relationship between international endeavors in this field, and the role of the International Atomic Energy Agency as a world-wide organization for coöperation and coördination. (auth)

6048 A/CONF.15/P/2415
THE DEVELOPMENT OF THE INTERNATIONAL CO-OPERATION BY THE U.S.S.R. IN THE PEACEFUL USES OF ATOMIC ENERGY. V. Yemelyianov (U.S.S.R.). 13p.

Activities of the Soviet Union since 1955 for the development of international cooperation in peaceful uses of atomic energy are summarized. Research activities and training programs are outlined. (C.H.)

PROCESSES AND METHODS 7.07

See also, under PROCESS CHEMISTRY AND ENGINEERING, SPECIAL PROCESSES (6.17).

AQUEOUS PROCESS 7.07.01

16090 CF-59-3-91(Rev.1)
Brookhaven National Lab., Upton, N. Y. and Oak Ridge National Lab., Tenn.
EUROCHEMIC ASSISTANCE PROGRAM: COMMENTS BY BNL, DATED FEBRUARY 17, 1959, ON EUROCHEMIC DOCUMENTS. B. Manowitz. June 25, 1959. 3p. Contract [W-7405-eng-26]. $1.80(ph), $1.80(mf) OTS.

Eurochemic reports were reviewed by BNL personnel concerning aqueous reprocessing, and several comments are offered for process improvements. Also, pertinent BNL documents related to waste and head end processes and corrosion are listed. (J.R.D.)

European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium.
CRITICAL SURVEY ON ALTERNATIVE PROCESSES IN AQUEOUS REPROCESSING OF IRRADIATED URANIUM. Technical Report No. 10. Sten Ahrland. Aug. 6, 1958. 8p. $1.80(ph), $1.80(mf) OTS.

Alternative procedures for U in the Eurochemic fuel reprocessing plant are surveyed. Choice of scrub solutions are considered as well as decontamination cycles, partition cycles, tail end treatment, amine substitution

PROCESSES AND METHODS 7.07

AQUEOUS PROCESS 7.07.01

for TBP, and substitution of extraction steps by sorption steps. It is concluded that additional information on several listed points is desirable before a decision is made. (J.R.D.)

14714 A/CONF.15/P/2409
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
AQUEOUS PROCESSES FOR SEPARATION AND DECONTAMINATION OF IRRADIATED FUELS. V. R. Cooper and M. T. Walling, Jr. 68p. $0.50(OTS).

Prepared for the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, 1958.

A review of recent developments and improvements in aqueous processes for accomplishing separation and decontamination of irradiated fuels from power reactors is presented. Research and development is currently being pursued in the United States on three distinct types of fuel processing methods; pyrometallurgical processes, fluoride volatility processes, and aqueous processes. Although the ultimate role of these processing methods in a nuclear power economy cannot be accurately assessed at the present time, it is felt that the proven reliability and versatility of aqueous processes guarantees them a prominent role in power reactor fuel reprocessing. Aqueous solvent extraction processes, for example, are ideally suited for installation in central processing plants which are designed to handle fuels from a number of power reactors generating a total of several thousand megawatts or more of power. Under these circumstances, nuclear fuels can be processed by continuous processes at high throughputs and at high on-stream efficiency and therefore at low unit cost. (auth)

7590
CHEMICAL PROCESSING IN THE NUCLEAR POWER INDUSTRY. III. AQUEOUS PROCESSES. F. S. Martin and G. L. Miles (Atomic Energy Research Establishment, Harwell, Berks, England). Atomics 7, 79-87 & 110(1956) Mar.

A number of different types of aqueous processes for irradiated nuclear reactor fuels are discussed. Fuel dissolution, precipitation, extraction, and ion exchange separations are described, together with some aspects of the basic chemistry of solvent processes. (auth)

GENERAL 7.07.02

6323 TID-7583
Division of Production, AEC.
PROCEEDINGS OF THE AEC SYMPOSIUM FOR CHEMICAL PROCESSING OF IRRADIATED FUELS FROM POWER, TEST, AND RESEARCH REACTORS, RICHLAND, WASHINGTON, OCTOBER 20 AND 21, 1959. Jan. 1960. 458p. OTS.

A review is presented in this symposium of the technology currently available for processing spent fuels from research, test, and power reactors. Twenty-one papers are included. Separate abstracts have been prepared for each paper. (W.L.H.)

6338 TID-7583(p.234-305)
Oak Ridge National Lab., Tenn.
CHEMICAL PROCESSING OF POWER AND RESEARCH REACTOR FUELS AT OAK RIDGE NATIONAL LABORATORY. R. E. Blanco, L. M. Ferris, J. R. Flanary, F. G. Kitts, R. H. Rainey, and J. T. Roberts. 72p.

The reactor fuels have been divided into classes based on processing criteria. Class one fuels, stainless steel clad ThO_2-UO_2, are dissolved by either the Darex Process, Sulfex Process, or HNO_3 dissolution and the solvent extraction processes used are either acid Thorex or Darex–Thorex. Class two fuels, stainless steel clad UO_2, are dissolved by the same processes used in class one. The solvent extraction processes used are Darex–Purex and Purex. Class three fuels, stainless steel clad Na-bonded cores, are dissolved by caustic decladding, HNO_3 dissolution, and HNO_3–Fe dissolution. The solvent extraction processes used are Purex and acid Thorex. Class four fuels, Al-clad enriched U–Al alloy core, are dissolved by HNO_3–Hg process and the solvent extraction process is TBP-25. Class five fuels, Al-clad Th in core, are dissolved by caustic decladding, dilute HNO_3 bond dissolution, and HNO_3–F dissolution. The solvent extraction process used is acid Thorex. Class six fuels, Zr alloy-clad Zr–U alloy core, are dissolved by a modified Zirflex NH_4F dissolution. The solvent extraction process used is Purex. Class seven fuels, aqueous solution or slurry, are processed by HNO_3–F dissolution and HNO_3 dilution. The solvent extraction processes used are TBP-25 and acid Thorex. The reactors that these fuels are taken from are listed. Flowsheets are given for the various processes discussed. The disposal of the high and low level wastes resulting from chemical processing is discussed. (W.L.H.)

PROCESSES AND METHODS 7.07

GENERAL 7.07.02

6340 TID-7583(p.400-31)
Oak Ridge National Lab., Tenn.
SPECIAL PROBLEMS IN CHEMICAL PROCESSING AT ORNL. A. R. Irvine. 32p.

The processing of power reactor fuels at ORNL will require the solution to a number of new or especially difficul problems. These problems reflect the change in fuel element composition brought about by the demand for heat generation in a useful temperature range and at maximum emission rate, both of which are necessary to the production of economic nuclear power. This demand for economic nuclear power has led to the use of claddings which are highly corrosion resistant, to ceramic or alloy core materials because of their resistance to radiation damage, and to an increase in U^{235} enrichment of core material. Each of these innovations contributes significant processing problems at ORNL, some of which are discussed. (auth)

8511
ATOMIC FUEL PROCESSING. PART IV. SAVANNAH RIVER DOES IT CHEAPER. Chem. Eng. 67, No. 4, 135-8 (1960) Feb. 22.

Three fuels are to be processed at Savannah River: the Enrico Fermi breeder power reactor (PRDC) and the NRX and NRU reactors at Chalk River. Methods which are used in the processing of the fuels are presented in order of shipment from the reactor to the solvent extraction of plutonium from the uranium solution. The processing of two PRDC cores yield about 100,000 gal of waste, which will be stored until fission products decay sufficiently for concentration to about 35,000 gal and final storage. (B.O.G.)

6330 TID-7583(p.113-43)
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
ICPP DISSOLUTION, EXTRACTION, AND WASTE TREATMENT PROCESSES AND FACILITIES. F. Morgan Warzel. 31p.

The processes and facilities for dissolution, extraction, and waste treatment are described in detail, including chemical flowsheets and schematics of various processes. The limitations that exist for processing various fuels as to fuel size, shape, composition, and weight are discussed. (W.L.H.)

7460
HOW AEC PLANS TO PROCESS POWER REACTOR FUELS. C. E. Stevenson (Phillips Petroleum Co., Idaho Falls, Idaho). Nucleonics 18, No. 2, 72-3(1960) Feb.

The processing of spent fuels from research, test, and power reactors is assigned to existing AEC facilities until industry is able to provide the service. The assignments were made to Hanford, Idaho, Oak Ridge, and Savannah River according to the capabilities of each in processing specific fuel types. An outline is presented of fuel types and processes for each facility. (B.O.G.)

6328 TID-7583(p.86-98)
Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho.
ICPP PLANS FOR PROCESSING IRRADIATED FUELS FROM RESEARCH, TEST, AND POWER REACTORS. C. E. Stevenson. 13p.

The variety of highly enriched uranium fuels, which consist primarily of aluminum, zirconium, or stainless steel, and are of various shapes and sizes, proposed for processing at the ICPP has been indicated. The applicable facilities and processes have been outlined to indicate the flexibility of this plant for handling all presently anticipated fuels in this category. (auth)

6324 TID-7583(p.17-25)
General Electric Co. Hanford Atomic Products Operation, Richland, Wash.
MANAGEMENT CONSIDERATIONS RELATIVE TO HANFORD. V. R. Cooper. 9p.

A plan for Hanford Works participation in the Atomic Energy Commission's interim chemical processing arrangement for power, test and research reactor fuels, has been designed. It follows five principal guidelines or considerations. From these considerations it was determined that a scheme utilizing a currently retired obsolete wartime facility could be modified and employed for the receiving, storage and feed preparation operations. The currently operating Redox plant can be incorporated into the plan to accomplish the decontamination and separation of uranium and plutonium for return to the nuclear materials cycle. The resultant system can accommodate uranium and plutonium bearing fuels enriched to a maximum of five per cent U^{235} or equivalent composed of metallic or ceramic cores; clad with Zircaloy, stainless steel or aluminum. The manifold direct and supporting functions can be provided with minor exceptions from the present Hanford organization. The facilities will be ready to receive fuels in January 1961 and to begin chemical processing one year later. Actual processing schedules will be developed around a campaign basis to yield maximum utilization of processing facilities and minimum isotopic degradation of the recovered

GENERAL 7.07.02

uranium. Engineering cost information will be obtained during the course of the program to provide industry with some of the information needed for appraising the possibilities of a private capital venture. The assignment of responsibilities regarding processing, engineering and operation are briefly considered. (auth)

6322 NP-8239
Massachusetts Inst. of Tech., Cambridge.
URANIUM EXTRACTION IN USSR; AN ORGANIZED REVIEW OF THE PUBLISHED SOVIET LITERATURE FOR 1930–1958. A. M. Gaudin and L. T. Romankiw. Apr. 30, 1959. 78p.
Included in the survey were the following topics: physical and physicochemical concentration methods; chemical concentration methods; properties of uraniferous solutions; and methods of analysis for U. (W.L.H.)

2471
SEPARATION METHODS FOR RADIOACTIVE ISOTOPES WITHOUT CARRIER. N. P. Rudenko. Khim. Nauka i Prom. 4, 441-8(1959). (In Russian)
A survey is given of methods for radioactive isotope separation from gaseous, liquid, or solid phases. 70 references. (R.V.J.)

Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho and Oak Ridge National Lab., Tenn.
EUROCHEMIC ASSISTANCE PROGRAM: COMMENTS BY ICPP, DATED MARCH 17, 1959, ON QUESTIONS FOR EUROCHEMIC. M. E. Weech. Mar. 26, 1959. 5p. $1.80(ph), $1.80(mf) OTS.
Comments by ICPP personnel on questions posed by Eurochemic Company are presented. Included is information on a fumeless dissolution system, recycle and rework system, liquid waste storage, criticality, in-line instrumentation, and a report listing Idaho Operations Area costs. (J.R.D.)

9455 BNL-483(p.145-8)
Oak Ridge National Lab., Tenn.
INTRODUCTORY REMARKS ON CHEMICAL REPROCESSING. F. R. Bruce. p.145-8 [of] THORIUM–U^{233} SYMPOSIUM, SPONSORED BY THE UNITED STATES ATOMIC ENERGY COMMISSION AT BROOKHAVEN NATIONAL LABORATORY, JANUARY 9-10, 1958. 4p.
The chemical reprocessing methods for power reactors employing U^{233} or thorium as fuel and blanket materials are reviewed. (W.L.H.)

13361 BNL-549
Brookhaven National Lab., Upton, N. Y.
REPROCESSING OF POWER REACTOR FUELS. The Enrico Fermi Fast Breeder Reactor Fuel Progress Report No. 2. C. W. Pierce. Mar. 1959. 8p. $0.50 (OTS).
A summary of work on the problems of reprocessing Enrico Fermi Fast Breeder Reactor between July 1958 and January 1959 is given. Dissolution experience with the Zr-clad U–Mo fuel pins is related. Corrosion of the stainless steel waste evaporator was studied. Nuclear hazards, flow sheet design and chemistry, and waste handling studies are also reported. (For preceding period see BNL-511.) (T.R.H.)

9455 BNL-483(p.145-8)
Oak Ridge National Lab., Tenn.
INTRODUCTORY REMARKS ON CHEMICAL REPROCESSING. F. R. Bruce. p.145-8 [of] THORIUM–U^{233} SYMPOSIUM, SPONSORED BY THE UNITED STATES ATOMIC ENERGY COMMISSION AT BROOKHAVEN NATIONAL LABORATORY, JANUARY 9-10, 1958. 4p.
The chemical reprocessing methods for power reactors employing U^{233} or thorium as fuel and blanket materials are reviewed. (W.L.H.)

4556 NP-7124
Brussels. Centre d'Étude de l'Énergie Nucléaire.
LES PROCEDES AQUEUX ET NON AQUEUX DE RETRAITEMENT DE L'URANIUM. (The Aqueous and Non-aqueous Processes for Retreatment of Uranium.) J. Schmets. June 16, 1958, 4p.
The pyrometallurgical, solvent extraction, and volatility processes for treatment of spent fuel elements are compared. (T.R.H.)

REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 1, No. 1. Lemont, Argonne National Laboratory, 1958. 38p. Available from U. S. Government Printing Office for $0.55.
Commercial Aspects of Fuel Processing. An AEC price list is presented for plutonium produced in private reactors. The price paid for plutonium varies as a function of Pu^{240} content. The construction and operating costs are given for a hypothetical chemical processing plant running at full capacity for 300 days/year. Storage of fuel elements from various types of reactors is discussed. A flowsheet is given of the Darex Process for processing stainless steel fuels by dissolution in dilute aqua regia. Various other processes

PROCESSES AND METHODS 7.07

GENERAL 7.07.02

are discussed for processing fuels consisting of other alloys. Fuel-Processing Research and Development. In this section new work is reported on existing separations processes and on proposed processes, solvent extraction, plant and equipment design and operation, ion exchange, fluoride volatility processes, bromine trifluoride processes, fused-salt process, pyrometallurgical processing, EBR-II melt refining process, processing of U–Bi reactor fuels by fused-salt extraction, blanket processing methods, corrosion, and homogeneous reactor processing. Waste Disposal. A flow diagram is given for a radioactive liquid and gaseous waste-disposal system for the Shippingport Pressurized Water Reactor. A flow diagram is given for radioactive solid waste disposal. A process is discussed for the evaporation and calcination of liquid wastes for disposal. Three methods are discussed for the isolation of Cs^{137} from liquid wastes. Conversion to Final Products Operations. The production of UO_2 and UO_3, oxidation of UF_4 to UF_6, and the preparation of Pu and U metal are discussed in this section. (W.L.H.)

11695

REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 2, No. 2. Lemont, Ill., Argonne National Laboratory, 1959. 42p. Available from U. S. Government Printing Office, Washington for $0.55 (domestic); $0.70 (foreign).

Firms making proposals under the AEC fuel-cycle program are listed with the number of proposals submitted. Fuel data and cost factors are tabulated for four commercial power reactor stations and the Shippingport Plant. A review of a serious criticality incident at Los Alamos is given. Developments in head-end mechanical and chemical processing are discussed including removal of Zr and Zircaloy jackets as well as stainless steel. Recovery of U from Zr fuel elements continues as an unsolved problem because of sublimation with $ZrCl_4$. Progress in dissolution of stainless steel in the Darex process is reported as well as nitric acid dissolution of U–Mo alloys. Developments and improvements in the Purex process such as near-quantitative recovery of Np in first-cycle extraction are reported. A solution of tri-n-octylphosphine oxide (TOPO) in cyclohexane was reported as an excellent extractant for Th from chloride or nitrate solutions, but not from sulfate. Data on stability of Purex diluents exposed to chemical degradation are presented. Also, graphs illustrating nuclear safety for Pu^{239}, U^{235}, and U^{233} are presented. Ion exchange separation of Cs from alkaline solution is discussed, and methods of fission product separation from U and Pu are reported. A flowsheet for Pu recovery and decontamination is presented as well as a two-cycle anion exchange flowsheet for processing Pu reactor fuels and Excer process treatment for recovery of U. Developments on interhalogen–UF_6 separations and fused-salt processing studies are reported, and data are presented from analyses of vapor samples taken from the BrF_5–UF_6 packed column separator. Discussions of research in pyrometallurgical processing are included in such aspects as melt refining, processing of Pu-rich fuels, UO_2 fuel, and liquid metal processes. Information from HRT run 16 summary is presented including fission product activity distribution data. Corrosion in fissionable material recovery in such environments as Sulfex and Thorex, fused-salt volatility processes, and data on corrosion in NaF–ZrF are presented. Waste disposal discussions are presented with emphasis on the congressional hearings, operating experience, and final disposal methods. A description of the UF_6 plant at Metropolis, Ill., is given in which 70% U_3O_8 is reduced to UO_2 and hydrofluorinated to UF_4 and fluorinated to UF_6; a flowsheet is included. Production of UF_4 from UO_3 and from various ores is discussed, and U recovery operations from scrap as well as from UF_6 vent gases are examined. (J.R.D.)

SEPARATION AND PURIFICATION OF MATERIALS. Rolt Hammond. New York, Philosophical Library, 1958. 332p.

The first section discusses the separation of solids by a large number of methods. The next two sections describe the separation of solids from gases and liquid by a number of different methods. The fourth section is devoted to the separation of various systems by distillation. The fifth section discusses the separation of various systems by centrifugation. The next section describes various methods for the separation of gases.

20996 ✓

CHEMICAL REPROCESSING OF IRRADIATED NUCLEAR FUELS. S. Lawroski (Argonne National Lab., Lemont, Ill.). Compt. rend. congr. intern. chim. ind. 31e, Congr., Liège, 1958. 4p.

PROCESSES AND METHODS 7.07

GENERAL 7.07.02

The chemical reprocessing of irradiated nuclear fuels is an important part of the nuclear energy industry. Various chemical processing methods have been studied in the United States with regard to their technical and economic potential for this application. To date, two types of aqueous methods have been developed and used on a production scale. The first of these was the Bismuth Phosphate Process which employed the co-precipitation principle. This process has been superseded by solvent extraction type processes which employ aqueous-organic solvent systems. At the present time all of the major plants for chemical reprocessing of spent fuel are based on solvent extraction methods. Meanwhile, two general types of non-aqueous methods are being intensively developed. They are the fluoride volatility and the pyrometallurgical methods. In order to commence and complete the fuel reprocessing cycle, it has also been necessary to develop suitable procedures for auxiliary operations such as fuel dissolution, conversion of intermediate products to finally desired forms, and handling of process wastes. (auth)

Oak Ridge National Lab., Tenn.
BIBLIOGRAPHY—NUCLEAR REACTOR FUEL PROCESSING. H. E. Goeller. Mar. 12, 1957. 14p. Contract (W-7405-eng-26). (CF-57-3-153).

The references of this bibliography have been grouped into the following categories: general surveys; economic studies; design studies; hazards; waste disposal; equipment; plant decontamination; process data-general; process data-uranium-aluminum; process data-uranium-zirconium; process data-uranium-stainless steel; process data-thorium; and process data-high temperature.

6304
CHEMICAL PROCESSING OF NUCLEAR FUELS. C. M. Nicholls and R. Spence. Nuclear Power 2, 152-4(1957) Apr.

Processing of spent fuels from power reactors is discussed. Since economy is important in processing it is proposed that moderate decontamination 10^2 instead of 10^8 is sufficient for power reactors since they will operate at high burnup and will not produce weapon material. A general chemical processing method is described. (W.L.H.)

5268
NEW PROCESSES PROMISE MORE ECONOMIC FISSION PRODUCT REMOVAL. S. Lawroski and W. A. Rodger (Argonne National Lab., Lemont, Ill.). Chem. Eng. Progr. 53, 70F-1F(1957) Feb.

The following separation processes for U from fission products are discussed; solvent extraction for natural U, volatility for natural U, volatility for enriched U-Zr fuel; and pyrometallurgical processing. (W.L.H.)

11762
CANADIAN FUEL REPROCESSING. W. M. Campbell (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucleonics 14, No. 9, 92-7(1956) Sept.

The history of Canadian fuel reprocessing is outlined and flowsheets are given. The processes and their modifications are described up to the present ion-exchange process, and comments on future demands and economic considerations are included. (T.R.H.)

4556
CHEMICAL PROCESSING IN THE NUCLEAR POWER INDUSTRY. 1. IMPLICATIONS OF RECENT TRENDS IN REACTOR DEVELOPMENT. F. S. Martin and G. L. Miles (Atomic Energy Research Establishment, Harwell, Berks, England). Atomics 7, 14-23(1956) Jan.

Trends in nuclear reactor development and associated fuel processing requirements are discussed. Different types of process for the recovery of nuclear fuel are considered, together with criteria for their selection. (auth)

683
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, HELD IN GENEVA, AUGUST 8-20, 1955. VOLUME 9. REACTOR TECHNOLOGY AND CHEMICAL PROCESSING. New York, United Nations, 1956. 771p. $10.00.

1228
THE FUTURE OF NUCLEAR FUEL REPROCESSING IN AUSTRALIA. G. L. Miles (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). p.413-19 of "Australian Atomic Energy Symposium, 1958."

An attempt is made to predict the nature and scale of the nuclear fuel reprocessing industry which might be expected to develop in Australia up to about 1975, and to indicate the kind of technical advances which will be required to achieve this. (auth)

11615 CF-56-3-22
Oak Ridge National Lab., Tenn.
OPERATING PROCEDURE FOR THE HRT CHEMICAL PLANT. R. B. Lindauer. Mar. 5, 1956. Decl. Mar. 14,

GENERAL 7.07.02

1957. 9p. Contract [W-7405-eng-26]. $1.80(ph OTS); $1.80(mf OTS).

A detailed procedure for operating the core processing plant for the HRT is described. The schematic flow diagram of the plant is included to aid in following the operations. (W.L.H.)

154 TID-7534

Atomic Energy Commission, Washington, D. C.

PAPERS PRESENTED AT THE BELGIUM SYMPOSIUM ON CHEMICAL REPROCESSING, BRUSSELS, MAY 20-24, 1957. (Issued in three books: (Bk. 1), 481p.; (Bk. 2), 331p.; and (Bk. 3), 364p.) $10.50(OTS).

The papers of the three sessions recorded in book one deal with aqueous reprocessing, auxiliary processes, and disposal of plant effluents. In Aqueous Reprocessing, typical chemical processes for dissolving and preparing relatively simple fuel elements (Al clad or canned) for solvent extraction treatment are discussed. Typical chemical and process flowsheets for solvent extraction separation and decontamination of U–Pu in natural U, U^{233}–Th from Th, and enriched U from U–Al alloy are presented. Performance characteristics of packed columns in Redox Process, and pulse columns and mixer-settlers in Purex Process are given. Auxiliary Processes are those dealing with unusual fuels, converting them to solutions amenable to solvent extraction. The most widely proposed diluents and claddings for these power reactor fuels are Zr and stainless steel, and the various methods for dissolving them are surveyed. Also described as auxiliary processes are methods for additional decontamination from Ru, Zr, and Nb, for concentrating dilute U^{233} and Pu, and for calcining UNH to UO_3 and converting $Pu(NO_3)_4$ to metal. In Disposal of Plant Effluents the methods used for treatment, concentration, storage, and dispersal of gaseous, liquid, and solid wastes from radiochemical processing plants are summarized. After waste disposal problems are treated in general, the treatment of gaseous effluents, preparation of waste for liquid disposal, and the retention of high level radioactive wastes are discussed. The problems of ultimate disposal of radioactive waste to the environment are surveyed with consideration of the development of a nuclear power economy during the next fifty years. Unit costs and economic relationships for some of the better understood stages of the general scheme of waste disposal are derived. Book two, entitled Nonaqueous Processing deals with fluoride volatility processes and pyrometallurgical or pyrochemical processes. The latter involves either an oxide drossing or molten metal extraction or fused salt extraction technique and results in only partial decontamination. Fluoride volatility processes appear to be especially favorable for recovery of enriched U and decontamination factors of 10^7 to 10^8 would be achieved by simpler means than those employed in solvent extraction. Data from lab research on the BrF_3 process and the ClF_3 process are given and discussed and pilot plant experience is described, all in connection with natural U or slightly enriched U processing. Fluoride volatility processes for enriched or high alloy fuels are described step by step. The economic and engineering considerations of both types of nonaqueous processing are treated separately and as fully as present knowledge allows. A comprehensive review of the chemistry of pyrometallurgical processes is included. Engineering and Economics is the title of book three which is concerned with several phases of chemical reprocessing of fuels which are of a general nature. Hot labs, radiochemical analytical facilities, and high level development cells are described. Dissolution equipment, contactors, flow generation, measurement, and control equipment, samplers, connectors, carriers, valves, filters, and hydroclones are described and discussed. Papers are included on: radiation safety, chemical safety, radiochemical plant operating experience in the U. S., and heavy element isotopic buildup. The general economics of solvent extraction processing is discussed, and capital and operating costs for several U. S. plants given. The Atomic Energy Commission's chemical processing programs and administration are evaluated and the services offered and charges therefor are listed. (T.R.H.)

1197

AUSTRALIAN ATOMIC ENERGY SYMPOSIUM, 1958. Proceedings of a Symposium on the Peaceful Uses of Atomic Energy in Australia held in Sydney from June 2 to 6, 1958. Melbourne, Melbourne University Press, 1958. 797p.

A selection of 114 papers presented at the 1958 Australian Symposium on Peaceful Uses of Atomic Energy are included. Of these papers, 39 have previously been presented in NP-6829, abstract 13642, NSA, Vol. 12. Abstracts were prepared for the remaining papers. (C.J.G.)

1227

CHEMICAL PROCESSING OF IRRADIATED URANIUM. J. E. Cole (E. I. du Pont de Nemours and Co., Wilmington, Del.). p.408-12 of "Australian Atomic Energy Symposium, 1958."

PROCESSES AND METHODS 7.07

GENERAL 7.07.02

A review is given of the chemical processing methods for irradiated uranium relative to equipment involved and the economics of separation plant operations. (C.J.G.)

1222
FRENCH PRIVATE INDUSTRY IN THE ATOMIC FIELD. p.330-2 of "Australian Atomic Energy Symposium, 1958."
A description is given of how the French national atomic energy authority has devised the allocating of commitments to enable private industry to increase its contribution toward atomic energy development. (auth)

1215
THE NUCLEAR POWER PROGRAM IN THE UNITED KINGDOM. H. H. Gott (United Kingdom Atomic Energy Authority, Risley, Eng.). p.235-8 of "Australian Atomic Energy Symposium, 1958."
A general review is given on technical and operating problems related to the nuclear power program in the United Kingdom. The power program for the future is discussed. (C.J.G.)

AQUEOUS FUELS 7.07.03

2055 AERE-CE/M-228
United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England.
SPECIFICATION OF THE EQUILIBRIUM COMPOSITION OF AN HAR FUEL SOLUTION WITH CONTINUOUS PROCESSING. D. Bradley. Aug. 1958. 15p. (HARD(B)/P-37). $0.35(BIS).
The equilibrium composition of the feed to the fuel processing system of a homogeneous aqueous reactor is calculated for a typical power reactor case. (auth)

4666 CF-55-5-156(Rev. III)
Oak Ridge National Lab., Tenn.
HRT PROCESS FLOWSHEETS. Revision III. F. C. Zapp. Jan. 30, 1957. 27p. Contract [W-7405-eng-26]. $6.30 (ph OTS); $3.00(mf OTS).

4677 CF-57-1-120
Oak Ridge National Lab., Tenn.
THE CHEMICAL PROCESSING OF TWO-REGION AQUEOUS HOMOGENEOUS REACTORS. D. E. Ferguson. Jan. 29, 1957. 21p. Contract [W-7405-eng-26]. $4.80 (ph OTS); $2.70(mf OTS).
A promising scheme for the chemical processing of a Th breeder reactor of the two-region aqueous homogeneous type consists of the following operations: concentration of insoluble fission and corrosion products from the core system into a small volume of fuel solution, combining this slurry with irradiated ThO_2 slurry taken from the blanket, recovery of D_2O by evaporation, dissolution of the Th and U in HNO_3, and after a suitable cooling period recovery of the U and Th by solvent extraction for return to the reactor. The use of a hydroclone and underflow container arrangement for concentrating insoluble fission and corrosion products under simulated reactor conditions has been successfully demonstrated on dynamic loops. An alternate method of processing the slurry removed from the core system by the hydroclone consists of removing the room temperature insolubles by centrifugation, recovering the U from the supernatant by peroxide precipitation, thermal decomposition of the UO_4 in dilute deuterated H_2SO_4 to produce reactor fuel. This method has been successfully tested on a laboratory scale using a simulated hydroclone underflow slurry. The results of laboratory and loop studies of iodine chemistry indicated that iodine is sufficiently volatile under reactor conditions to be removed by gas stripping. The effect of radiation, temperature and other fission products on iodine valence have been studied. (auth)

188
CHEMICAL PROCESSING OF AQUEOUS BLANKET AND FUEL FROM THERMAL BREEDER REACTORS. F. R. Bruce (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr. 52, 347-52(1956) Sept.
The principles of thermal breeder reactor fuel and blanket processing are discussed, and flowsheets for a three-reactor power station described. (T.R.H.)

12364 CF-56-3-129
Oak Ridge National Lab., Tenn.
CHEMICAL PROCESSING OF TWO-REGION THERMAL BREEDER REACTORS. F. R. Bruce. Mar. 22, 1956. Decl. Apr. 17, 1957. 27p. Contract [W-7405-eng-26]. $0.35(OTS).

8505 CF-55-5-156(Rev. 5)
Oak Ridge National Lab., Tenn.
HRT PROCESS FLOWSHEETS—REVISED EDITION. Roy C. Robertson and J. E. Jones. Dec. 15, 1959. 18p. OTS.

PROCESSES AND METHODS 7.07

AQUEOUS FUELS 7.07.03

Revised HRT flowsheets are presented. These revisions cover such items as relocation of freezer units on the lines, corrections to the numbering of lines, valves or instruments, and the addition of a few lines in the service areas. The waste and vent system flowsheet was redrawn as two sheets. (C.J.G.)

CONTINUOUS PROCESSING 7.07.04

See also, this section,

AQUEOUS FUELS (7.07.03).

21733
ION EXCHANGE PROCESSES FOR NUCLEAR POWER PLANTS. Joseph Thompson and A. C. Reents (Illinois Water Treatment Co., Rockford, Ill.). Ind. Eng. Chem. 51, 1259-61(1959) Oct.

Removal of boric acid from primary loop water by means of a strong base anion exchanger is reported. A quaternary ammonium-type exchanger, Illco A-284, was converted to the hydroxyl form with sodium hydroxide. With this exchanger boric acid was removed to levels required for reactor operation. Ion exchange applications are presented for primary and secondary loops of a pressurized water reactor. Handling of spent radioactive mixed-bed resins is discussed. (C.J.G.)

4698
CONTINUOUS PROCESSING OF HETEROGENEOUS REACTORS. Herbert H. Hyman and Joseph J. Katz (Argonne National Lab., Lemont, Ill.). Chem. Eng. Progr. 52, Symposium Ser. 19, 67-72(1956).

An unconventional approach to fuel element processing is proposed. A heterogeneous reactor lattice can be constructed of randomly packed bare uranium fuel elements, and these may be slowly dissolved in the coolant and the resulting solution continuously processed. The heterogeneous lattice using dense fuel elements yields a more efficient reactor. The continuous processing feature retains some of the advantages of a homogeneous reactor. The problems introduced by this approach are discussed. (auth)

BREEDING 7.07.05

19740 TID-3534
Technical Information Service Extension, AEC.
FUEL BREEDING. A Literature Search. James M. Jacobs, comp. Aug. 1959. 72p. $2.00(OTS).

A compilation is presented of selected references to data on breeding theory, breeder element and blanket design and fabrication, breeder reactors, and breeder reactor fuel elements. There are 696 references to unclassified reports. (T.R.H.)

21800 WAPD-CDA(AD)-528
Westinghouse Electric Corp. Atomic Power Div., Pittsburgh.
THE PERFORMANCE OF BASE-FORM ION EXCHANGERS FOR pH CONTROL AND REMOVAL OF FISSION PRODUCTS FROM PRESSURIZED WATER REACTORS. G. P. Simon, C. S. Abrams, W. T. Lindsay, Jr. [Apr. 1959]. 114p. Contract [AT-11-1-GEN-14]. $18.30(ph), $6.00(mf) OTS.

Laboratory experiments and in-pile loop tests designed to evaluate, explain, and predict the performance of mixed-bed ion exchange columns in the base form for control of pH and removal of radioisotopes from reactor coolant are summarized. The results of the tests are evaluated with the aid of a simple theory of column performance for absorption of radioactively decaying ions, based on an approximate model for an ion exchange column. It is concluded that LiOH-form resin will perform satisfactorily for both pH control and activity removal. The results indicate that LiOH resin is more effective than either KOH resin or NH_4OH resin for these purposes. (auth)

95
FISSION PRODUCT CONCENTRATIONS IN FLUID REACTOR FUELS WITH CONTINUOUS PROCESSING. A. M. Eshaya. [1957]. 10p. (BNL-3368)

A mathematical relationship relating the concentrations of fission products to the rates of removal from the cycle is developed for the continuous processing of a fluid fuel reactor fuel.