

APPENDIX A – UK CIVIL NUCLEAR POWER CONSORTIA 1955-1972

The consortia established in 1955 were:

CONSORTIUM	POWER PLANT	BOILERS	REACTOR MECHANICAL PLANT	REACTOR PRESSURE VESSELS	CIVIL ENGINEERING CONSTRUCTION
AEI - JOHN THOMPSON ⁱ	Associated Electrical Industries	John Thompson	John Thompson Ordnance	John Thompson	Balfour Beatty and John Laing employed but were not consortium members
EE/B&W/TWC ⁱⁱ	English Electric	Babcock & Wilcox	English Electric	Babcock & Wilcox	Taylor Woodrow Construction
GEC / SIMON CARVES ⁱⁱⁱ	GEC	Simon Carves	GEC	Motherwell Bridge employed but was not a consortium member	John Mowlem (Scotland) employed but was not a consortium member
NUCLEAR POWER PLANT CO (NPPC)	C A Parsons and A Reyrolle	Clark Chapman and Head Wrightson	Strachan & Henshaw ^{iv}	Whessoe	Sir Robert McAlpine and Alexander Findlay

plus in 1957:

ATOMIC POWER CONSTRUCTIONS (APC) ^v	Richardsons Westgarth and Crompton Parkinson	International Combustion	Fairey Engineering	Babcock & Wilcox employed but not a consortium member	Trollope & Colls and Holland, Hannen & Cubitts. ^{vi}
---	--	--------------------------	--------------------	---	---

ⁱ The AEI-John Thompson and the Nuclear Power Plant Co. consortia amalgamated in 1960 to form the NUCLEAR POWER GROUP (TNPG).

ⁱⁱ Reformed as Nuclear Design & Construction (NDC) in 1965. Incorporated as British Nuclear Design & Construction (BNDC) in 1969.

ⁱⁱⁱ The GEC / Simon Carves Atomic Energy Division joined the Atomic Power Constructions in 1962 to form the UNITED POWER COMPANY (UPC). UPC was dissolved in 1964. GEC remained responsible for the completion of Hunterston A and Tokai Mura, but sold their turbine-alternator business to Parsons.

^{iv} Strachan & Henshaw also designed and supplied fuel charging machines for other consortia's reactors.

^v APC, BNDC and TNPG went on to undertake the UK's programme of Advanced Gas-Cooled reactor (AGR) power stations, but APC went into administration in 1969.

Staff from BNDC and TNPG finally formed the core of the NATIONAL NUCLEAR CORPORATION (NCC) organization last employed on the Sizewell B pressurized water reactor (PWR) project. NNC was purchased by Amec in 2007.

^{vi} These two civil engineering contractors had formed 'Nuclear Civil Constructors' when planning to be founder members of APC, but they and Elliott Automation withdrew from being consortium members of APC before it was awarded a contract.

APPENDIX B - THE UK MAGNOX AND AGR POWER STATION PROJECTS

The UK consortia undertook the engineering, construction and commissioning support of the following projects:

PROJECT	REACTOR net MWe	TYPE	CUSTOMER	CONSORTIUM	YEAR*	CLOSED	COMMENTS
Berkeley (Glos)	2 x 138	Magnox	CEGB	AEI - John Thompson	1962	1989	
Bradwell (Essex)	2 x 150	Magnox	CEGB	NPPC	1962	2002	
Hunterston A (Ayrshire)	2 x 160	Magnox	SSEB	GEC / Simon Carves	1964	1990	Managed by UPC 1962-1964
Latina (Italy)	1 x 200	Magnox	Enel	NPPC	1963	1986	
Hinkley Point A (Somerset)	2 x 225	Magnox	CEGB	EE/B&W/TWC	1965	2000	
Trawsfynydd (Gwynedd)	2 x 235	Magnox	CEGB	APC	1965	1993	
Tokai Mura (Japan)	1 x 166	Magnox	JAPCo	GEC / Simon Carves	1966	1988	Managed by UPC 1962-1964
Dungeness A (Kent)	2 x 250	Magnox	CEGB	TNPG	1965	2006	
Sizewell A (Suffolk)	2 x 210	Magnox	CEGB	NDC	1966	2006	
Oldbury (Somerset)	2 x 217	Magnox	CEGB	TNPG	1967		
Wyifa (Anglesey)	2 x 495	Magnox	CEGB	BNDC	1971		
Dungeness B	2 x 545	AGR	CEGB	APC → NDC	1985		Managed by GEC from 1969
Hinkley Point B	620 & 600	AGR	CEGB	TNPG	1976		
Hunterston B	610 & 605	AGR	SSEB	TNPG	1976		
Hartlepool (Durham)	2 x 595	AGR	CEGB	NDC	1984		
Heysham 1 (Lancashire)	2 x 615	AGR	CEGB	BNDC	1985		
Torness (East Lothian)	2 x 625	AGR	SSEB	NNC	1988		
Heysham 2	2 x 615	AGR	CEGB	NNC	1988		

* Year of completion of the first reactor of each pair.

Berkeley to Sizewell A had steel reactor pressure vessels. Oldbury and all after had prestressed concrete reactor pressure vessels.

The capacity of each Calder Hall 'PIPPA' reactor was 50 MWe (first reactor completed in 1956, closed in 2003).

Some of the Magnox reactors were operated below the MWe stated above

Sources: <http://www.british-energy.com/pagetemplate.php?pid=425>; <http://www.nda.gov.uk/sites/>; <http://www.world-nuclear.org/info/inf84.html>.

APPENDIX C – BIBLIOGRAPHY

MAGNOX PROJECTS ENGINEERING

Atkinson R V, Bird R H *et al*, 1968, Refuelling of gas-cooled reactors, symposium, 12 December 1968, *Proceedings of the Institution of Mechanical Engineers*, v 183, part 3 G, papers covering:

Berkeley - Connor F P & Thomas T, pp 45-55.

Bradwell, Dungeness 'A', and Oldbury - Fortey J & Vowlest A F, pp 116-123.

Hinkley Point 'A' - Atkinson R V & Lawson D S, pp 131-159.

Sizewell and Wylfa - Rawson P J & Shipman T, pp 99-108.

Tokai-Mura - Bird R H & Saunders A S, pp 56-61.

Trawsfynydd - Harding H W, pp 37-44.

Bailey R W & Hicks R, 1960, Behaviour of perforated plates under plane stress, *Journal of Mechanical Engineering Science*, v2, n2, pp 143-161.

Bailey R W & Hicks R, 1960, Localized loads applied to a spherical pressure vessel through a cylindrical insert, *Journal of Mechanical Engineering Science*, v 2, n 4, pp 302-311.

Baker A L L, Moncrieff M L A *et al*, 1962, The design, construction testing of a prestressed concrete reactor pressure vessel model, *Proceedings of the Institution of Civil Engineers*, v23, n3, paper 6557.

Brown A & Weston J M, 1966, Steam turbine plant for Wylfa nuclear power station, *Nuclear Power Plant*, conference, Paris, Société des Ingenieurs Civils de France and the Institution of Mechanical Engineers, Institution of Mechanical Engineers, pp 12-26.

Chambon P, 1966, Boiler plant at Wylfa nuclear power station, *Nuclear Power Plant*, conference, Paris, Société des Ingenieurs Civils de France and the Institution of Mechanical Engineers, Institution of Mechanical Engineers, pp 1-11.

Gill S S, 1970, *The Stress Analysis of Pressure Vessels and Pressure Vessel Components*, Pergamon Press

Gill S S, 1982, Pressure vessels - analysis for design, *International Journal of Mechanical Sciences*, 24, special issue.

Harwood A E, Scott P & Stonehouse B H, 1959, The design of electro-mechanical auxiliaries directly associated with power producing reactors, *Proceedings of the Institution of Electrical Engineers*, 106, pt A.

Hicks R, 1958, Theoretical analysis of the stresses induced in a spherical pressure vessel due to the constraining effect of a cylindrical skirt, *Proceedings of the Institution of Mechanical Engineers*, v 172, pp 707-726.

Hicks R, 1959, Asymmetrically ring reinforced circular hole in a uniformly end-loaded flat plate with reference to pressure vessel design, *Proceedings of the Institution of Mechanical Engineers*, v 173, pp 329-342.

High pressure gas as a heat transport medium, symposium, 9-10 March 1967, *Proceedings of the Institution of Mechanical Engineers*, 1966-67, v 181, part 3 I.

Holmes R L, Southwood J R M & Whitehouse P R, Boilers for nuclear plant, in Steam Plant for the 1970s, convention, 23-25 April 1969, *Proceedings of the Institution of Mechanical Engineers*, v 183, part 3O, pp 64-70.

Institution of Civil Engineers, 1967, *Prestressed Concrete Pressure Vessels*, conference, London. 1967.

Irving J, Carmichael G D T & Hornby I W, 1974, A full-scale model test of hot spots in the prestressed concrete pressure vessels of Oldbury nuclear power station, *Proceedings of the Institution of Civil Engineers*, 2, 57, pp 331-351, and pp 795-798.

Jones T E M & Twigg B K, 1962, Fabrication of heat-exchanger shells for Bradwell nuclear power station, *British Welding Journal*, v 9, pp 199-.

Muto K, Bailey R W & Mitchell K J, 1963, Special requirements for the design of nuclear power stations to withstand earthquakes, *Proceedings of the Institution of Mechanical Engineers*, v 177, n 7.

Noone M J & Bishop R F, 1961, Pressure vessels for gas-cooled graphite-moderated reactors, *Proceedings of the Institution of Mechanical Engineers*, v 175, pp 471-495.

Stonehouse B H & Spurgin A J, 1961, The control of nuclear power stations, *Electrical Review*, v 169, n 24, 15 December, pp 945-949

Udall, Marilyn S. (ed.), 1968, *Prestressed Concrete Pressure Vessels*, conference, Institution of Civil Engineers:

Barber D, McLelleand G S & Seaton A R, *Corrosion protection of the Wylfa vessel cooling system*, pp 725-733

Langan D, *Correlation between theory and experiment - Wylfa vessel*, pp 435-446.

Vaughan R D, Southwood J R M *et al*, 1964, Berkeley and Bradwell nuclear power stations, symposium, 1963, *Proceedings of the Institution of Mechanical Engineers*, special volume.

Waters T C & Barrett N T, 1963, Prestressed concrete pressure vessels for nuclear reactors; *J. Brit. Nuclear Energy Soc*, July 1963; and discussion April 1964.

BIBLIOGRAPHY - AGR PROJECTS ENGINEERING

The Construction, Commissioning and Operation of Advanced Gas-Cooled Reactors, 1977, conference, May, Institution of Mechanical Engineers.

IAEA, 1980, *Advanced Gas-Cooled Reactors*, conference, Lausanne, September, International Atomic Energy Agency.

Jenkins G E C, 1992, AGR - fulfilling the potential, *Proceedings of the Institution of Mechanical Engineers*, pp 21-31.

Jones W K C, Rider G & Taylor D E, 1986, Modification increases AGR boiler output, *Chartered Mechanical Engineer*, pp 58-62.

Johnston G, 1989, Heysham 2 and Torness AGRs raise power in record time, *Nuclear Engineering International*, v 34, pp 59-61

Logie J H & Royston D E, 1995, Hunterston B advanced gas-cooled reactor - development of electrical auxiliary system with station life, *Nuclear Energy*, v 34, n 6, pp 361-368.

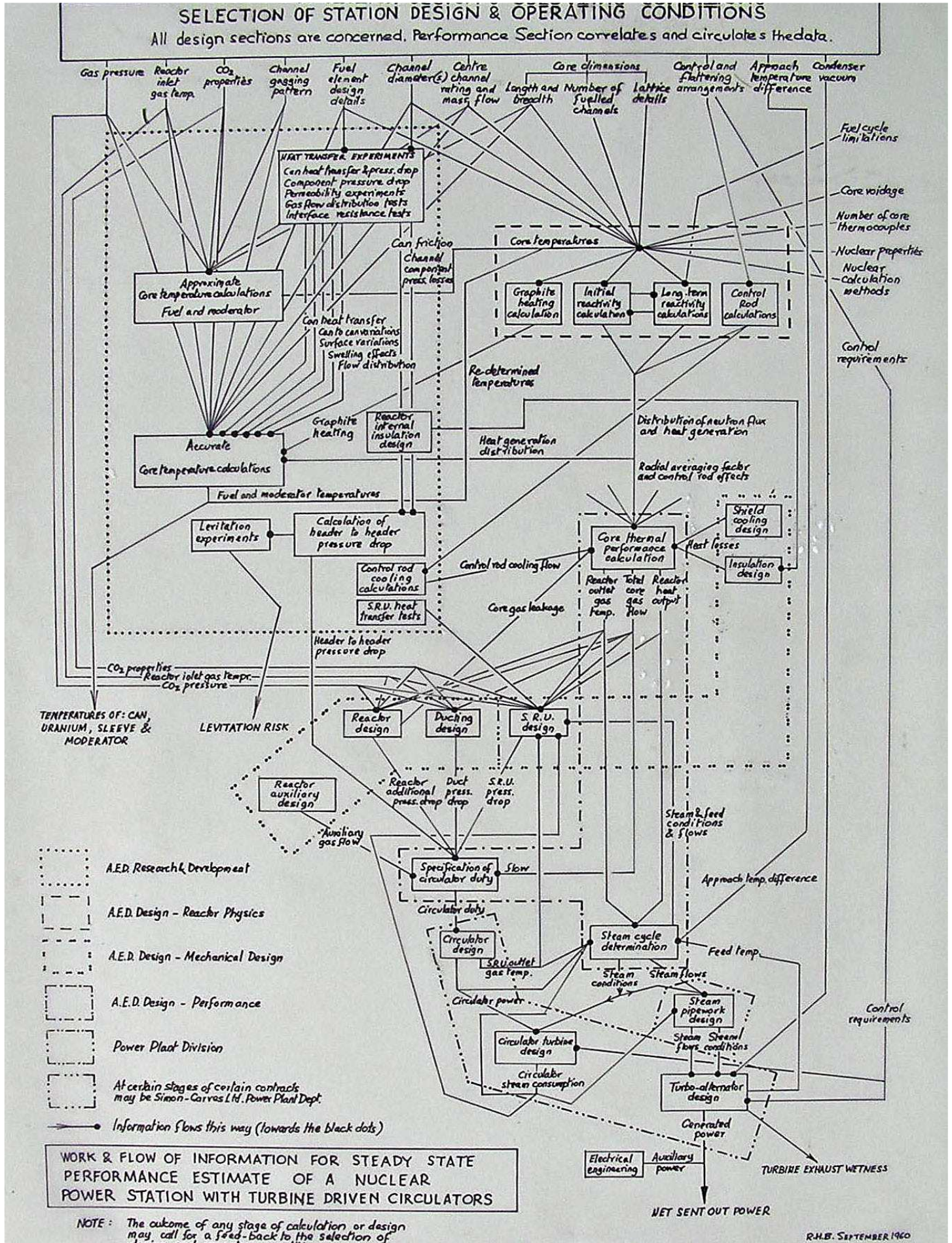
Simpson H, 1990, A comparison of predicted and measured temperatures in the insulated areas of four advanced gas cooled reactors, *Thermohydraulics of Nuclear Reactors*, conference, Institution of Mechanical Engineers, pp 68-75.

Smith D R, 1979, AGR design for Heysham 2 and Torness, *Nuclear Energy*, v 18, n 4, pp 251-259 , and v 19, n 2, pp 104-104.

Vaughan R D & Smith D R, 1966, Exploitation of the AGR for Hinkley Point B, *Nuclear Power Plant*, conference, Paris, Société des Ingenieurs Civils de France and the Institution of Mechanical Engineers, Institution of Mechanical Engineers, pp 27-43.

Westerman M, 1988, Commissioning: programmes, problems and procedures at Heysham-B and Torness reactors, *Nuclear Power Station Project Management*, conference, British Nuclear Energy Society in association with the British Nuclear Forum, the CEGB, the SSEB and the National Nuclear Corporation, Blackpool, 20-22 July 1988.

APPENDIX D – REACTOR DESIGN DEPENDENCIES



APPENDIX E – PROCUREMENT CHOICES

If, as the government envisages, the utility companies will promote new nuclear power station projects in the UK, the procurement choices for a utility are those of any customer for a capital project:

- **FORM OWN TEAM** - Establish the customer's own project team to engineer and manage each project, to be in effect their own main contractor and design and buy plant, construction and other services from consultants, suppliers and contractors. Many utilities and other asset owners in industrial countries regard this option as their high risk last resort, to be followed only if they wish to retain control of information or they have a regular programme of related projects or if other options are not available. For Sizewell B the CEGB followed this option, but formed only a temporary team employing NNC to manage design and construction.
- **HIRE MANAGING CONTRACTOR / CONSULTANTS** - Hire a managing contractor or consultant to engineer and manage each project, at the customer's risk buying the plant, construction and other services from manufacturers and contractors.
- **APPOINT TURNKEY CONTRACTOR** - Invite a manufacturer or contractor to undertake a 'turnkey' contract for a complete station, an option that reduces the need for an owner's team but reduces the owner's control and depends upon selection of a competent and committed contractor able and willing to take the project execution and performance risks.
- **APPOINT CONSORTIUM** - Invite a consortium of manufacturers and contractors to undertake a 'turnkey' contract for a complete station, as in the UK Magnox and AGR programmes and now for the current Finnish project Olkiluoto 3, where manufacturers' and contractors' combined resources were required but the project was only a part of each company's market.
- **TWO STAGE CONTRACTING** -
 1. **Front End** - Establish own team or hire a managing team to define requirements, initiate design, obtain planning consents and order long-lead materials, followed by –
 2. **Novation** - Invite a contractor or consortium to tender to take over responsibility for completing the design and supply of the project.This choice provides flexibility for changes to the scope and cost before commitment to Stage 2.
A contractor employed for Stage 1 is expected to tender with others for Stage 2, to try to achieve continuity and competition.
- **FINANCE PARTNERING** – In these last three options also invite contractors and other investors to finance the project and share the risks of operating and maintaining the asset.

Contractors and consultants employed by the promoting utility would expect to be free to employ consultants, manufacturers and contractors in normal sub-contracting and supply chains.

APPENDIX F – CONTRIBUTORS TO THESE NOTES

D W T Angwin

BSc, CEng, FIMechE, CCIMgt.

War service, Royal Navy. 10 years with GEC, including secondment to UKAEA during building of Calder Hall. Chief Engineer Construction, Hunterston A, and Resident Manager, GEC/Simon-Carves Atomic Energy Group. 10 years with Guest Keen & Nettelfold Group as a director of several companies. Chairman, British Metalworking Plant Makers Association. Since 1974 independent business management consultant in a variety of temporary executive roles including “company doctor” on four successful turnarounds and other assignments involving the management of change and exploitation of opportunity.

R H Bird

CEng, BScTech(Hons), FIMechE, AMCT.

Transferred from Simon-Carves Boiler Department to the GEC/Simon-Carves Atomic Energy Group to work on various aspects of the nuclear power stations at Hunterston and Tokai Mura. Served for two years on the Tokai site as Chief Engineer and saw the project to its conclusion. Subsequently joined the Reyrolle-Parsons Group of companies (later Northern Engineering Industries) and played a leading role in ‘conventional’ power station projects for London Transport, British Steel and the National Thermal Power Corporation of India. Now retired and living on the edge of the Lake District.

Peter Cameron

MBE, FREng, BSc(Tech), FIMechE

Seconded from Metro-Vickers (AEI) at the formation of the AEI-John Thompson consortium in 1955. Responsible for turbo-generators and associated equipment. Later member of BWR proposal team and the Design Manager, Inverkip Project. Manager, Conventional Engineering, NNC, 1980. General Manager of Gas Reactor Construction, NNC. Project General Manager and Chief Engineer, Heysham 2 and Torness, NNC.

R A Flint

CEng, FIEE, FIERE

In 1955 joined English Electric Atomic Power Division; on design and build of large analogue computer for reactor kinetics and control studies; leader fuel handling machinery control equipment design; 1964 Deputy Head Control and Instrumentation Department; 1966 Chief Electrical Engineer NDC; 1971 Engineering Manager, Dungeness ‘B’ (secondment from BNDC); 1975, on formation of NNC, Special Assistant to Chairman and Managing Director; 1976 General Manager Nuclear Power Company (Whetstone); 1980 General Manager PWR; 1982 Lead Witness on Capital Costs, Sizewell ‘B’ Inquiry; 1986 Business Manager; 1987 General Manager Special Projects; May 1990 Deputy Operations Director for Defence and Process Engineering Divisions; September 1990 Operations Director for Defence and Process Engineering Divisions. Retired in 1991. Author of published papers on large analogue computers, application of digital computers to reactor control and instrumentation, and nuclear power plant control systems.

S A Ghalib

CBE, FREng, BSc(Eng).

Sel Ghalib was the General Manager responsible for the formation of the AEI-John Thompson consortium in 1955. On the merger with the Nuclear Power Plant Co in 1962 he became the Commercial Manager and Deputy General Manager of The Nuclear Power Group. From 1966 to 1973 General Manager of The Nuclear Power Group. Managing Director, National Nuclear Corporation 1973 until retirement in 1975.

Raymond Hicks

BSc, MSc, PhD, CEng, MICE, MIME.

Head of Structural Development, GEC/Simon-Carves Atomic Energy Group, 1955. Led a team of specialist graduates to analyse stress distributions in reactor vessels, supporting skirts, grillages, etc. Worked closely with Japanese engineers on problems of earthquake design. Joined Head Wrightson in 1960 as Development Manager, and the Winget

Gloucester Group in 1962 as Group Technical Director. As a result of this group being taken over by Babcock moved to Tyneside to be Managing Director of Huwood. In 1979 became Managing Director of Babcock Mining Services. Retired in 1985.

George Inglis

CBE, FEng, BSc, CEng, FIMechE.

In 1952 seconded by Parsons to the PIPPA design team at Harwell. Senior Design Engineer on Calder Hall. Joined the Nuclear Power Plant Co at its formation in 1955 as Chief Mechanical Engineer. In 1961 joined the UKAEA Production Group as Chief Engineer (Fuel). Appointed Director, Fuel Division, British Nuclear Fuels Ltd, and main Board Member. In 1984 appointed Managing Director, URENCO. Retired 1992.

Harry Kline

MC, MBE, CEng, FIEE.

Deputy Commercial Manager, Atomic Power Constructors, 1957-1962. United Power Company and then GEC, 1962-1969. Project Manager, Tokai Mura, 1962-1966. Project Director, 1969. Managing Director, GEC Transportation Projects, 1969.

Peter A. Lindley

BSc(Eng), ACGI

Chief Engineer of the GEC/Simon-Carves Atomic Energy Group at its formation in 1955. Led the design team which prepared the initial proposal (tender) designs for Hunterston and Tokai Mura for the GEC-Simon Carves group. Later joined Westinghouse Electric Corp. in their Nuclear Fuel Division and was responsible for the management of some of their development programs for PWR fuel. Has also worked on uranium extraction technologies for both Westinghouse and Gulf Oil Corp.

Stephen Mitchell

BSc(Eng)

Initially with Shell Tankers (UK) Ltd, then moving to GEC Large Steam Turbine Division based at Rugby. Worked on various aspects of the Power Plant Technology, Construction and Commissioning associated with the AGR Program at Hartlepool and Heysham. Joined BP Group of Companies in 1978 and after initial involvement in their power generation projects moved into management of their major project portfolio in South East Asia and the USA. On retiring from BP in 2008 and returning to the UK. engaged by BP initially as a Subject Matter Expert for their Managing Projects and Engineering Management courses held at the University of Manchester and then as a Project Management Consultant for their Alternative Energy Business.

Norman Sellers

MSc, CEng, MIET, MInstP.

Joined the UKAEA Fast Reactor team at Dounreay in 1957, and then to NPPC and commissioned the reactor control system at Latina. Appointed Head of Electrical Research, Central Electricity Generating Board, North West Region in 1962, returning to Nuclear Operations at Wylfa and as Deputy Power Station Manager at Hartlepool in 1974. Seconded to the Sizewell B Project Team in 1998 and after two years in Atlanta with the Institute of Nuclear Operations (INPO) was appointed Operations Evaluation Manager until retirement in 1992.

Derek Smith

OBE, MA, FEng, FIMechE, MIEE.

In 1955 joined AEI-John Thompson consortium as a founder member, soon made responsible for the design the reactor design of Berkeley Magnox nuclear power station. Following the merger to form TNPG in 1959 served that Consortia and its successors in various senior management roles. Appointed Chief Engineer of the Sizewell B Joint Project Team in 1981, continuing in that role throughout the successful Public Inquiry. Appointed Engineering Director of the National Nuclear Corporation in 1983 and elected a Fellow of the Royal Academy of Engineering in the same year. Author of numerous invited technical papers on nuclear reactor design and safety. Retired 1991 and joined several retired

colleagues to write *The NNC Story*.

Bernard Stonehouse

BSc(Eng), CEng, FIET

Joined GEC/Simon Carves Atomic Energy Group in 1955 to design the electrical plant associated with the nuclear plant. Chief Electrical Engineer of the Group 1959-1963. Returned to GEC 1964.

Malcolm Tilley

BSc, BA, CEng, FIMMM, MIMechE.

Joined GEC Atomic Energy Division in 1959. Assistant Engineer at Hunterston. Reactor Plant Engineer at Tokai Mura, British General Electric Co, Japan, 1965-1967. Joined ICI Dyestuffs Division as Technical Officer. Ritchies Blasting Agents, Plant Manager, Widnes. In 1969, joined Anglo American Corporation on the Zambian Copperbelt, in engineering and managerial appointments, the major appointment being General Manager, Maamba Colliery. In 1989 returned to the UK as Senior Port Engineer, Forth Ports in Edinburgh. Progressed to Chief Engineer for the company, now Forth Ports plc. Retired in 1996.

Roger Vaughan

OBE, FREng, BMechE, FIMechE

Chief Engineer of the Nuclear Power Plant Co at its formation in 1955 and appointed Director in 1959. Held same position in The Nuclear Power Group following the merger of NPPC and AEI/JT in 1962. He was single-minded in promoting gas-cooled reactors beginning with the Oldbury Magnox concept for overseas and then the AGR. These reactors were succeeded by the helium-cooled HTR with ceramic fuel and the CO₂ cooled fast breeder reactor conceived as an international project in Brussels. With the amalgamation of TNPG and BNDC to form NNC in 1975 headed a new Technology Division responsible for physics and performance as well as research and development for all company projects. Took over the Fast Reactor Division which was to secure the early operation of PFR and the CDFR concept to surpass the French Super-Phenix. The fast reactor was seen to be costly and uncompetitive until there is at least a fourfold increase in uranium price. This led to many collaborative schemes with other countries which have yet to bear fruit..

Stephen Wearne

BSc(Eng), DIC, PhD, CEng, HonFAPM.

Site mechanical construction engineer at Bradwell, NPPC, 1957. Moved to the GEC/Simon-Carves Atomic Energy Group as reactor engineering coordinator for Hunterston A and then Project Engineer for Tokai Mura. Previously employed in the design, construction and coordination of hydro-electric projects in the UK and South America. Professor (now Emeritus) of Technological Management, University of Bradford, 1973-1984. Now Senior Research Fellow, Management of Projects Group, University of Manchester, UK. Author and co-author of books and papers on project organization, engineering contracts, joint ventures and emergency project management.

Alan Young

BSc(Hons)(Eng), MBA

Civil engineer British Railways 1957. Planning engineer UKAEA 1959 for projects at Risley, Capenhurst, Windscale, Chapelcross and Hunterston A. Moved to GEC in 1962 as planning engineer at Hunterston A and site manager for Tokai Mura in 1964-1965. Joined SSEB in 1966 as senior engineer for Hunterston B and deputy project manager for Torness. Operations director, John Brown Engineering, 1982-1989, responsible for 63 power stations world wide. Commercial director, Scottish Hydro-Electric 1989-1994. Managing director Scottish Overseas Health Support 1994-1997. Non-executive director UKAEA 1999-2007, Member Competition Commission 1998-2008 and director Webster Young Limited (energy and business consultancy) 1965 to present.

UK Experience of Consortia Engineering for Nuclear Power Stations

Parts or all of this report and the appendices may be freely copied provided the source is acknowledged:

Wearne S H & Bird R H (2009), *UK Experience of Consortia Engineering for Nuclear Power Stations*, School of Mechanical, Aerospace & Civil Engineering, Dalton Nuclear Institute, University of Manchester.

Copies can be downloaded from the Dalton Nuclear Institute's webpage, at:
http://www.dalton.manchester.ac.uk/aboutus/reports/uk_consortia.html