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THE EMERGENCY SCIENTIFIC RESEARCH BUREAU 1941-1945

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THE EMERGENCY SCIENTIFIC RESEARCH BUREAU 1941 - 1945

An analysis and evaluation of

the scientific and technological impact of the ESRB

Robert John Anthony Bradley

A dissertation submitted to

Trinity College

University of Dublin

in candidacy for the degree of

Doctor of Philosophy

Michaelmas 1991

DECLARATION

This is to certify that this thesis is entirely my own work and has not been submitted to any other degree awarding body or institution.

Signed: R. J. A Bradley

Date: 17 October 1991

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SUMMARY

This thesis deals with the establishment, activities and impact of the Emergency Scientific Research Bureau which funtioned from February 1941 to March 1945 and which reported directly to the Taoiseach's Office.

The research methodology centres on the examination, analysis and evaluation of archival material and documentation from various locations. The findings are presented under a number of headings. These include an outline of the historical context in which the Bureau was established, an examination of its remit and functioning, an analysis of its scientific achievements in its main fields of activity and an assessment of its contribution to economic and industrial activity during its term of office. In addition, the long-term impact of the Bureau is described in terms of the careers and the contributions of its personnel and of its influence on subsequent science and technology policy and agencies.

It is clear from the surviving archival documentation that the pioneering work carried out by the Bureau during World War II made a unique and notable contribution to the maintenance of economic and industrial activity in Ireland, faced with severe restrictions on imports of raw materials and essential commodities. The experimental investigations carried out by the Bureau led, in some instances to the development of substitute processes using indigenous raw materials while in other cases solutions were devised to overcome various problems of a scientific and technical nature being encountered by Irish industry.

These successes emphasised the important role which science and technology could play in economic development; they led to the Bureau playing a significant role in the subsequent development of scientific and technological research in Ireland and presaged the creation of an environment conducive to the later development of other institutions and agencies for the promotion and implementation of science and technology policy.

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To my parents

and

especially to my wife Renée

CHAPTER 1

TWO CENTURIES OF DEVELOPMENT IN SCIENCE & TECHNOLOGY

Just two centuries ago, a fundamental revolution began in the history of mankind which was to lead to the development of the world as we now know it. This revolution, developing first in Britain and then spreading to a few areas in Europe and North America, began the shift in the balance of productive activity from agriculture to industry. This process, commonly described as industrialisation, is characterised by fundamental changes in the methods and the materials of production, in the use of scientific and technical knowledge and in the growth and speed of communications; it became the basis for an enormous growth in industrial productivity, led to economic specialisation in many different sectors and the provision of an extensive range of commodities. This emerging industrial society became the focus of economic development and wealth generation. In this chapter these developments will be examined in their early manifestations in Britain and Germany and later in their wider dissemination.

This growth in industrial output was accompanied by an equally dramatic growth in and movement of populations of industrialised societies; however, as the population growth was lower than the growth in output, the result was an increase in income per head. Industrialisation therefore was not limited to production; it involved a total drastic change in the socio-cultural environment.[1] In turn a new environment for work was created which gave rise to a reorganisation of labour, to the concentration of workers in big industrial centres and to the proliferation of towns to house this new working population.

Another feature of the general population increase in Europe was the variation in the growth rate from one country to the next as indicated by the data given in table 1 below.

Table 1 Estimated populations of selected European countries from 1800 to 1900, in millions

Country	1800	1850	1900
Gt Britain	10.9	20.9	36.9
Germany	24.5	31.7	50.6
Ireland	5.0	6.6	4.5

Source: Cipolla, C.M.(ed.),The Fontana Economic History of Europe, adapted from data given in Vol.3,29.

However, the population in Europe often grew faster than economic resources and emigration resulted inevitably; Ireland particularly suffered with almost two million emigrating during the decade 1845-55; emigration became a characteristic feature of the fabric of Irish society thereafter. Famine in Ireland during this same period was another additional factor which added greatly to the difficulties of the country. Equally dramatic increases in urban population occurred to meet the increasing demand for labour; this accelerated in the nineteenth century. One example alone will suffice to confirm this trend; in 1800 there were twenty three towns in Europe with populations of more than one hundred thousand; in 1900 there were one hundred and thirty five with a total population of forty five million.[2]

By the second half of the eighteenth century, the time of the classic Industrial Revolution in Britain, conditions existed which were generally favourable to industrial development and expansion This process of industrialisation is directly linked to and founded on significant advances in technology. Indeed, David Landes in The Unbound Prometheus, begins his account of the Industrial Revolution in Britain by referring to

> a series of inventions [which] transformed the manufacture of cotton in England and gave rise to a new mode of production-the factory system.

He goes on to state that

> the abundance and variety of these innovations almost defy compilation ------- these improvements constitute the Industrial Revolution; they yielded an unprecedented increase in man's productivity and with it a substantial rise in real income per head; moreover, this rapid growth was self-sustaining (as) -------- now for the first time in history, both the economy and knowledge were growing fast enough to generate a continuing flow of investment and technological innovation.[3]

This connection between the growth of scientific knowledge and the technological aspects of early industrialization is referred to by A E Musson as 'fruitful collaboration' between scientists, technologists and industrialists. It would, however, be equally possible to begin with social developments, which produced a receptivity to change and an encouragement of new methods of production and organisation which would lower costs and increase profits on investment. Thus, one has to recognise the existence of a multiplicity of interacting factors, economic, social, political and psychological, as well as scientific and technical, all contributing to the process of industrialization. However, it was the existence of industry, organised on capitalist lines by

entrepreneurs employing waged-labour and producing commodities for sale in the market, that provided the immediate setting for the technological changes of the Industrial Revolution. With the growth of this type of society there developed a growing interest in and respect for science and scientists. It is thus possible to trace many direct links between industrial innovation and science, while, at the same time, recognising the different worlds lived in by the scientist and the business man.

Science, during the seventeenth century, was patronised more by the state and by enlightened members of the leisure classes than by industry. However, science lacked formal organisation or indeed an established position in most education systems. Moreover, science's official or aristocratic patrons did hope for some practical results which could be utilized to assist the army, to improve navigation, to assist farmers or to encourage the founding of new industries. This aspect is particularly highlighted by the expansion of science in colonial societies where scientists worked for the greater glory of the mother country and assumed a central role in the 'imperialist civilising mission'.[4]

In Britain and in some European countries learned societies were significant in promoting scientific learning. The Royal Society, founded in 1662, provided a valuable rallying point for scientific and literary minded people as well as gifted amateurs from the ranks of the aristocracy; but it also provided a forum for discussion of a wide range of practical questions. This was even more true of the Society for the Encouragement of Arts, Manufactures and Commerce in Great Britain, founded in 1755, which

set out to stimulate invention by offering prizes. Numerous local societies and clubs were set up and followed a similar programme for stimulation and encouragement of science and technology. In some branches of science Britain led the way, but a similar scientific movement took place in France and in European countries less developed industrially and there were fields in which they were ahead. Scientific societies similar to the Royal Society were set up in other European countries, e.g. the French Académie Royale des Sciences (1666) and the Die Berliner Akademie (Stiftung) des Wissenschaften (1700).

The presence of a cadre of amateur enthusiasts in England possibly indicated the lack of a high level of vocational commitment with the result that scientific leadership passed to France about 1800. Here a centralised state supported a corps of eminent professional scientists concentrated around the Académie. However, this scientific community, languished as an instrument of scientific innovation during the 19th century mainly due to administrative lethargy and over-centralisation. It was left to Germany to develop the optimum role of the scientist. This occurred through the role of the professor in their dynamic university system, the innovating scientist in his laboratory flanked by a cohort of colleagues and students.[5] This university impetus was strengthened and considerably empowered by the reforms initiated by Humboldt.

This organisational breakthrough speeded the development of science by encouraging the exchange of ideas, by bringing together potential collaborators, through the acquisition of research funds and by the employment of research assistants. The

learned societies took upon themselves the responsibility for publication of experimental results, thus broadening the communication base and laying the groundwork for today's scientific paper. These European organisations and their publications did much to shape the scientific community and to create a stable continuum for scientific debate and communication which resulted in the professionalism of science in the 19th century. In addition, they served to broadcast, to the public at large, both the usefulness of science and the contribution which science made to technological and economic development and thereby created an opportunity for the explicit popularisation of science.[6]

Although economic historians have elaborated on the connections between science and technology in the eighteenth century and on contributions made by scientists to industrial problems, it could scarcely be maintained that the crucial inventions that initiated industrialization owed much to professional scientists. The textile inventors, John Kay, James Hargreaves and Samuel Crompton, were practical craftsmen, not scientists and Richard Arkwright and Matthew Boulton, key figures in the industrial innovations of the time, were shrewd businessmen. Abraham Darby was a practical ironmaster, Henry Cort worked for the Admiralty and Edmund Cartwright was a country vicar. Whatever the motive for invention, the man who turned an invention into a practical business proposition needed neither scientific nor technical knowledge, though such might prove valuable assets.

The critical inventions in industry, such as those of the

inventors mentioned, were thus more likely to be made by practical men working empirically on particular problems known to them than by scientists beginning with general principles and developing theoretical models. But once technology moved on from the stage of improving existing tools and machines or solving relatively simple problems, such as those posed by spinning textile fibres, progress was more closely linked to the application of scientific knowledge. This was so particularly in the harnessing of steam power, in the use of chemicals for industrial purposes, in metallurgy and the machining of accurate metal parts and, also, in civil engineering concerned with the vital infrastructure of an industrializing society, particularly the transport industry. However, the direct application of physics and chemistry to the problems of production came mostly after the first stage of industrialization; such application was necessary to maintain the momentum of the process rather than to initiate it.

The Crystal Palace Exposition of 1851 is generally regarded as marking the pinnacle of Britain's position as the leading industrialized nation. Britain was at that time producing about two-thirds of the world's coal and more than half of its iron and cotton cloth. Its income per capita, in so far as comparisons can be made, was higher than that of its competitors. British merchandise dominated world markets with little fear of competition. In short, Britain had become the model of industrial excellence, an achievement to be emulated and envied.[7]

At this time according to Landes, continental Europe was still about a generation behind Britain in industrial development. Over the next twenty five years, however, Germany, France and Belgium

experienced a period of unprecedented rapid growth as evidenced by the data in Table 2.

Table 2 **Economic Development in Germany, France, the United Kingdom and Belgium for the years 1850, 1869 and 1873, as indicated by the stated indicators.**

	Railroad mileage (statute miles)	Coal production or consumption (1000 metric tons)	Steam-power capacity (1000 h.p)	Pig iron output (1000 metric tons)	Raw cotton consumption (1000 metric tons)
Germany					
1850	3,639	5,100	260	212	17.1
1869	10,834	26,774	2,480	1,413	64.1
1873	14,842	36,392	-	2,241	117.8
France					
1850	1,869	7,225	370	406	59.3
1869	10,518	21,432	1,850	1,381	93.7
1873	11,500	24,702	-	1,382	55.4
United Kingdom					
1850	6,621	37,500	1,290	2,249	266.8
1869	15,145	97,066	4,040	5,446	425.8
1873	16,082	112,604	-	6,566	565.1
Belgium					
1850	531	3,481	70	145	10.0
1869	1,800	7,822	350	535	16.3
1873	2,335	10,219	-	607	18.0

Source: Landes, D.S., The Unbound Prometheus - Technological Change 1750 to the present (Cambridge 1969),201.

These were also the years of technological maturation as evidenced by the use of the power loom in the textile industry, the use of mineral fuel in the iron industry, the establishment of a heavy chemical industry and the widespread introduction of machines into many fields of production. These years saw also some of the most important technological innovations of the century, such as the Bessemer converter in steel production, the industrial use of electricity to complement gas and steam power as energy sources and the production of artificial coal-tar dyes. Furthermore the Solvay ammonia process laid the basis for a new and more sustained wave of expansion, often referred to as the Second Industrial Revolution.

The growing technological competences of many of the other continental European countries resulted largely from 'on-the-job' or man-to-man transmission of skills. In the long term, the provision of formal training for mechanics and engineers was of significant importance; this training was available in prestigious institutions, such as the French Ecole Polytechnique and the Gewerbe-Institut in Berlin and in the Ecoles des Arts et Metiers and the Gewerbeschulen which ranked as mechanical training schools. These pedagogical institutions, jointly funded by central state and local regions, were part of a larger system of technical education, designed to introduce the new techniques and diffuse them throughout the economy. Other efforts were made through non-teaching academies, museums and expositions designed to stimulate technological uptake and development. These developments occurred at a time when the premier universities in England, Oxford and Cambridge, were deemed to be in need of the attention of a Royal Commission; both also remained indifferent to experimental science as a subject worthy of inclusion on their curricular offerings.

The recognition of the value of formal science education and its inclusion on academic programmes proved a significant boost to rapid industrial development and economic growth on the continent. Other positive forces contributing to expansion included (i) the improvements in transport particularly the expansion of the railway system, (ii) the availability of new sources of energy and raw materials, (iii) a sharp increase in the supply of money, (iv) a creative entrepreneurial response to market opportunities, (v) the continuation of more systematic state support for science and

science education and (vi) the flow of skills and knowledge from higher education.[8]

In Britain, up to mid-century, there was effectively a continuous governmental indifference to science with only one publicly financed laboratory, the Royal Institution. This became the home of a long line of distinguished researchers such as Humphrey Davy, the inventor of the miner's safety lamp and discoverer of a number of chemical elements and Michael Faraday, who in many respects may be regarded as the father of the electrical industry. The period from 1800 onwards was characterised by the provision of Mechanics' Institutes which did much to generate public interest in science. These were designed to provide a largely working-class clientele with knowledge and appreciation of the industrial applications of current scientific developments. Prominent amongst the activists of the Mechanics' Institutes movement in Britain was George Boole, who for many years was an enthusiastic but unpaid teacher at the Lincoln Mechanics' Institute. A keen advocate of the progress of the individual by means of adult education, Boole devoted time and effort on behalf of adult education to the Cuvierian Society, founded in Cork, in 1835.[9] No doubt the demand for increased numbers of skilled and semi-skilled manpower contributed to this movement.

The economic and industrial supremacy of Britain in the last century was underpinned by the increasing number of colonies which provided essentially soft and politically protected markets for British goods and offered unlimited supplies of raw materials. These goods were carried cheaply and quickly in British ships by virtue of the country's maritime supremacy. Thus, throughout the

whole of the 19th century and the early part of the 20th century, British industry was provided with a guaranteed market for its goods which diminished the urgency for investment in technological innovation and product development. There was little to fear from foreign competition and therefore little incentive towards greater utilization of science and technology. The availability of cheap raw materials from the colonies diminished the need to develop more economic and therefore technologically more sophisticated ways of processing and manufacture. The outcome of these factors was a commercial climate which displayed little interest in creating new science-based industries.

The maintenance of such markets required primarily an efficient administration and an army equipped to ensure political stability. The educational system reflected this political reality; from the 1830's onwards it was geared more to the education of administrators and officers rather than that of scientists. It was not until the turn of the century that this tradition in the British education system changed somewhat, mainly due to the impact of the New Education Movement.[10]

France and Germany, with smaller colonial markets and lesser maritime and trading strengths, were committed to innovate, to develop better and more advanced products in order to compete with Britain and each other. Consequently, these countries placed a greater emphasis on technology and on scientific education; by the middle of the 19th century, new types of scientific organisations were beginning to appear in Germany and to a lesser extent in France. These developments, according to the sociologist Joseph

Ben-David, prompted the introduction of actual laboratory-based training in German Universities (compared to the learning of theory in Universities in Britain) and the development of large research groups working on inter-related topics.[11] A further and crucial distinction was the willingness of German manufacturers to absorb graduates and to promote their transformation into industrialists.[12]

The Physikalisch-Technische Reichsanstalt (The Imperial Institute of Physics & Technology) was prominent among the German institutions; founded in 1887, it represented the best of both pure sciences and industrial technology. The Reichsanstalt's scientific achievements, especially its work on blackbody radiation and the new quantum physics, its commitment to physical metrology particularly in the development of electrical standards, its certification and testing of measuring apparatus, scientific instruments and materials were indicative of the intellectual and social benefits which science and technology could confer on a modern society and state.[13]

The Reichsanstalt had many admirers and imitators abroad. In Britain a groundswell of opinion from scientists and industrialists persuaded the British Treasury to establish the National Physical Laboratory at Teddington in 1899. American scientists, engineers and manufacturers were also very much aware of the Reichsanstalt's achievements in conducting research in science-based technology aimed at helping industry; In 1901, as a result of extensive lobbying, the United States Congress in 1901 established the Bureau of Standards at Washington DC. The German foundation also provided the model for Japan's Institute of Physical and Chemical Research.

However by 1914 according to Cahan, the Reichsanstalt had fallen from its position of preeminence and was overshadowed by the National Physical Laboratory and the Bureau of Standards.[14]

The German developments however, exercised a profound long-term effect on British policy. In connection with the Great Exhibition of 1851, the scientific activist, Lyon Playfair, gave a series of public lectures on 'National Science Policy', in which he drew attention to the superior quality of German industrial research compared with British achievements; to remedy this situation he called for the establishment of an industrial university to produce the much needed scientists and engineers. Eventually, Parliament established the three Royal technical schools which became, in 1907, the Imperial College of Science & Technology. It would seem that the 1851 Exhibition highlighted successfully the potential role and function of the state in financing and organising British industrial research. As a consequence, a new Department for Science and Arts, with Playfair as Science Secretary, was established; this department was the forerunner of the present Department of Education & Science.[15]

The contrast between Britain and Germany in the recognition of the role of science and technology in industrial development, can be clearly demonstrated by looking at the particular example of the aniline dye industry. William Perkin discovered the first of these coal-derived dyes in 1856 at the Royal College of Chemistry. Recognising the commercial potential of his discovery, he set up a business to manufacture the dyes. But, within six years of his discovery, at least four factories had been set up in Germany to

develop and produce the dyes. Within a few years Germany dominated the dye industry because of the willingness of technologically-aware industrialists to invest in a new science-based industry.

This failure to exploit a research lead was due mainly to under-investment in innovation and partially to a lack of qualified manpower to sustain the effort to commercial success. Although this is perhaps the most widely known example, others exist, such as Andrew Carnegie's successful exploitation in the U.S.A., of research into steel production performed in Britain by Bessemer and others. J J Beer has shown the decisive role played by the German state in gearing the educational system to the scientific manpower requirements of industry; between 1880 and 1900 the German annual expenditure on education was ten times that of Britain.[16]

The sustained agitation and concern for the state of science education expressed by many groups and individuals, led eventually to the setting up in 1870 of a Royal Commission under the Duke of Devonshire. This commission proposed that a separate Ministry 'dealing with science and education as a public service should be set up' with a Science Council to advise it; some eighty-eight years were to elapse before its implementation. The Commission sought also the establishment of state science laboratories and official encouragement for increased productivity amongst British scientists. The Government's response to these deficiencies in the teaching of scientific and technical subjects was neither encouraging nor supportive. Apart from existing provision in Scotland in the University of London and in a small number of technical colleges, formal technical education only began in

earnest with the founding of the 'red-brick' or city Universities in the 1870s and 1880s. Even then, the technical departments of these new universities suffered from the start from inadequate funds and low prestige. In Britain a stigma was associated with scientific and technical education or indeed with any formal education with an industrial leaning. Indeed universal primary and secondary education were instituted reluctantly in Britain and were mainly more instrumentary than instructional. This was in sharp contrast with some systems in Europe and the USA where scientific education was promoted and hence in high demand. This failure on the part of Britain to establish an adequate system for technical and scientific education was symptomatic of the gulf between Government and industrial production. It was left more to individual effort and motivation to secure the necessary co-operation between the entrepreneur and the researcher with a view to facilitating industrial innovation and the development of science-based industries.

The lack of state intervention and support for science and technology education meant that, while German universities and polytechnics provided a broad career structure in pure and applied research, Britain could offer only very limited opportunities for graduate scientists, combining low rates of pay and poor working conditions. Indeed by 1913 there were only about 300 postgraduate research students in Britain involved in systematic scientific research. In the early decades of this century Britain slipped further behind her continental partners in the struggle to develop scientific institutions and in the training of sufficient numbers of scientists and engineers to compete in the international marketplace.[17]

Thus it can be argued that those countries which entered the industrialization arena later in the day were, from the beginning, more conscious of the links between science, technology and industry. This is clearly exemplified by the importance placed on scientific training in some Continental countries where scientific awareness developed ahead of the process of industrialization. Machines and processes developed in Britain could be transported to other countries where improvements and more successful applications were evolved through scientific research and technological innovation. Thus, during the later part of the 19th century, British industry tended to fall behind in the use of scientific knowledge while rivals abroad forged ahead. Technological superiority, especially in the new industries, went to those who were aware of the technological advantages which would accrue when science was applied to industrial problems.[18] While science and technology played a major role in shaping modern society, the dynamic of the resulting technical developments cannot be fully understood without reference to the scientific and technical institutions, to the quality of the educational systems, to the financial support given by the different countries to support science education and to the close involvement of the banking institutions with industrial development.

Barnett, Roderick and Stephens and most notably Wiener, have argued that the failure of Britain's governing and industrial classes to develop a more practical, applied and technical system of education in the 1880's was the main factor in Britain's present day eclipse n the international market place.[19] Such a claim may be somewhat too narrow as there were other factors at

work; the professional status aspired to by scientists, engineers and industrialists may have served to distance their activities from the craftsmen and artisans needed to implement and work with technological innovation. The dominant view that liberal or classical education was, because of , social attitudes 'superior' to technical education may also have been a contributory factor.

In Germany, the gymnasium or grammar school became the focus of attention with the classical curriculum forming the basis of the Abitur, the school-leaving examination, which allowed middle-class pupils matriculate into the universities or obtain direct entry into various state examinations for the civil service. Another type of secondary school, the Realschule (modern school) promoted and developed science teaching, but their pupils were unable to enter universities until legal battles had been fought in the 1860's. Typically, their students obtained their higher education in the Technische Hochschulen, institutions similar to the modern day Polytechnic; by 1914 there were ten technical institutes devoted chiefly to the applied sciences and to engineering. These institutes greatly strengthened the German chemical and electrical industries during the closing decades of the 19th century but they were constrained since they could not equal the universities in academic standing and prestige.[20] Thus, until 1900, when all secondary school pupils were allowed to enter for the Abitur, most ranking German scientists had experienced a classical education and first encountered science at university.

The main educational objective of Germany's universities was success in state examinations which allowed entry into Government service including the professions, pharmacy, medicine and academic teaching. However, the development of faculties of philosophy and their attendant ideology of the search for knowledge, led to an increasing number of students throughout the 19th century staying on to take a doctoral degree. This called for independent research and the submission of a thesis and it was in this atmosphere that teaching and research laboratories emerged, beginning with Liebig's internationally renowned chemical laboratory at the University of Giessen in 1824. The development of experimental research was also boosted by the competition for prestigious professional staff that occurred between the various German state governments prior to unification in 1870.

It should not, however, be thought that the German system of research organisation was beyond reproach. The professor at the apex of the rigid hierarchical system ensured rapid development of line of research within the professor's 'discipline' but frequently caused extreme difficulty in introducing the new interdisciplinary subjects which emerged as a result of the natural growth and development of science. These deficiences led to the development of special research institutes in the late 19th century such as the Kaiser Wilhelm Gellschaft in Germany and the Institut Pasteur in France.[19] Nevertheless, Germany remained to the forefront in laboratory-based science teaching to the First World War. By then the Technische Hochschulen had become accredited technical universities, authorised to award doctorates for research in applied sciences.

However, it must be remembered, that large numbers of British chemists had been taught and trained by Liebig who enjoyed tremendous populariy in Britain. Indeed, the Geissen method of scientific training was copied and utilized by A W Hofmann in the privately-financed Royal College of Chemistry, in view of this, it is possible that chemical education in Britain was comparable with that of Germany.[22]

The position of science and technology in France was influenced significantly by some historical characteristics of the French education system. The French Revolution led to the setting up of an integrated and centralised education which was unique in Europe. Until the 1850's the curriculum in the state lycees was very classical in content and culminated in the very difficult Baccalaureate examination. Under the influence of industrial demands for a more technically competent work-force, students were provided with a choice in 1852, with the provision of a science-based baccalaureate.This same pressure led to the regional development of faculties of science. These initiatives coupled with the role played by the specialised Grandes Ecoles were key elements in the industrial development of France.[23]

As already indicated, Britain's pre-eminence in the first period of industrialisation was based on a combination of good natural mineral resources, availability of capital, the development of transport systems for both internal and external markets and the production of technical innovations which gave an initial lead over other European nations. This industrial success had little to do with the traditional and classical education prevalent at

that time, which at most was available to a fraction of the cohort; legally compulsory elementary education was not provided until late in the century.

In the early part of the 19th century Oxford and Cambridge were noted for their religious exclusiveness, their privileges, indifferent academic standards and their restricted curricula. The monopoly of the classics ended in Oxford in 1850 with the creation of honours examinations in mathematics and science and in Cambridge in 1851 with the addition of a natural sciences degree to the existing mathematics degree. These new science degrees laid a solid foundation for the more laboratory-based and research oriented science degrees of the 1880's.

Reactions to the Oxbridge ethos led to the foundation of the secular University of London in 1826 and the provision of science subjects in its degree. Its capacity to act as an examining body allowed dozens of London, provincial and overseas institutions to offer external University of London degrees. Its federal structure became a model for Universities in Canada, India, Australia, New Zealand and Ireland, all of which followed its 1859 precedent of establishing separate bachelor degrees in arts and sciences. However, due to restricted access to secondary education for most of the 19th century, there was no easy route to a scientific career or indeed other careers, for working-class children. Those ladders of opportunity which did exist owed much to the principles of self-help and informal education prevalent in Victorian society, to the availability of apprenticeships, to the Mechanics' Institutes, to the provision of cheap books and

periodicals made possible by the steam press and to the teaching and examination system offered by the Department of Science and Arts after 1853.[24]

Technical education was thus seen as a lower form of education appropriate only to artisans. Engineering was a craft and industry essentially a collection of craft-based industries. From the acceptance of this empirical approach a belief had grown that engineering was something to be learned on the job.[25]

The situation on the Continent was different, where the engineer was a highly educated professional. This image originated in the mining academies and military schools of France, Germany and Hungary in the 18th century and was adopted subsequently by the Ecole Polytechniques and Technische Hochschulen.

The systematic application of research efforts to problems relevant to commercial enterprises, as initiated in the Giessen laboratory of Liebig, became a model for future development. Throughout the 19th century research establishments, based on the German model, were founded in universities, in private companies and eventually in state research institutes. In turn, large industrial firms, such as General Electric, created quality control and research laboratories; in the USA, AT & T and Dupont pioneered industrial research laboratories during the later decades of the last century.

This basic model was deployed differently in different socio-political contexts in the latter part of the 19th century; there were two broad approaches. The first approach was the opening of new markets and territories for investment, via

colonialism, while the second approach concerned itself with more intensive exploitation of labour within industry. Richer nations such as Britain adopted the first approach and in doing so opened up a great storehouse of material for investigation and overcame many technical challenges in conquering inhospitable environments. America on the other hand concentrated on the second strategy in the form of mechanisation of industry.[26] The adoption of this strategy originated largely as a response to a scarcity of skilled labour. It became necessary to find methods for substituting non-skilled operators for craftsmen and of compensating for the lack of skills; this was achieved through the introduction of machines and mechanised production methods. As a consequence America gained a very significant lead in mass-production methods; in turn, this produced a great expansion in consumer durables.

By the end of the 19th century, the systematic development of research in chemistry and other scientific disciplines had produced a body of knowledge and investigative technique which predicted progress in three areas of application, developing new materials and new ways of preparing old materials, utilizing new sources of energy and power and introducing mechanisation and division of labour. Developments in each of these areas will be described in turn.

The two most important advances in the chemical industry were the Solvay method of alkali manufacture and the synthesis of organic compounds. In 1863 Ernest Solvay founded, with outside assistance, the firm that bears his name; within a decade he had perfected the process which replaced the more costly and environmentally damaging Leblanc process which had hitherto

dominated alkali production in Britain.[27] The Solvay method was introduced into France and England in 1874 and into the USA in the early 1880s.

The theoretical and experimental work which underlay the development of the organic chemical industry was largely German and British. The critical landmarks in this development included Faraday's isolation of benzene (1825), Wohler's discovery of the isomerism of organic compounds and his synthesis of the first organic material synthesised, urea (1829), the fractional distillation and analysis of coal-tar by Hofmann (1849), and Kekule's theoretical elucidation of the benzene molecule (1863).[28]

The demand for new and more efficient sources of energy and power provided a further incentive for technological innovation. The steam turbine and generator developed by Charles H Parsons in 1884 made possible the development of an efficient, large-scale electrical power industry;[29] the development of the internal combustion engine using fossil fuels heralded a new era for the transport industry.[30]

At the start of the 19th century, electricity was a scientific curiosity mainly confined to the laboratory. As a result of intense and widespread investigation it became a commercially useful form of energy in turn in communication, in metallurgy and in illumination. With the invention of the telegraph in Britain by Cooke and Wheatstone around 1873, the telephone by Alexander Graham Bell in 1876 and the wireless transmitter by Marconi in 1895 electricity had been successfully employed in developing electronic communications. It was applied in electrochemistry, in metallurgy

and in electroplating, following on the work of Faraday and of John Wright in Birmingham in 1840; its application to illumination centred on the crucial invention of the incandescent filament lamp by Swan (1860), perfected by Edison twenty years later. Since it proved so essential to the home and to industry, demand grew rapidly and created the need for a centralised system of power generation and distribution.

These major applications of electricity were made possible by various theoretical advances and practical innovations throughout the century; among these were Volta's chemical battery of 1800, Oersted's discovery of electromagnetism in 1820, Ohm's Law in 1827, Faraday's Laws of electromagnetic induction in 1831 and th development of alternators and transformers in the 1880s.[31] The availability of electrical power provided the impetus for other uses and applications most notably in transport where Siemens demonstrated the first electric railway at the Berlin Industrial Exposition in 1879. Among other applications aluminium manufacture (1886), sodium, sodium cyanide and caustic soda processes (1886 and 1878), electro-metallurgy and the electric furnace (1878) and electric motors constituted major developments. Perhaps the most striking achievements occurred in the German electrical manufacturing industry where by 1913, German exports were the largest in the world, more than two and one half times that of Britain's total and three times that of America.[32]

The turning point which hastened and marked the decline of the old international economy for Britain was 1914 when it returned to the policy of trade protectionism and began to impose import duties. At the same time the economies of central and eastern Europe were

fragmented by the dissolution of the multi-national empires. Britain found herself in the position of importing from Germany glass for range-finders, dyes for uniforms, magnetos for transport, tungsten for steel, zinc for smelting and was even paying royalties to Krupps for shell fuses.[33] The World War thus provided the British Government with the spur to act. Committed to war against a state which supplied the bulk of the world's optical equipment, drugs, magnetos, dyestuffs and all the acetone essential in the manufacture of explosives, the Government set up a Committee under the chairmanship of Lord Haldane, the distinguished scientist and politician, to 'advise the Government on best obtaining for British industry chemicals, colours and dyestuffs'; this committee included amongst its members, ironically enough, W H Perkin himself, whose involvement provided an object lesson in the previous failure of British technology. Concurrently, the Board of Education was formulating its own plan for the reorganisation of British university science. A special committee of the Privy Council was set up and empowered to direct Treasury funds towards (i) the development of research, (ii) the support of specific proposals and individual research projects, (iii) the setting up and development of special institutions or departments for the study of particular industrial and technological problems and (iv) funding for research studentships and fellowships. It was allocated £25,000 to fund its first year of operation and £40,000 for the second year. In carrying out its work this Privy Council Committee was backed by an advisory council of scientists, the Scientific Advisory Council, appointments to which were made on the advice of the President of the Royal Society.

These rapid developments resulted in greater demands by the scientists and more political leverage accompanying their work. No more dramatic illustration of the political pay-off from such demands could perhaps be cited than that achieved by Dr Chaim Weizmann, who obtained the Balfour Declaration of 1917, by which the British government agreed to tha establishment of a Jewish national home in Palestine. This represented a reward for achievements in providing a new chemical synthetic method for manufacturing explosives which helped the British industry towards trade independence from the Germans.[34] In addition, the Royal Society was participating in the setting up of a voluntary Institute of Industry and Science to sponsor research and was pressing for the creation of an independent Ministry of Industry.

By 1916 the point, indeed, had been made, largely under the influence of Lord Haldane, and the Committee was reconstituted as a separate department, the Department of Scientific and Industrial Research (DSIR); this body was to form the backbone of support for science for virtually half a century. As a department of state, DSIR now had its own parliamentary vote, and was, at least nominally, responsible to Parliament by way of whichever Minister held the post of Lord President of the Council.[35] In passing, it is worth noting that two other similar bodies of significance were set up around the same time, the Medical Research Council in 1920 and the Agricultural Research Council in 1931.

The major tasks of the new DSIR were, inevitably, industrial. It continued to provide a small but increasing number of research studentships for graduates going on to take higher degrees; in 1917 there were only twenty-four of these and twelve post-doctoral

researchers were also supported. More and more, in these early years, the DSIR became concerned with promoting technological change in industry through the setting up and funding of trade research associations which developed with varying degrees of success.[36]

The DSIR became also the chosen agent for expansion of government-sponsored research and for attempts to coordinate war and civil research efforts. An increasing number of DSIR research stations were set up also, starting with the Fire Research Board (1917), the Food Investigation Board, the Industrial Fatigue Board and the Tin and Tungsten Board (1919). Meanwhile, the National Physical Laboratory, which had been run since its inception under the supervision of the Royal Society, was handed over in 1918 to DSIR, and the Geological Survey was taken over from the Board of Education in 1919. By the mid 1920s, the Department had grown more ambitious; it began extending old laboratories, such as the Low Temperature Research Station at Cambridge, and building entirely new ones, like the Torry Research Station, concerned with fisheries, at Aberdeen.

Many of the *ad-hoc* pre-1914 institutions were gathered under one administrative roof, and the DSIR's annual budget continued to rise; in 1939, on the eve of the Second World War, it stood at £930,000, three times what it had been in 1919; at the same time the permanent staff had risen to around 2,000, compared with 900 (mainly at the National Physical Laboratory) in 1920. However, the DSIR had neglected to provide for adequate financing for university research. Only eighty-one student research grants were awarded in 1938-9 for the whole of Britain whereas there had been twenty-four in 1917 and fifty-six in 1920; this produced the situation whereby

entry into university research, or even the gaining of a doctorate before entry into industry was still almost the exclusive privilege of those with private income.[37]

Britain's decline in industrial performance in the 19th century is thus characterised by the inertia of industry clinging to old techniques and technologies, by the defence of outmoded but long-established working practices by craft unions, by the slow development of the necessary educational supports to serve the needs of an advanced industrial economy, by the lack of interaction between the Government and the owners of industry, by the lack of investment interest by the financial institutions in industrial development. This lethargy contrasted sharply with the energy and innovation of other emerging industrial states, particularly Germany and USA, where it was accepted that the state should pursue an active industrial policy, promoting structural changes, ensuring supplies of skilled manpower and developing trading strategies. The story of the success of the synthetic dye industry in Germany and the synthetic chemical industry which evolved from it,served as an important lesson to Britain; that to maintain technological progress in the conditions that were maturing at the end of the nineteenth century, industry must utilize not only science but also must employ scientifically qualified personnel to assist in its direction; in addition the educational system to produce the scientists and engineers must be set up at least a generation in advance. The Empire, of which Ireland was a part, played a crucial role in sustaining the British economy during this period of industrialisation and transformation and served to soften the perturbations caused to the social and economic fabric by the upheavals of the early 20th century.[38]

CHAPTER 2

THE IRISH FREE STATE 1922 - 1940

The Irish Free State entered the twentieth century burdened with a predominantly agriculture-based economy, confined almost entirely to primary agricultural produce. In the international marketplace the country was severely disadvantaged by virtue of the fact that the new state remained a part of an economic complex of which Britain was the dominant partner. Over the next two decades, a number of key and novel initiatives took place, which were, not only central to economic development, but also contributed significantly to a growth in awareness of the role which science and technology could play in the process of industrialisation. In this chapter an examination of the functions and impact of these initiatives on socio-economic development will be undertaken.

From the foundation of the State, (1922), it was realised that real economic independence required the development and enhancement of the industrial infrastructure of the country. This task was a major undertaking particularly because of the dominance of Britain in the trading relationships which had evolved between the two countries. This dominance, which had been asserted as far back as the seventeenth and eighteenth centuries with the suppression of Irish industrial activity, continued through the enforcement of a free trade policy towards industrially advanced Britain in the nineteenth and the early part of the twentieth century. Secondly, the situation was exacerbated by the exclusion from the Irish Free State of the only highly developed industrial area in the island, i.e. Northern Ireland.

The impact of the dramatic economic expansion experienced by Great Britain during the first half of the nineteenth century has already been reviewed. By contrast, Ireland remained a predominantly rural country, with few cities, or industries and where a large majority of the population depended on farming for its livelihood. The most important industrialised region, was located in the north-eastern part of the country where the linen and ship-building industries grew and expanded and stimulated the growth of other enterprises in the Lagan Valley. Spinning and weaving machinery was manufactured and exported all over the world while shirt and rope-making also became important. By 1900 the population of Belfast was over 350,000 while that of Dublin at the same period was 393,000.[1] It is highly possible that the industrial and commercial prosperity of Belfast inspired a political self-assurance which subsequently influenced the Unionist constitutional struggle from 1912 onwards.

This general economic trend continued over the next two decades with the result that, on the establishment of the Irish Free State in 1922, the country was still predominantly a rural country with little industrial development and economically dependent on agriculture. Indeed, the future development of the economy depended on the ability of agriculture to diversify and to expand production. It is not surprising therefore to find the Cosgrave Government giving priority to the improvement of agriculture production for export, to the introduction of tariff protection for the little local industry existing, to stabilizing the public finances and to the reduction of taxation.[2]

Under the direction of P Hogan, the Minister for Agriculture, agricultural activity experienced a revival in terms of both production and marketing. The volume of total exports rose between 1926 and 1929 by 25%; by 1929 they had a value of £47 million, a figure which was not reached again until 1948.[3] This improvement however was short lived in the face of the great worldwide depression of the 1930's and the consequent protective duties imposed by the British Government on agricultural products entering the United Kingdom. The effects of this 'tariff war', were particularly severe on Ireland; the basic issues were not resolved until the Anglo-Irish Trade Agreement of 1938. During this same period, 1923-1932, the Cosgrave Government had been involved in encouraging the growth of manufacturing, industry and while some expansion did take place, the overall position, shown below in Table 3, could hardly be called dramatic.

Table 3 : Some indicators and parameters of industrial production and for transportable goods industries for 1926, 1931

YEAR	GROSS OUTPUT £million	COST OF MATERIALS £million	NET OUTPUT £million	SALARIES & WAGES £million	AVERAGE NUMBER EMPLOYED £million
			For all industries		
1926	54.477	36.399	23.078	13.671	102.515
1931	54.884	29.282	25.602	14.041	110.588
			For transportable goods industries		
1926	49.360	32.953	16.407	7.865	57.768
1931	44.125	25.907	18.218	8.129	62.608

Source : *Census of Industrial Production* for years stated.

As can be seen from these figures, the net output of industries producing transportable goods was valued at £16,407,000 in 1926 and £18,218,000 in 1931, hardly indicative of major growth in industrial production. Another feature of Irish industry at this time was the emphasis on production for the home market. Such production accounted for about eighty five percent of all the labour employed in industrial concerns.[4]

Indeed, the majority of Irish commercial and industrial activity was practically confined to small family firms, except for a small number of large-scale enterprises, brewing, distilling and biscuit manufacture; the scale of operation was small and limited to preserving existing markets. This low level of industrial development, coupled with depressed agricultural prices and high unemployment, forced the Government in 1931 into imposing or endorsing wage cuts, and reducing the level of public expenditure.

Such measures were hardly designed to endear the Government to the electorate and it was, therefore, not surprising to see a change of Government following the election in 1932. Fianna Fáil won seventy two seats, five short of an absolute majority, but sufficient to put De Valera and his Fianna Fáil party in power. De Valera and his Government immediately introduced more extensive tariffs and announced that the Government would not pay to Britain the land annuities accruing under the Irish Land Acts. The argument was that the agreements of 1923 and 1926, relating to these annuities, were invalid as they had never been formally ratified by the Dáil.[5] Attempts to settle this dispute were unsuccessful and the British Government imposed duties on Irish agricultural exports to the United Kingdom.

The 'tariff war' between the Irish Free State and Britain had serious economic consequences for the Irish Free State. The value of Irish agricultural exports, the greater portion of which went to Britain, fell from £35.8 million in 1929 to £13.9 million in 1935, while total exports to Britain fell from £43.5 million in 1929 to £18.0 million in 1935. Indeed, at the end of 1937, it was calculated that 1,947 articles were subject to restriction or control.[6]

The trend towards self-sufficiency, a policy to which De Valera and his Government were deeply committed even before coming to power, was thus reinforced by the effects of the 'tariff-war'. During this period 1932-38, the policy of economic self-sufficiency was vigourously pursued by De Valera and his Government in an attempt to wean the country away from dependence on foreign manufacturers for its daily needs; this was attempted by encouraging home production of commodities and goods hitherto imported. When the Government announced its policy of industrialisation for the country, a number of Saorstát manufacturers met and decided to establish an organisation 'which would accomplish in the industrial field what other associations had achieved in the political and other aspects of the national economy'. This organisation, called the Federation of Saorstát Industries, was formally set up in November 1932; a similar organisation, the National Agricultural and Industrial Development Association, had been set up in 1902, to promote the greater use of Irish-made goods. Following consultation, the N.A.I.D.A. amalgamated with the Federation in 1937; the organisation was renamed the Federation of Irish Manufacturers.[7]

The guiding principle of the Federation was vested in the philosophy that all control and ownership of industry must be in national hands, under national control and free from any vestige of external domination. Accordingly, the Federation strongly opposed all external or foreign penetration of Irish industrial development whether financial, managerial, open or covert.

The Federation, sponsored the Control of Manufactures Act, 1934 in an effort to secure and consolidate the position of the national manufacturer in industrial development; in turn, the Federation was *de facto* recognised by the Government as the authoritative voice of Irish industry. This position was further consolidated by the Minister for Industry and Commerce when he appointed the Council of the Federation to act as an advisory body to his Department and the views of the Federation were largely instrumental in shaping the provisions of the above Act. Typically, the Act required a new manufacturing company, before beginning operations, to have one-half of the issued capital and at least two-thirds of the capital with voting rights in the beneficial ownership of persons born in Ireland, or qualified by residence. Another provision stated that a majority of the directors, other than whole-time managing directors, should be Irish nationals.

Despite this attempt to keep Irish production in Irish hands, there was a sizeable minority of foreign establishments, mainly British subsidiaries, set up behind the tariff barriers to preserve their sales in Ireland. This occurred due to a provision in the 1934 Act which allowed the issue of new manufacturing licences to external firms and their exemption from compliance with the general

provisions of the Act. In all, some 96 licences were granted up to 1939. This development was not surprising since the protectionist policies sought to discourage imports of consumer goods in favour of importing the raw materials and processing them within the country. However, little thought had been given to the development of industries using indigenous agricultural and industrial raw materials; such a scenario might have led to more meaningful initiatives to encourage greater industrialisation for exploiting export markets as well as home outlets.

In the industrial sector both the volume and value of production, as well as the numbers employed, increased between 1931 and 1938, as indicated in Table 4:

Table 4 : Some indicators and parameters of industrial production and for transportable goods industries for 1931, 1936, 1938.

YEAR	GROSS OUTPUT £million	COST OF MATERIALS £million	NET OUTPUT £million	SALARIES & WAGES £million	AVERAGE NUMBER EMPLOYED £million
			For all industries		
1931	54.884	29.282	25.602	14.041	110.588
1936	81.405	47.467	33.938	18.723	154.056
1938	89.996	53.964	36.032	21.429	166.000
			For transportable goods industries		
1931	44.125	25.907	18.218	8.129	62.608
1936	68.084	43.151	24.897	11.879	100.575
1938	73.098	47.825	25.273	13.010	104.363

Source : *Census of Industrial Production* for years stated.

Thus, while the value of net industrial output and industrial employment increased, a price was paid for this achievement. The amounts earned by exports from the few large existing export industries, brewing, distilling and biscuit manufacture, all fell sharply during the 1930's as a result of the protective tariffs imposed. Indeed, the total of non-agricultural exports fell from £6.4 million in 1932 to £4.4 million in 1938. The reasons for this were that the products were costly, wages relatively high and the home market so restricted as to inhibit the development of businesses large enough to trade successfully with the external markets.[9] Of particular interest here is the chemical industry, producing chemicals, drugs, oils, paints and varnishes which had a total output valued at £628,752 in 1931, £1,034,670 in 1935 and £1,335,940 in 1936.[10] The development of small home-based industries was further inhibited by the lack of most kinds of cheap fuel or raw materials, the importation of which meant a larger import bill; imports of machinery and semi-manufactured goods for further processing cost £27.6 million in 1932 rising to £30.0 million in 1938.[11]

A further factor to be considered was the scourge of emigration which was proving to be an enemy of economic change. It is likely that emigration, more than any other single factor, was responsible for the industrial immobility of Ireland in the opening decades of the new state.[12]. The Irish Free State and Britain tended to form one labour market with the drift of labour towards British cities where there existed better salaries and wider opportunities for employment. An additional factor arose from the country's almost total lack of natural resources and her proximity and ready access

to large industrial and urban complexes in Great Britain. These factors combined to exacerabate the difficulties of establishing manufacturing industry on any significant scale and of retaining the small pool of skilled labour required to assist in the development of industry.

From 1921 up to 1940 the rate of economic growth was only 1% *per annum* yet the country's external assets remained high in relation to the gross national product throughout these years. The greater portion of this money was invested in Great Britain and, apart from one small loan in the 1920's and some minor assistance in 1945 under Marshall Aid, Ireland never borrowed abroad, In short, neither capital nor credit was utilized for development to any large extent before 1959.

From the foundation of the State, a consistently increasing proportion of State revenue had been devoted to all types of social services with a further major proportion of revenue devoted to State capital outlay. In 1929-30, expenditure on social, health and welfare accounted for 16% of State expenditure, by 1949-50 this had risen to 38.2%. The corresponding figures for education were 20% and 10.4%.[13] It is therefore apparent that in these years the bulk of national investment was going towards the replacement or extension of the existing stock of houses, roads, schools and hospitals rather than into productive sectors of the economy. It is also noticeable that investment in education, particularly higher education for the provision of an educated and technically skilled workforce upon which the development of the industrial sector would depend, was low in the priorities established by the Government.

This position is highlighted by consideration of the percentage distribution of public expenditure on the different sectors of education, shown in Table 5 below:

Table 5 : Percentage distribution of public expenditure on education by sector for selected years 1926-'87

Year	Primary	Secondary	Vocational	University	Other
1926	80	5	6	4	5
1946	68	11	11	3.7	6
1961	58	13	12	7	10
1975	45	15	15	10	14
1987	38	45		10	7

Source: Ó Buachalla, S., 'The University and Irish Education Policy' in *The Future of University College Cork*, Proceedings of Symposium at UCC, 22.4.1989.

This attitude to higher education is highlighted by the table following which illustrates the lack of attention given by the Government to issues concerned with funding, higher education, educational opportunity and new policy directions for education in the early decades of the states existence.

Table 6: Dáil questions asked on education classified in issue for the periods 1922/32, 1932/48 and 1960/69

		1922/32		1932/48		1960/69	
	CATEGORIES	N	%	N	%	N	%
1.	Access and school attendance	17	7.8	62	16.1	-	-
2.	Irish Language	38	17.4	102	26.5	20	2.3
3.	Teacher working conditions	54	25.0	105	27.2	59	7.0
4.	Curriculum and examinations	13	6.0	28	7.2	100	11.9
5.	Teacher training prep. colleges	20	9.2	22	5.7	19	2.2
6.	Vocational education	20	9.2	28	7.2	-	-
7.	School Buildings	56	25.7	38	9.9	453	54.0
8.	Funding	-	-	-	-	27	3.2
9.	Special Education	-	-	-	-	28	3.3
10.	Higher Education	-	-	-	-	101	12.1
11.	Educational Opportunity	-	-	-	-	84	10.0
12.	New Policies	-	-	-	-	110	12.3
	Totals:	218	100%	385	100%	838	100%

Source: Ó Buachalla,S., *Education Policy in Twentieth Century Ireland* (Dublin 1988), table 13.6, 386.

It should be noted that, at this time, the external environment for economic development was unfortunately less than supportive. International trade was contracting, prices were falling and the primary producers, in the agricultural sector were worst hit. Even so, had the environment been adequate, De Valera's economic strategies were unlikely to be productive; his policies were founded on political rather than economic considerations, based on high protection for local industry and agricultural products and dicated by a desire for self-sufficiency. De Valera's vision of Ireland was of a 'home of a people who valued material wealth only

as a basis of a right living, of a people who were satisfied with a frugal comfort and devoted their leisure to the things of the spirit'. De Valera's monastic vision of a Celtic homeland was not likely to facilitate nor to encourage industrial development of the quality likely to have a major impact on the economy generally nor indeed to reduce emigration. A review of the trade returns for the years 1936 and 1937 reflect clearly the slow growth in the total value of exports and the dependence of the country on imports of raw materials and manufactured goods.[14]

Table 7: The trade returns including the value of exports and imports for various classes of goods for 1936, 1937

ARTICLE	EXPORTS		IMPORTS	
	Total Value		Total Value	
	1936	1937	1936	1937
Class 1: Live Animals	£ 8,952,540	£ 9,804,507	£ 645,084	£ 805,712
Class II: Food,Drink & Tobacco	£10,493,137	£ 9,520,928	£10,617,091	£12,209,005
Class III: Other Raw Materials & Manufactured Goods	£ 2,308,942	£ 2,664,912	£28,297,135	£30,173,377
Class IV; Parcel Post	£ 240,563	£ 250,945	£ 356,342	£ 938,269
Totals:	£21,995,182	£22,241,292	£39,915,652	£44,126,363

Source : *Irish Industrial Year Book* for 1936, 1937, 1938

It was evident therefore, that any real advance in economic activity and expansion of export markets would depend on agriculture and the implementation of proposed new agricultural policies directed to

> making the country self-sufficient in respect of all agricultural commodities for the production of which the soil and climate are suitable, or for which suitable substitutes can be grown in the country and producing for export a surplus of such commodities over and above home requirements, equivalent to what the export trade can absorb at an economic price.[15]

But the 1930's was a period of acute economic difficulty, not only in the Irish Free State, but also throughout the world. The situation was further complicated by the 'tariff-war' with Britain referred to earlier. Between 1929 and 1934, Irish exports, mainly agricultural, dropped from £47.0 million to £18.0 million, a fall of 27% by volume.[16]

It is obvious that drastic action was called for to prevent the industry from total collapse. Various devices were used such as a guaranteed price for wheat, import controls on flour and bacon, export subsidies on butter, bacon and sheep offal, compulsory orders to use home-produced grain in animal feed stuffs, bounties on cattle exports, the development of the sugar beet industry and the halving of land-annuity charges.[17]

Despite these varied state interventions, requiring no less than forty Acts dealing with agriculture, the overall volume and structure of Irish agriculture showed remarkably little change during this period of depression, except for wheat growing where acreage increased from just under 21,000 acres in 1931 to 255,000 acres in 1936.[18] It should, however, be noted that the increase in the acreage under wheat, which represented in the main a switch from other crops, was encouraged by the availability of a fixed minimum price for wheat.[19]

The action taken by the Government during the period 1932-36, to establish alternative exports markets for Irish agricultural products and to promote the development of native industries by the application of protective tariffs, was unfortunately not very successful. Indeed, this consequence might have been predicted for the economic policies of De Valera and his Government had been motivated by political and nationalistic philosophies rather than economic realities.

First of all the idea of national self-sufficiency with the corollary of protection had been accepted as the ultimate expression of nationalism and independence from Britain.[20]. This policy of tariff protection had the effect of excluding foreign products from the Irish market, thereby encouraging domestic industries to produce import substitutes. Since the Irish home market was small, this inevitably meant that only small-scale industries would develop. Since small-scale industries tend to operate with relatively high production costs, they were unlikely, to be competitive on an international scale. A further effect of the extended period of tariff protection was the prolonging of the life of some inefficient industries, and the feather bedding of other industries which might have been able to respond to and compete favourably with international competitors.[21] Secondly, the 'tariff-war' with Britain forced Ireland to seek new export markets and to develop new indigenous manufacturing industries in an internationally depressed market place, a formula hardly conducive to success. Finally, there was a reluctance to recognise the reality of the situation which was that Ireland had a long established dependence on Britain for its markets and supplies, and

could never hope to be self-sufficient.

A further consequence of the economic difficulties being experienced was caused by the fact that, although Irish incomes were increasing slowly during this period, the gap between Irish incomes and British incomes was widening. For example, in 1931 the average income per head in Ireland was 61% of that in Britain, by 1939 the corresponding figure was 49%. It was hardly surprising to find that emigration once again started to increase.[22]

One significant and unique aspect of economic activity, destined to have a great effect upon the social and economic life of the country, was initiated in the 1920s. In 1927, the Government introduced the Agricultural Credit Act, following the failure, in 1926, of the Industrial Trust Company of Ireland in which the Government had bought shares. This Act provided for the setting up of the Agricultural Credit Corporation, an ordinary limited company to make capital available to farmers on a long-term basis. Although shares were offered to the public, the state eventually became the dominant partner, a fact later recognised when the company was reorganised in 1947 into a wholly owned state enterprise. Coupled with this was a scheme to provide electricity from water power, the Shannon Hydro-Electric scheme. This scheme, which was first mooted in December 1923, culminated in the passing of the Electricity Supply Act of 1927 which set up the Electricity Supply Board.

These early initiatives shared the distinction of being first visible evidence of a trend that was to become more and more

important as time went on. These two organisations were the first of a line of similar semi-state bodies whereby the state was increasingly drawn to intervene in various sectors of the economy into which private capital had been unable or unwilling to enter.[23]

This pattern of state intervention to stimulate economic development was continued by successive Governments; between 1927 and 1939 there were 19 such enterprises established.[24] These included:

(i) the setting up in 1933 of the Irish Sugar Company (Comhlucht Siúcre Éireann Teo), and the establishment of four factories at Carlow, Mallow, Thurles and Tuam to process sugar beet,

(ii) the establishment of the Turf Development Board in 1935 to exploit and develop turf resources; it should perhaps be noted that there had been various other schemes and enquiries relating to use of the bogs in Ireland prior to this initiative,[25]

(iii) the setting up in 1933 of the Industrial Credit Company to provide finance and advice to industrialists,

(iv) the establishment in 1938 of Ceimicí Teoranta, following the enactment of the 1934 Industrial Alcohol Act, to make industrial alcohol and related products from agricultural surpluses and by-products,

(v) the Dairy Disposal Company Limited in 1928,

(vi) Aer Rianta (for the management of Dublin Airport) in 1936,

(vii) Aer Lingus (European Air Services) in 1936,

(viii) Milk Boards for Cork and Dublin,

(ix) The Irish Life Assurance Company.

Non-trading enterprises of the same period included Bord Fáilte Éireann (for tourism), the Hospitals Trust Board and the Medical Research Council. During the war years the most important of the economic bodies set up were Irish Shipping Ltd, the Central Bank of Ireland, the Pigs and Bacon Commission; this trend continued after the war and amongst the most important then established were Córas Iompair Éireann (CIE) for public transport and Bord na Móna for turf development in 1946.

It is worth recalling that such intervention by central Government had already been attempted in the 19th century, when, in 1891, Arthur Balfour established the Congested Districts Board to stimulate the transport, fishing, agricultural and similar industries in the poorest regions. This innovative concept of a regional dimension to economic policy was noticeably absent from the main economic policies pursued from the 1920s to the early 1950s. Regionalism came to the fore again with the passing of the Underdeveloped Areas Act of 1952. Since then it has remained an important aspect of state regional policy and, more recently of EEC policy.[26]. But it was only after independence that the state entered without hesitation into an area more conventionally, the prerogative of private economic investment. It did so only because of the necessity to utilize native, rather than imported products and resources, to provide new employment opportunities, and to move towards the goal of national self-sufficiency.

The achievement of political independence in 1922 removed the source of many of the previous obstacles to industrialisation; the Government of the Irish Free State was free to assist the process of industrialisation. This was achieved by investing in the social and economic infrastructure of the country, in particular through the establishment of the 'state-sponsored bodies' already mentioned. As indicated these bodies included large production and service industries, finance and credit organisations, trading, marketing and promotional organisations, regulatory bodies for selected industries or activities, research bodies and bodies providing social services. Priority was given also to the improvement of agricultural production for export, to a policy of tariff protection to protect struggling indigenous industries, to the re-establishment of the public finances and the reduction of taxation.

The prolonged period of economic difficulties with Great Britain during the 1930s did little to assist the process of social and economic development; the economic reality of the trading relationships with Britain served to illustrate that the goal of self-sufficiency was very difficult to achieve. The imposition of stringent import restrictions by Great Britain at the beginning of World War II posed even more serious problems for the economy. Of necessity, these events produced a policy of import substitution, utilization of indigenous raw materials and strong policy support for industries catering for the home market.

The main consequences of the large scale emigration which had occurred in the 19th and early 20th century, had been to deprive

the country of its most productive elements. Among those who emigrated there were undoubtedly, many potential entrepreneurs and people with professional and other training, people who could have contributed positively to economic development; indeed many emigrants did make major contributions to their adopted homelands in various fields. As already stated, the establishment of the state-sponsored bodies in the early years of the state represented a major investment by the Government to stimulate not only economic activity but also to vitalize the social environment. These initiatives represented also a *de facto* growing recognition of the importance of utilizing science and technology to stimulate economic and social development for the success of the ventures depended on the successful application of the scientific and technological principles and processes being utilized. These early successes however did little to convince the Government of the need to develop an overall co-ordinated policy on science and technology. Such a policy, as a basic contributory factor in an economic and social megapolicy, would address issues such as sectoral manpower requirements and would lead inevitably to the development and expansion of higher education.

The slow official response on the importance which science and technology could play in social and economic development probably derived from the educational profile of early Government personnel. Of the sixty five ministers who held office between 1922 and 1965, journalists, teachers, lawyers were more strongly represented than engineers and scientists who accounted for only three ministerial posts in the same period.[27] The Governments were thus deficient in

the type of people, engineers, scientists, industrialists, who could have contributed to the more rapid evolution and recognition of the role which science and technology plays in economic and social development.

CHAPTER 3

SCIENCE & TECHNOLOGY IN THE IRISH FREE STATE 1922-1940

The establishment of the state-sponsored bodies in the early stages of economic development represented not only a unique and novel initiative but also a major investment by the Government in an effort to stimulate economic development; it marked also a recognition of the relevance of science and technology in assisting industrial and economic development. In this chapter it is proposed to examine and evaluate the extent of the provision for science and technology-related activities in the Irish Free State up to 1940. In addition it is proposed to examine critically some important landmarks in the development of science and technology as elements in industrial and economic policy. In particular the origins of the Industrial Research Council, the IRC, will be examined and its contribution to industrial-linked research will be evaluated.

The plans being made by the Government, in the twenties, for industrial development and for the establishment of state-sponsored bodies prompted the Government to review the provision of technical and industrial education. This task was given to a specially appointed Commission, chaired by John Ingram, which was asked 'to enquire into and advise upon the system of technical education in Saorstát Éireann in relation to the requirements of Trade and Industry'.[1] A year later, on 5th October 1926, the Commission presented its report.

The Commission found:

> that the work of the schools in the more important districts bear too little relation to the local requirements of trade and industry and that a general change of outlook is required.[2]

The Commission examined also the existing facilities for technical education and concluded 'that radical changes are necessary to meet the existing and probable requirements of traditional industry'. An obvious conclusion in view of the fact that science and handicraft, seen by the Commission as the mainstay of technical education, were taken by only 18% and 5% respectively of enrolled students.

Table 8: Number of students and range of courses in established technical schools for the year 1924

Subject Group	Number of Students	Percentage
Introductory	1,757	8%
Commerce & Languages	8,811	40%
Science (pure and applied)	3,757	18%
Handicraft	1,009	5%
Domestic economy	5,354	24%
Art	916	4%
Other Subjects	204	1%
Total	21,808	100%

Source : Commission on Technical Education Report,(Dublin,1928),18

The Commission made some ninety recommendations which included:

(i) the introduction of a school-leaving certificate for all

sixth standard primary school pupils in order to improve basic standards of elementary education, introduced in 1929 on a voluntary basis; it became compulsory in 1943.

(ii) the inclusion of science, drawing, manual instruction and domestic economy as compulsory subjects in secondary schools.

(iii) the establishment of a system of practical continuation schools and classes for young people between 14 and 16 years of age; the existing technical schools were seen to cater for the 16+ age group.

(iv) the statutory regulation of apprenticeships.

(v) the development of higher technological work; this came about as a consequence of the establishing of those new state-sponsored industrial enterprises which were technology based, e.g. the Shannon Hydro-Electric Scheme for the generation and distribution of electric power and the manufacture of industrial alcohol and sugar.

(vi) the introduction of new schemes for the intensive training of technical teachers.[3]

The main recommendations of the Commission on Technical Education formed the basis of the Vocational Education Act of 1930. This act remodelled the system of technical education which had existed since the passing of the Agricultural and Technical Instruction (Ireland) Act of 1899 provided for the setting up of a system of continuation education in post-primary schools known as vocational schools. Although an examination system for the vocational schools was eventually introduced in June 1947, the fact that access to the state examinations, Intermediate and Leaving Certificates, was

denied to students in the vocational schools until 1967 militated strongly against their development.[4] Other debilitating factors were their size (generally small) and distribution (linked to demand for evening classes), the high pupil drop-out rate and the lack of a comprehensive plan for technical teacher training.[5] It was not until the 1960s, following the publication of the first programme for economic expansion in 1958, that the area of vocational and technical education once again was brought to the forefront of education policy formulation.[6]

In the year 1924, there were 278 secondary schools; these were generally privately-run, denominational, fee-paying and free to conduct their own affairs, within the Departmental rules. The state established no ordinary secondary schools, the initiative for which was left purely in voluntary hands. Indeed, it was not until 1964 that the first state grant was given for capital expenditure on secondary schools; this state of affairs was largely due to opposition from the churches in Ireland to state encroachment on secondary school management.[7]

Secondary schooling was thus seen as very much a middle class concern; it appeared to be the prerogative of the professional and merchant classes and of established tenant farmers. For four decades following independence, the education system operated as an elitist system. Only a fraction of school-going population experienced post primary education, with higher education being the preserve of a wealthy minority. This fact was made starkly evident by De Valera in the estimate speech of June 1940 when he stated that 'for ninety percent of the people the primary school is their only educational

experience.'[8] The low participation and completion rates at second level coupled with the type of school attended and other socio-economic factors meant a very low access rate to higher education. In 1928/29, the total enrolment of full-time students in the university sector was 3,532[9]; the enrolments for selected later years are given in the table below.

Table 9: The Numbers of full-time students in each University college and separately for science and engineering for the years 1938/39 and 1948/49

University College	Year 1938/39	Year 1948/49
UCD		
Science	193(5)	256(16)
Engineering	214(*)	274(*)
All faculties	1,998	2,862
UCC		
Science	48(3)	151(14)
Engineering	88(*)	80(*)
All faculties	853	936
UCG		
Science	35(3)	97(0)
Engineering	113(*)	114(*)
All faculties	584	752
TCD		
Science	68(12)	206(24)
Engineering	63(*)	115(*)
All faculties	1,543	2,236

Note : (i) Figures in parenthesis give numbers of full-time and part-time postgraduate students
(ii) Postgraduate degree students in engineering were returned only in occasional years with never more than two per year, this in indicated by (*).

Source: Commission on Higher Education 1960-67, (Dublin 1967),Vol 1

These figures starkly reflected not only the low participation rates in higher education overall, but more importantly the small numbers of students reading for science and engineering degrees. The figures for students studying for higher degrees (shown in

parenthesis) are equally revealing since they are indicative of the low level of postgraduate research in the University sector.

This sector of education had developed piecemeal mainly since the middle of the nineteenth century, and largely to meet particular requirements. As the Commission commented, there was an 'absence of a positive attitude amongst institutions towards policies of co-operation and co-ordination' and in some instances 'attitudes of antagonism'. The general attitude of the Government was that 'it should not intervene in university affairs except to the limited extent indicated by the Irish Universities Act, 1908'. This state of affairs effectively led to an absence of any recognised system of planning in higher education, and the lack of formulation of policies to enhance higher education provision.[10]

Further problems were experienced by the universities in catering for a growth in numbers. In general, numbers increased without any significant increase in accommodation with the result that lecture halls, laboratories and other facilities were overcrowded. The general picture of university studies was 'one of increasing student numbers, inadequate accommodation and facilities'.[11] Despite these problems, there had been, over many decades, substantial achievements which testified to the rich scientific and technological heritage of the system, a heritage vested in and cultivated by the universities and other learned institutions and societies. This heritage was marked by some notable individual achievements by Irish scientists and engineers.

During the 19th century and the opening decades of the twentieth

century, Ireland was viewed by Britain and indeed by a considerable section of Irish society as an integral part of the United Kingdom. As such, the science history of Ireland during this period was intertwined with what went on in the rest of the U.K. The scientific institutions which existed in Ireland cannot be viewed simply as homegrown products but rather as parallel developments within the continuum of all the scientific activity occurring throughout both islands.

It was possible, therefore, to pursue a professional scientific career in Ireland through involvement in institutions such as Trinity College, Dublin (1591), the Royal Dublin Society (1731), the Royal College of Surgeons in Ireland (1784), Royal Irish Academy (1785), St Patrick's College, Maynooth (1795) which became a recognised college (1910) of the National University of Ireland (1908) with constituent University Colleges at Dublin, Cork and Galway.

In Trinity College, though little original work of note was done before 1800, there was, however, a burst of creative activity at the beginning of the nineteenth century. Those who were prominent in this revival included Brinkley in astronomy, the Lloyds and later Rowan Hamilton in mathematics and physics, Maccartney in anatomy and Graves in physiology and medicine. Other landmarks included the founding of the School of Engineering and a chair of geology in 1843 and the appointment of George Fitzgerald in 1881. Among the well-known scientific figures in Trinity College in the early decades of this century were Joly in geology and physics, Young and Werner in chemistry, Dixon in botany, Bigger in bacteriology and Bastable in economics.[12]

University College Dublin traces its origins to the foundation of the Catholic University of Ireland in 1851; the first Rector was John Henry Newman. It began its work in 1854, with faculties of Philosophy, Letters and Science. In 1855 a Medical School was opened and in 1856 chairs of natural philosophy and chemistry were founded.

The present structural position was established with the Irish Universities Act of 1908 when University College, Dublin, became a constituent college of the National University of Ireland. The University was not endowed and had neither funds nor space for suitable laboratories or research equipment, so that scientific work was largely confined to introductory classes for medical students. A new phase had begun when Hugh Ryan was appointed Professor of Chemistry in 1899 and J A McClelland Professor of Experimental Physics in 1902. Advanced teaching and research were organised with McClelland's work in this area being recognised by his election to the Royal Society in 1909. Nevertheless, demands, on staff and equipment alike, grew even more quickly than improvements could be made; many departments, particularly those covering the natural sciences, laboured under difficulties.

These difficulties were alleviated somewhat in 1926 through the absorption of the Royal College of Science by UCD. The College of Science, set up in 1867, had evolved from public lectures given under the auspices of the Royal Dublin Society. In 1900, responsibility for the College became vested in the new Department of Agriculture and Technical Instruction, in the establishment of

which Sir Horace Plunkett played a vital role; the College was provided with new and well-equipped buildings in 1911. This acquisition was thus of special value to UCD as it provided a direct association of the applied sciences with the development of agricultural techniques; such techniques were of exceptional importance to the community and to the economy.[13]

The Chancellor of the National University of Ireland from 1921 was Eamon De Valera who headed the Fianna Fail Government which came to power in 1932. The problems confronting the constituent colleges of the NUI, mentioned earlier in respect of UCD, would have been known to De Valera in his capacity as Chancellor. Regretably, his interest in the world of academe did not progress to the extent of prioritising the need for realistic investment in higher education. It is possible that the importance and necessity of providing for specific investment in science and technology related activities most likely to contribute to economic development could not be to the fore in the scientific consciousness of De Valera because of the internal economic constraints under which the Government laboured. This attitude is amply demonstrated by consideration of one of his greatest achievements, the founding of the Dublin Institute for Advanced Studies.

In introducing the Bill establishing the Institute in the Dail on 6 July 1939, De Valera, who, in addition to his role as Taoiseach, was Minister for External Affairs and Minister for Education from September 1939 - June 1940, stated that Ireland ought to be a world centre for Celtic Studies; when speaking about the proposed

School of Theoretical Studies for the Institute, he said 'there is a branch of science in which all you want is an adequate library; the brains and the men, and just paper'. He went on to state that Ireland had in the past an important place in both mathematics and theoretical physics and that the establishment of the schools would enable the country to achieve a reputation for learning similar to that enjoyed in the middle of the nineteenth century.[14]

These statements reveal vividly the nature of De Valera's understanding of the role of science and technology initiatives, particularly those activities which could assist economic development; he failed also to appreciate the absolute necessity for investment in science and technology to support and develop the industrial infrastructures required by the country; as already indicated, this may have been related to the economic climate of the period in which not only higher education but secondary education was grossly underfunded. This attitude can be substantiated further by reviewing the role and supports given to the Industrial Research Council, discussion of which follows. No doubt these attitudes were a by-product of De Valera's educational vision and of his own concept of higher education being structured along classical lines.

The Royal Dublin Society was founded in 1731 for the advancement of agriculture and other branches of industry and for the advancement of science and art. The Society's activities covered a wide range and it frequently happened that work commenced by the Society grew in importance until it was eventually taken over by the state or by a state-sponsored institution. The Geological

Survey, the National Gallery, the Royal College of Science, the National College of Art, the National Library, the National Museum, the Botanic Gardens, the Veterinary College, and the Fisheries Branch of the Department of Agriculture all developed, directly or indirectly, out of the Society's work. A striking example of such pioneer work was its Radium Institute. This was founded in 1914 through the efforts of Professor Joly, who devised a method of using capillary tubes containing radon, obtained from a stock of radium kept in solution in the Society's laboratories. This development led to the introduction of radiotherapy in Irish hospitals.

The Society's agricultural work centred originally round its three great shows, the Horse Show, the Spring Show and Industries Fair, and the Bull and Pig Show; the Horse Show was and remains an important feature in Irish economic and social life; it is both an international market for high-class horses and a social event which attracts many visitors to Dublin.[15]

The other major institution of note was the Royal Irish Academy founded in 1785. Its founders aimed to include within the scope of its activities all aspects of scholarship; this aim was supported by the Academy's long and distinguished record as an academic publisher through its Transactions (1787-1907) and later its Proceedings.

In its first few decades the Academy served mainly as a meeting-place for Irish savants, but early in the nineteenth century it began, under the influence of men like Rowan Hamilton,

the Lloyds, McCullagh and Petrie, and later Hincks, Reeves and Todd, to publish very substantial additions to knowledge, and to sponsor several undertakings valuable to scholarship. The earliest of these was the formation of a collection of Irish manuscripts, which before long became more important than all other existing local collections. This was followed by the assembly of a collection of Irish antiquities, which grew so rapidly in size and importance through the nineteenth century that it was transferred in 1890 to the National Museum. Scientific projects sponsored by the Academy included, ethnography in the Torres straits, zoology on the Rockall bank, astronomy in Canada, plant geography in Ireland, the Clare Island Survey, quaternary research in Ireland and the Dictionary of the Irish Language.[16]

As already mentioned, there have been many Irish graduates who have been conspicious for outstanding achievements in their subsequent professional activities. It is worth reviewing briefly the careers of two such graduates as their careers are illustrative of the quality of scientific and engineering expertise available to the country.

James J Drumm graduated in the School of Chemistry at UCD and proceeded to the degree of MSc in 1917. For several years afterwards he carried out research in applied chemistry. Eventually, he concentrated his research efforts on the electric traction battery and succeeded in designing an alkaline storage cell of remarkable quality and properties. In 1930, the Drumm battery was mounted in a demonstration rail coach built by the Great Southern Railway company and a series of trials were

undertaken. So successful were the results of these trials that Dáil Éireann financed the building of 'Drumm Trains'; these were used on the Dublin-Bray line in 1932 and later on the Harcourt St-Bray and the Howth lines. For his published scientific work he received the D Sc degree from the National University of Ireland (NUI) in 1931.[17] Dr Drumm was a member of the senate of the NUI from 1934; he also served as vice-president of the Federation of Irish Manufacturers.

Thomas A MacLaughlin graduated with honours in mathematical science in 1917 obtaining the degree of MSc by research the following year. He became an assistant in the Department of Physics at University College Galway to Dr A Alexander, who was both President and Professor of Experimental Physics and Mathematical Physics. In 1922 he obtained the degree BEng with first class honours and in 1923 was awarded a PhD. His research work eventually led to a period of time spent in the Siemens' Institutes at Berlin which culminated in his initiation of the Shannon Electrical Scheme; he served as Managing Director of the Scheme and at times employed up to sixty engineering and science graduates.[18]

Although many other Irish scientists and engineers have in their time made fundamental contributions to the advancement of knowledge, the contribution which they could have made to industrial development was never fully recognised or utilized to optimum advantage.[19] As a result, the co-ordination and direction of the scientific tradition, at least in the early decades of the state, had never been recognised as being of prime importance to economic development.

The realisation that science and technology had an active role to play in the economy became more generally recognised by the Government of the Irish Free State only during World War II; the fact that war had become a scientific affair had of course been recognised in Britain at the beginning of World War I.[20] The marshalling and mobilisation of scientific skills, materials, plant and machinery which occurred after 1940 was thus the first positive indication that the Government of the Irish Free State was moving slowly and tentatively towards a recognition of the need for evolving a coherent science policy for the country.

The first major suggestion that Ireland's economy would benefit from the application of science and technology had been made in the late 1890's by the Recess Committee. The formation of this Committee can be traced to an appeal by Sir Horace Plunkett, in the form of a letter to the Irish press on 27 August 1895, outlining a scheme for promoting the 'general welfare of Ireland'; prior to this, Plunkett had been since 1888 engaged in establishing a rural self-help movement centred around cooperative creameries; this resulted, in 1894, in the formation of a coordinating body, the Irish Agricultural Organisation Society. His sincerity, honesty and stature was thus apparent and he was able to persuade the unionists and the nationalists to join together in a demand for, as it emerged, a department of agriculture; it was envisaged that this new department would be responsible for the development of agriculture and of a system of technical education. This committee, which met during the Parliamentary recesses of 1895-96, consisted of Irish members of Parliament nominated by the leaders of the different sections in

the country who in turn invited others with useful knowledge and interest to join.

Under the Chairmanship of Sir Horace Plunkett, the Committee instituted an enquiry into the means by which the Government could best promote the development of Ireland's agricultural and industrial resources. Commissioners were sent on fact-finding missions to numerous European countries where they obtained invaluable information on their agricultural and industrial production methods, on the part played by the State and on the efforts of the indigenous population to promote economic development.[21]

In its Report, the Committee showed how British legislation in the past had crippled Irish industry and commerce, and had led to a diminishing population without industrial habits or technical skill. The Report indicated that this legislation forced the population to depend on agriculture and that because of periodical famines the most energetic elements of the population were driven to emigrate carrying their skills with them to foreign countries; another inhibiting factor mentioned was 'the operation in foreign countries of great systems of technical education and of State aid to agriculture and industries'.[22]

The Recess Committee recommended the setting up of a new department to deal with both agriculture and industries, and the technical instruction relating to these branches. Three years later, in 1899, this recommendation came to fruition with the passing of the Agriculture and Technical Instruction Act which provided for the

setting up of this new department on 1st April 1900. One particularly interesting development at the time was the introduction of a new programme of experimental science, drawing, manual instruction and domestic economy into the secondary schools. In addition, a scheme of 'Pioneer Lectures' was organised to illustrate the need for and use of scientific instruction in agriculture and industry, and to explain how the department could assist in supplying this need. These schemes thus represented the beginnings of a variety of educational and advisory services designed to aid agriculture and industry.

The role and importance of education in the development of agriculture and industry had of course been recognised much earlier by Sir Robert Kane (1809-1890), a distinguished pharmacist and chemist and Professor of Natural Philosophy at the Royal Dublin Society, whose writings on Ireland's industrial resources had made him one of the father figures of Irish economic nationalism. In May 1843, he delivered a set of lectures at the Royal Dublin Society based on his researches on the natural resources of Ireland and their uses in industry, which was repeated in February 1844 and subsequently expanded and published.[23] The last fifteen pages of this book contain the essence of Kane's ideas on industrial education; it ultimately led to the setting up of the College of Science and Art in Ireland in 1867. Unfortunately, despite the acclaim which greeted Kane's contribution, no national coordinated effort for applying science and technology to the development and utilization of Ireland's natural resources had been evolved by the outbreak of World War II.

Indeed little thought had been given by the Government as to how a nationally coordinated programme for science and technology might contribute to the realisation of the economic and social policies being proposed for the Irish Free State. Despite this lack of a national programme, there was at least a number of important initiatives from the 1920's onwards which contributed to the development of a national policy for science and technology.

The first initiatives were taken following the publication by the Commission of Inquiry into the Resources and Industries of Ireland, in the 1920s, of a series of Reports, covering essentially, but in greater detail, the same ground as Sir Robert Kane and the Recess Committee. These initiatives had led to the establishment of the various state-sponsored bodies already referred to, but more importantly, they represented a major investment by the Government to stimulate economic activity through the application of scientific and technological knowledge in specific areas; e.g. generation and distribution of electric power, manufacture of industrial alcohol and sugar.A later development of significance was the setting up of the Industrial Research Council in 1934; other developments included The Medical Research Council of Ireland in 1937; The Dublin Institute for Advanced Studies in 1940, and the Medical Research Council Laboratories in 1943. The evolution of a National Science policy can be traced through the setting up of such organisations and bodies and through consideration of the role and remit determined for each; the table following presents summary confirmatory data for the more important organisations and bodies on this dimension.

Table 10: A listing of important S & T oriented state sponsored bodies by year of establishment, remit

Title of Organisation	Mode and Year of establishment	Summary of Remit and Scope of Activities
Industrial Research Council (IRC)	Established by Government in 1934	To promote use of natural resources; research to improve and develop industrial infrastructure, direction, supervision and initiation of industrial research.
Medical Research Council of Ireland (MRCI)	Established by Minister for Local Government and Public Health in 1937	To organise, assist and promote research on all branches of medicine; the MRC Laboratories were located at TCD
Monarchana Alcóil na hÉireann Teoranta	Industrial Alcohol Act 1938	To manufacture and sell industrial alcohol.
Emergency Scientific Research Bureau (ESRB)	By direction of the Taoiseach in 1941 during 'Emergency'	To deal with technical problems in provision of substitute processes and materials; and the use of native materials; to direct or conduct special researches to offset shortages in vital supplies/commodities.
Institute of Industrial Research & Standards (IIRS)	Industrial Research & Standards Act 1946	Encourage and assist the use of science and technology in industry; research and development, consultancy and advisory work, testing, standards and provision of national technical information service.
Ceimicí Teoranta	Amendment to Industrial Alcohol Act 1947	Amendment changed name of Monarchana Alcoil to Ceimici Teoranta; remit/activities extended to cover experiments, research manufacture and sale of chemicals.
National Science Council (NSC)	Established by Government in 1967 for four year period	Body set up on the recommendation of 'Research & Technology Survey Team' in association with O.E.C.D. to assist in the evolution of a national science policy; to advise on research, science & technology development and priorities for expenditure
National Board for Science & Technology (NBST)	Statutory Body established in 1977; it became operational in 1978	To advise on national policy for S & T and investment in these areas; prepare national programme for S & T, coordinate activities, promote research and development of national resources.
The Irish Science & Technology Agency (EOLAS)	Established in 1987 under the Science & Technology Act through the merger of the IIRS & NBST	Responsible for development, application, coordination and promotion of S & T in Irish industry, forging links between higher education and industry; advising Government on S & T policy; provision of technical services.

On 31 October 1933, the Executive Council considered a document entitled 'Industrial Research Council' which had been submitted by Mr S Lemass, the Minister for Industry & Commerce, for consideration. This document drew attention to the rapid progress made in other countries, in recent years, in the development and organisation of industrial research and proceeded to detail a proposal for the establishment of an Industrial Research Council with powers and resources to direct and encourage industrial research;brief summaries of the functions of similar organisations set up to control and direct industrial research work in other countries were appended; these included Gt Britain, Canada, Australia, New Zealand, South Africa, Denmark, France, Sweden, USA and Germany.

In his proposal, he indicated that no attempt had yet been made to carry out a scientific investigation of the problems facing industry nor indeed had any central body been established to coordinate the research work being undertaken by a few of the larger industries and the universities. He pointed out that, apart from the provision of a small sum for grants to enable students to carry out scientific research, there had been no allocation from public funds to promote industrial research.

He stated

> there is room for industrial development in the Saorstát and if such development is to be intelligently planned and successfully carried out, scientific industrial research must form a definite feature of the Government's programme.[24]

The Minister for Industry & Commerce drew attention to the fact that, while in some countries, agricultural research is included in the remit and responsibilities of the national research institution

concerned, it was not his intention to interfere with present agricultural arrangements for research; this work was undertaken under the aegis of and was funded by the Department of Agriculture. Amongst the functions listed for the Industrial Research Council was the granting of financial assistance to Saorstat inventors whose investigations may bring beneficial national results and a sum of £1,000 for scholarships to selected students showing a capacity for research work. While the total annual budget proposed was £6,500, there was an indication that this sum might be augmented, in the future; this would occur where the IRC was asked to prepare and supervise industrial standards and on the establishment of a research laboratory.[25] The Executive Council approved the establishment of the IRC subject to the appointment of a Director of Research; later, having reconsidered the matter, the Executive Council decided

(a) that the functions of the Council should be purely advisory, during an initial experimental stage;
(b) that the post of Director of Research should not be filled for the present.[26]

These conditions virtually ensured that the IRC's remit would not include or facilitate the initiation of joint collaborative research or promote the IRC as an agency for dealing expeditiously with problems of a scientific or technological nature experienced by Irish industry.

The inaugural meeting of the Industrial Research Council (IRC) took place on the 21st March 1934 and was attended by Mr S Lemass, Minister for Industry & Commerce and Mr J Leyden, Secretary of the Department of Industry & Commerce.

The terms of reference as laid down for the IRC were:

> To furnish advice or take such action as may be appropriate at the request or with the approval of the Minister for Industry and Commerce in respect of
>
> (a) Promoting the utilisation of the natural resources of the Saorstát.
>
> (b) Research with the object of improving the technical processes and methods used in the industries of the Saorstat and of discovering processes and methods which may promote the expansion of existing or the development of new industries, including research into the utilisation of the waste products of such industries.
>
> (c) Direction or supervision over research which may be undertaken under conditions to be determined in each case by or for single industrial firms, or by such organisations or persons as may determine to avail themselves of the facilities offered for this purpose.
>
> (d) Questions of scientific and technological methods affecting Saorstát industries.
>
> (e) Other matters affecting industrial research in the Saorstát.[27]

Speaking at the inaugural meeting of the IRC, the Minister, Mr Lemass, stated that the Government was satisfied of the definite need for scientific industrial research to support industrial development.

He commented:

> the cost of such research should in ordinary circumstances be borne to some extent at least by industrial enterprise; the Government is, however, taking the initiative and establishing a research organisation, but it is hoped that our industrialists will show appreciation of the importance of the undertaking by making definite contributions at the appropriate time to the expenditure incurred in making investigations which will primarily benefit themselves.[28]

He went on to indicate that the Industrial Research Council was intended to be primarily an advisory body, a statement which in fact negated the apparent positive attitude by the government to provide support for industrial research and the related investigations to be undertaken by the newly formed 'research organisation'. The Minister provided the IRC with its first work plan by directing the Council's

attention initially to the utilisation of peat resources, the extraction of oil from native coal, the establishing of a library of technical orientation to contain information on other countries industrial research activities and a review of the postgraduate scholarship scheme.[29]

For a Council appointed as an advisory body for industrial research and development, the absence of members from Irish industry was striking and indicative of the low level of understanding by the Government of the mechanisms and strategies required to promote industrial development. The absence of expertise relating to agriculture and dairy science was particularly noticeable, particularly with the emphasis which had been laid by the Government on the development of the agriculture and food processing/technology sectors of the economy. The imprecise definition of the role envisaged for the IRC was another cause of confusion.

The Minister for Industry and Commerce had emphasised that one of the main objectives of the Council should be to establish contacts with industrial concerns, and to assist them to solve their problems and improve their manufacturing processes. However, within a short time the Council realised that it was impossible to set up the requisite levels of liaison and co-operation with industrialists; this was largely due to the delays in obtaining, through the bureaucratic departmental channels under which the Council was compelled to operate, the necessary sanctions for responding to and initiating action on behalf of industrialists. This situation developed because of the inability of the Council to obtain sanction to appoint the appropriate technical staff and to acquire the laboratory facilities necessary to deal quickly and

effectively with problems referred to it by industrialists. In other words the 'research organisation' which was supposed to assist industry in solving technical problems had become *de facto* an 'advisory body' because of inadequate investment by the Government.

Early in 1936 the Industrial Research Council pressed the Minister for Industry and Commerce to establish an alternative method of financial provision and administration to minimize the departmental delays being experienced. At the same time, the Council pressed for an increase in the scope of the Council's activities. The role and function of the Council was raised again in June 1937, when, the Council sought approval in principle for acquisition of its own laboratories and permanent scientific and technical staff. Once again, the pleas of the Council met with little success.

It is apparent that the majority of the investigations, carried out under the auspices of the Council, were initiated by individual members of the Council primarily because of their own personal interest in the problems under investigation. This is clear from the existing records of the Council.[30] These Council members supervised these investigations on a voluntary basis, generally in premises attached to the Universities; the Council relied on these same members to supply the impetus to continue the work from stage to stage and indeed to control the development trends of the work. The Council did little more than approve the general plan proposed for the investigations and recommend the provision of financial assistance.

As the IRC was in effect an advisory body, there seemed little point in contacting industrialists to engage in collaborative research towards finding solutions to the problems affecting industry when the Council had neither facilites nor staff to conduct even preliminary work on any particular problem. If the primary objective was to engage in collaborative industrial research to promote the better utilization of native resources and to improve the technical processes and methods used in industry, then surely such research should have been located in purpose-built industrial research laboratories, properly equipped and staffed by trained scientific investigators, with appropriate industrial experience.

The Council, because of its structure and funding, found it impossible to establish the necessary levels of contact and liaison with industrial concerns 'to assist them solve their problems and improve their manufacturing processes'; a task which, the Minister had stated, was to be one of the main objectives of the Council. The Council blamed the departmental systems of control under which it was compelled to operate for this state of affairs; it stated that 'the delay involved in obtaining staff and facilities made it impossible for the Council to deal effectively and quickly with specific problems from industrialists'.[31]

The necessity for a properly constituted and funded industrial research organisation should have been obvious to the Government since the majority of Irish industries consisted of small industries which could not afford research laboratories; furthermore, small factories did not have the resources to employ

qualified technical staff to supervise quality control and to optimise production processes and methods.

The policy of protection operated by the Government constituted a further hindrance to the development of the IRC; this effectively inhibited industrial competitiveness and diminished the necessity to lobby for industrial research services.

In October 1937, the Council wrote to the Secretary of the Department of Industry and Commerce submitting further proposals for consideration by the Minister on the provision of meaningful 'help to the industrial development of this country'. This submission indicated that 'at the outset of its career, the Council was dependent upon researches which had already been in contemplation, or actually began, mainly by individuals who were serving on the Council'.[32] The major thrust of the Council's work had been devoted to facilitating research work carried out in the Universities under the supervision of University staff; the Council took the view that the scope of such research activities had to be limited otherwise the Universities might be required to divert resources from their normal activities of teaching and fundamental research. The Council proposed that 'a determined effort should be made for a period of at least five years, to deal with industrial research problems by an organisation designed and staffed specially to that end.' In order to give effect to this objective the Council sought approval for the provision of an additional £40,000 over a five year period to facilitate the acquisition of the necessary premises and the appointment of the specialised technical staff to undertake the research activities agreed to by

the Industrial Research Council. It was pointed out to the Minister and the Department that:

> if state-aided industrial research is to become of importance in the country, it must, while working in the closest collaboration with all the existing scientific and industrial organisations, develop at a certain stage as an entity distinct from existing institutions.[33]

Although the IRC reiterated its proposals in 1938, there is little evidence to indicate the matter was considered to be of immediate importance. In June 1940, correspondence from the Secretary of the Department of Industry and Commerce to the Secretary of the Department of the Taoiseach indicated that the reorganisation of the Industrial Research Council was under active consideration and that aspects of the reorganisation scheme were under scrutiny by the Department of Finance. It was stated that it was hoped to provide the details of the reorganisation scheme to the Department of the Taoiseach at an early date, once the sanction of the Department of Finance had been obtained. Revisions to the reorganisation scheme together with continued interdepartmental discussions between Industry and Commerce and Finance over sanction for the proposals continued to delay the appearance of the scheme; this was despite further requests from the Department of the Taoiseach and a specific request from the Cabinet Committee on Emergency Problems for information on the scheme.[34]

A note appended to the correspondence stated that 'deadlock had been reached between Industry and Commerce and Finance' and it was proposed to get the Minister for Industry and Commerce to intervene personally.[35]

In October 1941 the Minister for Industry and Commerce advised the Department of the Taoiseach that during the current emergency it would neither be necessary or desirable to proceed with the reorganisation of the IRC particularly with setting up of the ESRB; he advised that the matter would be dealt with expeditiously on the return of normal conditions. The Taoiseach concurred with these views and the reorganisation scheme was left in abeyance until after 1945.[36]

Up to February 1940, the Industrial Research Council had spent some £22,000. Of this £6,700 had been spent on administrative and general expenses, £1,100 on the Library, and £10,300 on special investigations; of this latter sum, a total of £9,700 had been spent on the peat waxes and seawood investigations. These small amounts are indicative of the low level of support for industrial research and of a lack of understanding of the impact which science and technology could have on industry; this low budget contrasts dramatically with the £930,000 given to the British DSIR in 1939 and with the substantive role visited on this organisation as described in Chapter 1. In addition, the Council administered through one of its sub-committees the awarding of Research Grants, amounting to £1,000 per annum, to postgraduate students, all of whom conducted research in the universities; in the year 1929-30, state research grants were first awarded. Among the early recipients were T Twomey, UCC and V Barry, UCG; later recipients were Ms M de Valera and D T Flood, both of whom carried out scientific investigations for the Bureau, Ms de Valera was a consultant while Mr Flood was a principal investigator employed by the Bureau.[37]

In spite of the limitations already indicated, the Council carried out a considerable amount of useful research and investigation work which demonstrated what could be done if circumstances and the approach by the Government had been different.

Major research investigations carried out which resulted in positive outcomes are given below in Table 11.

Table 11: Some major research investigations carried out under auspices of IRC listed by research topic, principal investigator and outcome

Research Topic	Principal Investigator	Outcome of Research Investigation
Production of wax from peat	Prof J Reilly (UCC)	Technique developed for extraction from peat of a wax of marketable quality; it replaced a German-produced wax originally used
Utilization of seaweed	Prof T Dillon (UCG)	Work resulted in setting up company, Arramara Teo; it processed seaweed to produce alginates and contributed to employment opportunities on the Western seaboard
Utilization of peat	Prof J Taylor (UCC)	A domestic turf range and turf stove designed; designs used by commercial manufacturers to produce products for the market

Source: Annual Reports of Industrial Research Council

Other outcomes of the work on the utilization of peat resulted in advice to ironfounders on using peat as an alternative fuel, developing ways for using peat for steam-raising and for central heating appliances and devising an accurate method for measuring the moisture content of peat. Another investigation established the suitability of using china clay from a deposit at Portacloy for manufacturing pottery; as part of this investigation, Portacloy sand was found to be unsuitable for glass-making. In addition, the Council, with the assistance of a special committee of non-Council members carried out an investigation on the growth, propagation and use of carrageen, an edible seashore algal species.

In addition to the principal research investigations referred to above, the Council dealt with a large number of individual queries from industrialists and from the Minister on various industrial and exploitation proposals. The topics investigated included:

(i) the production of charcoal and coke from peat and their utilisation for transport,

(ii) several proposals regarding the production of petrol and oil from peat and soil,

(iii) the growth and use of special herbs for medicinal purposes,

(iv) the growth and use of special plants for industrial fibres,

(v) the production of oil from the seeds of indigenous plants,

(vi) the utilisation of oat hulls for the production of commercial chemicals,

(vii) the use of local sand for foundry purposes,

(viii) the fermentation of sewage and the industrial use of sewerage gas.

Investigations proposed by the Council which were not approved by the relevant departments of state included investigations into the possibility of obtaining from native sources activated carbon for gas masks and other industrial purposes, the occurrence of native pigments suitable for industrial use and special methods of treating creamery effluents.[38]

By 1939 the clouds of war were gathering over Europe and while proposals for reorganisation of industrial research had been under consideration by the Department of Industry and Commerce, it was obvious that urgent action was essential to mitigate the dislocations to economic activity which would inevitably occur in a war situation. The Industrial Research Council, by its own admission, had been unable to make any major contribution to resolving, quickly and effectively, problems encountered by industrial concerns; it was unable to convince the Minister for Industry and Commerce of the need for the immediate re-organisation of the Industrial Research Council itself.

These particular shortcomings of the IRC and the justification for establishing the ESRB were referred to by De Valera on 6 March 1941 in a statement in Dáil Éireann on the introduction of a Supplementary Estimate for the Bureau. He stated that it was considered desirable to have a small body of scientists, the ERB, to investigate technical and industrial problems arising out of the emergency situation. He commented:

> reorganisation of [the IRC] would need legislation to give effect to it and it was felt that it would be better to ... set up an *ad hoc* body [the ESRB] to deal with the present situation. [39]

De Valera's obvious support for the Bureau is clearly indicated in this statement. When referring to the IRC as being 'formed for long-term investigation and planning' a phrase which does not appear in its terms of reference, he was articulating, implicitly,

a need for industrial research undertaken by a body adequately funded and with the necessary supports to enable it to function, perhaps, in a manner similar to the British DSIR which had gone from strength to strength. The IRC was, by its own admission, unable to fulfill this role; a reorganisation was not only required but essential if meaningful industrial research was to be undertaken and thus be of value to industry.

The shortcomings of the IRC were referred to again by the Taoiseach in Dáil Éireann on 17 July 1941 when he stated:

> it has been decided to set up an ad hoc body [the Bureau] rather than to make use of the Industrial Research Council which as at present constituted is not well adapted to deal with the immediate problems confronting the State.[40]

It is thus possible that the inability of the IRC to function, in the way it considered research organisations should operate, prompted De Valera to take note of the IRC's shortcomings; in so doing, the remit given to the Bureau was framed to overcome such shortcomings; this enabled it to bring a substantial measure of success to all of its activities throughout its period of existence.

On the outbreak of World War II the Council drew the Department's attention to the fact that their services were fully available for the investigation of the supply of substitute materials for supplies cut off owing to war conditions; the Council's offer was never availed of to any major extent. With the establishment of the Emergency Scientific Research Bureau in 1941 the demise of the Council was clearly indicated; the Bureau had the use of the Council's premises and most of its staff, particularly the

Secretary, Dr J J Lennon who acted as the full-time Secretary to the Bureau. The Council continued to meet periodically every one or two months with a much reduced volume of activity and membership attendance. The last minuted meeting of the Council took place on 27 May 1946; the Council officially ceased activities on 3 October 1946 on the establishment of the Institute for Industrial Research and Standards in 1946.

The development of a national policy on science and technology was a slow process, mediated, at times, by some very significant contributions by individuals and institutions. The IRC, despite its restricted budgetary allocations and remit proved to be a valuable catalyst which contributed to the establishment and to the formulation of the remit of the ESRB.

CHAPTER 4

NEUTRALITY & ECONOMIC ACTIVITY IN IRELAND DURING THE YEARS 1939-1942

Prior to the outbreak of World War II, the Irish Free State was required to import a very high proportion of essential supplies in the form of raw materials or finished products. As such supplies came from countries, the majority of which could eventually be involved in the war, there was every liklihood that economic activity in the country would be very seriously affected if not paralysed. In addition, the Government and the people were committed to a policy of neutrality; such a policy of neutrality was viewed as the ultimate expression of independence and of freedom from Britain. This chapter analyses the effects of the war on economic activity within the country and evaluates the steps taken by the Government to maintain both neutrality and economic activity against a background of economic sanctions imposed by Great Britain.

On the 18 April 1939, the Department of Industry and Commerce circulated a detailed memorandum to Government Ministers setting out in grim detail the position in which, in the event of war, Ireland would find itself regarding:-

(i) sources of supply of essential imports;

(ii) markets for exports;

(iii) shipping tonnage required to carry imports and exports.[1]

It was pointed out that a high proportion of the imports into the country consisted of essential supplies, either in the form of raw

materials or finished products. These commodities which could not be provided from within the country, came from a small number of sources as indicated in Table 12.

Table 12 : Percentage distribution of imports by country of origin for the year 1938

Percentage of Imports	Country of Origin
50	United Kingdom
11	Canada and USA
11 in total	Belgium, Netherlands, France, Germany, Sweden and Russia
5	Argentine
4	Australia
4	India
15	Other Countries

Source : Department of Industry & Commerce Memorandum 18.4.1939.

As is indicated in Table 12, imports were mainly from the UK and our exports showed greater dependency on the same market. In the event of war, the economy would be very largely at the mercy of other countries, particularly the United Kingdom.

Table 13 : Percentage value of exports from Ireland to country of destination for the year 1938

Percentage Value of Exports	Country of Destination
90.6	Great Britain & Nr Ireland
3.8	Germany
1.0	USA
0.9	Belgium
0.5	Netherlands
2.3	All other countries

Source : Department of Industry & Commerce Memorandum 18.4.39.

Shipping constituted another crucial area of concern. Of the shipping entering Irish ports in 1938 some 64% was British-owned, 31% was owned by other countries and a mere 5% was wholly Irish owned; however, while 37% of the total was tonnage was actually registered in Britain, 32% of the total was registered in Ireland.

In 1939, Irish-owned shipping amounted to some 27 ships with an aggregate net tonnage of 9,874, the largest being one of 827 tons and the smallest one of 131 tons. It was clear, therefore, that Irish-owned vessels were capable of carrying only a very small proportion of the country's imports and exports; the country was totally dependent on other countries for the shipping space necessary to carry the total imports of bulk cargoes from abroad. A striking example of this situation was the country's dependence on British shipping for coal imports. If the nine Irish-owned vessels employed on transporting coal were engaged on this task exclusively, they could carry about 8% only of the total imported tonnage of coal.

There was no doubt therefore that the British Government would immediately exercise control and jurisdiction over all shipping moving to and from Ireland on the outbreak of war. It was inevitable therefore that disruption of external trading would occur with serious consequences for the country.

In the event of war occurring, the maintenance of essential supplies and services would become, of necessity, an issue of prime importance to the Irish Government, indeed to the very survival of the country; the first step taken by the Government was the

preparation of legislation to regulate imports and exports, fix prices and control distribution of goods; very draconian censorship laws were enacted also to ensure absolute partiality in reporting on and commenting about the war.

Towards the end of August 1939, the Emergency Supplies Branch of the Department of Industry and Commerce had completed an inventory of the stock position of essential supplies and commodities within the country. This inventory showed that the position with foodstuffs was fairly satisfactory with between 10-20 weeks supply of different categories in stock; the position with flour was more serious in that there was just three and a half weeks supply. The supply position for raw material for industry varied somewhat; there was 8 weeks supply of fertilizers, 40 weeks supply of matches, and about 14 weeks supply of different petroleum products.[2] In addition, while arrangements had been made with the banks to provide the necessary funding for the purchasing of additional reserve stocks, the identification of secure and suitable storage facilities for additional stocks of cereals, petroleum and fertilizers would not be easy and presented many problems for the Emergency Supplies Branch assigned to this task.

The extent of the country's economic dependence on Britain has already been described. De Valera had no option but to try to explain to Germany that, while Ireland was determined to remain neutral, it was essential to the country's economic survival that trade with Britain continue as before. On 31 August 1939, the day before Germany attacked Poland, Dr Edouard Hempel, the German Ambassador in Dublin, called on De Valera, to ascertain the

attitude of the Irish Government in the event of war. When Hempel indicated that Germany was anxious to respect the neutrality of Ireland, De Valera replied that it was of the utmost importance to Ireland to maintain her trade with Britain and in these circumstances, the Irish Government would have to show 'a certain consideration for Britain'.[3] Thus began the delicate path of diplomacy, which De Valera exploited so brilliantly in convincing all belligerents that Ireland would oppose by force the first power which tried to interfere with Irish neutrality and that the advantages to be derived from any occupation would not merit the costs, moral and military, involved in such an operation.

On Sunday, 3 September 1939, both Houses of the Oireachtas met in emergency session; a 'National Emergency' was declared and the 'Emergency Powers Act' was passed. The proceedings were unusual in that they had attracted a full attendance of the members of both the Dáil and the Seanad; the Public Gallery was crowded while the Strangers' Gallery was filled with members of the Diplomatic Corps and other notable public figures. During the debates, it was stressed that it was intended that the country should remain neutral and that the measures being enacted were such as to reinforce this policy decision. It might of course be added that this policy of neutrality had received widespread support from both the Government and the electorate.[4] That same night, De Valera broadcast to the nation and affirmed that neutrality was the proper policy for Ireland; he stated further

> with our history, with our experience of the last war, and with part of our country unjustly severed from us, we [the Government] felt no other decision and no other policy was possible.

For a small, defenceless country, occupying a geographically strategic position in Europe, a declaration of neutrality was, in the final analysis, 'a finely calculated blend of principle and pragmatism'.[5]

On the first night of war the British passenger liner Athenia was attacked and sunk by a U-boat north west of Donegal with the loss of 115 lives, 28 of whom were American citizens; over the next two weeks a total of 28 ships were sunk; this was followed by the sinking of the British aircraft-carrier Courageous south west of Ireland on the 17 September.[6] The British press was particularly scathing in its comments, accusing Ireland of causing the deaths of thousands of sailors bringing vital supplies across the Atlantic, some of which were destined for Ireland itself. Thus, from the first days of the war, it was inevitable that Ireland would be pressurised by Britain to allow the Allies the use of the 'Treaty Ports'.

Shipping losses continued to mount alarmingly throughout September. A major blow occurred on 14 October 1939 when another U-boat successfully penetrated the defences of the naval base of Scapa Flow, in the Orkney Islands where the British fleet was based; the battleship Royal Oak was sunk with the loss of 785 lives.[7] It was now inevitable that the British would seek alternative harbours further to the west; the push for the use of the 'Treaty Ports' went into top gear. These post facilities were situated at Cobh (formerly called Queenstown) on the south coast, at Berehaven in Bantry Bay on the south west and at Lough Swilly in Co Donegal; up to 1938, these ports and their shore installations had been in the care and maintenance of small parties of British military; although

their shore equipment was largely out of date and inappropriate to support a modern fleet, their main value was as large deep-water anchorages.

The British War Cabinet considered a special memorandum, prepared by Rear Admiral Tom Phillips, the Deputy Chief of Naval Staff, in which he gave detailed reasons for the need to use the 'Treaty Ports' particularly Berehaven.[8] The War Cabinet agreed to make another approach to De Valera and Sir John Maffey, the United Kingdom Representative to Ireland, was briefed and instructed to request the use of Berehaven. On the 21 October 1939 Maffey put forward the British point view to De Valera but to no avail. The decision had already been made, the British could not have the ports; De Valera was determined to keep Ireland neutral. Indeed, this decision should have come as no surprise to the British for he had enunciated such a course of action at the League of Nations in June 1939 when economic sanctions against Italy over the annexation of Abyssinia were lifted; when he reported to the Dáil on the same subject, this policy of neutrality was reinforced.[9]

The fragile nature of this policy of neutrality was brought into sharp focus on 11 April 1940 when Churchill informed the House of Commons that

> the strict observance of neutrality by Norway has been a contributory cause to the sufferings to which she is now exposed and to the limits of aid which we can give her. I trust this fact will be meditated upon by other countries who may tomorrow, or a week hence or a month hence, find themselves victims of an equally elaborately worked-out staff plan for their destruction and enslavement.

It is not unreasonable to suppose that the neutrality of Ireland

was to the fore in Churchill's mind when he uttered these words, a warning perhaps also that such neutrality was poised on a knife edge.

By the middle of June 1940, the battle for France was almost over and as the German armies continued their advance to the Channel ports, there was a very strong possibility that an invasion of Britain was to take place before the end of the year. At the same time, there had been a succession of reports of an impending invasion of Ireland by Germany; there were even suggestions of a preemptive occupation of the Treaty Ports by the British.[9]

Because of the seriousness of the military situation, the British Government, in an atmosphere of near panic, explored various possibilities with the Irish Government which would lead to active Irish defence co-operation. The final British proposal was that there would be a declaration of a 'United Ireland' in principle with the constitutional and practical details of the Union to be worked out in due course, the setting up of a joint Defence Council and Ireland to immediately enter the war on the side of the Allies with the British Government providing military assistance.[11] De Valera rejected this proposal because, not only did he want prior agreement on the Constitution of this 'United Ireland' but also because, and this was probably the main reason, the nation was almost totally unprepared for war.[12] The country was virtually defenceless having only a small poorly equipped army and practically no naval or air defences; this was probably a consequence of the original decision to remain neutral. In addition he felt that the intransigence of the Northern Unionists might prove to be an insuperable barrier. It is also possible that De

Valera and his cabinet remembered all too vividly Redmond and the promise of Home Rule for all Ireland when World War I was over.

Shipping losses continued to escalate at an enormous rate over the initial months of the war and Churchill continued to put a large share of the blame on Ireland for refusing to hand over the ports;[13] this same view was held generally in Britain at the time. While it cannot be denied that the unavailability of the 'Treaty Ports' may have been a major contributing factor to the shipping losses, it should be noted that the Germans had deciphered, as far back as 1936, the secret codes used by the Royal Navy. This breach of security was eventually overcome by the summer of 1943 but in the critical first years of the war, through a combination of factors, the German Navy was able to sink 11 million tons of shipping in the North Atlantic.[14] However, in the eyes of Churchill, Ireland was largely responsible for the huge losses suffered by the Atlantic convoys and he was continually urging the Chancellor of the Exchequer, Sir Kingsley Wood, to bring economic pressures on Ireland to force her to depart from the avowed policy of neutrality.

From November 1940, the British threat to Ireland's neutrality began to reach critical proportions. On 5 November 1940, Churchill, in the House of Commons, referred to the fact that the cause of the free world and the interests of Britain were seriously hindered by the inability of the Royal Navy to use Irish ports. The American Ambassador at the time, David Gray, was particularly active also in his attempts to get Ireland into the war.[15]

On the 6 December 1940, Sir Kingsley Wood presented to the War Cabinet a lengthy memorandum detailing two strategies, the second more drastic than the first, for applying economic pressures to Ireland (reference Appendix 2).[16]

The first strategy rested on the premise that, as long as Britain was itself subject to difficulties in the supply of raw materials and commodities, Britain could not continue to supply Ireland with the quantities allowed so far; the first item to be affected was shipping. There was an unwritten understanding that Ireland chartered ships through the Minister of Shipping's Charter Office or obtained space in ships chartered to Britain. Using both types of shipping it was estimated that Ireland's needs equated to forty whole time ships. It was now proposed not only to discontinue both these types of chartering facilities but also to tell the Greeks and the Norwegians that, in present circumstances, they should charter ships only to allies or those co-operating with Britain. It was estimated that Ireland would be very lucky to get ten ships which would give her 25% of her needs. Secondly, it was proposed to alter the export licensing arrangements to exclude the export to Ireland of food, feed-stuffs, fertilizers, agricultural and other machinery, spare parts of all kinds, iron and steel, non ferrous metals, chemicals, electrical goods, paper and cardboard. The only exceptions were tea, where the ration was to be below that of Britain, coal, because the current supply to Ireland of some three million tons per year kept some ten thousand miners in employment, and cotton goods and textiles, in which there was an export drive.

The second strategy to be proposed was the withholding of insurance

facilities for ships going to Ireland. This would mean that Éire would not be able to get any ships; this second plan would be in effect economic war.

During this period, Roosevelt had been attempting to bring about changes in the American Neutrality Act so as to permit him to help Britain through the lease-lend mechanism. With this in mind and being afraid of a possible unfavourable reaction in the USA to the enforcement of these economic sanctions on Ireland, Churchill delayed their implementation; however, on 2 January 1941, it was decided by the War Cabinet to implement the new export licensing arrangements.

It is interesting to speculate that, if the Anglo-Irish Trade Agreement, agreed to by both Britain and Ireland, had been duly signed the previous August, the War Cabinet might not have been able to apply these sanctions. However, the Irish Government, which had taken the initiative to open the talks in April 1940, refused at the last minute to sign the agreement, thus presenting Churchill with an open invitation to apply these economic restrictions. The Irish public was never informed of this refusal by their Government to sign the agreement and when opposition spokesmen criticised the Government in the Dáil for not having made formal arrangements with Britain for the supply of essential goods and commodities in exchange for farm produce, the Government reacted by putting the blame on Britain.

When the economic sanctions had been in force for some three months, the British War Cabinet received a progress report on their

effect. The general view of the Cabinet was that the current policies should in no way be relaxed. These policies were 'consistent with our needs and ostensibly they should continue to be based on those needs. At the same time it was important from the political point of view that the pressure on Ireland should be fully maintained'.[17] Indeed to ensure the maintenance of economic pressures on the country, the informal committee which Churchill had set up in 1941, within the War Cabinet, to give effect to and to monitor these sanctions was made into a full War Cabinet Committee in 1942 under the chairmanship of C R Atlee, the Secretary of State for Dominion Affairs (reference Appendix 2).[18]

There was, of course, the possibility of Ireland giving way under the economic sanctions being imposed by Britain. The British Chiefs of Staff were asked to consider the military situation arising out of such a development. Their appraisal clearly indicated that the defence of Ireland would involve a substantial military commitment; although such a commitment had been promised by the War Cabinet on 6 December 1940, during the discussions for access to the Treaty Ports, Britain was really not in any position to undertake the defence of Ireland at this time.[19] Indeed Belfast, which was supposed to be protected, could offer little or no resistance to the German Luftwaffe in April and May 1941 when massive airstrikes caused almost 900 deaths with more than 1,500 injured and seriously damaged large sections of the city and shipyards. It is perhaps worth noting that, following requests for help by J C MacDermott, Minister for Public Security in Northern Ireland,[20] De Valera ordered as many fire-fighting units as possible to travel North. As a neutral country this action could have compromised that stance.

The fears of De Valera in abandoning neutrality and exposing the country to the full horrors of modern warfare were realised later, albeit apparently accidentally; it is probable that the incident was caused by British countermeasures deflecting the radio beams used by the Germans to guide bombers to their targets. On the night of 30/31 May 1941 Dublin suffered bombardment by the Luftwaffe; some twenty-seven people were killed, with forty-five injured, 25 houses destroyed and some 300 houses damaged. The effect of this bombing together with other bombing incidents which had occurred at the beginning of 1941 dramatically reinforced the vulnerability of the country to German air strikes.

After the Japanese attack on Pearl Harbour, more strenuous pressure was applied and when the effects of the conomic sanctions really started to hit home in 1942, Roosevelt expressed little sympathy for De Valera or for Irish neutrality. There can be no doubt of the determination exercised by the British Government in seeking access to the Treaty Ports. As a consequence, the economic sanctions imposed were draconian in scope, and application. Equally their effects on both economic activity and the ordinary every day lives of the citizens of Ireland were punitive and caused acute hardships.

The initial effects of the economic sanctions imposed by Britain can be best illustrated by extracts from the 1940 Christmas broadcast to the USA by the Taoiseach, Éamonn De Valera, where he said that

> a picture of us has been given by certain publicists ... that we in Ireland are living our normal peace time lives ... just as if there was no war. It is a false picture ...

> many Irish sailors have lost their lives. We have sustained heavy material losses. A large percentage of our shipping tonnage has been sunk. Shortage of raw materials for our industries has increased unemployment and deprived many workers of their livelihood ... it will be hard for you to realise that there is at this moment probably no country of Europe so effectively blockaded as we are ... our stocks of the raw materials and foodstuffs which we must necessarily import ... are being steadily exhausted. As the blockage tightens ... we may be compelled to resort to the rationing of bread ... help us, should the blockade grow tighter, to secure the supply of foodstuffs which are essential if the most acute hardships for our people are to be avoided[21]

Again, in his broadcast to the nation on 29 January 1941, the Taoiseach said

> a total blockade will, if the war lasts for any considerable time, cause this community much suffering ... our first step must be to make sure of the Nation's food ... we can now in fact be sure of nothing which we do not produce ourselves[22]

Petrol rationing had been introduced on 2 October 1939 in order to conserve supplies and to ensure an adequate supply for essential public services. The first shock had come in December 1940 when petrol pumps all over the country ran dry; this was the result of an early decision of the British War Cabinet that oil supplies in 1941 should be made on the basis of 50% of normal consumption of motor spirit and 60% of normal consumption of kerosene, gas and fuel oils. This quantity was even further reduced by 25% in 1942; petrol supplies in Ireland were subsequently very severely rationed as a direct result of these decisions. The petrol shortage was so acute in January 1941 that the Minister for supplies made an order which reduced the value of the unit of each petrol coupon to a quarter gallon (previously one gallon) and fixed the price of petrol at 2/2d per gallon in the Dublin zone and 2/3d per gallon in other parts of the country.[23] This same month marked the

introduction of coal rationing. This had to be imposed to conserve existing stocks; the people were advised to fall back more and more on the only readily available native fuel, turf.

The seriousness of this drastic reduction in petroleum fuel supplies can be viewed by considering the actual tonnage delivered in 1942 compared with that delivered in 1938.

Table 14 : Tonnage of various petroleum products delivered to Ireland in 1938 and 1942 and the relevant reductions

	1938	1942	Reduction on 1938
Motor Spirit	133,000	42,700	68%
Kerosene	65,000	36,400	44%
Gas & Fuel Oils	53,000	26,800	50%
Total	251,000	105,900	58%

Source: British War Cabinet Memoranda, Series CAB66 and CAB72/25

In terms of tankers these supplies involved ten ocean-going tanker voyages and about the same number of trips by small coastal tankers from the United Kingdom. The latter carried 1,000 tons of fuel oil every other month with additional quantities of kerosene during the winter months. A special arrangement had to be made with the British Was Office to supply, as a reserve, 1,000 tons of motor spirit and a mere 475 tons of aviation spirit to the Irish Army.

The Committee on Economic Policy towards Ireland subsequently decided that petroleum supplies 'to Ireland in 1943 should be

reduced to the amount supplied in 1942 less 25% as reduction in supplies to Ireland will correspondingly alleviate the United Kingdom position'.[24] This further reduction in 1943 drew a strong protest from the Irish High Commissioner, J W Dulanty. In a letter to the Secretary of State for Dominion Affairs he stated that 'my Government has been forced to the conclusion that the proposals in your letter regarding provision for Ireland in 1943 are not only harsh but inequitable.'[25] He indicated further that if this action was pursued then the Government would have no option but to request the immediate return of tanker tonnage equivalent to the seven tankers transferred from the Irish Register to the British Register on the 6 September 1939.[26]

The effect of all these shipping restrictions was such that the Irish Government decided in February 1941 to establish a deep-sea fleet and in March 1941 Irish Shipping Ltd was incorporated under the Chairmanship of John Leydon, Secretary of the Department of Supplies.[27] It was hoped that this new and innovative strategy would somewhat offset the severe restrictions on obtaining shipping space on British ships. However, there was another problem facing the ships acquired by Irish Shipping Ltd; the ships were obliged to obtain a navicert warrant.[28]

The British Government's policy on the shipment of coal was to allow 'only such coal as was not required in this country to be exported to Ireland' and even then the quality was so particularly poor that the continued operation of public utilities was in serious jeopardy. The British were aware that the Gt Southern Railways and the Dublin Gas Company might have to cease operation

because of the restrictions being imposed. Nevertheless, it was decided that there should be 'no modifications in present policy of restricting supplies notwithstanding that this might have a serious effect on public service utilities'[29] Indeed during the early part of 1942 the British Government released only 1,000 tons of gas coal for distribution amongst all the gas works in Ireland although the normal consumption of gas coal by the Dublin Gas Company was 3,500 tons per week.

However, an increase in the supply of coal was approved wherever such an arrangement was advantageous to Britain. A particularly striking example of this was the approval given on 19 August 1942 to ship an additional 5,000 tons of coal per month for use at the Drogheda Cement Works on the understanding that Ireland would export to Nr Ireland some 12,500 tons of cement per month which was urgently required for aerodrome construction. Other similar arrangements advantageous to Britain are cited in Appendix 2.

Coal supplies continued to diminish both in quantity and quality and eventually disappeared altogether for domestic use. As the economic sanctions continued to bite, the country was obliged to fall back on its own meagre resources to ensure not only economic but political survival and a doctrine of self-sufficiency was once again proposed by the Government.

As already indicated the Government had initiated such a policy during the period of the tariff war in the 1930s 'to build up the industries of the country with native capital and organisation and to permit outside control of industries only when the possibilities

of developing the industries concerned under home control had been exhausted'[30] The limited success of this policy of self-sufficiency has been discussed already but worthy of brief summary again. Employment rose from 111,000 in 1931 to 166,000 in 1938; industry was heavily dependent on imports, had a limited domestic market and high labour costs; attempts to diversify trade outlets were hampered by international conditions and the development of agriculture was far from satisfactory. However, what this policy did highlight was the continued economic dependence of Ireland on Britain.

This dependence had in fact been forecast as far back as 1935 in a memorandum drawn up by De Valera's own department. This stated that in the event of war ' the stoppage or serious curtailment of supplies ... of petrol and other fuel and lubricating oils would practically bring road transport in this country to a standstill in a short time.'[31] A similar state of affairs would apply to coal for rail transport. The document urged the Government to investigate the use of wood or peat-burning transport engines and the construction of a factory to make spare parts for engines. Supplies of raw materials, it said, would also be critical during a war. Despite these predictions, no precautions had been taken by the Government against the possibilities of being isolated economically in the future. The result was that, although there was a fair supply of basic food stuffs, many commodities had to be rationed.

At the beginning of 1941 the supplies situation was so serious that a special conference was organised for 31 January 1941. This conference was attended by representatives from the Department of Supplies and the Department of Industry and Commerce who met to

consider the initial steps to be taken in the event of a complete stoppage of imports of industrial raw or semi-manufactured products.[32] It was agreed, as a first step, to investigate the position of industries generally in the order of their importance to the community and to set up conferences with representatives of each industry. These conferences were to be used to determine the extent to which imports could be replaced from indigenous sources or by the substitution of other materials which would give a substantially similar product. In the case of imported materials which could not be replaced or substituted, it was agreed to determine the extent to which existing supplies could be stretched to cover the anticipated period of shortage which was estimated at two years.

A subsequent review of the general supply position indicated that:-

(i) although the overall position with the food industry was somewhat better than in the case of manufacturing industry, it would be necessary to consider provision of agricultural machinery, cold storage facilities, yeast supplies and substitute chemicals for use by millers and bakers;

(ii) increased production of native coal was unlikely to make any major contribution to the overall stock position and that, in the event of coal imports stopping altogether, the only realistic alternative was to seek increased turf production;

(iii) despite the economies which had been made in the use of electricity and gas, there would be major problems still in maintaining supplies;

(iv) special attention would have to be given to the provision of essential chemicals for tanning and grindery operations of boot and shoe manufacturers;

(v) while no substitutes were available for cotton, silk, jute and linen, there was no immediate concern about the manufacture of woollen goods from native wool;

(vi) the country would be dependent entirely on the existing stocks of iron and steel, together with more intensive use of scrap metal;

(vii) the lack of adequate facilities for drying timber might lead to rationing of timber supplies for building;

(viii) the continued production of cement would be dependent on the availability of imported supplies of coal and coke;

(ix) imports of rubber had virtually ceased.[33]

The seriousness of the supply position was further highlighted in a letter to the Taoiseach from Erskine Childers, (later to become President of Ireland), Secretary to the Federation of Irish Manufacturers Ltd. written on the instructions of the Substitute Materials Committee of the Federation[34] Attention was drawn to:-

(a) the need for substitute materials to replace imports used in the manufacture of cordage, ropes, binder twine, sacks and bags essential for the flour milling, baking, sugar and other industries and vital for the distribution of foodstuffs;

(b) the manufacture of cardboard and paper, particularly through the use of wood pulp from native forestry resources and the collection and re-cycling of waste paper;

(c) the low levels of stocks of chemicals, previously imported but now in short supply because of import-restrictions, which were required for the woollen, hosiery, paper, soap, leather,

electric lamp and food industries;

(d) the continued need for large quantities of starch products and the desirability of increasing the home-manufacture of starch which hithertofore had been carried out on a small scale;
(e) the desirability of immediate action to manufacture the various acids required in the country.

The sudden reduction in the supply of vital raw materials and commodities was a severe blow to the country. The shortages and rationing which occurred left no facet of economic activity or sector of the population unaffected. Kerosene was issued only for essential purposes such as for tractors at harvesting times or, in Winter, to those dependent on this fuel for lighting. When petrol became unavailable, some motorists tried to keep their cars on the road by fitting producer plants using anthracite or turf charcoal or rubber bags containing coal gas carried on the car roof. But eventually nearly all family cars were put into storage for the duration. Public transport, when it was available, and the bicycle became the only options available.

The shortage of fuel was exacerbated by the quality of the so called emergency coal being imported. There was a drastic reduction in rail services with only one passenger train daily possible. The shortage of gas coal led to a scarcity of domestic gas with supplies available only at certain hours of the day. Electricity was rationed with households allocated a certain number of units per month. Turf started to become more universally used with the people of Dublin going up into the Wicklow mountains at the

weekends to cut their own supplies; however, householders in non-turf areas were rationed to a half-ton of turf per month. Building materials were strictly limited also as practically no timber was being imported and existing stocks were being depleted.

Oranges and bananas were unobtainable most of the time while eggs and milk were expensive. Sugar and tobacco were all in short supply and because of reduced imports of wheat, the bread on sale was brown/black in colour and coarse to tastes used to white bread. The tea ration was a half-ounce per person per week until April 1943 when it was increased to three quarters of an ounce. Clothes, like tea and sugar, were on coupon rations and while a suit of clothes might cost £2.10.0 it usually required more coupons than an individual possessed. The war for the majority of people in Ireland was tolerable but one of deprivation and hardship.

The overall effect of the economic sanctions can be illustrated by comparing the volume of imports to Ireland against the volume of exports being sent to Gt Britain and Nr Ireland.

Table 15: Comparison of value of imports and exports for years stated

	Value of Imports (in £ millions)			Value of Exports (in £ millions)			Excess in Exports to UK over imports from UK (in £ millions)
Year	From UK	From Other Countries	Total	To UK	To Other Countries	Total	
1938	20.9	20.5	41.4	22.1	1.8	23.9	+ 1.2
1939	24.2	19.2	43.4	24.8	1.7	26.5	+ 0.6
1940	24.8	22.0	46.8	31.4	1.3	32.7	+ 6.6
1941	21.1	8.4	29.5	30.8	0.9	31.7	+ 9.7
1942	19.8	14.9	34.7	32.2	0.4	32.6	+12.4
1.1.43-30.6.43	7.0	6.1	13.0	12.7	0.1	12.8	+ 5.7

Source: Compiled from documentation in S.P.O.Folio S11394

This excess in export value meant that most of Ireland's external assets consisted of sterling securities; this restricted the capacity of the country to buy many important suplies, e.g. wheat from outside the sterling area.

Officially, the policy of neutrality meant that no co-operation with either Great Britain or Germany was possible. Nevertheless, there were instances when cooperation with Great Britain did take place on a number of fronts, notably the provision of what was called 'The Donegal Corridor' This concession enabled Coastal Command (RAF) operating out of bases on Lough Erne and Lough Foyle to overfly Irish territory and extend somewhat the range of air cover which could be provided for the convoys; other examples included the transmission by Ireland of meterological reports and of reports of aircraft and submarine activity around the Irish coast in a code supplied by the British, and an agreement, in February 1945, allowing the British to set up a radar station in Ireland to be used against the U-boats.[35]

Throughout the war, the British regarded the Irish position as one of benevolent neutrality. Even Viscount Cranborne, a British Dominions Secretary who was bitterly anti-Irish was constrained towards the end of the war to acknowledge that the Dublin Government 'have been willing to accord us any facilities which would not be regarded as overtly prejudicing their attitude to neutrality'.[36] Indeed, this stance was confirmed by a covering memorandum, dated 12 October 1945, written by Carter Nicholas, the head of the Irish Desk of the Office of Strategic Services, the wartime precursor of the CIA. Carter, who had written a long

secret history outlining American intelligence activities in Ireland, stated that his study revealed 'pro-Allied unneutral acts of officials of a neutral Government'. He asked that 'the history should be treated with the very highest of security'.[37]

Further co-operation led to high level secret talks between military and political leaders in May 1940; these led to a measure of military liaison between Britain and Ireland throughout the war; the most notable achievement was the holding of manoeuvres both north and south of the border in 1942 which were designed to provide a joint Anglo-Irish military response to a German invasion of Ireland. Notwithstanding this co-operation, there were two instances during the period 1940-1944 when the Irish Defence Forces went on 'alert' status when there were strong indications that an invasion from the north was considered to be a strong possibility.[38] Such 'invasions' were not imagined; in October 1940, the Defence Committee of the British War Cabinet commissioned a full scale study of the measures necessary if the Irish bases were to be taken by force; again in the Summer of 1943, President Roosevelt ordered the American Joint Chiefs of Staff to consider the desirability of taking over air and naval bases in Ireland.

While throughout the war neutrality was the avowed policy of De Valera and his Fianna Fáil Government, a great many Irish people felt differently and took an active part in the war through joining the British Forces or by working in British war-time industries. Most reasonable estimates indicate that about 100,000 Irish people were working in war-time industries with between 60,000-100,000

serving with the British Army, Royal Navy and Royal Air Force.[39]

It may be argued that neutrality was the only safe option for Ireland. Certainly up to the end of 1941, it was probably the only realistic option; an alliance with Britain would have exposed the vulnerability of Ireland to German retaliation. Throughout the war, Ireland was never of critical strategic benefit to any of the belligerents, and as a consequence, the occupation of Ireland never became a vital necessity. Moreover, the military costs of such an occupation always appeared to outweigh any advantages that might have been gained. Public support in Ireland for neutrality was overwhelming; this factor coupled with the build-up of the regular defence forces to about 40,000, supported by a Local Defence Force of 98,000 and a Local Security Force of about 100,000 older men in support duties; this presented a defence posture which would have to be seriously considered by an invading belligerent. Although arms and munitions were scarce, but being produced locally, the country was prepared to resist any invader to defend its neutrality.[40]

There was a number of key external factors which facilitated the maintenance neutrality. These included the failure of the Luftwaffe to establish air superiority against the Royal Air Force, a prerequisite for any successful sea-borne invasion, either of Gt Britain or Ireland. This failure resulted in the cancellation of the invasion of Britain, 'Operation Sea Lion'; the invasion of Ireland, 'Operation Green', was to have been a feint operation in support of the main landings in Britain.[41] Another key factory was the invasion of Russia, 'Operation Barbarossa'; Germany was now totally committed to fighting on two fronts against formidable

opponents. In addition, Northern Ireland, as part of the United Kingdom provided a base for sea and air operations, particularly in the Atlantic and acted subsequently as a staging post for American forces after December 1941.[42]

Important steps were taken by the Government during the period 1939-1942, which, in no small measure, assisted in maintaining neutrality and enabled the continuance of a measure of economic activity in the face of the severe economic sanctions. These included a policy of strict censorship, carried out, to extraordinary lengths by F Aiken, Minister for Co-ordination of Defensive Measures, which prevented any expression of bias or favour for either of the belligerents and an 'open-door policy', which operated between Ireland and Great Britain, allowing tens of thousands of Irish men and women to migrate to Great Britain, joining the Armed Forces or augmenting the industrial work force, thus providing a net- benefit to Great Britain.

These policies also included the establishment of a deep-sea merchant marine fleet, Irish Shipping Ltd. and the successful diplomatic channels which Ireland maintained with the belligerents on both sides.[43] Thus, while neutrality was threatened but never really under serious risk, the Irish Government was nevertheless faced with the consequences of severe economic sanctions. The sudden reductions in the supply of vital raw materials and other goods left the country reeling and in a bid to meet some of the problems being faced, the Government took another counter measure by establishing, in February 1941, the Emergency Scientific Research Bureau.

CHAPTER 5

Establishment and Remit of the Emergency Scientific Research Bureau

From the outbreak of World War II in 1939, the shortage of materials and the effect on Irish Industry was gradual;initially manufacturers were more concerned with continuity of supplies rather than the actual quantitative shortages of basic raw materials. However, from January 1941, the economic sanctions imposed by Gt Britain began to have a more progressive impact and their effects on Irish industry and commercial life became more pronounced and more dramatic. Many factories were forced into a rather precarious existence and some indeed had to close down totally. However, through ingenuity and improvisation, the wheels of industry were kept turning. This was achieved with the active assistance of the ESRB.

It is proposed now to examine the main factors which led to the establishment of the Emergency Scientific Research Bureau (ESRB). The significance of the Bureau's remit will be examined in particular; this remit, to which the IRC had aspired unsuccessfully since its foundation, enabled the Bureau, through scientific ingenuity and technological improvisation, to resolve a number of potentially serious problems facing the economy and specific sections of industry.

The major reductions in the supply of petrol for the transport industry threatened to become a major problem; the shortages in the supply of lubricating oil posed an even more serious threat for both transport and industrial machinery. The match-making industry

depended primarily on two chemicals, phosphorous and potassium chlorate, neither of which was produced in Ireland; since both were used in the munitions industry, it was inevitable that they would become unavailable as they were used in the manufacture of munitions. Another problem related to disinfectants, which due to the previous campaign against 'foot and mouth' disease, were already in short supply. Again, the bulk of the phosphate fertilizers then in use was manufactured from materials imported from Spain and North Africa and it was going to be difficult to provide adequate supplies of both of these commodities. The Irish Government was faced with major crises on a number of technical fronts, accentuated by the economic sanctions being imposed by Britain. It was not surprising therefore to find that the special Cabinet Committee which dealt with emergency problems, discussing what could be done to deal with the economic and social consequences resulting from a complete cessation of all imports of supplies.[1]

On the 30 January 1941, a memorandum was forwarded to both the Minister of Supplies and the Taoiseach from the Council of the Federation of Irish Manufacturers. This memorandum, prepared by Dr J Drumm, detailed a series of proposals 'to deal with the pressing problems of national supply arising out of the present war situation'. A deputation from the Federation subsequently met the Taoiseach when the proposals, together with detailed supplementary suggestions, relating to alleviation of the shortfall in supplies, were discussed at length.[2] The Council of the Federation of Irish Manufacturers proposed that a special Board or Body consisting of business men and senior scientists working under the control of the

Minister for Supplies or the Minister for Industry and Commerce should be established. This special Board should be empowered to address the industrial problems being faced by the agricultural, food, clothing and building industries, the fuel and transport industries and engineering industries; it should be asked also to consider what steps might be taken to exploit and use native raw materials during the current 'Emergency'. The Council made other proposals for

> the marshalling and mobilization under effective direction of the skill, plant and machinery in the Universities, the College of Science, Technical Schools, the various industries and public utilities [and] the development during the present national emergency of the available material resources such as paper, rags; old motor and cycle tyres; saw mill refuse; unusable fodder; scrap metals; Clare phosphate; ammonia and potash fertilizers from kelp; alcohol from ethylene; sea water evaporation; barytes and zinc ores and Portacloy china clay.[3]

The seriousness of the supply position faced by Irish industry can be inferred from the range of by-products and waste materials which the Federation was suggesting could be utilized and recycled.

On the 5 February 1941, Dr J J Lennon, the Secretary of the Industrial Research Council, discussed with the Taoiseach the setting up of a small advisory committee to deal with the technical problems involved in providing essential supplies from native materials during the Emergency. Subsequently, at the invitation of the Taoiseach, Dr Lennon sent him, the following day, a short memorandum on the topic in which he indicated that 'unless the proposed committee can effectively spend £10,000 in one year they will achieve very little'.[4] Dr Lennon proposed further that the committee should consist of not more than five persons who would be

expected to devote a considerable amount of their time to the work and that it would be necessary to remunerate the members for their services and, perhaps most significantly, that the committee should be set up under the Department of the Taoiseach. The fact that the ESRB was subsequently constituted along the lines proposed by Dr Lennon, including the provision of £10,000 by a grant-in-aid to cover expenses of investigations and researches in the first year of operation is indicative of the regard which the Taoiseach had for Dr Lennon and his proposals.[5]

As a result of these representations, the special Cabinet Committee dealing with Emergency problems decided on 6 February 1941, that:

> with a view to overcoming as far as is practicable, the difficulties created by the restrictions, due to the emergency, on the supplies of industrial materials, a small committee should be set up consisting of persons of suitable professional and technical qualifications, to advise Departments as may be required from time to time on technical problems relating to industrial processes and the use of substitute materials, to draw up a panel of persons qualified to undertake research work in regard to such problems, to assign particular tasks of research to persons qualified to undertake them and to supervise generally the carrying out of the research work so assigned, the Committee should be established for a period of twelve months in the first instance and that its members should be paid honoraria at the rate of £300 per year'.[6]

The selection of the personnel of the proposed committee was to be left to the Taoiseach following discussion with the Minister for Industry and Commerce. As it was anticipated that this special committee, the Emergency Scientific Research Bureau as it was eventually called, would probably be engaged in activities of concern to a number of Government Departments, it was decided that the Bureau should be placed under the general control of the Department of the Taoiseach; this tactic would facilitate and

expedite the decision-making process. It is very possible that the circuitous reporting relationships of the earlier IRC, referred to already, contributed to this particular decision.

Initially the Bureau was established for the period 20 February 1941 to the 31 March 1942 but it was subsequently continued in office for each of the next three years. By the end of 1944, the supply position for imported materials was improving, helped to some extent by the efforts of Irish Shipping Ltd; it was inevitable that by 1944, the Bureau, established to meet specific problems arising from the 'Emergency', would begin to wind down its operations.

The setting up of the Bureau and its terms of reference did not attract support from all Government Ministers. In a letter to the Taoiseach, the Minister for Finance, S.T. Ó Ceallaigh, indicated that

> there is little use at this stage of the war in setting up an entirely new body and charging it with such major tasks, as are mentioned in the opening paragraph of the memo accompanying Mr Lennon's letter of the 6th instant and there is grave danger of conflict between different organisations. At the present time we have the Industrial Research Council; we know that the Minister for Industry and Commerce is devising plans for the reorganisation of industrial research; and now there is this proposal for an additional Research Committee.
>
> I do not know whether the Department of Industry and Commerce, of which Mr Lennon is a whole time official, had an opportunity of seeing his [Dr Lennon's] proposals before they were put up or whether he consulted the Industrial Research Council on the matter.[7]

The Secretary of the Department of the Taoiseach wrote to the Secretary of the Department of Finance on 17 February 1941 advising him of the Taoiseach's decision to set up the Bureau and requesting

> the early sanction of the Minister for Finance for the setting up of the Bureau along the lines indicated and for the provision of the sums mentioned for the purposes of its work.[8]

The Minister for Finance still objected; he stated that, while he was prepared to approve the proposal in principle, he wished to have a number of matters dealt with before this new body was formally established; he indicated also that he would prefer to have this new body attached to the Department of Supplies or preferably to the Department of Industry and Commerce. However,

> if the Taoiseach desires to keep the work of the Bureau under his personal supervision, it should be practicable to arrange that the Bureau would report to him [the Taoiseach] through the Secretary or the Assistant Secretary of the Department to which the Bureau is attached.[9]

The Minister for Finance stated also that, in his view, the Bureau will have 'a roving commission' which was undesirable. He also voiced serious objections to having the Secretary and staff of the Industrial Research Council placed at the disposal of the Bureau and to the paying of honoraria to the members of the Bureau; this was a precedent and counter to existing practices where 'citizens, in response to appeals by the Government, are spending their time and energy without reward in the work of National defence'; the Minister for Finance also sought clarification of the 'basis upon which the proposed grant-in-aid had been assessed'.[10]

Despite these objections from the Minister for Finance, the Taoiseach had already decided that the setting up of the Emergency Scientific Research Bureau was to proceed forthwith. In a letter, dated 21 February 1941, from the Secretary of the Department of the Taoiseach, the Secretary of the Department of Finance was advised that:

> in view of the urgent and unprecedented circumstances in which it has been found necessary to establish the Bureau, he [the Taoiseach] is satisfied that it will not be possible to conform to the usual lines of official procedure in regard to its institution, its activities, or its position vis-a-vis other Departments. He [the Taoiseach] regrets, therefore, that he cannot accept the proposals ..... [referred to in] your reply.[11]

The Taoiseach's rejection of the proposals had of course already been made publicly; the Government Information Bureau had released a statement on 20 February 1941 on behalf of the Department of the Taoiseach, announcing the formal setting up of the Bureau.

The establishment of the ESRB under the control of the Department of the Taoiseach was a significant and new development. It will be recalled that the Industrial Research Council was obliged to submit its recommendations to both the Department of Industry and Commerce and to the Department of Finance before approval was given. It is reasonable to assume that De Valera was well aware of the difficulties under which the IRC and its proposals laboured. In the special circumstances prevailing during the 'Emergency', De Valera had recognised that, a more flexible and responsive mechanism was required. The expectation was that this new body, in reporting directly to the Taoiseach, could anticipate a more expeditious handling of the necessary sanctions needed to proceed with the investigations recommended by the ESRB. The Taoiseach had been convinced, particularly by Dr J J Lennon, of the necessity of having a small body of scientists with a definite remit and budget arrangement to advise the Government. The remit was very specific; the Bureau was required to investigate the development of substitute materials and processes to mitigate the interruptions and shortages of supplies of imported raw materials and commodities; these shortages were causing serious difficulties and problems for the country and immediate action was called for.

It should be recalled that, at the time of the establishment of the Bureau, the Department of Industry and Commerce had been examining proposals for the reorganisation of industrial research on a more permanent and autonomous basis. The Taoiseach indicated, in a statement to Dáil Éireann on 6 March 1941 that the proposals under consideration had come from the IRC itself; he did not however advert to the fact that the proposals were first submitted to the Department of Industry and Commerce early in 1936; no doubt the Department's lethargy in making up its mind may have contributed to the decision to put the ESRB under the Department of the Taoiseach.

He went on to indicate that new legislation would be required to implement the proposals relating to reorganisation of industrial research; this legislation would require a good deal of preparation and an appreciable time to complete, particularly as most of the relevant Departments concerned were fully engaged on other emergency work. In these circumstances, it was decided to set up an *ad hoc* body rather than to make use of the Industrial Research Council which, as has been shown, could not deal with the immediate problems confronting the country due to the way it had been set up and funded.

A significant series of events occurred even before the Minister for Finance received the letter of 17 February 1941 advising him of the Taoiseach's decision to set up the ESRB. On the 15 February 1941, the Taoiseach had written to Prof J J Dowling, Professor of Technical Physics,University College Dublin and invited him to comment on the proposed terms of reference for the *'Emergency Scientific Research Bureau'*.[12] On the same date, there was an

informal meeting of the proposed members of the Emergency Scientific Research Bureau, after which Prof Dowling advised the Taoiseach that:

> the members are of the opinion that to carry out their duties they must have the assurance of the full backing of the Government in arranging for the immediate construction, utilization and improvisation of plant and facilities in co-operation with Government Departments, Public Authorities and industrial takings[13]

Some minor amendments to the proposed terms of reference were suggested together with the inclusion of the sentence 'generally to do all that may be necessary to implement the above terms of reference'. That same day, the Minister for Industry and Commerce, Séan McEntee, wrote to Dr L J Kettle, the Chairman of the Industrial Research Council, advising him of the desirability of reorganising industrial research after the war and informing him of the setting up of the Emergency Scientific Research Bureau.[14] These events are indicative of the dedication and commitment shown by the Taoiseach in the establishment of the ESRB; no one was permitted to stand in the way or delay the implementation of his policy, once he had decided to proceed.

The statement released by the Government Information Bureau, on 20 February 1941, on behalf of the Department of the Taoiseach, stated

> In view of the restrictions, arising from the emergency, on the imports of essential commodities and raw materials, the Government have decided to set up a small advisory body to deal primarily with the technical problems involved in the provision of substitute processes and materials during the period of the emergency. This body, which will be known as the Emergency Scientific Research Bureau, will be attached to the Department of the Taoiseach and will have the following terms of reference:-
>
> (1) To give technical advice to the Government on such special problems relating to industrial processes and the use of substitute materials as may be referred to them.

(2) To advise the Government generally on the use of native or other materials to meet deficiencies caused by the restriction of imported raw materials and commodities.

(3) To direct or conduct special researches and inquiries connected with the above.

The following have been appointed to be members of the Bureau:-

J J Dowling Esq. MA — Chairman
Professor of Technical Physics
University College
Dublin

J J Drumm Esq, DSc

M A Hogan Esq, DSc
Professor of Mechanical Engineering
University College
Dublin

J H J Poole Esq, ScD
Professor of Geophysics and Experimental Physics
Trinity College
Dublin

T S Wheeler Esq, DSc
State Chemist

The Secretary to the Industrial Research Council, Mr J J Lennon, MSc, DPhil, will act as Secretary to the Bureau which will utilize the premises of the Industrial Research Council at 45 St Stephen's Green, Dublin as headquarters.[14]

On the 20 February 1941, Prof Dowling wrote to the Taoiseach advising him that the Bureau had met informally that same day to discuss generally their lines of work and that the members had decided that they could immediately offer useful suggestions on the following urgent matters:-

(i) substitute fuels for road transport, e.g. fuels for producer plants, substitutes for petrol and diesel oil.

(ii) materials in short supply, such as,

Material	Purpose
oils	illumination etc
liquid sulphur dioxide	fruit preservation
glucose	confectionery
liquid carbon dioxide	mineral waters, etc
alum	paper making

	starch	laundry, etc
	solvents	paint industry
	glycerine	various
	drugs	medical, etc.

(iii) fertilizers

(iv) salvage and utilization of waste products.

(v) the utilization of seaweed and peat in collaboration with the Industrial Research Council.[16]

A copy of Prof Dowling's letter was forwarded to the Minister for Industry and Commerce; he advised the Taoiseach that both the Department of Industry and Commerce and the Department of Supplies had already arranged to call together representatives from the essential industries to discuss the stock position and the steps to be taken to obtain substitute materials.[17] The Minister also advised the Taoiseach that representatives of the 'new Research Bureau' would be invited to attend these conferences with the essential industries in order to get into direct contact with industry and to be informed of the problems which the Bureau might help to solve.[18]

In Dáil Éireann on the 6 March 1941, the Taoiseach introduced a supplementary estimate for the Emergency Scientific Research Bureau; in this statement he reviewed the reasons for the setting up of the Bureau and in considering its remit, referred to its terms of reference, and stated that:

> proposals for work to be dealt with [by the Bureau] will be submitted to the Taoiseach, and when he [the Taoiseach] has satisfied himself, after consulting with such advisors as he thinks necessary .., that it is desirable that the work should be undertaken, a decision will be forthcoming at once. Certain delays which would otherwise occur it was felt would be obviated in that way'[19]

From this statement and subsequent events, it can be concluded that De Valera, in his capacity as Taoiseach, was not going to permit Government Departments to delay or withhold sanction from proposals or projects which the Bureau submitted to him for approval. The Minister for Finance, in particular, would be obliged to pay the necessary sums of money to the Bureau on the recommendation of the Taoiseach.

All the members of the Emergency Scientific Research Bureau were resident in Dublin and this facilitated daily consultation and rapidity of response. No attempt was made to select representatives of different interests or institutions. What was aimed at, and largely achieved, was to establish a small cadre, whose combined activities, interests and experience equipped them to handle a variety of problems.

This lack of representation prompted the President of University College Cork to write to the Taoiseach to 'regret that the services of none of them [college staff] can be availed of in connection with the Emergency Bureau'. The Registrar of UCC, Prof A O'Rahilly, whose letter was attached was even more critical of the Bureau. He considered the establishment of this 'centralised Research Bureau', under the control of a small number of people in Dublin, to be a serious threat to the status and academic standing of UCC and to the retention of its postgraduate students. He alleged that insufficient attention and consideration had been paid to the scientific quality of the work and research of the staff of UCC

and questioned the wisdom of a 'policy of bureaucratisation' instead of the current principle of decentralisation of scientific research. However, commenting on the projected demise of the IRC, he acknowledged that while its failure could be attributed to its inherent defects,

> its replacement by a smaller body directly responsible to the Prime Minister is long overdue.[20]

This outburst was rather premature since it had been anticipated that the Bureau would obtain the services of other scientists and technicians as required. It ultimately turned out that UCC and its scientific staff contributed to the activities undertaken by the Bureau.

The office accommodation and the administrative support staff necessary to underpin the activities of the Bureau came from the Industrial Research Council. The redeployment of these resources enabled the Bureau to begin work immediately; in the course of time, these IRC staff members were augmented by members of the Civil Service, by members of the army and by staff from various companies. Such personnel normally possessed special qualifications and expertise required by the Bureau; they were seconded for whole and/or part-time service with the Bureau. A large amount of abstraction and translation of scientific literature was necessary and this was carried out with great efficienty by the Records Officer of the Industrial Research Council.

In the beginning, the boundaries attaching to the Bureau's remit were somewhat unclear; it was not immediately obvious whether the Emergency Scientific Research Bureau would operate in an advisory capacity, whether it would initiate and direct investigations carried on by others or by itself, or, indeed, whether it would take over the complete direction of such investigations on a national basis. In the final analysis, it will be seen that the Bureau used all of the above mentioned modalities in discharging the various responsibilities entrusted to it. It will emerge also that, under De Valera's control and patronage, the Bureau enjoyed a very high measure of scientific autonomy; this will be evident by consideration of the autonomy enjoyed by the Bureau in the selection of investigators and in the diversity of scientific investigative methods employed.

Although the Bureau was financed by a grant-in-aid and had degrees of freedom of action not enjoyed by other organisations, the Department of the Taoiseach still maintained effective control over the Bureau's activities. Sanction had to be obtained from the Department of the Taoiseach in advance of the initiation of any new project; in addition a tentative estimation of the financial expenditure, likely to be incurred, had to be supplied. Furthermore, no new post could be created nor could anyone be taken into employment without prior sanction being obtained. The Bureau was required to furnish the Department of the Taoiseach with not only progress reports at regular intervals on all work in hand but also a copy of the minutes of each meeting. Indeed, the officers of the Bureau and those of the Department of the Taoiseach were in almost daily contact and the Taoiseach conferred frequently with

the members of the Bureau throughout the entire period of its existence. This involvement is perhaps a direct measure of the Taoiseach's regard for and personal interest in the activities of the Bureau. This intense interest and involvement in the work of the Bureau may be attributed to De Valera's lifelong interest in science, and in particular, mathematics. Between 1906 and 1912, he held a number of teaching posts including teaching mathematics at Carysfort Training College, Blackrock; however, following an unsuccessful application for the chair of mathematical physics in University College Cork, his energies were directed more and more to the activities of the Gaelic League and to republican politics. Throughout a long and arduous political career he never lost his interest in matters scientific and mathematical. [21]

This interest is perhaps best illustrated by an event which occurred during the negotiations which led to the 1938 agreement between Ireland and Great Britain on the return of the naval bases. British security men, who accompanied De Valera during his time in London, had noticed him looking carefully at a certain book in Foyles of Charing Cross Road; the book was a first edition of a book by Hamilton on the elements of quaternions. On being informed of this Malcolm MacDonald, the Dominions Secretary, who wished to give De Valera a souvenir of their association during the agreement discussions, bought the book, had it rebound and presented it to De Valera; it became a treasured possession.[22]

A further example of his interest in the world of academe was his serving as Chancellor of the National University of Ireland to which he was elected in 1921. His most significant achievement in

his role as a patron of learning was the establishment in 1940 of the Dublin Institute for Advanced Studies with schools of Celtic Studies, Cosmic Physics and Theoretical Physics. It was inevitable therefore, that when it came to the appointment of the members of the Bureau, his own personal knowledge and academic friendships would be used to full advantage in the selection of people of eminence and ability.

Professor Dowling, the Chairman, was a founder member of the Institute of Physics and had been a fellow-student with De Valera at the Royal University of Ireland. Dowling's first university appointment in UCD occurred in 1907; later, he became Professor of Technical Physics in 1937. Amongst his most notable public achievements might be listed his work for the Dublin Ports and Docks Board which resulted in the installation of an automatic fog-signalling system in the port of Dublin. Another notable achievement was the production of the first electronic seismograph which was exhibited in September 1921 at the Edinburgh meeting of the British Association for the Advancement of Science.[23]

Dr Drumm's eminence as a scientist has been referred to in an earlier chapter; he was therefore a most appropriate appointment particularly as he was also a prominent member of the Federation of Irish Manufacturers Ltd.[24]

Professor Hogan graduated in 1918 obtaining the degree of BEng with first class honours from the NUI; later in 1919, he became the first student to gain the MSc degree in Geology, a qualification which assisted him in his later work with the Safety in Mines

Research Board, London and as a member of the Board of Mianrai Teoranta. From 1919-1939, his career was in Britain and abroad, at Imperial College, London, with the British Department of Scientific and Industrial Research, Sir Wm. Arroll (Glasgow) and Siemens Bau-Union (Berlin). In 1939 he returned to UCD on his appointment as Professor of Mechanical Engineering.[25]

Professor Poole spent his entire academic career at Trinity College, Dublin obtaining the degrees of MAI and ScD. His first appointment, in 1919, was as a junior research assistant to Professor John Joly; Joly was a Fellow of the Royal Society and Professor of Geology at TCD and had many outstanding scientific achievements to his credit. In 1921, Poole became assistant to Professor W E Thrift in the Department of Physics and was appointed physics lecturer in 1930. In 1934, he was appointed Professor of Geophysics, a position he occupied until his death. Professor Poole pioneered the photographic plate technique for recording and measuring levels of radioactivity in minerals. His status as a scientist and research was confirmed by Trinity College in the award of the degree ScD.[26]

Dr Wheeler, who held the degrees of BSc and PhD from London University, worked as a research chemist in the Royal Naval Cordite Factory (Dorset) and Royal Arsenal (Woolwich) from 1921-1928. Later he became senior research chemist at ICI Ltd (Northwich), Professor of Organic Chemistry at the Royal Institute of Science (Bombay); this was his last post abroad prior to his appointment as State Chemist in Ireland in 1938. Already a scientist of international reputation, he had over 100 published papers, 20 patents and a

number of text books to his credit.[27] He was later Professor of Chemistry in UCD from 1946-1968.

Dr Lennon obtained the degrees of BSc and MSc from the National University of Ireland. In 1921, he was awarded an *1851 Scholarship* and continued his studies at Lincoln College Oxford, being awarded the degree of DPhil in 1925. After working with Lever Bros in England, he returned to Ireland in 1935 on his appointment, as Secretary to the Industrial Research Council.[28]

The establishment of such a body in the context of the 1990s may be seen as a normal occurrence but in the Ireland of the 1940s this was a significant development. Given the scientific eminence of its members and the political support from the Taoiseach and his Department which the Bureau received, it was bound to be a success. Moreover, given the critical economic conditions obtaining at the time of the Bureau's establishment, its task was indeed a major one. The following four chapters will detail the contribution made and the successes achieved in a number of specific crucial areas over the short four year existence of the Bureau.

However, there is one anomaly on the establishment of the Bureau which had never been noticed at the time, i.e. there was no formal order ever made by the Government on the matter of the establishment of the Bureau. Indeed, there is no record whatsoever of a formal decision of the Government to set up or establish the Bureau. At a later date, when a pensions scheme for the Institute for Industrial Research and Standards was being prepared, including

making provision, *inter alia*, for a pension for Mr Donal Flood, the Director of the IIRS, which would include as reckonable service his period of service with the ESRB, it transpired in official documents, that the Bureau had no statutory status. However, since the Dáil had voted on and sanctioned expenditure for the Bureau and because the press notice of 20 Februrary 1941 and the Taoiseach's statement in the Dáil on 6 March 1941 indicated that the Bureau was established by the Government on 20 February 1941, the issue was resolved on that basis.[29] It is of interest to note in connection with this issue that the Report of Activities of ESRB, dated 7 November 1945 and published in October 1946 contains the statement 'The Emergency Scientific Research Bureau was set up by the Taoiseach on the 20 February 1941';[30] an example, perhaps, of the power which De Valera exercised in controlling the affairs of the Government and the destiny of the country. This power base and status was constantly affirmed by his own ministers who spoke and referred to him as the 'Chief'.

CHAPTER 6

Fuels and Heavy Industry

The extent of the country's economic dependence on Great Britain has been already outlined. It was obvious therefore that serious consequences would result from the country's declaration of neutrality. The effects of the resulting economic sanctions, imposed by Great Britain, have been considered in detail, particularly the critical shortages caused by massive reductions in the supplies of fuel oils, petroleum, coal imports and iron and steel. The altered export licensing arrangements caused other major problems to economic activity; export to Ireland of a wide range of essential commodities was curtailed severely or prohibited entirely to such an extent that virtually no sphere of industrial or community activity was left unaffected. In an attempt to redress the problems caused, the Emergency Scientific Bureau was set up by the Government. In this chapter an examination will be conducted of the work undertaken by the Bureau to ameliorate the difficulties caused to heavy industries by fuel shortages and by the cessation of iron and steel supplies.

At the first meeting of the Bureau held in University College Dublin on 21 February 1941, Prof Dowling, the Chairman, advised members that he had discussed with the Taoiseach the Bureau's remit. Their attention was to be directed, as a priority, to the possible development of substitutes for imported fuels[1]. The members were advised that the Taoiseach was particularly anxious to know, in addition, if native anthracite supplies should be reserved for producer plants for road transport and if there was a

sufficient supply of steel for the construction of producer plants. Other matters which the Bureau was directed to consider included re-cycling used oil to offset the shortage of lubricating oils, utilizing waste materials and exchanging scrap metal for special steels.

The directive from the Taoiseach that the Bureau should initially direct its energies to the possible development of substitutes for imported fuels was a direct consequence of the decision by the British War Cabinet to curtail drastically oil supplies to Ireland. As already indicated, oil supplies in 1941 were some 50% below previous normal consumption levels and the effect was very serious; it was of crucial importance, therefore, for the country to seek alternative means to maintain essential road transport services. The Bureau concluded that the only practical alternative was producer gas generated from a solid fuel in a portable plant attached to a vehicle[2]. This did not of course exclude the use of town gas as another petrol substitute; however, if town gas was to be used for this purpose, it would be necessary to monitor this type of consumption of town gas as otherwise unwarranted reductions might occur in supplies for other more essential purposes such as household use.

The number of producer plants, which could be manufactured, was not of immediate concern as there was sufficient material available for the manufacture of about 3,000 producers for road vehicles. However, the available supplies of Irish anthracite was sufficient only to operate about 400 producer units on heavy vehicles covering about 150 miles each per day.[3] It was thus apparent that the major

factor limiting the extent to which producer plants could replace petrol was the amount of suitable solid fuel that could be obtained.

The most suitable fuels for producers were anthracite, coke, and charcoal and immediately the Bureau took steps to ascertain the quantity and quality of the different types of fuel likely to be available. The Forestry Division of the Department of Lands indicated that supplies of wood suitable for making charcoal were very limited and so the Bureau decided that wood charcoal could only be considered of minor importance as a producer fuel.[4] The information available indicated that turf charcoal was unlikely to be as suitable as anthracite and it was agreed to postpone detailed consideration of turf charcoal in favour of anthracite.

On the 27 February 1941, two members of the Bureau, Professor Hogan and Dr Wheeler visited the anthracite mine at Castlecomer and concluded that, although 100,000 tons of anthracite were mined annually, it would not be possible to expect any significant expansion of output on account of the lack of pit space and trained miners.[5] Approximately 5,000 tons per year of anthracite, suitable for producers, could be made available; to increase this amount would require the crushing of large coal which was impractical as this coal was being used for other purposes. As a 'producer' lorry covering 150 miles per day would require about 25 tons per year, the amount of fuel available from Castlecomer would be sufficient for just 200 lorries. By re-organising the production methods being used at Castlecomer, a further 5,000 tons of suitable anthracite might be made available.[6] However, all of these supply calculations

depended on the steel haulage cables being used in the mines; production would cease if the steel cables became worn out as they could not be replaced because of the sanctions imposed. A further visit to the anthracite mine near Athy indicated that although production there was about 15 tons per day, re-organisation might produce between 50 and 100 tons per day.[7] It was apparent that supplies of native anthracite were insufficient to make any significant impact. This shortfall in anthracite supplies for producer-driven lorries was so serious that the Chairman immediately reported the position to the Taoiseach. Prof Dowling indicated that, if producers in any number were to be fuelled, it would be necessary to import anthracite; the only other viable alternative was to provide turf charcoal.

Overall, the fuel situation, at this time, was giving serious cause for concern; a reduction in the supply of certain fuels resulted in the increased use of other fuels and the depletion of the fuel supply position as a whole. The Bureau concluded that it would be necessary to co-ordinate the fuel supply on a national basis by appointing a Fuel Controller. The Bureau urged strongly on the Taoiseach that this appointment be made to make the most effective use of the available supplies of both native and imported fuels, and to co-ordinate and control the purchase, storage, distribution and use of such fuels. This recommendation for the appointment of a fuel controller was referred to the Department of Supplies for consideration. In a subsequent reply, the Minister for Supplies indicated his opposition to the adoption of this suggestion on the grounds that:

> if a controller were appointed with separate statutory powers ... serious difficulties would arise if he showed any disposition to exercise those powers in a manner which would not be entirely consistent with the Minister's policy[8]

This recommendation from the Bureau caused some concern; the Bureau was accused of going beyond its remit, to the point of interference in the normal work of a Government Department. It resulted in a personal meeting between the Taoiseach, and Prof Dowling where it was pointed out that this specific matter was primarily one for the Department of Supplies; the Bureau was asked to exercise every care to avoid any overlapping between the work of the Bureau under its terms of reference and the work for which other Departments of State might be responsible. A letter along the same lines was drafted in the Department of the Taoiseach but never sent, presumably in case it would have been interpreted as an official reprimand.[9]

As there was no possibility of importing the supply of anthracite needed, the Bureau decided to concentrate on the manufacture of turf charcoal. A conference was arranged for 7 March 1941 to which representatives of the Department of Defence, the Turf Development Board, the Great Northern Railway and the Great Southern Railways were invited to attend. The outcome of this conference was a decision to concentrate on producing charcoal in closed retorts; the alternative method was to produce turf charcoal in meilers, pits or portable kilns; such charcoal was considered to be unsuitable for use in producers attached to vehicles. Three experts, Messrs Bratt, Burnell and Warner were commissioned to submit a report giving details of a scheme for the manufacture of a total of 8,000 tons of turf charcoal per annum; this amount would be equivalent to 1,000,000 gallons of petrol. Their report,

submitted 31 March 1941, outlined a scheme for the manufacture of this quantity of turf charcoal at four plants erected on bogs at Turraun (Co Offaly), Lyrecarumpane (Co Kerry) and in Galway and Donegal; the estimated cost of these plants was £60,000 with the total quantity of air dried-turf required of the order of 35,000 tons per annum.[10] The fact that such a massive scheme was contemplated at such short notice is indicative of the degree of crisis existing in the overall fuel position and of the official view of the steps which were necessary to mitigate the shortages.

The Bureau realised quickly that the proposed carbonisation plants embodied many technical features, practical experience of which was lacking in Ireland. As a consequence, it would be necessary to carry out some large scale experimental work on the carbonisation of turf in existing vertical retorts at the gas works in Dundalk and Dublin. These experiments, which proceeded during April and May 1941, indicated that good quality turf charcoal could be made in a vertical retort, but the yields obtained were lower than the estimated yields[12]. This experimental result was disappointing to say the least and suggested caution before embarking on the construction of the plants on the scale originally contemplated. This caution translated into a decision to build and operate a full-scale experimental plant to gain the necessary technical experience. At the same time, with the growing fuel shortage, it had become clear that it would still be necessary to plan for the location of a plant, which would ultimately require up to 35,000 tons of turf per annum; as such sites were somewhat remote from the major centres of consumption, this factor would cause additional transport problems.

A conference, held in June 1941, between representatives of the Turf Development Board, the Secretary to the Department of Finance, who was then Turf Controller, and the Department of Supplies, led to the finalisation of a scheme to erect a full-scale experimental plant designed to produce 1,000 tons of turf charcoal per annum. The site finally selected was a bog at Turraun owned by the Turf Development Board.[13] There was no one with the requisite operational experience of such a plant available in Ireland and thus information was sought from the Fuel Research Station, Greenwich, England on the type of plant necessary to produce turf charcoal[14]; this request was followed up later by a visit of one of the members, Professor Hogan, during February 1942.

The Director of the Fuel Research station intimated his willingness to assist the Bureau in this task; more importantly, he indicated his support for any export licences needed for materials required for the Bureau's experimental plant at Turraun[15]. This assistance took the form of the Fuel Research Board undertaking experiments for the Bureau on the carbonisation of Turraun turf in vertical retorts; the experimental data obtained provided useful information for the design of the Turraun plant. In addition, the Board offered critical comment on the plant design in the early stages of its development.

The laboratory experiments indicated that turf heated in vertical retorts to a temperature of about 700^{o}C produced charcoal of the right consistency. The retort could be of cast iron for

temperatures up to about 650°C; a higher temperature than this for any period of time caused deterioration of the metal. An alternative was to have the retort made of good quality firebrick which could sustain temperatures of up to 1500°C. Another factor to be considered, in the selection of the type of retort to be used, was the superior mechanical strength of cast iron segments bolted together; in addition, a cast iron retort would be easier to erect and less prone to gas leaks. Firebrick, even when made of interlocking segments, was still mechanically weaker and liable to damage during stoking operations. It was decided finally to erect two retorts one of cast iron and the other of firebrick; the designs of the retorts were based on the information from the Fuel Research Board. Since turf is a bad conductor of heat, the width of the retorts had to be kept small; the width of the firebrick retort was set at 11 inches, the cast iron retort at 15 inches.

Construction of the plant began in October 1941. However, delays inevitably occurred due to various problems caused by the 'Emergency' situation in the country; a transport stoppage occurred on the canal; it proved difficult to get suitable machinery, firebricks and steel; again, because of the wartime conditions, the normal procedures for selecting machinery or material could not be followed; it became a question of using whatever was available, e.g. second-hand machinery or near-suitable materials suitably modified for the purpose required. Other difficulties arose due to inability of the Turf Board power station to supply the power necessary for the operation of the plant and a

separate gas engine and generator had to be installed. In the original designs no provision had been made for the recovery of by-products but as there was considerable interest in tars and waxes in 1942 it was decided to instal a condenser plant in addition[16].

Approval was sought and obtained by the Bureau for additional expenditure up to £2,000 to cover the cost of erection of a power house, condensing plant and the temporary control laboratory at the Turraun plant. This additional sum brought the total estimated expenditure to the end of the 1942 financial year to approximately £10,800. Set against this was an estimated revenue of £4,200 from the sale of products. By the end of August 1942, approval had been given to the Bureau to engage twelve workmen required for the operation of the plant at Turraun. By December 1942 this number had increased to twenty four.[17]

It was not until 22 February 1943, some eighteen months after construction of the plant had started, that both retorts at the plant began to make charcoal; by the 29 June 1943 a total of 117 tons of charcoal had been produced.[18] However, by this time sales of charcoal had fallen and a surplus of about 80 tons existed. It was obvious to the most casual observor that the use of a producer fuelled by turf charcoal was proving not to be a viable alternative to offset petrol shortages. It was not surprising to find the Department of the Taoiseach reluctant to authorise additional expenditure on the experimental plant; an upturn in the sales of turf charcoal was to be a prerequisite for further funds.[19] It is

somewhat surprising that a surplus existed for the Turf Development Board had been approached by a commercial firm, around 11 August 1943, which offered to buy the entire output of the Turraun Plant at £20 per ton; no follow-up action on this offer was apparently initiated by either the Bureau or the Turf Development Board. It may well be that the sale was never sanctioned as it would have brought a small but potentially important fuel supply outside the control of the Government.

Despite the ongoing experimental nature of the plant, it was decided, following discussion between the Taoiseach and Professors Dowling and Hogan that the Turf Development Board would be responsible for the work at Turraun from 1 December 1943 on the understanding that the Bureau, through Professor Hogan, would retain day-to-day control of the plant and have a free hand in carrying out further experimental work.[20]

The difficulties being experienced in obtaining a market for the output of the plant were still unresolved by end of August 1944 and the Bureau started to consider whether or not it was advisable to maintain the operation of the plant.[21] The Bureau decided to advise the Department of the Taoiseach that production of charcoal at Turraun should cease but that the plant should be kept running on a care and maintenance basis, for a further two months, pending the completion of some alterations and experimental work which had been started.[22] Sanction for the additional experimental work was obtained. This work was completed about 24 November 1944 after which the plant was closed down; a careful study was made of the condition of the plant as it was being dismantled.[23]

The retorts were in production for a total of 92 weeks and a total quantity of 1,218 tons of charcoal was produced from 9,235 tons of turf. These figures cover not only the early period of the experiment when there were numerous problems caused by the makeshift plant and the inexperience of the operators but also periods when the plant was producing charcoal at almost maximum output. The performance of the plant overall might be better considered by considering the average weekly production at selected times when the plant was working to the design specifications, i.e. 3 weeks from 19/5/44 to 9/6/44 and 4 weeks from 21/7/44 to 18/8/44. During these periods the plant was free from any prolonged stoppage due to failure of the power supply.

Table 16 Average weekly production of turf charcoal at Turraun for the periods stated

Production Period(weeks) Beginning	Machine won turf in Retorts		Hand won turf in Producer		Refuse in Boiler	Charcoal produced Tons	Volatiles %
	Tons	Moisture %	Tons	Moisture %			
(3)19.5.44.	75.6	25.1	25.6	31.8	6.25	21.3	11.6
(4)21.7.44.	77.5	28.2	34.5	47.8	4.00	21.75	17.2

Source: Hogan, M.A., Report on Experiments on the Production of Charcoal and Producer Gas from Turf

From the above figures the following conclusions can be drawn:-

(i) Consumption of hand won turf in the first period was much less than that in the second period, due to difference in moisture content.

(ii) When the plant was running almost normally it took approximately 5 tons of air-dry turf to make one ton of charcoal.

The moisture content of the turf was critical to both the calorific value of the gas produced and the yield of charcoal produced. In general an increase in moisture content caused a reduction in the calorific value of the gas and in the yield of charcoal.[24]

In studying the gasification of peat, it was necessary to obtain precise information and data on the composition of the gas produced. Normally, such analysis would be carried out using a relatively slow wet-chemistry method. There was a need for a quicker method to plot the progress of the reaction; a determination of the specific gravity of the gas could serve as an indirect indication as to the composition of the gas mixture. There was a number of devices which could be used to measure specific gravity. However, the conditions, under which the apparatus had to be used, i.e. in a small wooden hut close to the retorts which were situated in a bog, to say the least, did not constitute ideal laboratory conditions.

As a result of the unusual experimental environment, a novel instrument, a centrifugal gas specific gravity meter was developed by Prof Dowling. The instrument proved to be extremely accurate and reliable and was of particular benefit to the monitoring of the quality of the producer gas produced at the plant in the Turraun bog.[25]

At an early stage, in the work of the Bureau, it was recommended that mobile producer units should be reserved for lorries and public service vehicles of 20 h.p. and over, and that all such converted vehicles be re-registered to regulate fuel usage.[26] It was not surprising to find the Bureau involved in experimental work on the actual producer units as their use became more common; by October 1942, there was about 1,145 vehicles with producer units being used in the country.[27] There were several objectives to this work. Firstly, it was necessary to gain experience of the operation of different types of producer using the different types of fuel available. Secondly, because of the iron and steel situation and the cessation of imports of machinery, it was considered prudent to study the effect of producer gas on the life and efficiency of different types of engine and to develop methods of testing the efficiency of producers and gas cleaning apparatus.

The actual laboratory experiments were carried out in the Mechanical Engineering Department of University College Dublin using two engines of different h.p., four different types of producers, a variety of wet and dry filters and five different types of fuel, anthracite, wood charcoal, high temperature turf charcoal, machine-won and hand-won turf both carbonised at 1050^{o}C and turf charcoal made in a steel kiln at 650^{o}C. All of this experimental work enabled the Bureau to respond with sound technical advice and information to operators of producer plants who were experiencing difficulties; manufacturers sought and obtained advice also on the design of producers.

The problem of the efficient filtration of producer gas for use in motor vehicles surfaced early in 1941 and it was decided to investigate the possibility of using electrostatic precipitation to clean the gas of ash particles and liquid tar droplets. Dr E T S Walton of Trinity College, Dublin was commissioned to carry out some special investigations on gas filtration.[28]; the subsequent experimental results demonstrated the feasibility of constructing an electrical filter for use on a mobile unit but the impracticability of its widespread use; this filter, while being slightly more efficient than other simpler types of mechanical filtration, proved to be more expensive to fit, needed more careful servicing, and was not sufficiently superior to the simpler types of mechanical filter to justify the extra expense and complication involved in fitting it.[29]

Prior to the advent of war, Ireland imported annually some two and a half million tons of coal made up as follows:-

Anthracite	45,000 tons
Gas Coal	295,000 tons
Household Coal	1,650,000 tons
Steam Coal	510,000 tons
Total	2,500,000 tons

However, with the imposition of economic sanctions, the quantity of coal being imported at the beginning of 1941 fell to a rate equivalent to 1,500,000 tons per annum. The Department of Supplies believed that the shortage of shipping was the main reason for this reduction; the fact that the country was being subjected to severe

economic sanctions had not yet been realised. It was thought that there was every possibility that the supply position would become progressively worse; as a consequence of this development the Bureau decided to survey the extent to which increased production of indigenous fuels might mitigate this serious shortfall.[30]

The survey indicated that, even with increased production of native fuels, i.e. turf, coal and wood, the maintenance of imports of coal supplies was going to be crucial if severe dislocation of community life was to be avoided. The Bureau anticipated that, even with reducing consumption of imported coal to the minimum, the country would require coal imports of some 1,745,000 tons, made up as follows:- Anthracite 45,000 tons, Gas Coal 400,000 tons, Domestic Coal 450,000 tons, Railways 250,000 tons, Industrial 600,000 tons (including ESB needs). This minimum total of 1,745,000 tons still represented an overall reduction of 30% of normal consumption levels. Against this could be set the anticipated increased production of native fuels, which, the Bureau estimated, would amount to a total of some 520,000 tons (coal equivalent); it would be necessary therefore to import over 1,000,000 tons of coal, at the very least, to avoid grave hardship in the community.

The drastic reduction in the supplies of imported coal that commenced in 1941 was exacerbated by the fact that the amount of gas coal was even more drastically curtailed than that of other coals; this specific shortage had a very serious effect on the production of town gas. The gas companies could only obtain limited supplies of poor quality coal which forced them to restrict output. The reduction and eventual stoppage of coal supplies for domestic

use led to an increased demand for town gas and further restrictions on the gas supply. As the gas supply deteriorated, many of the smaller gas works were forced to experiment and had resorted to the use of wood and turf to supplement their meagre supplies of coal.

At the request of the Department of Supplies, the Bureau made arrangements to carry out a series of experiments at the Kilkenny Gas Works on the production of town gas using turf.[31] These experiments indicated that a mixture of coal containing 20-30% peat could be used successfully in the existing installation but that difficulties developed with the use of a mixture containing 40% peat.[32] The data on this experimental work on the production of town gas from peat was later compiled into a report which was circulated to all the Gas Managers and the various Government Departments.

The principal difficulties identified on using turf gas for town supply, were the greater volume of turf required to make a given number of therms of gas and the lower calorific value and greater density of turf gas. Indeed, the volume of turf required to make a given number of therms varied from three to six times that of the coal required to make the same number of therms. Consequently the retorts, bunkers and conveyers of a plant specifically designed for coal would be inadequate when used with turf. Further, the shape of the retorts allowed for the swelling of the coal on conversion to coke, whereas turf contracted on conversion to charcoal. Appliances could be adjusted to work on turf gas of about 330 BTU calorific

value but the presence of a large amount of carbon dioxide increased its density so that more work had to be done in pushing it through the pipes. This meant that a distribution system designed for coal gas would not be adequate to supply the same amount of thermal energy to the consumers if turf gas were used. This difficulty could be overcome by removing the carbon dioxide by passing the gas over lime; as this treatment was expensive, the usual practice adopted was to wash the carbon dioxide out with water. With the removal of the carbon dioxide the calorific value of the washed gas increased to about 400 BTU per cu.ft.

However, in August 1942 the Dundalk Gas Works reported a failure of the retorts after being in use for about a year [33]. The continued use of peat in gas works was under threat and the Bureau was obliged to investigate the circumstances which led to the problem with the retorts. The investigation determined that the deterioration of the retorts at the Dundalk Works was probably due to the use of unsuitable turf with ash containing a high proportion of free lime; the lime combined with the silica of the retort wall to form a fusible slag. At other gas works and at the Bureau's carbonising plant at Turraun, no damage had been done to the firebrick lining of the retorts which could be attributed to the action of turf ash. The obvious cure was to avoid turf of high ash content and, if possible, to use fireclay retorts. The Bureau had of course recognised that the use of turf in high temperature silica retorts was an emergency operation, to be carried out in the event of stoppage of coal supplies, on the principle, that, turf gas would be better than no gas.

While gas coal continued to remain in short supply, coke became more readily available with the result that water gas made from imported coke began to form a substantial proportion of the output of the Dublin Gas Company[34]. The Bureau was of the view that town gas supplies could be augmented substantially by increasing the production of water gas; the Bureau achieved this objective by devising a method which enabled two hand-operated water gas plants to be operated simultaneously with the two existing automatic water gas plants. Shortly after this arrangement became fully operational, one of the automatic plants had to be stopped for repairs. However, because of the new layout, it was possible to use the two hand-operated plants to replace the damaged automatic set and thereby maintain the supply. Had this change not been made, the gas supply in Dublin would have been immediately reduced by about 1,000,000 cu.ft. per day. Such a reduction would have had the most serious consequences for users of gas in Dublin.[35]

Steel was an essential raw material for many industries and after fuel, was possibly the most important of the industrial imports. The Haulbowline works of Messrs Irish Steel Ltd had been in the process of development but on the outbreak of World War II, the plant was capable of carrying out rolling operations only on imported billets or on old railway lines.[36]

At the beginning of 1941, the supply position of the necessary raw materials was particularly critical. Supplies of imported billets from Britain and the USA had been cut off for sometime and a number of unsuccessful attempts had been made to exchange scrap for steel. Coal imports had been reduced to crisis levels and shipping space

had been drastically curtailed also. These factors, coupled with the inability of the country to manufacture steel, presented very serious problems. The lack of steel imports was going to cause major problems for heavy industry and for manufacturers of various steel products such as wire, bolts and nails; the lack of iron and steel would also seriously curtail the maintenance of railways and motor vehicles.[37]

As a consequence, it was not surprising that investigations directed towards the easing of the shortage of iron and steel formed a considerable part of the Bureau's activities. This work consisted of a number of parallel but complementary investigations[38]. These included:-

(a) an investigation into the possibility of producing iron sheets by electro-deposition when supplies of iron and steel sheets became very difficult to obtain towards the end of 1941.;

(b) the re-use of scrap alloy steel became important when, because of a shortage of spare parts for cars, engines and machine tools, it became necessary to manufacture these items;

(c) the more extensive use of scrap iron in the foundry industry, required attention to be given to the supply position of ferrosilicon which was needed for de-oxidising iron;

(d) the use of turf charcoal as an alternative fuel by both foundries and blacksmiths when coal supplies diminished;

(e) geographical surveys for iron and nickel ores carried out with the collaboration of the Geological Survey.

A preliminary report from Prof Hogan on the production of iron sheets by electro-deposition indicated that the erection of a full scale plant producing some 10 tons per week of electrolytic iron would involve expenditure of around £10,000. Furthermore, as the consumption of electrical energy in the process was of the order of 2000 kWh per ton of iron produced, a special generator would be required[39]. Once again, as a first step, it was decided to carry out some laboratory investigations; Dr Drumm was deputised to carry out the experimental work on the electro- deposition of iron. By May 1942, Dr Drumm had prepared samples of electro-deposited sheet iron; the Bureau concluded that the results of the work were such as to justify moving to larger scale experiments.[40] The Department of the Taoiseach approved the project and the Bureau made arrangements with a commercial firm to lease a part of their premises[41]. Unfortunately, the adaptation of the premises and the construction of the plant took longer than originally anticipated. This was caused by supply shortages and by the limited resources available for adapting and making the alterations to the premises which originally housed a nickel plating plant. Such problems of course were typical of the circumstances under which the Bureau was obliged to operate; in many instances, the pace and success or otherwise of many of the investigations undertaken were determined by factors outside the control of the Bureau.

By 21 October 1942, Dr Drumm reported to the Bureau that two trial runs had been carried out and that while the work was nearing the production stage, the rate of deposition of iron was lower than had been expected.[42] Even so, the installation was sufficient to produce iron sheets of dimensions 4.5 feet by 2.0 feet of any

thickness up to 0.25 inch. When annealed the sheets yielded a sound, ductile soft iron of high chemical purity. The process used was essentially that employed by the firm of Langbein Pfanhauser in Germany during the period 1914-1918.[43]

At a meeting of the Bureau on 25 March 1943, Dr Drumm expressed doubts as to the eventual success of the investigation on electro-deposition.[44] This somewhat surprising development arose partially as a result of the slow progress of the investigation itself but also because of information given to Dr Drumm about similar experimental work carried out in Gt Britain; this work had not resulted in the development of a successful process for commercial exploitation despite expenditure of some £100,000.[45] The Bureau postponed making a final decision on the matter for a few weeks to enable Dr Drumm to prepare a critical report of the work undertaken to date. Eventually, in September 1943, the Bureau terminated this work and decided, with the agreement of the Department of Industry and Commerce, to resume the work only if it became necessary to undertake production for some essential purpose.[46]

It was not really surprising to find the Bureau coming to this decision for the process as a whole was complicated and costly and required skilled supervision at all stages. The first sheets of steel produced worked out at £225 per ton of iron, mainly because of the amount of electric power required; the cost of electric power for the electro-deposition process itself worked out at £107 per ton of iron, while the operating costs of the immersion heaters worked out at £66 per ton of iron produced.[47]

As already mentioned, the continued deterioration of iron and steel supplies, brought about a need for the collection and grading of high alloy steel scrap for re-use in an attempt to relieve the shortages. Towards the end of 1942, imports of spare parts for vehicles and other mechinery virtually ceased and it became necessary to manufacture these essential spare parts from whatever available scrap material existed in the country. As some of the parts being manufactured needed to be heat treated or hardened, it became necessary to know the precise composition of the steel in order to determine the type and duration of heat treatment required.[48]

At that time chemical analysis was normally used for classifying different types of alloy steel; this method was slow and expensive, if a large number of samples had to be analysed. It was obvious therefore that a more rapid method which would be both accurate and inexpensive was required to classify samples into the different grades of alloy steels.[49] The method selected was one using spectographic analysis; this selection was influenced by the fact that this type of analytical method had been introduced recently into the steel-making and steel-using industries of Gt Britain and the USA.[50] Another relevant factor leading to this decision was the availability of a suitable spectograph and microphotometer for measuring spectograms.

This apparatus, which had been designed by Dr T Nevin, was in the course of construction in the workshops of University College Dublin. It was agreed to accelerate the construction and the manufacture of the additional parts required to make it a direct

reading instrument.[51] Over the next few months, during 1943, experimental work progressed and arrangements were made with the British Ministry of Supply to license Messrs Hadfield Ltd, Sheffield, to export the necessary metallurgical specimens which would be necessary for calibration purposes.[52] Eventually the Bureau obtained a set of fourteen standard samples in which the proportions of the alloying elements had been repeatedly checked by chemical analysis. With the aid of these samples, calibration curves were constructed which enabled the determination of the different alloying elements from microphotometer observations on the spectogram plates produced.

The method was entirely successful but was never brought into full use; by the beginning of February 1944, the supply position for alloy steels had improved and the Bureau decided that it would not be necessary to continue with the work unless the Bureau was approached for advice and/or technical assistance by industrial firms.[53]

The increased use of scrap iron in the foundry industry required the use of ferro-silicon as a de-oxidising agent. Supplies of ferro-silicon had been arriving at intervals but, as with so many other supplies and commodities, there was a risk of interruption or stoppage of supplies. In view of this the Bureau decided to investigate the production locally of ferro-silicon. During July 1942, arrangements were made for the erection of an electric arc furnace in University College Dublin and the repair of a generator which would be required for the operation of the furnace. This

work, supervised by Prof Hogan, progressed satisfactorily and a trial run of the furnace took place on 27 November 1942.[54]

By the beginning of February 1943, production of the material had progressed to the stage where the next step was to move on to production on a semi-technical scale. This step required the relocation of the plant to another site and the appointment of additional staff.[55] The Department of Defence agreed to provide the necessary facilities for the plant at the Parkgate site which, in March 1943, was being used solely for the manufacture of chemicals required by the Army for the production of munitions.[56] By June 1943, the production of ferro-silicon had now reached a stage where a trial production run was required by a commercial concern possessing the necessary technical competence in arc furnace operation and power supplies. A commercial firm, Southern Chemicals Ltd. was approached but because of the high costs quoted by the firm, the Bureau decided to defer further action.[57] In early December 1943, the Bureau received a letter from the Department of Industry and Commerce stating that a further 35 tons of ferro-silicon had been imported making a grand total of 52 tons since August 1942. With this news, the Bureau decided that it would no longer be necessary to pursue the commercial production of ferro-silicon.[58]

The drastic reductions in the supplies of imported coal focussed attention on the need to provide alternative fuels for use by both foundries and blacksmiths. As a consequence the Bureau decided towards the end of September 1942 to investigate the melting of iron using turf and turf charcoal. By the middle of November the

experimental work had been completed and the results of the investigation had established that both raw turf and turf charcoal could be used as alternative fuels for melting iron.[59] However, although the use of turf charcoal was a viable alternative fuel which gave excellent results, the cost involved in providing turf charcoal was prohibitive and its use was not recommended except under conditions of extreme emergency.

Other minor investigations undertaken by the Bureau with varying degrees success during this period dealt with hardening mild steel for the manufacture of knife blades, taps for the threading of steel nuts, annealing of wire, manufacture of beet knives and the manufacture of refractory bricks.

In the crucial areas of fuel and of supplies of iron and steel for heavy industry, the Bureau was able to make a significant contribution. This resulted in making available supplies of turf charcoal as a fuel for producer plants attached to motor vehicles, in the maintenance of town gas supplies using turf to augment the available coal supply and in the provision of technical advice and information to both manufacturers and operators of producer plants. In addition, it was determined that sheet iron could be manufactured by an electrodeposition method if needed for essential purposes; the reuse of high alloy steels and scrap iron was facilitated also by the Bureau's technical developments. Such developments by the Bureau contributed to the maintenance of industrial activity and came to the aid of an economy under siege.

CHAPTER 7

MANUFACTURE OF CHEMICALS

Towards the end of February 1941, the Bureau, at the request of the Taoiseach, discussed the possibility of the home manufacture of red phosphorus, phosphorus sesquisulphide and potassium chlorate.[1] These chemicals, which were required for the manufacture of matches, were then in short supply and it was becoming virtually impossible to get licences to import these chemicals from England. In this chapter it is proposed to examine critically the development and outcomes of the experimental work initiated by the Bureau in an effort to overcome supply shortages of these chemicals.

At the February 1941 meeting, two strategies were agreed by the Bureau; the first involved Messrs Maguire and Paterson Ltd.,(the sole manufacturer of matches in the country), contacting Southern Chemicals Ltd. of Askeaton, with a view to agreeing arrangements for carrying out experimental work on the manufacture of phosphorus; the second strategy took the form of commissioning Professor K C Bailey of TCD and Professor T J Nolan of UCD to investigate the possible manufacture of these chemicals.[2]

Agreement was reached between Messrs Maguire and Paterson Ltd. and Southern Chemicals Ltd; under this agreement, Southern Chemicals undertook to carry out the experimental work, with help and advice from the Bureau, on the manufacture of the required chemicals and Maguire and Paterson's agreed to underwrite the cost of this work.[3] This type of financial arrangement was to be anticipated since the main beneficiary was a commercial company. However, it turned out,

a short time later, that these investigations became of direct relevence, to the Department of Defence; when this occurred the cost of the investigations was then funded totally by the Bureau.[4]

Sir Alexander Maguire wrote to the Taoiseach early in March 1941 to to advise him that he was leaving for London to discuss the supply of these chemicals; he hoped to see Mr Lyttleton, the President of the Board of Trade, in London, and then travel to Belfast to meet Mr J Andrews, the Prime Minister of Northern Ireland and Sir Basil Brooke, the Minister of Commerce.[5] He told the Taoiseach that he would inform him of the outcome of his discussions on his return; he expressed to the Taoiseach his satisfaction with the work and efforts of Dr Lennon and Prof Dowling to build up an organisation in Ireland to manufacture the three chemicals needed by his factory.

By the middle of March 1941, Prof Nolan had succeeded in making a small quantity of yellow phosphorus using laboratory-scale apparatus and was proceeding to experiment on the conversion of the yellow phosphorus to the red form and on the production of phosphorus sesquisulphide. Prof Bailey's laboratory experiments had been successful also and by June 1941, he had concluded that the commercial production of potassium chlorate was possible; the process involved the electrolysis of sodium chloride solution to produce a concentrated solution of sodium chlorate which yielded potassium chlorate when treated with an aqueous extract of kelp.[6]

When Sir Alexander Maguire returned to Ireland, he advised the Bureau that, he was now sure that he could obtain the required

chemicals with the assistance of Albright & Wilson, a manufacturer of chemicals in England. However, because the supply of the chemicals was not guaranteed, it was decided to continue with the laboratory-scale experimental work being undertaken under the auspices of the Bureau; it was hoped that this work would lead to the development of processes which could be adapted to produce the quantities of chemicals required by the match-making industry. Sir Alexander Maguire agreed to continue meeting the cost of this work at least until the necessary imported supplies were assured.[7] It was decided also to halt the larger-scale work being undertaken by Southern Chemicals and the Company was advised to await the outcome of the laboratory investigations; this would determine both the feasibility and practicality of producing the chemicals in Ireland on a commercial scale.[8]

In the middle of June 1941, the Bureau was informed that Messrs Maguire and Paterson had sufficient red phosphorus for 238 working days, phosphorus sesquisulphide for 36 working days and potassium chlorate for 75 days. During the following months the supply position continued to deteriorate with the result that by late September 1941 the closure of the Dublin factory of Maguire and Paterson appeared to be imminent. It should perhaps be pointed out that the output of both the Dublin and Belfast factories of Messrs Maguire and Paterson supplied the whole island with matches; neither factory, operating singly, could take the place of the other. This had been tried but political feeling was so acute at the time that the matches from either part of Ireland was not acceptable by the public in the other part.[9]

On the 29 September 1941, Sir Ernest Graham-Little MP wrote to Mr H MacMillan, the Parliamentary Secretary to the Ministry of Supply, in advance of a meeting to be held the following day, concerning the supply of chemicals for the manufacture of matches. In his letter Graham-Little advised MacMillan that he proposed to ask the President of the Board of Trade:

> whether he is aware that the match industry in Éire is threatened with the closing down of the Dublin factory [of Messrs Maguire and Paterson Ltd] within the next fortnight, as a result of the cessation of supplies of chemicals from England, essential to match manufacture; and whether it is the official policy of the Government to discriminate against Éire by cutting off these supplies.[10]

Graham-Little suggested further that discrimination was in fact being effected by virtue of the difference in treatment being accorded to the Maguire and Paterson factory in Belfast compared to the Dublin factory.

At this time, the factory in Northern Ireland was receiving at least 45% of pre-war quantities of the essential chemicals while the factory in Ireland was receiving very small quantities, with uncertain deliveries; this meant that the Dublin factory was under constant threat of closure. It was believeed that this differential treatment was due, apparently, to the delaying of export licences for these chemicals for Dublin; this practice had of course started some twelve months previously, as part of the 'economic war' being waged by Gt Britain and as a consequence of a deliberate decision to withhold or delay essential supplies required by Ireland. As already indicated, the Dublin factory had first begun to experience supply difficulties from early 1941. This could be attributed in part to the cessation of some supplies, previously obtained from

Sweden and Germany, but also because the major source of supply, England, was then subject to the controls imposed by the British Government under its policy of economic sanctions. The overall result of this supply deficit was an anticipated closure of the Dublin factory; this closure would throw some hundreds of employees out of work and would bring about the cessation of a highly successful enterprise in which 70% of the subscribed capital was British.

In a follow-up letter, sent to MacMillan on the 4 October 1941, Graham-Little restated his deep concern over the withholding of such paltry supplies of chemicals. He stated:

> closure of the Dublin factory, while the Belfast factory was receiving its full quota would inevitably convey the conviction that it is a deliberate policy of the British Government to discriminate between Northern and Southern Ireland ... nowhere would reaction to this event be more disastrous than in the United States of America ... it might gravely imperil the present cordial relations between our two countries, the maintenance of which is the keystone to our war effort.[11]

It should perhaps be remembered that during this period Britain was receiving substantial help from America. The continuation of this aid, particularly under the lease-lend mechanism, could have been compromised, through political action on the part of Irish-Americans, if it had become apparent that Ireland was being deliberately subjected to economic sanctions.

As a result of all these efforts, confidential arrangements were made subsequently which avoided the closure of the Dublin factory. These arrangements were known only to a very small circle restricted to De Valera, Mr Brendan Bracken, Archbishop Downey, Bishop Mathew, the representative of Cardinal Hinsley, Sir

Alexander Maguire and Sir E Graham-Little.[12] With the continued operation of the Dublin plant assured, the Bureau decided in June 1941 to discontinue the laboratory investigations on the home manufacture of the chemicals required. Although supplies were received thereafter on a regular basis, delays of up to a month were encountered between the dispatch of the consignment from the supplier and their arrival at the factory; the delay was attributed in Ireland to difficulty in arranging for their transportation; however, at this time, the Irish Government was still unaware of the deliberate withholding of supplies under the economic sanctions being imposed by Gt Britain. The volumes of raw materials being provided were sufficient for the maintenance of reduced production levels only; this led to a reduction in the workforce from 375 to 215, to a five-day, 40 hour working week and to all buyers being reduced to two thirds of their normal pre-war deliveries.[13]

In August 1941, the Bureau was advised that the Department of Defence required urgently a substantial quantity of phosphorus and phosphorus sesquisulphide for the manufacture of munitions. In the light of this new and urgent need by the Army, the Bureau was obliged to return to the problems of manufacturing phosphorus in appreciable quantities. It was decided to commence experiments on the large-scale production of phosphorus. Two methods were selected; the first involved the reduction of phosphate rock by heating with carbon and silica in an electric arc furnace, the current normal commercial method; the other method was the reduction of sodium metaphosphate with metallic aluminium and silica, the 'thermite process'.[14] The 'thermite' process was particularly hazardous with a constant danger of explosions

occurring. Accordingly, work using this method started on a small scale with the cooperation of the Defence Forces. The laboratory experiments were successful and the Bureau was able to prepare over 1/2 lb of phosphorus in one laboratory run.[15] However, further work on this process proved to be unnecessary due to the successful operation of the method using the arc furnace.[16] A small laboratory-scale arc furnace (10 kW) used in the work had been built in the Mechanical Engineering Department of UCD; the furnace came into operation in early October 1941 and experiments using it on the production of phosphorus continued up to the end of 1941.

The preliminary work on the arc furnace was handicapped by virtue of the fact that those involved had never seen phosphorus made in an arc furnace; there was also a scarcity of literature in the country; a request by the Bureau to visit a phosphorus plant in Gt Britain to obtain experimental data was turned down by the British authorities. [17] The cost of producing phosphorus in this way was estimated at about £1,250/£1,500 per ton with the capital cost of the plant being around £5,100.[18] On the basis of the experience gained using this 10 kW furnace, and with other information obtained on the construction and operation of a large scale phosphorus plant, by the Tennessee Valley Authority in the USA, it was decided to construct a larger plant of up to 100 kW capacity.

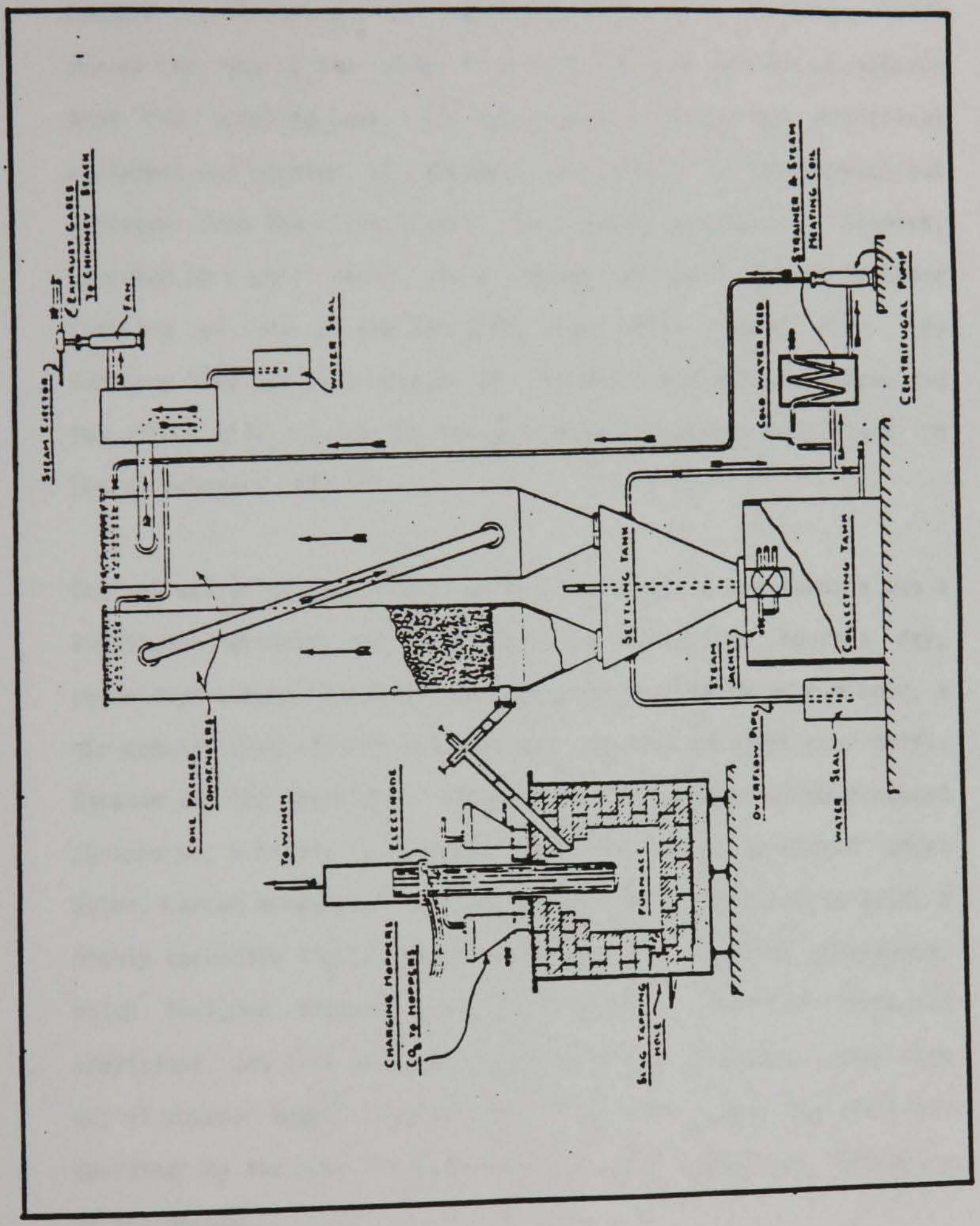
In December 1941, work commenced on the design of this full-size plant. This larger plant consisted of a single furnace with a vertical electrode eight inches in diameter connected to two coke filled condensing cylinders in series through which the furnace gases passed in countercurrent to a water spray. The condensed

phosphorus dripped into a water-filled settling tank directly below the cylinders. The graphite electrodes had to be obtained initially from the United States; subsequently a technique for the home manufacture of the electrodes was developed with the cooperation of Messrs Electrodes Ltd, a subsidiary company of Southern Chemicals Ltd; the supply of electrodes produced was sufficient to meet the immediate supply needs of the country.[19] In the initial stages of the development of this plant the cost was shared between the Bureau and the Army; however, by December 1942, the total operating costs were borne by the Army.[20]

In selecting a site for this plant, it was considered essential to have the site within easy reach of the Bureau and of the workshops of University College Dublin where much of the mechanical work connected with the construction and maintenance of the plant was carried out; this enabled those directing the experimental processes to maintain close contact and to ensure that the frequent alterations and repairs required were being carried out rapidly. Other essential requirements for the site were size, adequate supplies of water and electricity and security. A site at Parkgate Street which met all these requirements was provided by the Army authorities; the only potential problem was the proximity of dwelling houses on the south and west sides of the site.

The existing buildings on the site were modified to provide offices, stores, washing and changing facilities for personnel. A fairly simple structure of tubular scaffolding with a corrugated sheet roof and partly enclosed sides was then erected to house the furnace and condensing system. The building had two floor levels.

Figure 1: SCHEMATIC OF PHOSPHORUS PLANT BUILT AT PARKGATE



Source: Hogan, M.A., and McCarthy, T., Report on Manufacture of Phosphorus by the Electric Furnace Method

The upper or charging floor provided access for regulating the furnace conditions and the system pressures while the lower level served for tapping the slag from the furnace and the phosphorus from the settling tank. The sub-station housing the electrical equipment was erected at ground level close to the furnace but isolated from the plant itself. As a safety precaution, showers, operated by a pull chain, were placed on both floors to douse clothing of any of the operating staff which caught fire. By February 1942 the construction of the plant had been completed and the first trial run on the production of phosphorus took place on the 15 February 1942.[21]

The production of phosphorus using the electric arc furnace was a continuous process, the plant operating twenty four hours a day, seven days a week. The plant was normally staffed by an engineer, a non-commissioned officer and four men, working an eight hour shift. Because of the hazardous nature of the process which produced phosphorus, a highly inflammable solid that had to be stored under water, carbon monoxide, an explosive gas and phosphoric acid, a highly corrosive liquid, there were stringent operating procedures, which included frequent medical checks, detailed first-aid provisions and fire precautions, in force at all times. The work was of course highly confidential; for that reason the plant was operated by the Army Ordnance Corp under the scientific direction of the Bureau.

Many of the initial teething problems were due to the fact that use had to be made of whatever materials and equipment were available whether fully suitable or not. In addition, the entire operating

personnel were inexperienced and therefore time was required to remedy this deficiency; it was not until June 1942, some four months after the plant had been commissioned that regular production took place. By the end of 1942 the plant had made 6 tons of yellow phosphorus; by September 1943 the full quantity of 13 tons required to complete the original programme had been made. Shortly thereafter the Bureau was informed that a further 13 to 14 tons was needed. It was decided at this stage to build a second furnace since the same number of men could operate a larger plant thus considerably reducing the cost of production. The opportunity was taken also to enlarge the condensing system and to improve the plant generally. These alterations reduced the cost of production from about 12 shillings per pound using one furnace to around 6.7 shillings per pound using two furnaces and increased the output per hour from 4.07 lbs to 7.88 lbs.[22] Up to 31 March 1945, the plant had run for 11,571 hours and produced a total of 26.5 tons of yellow phosphorus.[23]

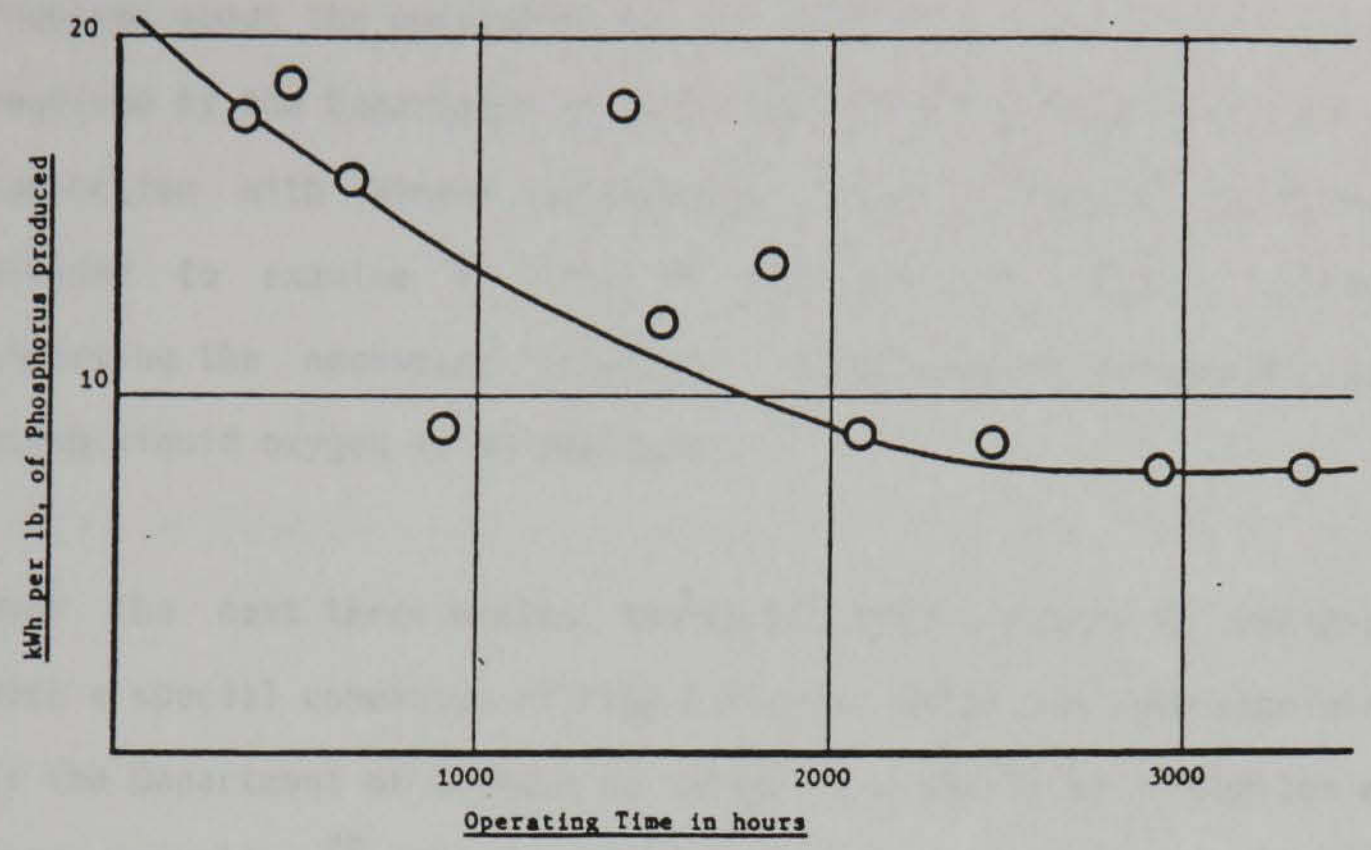
The phosphate sources were 'Florida pebble', a 200 ton shipment of which arrived in Dublin in the autumn of 1941, and 'Clare phosphate' mined locally. 'Clare phosphate' was inferior to the high grade 'Florida pebble' and it cost more to produce phosphorus from the local supplies. For the preliminary experimental work, quartz pebbles from Killiney beach were used; later, crushed quartz from Hackett's Town Quarry (Co Carlow) was utilized in the plant at Parkgate. Anthracite, both native and imported was the source of carbon.[24]

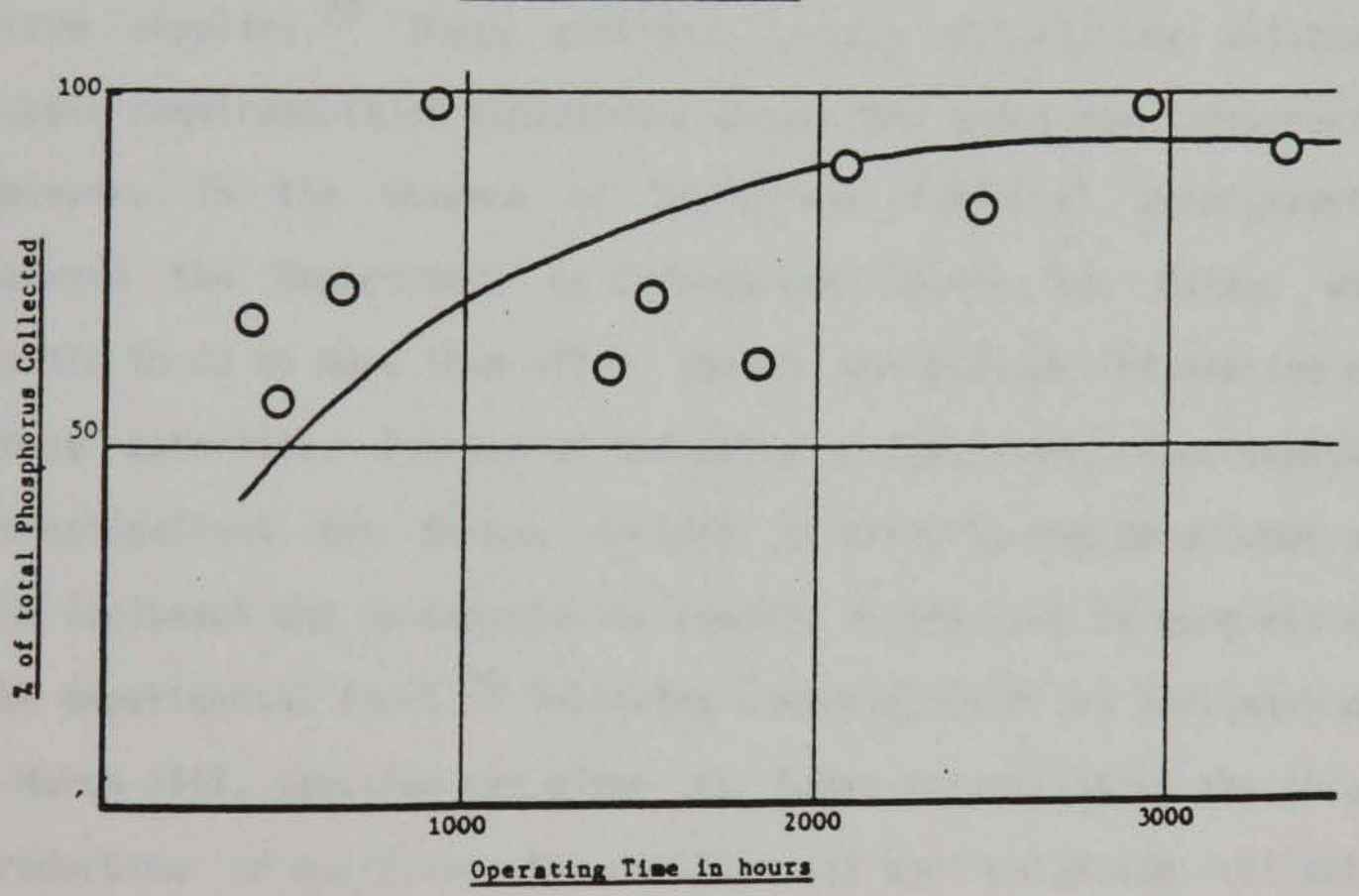
The plant was stopped from time to time for long periods. This was due to the production of phosphorus outstripping the capacity of the subsequent stages of munitions manufacture; storage was an additional problem. Another problem was caused by restrictions imposed on the country generally on the use of electricity in June 1944; this caused additional problems for Industrial Gases Ltd which supplied carbon dioxide for the plant.[25] Overall these stoppages and disruptions caused serious deterioration of the plant which in turn led to the need for considerable maintenance work.

As indicated earlier, initial difficulties in operating the plant were due largely to the inexperience of the personnel employed. Stoppages were also due to various technical problems, including electrode breakages, pipe corrosion and condenser chokages. Erosion of the tapping hole was one of the most troublesome problems encountered;this required constant redesign and modification. Bearing in mind that the plant was experimental and was undergoing frequent alteration, there was a gradual and remarkable improvement in the efficiency of operation; a yield of above 92% was eventually reached.[26] This was a very commendable achievement bearing in mind the make-shift nature of the plant coupled with the various other difficulties which surfaced in its operation. Indeed the entire operation was a spectacular success and reflected well on the Bureau.

The Bureau's next major project concerned explosives. In May 1942 the Bureau received letters from both the Department of Industry & Commerce and the Department of Supplies requesting the Bureau's advice on the possibility of establishing in Ireland a plant for

Figure 2 : EFFICIENCY OF PHOSPHORUS PLANT AS A FUNCTION OF ENERGY CONSUMED PER LB OF PHOSPHORUS PRODUCED AND AS A PERCENTAGE OF TOTAL PHOSPHORUS COLLECTED PLOTTED AGAINST OPERATING TIME





Source: Hogan, M.A., and McCarthy, T., Report on Manufacture of Phosphorus by the Electric Furnace Method

the manufacture of explosives for industrial purposes.[27] A few months later this topic was again raised by the Taoiseach when he inquired about the possibilities of providing blasting explosives required by the Department of Local Government and Public Health in connection with Winter employment relief schemes.[28] The Bureau decided to examine a number of possibilities; these included importing the necessary supplies, manufacturing gun powder, and using liquid oxygen as an explosive.

Over the next three months, the Bureau held a number of meetings with a special committee of Army Officers, which had been appointed by the Department of Defence to investigate the local production of these supplies.[29] These meetings quickly established military supply requirements of explosives, detonators and smoke producers. However, in the absence of definitive financial arrangements between the Departments of Defence and Finance, the Bureau was unable to do no more than offer advice and provide information on these materials. Because of the delay in initiating experimental investigations, the Bureau decided to write to the Department of the Taoiseach and to express its concern at the lack of progress on the experimental front.[30] Following a meeting with the Taoiseach on 1 March 1943, sanction was given to begin investigating the local production of explosives for civilian use and potassium chlorate for Army use.

The Bureau carried out some preliminary experimental investigations on the production of explosives on a small scale. However, by the beginning of October 1943, the Department of the Taoiseach had written to the Bureau advising that action on the production of

explosives should be deferred for the present. This decision arose out of an improvement in the supply of imports of gelignite; in any event there was a shortage of potassium nitrate required for the production of gun powder. In view of this the Bureau decided to terminate the experimental work on industrial explosives.

The earlier laboratory investigations of Professor K C Bailey had identified a viable commercial process for the manufacture of potassium chlorate. By the 29 April 1943, some preliminary testing had been carried out at TCD with an experimental cell made of concrete and using locally produced carbon anodes and iron cathodes.[31] This laboratory experiment was terminated at the end of June 1943; except for some slight surface pitting of the carbon anodes and difficulty in maintaining control over the pH value of the electrolyte, the experimental cell in Trinity College Dublin had run satisfactorily for some 94 hours.[32]

During this same period, the design of a large-scale plant for the production of potassium chlorate had progressed steadily with the Bureau reporting satisfactory progress on the acquisition of the necessary plant and materials. On the 6 May 1943 the Army started work on the foundations of the chlorate plant; the following day the Bureau was advised by the Department of the Taoiseach that the Department of Finance had agreed to the costs of this work being paid for by the Army.

The major problem which occurred was the tendency for the home-produced carbon electrodes to disintegrate.[33] However this problem was eventually overcome with the issue of a licence to

import graphite electrodes from USA; the Department of Supplies managed to secure shipping space for their transportation and they were delivered in November 1943.[34]

By the end of September 1943, the first trial run of the experimental cell had been concluded satisfactorily. After some 770 hours operation, the graphite electrodes were found to be in good condition.[35] This experimental work continued over the next four months; various cell configurations, operating at different current densities and using the electrodes imported from the USA were tried. A number of technical problems surfaced during the operation of the cell; these were resolved satisfactorily with the result that by the beginning of February 1944, some six cwts of pure potassium chlorate had been produced and delivered to the Army for the manufacture of explosives.[36]

As a result of this semi-technical work the Bureau concluded that it would be necessary to use 32 cells to produce 100 tons of potassium chlorate a year; each cell was in the form of a three foot cube, each containing 30 sets of electrodes and carrying a current of 1,100 amps. The 32 cell plant was located beside the tennis courts at Parkgate, in two lines of cells, in a well ventilated shed. Although the plant was designed for an annual output of 100 tons of potassium chlorate, it was agreed that the immediate target figure should be 50 tons *per annum*. The construction of the full-scale chlorate plant progressed satisfactorily during June 1944 with cells being cast at a rate of one per day. [37] At the same time a kelp extraction plant was set up; this consisted of 6 mine cases, each capable of holding 150

gallons, and sand filters for the treatment of the extract. In addition, a precipitation plant, was erected; this consisted of 7 concrete tanks of the same type as used for the electrolytic cells and 3 sand filters.

In early July 1944, the first trial run of the plant took place; it started with eight cells only operating, with production running at a rate of 1 kilogram of potassium chlorate per 8 kilowatt hours.[38] Progress continued steadily and by the 26 September 1944, the entire 32 cells of the full-scale plant were operating;[39] by the 13 December 1944, 3.5 tons of chlorate of the quality required by the Army had been made. Production of potassium chlorate continued steadily such that by the end of January 1945, the plant was producing potassium chlorate at a rate of 2.25 tons per week; the total production up to this date was about 18 tons. The success of this particular venture was acknowledged on the 27 February 1945 when the Taoiseach, together with the Minister for Defence and the Minister for the Co-ordination of Defensive Measures, visited the Parkgate Plants. When the Bureau ceased its activities on 31 March 1945, the plant had produced over 35 tons of potassium chlorate; by any measure, this operation was successful, supplying the Army with its immediate requirements of potassium chlorate.

Phosphorous sesquisulphide was one of the three chemicals mentioned earlier which was required for the manufacture of matches. As already indicated, the laboratory work on the production of phosphorus sesquisulphide had been completed satisfactorily and work had started on the design of a plant to product the

chemical.[40] This resulted in the construction of a semi-technical scale plant at Parkgate by the end of August 1942; this plant functioned satisfactorily for over two years producing upwards of 5 tons of phosphorus sesquisulphide most of which was supplied to the Army. [41]

At a conference held by the Department of Supplies on the 28 Feburary 1941, manufacturers had expressed concern on the poor supply position of sulphur dioxide, glucose, starch, gelatine and organic acids; all of these chemicals, particularly sulphur dioxide used in the preservation of fruit, were required by the confectionery and jam manufacturers.[42] Although small quantities of these chemicals continued to be imported from Gt Britain, the Bureau decided that it would be important to obtain a home source of sulphur so that sulphur dioxide could be manufactured in the event of the stoppage of imported supplies. Indeed the importance of this decision and the relevance of the investigation became more apparent subsequently when difficulties were experienced in maintaining supplies of imported pyrites, used for the manufacture of sulphuric acid.[43]

A conference was held to consider the possibilities of the home production of sulphur and sulphur dioxide and arising out of this the Bureau initiated a number of experimental laboratory investigations on the recovery of sulphur from gas works' *spent oxide*;[44] this chemical is a compound containing mostly ferric oxide and contaminated with sulphur and iron sulphide; as *spent oxide* was the scientific term generally used to describe the material, the usage of this term will be retained. The production of *spent oxide*

in the country war around 1,000 tons *per annum* with about 700 tons alone being produced at Dublin Gas Works.[45] There was at least ample supplies of raw material available locally to redress the diminishing supplies of sulphur if a suitable process for the extraction of sulphur on a large scale could be developed.

During the course of some initial experimental laboratory work which was carried out by Professor Nolan, it was ascertained that sulphur could be produced by a process involving vacuum and steam distillation of gas works' *spent oxide*.[46] However, because of the shortage of the necessary materials for building a large scale plant using this process, the Bureau considered an alternative method. This alternative process, which was investigated by Dr Wheeler, involved the removal of sulphur in the *spent oxide* in the form of ferrous sulphide. The sulphide was then treated with sulphuric acid to yield hydrogen sulphide from which sulphur was obtained by burning in a special furnace. Here again, because of the lack of the necessary materials and due to the economics involved in this process, it was decided that it would not be feasible to fabricate a large-scale plant. Solvent extraction methods which were also tried proved to be unsatisfactory; other experiments carried out on the extraction of sulphur from pyrites were rejected as well.[47]

Eventually the Bureau decided that sufficient progress had been made to justify the erection of a semi-technical scale plant; the process to be used involved the direct distillation or sublimation of sulphur from the *spent oxide*.[48] By the middle of June 1942, a semi-technical scale plant was operating and producing about 7 lbs

of sulphur per day.[49] An additional impetus was given to the importance of the investigation when on 13 July 1942, the Department of Supplies wrote to the Bureau advising that while the normal annual requirements of sulphur was about 400 tons, 130 tons only had been imported to date with little likelihood of getting further supplies.[50]

The production of sulphur from *spent oxide* using this process was considered to be successful particularly since the product obtained was uilized subsequently in the manufacture of other chemicals. However, the Bureau decided to investigate the general supply position before contemplating the development of a plant large enough to make a substantial contribution towards the country's sulphur requirements. The enquiries carried out by the Bureau indicated that there was no need to proceed further with the development of a large scale plant; work on this particular investigation was thus suspended.

The principal chemicals required for the manufacture of matches were amorphous (red) phosphorus, phosphorus sesquisulphide and potassium chlorate; other materials required were paraffin wax, china clay and glue.

The match-making industry had been receiving adequate if reduced quantities of these chemicals and supplies since late 1941. However, towards the end of 1944, it appeared that these chemicals were going to be in short supply again. Thus, once again, the supply of these chemicals from native sources became a topic of extreme importance.

Up to November 1944, red phosphorus had been produced only on a laboratory scale in the course of the Bureau's investigations. However, in an effort to meet this threatened termination of the supplies of chemicals needed by the match making industry, the Bureau embarked on the development of the production of red phosphorus on a pilot plant scale.[51]

Since phosphorus sesquisulphide had already been produced for the Army, the Bureau believed that phosphorus sesquisulphide of the required quality and quantity could be produced. As far as potassium chlorate was concerned, production of this chemical at Parkgate was proceeding at a rate of 100 tons *per annum*. The Bureau was reasonably confident that it could supply Messrs Maguire & Paterson's with its annual requirements of this chemical also. During 1942, supplies of imported glue had become difficult to obtain. A substitute glue from a local company, Dungarvan Glue and Gelatine Ltd proved to be unsatisfactory initially; following advice from the Bureau the product was improved and the company was able to produce a glue to the specifications required by Messrs Maguire & Paterson.[52]

On the 21 November, the Taoiseach met Sir Alexander Maguire together with Prof Dowling, Prof Hogan and Dr Wheeler to discuss the supply of the chemicals required for match making. The Taoiseach indicated that all the basic raw materials were available in the country except for sulphur which did not present an insurmountable problem; even Irish timber was proving to be a suitable substitute. It appeared therefore that they were now in a position to supply the chemicals needed. Sir Alexander Maguire

responded that he would be happy to avail of these supplies subject to their being judged of satisfactory quality; this would necessitate tests being carried out. He also indicated that he would be happy to enter into a longer term contract for the purchase of these supplies.[53]

The supply of these chemicals from local sources had of course been addressed previously. In June 1944, Prof Dowling informed the Bureau about a meeting he had with the Taoiseach and Sir Alexander Maguire at which Prof Hogan and Dr Wheeler were present also.[54] At this meeting, Sir Alexander Maguire had indicated his interest in the possibility of the supply from native sources of the various chemicals required for the match industry. He indicated that if suitable native materials were available then he would be prepared to give a five-year contract to whatever company produced the materials. The Taoiseach was obviously interested in the commercial possibilities of such a venture and he asked the Bureau to prepare estimates for him of the likely production costs of the chemicals required. The Taoiseach asked the Department of Industry and Supplies also to examine the possibility of establishing a company for the production of the various chemicals on a commercial scale.[55]

With the agreement of the Department of Defence, the Bureau provided Maguire & Patersons with the necessary quantities of the chemicals required for full scale trials. While testing of the chemicals was proceeding, the Bureau was involved in a series of discussions on the supply needs of Maguire & Paterson and attempting to finalise arrangements, including costings, for the large scale production of chemicals for the match industry.[56]

By the 10 January 1945, Messrs Maguire & Paterson reported that the manufacture of batches of matches using only chemicals supplied by the Bureau had given satisfactory results. The next day a letter was received from the Dept of the Taoiseach authorising the Bureau to proceed, in collaboration with the Army, with the production of the chemicals required by Messrs Maguire & Paterson. The Bureau was advised also that the Department of Industry and Commerce had been asked to discuss the necessary financial arrangements with the Department of Finance. In the meantime expenditure was to be met from the Bureau's funds which could be recouped later. The Department of Defence was asked to provide facilities for the work without delay.[57]

However, the general fate of the Bureau intervened in this project for the decision had been made to terminate the experimental work being undertaken by the Bureau by the 28 February 1945. During this final period of the Bureau's existence, the Bureau continued to arrange for the supply from Parkgate of the chemicals required by Messrs Maguire & Paterson. This arrangement was continued by the Department of Defence when the plant was transferred to it on 1 March 1945; indeed the Department of Defence agreed to continue to manufacture and make available supplies of the chemicals pending the completion of other arrangements for their commercial production; a brief summary of the arrangements made for the manufacture and supply of these chemicals and of the eventual closing down of the Parkgate plant is given in appendix 3.

The home production by the Bureau at the Parkgate Plant of such a critical range of chemicals represented a very significant and

important achievement; it ensured chemical supplies crucial to the country's defence needs and later for the matchmaking industry. It demonstrated also what could be achieved by an industrial scientific research organisation provided with the necessary Government support, adequate funding and autonomy of action. Moreover, the fabrication of the plant was achieved against an unfavourable supplies background. In the final analysis , it is not unreasonable to conclude that the commissioning and continuous operation of the Parkgate Plant must rank as one of the Bureau's greatest challenges and successes.

CHAPTER 8

FOOD AND HEALTH RELATED INVESTIGATIONS

The Irish Government had taken note of the warning signals in the months preceeding the outbreak of World War II. It was anticipated that shortages would occur and thus it set up an Emergency Supplies Branch within the Department of Industry and Commerce. However, on the outbreak of hostilities, it was decided to establish a separate Department of Supplies and to appoint a special Minister to co-ordinate defensive measures. The economic sanctions imposed by Gt Britain resulted in a drastic curtailment in imports of all kinds; food commodities and various health-related products were particularly effected. In this chapter it is proposed to examine the work of the Bureau in response to fluctuating, sometimes potentially serious, shortages of supplies in food and health-related commodities. These included fertilizers, additives to flour for breadmaking, carbon dioxides and ammonia for refrigeration plants, glucose, invert sugar, digitalis and formalin.

Immediately after the outbreak of war, the Government launched a nationwide campaign for increased food production and intensive publicity was conducted to bring home to the people the grim realities of the current situation. Numerous meetings were held at which the Taoiseach and members of the Government spoke; special food production lectures were organised throughout the country; radio talks were given and advertisements appeared in newspapers. Of particular interest was the showing in cinemas of a special documentary film entitled 'Tomorrow's Bread' (the Irish version was titled 'Arán an Lae Amáireach') produced specially for the

Department of Agriculture; it was estimated that the film was seen by over 400,000 people.[1]

The reductions in imports led to shortages in seeds, spraying materials, machinery and spare parts, sisal for the manufacture of twine, fuels, lubricating oils, iron for making horse-shoes and particularly fertilizers. The fertilizers normally used in the country were farmyard manure and artificial manures containing nitrogen, potash and phosphates; lime was also essential but there was no difficulty with supplies as it was produced locally. However, with the stoppage of imports of artificial fertilizers,[2] the country was faced with major difficulties; these problems would seriously inhibit an increase in agricultural production which it was hoped would minimize the effects of the curtailments in imports of both human and animal foodstuffs.

In the case of artificial nitrogenous fertilizers, used in cereal crop production, the country normally imported about 2,000 tons of sodium nitrate from Chile and 25,000 tons of ammonium sulphate from Great Britain. In 1940 the country managed to import some 31,000 tons of ammonium sulphate but in December 1941 imports ceased leaving a shortfall at that time of about 20,000 tons. While some 2,000 tons of ammonium sulphate were produced per annum by domestic gasworks, the production of this quantity depended on the amount of coal used and with shrinking coal imports, the yield from this source was likely to be reduced.[3]

The normal annual imports of artificial potash fertilizers was equivalent to 7,300 tons of potassium superoxide. Here again

imports of this fertilizer, used to fertilize pastures and meadows stopped. This meant that, without the application of potash fertilizers, the fertility of the soil would gradually diminish.

However, there was a possibility that some 2,000 tons of potassium superoxide could be provided in the form of carbonised seaweed which would contain some 20% potassium superoxide .[4] In 1941, it was estimated that some 240,000 tons of superphosphate would b e required with about half this quantity being actually available; furthermore there was no prospect of being able to import additional supplies of the rock phosphate from which it was manufactured. There existed in the country a deposit of rock phosphate, about 65,000 tons, from which a low grade superphosphate was being manufactured by Messrs Goulding; 200 tons per week of this rock phosphate was required to manufacture about 400 tons of superphosphate. While it was hoped to increase weekly output of superphosphate to 600 tons, this depended on availability of supplies of sulphuric acid; another limiting factor was the transportation of the rock phosphate some 20 miles by lorry to the railhead at Ennis.[5] As regards phosphate fertilizers, a commission appointed by the Government in 1933 had raised hopes that the Clare phosphate deposits might lead to the establishment of a native industry for the production of phosphate fertilizers for the home-market; however, following detailed analysis of all the relevant parameters it was concluded that this development was not feasible.[6]

Throughout 1941, the Bureau was more concerned with other more important investigations; these included the investigations on

fuels, iron and steel, and chemicals to which resources and effort had to be concentrated. As a result the supply of home-produced fertilizers was more or less left in abeyance. Occasionally various proposals were considered and advice offered as to their practicability or value. The critical nature of the supply position might be gauged by the esoteric nature of some of the solutions offered by various individuals; one particular suggestion for the production of a nitrogenous fertilizer would have required the entire electrical output of the Shannon Hydro-electric Scheme.[7]

At this time Clare phosphate was being used for the manufacture of phosphorus required by the Army in the production of munitions; regular production of phosphorus had started in June 1942. After the immediate needs of the Army had been met by the Parkgate Plant, the Bureau returned to the possible home manufacture of fertilizers. On 26 August 1942, the Bureau decided to initiate investigations on the preparation of fertilizers from Clare phosphate.[8] By the end of October 1942, experimental laboratory-work on the preparation of fertilizer from Clare phosphate had been completed satisfactorily and the Bureau decided that this work should be continued on a larger scale.[9] Arising out of the work of the Clare Phosphate Commission an experimental batch of superphosphate had been made in 1933. In this work some 20 tons of Doolin phosphate had been used and this had produced a superphosphate which compared unfavourably with superphosphate prepared from better quality imported phosphates.[10]

Although this earlier work and the later experimental work and

field trials undertaken by the Bureau confirmed that the large-scale manufacture of both superphosphate and phosphate fertilizers could be undertaken, the Bureau eventually decided, notwithstanding the importance of fertilizers for the country, that it would not be profitable to continue with this work; the major problems were the limited home supplies of suitable rock phosphate and sulphuric acid; the most important limiting factor was the serious fuel shortages which still existed.[11]

The total outcome of the Bureau's work on fertilizers resulted in the home manufacture of limited quantities of superphosphate and low grade compound fertilizers; both types had to be subsidised heavily to enable their purchase by farmers. This amount coupled with the very limited imports available, provided about 50,000 tons of fertilizer per annum in 1943 and 1944; the result was inadequately manured tillage crops with nothing left over for pastures and meadows.[12]

The result of the Compulsory Tillage order enacted in 1939 led to a progressive increase in the acreage allocated to wheat, sugar beet, barley and potatoes between 1939 and 1944. In general, the campaign to increase food production was adjudged to be successful. However, there were some other difficulties relating to food supplies which the Bureau investigated. These included the provision of home-produced chemicals for yeast manufacture, the manufacture of a substitute for imported supplies of baking powder,[13] the storage of yeast in areas with insufficient cold storage facilities[14] and the manufacture of starch.[15]

A number of other minor investigations were undertaken by the Bureau; these included the bacteriology of canning, bacon curing, manufacture of ammonium carbonate required in the manufacture of biscuits, a modified Gerber method for estimation of fat in milk and the utilization of spoilt beer.[16] These particular investigations indicate the diversity of the tasks which the Bureau was asked to address but also the value of the work of the Bureau in resolving problems and difficulties facing the food industries.

Prior to the war, the flour used for breadmaking was wheaten flour of 70% extraction, but from the end of 1939, the country experienced continuous difficulties with flour supplies.[17] To ease the situation, the extraction was continuously increased until, in May 1942, wheaten flour of 100% extraction became the norm. In May 1943, the Bureau was advised by the Dietetic Council of the Medical Association of Ireland that the incidence of rickets had increased; it recommended the use of flour of 85% extraction fortified with the addition of calcium as a solution to this problem.[18] The Bureau undertook a series of investigations with a view to identifying the most suitable sources of limestone available in the country for the production of pure calcium carbonate.[19] The Geological Survey was asked to assist by selecting the most suitable samples of calcium carbonate for use in the baking tests.[20] These samples were subsequently used in baking tests carried out in August 1944 by the Dock Milling Co.[21] As a result of all the investigations carried out under the auspices of the Bureau it was established that, suitable calcium carbonate could be obtained from home sources should the necessity arise, this could be used as an additive to

flour. All the information on this topic accumulated by the Bureau, enabled the making of a case for a reduction in flour extraction. in December 1943, the 100% extraction flour was replaced by a flour made from wheaten flour of 85% extraction to which was added barley flour; the Bureau organised, in addition, information for the public on the use of this flour in home baking.[22]

Towards the end of March 1942, Prof Dowling informed the Bureau that the Taoiseach had requested information on the preparation of potato flour to be used as a supplement to wheaten flour; the use of potato flour as a supplement to wheaten flour had been advocated also by the Dietetic Council; it was also known that during the period 1914-18 potato flour had been used on an extensive scale in Germany to supplement supplies of wheaten flour.[23] Over the next couple of months baking tests were carried out and the Bureau examined the samples of bread produced which contained up to 50% potato flour; it was concluded that satisfactory bread could be made with the addition of up to 50% potato flour if, in addition, an increased amount of bakers yeast was used.[24]

Following discussion, it was decided to inform the Taoiseach that consideration should be given to carrying out a large scale experiment on the drying of potatoes at one of the sugar factories; almost all of the machinery required for this task would be available there. Unfortunately, the proposed arrangements for the carrying out of a large scale experiment at the Carlow Sugar Factory had to be abandoned. There were major reasons for this decision. The plant would require a thorough overhaul at the end of

the beet campaign; the completion of this work was hampered by shortage of spare parts. Secondly, this additional task would cause further wear and tear on the machines which might be difficult to repair before the next beet season. Finally, the supply of the necessary coal to operate the driers and the boilers was barely sufficient to meet the needs of the plant during the beet campaign; it would not be possible to obtain the additional coal supplies required.[25]

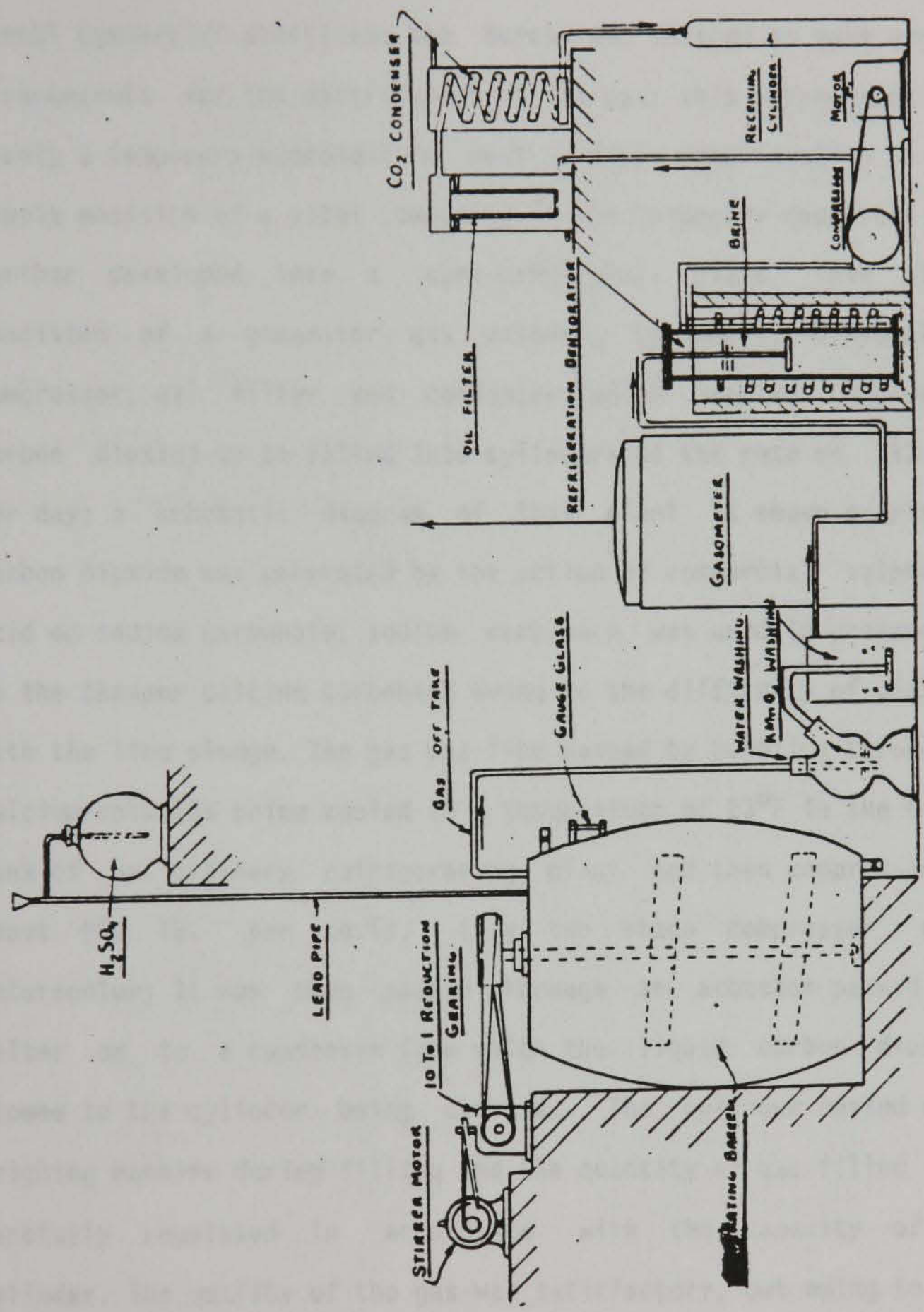
In early June 1941, the importation of cylinders of compressed carbon dioxide stopped. This was a particularly serious development for it effected creameries and the mineral water industry. About one third of the creameries used carbon dioxide as a refrigerant and the lack of supplies would result in a serious loss in the output of butter. While only about 10 tons *per annum* was required by the creameries, some 200 tons, not necessarily at high pressue, was needed by the mineral water industry with another ton required for fire extinguishers at power stations and airports.[26]

On the 19 June 1941, Dr Wheeler reported that Messrs Schweppes had run out of supplies of carbon dioxide and was about to close down. However, he had been able to assist the firm in setting up a temporary carbon dioxide generator at the plant which had enabled the firm to continue production.[27] This success enabled the Bureau to advise and assist a number of other mineral water manufacturers set up carbon dioxide generators similar to that being used by Schweppes.[28]

A short time later a number of creameries were forced to curtail their operations owing to the lack of compressed carbon dioxide for replenishing their refrigeration plants. On receipt of this news, the Bureau initiated a series of experiments in the Mechanical Engineering Department of University College Dublin on the generation, purification and compression of carbon dioxide; the method of gas generation was very simple, involving the action of sulphuric acid on limestone or soda.[29] In addition arrangements were made with Messrs Guinness Ltd to investigate the possibility of collecting and purifying the gas evolved during the brewing processes.[33] It was decided also that the Irish Agricultural Organisation Society would act as the agent for the distribution of the carbon dioxide cylinders to the creameries, the creameries were to be charged 21d per pound of gas delivered. It was estimated that this price would be sufficient to meet the cost of production; in addition, it would provide a financial contribution towards meeting the costs of the investigation.[31]

Towards the end of July 1941, a temporary carbon dioxide generator, shown in figure 3, had been set up at UCD. During the period 19-31 July 1941, eighteen cylinders containing 469 lbs of compressed gas were filled and supplied to the creameries; from 1-20 August 1941 a further 45 cylinders, containing 1225 lbs of compresed gas were supplied. This meant that the Bureau was able to supply to the Creameries about 85% of their normal comsumption of compressed carbon dioxide.[32]

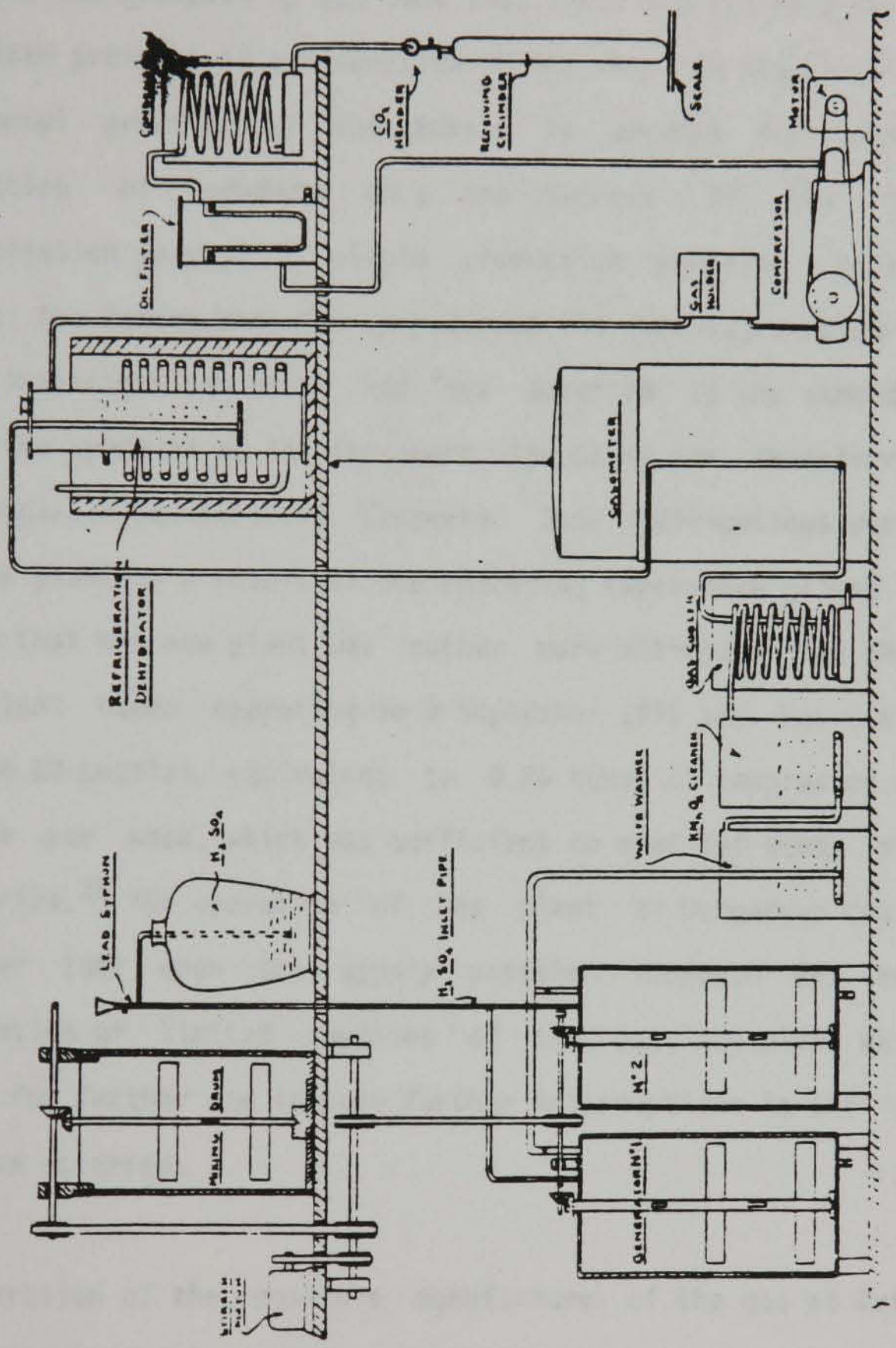
Figure 3: Schematic of Temporary Carbon Dioxide Generator Fabricated at University College, Dublin



Source: Leahy,P., Investigation of Flow of Fluids Past Solid Bodies, 108 .

A number of firms complained about the Irish Agricultural Wholesale Society having the sole distribution rights for the gas. However, in the circumstances prevailing, there was no time to undertake normal commercial practices; the Bureau was obliged to make urgent arrangements for the distribution of the gas; this arrangement was merely a temporary expedient to meet a rapid deterioration in the supply position of a vital commodity.[33] The temporary apparatus was further developed into a semi-commercial plant. This plant consisted of a generator, gas washers, gasometer, dehydrator, compressor, oil filter and condenser which enabled compressed carbon dioxide to be filled into cylinders at the rate of 112 lb per day; a schematic diagram of this plant is shown overleaf. Carbon dioxide was generated by the action of commercial sulphuric acid on sodium carbonate; sodium carbonate was used in preference to the cheaper calcium carbonate owing to the difficulty of dealing with the lime sludge. The gas was fine washed by bubbling through a calcium chloride brine cooled to a temperature of 23°F in the brine tank of an ordinary refrigerating plant and then compressed to about 950 lb. per sq.in. in a two stage compressor with intercooler; it was then passed through an asbestos packed oil filter on to a condenser from which the liquid carbon dioxide flowed to the cylinder being charged. The cylinder rested on a weighing machine during filling and the quantity of gas filled was carefully regulated in accordance with the capacity of the cylinder. The quality of the gas was satisfactory, but owing to the temporary nature of the plant, the cost of production was rather high. Nevertheless the plant did ensure creameries of vital supplies until such time as supplies from a less expensive source became available.[34]

Figure 4: Schematic of Semi-Commercial Plant for Generation of Carbon Dioxide



Source: Leahy,P., Investigation of Flow of Fluids Past Solid Bodies, 108.

The plant continued to operate in University College for a couple of months but in the middle of August 1941 it was decided to arrange for the plant to be transferred to a creamery[35]. This decision was prompted by the fact that there did not seem to be any immediate prospect of a resumption of imports. In any case, it was the normal practice of the Bureau to arrange for commercial production of products once the success of the initial investigation assured a viable production process. Using this tactic the Bureau was able to redirect its own meagre resources to other investigations which had not advanced to the same degree. With the approval of the Taoiseach, the plant was transferred to the Dungarvan Co-operative Creamery. Some modifications were made to the plant as a result of the operating experience gained in its use so that the new plant was rather more efficient than the old. The plant began operating on 9 September 1941 and was able to produce 20 bottles, equivalent to 0.25 tons, of compressed carbon dioxide per week, which was sufficient to meet the needs of the creameries.[36] The operation of the plant at Dungarvan ceased in November 1941 when the supply position improved due to the importation of limited supplies of the gas, the plant was kept ready for further use in case further interruptions in the supply position occurred.

Consideration of the possible manufacture of the gas at Guinness Ltd., which involved the co-operation of Industrial Gases Ltd., dragged on without much progress being reported. It had been hoped that production of the compressed gas at Guinness Ltd might begin in January 1942.[37] As it turned out, this was a rather optimistic forecast for it was not until June 1942 that production of

compressed gas got under way; Prof Hogan and Dr Wheeler assisted in the setting up of the plant. Subsequently sufficient gas was produced to meet the supply needs of the creameries; a potentially serious problem was thus averted and the country did not need to depend on imported supplies of carbon dioxide.

The aftermath of this particular crisis was a decision by the Bureau to set up a plant for the production of compressed ammonia; it was anticipated that supplies could be cut off at very short notice. The cold storage industry, which required ammonia, was particularly vulnerable; any stoppage in supplies could result in serious loss of stored food stuffs. The total annual consumption of ammonia was about 25 tons, practically all of which was used in refrigeration plants. As this quantity was relatively small, the Bureau was of the view that this amount could be made from chemicals within the country.

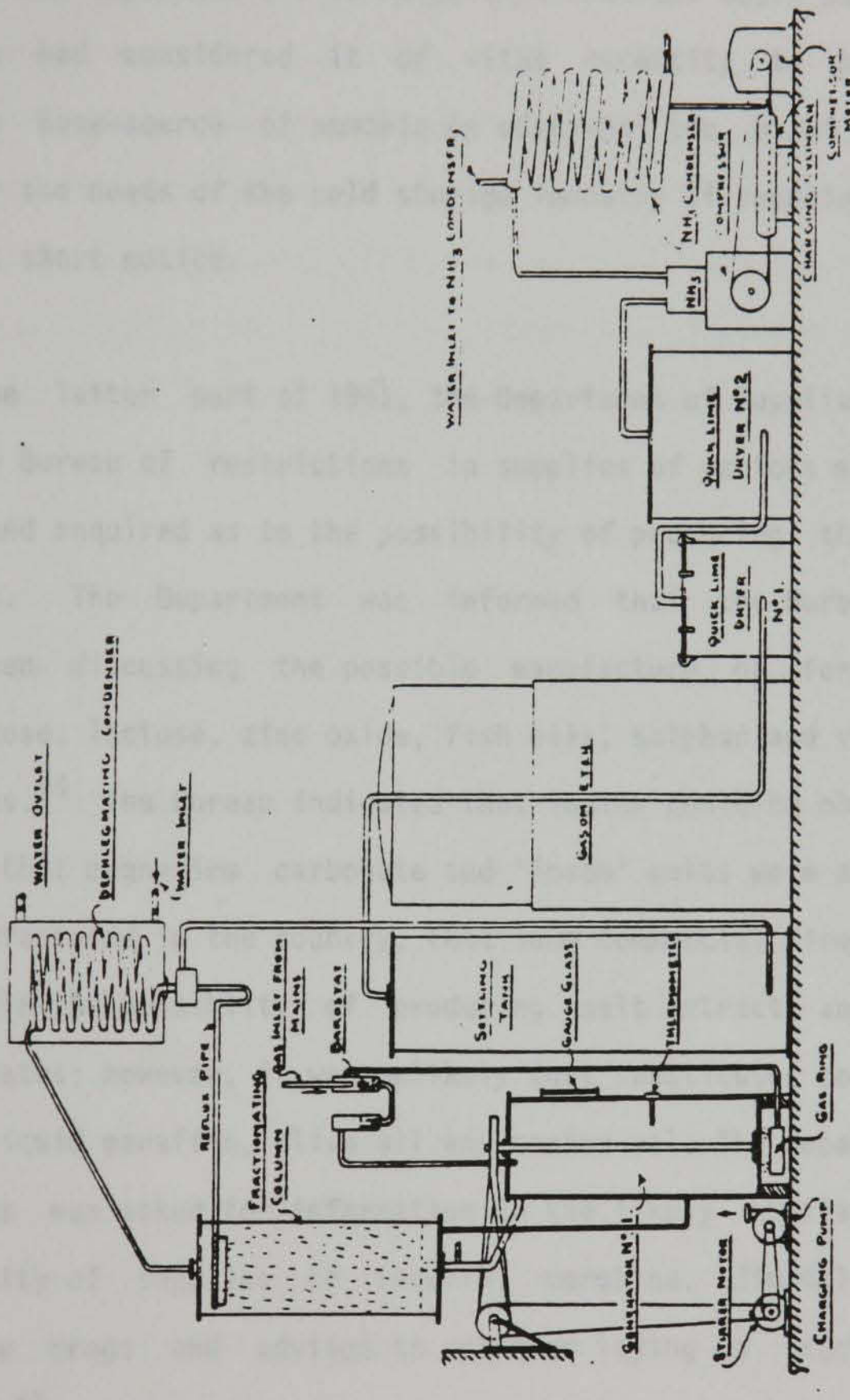
In July 1941, the Bureau commissioned Dr K Bailey, Trinity College Dublin, to carry out some preliminary experiments on the production of ammonia from ammonium sulphate and caustic soda; Prof Poole agreed to supervise the engineering work connected with larger scale investigations for the production and utilization of ammonia as a refrigerant.[38] By the end of August 1941 the laboratory investigation had led to some liquid ammonia being produced. This led to arrangements being made, a short time later, for the erection at Trinity College Dublin, of a plant to produce about 20 lbs of ammonia per hour; this decision required sanction for expenditure of up to £200.[39] The Bureau arranged with the Department of Supplies to have 60 tons of ammonium sulphate

reserved for the plant; this required the agreement of the Department of Agriculture as well as this chemical was intended for use in the production of fertilizers.[40]

The Department of Supplies queried the need to reserve this quantity of ammonium sulphate particularly since supplies of ammonia were being delivered. The Bureau indicated that although supplies were arriving still, it would be necessary to have this quantity of ammonium sulphate set aside in the event of a stoppage of imports of ammonia supplies; if such an event occurred then the food stuffs held in refrigerated stores would be at risk unless an alternative source of ammonia was available immediately.[41] Eventually, the erection of the plant was completed and by early February 1942, the plant was ready to begin production of anhydrous ammonia, should the necessity arise.[42]

Ammonia was produced by the reaction of solutions of caustic soda and ammonium sulphate in heated vessels. Ammonia was evolved together with large quantities of water vapour. This mixture of gases was passed through a distillation column with a condenser which condensed the water vapour out and returned it to the reaction vessel. The gas was then passed through lime tray driers and on to the compressor. The compressed gas was then passed through a concentric tube water condenser from which the liquid ammonia was filled into cylinders. The plant, shown in figure 5, was so designed that it could, where necessary, use ammonium sulphate generated by the Gas Works. The plant was held on a care and maintenance basis thereafter.[43]

Figure 5: Semi-Commercial Plant for the Generation and Liquifying of Ammonia



Source: Leahy,P., Investigation of Flow of Fluids Past Solid Bodies, 125.

Thus, except for the initial production carried out when the plant was first commissioned, the Bureau was not called on to engage in further production of ammonia up to 31 March 1945. Nevertheless because of the important use to which this chemical would be put, the Bureau had considered it of vital necessity to have an alternative home-source of ammonia on stand-by; the plant could provide for the needs of the cold storage industry if supplies were required at short notice.

Towards the latter part of 1941, the Department of Supplies had advised the Bureau of restrictions in supplies of various medical products and enquired as to the possibility of producing them in the country. The Department was informed that the Bureau had already been discussing the possible manufacture of formalin, ether, glucose, lactose, zinc oxide, fish oils, sulphur and vitamin concentrates.[44] The Bureau indicated that iodine could be obtained from kelp, that magnesium carbonate and 'Epsom' salts were already being manufactured in the country, that some commercial firms were interested in the possiblity of producing malt extracts and coal tar distillates; however, it was unlikely that substitutes could be found for liquid paraffin, olive oil and castor oil. The Department of Supplies was asked for information on the likely availability and continuity of supplies of insulin, morphine, digitalis and sulphonamide drugs and advised to consider laying in stocks of these drugs.[45]

Over the next few meetings of the Bureau, discussion centred on a number of possible developments. These included the preparation of invert sugar, the possible use of rose-hip jelly as a source of

vitamin C, the quantity of sulphonamide drugs which could be obtained, and the testing of products for vitamin A. Attention was given also to the collection of information on the preparation of liver extracts; an attempt was made to quantify the likely demand for infant foods and the extent to which this could be met from within the country. The Bureau investigated the possibility of obtaining an increased allocation of fuel oil for Mitchelstown Creameries to enable the restoration of lactose production there; consideration was given also to the allocation of shipping space for importation of surgical instruments and various vitamin products.[46]

Ether was the first pharmaceutical product in which a shortage occurred. As a result of a conference convened to discuss the possibility of the manufacture of ether from indigenous materials, some preliminary experiments were carried out on the production of ether using home-produced sulphuric acid.[47] The results of these experiments were such that the Bureau discussed the possibility of engaging in the large scale manufacture of ether.[48]

Near the end of July 1941, the Bureau received a letter from Prof Nolan, who was Chairman of Irish Alcohol Factories Ltd, to the effect that his Board was prepared to undertake the manufacture of ether provided that a suitable plant could be obtained. This was indeed significant progress and the Bureau undertook to provide every possible assistance to the Company in obtaining the required plant; as an initial step the Bureau sought and eventually obtained copies of official British Government publications on the manufacture of ether.[49] Unfortunately, despite this initial burst

of enthusiasm, no positive developments on the production of ether took place for over a year; this delay was due to difficulties experienced in attempts to import the plant.[50]

The Bureau regarded this situation as most unsatisfactory and consequently decided to advise the Secretary of the Department of Industry and Commerce that consideration should be given to the setting up of an emergency plant for ether production.[51] By February 1943, the Bureau had under consideration proposals from Irish Alcohol Factories Ltd for the erection of a plant at Cooley (Co Louth) for the manufacture of ether. At the same time, the Department of Industry and Commerce had been asked by the Bureau to assist in obtaining a licence from the British authorities for the export of the necessary materials required for the fabrication of the plant.[52] Although progress subsequently on the erection of the plant was slow, the Bureau was not unduly concerned at this rate of progress as the supply position with imported stocks of ether continued to remain at a satisfactory level.[53] By August 1943 the required material had been delivered and the plant was being fabricated.

The timing of actual ether production was important; ether has a low boiling point, and its manufacture in the summer could be extremely difficult as the temperature of the water in the cooling system would be too high.[54] This problem could have been overcome by the erection of a suitable cooling plant for the water but lack of materials and a scarcity of refrigerants prevented such a development; the concurrence of these factors meant that progress could only be realised during the winter months.[55]

Experimental work on the production of ether finally started on 7 February 1944; since the process required continuous operation and analytical control of the plant, it was agreed that a total of four chemists would be required for this work.[56] By the end of March 1944, the experimental production of ether at the Cooley factory had been concluded successfully with the production of about 185 gallons of a good quality technical grade ether, at a rate of almost 35 gallons per day.[57] This output represented a yield of 80% of the calculated theoretical output of 2.25 gallons/hour.[58] Laboratory tests carried out subsequently on methods for refining this technical grade ether established that ether of the quality required for use as an anaesthetic could be produced.[59] However, following a meeting on 4 April 1944 between Prof Dowling, Dr Wheeler and representatives of Irish Alcohol Factories, it was agreed to suspend production of the technical grade ether pending the investigation of the purification/ refining process on a larger scale.[60]

No further production of technical grade ether took place at Cooley as the supply of exports from Gt Britain met the immediate needs for anaesthetic grade ether; there was however a shortfall in the amount of technical grade ether being delivered. There was of course another more worrying factor for the non-resumption of production. It appeared that Dr Drumm had been given information to the effect that the proposed manufacture of ether in the country was having a detrimental effect on obtaining supplies from Gt Britain.[61] This was a new and novel dimension to the economic sanctions imposed by Gt Britain. The country was now to be

penalised for developing processes for the home-manufacture of commodities in short supplies.

The first indication of a possible shortage of glycerine occurring came in August 1941 when the Bureau considered a request from the Department of Supplies for a substitute for glycerine.[62] It was almost a year later before any significant process was reported. Two commercial firms were each attempting to fabricate a plant which could be used for refining crude glycerine. The firms experienced a number of difficulties which the Bureau was called upon to address. During this same period some of the Bureau's staff had been carrying out experimental work on a new process for the production of glycerine from vegetable oils which looked promising; this investigation led eventually to the production, without recourse to distillation, of glycerine of BP quality.[64]

By the beginning of July 1942, a quantity of glycerine had been produced by one of the firms using soap lyes. This success led to arrangements being made to enable the firm to engage in the large scale production of glycerine; this included granting of a licence to manufacture glycerine by the Department of Industry and Commerce. All of this effort resulted in the production, by October 1942, of some 15 tons of very high quality material which met BP standards.[65] Indeed progress was such that at a subsequent conference in the Department of Industry and Commerce, arrangements were made for the marketing of the material.[66] However, in February 1943, the firm had been forced to discontinue distillation of the crude glycerine owing to curtailment of fuel oil supplies; up to this time some 30 tons had been made.[65]

The Bureau had two options open to it to resolve this problem. The first option involved the use of a turf-heated boiler for providing the supply of steam required in the process. The second option developed from an offer by Unilever Ltd in Britain to exchange refined glycerine for the crude material. After discussion of both options, the Bureau decided to recommend acceptance of Unilever's offer because of the inherent difficulties which would be involved in providing an adequate supply of steam from a boiler using turf.[68]

The accumulation of reserve stocks of particular medical supplies has been referred to briefly already. The Bureau had already examined the possibilities, using local resources and expertise, of producing supplies of some of these pharmaceutical commodities; those of particular interest were glucose, insulin, digitalis, liver extracts and vitamins.

Various laboratory investigations were initiated by the Bureau to ascertain the possibility of developing viable processes for their home manufacture. In addition a number of manufacturers with the necessary plant and technical expertise cooperated in ventures geared towards the larger scale manufacture of these commodities. The results of all of this investigative work carried might be best illustrated in tabular form, shown in table 17.

Although foot and mouth disease had been rampant in Gt Britain during the 1920's, there had been only two outbreaks of the disease in Ireland. The first had occurred in 1921, while the second outbreak had occurred in Co Wexford in the Spring of 1928. From

this period onwards, the disease was controlled in Ireland by virtue of stringent preventative measures taken by the Department of Agriculture. However, in January 1941, a very virulent form of the disease occurred in Co Donegal which spread rapidly with 556 outbreaks being detected in fourteen counties. In all, some 27,942 cattle, 10,187 sheep, 3,210 pigs and 608 goats were slaughtered at a cost to the Exchequer of some £410,963 paid in compensation.[69]

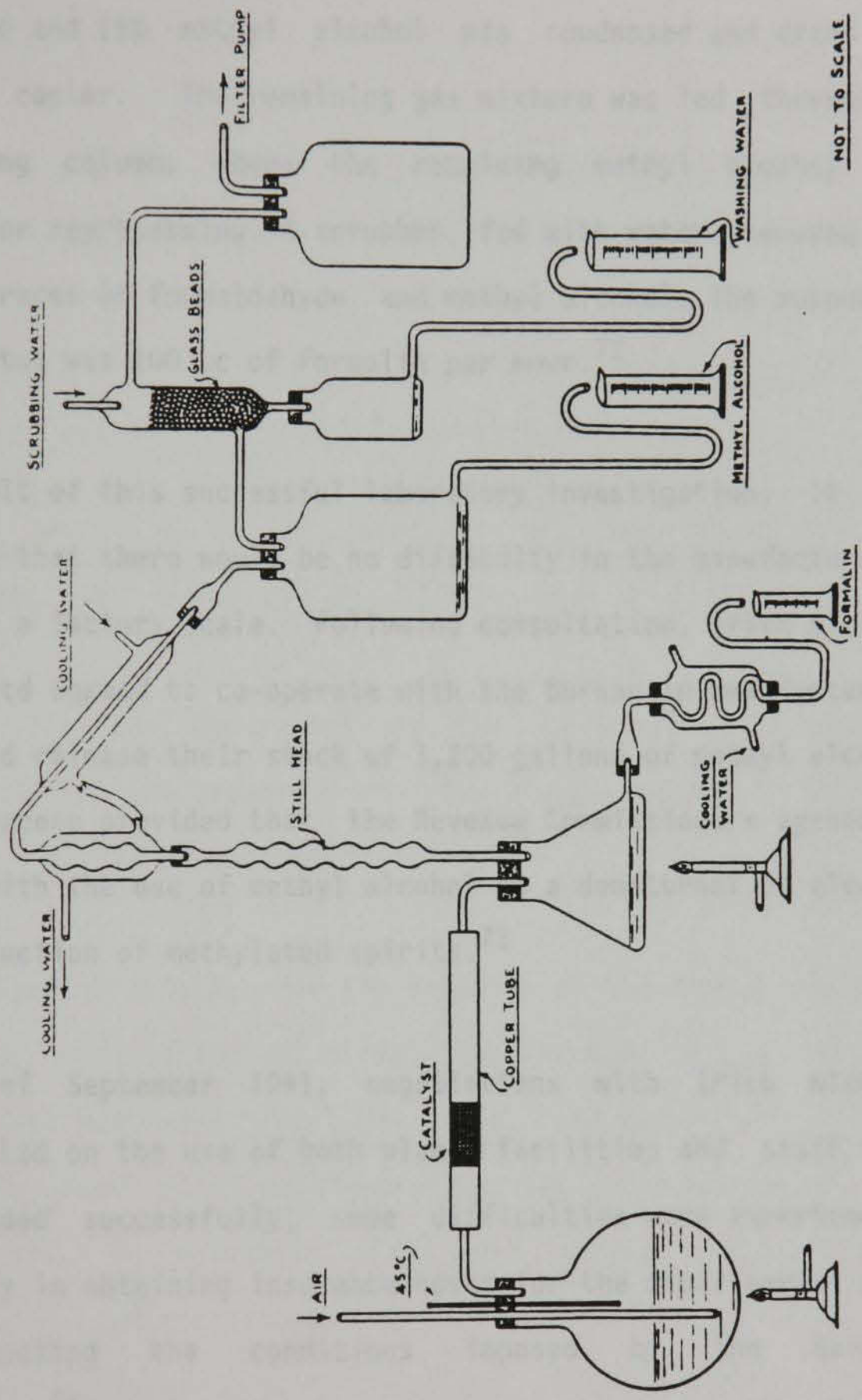
Table 17: Outcomes of Investigations carried out under the auspices of the Bureau on the home-manufacture of selected pharmaceutical products during periods indicated

Pharmaceutical Product	Initiation date and scope of investigation	Termination date and outcome of experimental work undertaken	Supply Position during period of investigation
Glucose	March 1941: Glucose extraction from sea weed, cane sugar	February 1942: Production deemed to be very tedious; large volumes of alcohol required. Impractical despite shortages occurring.	Serious shortfall in glucose imports initially. By Nov 1942, sufficient supplies being imported.
Invert Sugar	November 1941: Conversion of sugar to protein - free invert sugar	August 1943: Invert sugar of high degree of purity produced in laboratory. Commercial firm assisted in assembling plant for manufacture of Invert sugar; plant kept in reserve	Invert sugar was to be substitute for glucose in which there was a serious shortfall in imports.
Insulin	January 1942: Preparation of testing of insulin solution made from solid insulin	May 1943: Officer in Army Medical Service trained in methodology in emergency preparation of insulin solution possible	Availability of solid insulin prompted investigation; supplies of insulin solution maintained.
Digitalis	May 1942: Processing of home supply of digitalis leaves	July 1943: Established that digitalis of the same standard as imported product could be prepared.	Imported supplies maintained
Liver Extracts	November 1941: Laboratory preparation; separate commercial activity undertaken.	February 1943: Clinical trials proved quality of liver extracts prepared; Bureau did not proceed further because of commercial developments.	No reported shortfall in supplies of liver extracts.

Formalin had been used extensively in the preventative measures adopted for controlling the spread of the 1941 outbreak of foot and mouth disease; as a consequence there was a very serious depletion in stocks. Following discussion on the possibility of the manufacture of formalin, the Bureau decided to seek approval for initiation of experimental investigations on the preparation of formalin and other disinfectants. Work started immediately on the erection of a laboratory plant for manufacturing formalin from methyl alcohol; by the end of the month a plant was in operation in the chemical laboratory at Trinity College Dublin.[70]

The apparatus used consisted of a five litre flask containing methyl alcohol, heated with a bunsen burner to about 45°C and through which air was aspirated using a filter pump as shown in figure 6. This arrangement provided methyl alcohol vapour mixed with air in proportions determined by the temperature of the alcohol. The resulting reaction mixture was led through a three foot length of copper piping, which contained a catalyst. The reaction was started by exterior heating of the copper pipe for two minutes and the catalyst promoted the transformation of methyl alcohol to formaldehyde.[71]

Figure 6: Schematic of Laboratory Apparatus for Production of Formalin



Source: S.P.O.Folio S12997 Technical Report No 1 - Manufacture of Formalin

The resulting reaction mixture of formaldehyde, water, methyl alcohol, nitrogen and oxides of carbon was passed into a heated flask. Here formalin solution containing approximately 40% formaldehyde and 15% methyl alcohol was condensed and drawn off through a cooler. The remaining gas mixture was led through a fractionating column, where the remaining methyl alcohol was recovered for reprocessing. A scrubber, fed with water, removed the remaining traces of formaldehyde and methyl alcohol. The output of this apparatus was 100 cc of formalin per hour.[72]

As a result of this successful laboratory investigation, it was anticipated that there would be no difficulty in the manufacture of formalin on a factory scale. Following consultation, Irish Alcohol Factories Ltd agreed to co-operate with the Bureau in manufacturing formalin and release their stock of 1,200 gallons of methyl alcohol for this purpose provided that the Revenue Commissioners agreed to dispense with the use of methyl alcohol as a denaturant of alcohol in the production of methylated spirits.[73]

By the end of September 1941, negotiations with Irish Alcohol Factories Ltd on the use of both plant, facilities and staff had been concluded successfully; some difficulties were experienced, particularly in obtaining insurance cover for the experimental work and in meeting the conditions imposed by the Revenue Commissioners.[74] The pilot plant was constructed at the Cooley Factory of Irish Alcohol Factories Ltd and by October it was functioning satisfactorily; in one experimental run lasting 68 hours, production of formalin occurred at a rate of almost 0.5 gallons per hour.[75] This success led to the conclusion that larger-

scale production of formalin could be undertaken successfully; the Bureau began to consider the necessary steps to be taken to erect a plant to produce the estimated one ton of formalin required per week.

The Bureau received a letter from the Company on 28 October 1941 setting out proposals for the continuation of the work. Following discussion of these proposals by the Bureau, it was agreed that a copy of the letter should be sent to the Department of the Taoiseach. It was decided also to recommend that,

> although the general tone of the letter did not appear to show a spirit of cordial co-operation, the conditions attaching to the proposals must be accepted as the provision of supplies of formalin was a matter of urgency.[76]

A few days later the Department of the Taoiseach authorised the Bureau to accept the proposals of Irish Alcohol Factories for the continuation of the production of formalin.[77]

The same site was selected for the erection of the commercial plant the necessary skilled labour, steam, air, and most of the required plant and equipment were available there. The design and erection of this commercial plant encountered various problems, mainly due to difficulties in obtaining plant and materials which met the original design specifications; this resulted in the utilization of whatever materials were available, e.g. steel scaffolding poles were used for some of the lines providing services. By the end of February 1942, the formalin plant had been erected and was producing some 120 gallons of 40% formalin each week.[78]

The first experimental run of the plant took place on 24 February 1942. Further testing and modifications of the plant continued up until 1 April 1942 when the plant was handed over to Irish Alcohol Factories Ltd for the commercial production of formalin. [79] By this time some 630 gallons of formalin had been made. Commercial operation of the plant continued periodically, when steam and compressed air supplies were available during the period 1 April 1942 to 12 January 1945. In all, some 19,500 gallons (95 tons) of 40% BP formalin were produced from approximately 18,400 gallons of methyl alcohol at a production rate of 3 gallons per hour.[80]

The food and health-related investigations undertaken by the Bureau covered a wide range of important topics. Some investigations, such as the work on carbon dioxide and the production of formalin, made a very significant contribution to the country's needs; others, such as the work on glucose, invert sugar and a range of pharmaceutical products, established that all of these products could be manufactured should the supply situation worsen. The various investigations and baking tests carried out with wheaten flour, supplemented with different additives, enabled positive conclusions to be drawn on the quality of the resulting bread; in addition, the devising of home-baking instructions for this flour assisted the community in a most pragmatic way as well as in bolstering morale. The production of fertilizers was a major undertaking and was largely successful; however, large-scale production was seriously retarded by the non-availability of sufficient fuel supplies. Overall, the Bureau's efforts in these fields must be adjudged as being successful.

CHAPTER 9

OTHER PROJECTS AND INVESTIGATIONS

In this chapter it is proposed to examine the responses of the Bureau to a number of other specific but nevertheless important topics. In many instances, these topics were of significant importance to the country and their very diversity is indicative of the difficulties overall being experienced by the country in the wake of the economic sanctions. It also gives a broad measure of the extent and quality of scientific knowledge and application harnessed by the Bureau in addressing these issues; the possible utilization of known mineral deposits to manufacture chemicals in short supply is an additional dimension of the Bureau's work which will be examined.

From its establishment the Bureau was represented at conferences convened by the Department of Supplies to discuss supply problems in different industrial sectors; the industries concerned were involved in the manufacture or supply of jam, timber, margarine, hosiery, soap, tanned leathers, candles, non-ferrous materials, rubber, cardboard, electric lamps, paper, salt, boots and shoes, agricultural machinery and pottery.[1] In addition, the Bureau was furnished with reports of similar conferences which had been held prior to the Bureau coming into existence; these meetings had considered difficulties in the availability or in the manufacture of electric cables, shirts and overalls, sacks and bags, brushes, ink, paint, polish and confectionery.[2] The major benefit in these conferences, as far as the Bureau was concerned, was in the exchange of information and in the early identification of specific commodities where shortages existed or were likely to occur; in

addition, the Bureau was able to set up a network of industrial contacts and to advise industry of the projected role and remit of the Bureau.

On the 30 July 1941, Dr Wheeler advised the Bureau that there was a strong possibility that imports of supplies of *aluminium sulphate*, required for the purification of water, would be restricted. Although subsequently the British Government agreed to release supplies, the Bureau considered the possibility of manufacturing this chemical locally; its crucial importance can be guaged by the fact that some 700 tons per year were required for water purification.[3] Over the following months in mid 1941 a number of conferences and individual discussions were held with specific manufacturers to discuss the home-production of water purification chemicals. A number of separate approaches were worked out, these included using electrolytic cells to produce *sodium hypochlorite*, using an *ozone* plant for sterilization as well as the manufacture of *aluminium sulphate*.[4]

Towards the end of 1941, a small ozoniser had been constructed at University College Dublin and biological tests were being carried out on samples of contaminated water treated with ozone. The Geological Survey had obtained samples of alum from Ballybunion which were submitted to the Bureau for analysis and testing. In addition, the laboratory experiments carried out on the production of ammonium sulphate were adjudged to be very successful; this resulted in a decision to seek sanction to spend funds on a semi-technical scale experiment to produce about a half ton of aluminium sulphate.

By the beginning of February 1942 the semi-technical scale plant, located at Messrs Gouldings, had produced a batch of 1 cwt of alum cake. Samples of this product obtained were forwarded for evaluation to the City Analyst and to two paper manufacturers, who also required this chemical. Subsequently it was reported that the aluminium sulphate made by Gouldings was suitable for water purification; the alum obtained from Ballybunion was found to be satisfactory as well. The value put on the product from Gouldings was £8 per ton and £6 per ton for the Ballybunion alum; these prices compared very favourably with imported aluminium sulphate which cost £12 per ton.[6] This outcome prompted the Bureau to ask the Department of Industry and Commerce to arrange for the immediate development of the Ballybunion deposits; it was hoped that this would provide a home source of supply of aluminium sulphate. However, it turned out subsequently that the Ballybunion deposit could not be readily exploited on a commercial scale.[7]

The paper manufacturers informed the Bureau that the samples of aluminium sulphate submitted to them for testing had been found to be satisfactory; they indicated that they would required 50 and 100 tons per annum respectively.[8] Subsequently, Gouldings submitted a report on the production process and a conference was arranged with Gouldings and the paper manufacturers to discuss arrangements for the large scale production of aluminium sulphate. Gouldings agreed to undertake the production of the chemical for the paper manufacturers; they, in turn, agreed to provide the capital for the erection of the required plant; it was agreed also to use the plant for the production of supplies for water purification, if this necessity arose.[9]

By July 1942, the plant was being erected and although, shortly afterwards restrictions on exporting the chemical from Gt Britain were lifted, the paper manufacturers decided to proceed with the erection of the plant so that they might be assured of supplies. This plant was capable of producing up to 6 tons of alum cake per week but as the supply position never reached a crisis level subsequently, the plant was never commissioned.[10]

In May 1944, the supply position of *chlorine* had once again deteriorated to such an extent that the Bureau was asked by the Department of Supplies to investigate, in conjunction with Dublin Corporation, the manufacture of *sodium hypochlorite* solution for water purification.[11] Some preliminary experimental work was carried out at Parkgate using one of the cells used for manufacturing chlorate. In order to carry out this work the Bureau was obliged to obtain official permission for use of the Parkgate facilities as the Parkgate Plant was under the control of the Department of Defence at this time. By the end of May 1944 the cells had been modified and a number of technical difficulties resolved; the modified cells were working so well that it was anticipated that the production of sodium hypochlorite would begin on 1 June 1944.[12]

Because of the continued problems with the supply of chlorine, required by both the public authorities and the creameries for water sterilization, a conference was arranged to discuss the matter. This meeting was held on 10 June 1944 and attended by representatives of the Bureau, of the Department of Agriculture and of the Irish Agricultural Organisation Society. The outcome

was a decision to proceed with the erection of a plant for the manufacture of sodium hypochlorite if supplies of chlorine could not be obtained.[13] However, once again the supply position improved and the proposed erection of the plant for the production of sodium hypochlorite was postponed.[14]

On the 15 January 1942 the Bureau received a letter from the Department of Supplies requesting the Bureau to examine the possibility of producing a substitute for *carbon black*; export of this material from Gt Britain had been prohibited. Prof Bayley Butler was asked to investigate the production of a substitute material for use in the manufacture of ink and certain types of paper.[15] A viable process was worked out which involved the regulated combustion of waste gear oil and the decision was made to erect a pilot plant for the production of the material.[16] By the middle of June the plant had been erected and was ready for operation. Although the product obtained from the initial trial run of the plant was satisfactory, expenses connected with the investigation increased to the extent that the Bureau was obliged to seek sanction for an additional amount over and above the sum authorised originally in connection with this investigation.[17] As a result of the experimental work carried out, it was established that it would be possible to make adequate substitutes for carbon black in the event of a complete stoppage of imports. This eventuality never occurred; the country managed to maintain a reasonable level of imports sufficient to meet the needs of manufacturers engaged in the production of ink and paper.

Following the attendance of Dr J J Lennon, the Secretary of the Bureau, at a conference convened by the Department of Supplies and attended by representatives of the *rubber* industry, the Bureau was advised, in March 1941, that almost all of the materials used in the industry were imported; in addition, as much as 70% of the output of Dunlop's Cork factory was actually exported.[18]

By January 1942, the situation had become so serious that the Bureau discussed the possibilities of reclaiming used rubber and of the production of synthetic rubber. In March of the same year, the Bureau was asked by the Taoiseach to examine the possibility of manufacturing synthetic rubber in the country.[19] Once again, as with so many other topics, the investigation started with an examination of the available literature. This first step was the most crucial, for in many instances, it either determined the *modus operandi* of the subsequent laboratory investigation or led to the decision not to proceed further.

By the end of March, Dr Drumm and Dr Wheeler had co-operated in the preparation of a report on synthetic rubber which specifically addressed the difficulties involved in such an undertaking.[20] In addition, Dr Drumm reported that he had succeeded in preparing a small quantity of *methyl rubber*.[21] It was decided, following discussion, to inform the Taoiseach that the Bureau was of the opinion that the problem of producing synthetic rubber was extremely difficult. Nevertheless, a planned investigation could be undertaken with a hope of making a useful contribution to national requirements. The cost of the investigation in the first year alone would be around £5,000; this amount was required to cover

laboratory work, salaries, materials and labour required for the erection of a pilot plant. The Taoiseach was advised also that it would entail the members of the Bureau giving over most of their time to this particular investigation; the Bureau indicated that the project would be abandoned if there was a likelihood that 'ultimate success was unlikely'.[22]

Although it was proposing to examine already known processes for the manufacture of synthetic rubber, the Bureau had estimated that, if the investigation proved successful, it would cost an additional £250,000 to set up a plant capable of producing some 400 tons of synthetic rubber per annum. The implications of such a venture were so significant that the proposal was discussed with the Secretary of the Department of Industry and Commerce and again with the Taoiseach on 5 June 1942.[23]

The outcome of these discussions led to the initiation of some fundamental investigations related to the production of synthetic rubber, so that, in the event of a Government decision being taken to proceed with the manufacture of synthetic rubber, it would be possible to proceed to production on a semi-technical scale with the minimum of delay. These investigations included an examination of methods for the direct production of *butadiene* from alcohol and the production of *pinacone* from acetone.[24]

Notwithstanding the apparent importance of these particular investigations, the Bureau was reminded by the Department of the Taoiseach that serious consideration must be given to the consequential practical value of such experimental work to the

ultimate goal, i.e. the production of synthetic rubber, before entering into financial commitments.[25] This is a further illustration of the strict restraining control being exercised on the Bureau's range of activities; direct practical relevance to offsetting shortages in the supply of essential commodities was to be the guiding principal and *raison d'être* for the initiation and continuance of any investigation.

While some useful information had been obtained from the investigations it was apparent that the likelihood of producing synthetic rubber on a scale likely to make a major contribution to the country's needs was indeed remote; no further work was therefore carried out on this particular topic.[26]

During the period in which his particular investigation was being carried out the Bureau undertook a number of related investigations on the provision of alternatives for various rubber-related products; these included rubber rings used for bottling fruit,[27] rubber from native plants,[28] and rubber washers.[29] In May 1942, the Bureau received a note from the Department of Supplies regarding quantities of various types of latex and pyroxylin cements required by the boot and shoe industry.[30] Arrangements were made for Professor Dowling and Dr Wheeler to visit Messrs Winstanley's factory in Dublin to examine the various processes which utilized these *adhesives*.[31] As a result of this visit, laboratory investigations were initiated and a number of substitute adhesive compounds were made and submitted to a number of boot and shoe manufacturers, for evaluative testing.[32] Although sanction for

expenditure up to £200 was obtained for the continuation of these investigations on substitute adhesives, the Department of the Taoiseach suggested that the Bureau should recoup some of the money from the firms assisted.[33] This work, some of which was carried out at University College Cork under the direction of Professor Reilly[34] resulted in:-

(i) the manufacture in late 1942 of an adhesive for insulating tape for the Torc Manufacturing Co which gave satisfactory results when subsequently tested by the ESB; subsequently, the Torc Manufacturing Co was assisted in setting up a plant for producing the tape.[35]

(ii) the development during the latter part of 1942 by the North Cork Co-operative Creameries, with the assistance of the Bureau, of a substitute for imported casein cement required for joinery work.[36]

(iii) the provision in January 1943 of supplies of an alternative engraving glue for *the Irish Times* for their photolithographic process; subsequently, Messrs Munster Simms undertook production of this substitute material, but had to receive further assistance from the Bureau to resolve difficulties caused by the growth of micro- organisms.[37]

(iv) the preparation of a substitute rubber cement for securing bristles into the tin ferrules of varnish brushes manufactured by a Dublin firm.[38]

(v) the manufacture of adhesives for fly-paper and glue for abrasive paper following a request for assistance in these matters.[39]

(vi) the development of an adhesive for two manufacturers of cellophane.[40]

(vii) the manufacture of an adhesive for block mounting as a substitute for Bostik cement.[41]

During its term of office, the Bureau received requests from very many industrial concerns which were experiencing difficulties in obtaining supplies or in the use of alternative materials to maintain production. In addition to those already detailed, it is worth noting further examples which illustrate the diversity of the technical assistance provided by the Bureau and the influence which it exercised in general. Typical of the miscellaneous help thus provided was:-

- the provision of expert assistance in the manufacture of glass;[42]
- assistance to a firm of metal workers in the recovery of copper from plating baths;[43]
- advice on the use of sodium bisulphite as a substitute for potassium permanganate in the cleaning of fish store-rooms on trawlers;[44]
- the elimination of metallic impurities from home-manufactured gelatine.[45]
- the regeneration of used lubricating oil;[46]
- the production of soap;[47]
- advising the Department of Supplies on granting licences to firms to export certain commodities;[48]
- developing a process for the resilvering of mirrors for cinema projectors;[49]
- processes were developed by the Bureau for the production of

sewing wax and of a thread lubricant for the boot and shoe industry;[50]

- the recovery of chromium from waste leather;[51]

Of course, it was not always possible to resolve each and every problem brought to the attention of the Bureau. The provision of supplies of fibre for rope manufacture from native sources, the supply from native sources of graphite for pencils and the use of scrap for supplies of zinc for batteries, are examples of particular enquiries to which the Bureau could not provide solutions to the manufacturers and firms concerned.[52]

The various examples outlined serve to illustrate the range of the Bureau's work in the context of the war and particularly the effects on the country of the widescale economic sanctions imposed by Gt Britain; they provide also a measure of the scientific and technical impact of the Bureau's work in alleviating various difficulties and problems encountered by Irish industry. Many of the problems which surfaced were dealt with by the initiation of experimental investigations, some by the provision of digests of literature, while other problems were resolved by the dissemination of technical information and advice through the personal expertise of the members of the Bureau and of its research staff.

The Bureau had, of course, to deal in addition with a variety of suggestions which, on analysis, were found to have no practical value or with problems in respect of which solutions could not be found in the circumstances prevailing at the time. The Bureau also provided expert advice to other relevant Government Departments on numerous subjects such as the establishment of priorities for the

use of various materials in short supply, the granting of export licences, rationing problems and ultimately, the commercial utilization of the results of the Bureau's work.

Most of the investigations carried out by the Bureau were undertaken by staff especially employed for the purpose, working under the supervision of the members of the Bureau. Occasionally, problems arose which required the assistance of outside investigators or facilities which were generously provided by the Universitities or commercial and industrial enterprises. The results of completed investigations were made available to the appropriate Government Departments and to those industrial firms to whom the information was likely to be of interest. In such cases contributions towards the costs of the investigations were sought and received from the firms concerned, particularly where the work was of direct commercial benefit to individual firms; in some cases the total cost of the experimental work undertaken was charged to the outside body concerned.

In dealing with problems arising from the shortages of supplies, the Bureau devoted most attention and resources to those areas which were more likely to be overcome by short term investigations, or which would have a major impact on alleviating potentially serious situations e.g. fuel supplies, manufacture of phosphorus, production of carbon dioxide and ammonia.

There were two other important investigations undertaken by the Bureau which are worthy of mention. The first concerned reductions which occurred in supplies of lead storage batteries and materials

for their repair, both of which were essential to the maintenance of transport, while the second involved the country's external radio communications.

The first problem which surfaced was the provision of *zinc* for battery manufacture. In April 1942, a laboratory investigation was carried out on the recovery of zinc from used dry batteries. The result of this investigation was considered at a conference, organised by the Department of Industry and Commerce, to examine the possibility of salvage and utilization of scrap batteries. Subsequently, the Bureau was advised that the Department was interested in obtaining costings on the operation of a full scale plant for the recovery of zinc, at a rate of 2 tons per week. However, the supply situation improved and no further action was taken on the commercial development of the process.[53]

Some months later, the Bureau initiated an investigation on the manufacture of batteries; a series of investigations carried out culminated in the production of the necessary *lead oxides* for replating, the development of methods for *re-casting of lead grids* and the *purification of antimonial lead*.[54]

The other interesting investigation which the Bureau undertook initiated followed a request from the Irish Motor Traders for the *production of separators* used in the manufacture of batteries.[55] Separators made of Irish pine, poplar and beech were constructed and subjected to various electrical tests and chemical treatments using alkalis and acids. These tests indicated that beech appeared to be the most satisfactory material and resulted in the Bureau

making arrangements for the testing of a battery utilizing both the experimental separators and the home manufactured lead oxide.[56]

By February 1943, testing of the battery, under the direction of Professor P J Nolan, was underway.[57] The following October the Bureau received a report to the effect that the test batteries made with the experimental separators and red lead had functioned satisfactorily for three months.[58] This investigation led the Bureau to conclude that acceptable substitutes for imported batteries could be produced locally if required.

The Government had been concerned about the implications of a communications breakdown particularly with America. It was not surprising therefore, to find that the Bureau received a letter from the Taoiseach on 31 December 1941 requesting 'an investigation into the position of Broadcasting from Eire on shortwaves'; it further added 'it had been decided that a junior engineer of the Department's [Posts & Telegraphs] staff should assist Professor Poole and the Chairman in an enquiry into the position and the appliances available'.[59]

In January 1942 Professor Dowling visited Athlone, to discuss the Bureau's proposals with the Engineer-in-Chief, Department of Posts & Telegraphs; arrangements were made for the secondment of the junior engineer to assist in the work.[60] Approval was obtained for expenditure up to £500 on this investigation and for the 'engagement of staff and labour in advance of specific sanction... on the understanding that the rates proposed should be submitted

for approval without delay'[61] As such latitude had never been given before, it was obvious that this particular investigation had been given the highest priority; it is highly probable that the precarious position of the country in maintaining neutrality at this time coupled with the very real possibility of invasion were key factors which influenced this course of action.

Throughout 1942 and early 1943 the investigation proceeded; this resulted in test transmissions of the transmitter by 28 April 1943; good reception was reported from Shannon Airport, Dublin and Sterling in Scotland.[62] However, the investigation continued to be beset with problems with the result that a meeting was held at the beginning of June 1943 to discuss progress and the future development of the work. Arising from this, it was agreed to proceed with the work and to seek sanction for a further £750 in expenditure.[63] Even so, the investigation continued to experience difficulties, with the result that Professor Hogan, Professor Poole, Dr Wheeler and the Secretary visited Athlone in August 1943 to carry out a critical review of the work.[64]

It was obvious that the investigation was running into almost insurmountable problems, and it became necessary, in early 1944 to halt temporarily work on the transmitter; this was due to problems with the vacuum and cooling systems, absence of proper test instruments and intermittent operation; all of these problems were of course due to the 'improvised nature' of the apparatus.[65] Another meeting was held on 9 September 1944 to discuss the future of this investigation. Subsequently, a letter was sent to the Department of the Taoiseach detailing the existing position and

future action which the Bureau estimated would require a further £2,500 to bring the work to a successful conclusion.[66]

Following this correspondence, the Bureau was advised that the Taoiseach 'wished to convey his views personally to the Chairman, Professor Hogan and Professor Poole'.[67] This meeting took place on 7 November 1944, and as a result, the investigation was discontinued and the apparatus dismantled and disposed of.[68]

At the early stage the Bureau decided that it would be important to undertake a geophysical survey of known mineral deposits of phosphates, pyrites and iron ore of economic importance in order to determine their potential for development; it was hoped that these deposits would underpin the home-manufacture of chemicals in short supply. As a first step it was agreed to carry out a magnetic survey of the known deposits and to purchase a Watts MAGNETIC VERTICAL FIELD VARIOMETER for this work.[69] The Bureau obtained sanction to appoint a physicist to carry out a geophysical survey in the Avoca district; this task was to be undertaken with the collaboration of the Geological Survey and the co-operation of the Department of Industry and Commerce.[70] Later, on the 29 June 1942, a second physicist was appointed to assist in the survey of the ore; initially this appointment was to be for a period of six weeks only but the appointment was extended up to end of March 1944.

The first task undertaken was a survey of a known magnetite deposit at Ballard, Co Wicklow. Assay returns received by the Bureau on 11 July 1942 from the Geological Survey indicated that the Ballard deposit might provide a satisfactory source of commercial iron

ore.[72] The results of this particular survey were then used to select sites for further prospecting by trenching; this work was carried out by the Minerals Exploration and Development Company.

There had been earlier reports of magnetite and nickel ore in a belt of serpentine at Slishwood in Co Sligo and a magnetic survey of the area was carried out; the survey showed that there was a considerable amount of iron present. However, the iron was diffused through the rock and there was no concentration of magnetite large enough to be mined economically; in addition, the nickel occurred in the form of a silicate which was unsuitable for development.[73]

Magnetic iron ores were known to occur in the Avoca mineral belt and attention was directed next in this area to quantifying the extent of the deposits. The survey covered a strip about a mile wide from the southern slopes of Croghan Kinshelagh to a little north of the village of Ballard and it traced out the mineral belt throughout this distance. The survey highlighted a potential source of mixed haematite/magnetic ore which could be possibly developed by the Minerals Exploration and Development Company.[74] Some exploratory work was carried out subsequently by the Minerals Exploration and Development Co Ltd; the results of this work did not become available until March 1944. The work indicated that, while a high grade magnetite ore might be obtained from the upper part of the lode, the indications were that the ore deteriorated in quality with increasing depth of deposit.

An approach was made to the British on the possibility of exporting this ore in exchange for imports of plant from Britain; this was

unsuccessful as the British Ministry of Supply indicated that the samples sent over had a phosphorus content of 0.08% which made it unsuitable for use by the Bessemer Process. As far as Irish Steel Ltd was concerned its use of the ore was contingent on the construction of open hearths, the supply of materials for which was currently being investigated.[75] It was unlikely therefore that shortages in supplies of iron and steel could be offset through home-production and by use of indigenous ores. In view of this, and the fact that the Bureau's investigations on the production of iron from this ore gave indications of high costs involved, the Company was of the opinion that further exploratory work was not likely to produce results of immediate benefit. With this information to hand, it was not surprising to find that the Bureau decided that no further action was called for in this matter.[76]

Before discussing other aspects of mineral development it is worth mentioning one specific result which surfaced during the magnetic survey carried out at Kingscourt (Co Cavan). An analysis of the data indicated the existence of a number of anomalies; further field work was carried out and a laboratory analysis was undertaken of samples from the area.[77] The anomalies were identified as being due to reverse polarisation of the rock; this phenomenon was new to this part of the world. This experimental finding was quite unexpected, particularly when basalt rock in the Limerick region gave the expected normal experimental results; the only difference between the ores was their different geological ages. The explanation for this phenomenon came to light twenty years later when it was shown that it was due to the reversal of the earth's magnetic field.[78]

In 1938 some 6,000 tons of sulphuric acid had to be imported to supplement home production of this chemical which had amounted to slightly over 2,200 tons.[79] The economic sanctions caused a reduction in both sources of acid through reduction in the quantity of the acid being imported and in the amount of pyrites needed for home manufacture. The only possible solution to offset these shortages was the development of native deposits of pyrites. As a consequence, the major emphasis in the magnetic survey carried out was accorded to the Avoca sulphide deposits. The area examined covered all known deposits of pyrites and in addition ground to the west and beyond the northern and southern extremities of the known deposits. It was of critical importance to determine the possibility of developing these native deposits of pyrites as a source of sulphur.

Examination of Avoca pyrites indicated that the ore was too low in sulphur content for use in existing plants for the manufacture of either sulphur dioxide or sulphuric acid.[81] Arrangements were then made for the experimental concentration of about 20 tons of Avoca pyrites. Unfortunately the concentrate obtained proved to be of no use for existing sulphur burners as the sulphur content was still not high enough. [81] Further experiments involving fine grinding and froth flotation were tried but this process was costly and found to be unsuccessful.[82] Some experiments were then carried out in December 1942 on the burning of some 200 tons of a higher grade of Avoca pyrites; it eventually emerged that Avoca pyrites with a sulphur content of not lower than 35% could be used satisfactorily in the manufacture of sulphuric acid.[83] Some problems did surface and various strategies were tried which culminated in a decision to

construct precipitation and flotation plants to upgrade the Avoca ore.[84] This plan was not proceeded with after November 1944; it was anticipated also that it might be possible to import the necessary plant. Work on this effectively ceased at this time as the termination of the Bureau's work appeared to be imminent.

The diversity of the topics investigated by the Bureau was a unique measure of the difficulties being experienced by the country during the 'Emergency'. That so many of those investigations resulted in significant technical assistance being provided to the industries and companies concerned is attributable to the broad remit and freedom of action enjoyed by the Bureau; such successes gave also a measure of the quality of the scientific and engineering expertise of the Bureau and of its members, staff and investigators, in discharging its role as an industry-related research organisation. All these factors featured predominantly in the establishment subsequently of the replacement organisation for both the IRC and the ESRB.

CHAPTER 10

THE BUREAU, ITS OPERATIONAL PARAMETERS AND TERMINATION

In this chapter, it is proposed to review the general operational factors which governed the work of the Bureau and some limiting factors which constrained its operational effectiveness will be discussed also. In addition, it is intended to describe the events leading to the termination of the Bureau and its activities.

The Cabinet Committee on Emergency Problems set up by the Taoiseach in May 1940 to review the broad range of problems arising out of the 'Emergency' met on sixty five occasions during the period 16 May 1940-20 February 1941.[1] The fragility of neutrality and the very real fears of a possible invasion during this time can be gauged by considering some of the problems discussed by this Committee. These included the protection of works of art and documents in the possession of the State, the security of vital installations such as broadcasting stations, telephone exchanges and public utilities such as water, gas, electricity and railways; steps were taken also to provide sleeping accommodation and meals for people made homeless as a result of enemy action, to set up medical facilities for casualties resulting from aerial attacks and to destroy petrol stocks in the event of invasion. An Emergency Powers Order was enacted to provide a mechanism for ensuring the continuity of Government in the event of an outbreak of hostilities and legal instruments were prepared to seek the assistance of allies and the appointment of a General Officer Commanding all Forces. This Cabinet Committee discussed also the setting up of an organisation to deal with the economic and social consequences which would result from a complete cessation of all imports of supplies.

It was thus apparent that the Government was very seriously concerned about the maintenance of supplies of imports of all kinds. Serious shortages of commodities already existed during this period and it was anticipated that other supplies, essential to the economic survival of the country, would become increasingly more difficult to obtain, if indeed these commodities could be obtained at all. In order to attempt to mitigate these problems and particularly the social consequences which would result from a complete cessation of all imports, which seemed very likely, the Cabinet decided to set up a small body of scientists to advise the Government. It was envisaged that such advice would be offered on technical aspects of problems associated with the drastic reductions in the supplies of imported raw materials and commodities; it was hoped also that this body of scientists would assist in the development of substitute materials or processes.

The establishment of the Emergency Scientific Research Bureau can be seen therefore as a consequence of the IRC's structure and remit; another crucial catalyst involved the various problems surrounding the issue of neutrality in the face of economic sanctions imposed by Gt Britain. From 1939 the shortages being experienced in the country were a natural consequence of the war situation in Europe and due in the main to the difficulties being experienced by Gt Britain itself in maintaining its own supply position. Furthermore, there was an expectation, on the part of the UK Government, that, as a result of the economic sanctions being imposed, Ireland would be forced to change its policy of neutrality to a policy of active war cooperation with the Allies. It should perhaps be recalled that British Ministers and officials

had denied that any economic pressure was being applied to Ireland; indeed De Valera and his Government were totally unaware, until August 1943, of the economic war being waged against Ireland. The evidence was cited in a memorandum on the supply position from S Lemass, the Minister for Supplies, submitted to the Cabinet in August 1943. He informed the Cabinet that it was his belief that Ireland was being subjected to an economic squeeze.[3] This conclusion was based on a written reply to a parliamentary question in the House of Commons on 4 August 1943. The reply from Dalton, President of the Board of Trade, stated 'in view of her neutrality, Ireland cannot expect the same consideration as those who are at war with the common enemy, and export licences are only very sparingly granted.' This significant reply showed how mistaken De Valera and his Government were up to this date in believing that the country's shortages of essential supplies were a natural consequence of a world at war and particularly due to the shipping losses in the Atlantic convoys bringing supplies to Britain.

With the setting up of the ESRB, de Valera was confident that this small group of scientists, reporting to his own Department, would be in a position to make some impact on the exceptional difficulties and problems caused in the country by interruptions and shortages of imported raw materials and commodities.

Initially the Bureau was established for the period 20 February 1941 to the 31 March 1942 but it was subsequently continued in office for each of the next three years. By the end of 1944, the supply position in imported materials was improving, helped to a large extent by the efforts of Irish Shipping Ltd. which had been set up in 1941; it was inevitable that the work of the Bureau would

be coming to an end. On the 27 September 1944, the Bureau discussed the liklihood of an early conclusion of it activities and considered the steps to be taken to meet this eventuality.[4] Subsequently it was agreed that, with the exception of the investigations on broadcasting, ether, fertilizers, mineral development and the production of phosphorus and potassium chlorate, all other experimental work could be terminated by the end of February 1945.[5]

During a telephone conversation with the Taoiseach towards the end of October 1944, Prof Dowling discussed at length the winding up of the Bureau's activities; amongst the topics referred to were the position of the Turraun Plant, the continuation of the experimental work on the production of matches using home-manufactured chemicals only and responsibility for the operation of the Parkgate Plant; other subjects included the preparation of reports on the Bureau's work, and possible permanent arrangements to be made for industrial research. During this dicussion with the Taoiseach, Prof Dowling indicated that the members of the Bureau would prefer 'not to be pushed but to go themselves' but would like time to 'tidy up' and to prepare the necessary reports which would be for him and his colleagues 'a labour of love'[6]

In a further letter sent on 2 November 1944 to the Department of the Taoiseach, the Secretary of the Bureau indicated that 'while not desirous of exerting any influence on the question of the termination or continuation of its work' the Bureau was anxious to have a number of matters considered before a decision was made as to the actual date of termination of the Bureau's activities.[7]

The first matter referred to in this letter was the production of phosphorus and potassium chlorate for the Army; these investigations represented the principle work which the Bureau was engaged in at that time. While it was anticipated that the outstanding experimental work on the production of phosphorus would be completed by the end of April 1945, it was thought unlikely that the quantity of potassium chlorate required by the Army could be manufactured before the end of September. The Bureau had been informed by the Committee on Warlike Stores that the Army authorities considered it necessary to retain the facilities and assistance provided by the Bureau and its personnel until the above operations were completed. It was expected that the experimental work associated with the production of potassium chlorate would be completed by the end of December 1944. However, it was likely, that, for as long as production continued, problems would arise which would require the technical knowledge and assistance of the Bureau.

Secondly, there were other investigations ongoing which could be brought to completion before the end of February 1945, because of the general improvement in the supply position. The topics under investigation in this category included the production of charcoal other than at Turraun, the augmentation of supplies of town gas and a range of fuel-related topics; other investigations which could be completed were concerned with the production and supply of red phosphorus, iron and steel, batteries, adhesives, non-ferrous metals, industrial explosives, warlike stores, preservatives for fishing gear, chemicals for water purification and organic solvents.

The third matter concerned the future of investigations on the production of charcoal at Turraun, short wave broadcasting, fertilizers, mineral development, medical supplies particularly the manufacture of ether, and the geophysical survey being conducted; these matters had already been referred to the Department of the Taoiseach for consideration and the Bureau was awaiting the appropriate decisions. The Secretary of the Bureau went on to indicate that, if no new problems arose and if it was decided to wind up these particular investigations, it would be possible to terminate the Bureau's experimental work by 28 February 1945. This proposed termination date was of course conditional on the provision of suitable arrangements for the continued production of phosphorus and potassium chlorate for the Army. He also advised the Department of the Taoiseach that even with the termination of the Bureau's experimental work at the end of February 1945, it would still require several months to check and dispose of all permanent equipment and stores, to vacate the Bureau's office accommodation, to dispose of the Bureau's papers and records dealing with the Bureau's work and to prepare final reports on the investigations carried out by the Bureau. The various matters referred to in the Secretary's letter were discussed subsequently at a conference held on the 7 November 1944 and attended by the Taoiseach, Prof Dowling, Prof Hogan, Prof Poole and the Secretary to the Government. As a result of this conference a number of crucial decisions were made:[8]

(a) Short Wave Broadcasting

It was noted that, although several times during the course of the investigation, success appeared to be within grasp, the position was that the apparatus would have to be dismantled and a fresh start made with still no guarantee of ultimate

success. In these circumstances it was agreed to discontinue this particular investigation.[9]

(b) Fertilizers

As it now appeared that the total deposits of Clare phosphate were not more than 100,000 tons, the view was expressed that the proposed large-scale experiment on the manufacture of fertilizer from Clare phosphate would scarcely be justified. Because of this and of the opinions expressed by the Departments of Industry & Commerce, Supplies and Agriculture, it was decided not to proceed with the proposed large-scale experiment for the treatment of Clare phosphates;[10] an additional factor which led to this decision was the continued shortage of coal.[11]

(c) Mineral Development

Information from the Department of Industry and Commerce had indicated that there was a possibility that the Mineral Development Company would be able to obtain a flotation plant from England. While this development altered the previous position, it was pointed out that it would probably be necessary to train some of the staff of the Company in the use of the plant. It was thought that at the end of three months the Company should be able to carry on without further technical assistance being provided by the Bureau.[12]

(d) Production of Charcoal at Turran

The Taoiseach was advised that the useful life of the present plant at Turraun was almost at an end and if large-scale production was to be continued then very extensive alterations and reconstruction would be necessary. Subject to the conclusion of the present experiment with the drier, the

Bureau would not object to the complete closing down of the entire plant thereafter. Having regard to these views expressed and to the latest information furnished by the Department of Supplies on the continued need for using turf charcoal in vehicles run by Government Departments and by the public generally, it was decided that the plant should be closed down on the completion of the drier experiment.

(e) Phosphorous and Potassium Chlorate

During the discussion on the above topic, the Taoiseach intimated that he did not know whether in the circumstances now existing the Army authorities would require considerable quantities of either of these chemicals. The Taoiseach expressed the view that, if it transpired that local production of a large supply of chlorate was necessary, it should be possible for the Army to take over the plant and to work it, keeping in touch with the members of the Bureau, i.e. Prof Poole and Dr Wheeler, who had hitherto been working on it; the Taoiseach also expressed the view that the work done on this experiment might be useful in connection with the development of an explosives industry in this country.

Although the investigation was then still at the experimental stage, the members of the Bureau present thought that, within two or three months, the investigation would have passed out of the experimental stage. In the light of these circumstances, it was decided that the Department of Defence should be asked to take over the operation of the Parkgate Plant.[13]

(f) The Future of the Bureau

The Taoiseach, having been advised that it would be possible for the Bureau to complete their active investigation work by the 28 February 1945, agreed that the Bureau should aim at finishing up by that date and that any outstanding matters could be cleared up subsequently. He was particularly anxious that steps should be taken at once to prepare reports on the more important investigations. In response to this, Prof Hogan intimated that the members of the Bureau would see the reports through as a matter of course even after the Bureau had ceased to function; he stated that the preparation of reports of this nature was part of the normal responsibility of investigators. In order to accomplish this it was agreed by the Taoiseach that the Bureau could continue to meet informally as an honorary body or group of individuals after the 28 February 1945 in order to clear up any outstanding matters. The Bureau was advised, that, while no provision for the Bureau would be made in the estimates for 1945-46, the remaining surplus from the 1944-45 Grant-in-Aid could be carried forward to meet any financial liabilities outstanding after 31 March 1945.[14]

(g) Future of Industrial Research

In discussing the future of industrial research in the country, the Taoiseach was reminded that he had already been provided with a report of the Bureau's views on the draft proposals of the Department of Industry and Commerce for the reorganisation of the Industrial Research Council. The Bureau had recently considered this matter afresh and had found no reason for altering the views already expressed in its previous report.The Bureau's report on the proposed

establishment of a National Institute for Industrial Research is cited in full in appendix 5.[15]

On the 21 February 1945, Mr R C Ferguson, Secretary to the Department of Industry and Commerce, received a letter from Mr M Ó Muimhneacháin, Secretary to the Department of the Taoiseach, to the effect that it was proposed to make an official public statement announcing the termination of the activities of the Emergency Scientific Research Bureau on the 31 March 1945.[16] It was also proposed to state at the same time that, proposals were under consideration for the setting up of a permanent Institute for Industrial Research and to inform manufacturers and other interested parties that, during the interval between the termination of the work of the Bureau and the establishment of this permanent Institute, the Industrial Research Council would still be available to assist them in connection with problems arising out of the emergency.[17]

Before the statement was actually issued the national press announced that the Emergency Scientific Research Bureau was to be wound up.[18] On the 28 March 1945, the Bureau met formally for the last time and concluded the arrangements for the winding up of its activities. After 31 March 1945 the members of the Bureau continued to meet as a committee in order to deal with the preparation and publication of reports on the work which the Bureau had undertaken during its term of office.[19]

On the 13 April 1945, the Taoiseach wrote personally to the Chairman of the Bureau, Prof Dowling, conveying his personal thanks

to everyone connected with the Bureau and particularly to the staff in the universities who had collaborated with the Bureau. In commenting on the energy and ingenuity which the Bureau applied to its investigations, he stated:

> The results attained by the Bureau met an immediate practical need, but over and above all that is the fact, that these results and the experience gained will be at the disposal of the permanent research body which the Government intend to set up as soon as the necessary legislation has been enacted.[20]

Prof Dowling in his reply, thanked the Taoiseach for his letter of appreciation and especially for being afforded such a splendid opportunity for national service and stated:

> What we achieved is largely due to the efforts of our technical and official staff and to the very helpful cooperation of our scientific colleagues in various institutions, Government departments and manufacturing concerns.[21]

The revival of the Bureau surfaced briefly in 1951, during the Korean War, at a meeting of the Inter-Departmental Emergency Preparation Committee when it was suggested that

> we now appear to be entering a period where the difficulties likely to arise from the growing shortages of essential materials will create a situation very similar to that which existed in this country during the recent war.[22]

It was proposed that

> the technical Departments concerned may, therefore, wish to consider whether it would be advantageous to re-create some such body as the Emergency Scientific Research Bureau to give technical advice on industrial processes and the use of substitute materials.

The Committee however decided that, 'having regard to the existence of the Institute of Industrual Research and Standards set up in 1946, there was no need for the revival of the Bureau.'[23]

The terms of reference laid down for the Emergency Scientific Research Bureau, gave the Bureau considerable latitude in determining its mode and scope of operation. The most significant outcome of this was the relative ease and rapidity with which the Bureau was able to react to the various problems which surfaced. Equally important, was the obvious faith and reliance which the Taoiseach had in the advice, judgement and recommendations which the Bureau tendered throughout the period. This confidence in the Bureau is substantiated by the very high percentage of proposals submitted by the Bureau which were subsequently approved by the Taoiseach and his Department. In addition, while adequate financial resources were made available to underwrite the various expenses associated with the different investigations undertaken, there were appropriate checks and effective safeguards, operating through the Taoiseach and his Department, to control the scope and duration of investigations and their related expenditure. It is apparent also that, under De Valera's patronage and control, the Bureau did have a great measure of both administrative and scientific autonomy. This autonomy is noticeable particularly in the selection of personnel, and the appointment of scientists and engineers to supervise and assist the Bureau in its activities; again, while approval was sought to cover the estimated costs of an investigation, the Bureau did exercise total scientific discretion as regards the scientific strategies and methods to be used in addressing a problem.

This autonomy was specially referred to by De Valera in the Dáil on 11 November 1943 during the debate on the vote of funds for the

Bureau for the financial year ending 31 March 1944. He stated:

> ... one of the difficulties about any research organisation set up by the State is that, if they are to work, they must be taken largely on trust, one cannot judge by means of an annual report of the value of the work that has been done by an organisation of that kind. They have to be given a considerable amount of freedom. In fact, I do not think it would be possible for the present Bureau to work at all if it were restricted in its operation by the close financial control that is associated generally with Government enterprises.[24]

This statement of the Taoiseach's, contains a clear indication of a policy shift and of a change in approach by the Government as to how industrial research might be organised and funded in the future.

It is also apparent that the members of the Bureau had easy and frequent access to the Taoiseach and his Department with the result that the Taoiseach was kept in touch with all the diverse activities and investigations undertaken by the Bureau. However, this mutual trust was not shared by all Ministers. The Minister for Industry & Commerce, Séan McEntee, was, to say the least, extremely critical of the Bureau; following receipt and consideration by himself and by his Department of the Bureau's First Progress Report, he submitted to the Taoiseach on 5.6.1941. a scathing fifteen page memorandum.[25] In this document, no aspect of the Bureau's work was left unexamined unscathed. He intimated that his understanding was that the Taoiseach had not intended the members of the Bureau to concern themselves 'in a highly authoritative and comprehensive fashion with the general administration of industry in this country'; such matters, he stated, would be handled more

properly and more effectively by the relevant Departments of State, which possessed the requisite information and experience to deal with such issues.[26]

He complained that a very large proportion of the first report was merely a re-hash of existing information and furthermore that the Bureau's suggestions did not relate to industry's current technical difficulties and were of little practical value. He was, he said, unaware of any special problem having been referred to the Bureau by the Taoiseach's department or indeed by his own department, and, as regards other supply matters, the Bureau was cutting in on the special functions of the Department of Supplies.[27]

Mr McEntee went on to criticise the Bureau's output on the various technical matters mentioned in the Report; these included the work on producer plants, the production of turf charcoal, supplies for the manufacture of matches. He complained also of the 'Bureau's meddling in the practical day to day administration' of various industries, including the Dublin Gas Company and the Electricity Supply Board, to the detriment of the role and function of both the Department of Industry and Commerce and the Department of Supplies. He regarded the useful work accomplished by the Bureau to date 'to be negligible' and a 'poor return for the £1,500 plus per annum' being spent by the Bureau.[28]

Such comment was typical of the Departmental and Ministerial dogmatism characterising many of McEntee's pronouncements. It is possible also that Mr McEntee and his officials were reacting to the implied criticisms being levied at the Department of Industry

and Commerce regarding the delays in the reorganisation of the IRC; a direct consequence of this procrastination had been the establishment of the ESRB. De Valera had previously discussed the remit of the Bureau with Prof Dowling in April 1941 and impressed upon him the need for the Bureau to avoid dealing with matters outside the scope or function of the Bureau; arising from McEntee's strictures, despite an indication that the Taoiseach proposed to discuss the matter again, the issue was not pursued.[29]

De Valera's answer to this criticism came two months later when McEntee was moved to Local Government and Public Health and Lemass added the portfolio of Industry & Commerce to his existing portfolio of Suplies. The subsequent record of the Bureau and the successes achieved must be acknowledged as a vindication of the Taoiseach's decision to establish the Bureau and to his selection of its membership; moreover his personal interest in and support for the Bureau and the special reporting relationships to the Taoiseach and his own Department were factors which contributed to its success and overall impact.

The Emergency Scientific Research Bureau consisted of five members all resident in Dublin, a factor which facilitated daily consultation and rapidity of response; in addition, their combined abilities, interests and experience, already described, enabled them to deal competently with a variety of scientific problems. A special mention must be made of the supportive roles played by Trinity College Dublin and University College Dublin. Both colleges responded generously to a personal request from the Taoiseach, on 17 February 1941, seeking the release of Professors Dowling, Hogan

and Poole for what turned out to be, four year of outstanding service to the country.[30] Notwithstanding the eminence of their scientific reputations and their selection being indeed a reflection and acknowledgement of their expertise and stature, there was some adverse comment. The Registrar of University College Cork, Prof A O'Rahilly, objected strongly to the setting up of a Bureau:

> completely controlled by a few men in Dublin and completely out of touch with an already existing institution such as this College where there already exist competent scientific workers and scientific equipment[31]

This reaction was possibly motivated by inter-institutional tensions and perhaps by local patriotism; it was certainly ill-judged and somewhat premature, for UCC did in fact participate in some of the Bureau's main activities.

During this period, there was considerable pressure on University staff and equipment largely due to the increasing numbers of students undertaking courses of study. Despite this the University Colleges at Cork, Dublin and Galway together with Trinity College provided laboratories, workshop facilities, equipment and plant to assist the Bureau carry out a large number of the investigations undertaken. In addition, other staff were enabled to participate in the investigation of specific problems at the request of the Bureau. The use of these facilities and staff ensured that a great number of investigations in a wide range of disciplines were carried out simultaneously, investigations which otherwise could not have been undertaken at all.

In view of the particular part played by Dr Lennon in the setting up of the Bureau, it was hardly surprising to find him play a central role as Secretary to the Bureau.[32] It should, however, be noted that, while the Federation of Irish Manufacturers Ltd would also lay claim to having 'made proposals for the formation of such a Bureau at a very early date in the war'[33], the available evidence supports strongly the view that Dr Lennon was the chief architect of the Bureau and was largely instrumental in convincing the Taoiseach of the need for its establishment along the lines suggested by him.

The office accommodation used and the administrative support staff employed were provided partly from other Government Departments and also from the Industrial Research Council itself by agreement with the Minister for Industry and Commerce. It would appear that once the decision was made to establish the ESRB, the Chairman of the Industrial Research Council, had little alternative but to agree to these arrangements as a consequence the role of the IRC became of secondary importance and its demise was clearly indicated. The additional staff who were appointed subsequently to undertake particular scientific and technical assignments were usually chosen for their specialist qualifications and expertise. While normally such appointments were made for the duration of the particular investigation only, some personnel were retained throughout the entire period and undertook scientific investigations of a number of specific projects. In general the duration of any scientific or engineering staff appointment depended largely upon the importance of the investigation undertaken and its likely contribution to overcoming shortages in the supply situation. Overall, while the

Bureau employed some 68 staff for various periods of time, the number of staff at any single point in time never exceeded forty.

Table 18: Numbers of Scientific and Technical Staff by Profession employed by the Bureau on selected dates between September 1941 and September 1944

Category of Staff	Numbers employed at						
	30 Sept 1941	31 Mar 1942	30 Sept 1942	31 Mar 1943	30 Sept 1943	31 Mar 1944	30 Sept 1944
Chemists	3	11	11	11	9	10	7
Engineers	4	9	9	13	14	9	8
Physicists	1	3	3	2	2	2	1
Botanist	-	-	1	1	-	-	-
Analyst	-	-	-	1	-	-	-
Technologist	-	1	1	1	-	-	-
Laboratory attendants	1	5	4	5	6	6	6
Workmen	-	-	3	5	3	5	4
Draughtsmen	-	-	-	-	-	-	2
TOTAL	9	29	32	39	34	32	28

Source : Report of Activities, 90 and Minute books of Bureau.

In addition to the above regular staff, the Bureau availed of the expertise of many eminent scientists, engineers and industrialists who were commissioned by the Bureau to undertake specific projects and investigations; they were normally paid a composite fee for the work undertaken and responsibility carried. A noteworthy feature of the personnel used by the Bureau was the close linkages established and developed between industrial and academic scientists and engineers; indeed the result was a blurring of the boundary between fundamental research and the application of the results of such research to industrial problems, a development which was most welcome *per se*.

The conclusion may be drawn that research which is industrially related can provide a most stimulating experience particularly for young graduates embarking on their careers. It is probable that the importance of the researches conducted by the Bureau and their importance to the economic well-being of the country provided an additional motivating force to these young graduates recruited by the Bureau; in addition there was a desire by all involved to play their part in the fight to maintain neutrality. All these factors contributed to the achievements of the Bureau and its scientists and engineers. These achievement were marked further by the award of higher degrees to a number of the personnel employed by the Bureau; permission from the Taoiseach was required before submitting work undertaken in the Bureau for such awards.[34]

Although the Bureau was financed by a grant-in-aid and had degrees of freedom of action not enjoyed by other organisations, which had to liaise with more than one Department of State, it has been clearly demonstrated that the Taoiseach and his Department still maintained an effective control over all of the Bureau's activities and financial expenditure. The Bureau was required to obtain sanction for any new project in advance of its initiation and to suply a tentative estimate of the financial expenditure likely to be incurred, including fees to be paid to any special investigator brought in to help with the experimental work. In addition, no new post could be created nor could any one be employed by the Bureau without prior sanction being obtained from the Department of the Taoiseach. Indeed authority had always to be sought for the continuance of employment outside the original period sanctioned.

One of the Bureau's major supports resided in the undoubted interest and personal commitment of the Taoiseach, Éamon de Valera, to the work of the Bureau. As a consequence the Taoiseach expected to be kept fully informed of all current activities; this was achieved through the submission to the Taoiseach, of the minutes of each meeting and at regular intervals, of Progress Reports which summarised the status of all investigations in hand; in all some sixteen progress reports and three annual reports were submitted to the Taoiseach. In addition, copies of all reports, except the sixteenth Progress Report, were circulated to all Ministers for information.

The question of the Bureau not having statutory status and the manner in which de Valera sought to establish and administer it, raise some interesting questions. These mainly revolve around the rivalry among departmental Ministers and the reluctance of de Valera to endanger the prospects of the Bureau by engendering hostility or non-cooperation from the universities. In the first case the attitudes and political ambitions of Mr McEntee may have coloured his antagonism to the proposal to establish within the Taoiseach's Department an agency, which he considered should be located within his own and which would be an interim replacement for the IRC. De Valera's actions may be justified in that the ESRB was an interim agency created within a policy sector which rightfully belonged to his own government sphere.

In relation to generating opposition within the universities, de Valera may have had in mind the reactions which he encountered the previous year (1940) when establishing the Dublin Institute for

Advanced Studies. Professor O'Rahilly of UCC may not have been typical of university thinking on the Bureau, but de Valera's political caution would have inclined him to find a formula which could utilise the expertise of university personnel and facilities without involving the institutions on a more formal basis.

The records of the Bureau, particularly the minutes, indicate that the officers of the Bureau and of the Department of the Taoiseach were in almost daily contact; in addition the Taoiseach met and conferred frequently with the members of the Bureau. Over a period of some four years approximately two hundred problems were handled by the Bureau; some of these were of considerable magnitude and importance. Such scientific endeavour must be considered as a remarkable achievement, more so since the Bureau's successes were achieved in a very constrained milieu occasioned by wartime emergency conditions and by punitive economic sanctions imposed by Gt Britain.

The Bureau normally held formal meetings each week; during the period 20 February 1941 to 31 March 1945, a total of one hundred and ninety nine such formal meetings were held. In addition, the Bureau met frequently on an informal basis and on another level, individual members participated in numerous conferences and discussions with representatives of industry or with officers of Departments of state. This contact ensured early knowledge of problems as they surfaced and facilitated industrial contacts with the Bureau.

From 1941, the Department of Supplies scheduled a series of conferences attended by representatives of the various key industries within the country; the objective was to ascertain the actual position with imports and supplies. The Bureau was represented at these conferences particularly when the discussion covered the possibility of providing, from home sources, materials or substitutes for goods previously imported; the Bureau was involved also where issues were raised concerning the reservation of specific imported materials for essential purposes or when discussion centered on maintenance of plant and machinery. In attending these conferences, the Bureau was enabled to create a network of contacts with technical and scientific personnel in a number of industries; as a result the members of the Bureau became familiar with the range and extent of the difficulties currently affecting Irish industry. Within a short period of time, as the work of the Bureau became known, some manufacturers actively sought the cooperation of the Bureau on specific problems; other gave assistance by making their facilities and technical staff available to help the Bureau in particular aspects of its work. Subsequently, a great number of technical conferences was arranged by the Bureau itself. The conclusions and recommendations emanating from such meetings and conferences were communicated to the Government and to the various Departments.

Problems submitted to the Bureau for investigation were tackled using a variety of methods. In all cases, the primary step was the collation of data and relevant literature by the office staff and, in particular, by the Records Officer of the Industrial Research Council, who was on secondment to the Bureau. This documentation

was then submitted to the Bureau or to a member of staff with the necessary expertise; on other occasions, the Bureau obtained assistance from external consultants possessing the specialised knowledge required to deal with the matter.

Another method was to hold conferences with industrial scientists; this strategy was used when there was a need for close collaboration between the Bureau and the industries concerned to resolve the problem. At other times, the Bureau acted as a 'sounding board' for industry; problems were discussed, plans of operation reviewed and investigations initiated or helped to a successful conclusion. The cumulative effect of all of these industrial contacts was the acquisition of an extensive range of information and specific knowledge on manufacturing processes and industrial production techniques; the Bureau often found applications or uses for this information in resolving other problems.

The main part of the Bureau's work consisted of experiments devised by the Bureau and carried out by specialist staff selected and appointed, for a specific period of time, to do the work. Such personnel worked under the supervision of a member of the Bureau or some senior scientist specially commissioned to act in this capacity. The location of these investigations varied with the type of work required. Some were carried out in the laboratories of the University Colleges or of commercial firms while others required the use of specialised premises and plant specially acquired and assembled for the purpose. In some cases the services of outside

investigators with specialist expertise were enlisted for particular investigations. Indeed throughout the course of its short history the Bureau obtained assistance from many of the country's senior scientists and engineers. Without these contributions much of the work of the Bureau could not have been undertaken nor brought to a successful conclusion.

The main finances for the Bureau came from sums voted by the Oireachtas Vote which consisted of two sub-heads. Subhead A provided for honoraria to members of the Bureau and for their incidental expenses including travelling and subsistence allowances. Subhead B provided a Grant-in-Aid for expenses connected with investigations and researches, including remuneration, travelling and subsistence allowances of investigators, purchase or hire of equipment and facilities.

Table 19: Funds granted by the Oireachtas to the Bureau by subhead together with details of monies spent per subhead for each financial year from 1940/41-1944/45

Year	Honoraria and Incidental Expenses		Investigations and Research (Grant-in-Aid)	
	Subhead A		Subhead B	
	Grant	Expenditure	Grant	Expenditure
1940/41	£200	£181	£1,250	£1,250
1941/42	£2,000	£1,678	£10,000	£10,000
1942/43	£1,750	£1,707	£17,750 £5,000*	£22,750
1943/44	£2,250	£2,226	£30,600	£25,000
1944/45	£2,250	£2,152	£17,000	£8,500
TOTAL	£8,450	£7,944	£81,100	£67,500

* Supplementary grant FOR 1942/43

Source: ESRB Report on Activities 1941-1945 (Dublin 1946), 87

Thus, during the Bureau's period of office, slightly over £90,000 was made available to support its work and activities; of this amount almost £75,500 was spent, the unspent amounts occurred mainly in 1943/44 and 1944/45 as the volume of activity of the Bureau began to diminish. It might be recalled that the total amount spent by the IRC from 1934 up to February 1940 was about £22,000. This difference in funding between the ESRB and the IRC was a significant factor in enabling the ESRB to function as a viable and productive industry-related research organisation.

When the Bureau decided on an investigation, an outline of the proposal and an estimate of the expenditure was submitted to the Department of the Taoiseach; the estimate detailed the likely expenses for that particular investigation and included specific requests for fee(s) and salaries to be paid; if additional funds were required the Bureau was obliged to submit a further request. In general, the cost of the investigations carried out was met by the Bureau if it was considered that the subsequent benefit was accrueing to the country as a whole; if the work benefitted an individual or firm then a contribution to the overall cost was requested. Some investigations were undertaken also at the request of Government Departments or large industrial organisations; if the results of these investigations were placed at the sole disposal of the organisation or department concerned, then the Bureau's expenses were refunded in full.

An examination of the Bureau's accounts in table 20 shows that in excess of £48,000 was received by the Bureau for various services and investigations undertaken on such a repayment basis; another

source of income was the sale of surplus material which netted almost £6,000 for the Bureau.

Table 20: Receipts and payments detailed by category of income and category of expenditure for the financial years 1940-41 up to and including 1945-46

RECEIPTS

	£	£
Issues from Grant-in-Aid:		
1940-41	1,250	
1941-42	10,000	
1942-43	22,750	
1943-44	25,000	
1944-45	8,500	67,500
Sale of Surplus Materials:		
1941-42	1	
1942-43	32	
1943-44	5,231	
1944-45	397	
1945-46	93 *	5,754
Sums received in respect of Services/Investigations carried out on a repayment basis:		
1941-42	2,578	
1942-43	4,412	
1943-44	11,080	
1944-45	24,583	
1945-46	5,627*	48,280
		121,534

PAYMENTS

	£	£	£
Expenses of Investigations Researches:			
Salaries, Wages, Fees, Insurance, etc.			
1941-42	3,970		
1942-43	11,481		
1943-44	18,542		
1944-45	11,436		
1945-46	1,250*	46,679	
Travelling & Subsistence of Investigators and other staff.			
1941-42	367		
1942-43	829		
1943-44	860		
1944-45	493		
1945-46	30*	2,579	
Purchase & Hire of Plant, Equipment, etc.			
1941-42	2,153		
1942-43	3,350		
1943-44	6,558		
1944-45	4,402		
1945-46	650*	17,113	
Cost of Supplies & Materials.			
1941-42	6,150		
1942-43	12,205		
1943-44	12,578		
1944-45	13,610		
1945-46	870*	45,413	
Miscellaneous Expenses			
1941-42	193		
1942-43	307		
1943-44	758		
1944-45	506		
1945-46	160*	1,924	113,708
Balance unexpended:			7,826
			121,534

Source: Report on Activities, 88

Notes: (i) Some materials were transferred without charge to Government Departments and to Companies set up under Government auspices; the value of these goods was about £12,600.

(ii) An asterisk * indicates an estimated figure as the Bureau was no longer officially in existence after 31 March 1945.

As a result of this practice in charging for services provided, the Bureau was able to cover over 44% of its operating costs; this was a remarkable achievement and a possible operating principle for any future industrial research organisation. However, the costs attaching to the University laboratories and other facilities, including staff, are not included in the financial statements; while this additional overhead would tend to reduce the net percentage and value of self-financing enjoyed, it could be argued that the Government, as a major contributor to higher education, could legitimately expect the free use of these facilities at a time of national crisis.

It was apparent that the scientific details of the work undertaken by the Bureau should be kept confidential; as a consequence disclosures were permitted only with the permission of the Bureau.[35] Indeed subsequently, when the Bureau agreed to any publication, it was on the clear understanding that the material in question would be vetted by the Bureau. Furthermore, the Bureau always sought the approval from the Department of the Taoiseach for each publication so recommended. An example of this was provided by a journalist proposing to publish an article in Chemical Age about the work of the Bureau; he was interviewed by Dr Drumm, Dr Wheeler and the Secretary on 19 November 1942 and required to submit his article to the Chairman for clearance before publication.

Other such examples, where prior approval had to be obtained, included a lecture on the chemical work of the Bureau to the local branch of the Institute of Chemistry given by Dr Wheeler in October 1943, and a lecture on 'Some Chemical Problems of the Emergency' given by Mr Flood at the Royal Dublin Society on 25 February 1944.

Further examples include articles on 'Engineering Aspects of the Work of the Bureau' and 'Applied Geophysics' authored by Mr Leahy and Mr T Murphy respectively and included in a handbook published by Cumann na nInnealtóirí. Other publications which appeared included articles by Prof Hogan on 'Producer Gas for Internal Combustion Enginers' and 'Experiments on the Production of Charcoal and Producer Gas from Turf', published by Cumann na nInnealtóirí and discussed at the Ordinary General Meetings of the ICEI held in January 1943 and April 1948 respectively.[36] Individuals seeking information were advised by the Bureau to consult the appropriate sections of the relevant Dáil Éireann Parliamentary Debates dealing with the Bureau's work.[37]

In September 1944, the Bureau considered the desirability of an official publication giving details of completed work. There was general agreement that

> publication in the form of monographs would be the most desirable form and that, where a definite contribution to scientific knowledge had resulted from investigation, publication might also be made in scientific journals.[38]

Eventually a draft document *Emergency Scientific Research Bureau, Report on Activities, 1941-1945* was prepared; however, it was not until 31 May 1946 that the Taoiseach directed that this report subject to a number of amendments, be published.[39] It was decided also to publish separately a number of technical reports dealing with selected aspects of the Bureau's activities. The first of these was to be a report on the manufacture of formalin. Unfortunately, while a draft of this report exists there is no record of its subsequent publication.[40]

The amendments made to the draft document, Report on Activities, 1941-1945, referred to above, were concerned with the work of the Bureau in the manufacture of chemicals at Parkgate. The draft contained experimental details of the thermite process and the production of phosphorus sesquisulphide and potassium chlorate; the Department of Defence had expressed reservations about the publication of these sections on grounds of security. These amendments were the subject of a discussion in April 1946 between representatives of the Department of Defence and the Bureau, meeting as the honorary body previously agreed to by the Taoiseach on 7 November 1944. Agreement was eventually reached on the content of the report for publication; the text was amended to take account of the reservations of the Department of Defence. These reservations stemmed not only from consideration of internal security issues but also because of the undesirability of publicising the fundamental weakness of the country in supplies of explosives and warlike stores.[41] Indeed according to one source, the chemicals manufactured at Parkgate were utilized in the preparation of sophisticated fire bombs and anti-tank mines for use by the Defence Forces against an invading army.[42]

The parameters under which the Bureau operated evolved over time and allowed it to develop into a relatively stable and extremely effective industrial research organisation. Probably the most important organisational factor, which contributed significantly to its overall impact and success, was the undoubted support from the Department of the Taoiseach and from the Taoiseach personally. Its very success and strong central government support, in turn contributed to an identifiable change in attitude by the Government

to its policy on industrial research. The termination of the Bureau thus served as a catalyst for the articulation and implementation of a new phase in government policy on scientific and industrial research.

CHAPTER 11

THE ESRB IN RETROSPECT, ITS IMMEDIATE IMPACT AND LONG TERM INFLUENCES

In this concluding chapter, it is proposed to evaluate the immediate impact of the Bureau during 'the Emergency' and to examine its major achievements. In addition it is proposed to examine the Bureau's long-term influences, in particular, what was perhaps the Bureau's main legacy, the generation of a political and ideological climate which sought to create subsequent agencies and institutions similar to the Bureau. These included the Institute for Industrial Research and Standards, the National Science Council, the National Board for Science and Technology and Eolas; the work of the Bureau may also have been instrumental in suggesting the creation of other research-oriented institutes such as An Foras Talúntais, (the Agricultural Institute) and An Foras Forbatha, (the Institute for Physical Planning and Construction Research).

The establishment of state-sponsored bodies in the early years of the state represented a recognition of the relevance of science and technology in promoting industrial and economic development. However, while the role and importance of education as an agent for the promotion of economic and social change had been recognised, it was never systematically exploited; there was in effect an absence of a central policy mechanism in higher education and there existed no programme for the expansion of provision in higher education until the late 1960's.

Probably the most crucial science and technology related development was the establishment of the Industrial Research

Council (1934); its contribution to industry-linked research was significant in the development of science and technology as elements of industrial and economic policy. Its potential impact however was diminished by virtue of its close umbilical links to the administrative Civil Service. This close administrative linkage denied the IRC the necessary freedoms required by such a scientific and research oriented unit. Furthermore, its budget and facilities were never adequate; it had no permanent scientific and technical staff nor premises properly equipped to undertake industrial research. Its overall contribution would have been even more limited were it not for the dedication of individual members of the Council of the IRC. What was clearly demonstrated however, was the need for an organisation with the appropriate structures, personnel and funding level to make a meaningful contribution to industrial development and innovation and with an administrative milieu conducive to research.

In evaluating the scientific merit and impact of the work of the Bureau, cognisance must be taken of a number of special factors and the unusual environment in which the Bureau was established and obliged to work. First of all the country was virtually isolated from the available market places of the world by the military blockade imposed by the Allies to prevent supplies being transported to Italy and Germany.

Secondly, the policy of neutrality espoused by the country led to the application by Gt Britain of severe economic pressure on the country in a bid to force the country into siding actively with the Allies. The strategies adopted for applying these economic

sanctions were little short of economic war; they led to a drastic reduction in the quantity of shipping available to transport Irish imports and exports and an alteration in export licensing arrangements which disadvantaged Ireland even further; they effectively reduced or stopped imports of key commodities and supplies, such as food, animal feedstuffs, fertilizers, fuels, iron and steel and machinery. Other results included the withholding of insurance facilities for incoming shipping which effectively meant that no ships could be chartered or hired by Ireland; this led in turn to the setting up of Irish Shipping Ltd. Another factor was the discrimination practised against Ireland in the operation by Gt Britain of the navicert system for shipping control.

Thirdly, because of the country's economic dependence on Gt Britain, Ireland was obliged to show a certain consideration for Britain, which meant the maintenance of certain trading relationships advantageous to Britain. It implied also an unchallenged acceptance that any deprivation caused by shortfalls in imports of essential goods and supplies to Ireland was a result of Britain's own precarious supply problems; these problems were exacerbated, in British eyes, by Ireland's stance on neutrality; a neutrality which was dependent to a large extent on Ireland receiving supplies of commodities and materials from a beleagured Britain; there was therefore little official sympathy from the British government regarding Ireland's difficulties.

Economic dependence on Britain was to a large extent the source of many of the problems experienced by Ireland; this dependence was exacerbated by the poor performance of the country, from the

foundation of the State, in developing its technical industrial infrastructure. Most of the firms dated from the 1930s when the first major effort was made to industrialise. The small size of the Irish market precluded most firms, native and foreign, from reaching an efficient scale or from entry into export markets. This state of affairs was not altogether surprising in the light of the conservative economic policies pursued by the main political groups between 1922 and the war. For example the political programme adopted by Fianna Fáil in 1926 was as follows:

> (1) Securing the political independence of a united Ireland as a republic.
> (2) The restoration of the Irish language and the development of a native Irish culture.
> (3) The development of a social system in which, as far as possible, equal opportunity will be afforded to every Irish citizen to live a noble and useful Christian life.
> (4) The distribution of the land of Ireland so as to get the greatest number possible of Irish families rooted in the soil of Ireland.
> (5) The making of Ireland an economic unit, as self-contained and self-sufficient as possible - with a proper balance between agriculture and the other essential industries.[1]

Of the two major political groups dominant in the period Fianna Fáil was regarded as the most radical.

The initiation, continuance and termination of the various investigations undertaken by the Bureau were subject to a number of critical constraints; these included the unpredictable ebb and flow of imports of essential commodities and materials and the need to maintain minimum levels of stocks of essential supplies such as food, animal feedstuffs, fuel, medicines and pharmaceutical products; other factors were the general effects of the economic sanctions on industrial and economic activity and the difficulties experienced by Irish Shipping Ltd in both acquiring ships and

transporting cargoes in a hostile maritime environment. The application of these constraints determined also the selection of topics for investigation, the order of priority of the investigations undertaken and, to an extent, the pursuit of any particular investigation to a successful conclusion or indeed to its early termination.

There was another significant factor which affected some of the investigations, that of the nature of the Dublin/London relationship. That the experimental progress and success of many of these investigations appeared to come to the knowledge of the policy makers in Whitehall can be deduced from the various memoranda and minutes in the Public Records Office (London). This occurred probably as a result of the close scrutiny of the British War Cabinet Committee, charged with monitoring the effects of the economic sanctions. The evidence shows that, for some commodities in short supply, the official policy of curtailing and reducing exports to Ireland was relaxed close to the point in time when the Bureau's research and experimental work appeared to be reaching a successful conclusion.[2] This appears to have happened in the case of the production of ether, ammonia, invert sugar, insulin solution, digitalis, aluminium sulphate, carbon black and zinc. Obviously these specific items did not constitute imports of major strategic significance to Ireland; for important imports such as coal, petroleum products and iron and steel, no similar relaxation of the regulations occurred since the Bureau would not have been able to make a substantial contribution to the country's needs.

Despite these many factors, some of them negatively constraining,

the Bureau in its short period of operation, achieved significant advances in the fields of fuel supplies and chemicals; it achieved major advances also in a number of other fields and specific investigations.

Fuel Supplies

Investigations relating to the augmentation and efficient use of fuel supplies were judged to be of prime importance, and thus occupied a large proportion of the Bureau's time and budget. The most important of these investigations were the manufacture of turf charcoal and the efficiency and use of mobile producer plants, as petrol supplies had been curtailed drastically; another important investigation was the maintenance of town gas, supplies of which were subject to the extremely adverse conditions prevailing.

Experimental work on the production of turf charcoal which began in March 1941 and ended in December 1944 resulted in the design, erection and operation of a plant on the Tarraun Bog (Co Offaly) for the production of turf charcoal. The plant was able to produce fuel at a rate of up to 22 tons a week. In operating the plant, the Bureau had to use whatever quality of turf was available; this meant that the product obtained was generally of variable quality with variable volumes of output. With a cumulative total output of 1218 tons of charcoal, equivalent to 609 tons of coal, the plant contributed minimally to alleviating shortages in fuel supplies. In terms of time and money spent, the return on the investment made was, by any measure, low, but the investment had to be made at the time because of the drastic reduction in petrol supplies referred to earlier; supplies of 44 million gallons in 1939,

reduced to 13.2 million gallons in 1942 and then to 9.9 million gallons in 1943. The effect of this reduction on transportation within the country was devastating and potentially catastrophic; the fact that the plant was set up at all was a measure of the seriousness of the position generally.[3]

Probably the most notable scientific output of this investigation was the accumulation of experimental data; this knowledge proved to be a vital asset in the maintenance of town gas supplies, the manufacture of which depended initially on inferior and reduced coal supplies which then had to be augmented with turf. In 1942, the critical nature of town gas supplies for Dublin caused De Valera to ask the Bureau to examine the feasibility of erecting a gas works on a bog; the plant was to use the turf *in situ* as the prime fuel and to supply town gas to Dublin. The idea was found by the Bureau to be impractical only because of the severe shortage of the necessary materials to build the plant; that such a development was considered at all is indicative of the severity of the consequences of the economic sanctions being imposed. Indeed, but for the assistance given to the Dublin Gas Company by the Bureau in the operation of additional water gas plants, supplies of town gas in Dublin would have been reduced by about 1,000,000 cu ft per day in late 1942; such a reduction on top of an already depleted and severely rationed gas supply would have had the most serious social consequences. Perhaps the most significant scientific achievement of this particular work was the development, by Professor Dowling, of a centrifugal gas specific gravity meter; this instrument was devised for measuring the composition of the gas produced at the Turraun Plant (ref appendix 5).

The detailed experimental work carried out on producer plants enabled the Bureau to respond positively to various technical queries from manufacturers and users for advice and information. The results from this work also proved valuable in determining requirements and standards relating to the design and operation of producer plants; this aspect of the Bureau's work in developing *standards* was novel and of specific interest later when the remit of the IIRS was determined. This accumulation of data enabled the Bureau to advise the Department of Supplies on the compliance of different designs of locally-produced producer plants with official regulations laid down for the safe operation of such plants. The ability of the Bureau to respond to such requests for technical assistance benifitted not only the local small-scale industries involved in the manufacture of producer plants, but also the users of the plants. The inability of the country to manufacture sufficient numbers of mobile producer plants was a serious inhibiting factor to their more general use; this in turn curtailed the need for fuel and therefore supplies of turf charcoal.

Other investigations in this area which contributed to the overall effort related to the storage of turf in large ricks, the use of substitute fuels in domestic heating appliances and the increased danger of chimney fires from the use of turf or wood. While these investigations may seem somewhat trivial in nature, they did contribute to alleviating public concern and assisted with morale building within the country generally.

Manufacture of Chemicals

The major scientific objective of a large number of important

investigations carried out, by the Bureau, was the development of processes for the manufacture of commodities which had not hitherto been produced on a commercial scale within the country. The necessity for the home-manufacture of these commodities had never arisen as the materials had been normally imported. In attempting to set up the necessary manufacturing plants, the Bureau experienced major difficulties as attempts were made to obtain the necessary equipment and the supplies of raw materials normally used; this was due to the virtual isolation of Ireland from its normal market places and to the stance adopted by Gt Britain. In addition, in many instances, there was a scarcity of published information within the country concerning the industrial methods and processes likely to be of use; again this was due in part to lack of development of manufacturing industry in the country since independence.

Although the fundamental scientific principles underlying all the work undertaken by the Bureau were known and could be applied in laboratories, the development of a successful pilot-plant or commercial-scale plant required very specialised industrial chemical and engineering expertise; the complexity of the operation is at least a number of orders of magnitude greater with factors such as scale-effect and energy losses becoming critical operating factors. Therefore, considerable experimental work was frequently necessary before a successful process was developed. Thus, the very conditions of shortage which led to the establishment of the Bureau created additional special scientific and engineering difficulties; the practical solution to many of the problems which the Bureau was authorised to investigate involved the imaginative use and

innovative adaptation of materials and machinery to suit the process under development.

Some of the Bureau's larger experimental investigations were very successful. They resulted in the production of commodities in short supply on a scale large enough to contribute significantly to the economic needs of the country. A dramatic demonstration of this aspect occurred during summer 1941. A member of the Bureau found out, that a crisis had arisen in the mineral water trade by the sudden complete stoppage of imported supplies of carbon dioxide. A Dublin factory, which had already given a week's notice to all its employees, agreed to postpone this course of action for another week. In this short period of time, the Bureau devised and set up temporary carbon dioxide generators and the company concerned and other companies similarly affected were able to maintain production. Thus not only was the continuity of supplies assured but jobs were saved in addition.

A much more serious consequence of the shortage of carbon dioxide was the effect on a number of creameries. One quarter of the creameries relied on supplies of carbon dioxide for the operation of their refrigeration plants. The Bureau devised a suitable plant to manufacture the gas; it was assembled first at University College Dublin and then transferred to Dungarvan Co-operative Creamery, where it was used to produce all the gas immediately required. Subsequently, Industrial Gases Limited, in conjunction with Guinness's Brewery, produced the gas on a scale which was more than sufficient for the country's total requirements. Had the Bureau not been able to intervene in this manner, many of the

industrial concerns depending on supplies of carbon dioxide would have been forced to shut down their operations and terminate the employment of many people.

Another outstanding achievement was the production of phosphorus, phosphorus sesquisulphide and potassium chlorate in sufficient quantities to meet the needs of the Department of Defence and later the match manufacturing industry. Details of the actual manufacturing processes for these chemicals, as distinct from their production in laboratory scale experiments, were a well-kept trade secret. In addition, there were relatively little supplies of the special materials required such as the large size carbon electrodes required in the electric furnace. Substantial engineering problems had to be solved using makeshift materials and equipment which had to be adapted and utilized to best advantage. Another problem was that the available literature gave scant engineering details of the type of plant and materials required. At one stage, the Bureau was obliged to seek the help of the Department of External Affairs to purchase Billiter Technische Elektrochemie and Ullman's Technishe Encyklopadie to augment the literature available: at a cost of some £80; this was an expensive but necessary source of information as technical details were given of many of the manufacturing processes which the Bureau had under consideration.

The major drawback at the Parkgate Plant was that production costs greatly exceeded those which might reasonably be anticipated from a commercially viable plant operating under normal engineering and market conditions. While increased costs were inevitable because of the inherent problems with the design, fabrication and operation of

the plant, at least the country had supplies of chemicals which could not be imported.

All the work undertaken by the Bureau at the Parkgate Street plant was affected by similar operating parameters and difficulties. Nevertheless, the achievement of the Bureau in producing a range of chemicals never before manufactured in the country must rate as an outstanding achievement; the supply of these chemicals, which were normally imported, met an immediate and urgent need. In terms of commercial viability, the plant may be considered a failure, but failure in wartime is a relative term particularly when the alternative was no supplies at all.

Other Investigations

The uncertain supply position, with the possibility of reduced imports or indeed a complete stoppage of supplies of key commodities, resulted in the carrying out of a number of investigations in collaboration with some industrial concerns. These investigations resulted in the following developments of significance:

(i) The setting up of a semi-technical scale plant for the commercial production of *ether*. It never became necessary to use the plant to produce ether, as imports were maintained at satisfactory levels; the plant was held on reserve stand-by status in case supplies were cut off.

(ii) Some 15 tons of *glycerine* was manufactured in another pilot-plant operation. This quantity made a significant contribution to the country's needs at the time. Production

was discontinued because of difficulties in obtaining adequate supplies of fuel for the plant and eventually by an improvement in the supply position.

(iii) A plant was set up to manufacture *invert sugar* but never brought into actual use due again to an improved supply situation. This operation established that *glucose* could be manufactured if it became absolutely necessary.

(iv) Other experimental investigations involved medical pharmaceuticals and established that the manufacture of *insulin solution*, *digitalis preparations*, *liver extracts* and *vitamin products* could be undertaken. Once again, it was decided not to proceed with any of these investigations as quantities of imported supplies, sufficient for the country's needs, were obtained.

(v) The successful completion of a series of investigations on the production of *formalin* culminated in the commissioning of a commercial plant which produced some 19,500 gallons of formalin; this was a significant and important development and it made a major contribution to the needs of the country.

(vi) *Organic solvents*, *adhesives* and *carbon electrodes* were manufactured in commercial quantities sufficient to mitigate serious shortfalls in imported supplies.

(vii) A pilot plant for the manufacture of *carbon black* was set up and held in reserve; it was not utilized as paper and ink manufacturers managed to obtain imported supplies sufficient for their immediate needs.

(viii) Some fundamental research on the preparation of *synthetic rubber* established the feasibility of producing rubber in

the country. This work was not proceeded with due to the projected large capital costs involved; it was established also that it would be technically very difficult to manufacture sufficient to make a significant contribution to the country's needs.

Some investigations were started in anticipation of expected serious shortages of essential commodities but were later suspended or abandoned totally due to an improved supply position. Typical of these investigations was the manufacture of sulphur and aluminium sulphate and the work on batteries. While these investigations did not proceed to commercial production, they did at least demonstrate that commercial production was feasible should it become absolutely necessary. Other experimental work established the feasibility of producing iron by electro-deposition and ferro-silicon for use in de-oxidizing iron. These particular processes could not be exploited due to the high costs involved; a particular problem here was the demand for electric power, the availability and use of which was severely curtailed throughout the emergency.

Due to the shortage of spare parts for automobiles, engine parts and machine tools, attention focussed on the re-use of scrapmetal. The development of a method for the rapid routine analysis of scrap metal by spectrographic analysis was a particularly noteworthy scientific achievement; this was of particular benefit as it enabled the easy re-cycling of scrap metal at a time when imported supplies of iron and steel had virtually ceased.

The successful semi-commercial experimental work carried out by the

Bureau on the production of high grade fertilizers using Clare phosphate could not be exploited to the full at the time because of the scarcity of fuel. Nevertheless, this work did result in the home manufacture of limited quantities of superphosphate and low grade fertilizers. On another front the scarcity of fuel prevented the manufacture of potato flour which the Bureau demonstrated could be utilized for making bread to supplement the 'emergency flour' then being used.

Other work undertaken by the Bureau was initiated to provide for contingencies which did not in fact materialize. Typical of this work was the erection, testing and maintenance of a stand-by plant to supply ammonia for refrigeration plants particularly for food storage. Other examples in this category were the manufacture of yeast using home produced chemicals, the setting up of a plant for the manufacture of aluminium sulphate for water purification and paper manufacture; the manufacture of ether, had to be stopped since it appeared that the proposed manufacture of ether was having a detrimental effect on obtaining supplies from Gt Britain.

A notable failure was the work carried out to improve radio communications. The technical difficulties encountered in the manufacture of the high vacuum valves could not be adequately resolved. Similar problems had been encountered by the British in manufacturing high-power short-wave valves capable of operating over long periods at high frequency; the technical difficulties were resolved only as a consequence of the high levels of technical resources allocated to developing television for entertainment; the first television broadcast took place in August 1936 at the

Radiolympia Exhibition in London. The success of this British venture underpinned the development of radar which was in operation when war broke out in 1939.

Another accomplishment of the Bureau was its ability to give relevant and useful technical advice to industrial concerns investigating particular problems. Problems solved successfully using this strategy included the manufacture of vinegar from spoilt beer, the provision of substitutes for oil and size for textiles, the use of 85% white flour for home baking and the use of Avoca pyrites in the manufacture of sulphuric acid.

As already indicated, some investigations developed to a scale of production that reached commercial proportions. It was not in the remit of Bureau to continue such scales of operation; the Bureau was primarily functioning as an organisation for industrial research and it was undesirable for it to engage in routine commercial production. As a result the charcoal plant at Turraun was handed over eventually to the Turf Development Board, which then proceeded to operate it under the technical direction of the Bureau. In a similar fashion, Irish Alcohol Factories Limited took over the plant for the manufacture of formalin while the plants for manufacturing phosphorus and potassium chlorate were handed over to the Department of Defence. It is of interest that fifty years later the most recently established whiskey distillery in the country has been located in Cooley.

The decision by the Taoiseach to establish the Bureau must surely rank as one of the most important decisions taken by the Taoiseach

during these 'emergency years'. For four critical years, the members of the Bureau devoted their undoubted talents and skills to the investigation of a large number of scientific and technical problems. An important characteristic of the Bureau was its ability to act as a catalyst and focus for the harnessing of the scientific knowledge and engineering expertise which existed in the country; this is evident by the successes of most of the investigations carried out by the Bureau. It is also reasonable to suggest that the benefits accruing from the scientific and technological investigations carried out by the Bureau far outweighed the total financial cost to the nation.

The young graduate scientists and engineers recruited by the Bureau proved to be adaptable and highly competent in carrying out the various investigations to which they were assigned, an encouraging indicator of the quality of higher scientific education in Ireland. The research and development opportunities afforded to such young graduates, under the supervision of some of the country's leading scientists and engineers, constituted a unique professional preparation and training in Ireland. Subsequently, many of these scientists and engineers obtained appointments in various branches of Irish industry and moved rapidly to posts of considerable seniority and status; they were thus in a position to contribute significantly to the development of science and technology related activities in the post-war period as indicated in Table 21.

The nature of the period in which the Bureau operated was also an important factor in moulding its philosophy which was grounded in a collective idealism. Because of the very real threat to the

autonomy of the country, the concept of national service and personal sacrifice predominated in society. This dedication may best be exemplified by the two hundred thousand men who volunteered to serve in different capacities in the defence forces and in the augmented tillage programme undertaken by farmers.

Table 21: Landmarks in the Career Development of some Bureau Staff by profession and level of responsibility achieved

Name of Staff Member	Professional Role with ERB	Subsequent Professional Appointment Level of Reponsibility
BELTON, James G	Chemist	Research Fellow with The Medical Research Council of Ireland
DE LACY, Hugh	Chemist	Principal, College of Technology, Kevin Street, Dublin
DONOVAN, John H	Engineer	Chief Executive of Esso Ireland Ltd., later Chairman Concrete Pipes Ltd., IBM Ireland Ltd., Irish Industrial Gases Ltd and Director of numerous other companies - Elected President of the Institute of Engineers of Ireland in 1976/77
FLOOD, Donal T	Chemist	First Director-General, Institute for Industrial Research & Standards, Dublin
HANLEY, Patrick J	Engineer	Director of various companies including Southern Chemicals, Messrs Carbide Ltd., Electrodes Ltd.
LARKIN, Declan M	Physicist	Professor of Electron Physics, University College, Galway
LAVELLE, W J	Engineer	Senior Engineer with Bord na Mona, Ireland
LEAHY, Patrick M E	Engineer	Professor of Mechanical Engineering, University College, Dublin
LUND, O A	Engineer	Managing Director and Vice-Chairman of Irish Cement Ltd (merged with Roadstone Ltd to become Cement Roadstone). Fellow of the Institution of Engineers in Ireland
LUNNY, F	Engineer	Senior positions in Bord na Mona and the NBST; elected Fellow of the Institution of Engineers of Ireland
MCPHILLIPS, James	Chemist	Senior Engineer, Electricity Supply Board, Ireland
MORRISSEY, Joseph J	Engineer	Professor of Electrical Engineering, University College, Dublin
MOYNIHAN, Patrick	Chemist	Chief Chemist with Coldchon and later Hygeia in Galway
MURPHY, Thomas	Physicist	Senior Professor, Dublin Institute for Advanced Studies
MURPHY, Diarmuid	Chemist	Worked for National Research Council Canada, became Chief Scientific Officer in An Foras Taluntais, seconded to National Science Council, later Secretary to NBST
OCALLAGHAN, Thomas	Engineer	Director, Engineering Division, Institute for Industrial Research & Standards, Dublin
ODUFFY, Peadar	Engineer	Training Manager, Electricity Supply Board, Ireland
OKEEFFE, John G	Engineer	Assistant Director of Engineering, Radio Telefis Eireann, Dublin
OREILLY, Henry B	Engineer	Manager, Sales Planning Dept, Esso Teoranta, Co Dublin
PURCELL, Denis J O	Engineer	Works Controller, Central Engineering Workshop, Office of Public Works, Dublin

Source : Names of staff from ESRB Records; professional details from private sources.

Perhaps the Bureau's major contribution was the generation of a political and ideological climate which subsequently sought to create agencies and institutions of a similar nature to the Bureau. The activities of the Bureau gave a clear signal that the implementation of strategies to develop the application of scientific and technological advances would be an important factor in promoting economic and social progress during the post-war period. Equally, it was recognised that previous Government funded scientific research and development activities had proved to be inadequate for the needs of the country.[4] A period of rapid expansion of scientific and technological research activities was required urgently. As a result, over the two decades following the demise of the Bureau, a number of major developments occurred which made a significant contribution to the evolution of science policy. The Government had already recognised the shortcomings of the Industrial Research Council and in 1941 had indicated that plans were under consideration to establish a new body.[5] Dr L J Kettle, Director of the IRC, was equally aware and critical of the Council's shortcomings; in a letter to the Taoiseach on 7 February 1941, he stated:

> The Industrial Research Council was, I believe set up without any close study having been given as to the most suitable organisation ... on the basis of the experience gained in the first couple of years a re-organisation would be found not only advisable but necessary[6]

It was thus anticipated that any new body would be so constituted that it could respond more rapidly to the emerging scientific and technological demands of a developing industrial economy; in addition it is not unreasonable to suggest that the role and remit of the ESRB together with its contribution to industrially-linked

scientific and technological research would provide a model for the policy makers in determining the operational framework and remit for this new body.

Prompted by the proposals emanating from the Industrial Research Council and, later from the Emergency Scientific Research Bureau on the necessity for setting up an industrial research organisation, with the necessary legislated status, financial provision, staff and premises, to make a meaningful contribution to industrial research, the Department of Industry and Commerce began to reconsider its views on the topic of industrial research. By the end of 1939, the Department of Industry and Commerce had proposals advanced to the stage that financial approval was being sought from the Department of Finance; however it was not until the beginning of October 1940 that sanction for these proposals was obtained from the Department of Finance; by then it was too late to embark on such an important initiative and the matter was deferred.[7]

The Bureau's considered opinion on the future of industrial research have been mentioned briefly; because of its pivotal role in the later establishment of a more effective industrial research organisation, the Bureau's suggestions are contained in appendix 6; these were firmly grounded in the experience of the Bureau, in its first year of operation, as it dealt with various industrial problems through the application of scientific investigations. That the Bureau reiterated those same views to the Taoiseach in November 1944, is indicative of the vision and conviction of the members of the Bureau as to how industrial research should be organised if it was to be effective; it forecast also the operational parameters which the members of the Bureau intended to

apply to the work of the Bureau. These factors are presented and contrasted in table 22.

Table 22: Important Characteristics identified by the Bureau to secure an effective industrial research organisation compared with specific operational activities under-

Important Characteristics identified for effective industrial research organisation	Operational Activities undertaken by Bureau during 1941-1945
1. Ability to provide scientific assistance and guidance to established and new industries	1. Application of scientific expertise, knowledge to a range of industrial problems.
2. Stimulation of research into utilization of natural resources	2. Survey of mineral deposits and processing of phosphate deposits
3. Scientific control vested in small committee of qualified scientific/technical professionals appointed by Government	3. Members of Bureau were all qualified scientists/engineers appointed by Taoiseach
4. Permanent Director of Research with high academic standing and industrial experience	4. Priority given to and identification of investigations dictated by war situation; forward planning difficult.
5. Relationship between Committee and Government must recognise special nature and demands of scientific research	5. Bureau reported to Taoiseach and his Department rather than to Department of Industry and Commerce as was case with Industrial Research Council
6. Autonomy in spending of funds in scientific investigations in accordance with stated public policy; adequacy of funds for tasks	6. Considerable degree of autonomy in scientific methodology once initial outlay approved by Taoiseach; Bureau had sufficient funds for tasks undertaken
7. Ability to carry out frontier research as well as applied industrial research	7. Some basic research carried out, e.g. rubber. Some innovative industrial research into manufacture of supplies and specific commodities
8. Research linkages with and provision of funds to Universities to engage in approved researches	8. Substantial work undertaken by Universities and staff on behalf of the Bureau.
9. Acquisition of special premises/laboratories to permit semi-commercial scale experiments	9. Bureau established special plants at Taurraun and Parkgate and utilized industrial premises.
10. Encourage and take steps to increase number of scientifically trained workers in industry	10. Recruitment of Bureau staff and researchers by industry, training of industrial workforce assisted by Bureau
11. Provision of scholarships for postgraduate training and study	11. Young graduates employed by Bureau for short periods; IRC did provide such scholarships during its existence
12. Development of library, information and translation services	12. Bureau had access to IRC's library and information officer
13. Publication of results	13. Some publication undertaken; extent dictated by war conditions and reasons of confidentiality
14. Establishment and application of system of National Standards	14. Bureau had made a small beginning in this direction

Source: Extracted from appendix 6 and ESRB Records.

Early in 1945, work was begun on the drafting of the necessary legislation for the establishment of an Irish Institute for Research and Standards; a copy of the proposed 'Industrial Research Bill 1945' with an explanatory memorandum was sent to the Taoiseach on 29 March 1945. Eventually, the Department of Industry and Commerce submitted its proposals for the establishment of an Irish Institute for Industrial Research and Standards to the Government on 29 September 1945; the full text of the memorandum containing these proposals is given in appendix 7. However, it was not until June 1946 that the text of the *Industrial Research & Standards Bill 1946* was approved by the Cabinet and circulated to Deputies; the Bill was passed by both houses of the Oireachtas on 21 August 1946.[8]

The Bill provided for the promotion of industrial research and the standardisation of industrial commodities, processes and practices. These objectives were to be realised through the establishment of an Institute for Industrial Research and Standards comprising of:

(i) the Council of the Institute, with a membership of up to 50, constituted every five years and meeting at least once a year;

(ii) the Industrial Research Committee constituted every three years and consisting of nine members appointed for their specific scientific attainments and practical experience of industrial matters;

(iii) the Standards Committee with a membership of seven.

The contribution of the members of the ESRB to the success of the

work of the Bureau was recognised by their appointment to the above constituent parts. Professors Dowling and Wheeler were appointed to both technical committees, Prof Hogan and Dr E T S Walton were appointed to the Industrial Research Committee and Prof Poole and Dr Drumm were appointed to the Council of the Institute. The other important appointment was that of Mr D T Flood as the Director; it will be recalled that he was one of the Bureau's investigators.[9]

The setting up of the Institute for Industrial Research and Standards, IIRS, as a statutory body represented a major and crucial advance by the Government to support and develop industrial research. The principal functions of the IIRS were to encourage and assist the use and application of science and technology in Irish industry. In the fifteen years up to 1961, the IIRS grew slowly and made relatively little impact on Irish industry; this may be attributed to its limited budget allocation, about £35,000, to the small staff complement of thirty five and to the absence of links with higher education. An amending Act of 1961 provided for the re-organisation and expansion of the Institute and thereafter the Institute developed into the principal national agency for the technical development of industry in Ireland.

The assistance which Monarchana Alcóil na hÉireann Teoranta provided to the Bureau has already been detailed. This company had been established in 1938 principally to manufacture and sell industrial alcohol. The work of the Bureau had highlighted the need for a chemicals manufacturing industry with the result that, in 1947, the Government introduced an amendment to the Industrial Alcohol Act, 1938. This amending Act changed the name of Monarchana

Alcóil na hÉireann Teoranta to Ceimicí Teoranta and extended the role of this new company to include:-

(i) the manufacture, refining and sale of industrial alcohol and products and derivatives thereof, and

(ii) the making, aiding or subsiding of experiments, researches and tests in relation to the possibilities of any substance, all or any portion of which is produced or obtained by chemical process, and

(iii) the manufacture and sale of any substance, all or any portion of which is produced or obtained by chemical process (which the Bureau had been engaged in also to some extent).[10]

In addition, there was an expansion of research and developmental work in other public sectors notably in the Department of Agriculture and Fisheries from 1947 onwards, until, in 1958, An Foras Talúntais (The Agricultural Institute) was set up. Other developments are summarised in Table 23.

Table 23: Research and development organisations and bodies set up by the Government, listed by title, year of establishment and summary of remit

Organisation/Body	Year of Establishment	Summary Remit
Bord Na Mona	1946	Established by Act of Oireachtas to develop the country's peat resources. It operates on a commercial basis without subsidies.
Irish Steel Ltd	1947	Established as State-sponsored body; it manufactures products for domestic and export markets.
Arramara Teo	1949	Private company in which the State acquired shares; it processes seaweed to produce alginates.
Industrial Development Authority	1949	Founded as agency of Department of Industry & Commerce to promote development of industry in Ireland.
Salmon Research Trust of Ireland	1955	Incorporated as a trust to carry out research on selective breeding of salmonids, rearing techniques and census of world stocks.
An Foras Talúntais	1958	Its remit includes promoting, coordinating and undertaking agricultural research; information disseminated to agriculture sector.
Institute for Industrial Research and Development	1961	Set up in 1946 and reorganised and expanded in 1961 as the principal national agency for the technological development of industry in Ireland.
Nitrigin Éireann Teo	1961	Set up as private limited company by Government to establish nitrogenous fertilizer industry in Ireland.
An Foras Forbatha	1964	Institute for Physical Planning and Construction Research with remit covering research, advisory, training and information services related to the physical environment.
Economic and Social Research Institute	1966	The Economic Research Institute was founded in 1960 to to undertake applied economic research in Ireland; in 1966 the State became the major source of finance and the name changed.

Source: Stationery Office, Index to the Statutes 1922-1975 with Tables and 1976 Supplement and relevant legislation.

The wartime scarcity conditions persisted in Ireland for some years after the war; coupled with this was a low rate of economic growth, poor performance in relation to job creation and a continued haemorrhage of the population through emigration. These factors were hardly conducive to assisting the process of economic development. Despite these factors, the above major developments serve to illustrate the existence, since 1945, of a positive commitment, by the Government, to expand and develop science and technology related activities.

Industrial economic growth, in a society which had relied largely on an agricultural-export dominated economy, would be dependent on investment in science and technology to develop its nascent industrial infrastructure. The development of new and improved products and processes through the application of science and technology was a necessity if increased productivity and competitiveness in the market places of the world was to be assured. The shortcomings of the political philosophy which sought to base economic development on protectionism and self-sufficiency had been painfully obvious during the emergency.

In the 1950's the economy was severely rocked by serious balance of payments deficits, which ate into the sterling reserves the country had accumulated during two world wars as a direct result of the imposition of import restrictions. The deficits of the 50's were due, according to Meenan, not only to domestic expansionary policies but also reflected the result of relying on agricultural exports as the predominant source of foreign earnings.[11] Even more critical was the obvious danger of having such products consigned

to one market, Gt Britain, where the policy was to keep food prices as low as possible and use cleverly chosen devices, such as deficiency payments to boost the incomes of British farmers.[12]

The measures taken by the Government to increase the rate of economic activity after World War II led to a rise in the rate of inflation; the serious balance of payments deficits later caused a period of severe deflation in 1956 and 1957. This same period also saw the first re-orientation of policy towards the stimulation of export-led growth with an emphasis on the freeing of trade; this was an almost revolutionary policy change in view of the previous commitment to the political dogmas of protectionism and economic self-sufficiency. The continued implementation of the policy of state intervention in the late 1950s and throughout the 1960s in both the agricultural and industrial sectors, particularly the inducements offered through the Industrial Development Authority (IDA) to foreign enterprises to set up in Ireland, led to a period of sustained economic growth.[13]

This change of policy was initiated in 1958 with the publication by the Government of the First Programme for Economic Expansion. It heralded essentially a recognition that protected manufacture for a home market of dwindling population and low purchasing power provided no hope of increased employment; the policy of continued high protection of indigenous industries could not guarantee even the maintenance of existing employment or reasonable standards of living comparable with neighbouring market outlets, particularly Gt Britain and Northern Ireland. It was recognised also that, if

existing jobs were to be protected, in addition to the annual creation of new employment opportunities, industry must quickly become more efficient and competitive in the export markets of the world. Finally, it was noted that, to achieve effective and rapid industrial efficiency, protective tariffs would need to be reduced and compensated for by export market gains; in addition it would be necessary to provide incentives to aid modernisation of the industrial sector.[14]

As a result of the implementation of this First Economic Programme which covered the period 1959-1963 and then a Second Economic Programme for 1964-70, the economic climate changed dramatically from the beginning of the 1960s. The level of employment began to rise, emigration declined significantly, the population increased, and the volume of manufacturing output increased. The chemical and electronic industries expanded rapidly, assisted by the growth of foreign investment in the Irish economy. Traditional industries such as clothing, footwear, leather, furniture and printing experienced a slower expansion; however, they remained viable and important for employment. Overall the country was gradually moving into a position of a balance of trade in manufactures. The original political philosophies adopted by the emerging state had been profoundly transformed, bringint about a dramatic change in the economic health of the country. The thrust of economic development was now centrally based on export markets with manufacturing industry becoming as important as agriculture.[15]

The establishment by the state of a wide spectrum of autonomous scientific, technological, and social development organisations

acted as a complementary factor in generating the new economic climate. The economic expansion of the 60's led inevitably to the creation of new R & D organisations; these were the National Science Council set up in 1967, the National Board for Science and Technology in 1978 and Eolas, the Irish Science and Technology Agency, in 1987; each in turn became an important agency for the coordination and development of science and technology research in the country. However, the setting up of these agencies was predated by another important Government initiative, the outcome of which acted as the catalyst for their subsequent establishment.

In November 1963, Mr J Lynch, the Minister for Industry and Commerce, appointed a Research and Technology Survey Team to assess the existing research situation and to develop a balanced plan for national research for the period to 1978. [16] The report, prepared in association with the organisation for Economic Cooperation and Development, was critical of the lack of coordination in industrial research and described the science research effort as 'scattered thinly, not always directed towards national needs ... and uncoordinated.[17] It contrasted the relative positions of agricultural and scientific research to the disadvantage of the latter. Research in higher education in general was said to be 'a long way below international standard' while interdisciplinary research, essential for new technological developments, was said to be 'all too rare'.[18]

There were twenty six recommendations in all, the main one was for the formulation of a national science policy and its integration into economic policy so that science would contribute to and make

possible desirable technological change. Various strategies were outlined to assist in the evolution of this national science policy, particularly the establishment of a National Science Council; it was recommended that this body should be set up immediately.[19] It was envisaged that the National Science Council would ultimately advise the Government on appropriate national policies for research, development and technology and, in particular, propose priorities for expenditure.

The NSC was established in December 1967 with a remit to advise the Government on science and technology with particular reference to economic development. Unfortunately, effective responsibility for science and technology continued to be fragmented in various government departments. These departments generally limited their responsibility to funding the various institutes under their own aegis and the National Science Council was thus effectively prevented from exercising its anticipated role as a coordinator. By 1971 the limited advisory role of the Council prompted it to demand, in its Council Report, a radical change. It sought (i) more sophisticated R & D intensive industry, (ii) more extensive processing of Irish natural resources, (iii) more concentration on priority areas, (iv) greater coordination of science and technology resources and (v) enhanced budgetary powers for the Council.[20]

The work undertaken by the National Science Council during its five year period of existence was nevertheless of importance; it represented , despite its vague terms of reference, absence of executive status and voluntary part-time service of its membership,

a major step forward in delineating the institutional arrangements necessary to underpin the articulation and implementation of science and technology policy for Ireland. The work of the Council is summarised in appendix 8.

The outcome of the work of the National Science Council led to the formulation of a set of proposals being made to the Government to facilitate the development and implementation of a science and technology policy.[21] Consideration of these proposals resulted in the Minister for Finance, Mr G Colley TD, stating, on 14 July 1972 that:

> following recommendations by the National Science Council, the Government have approved in principle of the establishment of a statutory body to advise on national policy regarding science and technology with particular reference to public investment in these areas. It is envisaged that the new body, which will be responsible to the Minister for Finance, will have wider functions than the National Science Council. The precise nature of these functions, the structure of the new body and its relationship with other organisations in the field of science and technology are being considered.[22]

Some six years later, in 1978, the National Board for Science and Technology was set up as a statutory body. The NBST had three statutory instruments available to it. These were a statement to Government which enabled the Board to give its observations and recommendations, a science budget which contained details of the funding allocations agreed for state supported science and technology activities and the articulation of a national programme for science and technology which was intended to help align investment in science and technology with national needs and priorities. A more extensive account of these instruments is presented in appendix 9.

The NBST operated within the framework of the Department of the Taoiseach, the same mechanism which had been adopted earlier with the Emergency Scientific Research Bureau except that the ESRB lacked statutory status. As part of its general functions, the Board was required:-

(i) to advise the Government on policy for science and technology and related matters;

(ii) to prepare and review a national programme for science and technology;

(iii) to coordinate activities related to science and technology;

(iv) to promote the coordination of public investment with private investment in science and technology;

(v) to promote research and to highlight the value of science and technology and its application to economic and social development;

(vi) to promote the development of natural resources.[23]

With the establishment of the NBST as the state-sponsored agency responsible for the development of science and technology in Ireland, there was now an agency with central responsibility for a broad range of promotional, advisory and review activities. In addition, the IIRS served as the principal national agency for the technological development of industry in Ireland; this was achieved by the provision of technical advice to support the efficient operation of Irish industry and, through technical consultancy, by assisting the growth and development of Irish industry. The functional roles of both the NBST and the IIRS are summarised in Table 24.

Table 24: Summary of the functional roles assigned to the NBST and to the IIRS listed by activities and areas of responsibility

NBST	IIRS
1. Advice to Government on policy for science and technology and related matters	1. Serves as Ireland's largest technical consultancy group for industry
2. Preparation of national programme for science and technology	2. Assists industrial development through technological innovation and transfer
3. Preparation of Science Budget for consideration by Oireachtas	3. Provides comprehensive technical information service on science and technology advances and applications
4. Promotion of research, linkages between higher education and industry, natural resources development and application of technology throughout the economy	4. Team of technical liaison advisers maintains contact with the various industrial sectors to promote IIRS services
5. Coordination of activities for all state-funded organisations involved in science and technology activities in Ireland	5. R & D programmes initiated in priority areas of benefit to Irish industry
6. Development of international cooperation in science and technology activities	6. Serves as Irish National Standards Organisation
7. Reviews effectiveness of scientific and technological programmes and agencies	7. Undertakes consultancy contracts both nationally and internationally
8. Publishes special reports and surveys central to science policy formulation	8. Publishes monthly journal Technology Ireland

Source: Summarised from data in NBST and IIRS statutes and publications.

On the 27 August 1987, the Minister for Industry and Commerce announced the Government's decision to merge the IIRs and the NBST into one body. This decision resulted in the setting up, in 1987, of EOLAS, the Irish Science and Technology Agency; ['Eolas' is the word in the Irish language for 'knowledge']. Through its statutory remit, EOLAS became the primary state agency responsible for the development, application, coordination and promotion of science and technology in Irish industry; in addition it was charged with developing the role of science and technology by forging links between higher education and industry,by initiating participation in national and international programmes and by advising the Government on science and technology policy. The range of

technical services provided to all sectors of industry include professional advice, industrial research, product development and identification, testing, patents, licensing and industrial education. The National Standards Authority of Ireland is a specialised division of EOLAS; it formulates and promulgates Irish standards and acts as the certifying agent for production and services to both national and international specifications.[24]

Thus, since 1844, the scientific effort and awareness of the country has been, at different times, awakened and stimulated into activity by various agencies and individuals. Sometimes this amounted to a mere listing of shortcomings, while on other occasions specific areas were identified for possible application of science and technology to achieve economic development. Occasionally such initiatives did lead to positive action, but the effort was seldom properly coordinated or sustained during the formative early decades of the century. Consequently, on the outbreak of World War II, the country was quite unprepared to meet the problems of maintaining neutrality and economic activity when faced with the severe economic sanctions imposed by Gt Britain.

The establishment in 1941 of the Emergency Scientific Research Bureau was an initiative of merit and significance which met with considerable success; it emphasised once again, the important role which science and technology could play in economic development and it provided also an examplar for the establishment of the IIRS. Unfortunately, as indicated above, it was not until 1978 that the synthesis of the previous initiatives and experiences finally crystallised in a major step forward with the establishment of the

National Board for Science and Technology, the endpoint to which all the previous organisations were logically destined to evolve.

In the major thrust towards intense industrialisation, which is of relatively recent origin, many problems have yet to be resolved in the areas of product and process innovation, improved productivity and product quality, diversification and rationalisation, management and marketing and industrial training. In seeking solutions to these problems, government policy on science and technology will play a key role. It will also be essential to ensure that the industrial, education, physical and telecommunication infrastructures are adequate to permit such a policy to function optimally.

It is thus apparent that the continued development and implementation of a comprehensive and co-ordinated national programme for science and technology will be crucial to future economic and social development in Ireland. Significant progress on the development and implementation of a national science policy has already taken place. Much more remains to be done if it is hoped to compete with those countries which have pursued and developed economic planning strategies based on close integration between economic policy and science policy. In the transition over fifty years, from an essentially inward looking agriculture-based economy to a current high level of scientific and technological industrial activity, the Emergency Scientific Research Bureau played a crucial and innovative role. It demonstrated eloquently the potential and the essential need for a national research and development agency; in doing so it generated the critical expertise and the scientific personnel who contributed significantly to later developments.

If at present, science and technology policy enjoys a high political profile on governmental agendae and the execution of this policy is implemented with dedication and efficiency by a well-funded national agency, EOLAS, much of the credit is due to the ESRB. The pioneering and creative work of the scientists and engineers of the Bureau in contributing significantly to the maintenance of economic activity during the Emergency constituted a task of immediate national importance. In heightening awareness among politicians and administrators of the importance of scientific research, they bequeathed a legacy of long term significance to the nation. In recognising the significance of the work of the Bureau, it behoves us also to pay tribute to the vision and political dynamism of Mr de Valera, who may rightly be seen as its creator. Other political leaders could have founded the Bureau, only De Valera's intellectual commitment and charismatic leadership could have attracted the professional allegiance which made it so resoundingly successful.

With limited resources, under difficult war circumstances, the ESRB made a major contribution to the economic, industrial and scientific life of the country. This was achieved due to strong political and administrative support and by personal support of De Valera; it was achieved by dedication, industry and the scientific eminence of members and staff. The spirit which informed the ESRB was typical of the spirit of the Emergency, when tens of thousands enrolled in the Defence Forces, when thousands of extra acres of land were put under the plough to feed a nation which, due to external economic pressures, had to rely on its own efforts. The story of the Bureau is the story also of a generation which cut

and saved turf as its domestic fuel, which endured food and clothes rationing, which learned to relish brown bread and learned to cook on reduced 'glimmer' gas pressures. That generation relied on radio and limited media circulation for its leisure and entertainment and utilized the bicycle mainly for its limited transport. That was also the generation of whom less than 15% gained access to postprimary education and of whom less than 5% experienced higher education.

The main lesson from the story of the Bureau is that a country which generates self-confidence in its own technical and scientific abilities and has the guidance of wise political leadership, which invests adequately in the higher education of its people and provides opportunities for the expression of the talents created by such education, such a country can expect to prosper economically and develop technically. The expansion of education, especially higher education in the recent past, whereby 20% of the cohort now proceed to higher education, leads one confidently to the conclusion that what was achieved in the 1940's could be more easily achieved in the 1990's by a generation of Irish people enjoying more supportive socio-economic conditions under the catalytic umbrella of European policy and support.

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Department of Finance files, especially files in the F series.

Eolas Archives
The files and records of the ESRB held in these archives constitute the main source. These records have not been preserved in their entirety but the available archives provide a comprehensive and authoritative picture of the work of the Bureau.

Army Archives
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Chapter 4 Neutrality and Economic Activity in Ireland during the years 1939-42

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13. Details of losses suffered by allies during this period are contained in P.R.O. (UK), CAB 65 and CAB 66.

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15. Carroll, *op.cit.*, gives accounts of British and American efforts to either force or persuade Eire to give up her neutrality position. Germany attempted to exploit the situation also by using the potential offered by IRA saboteurs for operations in Northern Ireland and to a lesser extent in Britain. The story of German agents sent to Eire during the war for this purpose is well documented in Stephan, E., (London,1963) Spies in Ireland; Dwyer, T.R., Irish Neutrality and the USA 1939-47 (Dublin,1977) provides a detailed analysis of American attitudes to Irish neutrality.

16. British War Cabinet Minutes and Related Memoranda released for public inspection in 1972. The minutes are contained in the series CAB 65 with the related memoranda in CAB 66. The memorandum referred to is in CAB 66/14. This memorandum and other important extracts from this file are included in Appendix 2.

17. Memorandum from Committee on Economic Policy to Eire to War Cabinet, dated 24.3.1941, P.R.O.(UK), CAB 65, 24.3.1941.

18 A written record, minutes and memoranda, detailing the enforcement and monitoring of the economic sanctions imposed is contained in P.R.O. (UK), CAB 72/25

19. Carroll, *op.cit.*,124-125. Eire's vulnerability and Gt Britain's shallow commitment was reinforced when even in 1943, Atlee remarked that it was 'very doubtful whether we could spare enough [military supplies for the defence of Eire] at this time and the strategic facilities [ports] would probably be very dearly bought at such a price' PRO (UK), Foreign Office Correspondence, FO371,36002.

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26. These tankers had been built in Germany for the Dublin oil refinery project and were owned by Inver Tankers Ltd. an English company itself owned by Messrs Andrew Weir & Co. When the refinery project was shelved, the Irish Government offered to transfer them to the British Register. In so doing the Irish Government attached to conditions of any kind to the transfer of the flag; with hindsight this decision was bitterly regretted.

27. During a debate in Dail Eireann on 17.6.1941 on the estimates for the Office of the Minister for Supplies, the Minister informed the Dail that there were almost no neutral ocean-going vessels available either for purchase or for charter and that the efforts of the newly established Irish Shipping Ltd. in acquiring shipping had met only limited success. Peterson,B., The Turn of the Tide (Dublin, 1962) gives a detailed account of the setting up of Irish Shipping Ltd. and its fortunes during the war.

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In August 1943, the Department of Supplies submitted a ten page memorandum, dated. 16.8.1943 to De Valera's cabinet which stated that Britain was using their navicert system to prevent Ireland from obtaining supplies from neutral countries; not only were warrants not being issued for the shipment to Ireland of vegetable oils and seeds, castor oil, and leather but where navicert warrants were issued, the British in some cases required half or more of the Irish ship's voyages to be on British service or an alternatively stipulated routes which added up to 1,300 miles to their voyages, S110394, D.T., N.A.

29. Minutes of second meeting of Committee dated 1.5.1942, P.R.O. (UK) CAB 72/75.

30. Dáil Cabinet Minutes, 18.3.1932.

31. Department of the President, memorandum War Essential Materials, dated 4.12.1935, S28208, D.T., N.A.

32. Secret memorandum prepared by Dept of Supplies for the Government outlines the serious position in relation to supplies from abroad, and the action agreed by the Government dated 9.8.1943, S11394, D.T., N.A.

33. Ibid.

34. Letter from Childers to Taoiseach dated 4.3.1941, S12300, D.T., N.A.

35. Henderson, Ian., 'The Donegal Corridor', in The Irish Times dated 22.10.1983.

36. On 21 Feb 1945, Cranborne appended the following list of examples for the British War Cabinet which amply demonstrates the degree of co-operation given by Ireland.

(a) They agreed to our use of Lough Foyle for naval and air purposes. The ownership of the Lough is disputed, but the Southern Irish authorities are tacitly not pressing their claim in present conditions and are also ignoring any flying by our aircraft over the Donegal shore of the Lough, which is necessary in certain wind conditions to enable flying boats to take off from the Lough.

(b) They have agreed to the use by our aircraft based on Lough Erne of a corridor over Southern Irish territory and territorial waters for the purpose of flying out to the Atlantic.

(c) They have arranged for the immediate transmission to the United Kingdom Representative's Office in Dublin of reports of submarine activity received from their coast watching service.

(d) They arranged for the broadcasting of reports by their Air Observer Corps of aircraft sighted over or approaching Southern Irish territory. (This does not include our aircraft using the corridor referred to in (b) above).

(e) They arranged for the extinction of trade and business lighting in coastal towns where such lighting was alleged to afford a useful land mark for German aircraft.

(f) They have continued to supply us with meteorological reports.

(g) They have agreed to the use by our ships and aircraft of two wireless direction-finding stations at Malin Head.

(h) They have supplied particulars of German crashed aircraft and personnel crashed or washed ashore or arrested on land.

(i) They arranged for staff talks on the question of cooperation against a possible German invasion of Southern Ireland, and close contact has since been maintained between the respective military authorities.

(j) They continue to intern all German fighting personnel reaching Southern Ireland. On the other hand, though after protracted negotiations, Allied service personnel are now allowed to depart freely and full assistance is given in recovering damaged aircraft.

(k) Recently, in connection with the establishment of prisoner of war camps in Northern Ireland, they have agreed either to return or at least intern any German prisoners who may escape from Northern Ireland across the border into Southern Ireland.

(l) They have throughout offered no objection to the departure from Southern Ireland of persons wishing to serve in the United Kingdom Forces nor to the journey on leave of such persons to and from Southern Ireland (in plain clothes).

(m) They have continued to exchange information with our security authorities regarding all aliens (including Germans) in Southern Ireland.

(n) They have (within the last few days) agreed to our establishing a Radar station in Southern Ireland for use against the latest form of submarine activity. P.R.O.(UK), CAB 66/62.

37. Dwyer, T.R., articles on American clandestine operations in wartime Ireland in the Sunday Independent dated 17.6.1984. and in the Irish Independent dated 8.5.1985; Gray, K., (ed.) 'The Emergency' supplement with The Irish Times dated 8.5.1985.

38. Confidential Source confirmed 'alert' status of Defence Forces on two specific occasions.

39. Carroll, *op.cit.*, 109, 182. Another estimate of some 350,000 working in armament factories in Great Britain was given in an article in The Irish Times (8.5.1985) by Dr F H Boland (who was Assistant Secretary at the Department of External Affairs during the war). While exact figures are difficult to ascertain, there is no doubt that a substantial number of Irish men and women contributed significantly to the British war. A counter-balancing argument is the remittances sent back to Ireland by Irish workers in Gt Britain which bolstered Ireland's economy.

40. Confidential Source confirmed determination and operational plans for Defence Forces to engage any invader; the guerilla war (Flying Column) tactics used in the War of Independence were to be the dominant tactical measures to be used until outside assistance could be organised.

41. Fisk, R., In Time of War - Ireland, Ulster and the Price of Neutrality 1939-45 (London,1983).

42. Blake, J.W., Northern Ireland in the Second World War (Belfast, 1956).

43. Carroll, J.T., op.cit. outlines the diplomatic train of events between Eire and Britain, Germany and the USA and the role of De Valera in maintaining the crucial diplomatic balance which assisted the preservation of neutrality.

Chapter 5 Establishment and Remit of the Emergency Scientific Research Bureau

1. Extract from minutes of 60th meeting of Cabinet Committee on Emergency Problems, dated 6.1.1941, S12282, D.T., N.A.

2. Documentation sent by Federation of Irish Manufacturers gives proposals and outline strategies from the Federation in considerable detail, dated 30.1.1941, S12282, D.T., N.A.

3. *Ibid*

4. Letter dated 6.2.1941 from J J Lennon to the Taoiseach, dated 6.2.1941, S12282, D.T., N.A.

5. Lennon, Dr J J, interviewed by author on 26.10.1983 confirmed close personal friendship with Taoiseach dating back to the Easter Rising and provided details of events narrated in this chapter; this resulted in Dr Lennon's proposals on the formation role and functions of the Bureau being accepted and implemented by De Valera.

6. Extract from minutes of meeting of Cabinet Committee on Emergency Problems, dated 6.2.1941, S12282, D.T., N.A.

7. Letter from Office of Minister for Finance to Secretary, Department of Taoiseach, dated 13.2.1941, S12282, D.T., N.A.

8. Letter from Secretary Department of Taoiseach to Secretary, Department of Finance, dated 17.2.1941, D.T., N.A.

9. Letter, reference S.101/2/41, from Secretary, Department of Finance, dated 19.2.1941, D.T., N.A.

10. *Ibid*.

11. Letter from Secretary of Department of the Taoiseach dated 21.2.1921, S12282, D.T., N.A.

12. Letter signed by E De Valera to Prof J J Dowling sets out the proposed terms of reference, dated 15.2.1941, S12282, D.T., N.A.

13. Letter from Prof Dowling to the Taoiseach in response to letter from Taoiseach. The minor amendments only were accepted and the proposed terms of reference were amended accordingly, dated 15.2.1941, S12282, D.T., N.A.

14. Letter from Minister for Industry and COmmerce to Dr Kettle, Industrial Research Council, dated 15.2.1941, S12282, D.T., N.A.

15. Copy of statement issued, dated 20.2.1941, S12282, D.T., N.A.

16. Letter from Prof Dowling to the Taoiseach, dated 20. 2.1941, S12282, D.T., N.A.

17. Letter from Minister for Industry and Commerce to Taoiseach, dated 27.2.1941, S12282, D.T., N.A.

18 Details of various conferences attended by members of the Bureau are given in the relevant minutes of the meetings held by the Bureau, ESRB Minutes.

19. Copy of statement made by Taoiseach in Dáil on 6.3.1941, S12282, D.T., N.A.

20. Letter from P J Merriman, President of UCC, to Taoiseach with copy of letter from Registrar of UCC, dated 21.2.1941, S12282, D.T., N.A.

21. Synge, J L, 'Eamon De Valera', Biographical Memoirs of Fellows of the Royal Society 1976, vol. 22 pp.635-653

22. Longford and O'Neill, op.cit., p.325.

23. Relevant NUI Calendars, private communication and Scientific American, February 1922.

24. Relevant NUI Calendars, The Times (London) published 15.2.1932 and Nature published 12.3.1932.

25. Relevant NUI Calendars and private communication.

26. Relevant TCD Calendars and private communication.

27. Relevant NUI Calendars and private communication.

28. After secondment to the Emergency Scientific Research Bureau, Dr Lennon went on to hold senior posts in the Irish Civil Service, in the Post War Building Section and later in the Civil Aviation Section. During this later period he was involved on a part-time basis with the newly formed Institute for Industrial Research & Standards and also acted as Secretary to the Commission on Nuclear Energy. His final posting was as Comptroller of the Patent's Office from which he retired in 1967. He was then re-employed by the Civil Service as a Consultant and Hearings Officer finally retiring in 1976. Dr Lennon was a member of the Council of Trustees of the National Library of Ireland.

29. Correspondence relating to pension entitlements of D R Flood who became the first Director-General of the IIRS, dated 23.1.1956, S12282B, D.T., N.A.

30. Report of Activities of ESRB, *op.cit.*,13.

1. 1st meeting of Bureau, dated 21.2.1941, ESRB Minutes.
2. 4th meeting of Bureau, dated 6,7 and 11.3.1941, ESRB Minutes.
3. 1st Progress Report covering period up to 12.3.1941. submitted to Taoiseach on 25.3.1941, S12322, D.T., N.A.
4. 4th meeting of Bureau, *op.cit.*
5. 3rd meeting of Bureau, dated 3.3.1941, ESRB Minutes.
6. Memorandum from Bureau on increasing the output of native anthracite, dated 12.3.1941, S12322A, D.T., N.A.
7. 3rd meeting of Bureau, *op.cit.*
8. 11th meeting of Bureau, dated 23 and 25.4.1941, ESRB Minutes.
9. 9th meeting of Bureau, dated 2.4.1981; 10th meeting, dated 8.4.1941, ESRB Minutes.
10. *Ibid.*
11. 14th meeting of Bureau, dated 14.5.1941; 15th meeting, dated 21.5.1941, ESRB Minutes.
12. 16th meeting of Bureau, dated 28.5.1941, ESRB Minutes.
13. 19th meeting of Bureau, dated 19.6.1941, ESRB Minutes.
14. 49th meeting of Bureau, dated 28.1.1942, ESRB Minutes.
15. 53rd meeting of Bureau, dated 25.2.1942, ESRB Minutes.
16. 65th meeting of Bureau, dated 27.5.1942, ESRB Minutes.
17. 75th meeting of Bureau, dated 19.8.1942, ESRB Minutes.
18. 102nd meeting of Bureau, dated 10.3.1943, ESRB Minutes.
19. 121st meeting of Bureau, dated 11.8.1943, ESRB Minutes.
20. 130th meeting of Bureau, dated 27.10.1943; 132nd meeting, dated 10.11.1943; 133rd meeting, dated 17.11.1943, ESRB Minutes.
21. 170th meeting of Bureau, dated 30.8.1944, ESRB Minutes.
22. 173rd meeting of Bureau, dated 20.9.1944, ESRB Minutes.
23. Stationery Office, Report of Activities of ESRB, (Dublin,1946),25.

24. Hogan, M.A., Report on Experiments on the Production of Charcoal and Producer Gas from Turf; paper presented at ordinary general meeting of Inst. of Civil Engineers of Ireland on 12.4.1948, p.272, 292.

25. See appendix 3 for details of specific gravity meter.

26. 4th meeting of Bureau, dated 6.3.1941, ESRB Minutes.

27. 83rd meeting of Bureau, dated 21.10.1942, ESRB Minutes; Report of Conference, file Bur 295, ESRB Records.

28. Walton, Prof E T S, interviewed by author on 24.10.1983; staff in TCD complained about smoke and debris emitted by producer unit built on top of Physics Dept., the unit was successful over short runs only but not for long runs as would be required if mounted on a vehicle.

29. 75th meeting of Bureau, dated 19.8.1942, ESRB Minutes.

30. Memorandum from Bureau on present position of coal in Éire, Bur.8, S12322, D.T., N.A.

31. 19th meeting of Bureau, dated 19.6.1941, ESRB Minutes.

32. 33rd meeting of Bureau, dated 1.10.1941, ESRB Minutes.

33. 76th meeting of Bureau, dated 26.8.1942, ESRB Minutes.

34. 80th meeting of Bureau, dated 30.9.1942, ESRB Minutes.

35. 11th Progress Report covering period 1.11.1942- 28.2.1943, submitted to Taoiseach on 12.3.1943, S12322, D.T., N.A.

36. Letter and memorandum (Bur.15) on Hawlbowline Steel Works sent by Secretary of the Bureau to the Taoiseach, dated 27.3.1941, S12322, D.T., N.A.

37. *Ibid.*

38. Annual Progress Report covering period 1.4.1942- 31.3.1943, S12322, D.T., N.A.

39. 48th meeting of Bureau, dated 21.1.1942, ESRB Minutes; 9th Progress Report covering period 1.4.1942-30.6.1942, S12322, D.T., N.A.

40. 65th meeting of Bureau dated 27.5.1942, ESRB Minutes.

41. 69th meeting of Bureau, dated 24.6.1942, ESRB Minutes; 10th Progress Report covering period 1.7.1942-31.10. 1942, submitted to Taoiseach on 14.11.1942, S12322, D.T., N.A.

42. 82nd meeting of Bureau, dated 14.10.1942; 83rd meeting, dated 21.10.1942, ESRB Minutes.

43. Report of Activities *op.cit.*, 65

44. 104th meeting of Bureau, dated 25.3.1943, ESRB Minutes.

45. *Ibid.*

46. 123rd meeting of Bureau, dated 1.9.1943, ESRB Minutes; 13th Progress Report covering period 1.7.1943-31.10.1943, submitted to Taoiseach on 25.11.1943, S122322, D.T., N.A.

47. Report of Activities, *op.cit.*,65.

48. 44th meeting of Bureau, dated 17.12.1941, ESRB Minutes.

49. 11th Progress Report covering period 1.11.1942-29.2.1943, submitted to Taoiseach on 12.3.1943, S12322, D.T., N.A.

50. Leahy, Dr P., Irish Engineers Handbook (Dublin,1944),60.

51. Report of Activities, *op.cit.*,63.

52. 102nd meeting of Bureau, dated 10.3.1943, ESRB Minutes; 12th Progress Report covering period 1.3.1943-30.6.1943, S12232, D.T., N.A.

53. 144th meeting of Bureau, dated 9.2.1944, ESRB Minutes.

54. Report of Activities, *op.cit.*,64.

55. 97th meeting of Bureau, dated 3.2.1943, ESRB Minutes.

56. 104th meeting of Bureau, dated 25.3.1943, ESRB Minutes.

57. 120th meeting of Bureau, dated 28.7.1943, ESRB Minutes.

58. 137th meeting of Bureau, dated 15.12.1943, ESRB Minutes.

59. 79th meeting of Bureau, dated 23.9.1942, ESRB Minutes.

1. 2nd meeting of Bureau, dated 25 and 26.2.1941, ESRB Minutes.

2. *Ibid.*

3. 3rd meeting of Bureau, dated 3.3.1941, ESRB Minutes.

4. 27th meeting of Bureau dated 20.8.1941; 29th meeting, dated 3.9.1941, ESRB Minutes.

5. Letter from Maguire to the Taoiseach, dated 4.3.1941, S13588A, D.T., N.A.
   Note: Sir Alexander Maguire, a native of Liverpool, was the Chairman and Managing Director of Maguire & Patterson Ltd. and he had received his knighthood for his work in prohibiting the use of white phosphorous in Great Britain, a practice ultimately adopted world wide. His standing can be further exemplified by virtue of his ability to obtain, on a regular basis, personal interviews on the matter of supplies with Mr J M Andrews, Prime Minister of Northern Ireland, Sir Basil Brooke, Minister of Commerce for Northern Ireland, Mr E De Valera, the Taoiseach, Mr Sean Lemass, the Minister of Commerce and Sir Andrew Duncan, all of whom expressed sympathy with the precarious position of the Dublin factory.

6. 5th meeting of Bureau dated 14.3.1941, ESRB Minutes.

7. 7th meeting of Bureau dated 24.3.1941, ESRB Minutes.

8. 8th meeting of Bureau dated 26.3.1941, ESRB Minutes.

9. Letter from Graham-Little to Duncan, dated 9.10.1941, S.13588A, D.T., N.A.

10. Letter and appendix dated 29.9.1941 from Graham-Little to MacMillan; a copy of this letter was sent also to Sir Andrew Duncan, S13588A, D.T., N.A.

11. Letter from Graham-Little to MacMillan dated 4.10.1941; a copy of this letter was sent also to Sir Andrew Duncan; the supplies referred to were 2000 lbs of red phosphorous, 44 tons of potassium chlorate and 10200 lbs of phosphorous sesquisulphide *per annum*, S13588A, D.T., N.A.

12. Letter dated 9.10.1941 from Graham-Little to Duncan dated 9.10.1941; no Nr Ireland representatives were involved since the matter concerned the Dublin factory, S13588A, D.T., N.A.

13. Letter from Director of Maguire and Paterson to Sir A Maguire, dated 7.5.1942, S13588A, D.T., N.A.

14. 27th meeting of Bureau, dated 20.8.1941, ESRB Minutes.

15. 53rd meeting of Bureau, dated 25.2.1942; it is worth noting that the Taoiseach personally attended at the trial run of the 'thermite process', an example of his keen interest in the Bureau's work, ESRB Minutes.

16. 41st meeting of Bureau, dated 26.11.1941; 45th meeting, dated 31.12.1941, ESRB Minutes; 10th Progress Report covering period 1.7.1942-31.10.1942, submitted to Taoiseach on 14.11.1942, S12322, D.T., N.A.

17. 24th meeting of Bureau, dated 23.7.1941; 28th meeting dated 27.8.1941, ESRB Minutes.

18. 89th meeting of Bureau dated 2.12.1942, ESRB Minutes.

19. 42nd meeting of Bureau, dated 3.12.1941; 51st meeting dated 11.2.1942; 43rd meeting dated 10. 12.1941, ESRB Minutes; 7th and 12th Progress Reports covering periods 23.10.1941 - 17.12.1941 and 1.3.1943-30.6.1943 respectively, S12322, D.T., N.A.

20. 92nd meeting of Bureau, dated 30.12.1942, ESRB Minutes.

21. Hogan, M.A., McCarthy, T., Report on Manufacture of Phosphorus by the Electric Furnace Method, ESRB Records.

22. 120th meeting of Bureau, dated 28.7.1943, ESRB Minutes.

23. Draft Report of Activities, *op.cit.*,31; Hogan & McCarthy, *op.cit.*

24. 149th meeting of Bureau, dated 15.3.1944, ESRB Minutes; Lund, A., Industrial Utilization of Clare Phosphates; This was a copy of a thesis submitted to NUI for the degree of MSc file ESR 19/8, ESRB Records.

25. 155th meeting of Bureau, dated 3.5.1944, ESRB Minutes.

26. Hogan & McCarthy, *op.cit.*, graphs are drawn from data given in report.

27. 65th meeting of Bureau, dated 27.5.1942, ESRB Minutes.

28. 77th meeting of Bureau, dated 2.9.1942, ESRB Minutes.

29. 87th meeting of Bureau, dated 18.11.1942; 89th meeting dated 3.12.1942, ESRB Minutes.

30. 92nd meeting of Bureau, dated 30.12.1942, ESRB Minutes.

31. 110th meeting of Bureau, dated 12.5.1943, ESRB Minutes.

32. 117th meeting of Bureau, dated 29.6.1943, ESRB Minutes.

33. 118th meeting of Bureau, dated 15.7.1943, ESRB Minutes.

34. 122nd meeting of Bureau, dated 25.8.1943; 123rd meeting dated 1.9.1943, ESRB Minutes.

35. 125th meeting of Bureau, dated 22.9.1943; 126th meeting dated 29.9.1943, ESRB Minutes.

36. 141st meeting of Bureau, dated 19.1.1944, ESRB Minutes.

37. 160th meeting of Bureau, dated 7.6.1944, ESRB Minutes.

38. 169th meeting of Bureau, dated 23.8.1944; 170th meeting dated 30.8.1944, ESRB Minutes.

39. Stationery Office, Report of Activities of Emergency Scientific Research Bureau (Dublin,1946).

40. 70th meeting of Bureau, dated 1.7.1944, ESRB Minutes; 4th Progress Report covering period 12.6.1941-16.7.1941, S12322, D.T., N.A; some 300g had been prepared and submitted to Messrs Maguire & Paterson for evaluation.

41. 131st meeting of Bureau, dated 3.11.1943, ESRB Minutes; 14th Progress Report covering the period 1.11.1943- 29.2.1944, S12322, D.T., N.A; Report of Activities, *op.cit.*

42. 4th meeting of Bureau, dated 6,7, and 11.3.1941, ESRB Minutes.

43. 5th meeting of Bureau, dated 14.3.1941, ESRB Minutes.

44. 4th Progress Report covering period 1.11.1943-29.2.1944, submitted to Taoiseach on 18.7.1941, S12322, D.T., N.A.

45. 16th meeting of Bureau, dated 28.5.1942, ESRB Minutes.

46. 55th meeting of Bureau, dated 11.3.1942; 58th meeting dated 1.4.1942, ESRB Minutes.

47. 86th meeting of Bureau, dated 11.11.1942, ESRB Minutes; 10th Progress Report covering period 1.7.1942- 31.10.1942, S12322, D.T., N.A.

48. 11th Progress Report covering period 1.7.1942-28.2.1943, S12322, D.T., N.A.

49. 68th meeting of Bureau, dated 17.6.1942, ESRB Minutes.

50. 72nd meeting of Bureau, dated 15.7.1942, ESRB Minutes.

51. 173rd meeting of Bureau, dated 20.9.1944, ESRB Minutes.

52. 81st meeting of Bureau, dated 7.10.1942; 89th meeting dated 3.12.1942; 92nd meeting dated 30.12.1942 and 98th meeting dated 10.2.1943, ESRB Minutes.

53. Typed minute of discussion prepared by De Valera; letter from Dr J J Lennon to Secretary, Department of Taoiseach, dated 21.11.1944, S13588A, D.T., N.A.

54. 182nd meeting of Bureau, dated 22.11.1944, ESRB Minutes.

55. 184th meeting of Bureau, dated 6.12.1944, ESRB Minutes.

56. 186th meeting of Bureau, dated 20.12.1944; 187th meeting dated 3.1.1945, ESRB Minutes.

57. 189th meeting of Bureau, dated 11.1.1945, ESRB Minutes.

Chapter 8 Food and Health related Investigations

1. Hoctor, D., The Department's Story - A History of the Department of Agriculture (Dublin,1971),207.

2. Hoctor, D., *op.cit.*,189.

3. Memorandum on present position in regard to Fertilizers in Eire', sent to Department of Taoiseach on 27.3.1941, ESRB Records.

4. *Ibid.*

5. 8th meeting of Bureau, dated 26.3.1941 records agreement on increasing output to 1,200 tons per week; letter subsequently sent on 28.3.1941 from Lennon to Secretary, Dept of Taoiseach, did not refer to this higher figure, ESRB Minutes.

6. Lund, A., Industrial Utilization of Clare Phosphate, 12-15, ESRB Records.

7. 63rd meeting of Bureau, dated 13.5.1942, ESRB Minutes.

8. 76th meeting of Bureau, dated 26.8.1942, ESRB Minutes.

9. 79th meeting of Bureau, dated 23.9.1942; 84th meeting, dated 28.10.1942, ESRB Minutes.

10. Lund, A., *op.cit.*,12-15; Hogan & MacCarthy, *op.cit.*

11. Lund A., *op.cit.*,14 and Report of Activities, *op.cit.*,73.

12. Hoctor, D., *op.cit.*209.

13. 21st meeting of Bureau, dated 2.7.1941, ESRB Minutes.

14. 5th Progress Report covering period 17.7.1941-3.9.1941, submitted to Taoiseach on 6.9.1941, S12322, D.T., N.A.

15. 13th meeting of Bureau, dated 7.5.1941, ESRB Minutes.

16. This matter was referred to at 16th, 17th, 31st, 32nd, 33rd, 41st, 42nd, 52nd and 53rd meetings of the Bureau, ESRB Minutes.

17. 12th Progress Report covering period 1.3.1943-30.6.1943, submitted to Taoiseach on 29.7.1943, S12232, D.T., N.A; 113rd meeting of Bureau, dated 2.6.1943, ESRB Minutes.

18. 114th meeting of Bureau, dated 9.5.1943; 115th meeting, dated 16.6.1943; 116th meeting, dated 23.6.1943, ESRB Minutes.

19. 132nd meeting of Bureau, dated 10.11.1943, ESRB Minutes.

20. 159th meeting of Bureau, dated 31.5.1944; 167th meeting, dated 26.7.1944, ESRB Minutes; 14th Progress Report covering period 1.11.1943-29.2.1944, submitted to Taoiseach on 8.3.1944, S12322, D.T., N.A.

21. 168th meeting of Bureau, dated 2.8.1944; 169th meeting, dated 23.8.1944, ESRB Minutes; 15th Progress Report covering period 1.3.1944-30.6.1944, submitted to Taoiseach on 25.7.1944, S12322, D.T., N.A.

22. 174th meeting of Bureau, dated 27.9.1944; 176th meeting, dated 11.10.1944, ESRB Minutes; 16th Progress Report covering period 1.7.1944-31.10.1944, submitted to Taoiseach on 23.11.1944, S12322, D.T., N.A.

23. 60th meeting of Bureau, dated 22.4.1942, ESRB Minutes.

24. 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, S12322, D.T., N.A.

25. 58th meeting of Bureau, dated 1.4.1942; 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, S12322, D.T., N.A.

26. Report of Activities, *op.cit.*, 43.

27. 19th meeting of Bureau, dated 19.6.1941, ESRB Minutes; 4th Progress Report covering the period 12.6.1941-16.7.1941, S12322, D.T., N.A.

28. This matter was referred to in minutes of 20th, 22nd, 24th, 31st, 34th and 36th meetings held during period 25.6.1941-22.10.1941, ESRB Minutes.

29. 23rd meeting of Bureau, dated 16.7.1941, ESRB Minutes.

30. *Ibid*; 5th Progress Report covering period 17.7.1941-3.9.1941, submitted to Taoiseach on 6.9.1941, S12322, D.T., N.A.

31. 23rd meeting of Bureau, dated 16.7.1941; 27th meeting, dated 20.8.1941; 28th meeting, dated 27.8.1941, ESRB Minutes.

32. 24th meeting of Bureau, dated 23.7.1941; 25th meeting, dated 30.7.1941; ESRB Minutes; 5th Progress Report covering period 17.7.1941-3.9.1941, S12322, D.T., N.A.

33. 30th meeting of Bureau, dated 10.9.1941; 31st meeting, dated 17.9.1941, ESRB Minutes.

34. Leahy, P, Investigation of the Flow of Fluids Past Solid Bodies, (PhD thesis, NUI, 1944), 108.

35. 26th meeting of Bureau, dated 15.8.1941, ESRB Minutes.

36. 27th meeting of Bureau, dated 20.8.1941; 28th meeting, dated 27.8.1941, ESRB Minutes; 6th Progress Report covering period 4.9.1941-22.10.1941, S12322, D.T., N.A.

37. 39th meeting of Bureau, dated 12.11.1941; 40th meeting, dated 19.11.1941, ESRB Minutes.

38. 20th meeting of Bureau, dated 25.6.1941; 21st meeting, dated 2.7.1941; 22nd meeting, dated 9.7.1941; 23rd meeting, dated 16.7.1941, ESRB Minutes; Report of Activities, *op.cit.*,45.

39. 32nd meeting of Bureau, dated 24.9.1941; 33rd meeting, dated 1.10.1941, ESRB Minutes.

40. 37th meeting of Bureau, dated 29.10.1941, ESRB Minutes; 8th Progress Report covering period 18.12.1941-31.3.1942, S12322, D.T., N.A.

41. 40th meeting of Bureau, dated 19.11.1941; 142nd meeting held on 26.1.1944, ESRB Minutes.

42. 22nd meeting of Bureau, dated9.7.1941; 33rd meeting, dated 1.10.1941; 50th meeting, dated 4.2.1942, ESRB Minutes.

43. 70th meeting of Bureau, dated 1.7.1942; 80th meeting, dated 30.9.1942; 86th meeting, dated 11.11.1942, ESRB Minutes; 10th Progress Report covering period 1.7.1942-31.10.1942, S12322, D.T., N.A.

44. 38th meeting of Bureau, dated 5.11.1941, ESRB Minutes.

45. *Ibid.*

46. 40th meeting of Bureau, dated 19.11.1941; 41st meeting, dated 26.11.1941; 42nd meeting, dated 3.12.1941, ESRB Minutes; 9th Progress Report covering period 1.4.1942-30.6.1942, S12322, D.T., N.A.

47. 21st meeting of Bureau, dated 2.7.1941, ESRB Minutes; 4th Progress Report covering the period 12.6.1941-16.7.1941, submitted to Taoiseach on 18.7.1941, S12322, D.T., N.A.

48. 23rd meeting of Bureau, dated 16.7.1941; 24th meeting, dated 23.7.1941, ESRB Minutes; 5th Progress Report covering the period 17.7.1941-3.9.1941, submitted to Taoiseach on 6.9.1941, S12322, D.T., N.A.

49. 25th meeting of Bureau, dated 30.7.1941; 28th meeting, dated 27.8.1941, ESRB Minutes.

50. 78th meeting of Bureau, dated 9.9.1942, ESRB Minutes.

51. *Ibid.*; 89th meeting, dated 3.12.1942, Report of Activities, *op.cit.*, 55/56 gives details of plant adaptations and production processes.

52. 98th meeting of Bureau, dated 10.2.1943, ESRB Minutes.

53. 103rd meeting of Bureau, dated 18.3.1943, ESRB Minutes.

54. 12th Progress Report covering the period 1.3.1943-30.6.1943, submitted to the Taoiseach on 29.9.1943, S12322, D.T., N.A.

55. 15th Progress Report covering the period 1.3.1944-30.6.1944, submitted to Taoiseach on 25.7.1944, S12322, D.T., N.A.

56. 143rd meeting of Bureau, dated 2.2.1944, ESRB Minutes.

57. 14th Progress Report covering the period 1.11.1943-29.2.1944, submitted to the Taoiseach on 8.3.1944, S12322, D.T., N.A.; 150th meeting of Bureau, dated 22.3.1944, ESRB Minutes.

58. 15th Progress Report covering the period 1.3.1944-30.6.1944, submitted to the Taoiseach on 25.7.1944, S12322, D.T., N.A.

59. 150th meeting of Bureau, dated 22.3.1944, ESRB Minutes.

60. 152nd meeting of Bureau, dated 5.4.1944, ESRB Minutes.

61. 172nd meeting of Bureau, dated 13.9.1944, ESRB Minutes.

62. 26th meeting of Bureau, dated 15.8.1941, ESRB Minutes.

63. 52nd meeting of Bureau, dated 18.2.1942; 63rd meeting, dated 13.5.1942; 69th meeting, dated 24.6.1942, ESRB Minutes.

64. 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, S12322, D.T., N.A.; 71st meeting of Bureau, dated 8.7.1942, ESRB Minutes.

65. 82nd meeting of Bureau, dated 14.10.1942, ESRB Minutes; Report of Activities, *op.cit.*,57/58 gives details of plant and processes; 10th Progress Report covering period 1.7.1942-31.10.1942, S12322, D.T., N.A.

66. 82nd meeting of Bureau, dated 14.10.1942, ESRB Minutes.

67. 99th meeting of Bureau, dated 17.2.1943, ESRB Minutes; 11th Progress Report covering period 1.11.1942-29.2.1943, submitted to Taoiseach on 12.3.1943, S12322, D.T., N.A.

68. *Ibid.*

69. Hoctor, D., *op.cit.*,220.

70. 21st meeting of Bureau, dated 2.7.1941; 22nd meeting, dated 9.7.1941; 23rd meeting, dated 16.7.1941, ESRB Minutes.

71. Technical Report No 1 - Manufacture of Formalin, S12997, D.T., N.A.

72. *Ibid.*

73. 25th meeting of Bureau, dated 20.7.1941; 26th meeting, dated 15.8.1941, ESRB Minutes.

74. 31st meeting of Bureau, dated 17.9.1941; 32nd meeting, dated 24.9.1941, ESRB Minutes.

75. Technical Report No 1, *op.cit.*, gives details of the pilot plant and its operation.

76. 37th meeting of Bureau, dated 29.10.1941, ESRB Minutes.

77. 38th meeting of Bureau, dated 5.11.1941, ESRB Minutes.

78. 54th meeting of Bureau, dated 4.3.1942, ESRB Minutes.

79. 55th meeting of Bureau, dated 11.3.1942; 57th meeting, dated 25.3.1942, ESRB Minutes.

80. Technical Report No 1, *op.cit.*,11-12.

Chapter 9 Other Projects & Investigations

1. 1st Progress Report covering period up to 12.3.1941, submitted to Taoiseach on 14.3.1941, S12322, D.T., N.A.

2. 2nd Progress Report covering period 12.3.1941-26.4.1941, submitted to Taoiseach on 26.4.1941, S12322, D.T., N.A.

3. 25th meeting of Bureau, dated 30.7.1941, ESRB Minutes.

4. 35th meeting of Bureau, dated 15.10.1941, ESRB Minutes.

5. 33rd meeting of Bureau, dated 1.10.1941; 38th meeting, dated 5.11.1941; 41st meeting, dated 26.11.1941, ESRB Minutes; 7th Progress Report covering period 23.10.1941-17.12.1941, submitted to Taoiseach on 22.12.1941, S12322, D.T., N.A.

6. 50th meeting of Bureau, dated 4.2.1942, ESRB Minutes.

7. 8th Progress Report covering period 18.12.1941-31.3.1942, submitted to Taoiseach on 7.4.1942; 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, S12322, D.T., N.A.

8. 55th meeting of Bureau, dated 11.3.1942, ESRB Minutes.

9. 57th meeting of Bureau, dated 25.3.1942; 61st meeting held on 29.4.1942, ESRB Minutes.

10. 70th meeting of Bureau, dated 1.7.1942; 75th meeting, dated 19.8.1942, ESRB Minutes.

11. 157th meeting of Bureau, dated 17.5.1944, ESRB Minutes.

12. 158th meeting of Bureau, dated 24.5.1944; 159th meeting, dated 31.5.1944, ESRB Minutes.

13. 161st meeting of Bureau, dated 14.6.1944, ESRB Minutes.

14. 16th Progress Report covering period 1.7.1944-31.10.1944 submitted to Taoiseach on 23.11.1944, S12322, D.T., N.A.

15. 48th meeting of Bureau, dated 21.1.1942, ESRB Minutes.

16. 58th meeting of Bureau, dated 1.4.1942, ESRB Minutes.

17. 62nd meeting of Bureau, dated 6.5.1942; 78th meeting, dated 9.9.1942, ESRB Minutes.

18. 5th meeting of Bureau, dated 14.3.1941, ESRB Minutes.

19. 55th meeting of Bureau, dated 11.3.1942, ESRB Minutes.

20. 57th meeting of Bureau, dated 25.3.1942, ESRB Minutes.

21. 59th meeting of Bureau, dated 15.4.1942, ESRB Minutes.

22. 60th meeting of Bureau, dated 22.4.1942, ESRB Minutes.

23. 61st meeting of Bureau, dated 29.4.1942; 64th meeting, dated 20.5.1942; 67th meeting, dated 10.6.1942, ESRB Minutes.

24. 11th Progress Report covering period 1.11.1942-29.2.1943, submitted to Taoiseach on 12.3.1943, S12322, D.T., N.A.

25. 98th meeting of Bureau, dated 10.2.1943, ESRB Minutes.

26. 12th Progress Report covering period 1.3.1943-30.6.1943, submitted to Taoiseach on 29.7.1943, S12322, D.T., N.A; Report of Activities, *op.cit.*,76.

27. 52nd meeting of Bureau, dated 18.2.1942; 58th meeting, dated 1.4.1942; 69th meeting, dated 24.6.1942, ESRB Minutes.

28. 60th meeting of Bureau, dated 22.4.1942, ESRB Minutes.

29. 61st meeting of Bureau, dated 29.4.1942; 65th meeting, dated 27.5.1942; 69th meeting, dated 24.6.1942, ESRB Minutes.

30. 64th meeting of Bureau, dated 20.5.1942, ESRB Minutes.

31. 67th meeting of Bureau, dated 10.6.1942; 73rd meeting, dated 22.7.1942, ESRB Minutes.

32. 78th meeting of Bureau, dated 9.9.1942; 89th meeting, dated 3.12.1942, ESRB Minutes.

33. 82nd meeting of Bureau, dated 14.10.1942, ESRB Minutes.

34. 81st meeting of Bureau, dated 7.10.1942, ESRB Minutes.

35. 80th meeting of Bureau, dated 30.9.1942; 84th meeting, dated 28.10.1942; 87th meeting, dated 18.11.1942; 92nd meeting, dated 30.12.1942, ESRB Minutes.

36. 84th meeting of Bureau, dated 28.10.1942; 89th meeting, dated 3.12.1942; 93rd meeting, dated 6.1.1942, ESRB Minutes.

37. 92nd meeting of Bureau, dated 30.12.1942; 93rd meeting, dated 6.1.1943; 95th meeting, dated 20.1.9143; 116th meeting, dated 23.6.1943; 123rd meeting, dated 1.9.1943, ESRB Minutes.

38. 63rd meeting of Bureau, dated 13.5.1942; 69th meeting, dated 24.6.1942; 77th meeting, dated 2.9.1942, ESRB Minutes.

39. 110th meeting of Bureau, dated 12.5.1943; 116th meeting, dated 26.6.1943; 120th meeting, dated 28.7.1943; 122nd meeting, dated 25.8.1943, ESRB Minutes.

40. 114th meeting of Bureau, dated 9.6.1943; 120th meeting, dated 28.7.1943; 131st meeting, dated 3.11.1943; 145th meeting, dated 16.2.1944; 151st meeting, dated 29.3.1944, ESRB Minutes.

41. 125th meeting of Bureau, dated 22.9.1943, ESRB Minutes.

42. 36th meeting of Bureau, dated 22.10.1943, ESRB Minutes.

43. 7th Progress Report covering period 23.10.1941-17.12.1941, submitted to Taoiseach on 22.12.1941, S12322, D.T., N.A.

44. 49th meeting of Bureau, dated 28.1.1942; 54th meeting, dated 4.3.1942, ESRB Minutes.

45. 8th Progress Report covering period 18.12.1941-31.3.1941, submitted to Taoiseach on 7.4.1942, S12322, D.T., N.A.

46. 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, s12322, D.T., N.A.

47. 9th Progress Report covering period 1.4.1942-30.6.1942, submitted to Taoiseach on 13.7.1942, S12322, D.T., N.A.

48. 65th meeting of Bureau, dated 27.5.1942; 68th meeting, dated 17.6.1942; 71st meeting, dated 8.7.1942; 83rd meeting, dated 21.10.1943; 146th meeting, dated 23.2.1944; 166th meeting, dated 19.7.1944; 136th meeting, dated 8.12.1943; 157th meeting, dated 17.5.1944; 75th meeting, dated 19.8.1942; 79th meeting, dated 23.9.1942; 64th meeting, dated 20.5.1942; 75th meeting, dated 19.8.1942; 108th meeting, dated 29.4.1943, ESRB Minutes.

49. 12th and 13th Progress Report covering periods 1.3.1943 - 30.6.1943 and 1.7.1943-31.10.1943 respectively, S12322, D.T., N.A.

50. 13th Progress Report covering period 1.7.1943-31.10.1943, submitted to Taoiseach on 29.7.1943, S12322, D.T., N.A.

51. 14th Progress Report covering period 1.11.1943-29.2.1944, submitted to Taoiseach on 8.3.1944, S12322, D.T., N.A.

52. Annual Report covering period 20.2.1941-31.3.1942, S12322, D.T., N.A.

53. 59th meeting of Bureau, dated 15.4.1942; 66th meeting, dated 3.6.1942; 71st meeting, dated 8.7.1942; 75th meeting, dated 19.8.1942; 81st meeting, dated 7.10.1942; 86th meeting, dated 11.11.1942; 87th meeting, dated 18.11.1942; 91st meeting, dated 16.12.1942; 117th meeting, dated 29.6.1943, ESRB Minutes; Report of Activities, *op.cit.*,70-72.

54. Report of Activities, *op.cit.*,70; 12th and 14th Progress Reports and Annual Reports covering periods 1.4.1942 - 31.3.1943 and 1.4.1943-31.3.1944, S12322, D.T., N.A.

55. 55th meeting of Bureau, dated 11.3.1942, ESRB Minutes.

56. 56th meeting of Bureau, dated 18.3.1942; 59th meeting, dated 15.4.1942; 76th meeting, dated 26.8.1942; 79th meeting, dated 23.9.1942; 81st meeting, dated 7.10.1942, ESRB Minutes.

57. 97th meeting of Bureau, dated 3.2.1943, ESRB Minutes.

58. 128th meeting of Bureau, dated 13.10.1943, ESRB Minutes.

59. 45th meeting of Bureau, dated 31.12.1941, ESRB Minutes.

60. 49th meeting of Bureau, dated 28.1.1942; 50th meeting, dated 4.2.1942; 51st meeting, dated 11.2.1942, ESRB Minutes; 8th and 10th Progress Reports covering periods 18.12.1941-31.3.1942 and 1.7.1942-31.10.1942, S12322, D.T., N.A.

61. 52nd meeting of Bureau, dated 18.2.1942, ESRB Minutes.

62. 9th and 11th Progress Reports covering periods 1.4.1942-30.6.1943 and 1.11.1942-29.2.1943, S12322, D.T., N.A.; Interview with Dr Walton by author on 24.10.1983; 102nd meeting of Bureau, dated 10.3.1943; 108th meeting, dated 29.4.1943; ESRB Minutes; 12th Progress Report covering period 1.3.1943-30.6.1943, submitted to Taoiseach on 29.7.1943, S12322, D.T., N.A.

63. 113rd meeting of Bureau, dated 2.6.1943; 114th meeting, dated 9.6.1943, ESRB Minutes.

64. 122nd meeting of Bureau, dated 25.8.1943; 123rd meeting, dated 1.9.1943, ESRB Minutes; 13th Progress Report covering period 1.7.1943-31.10.1943, submitted to Taoiseach on 25.11.1943, S12322, D.T., N.A.

65. 153rd meting of Bureau, dated 19.4.1944, ESRB Minutes; Report of Activities, *op.cit*.51-55; 15th Progress Report covering period 1.3.1944-30.6.1944, submitted to Taoiseach on 25.7.1944, S12322, D.T., N.A.

66. 171st meeting of Bureau, dated 6.9.1944; 173rd meeting, dated 20.9.1944, ESRB Minutes; 16th Progress Report covering period 1.7.1944-31.10.1944, submitted to Taoiseach on 23.11.1944, S12322, D.T., N.A.

67. 179th meeting of Bureau, dated 1.11.1944. ESRB Minutes.

68. 179th meeting of Bureau, dated 1.11.1944; 182nd meeting, dated 22.11.1944; 185th meeting, dated 13.12.1944; 188th meeting, dated 10.1.1945, ESRB Minutes.

69. 6th meeting of Bureau, dated 19.3.1941; 8th meeting, dated 26.3.1941, ESRB Minutes; Report of Activities, *op.cit*.

70. 8th meeting of Bureau, dated 26.3.1941;10th meeting, dated 8.4.1941; 11th meeting, dated 23 and 25.4.1941; 35th meeting, dated 15.10.1941, ESRB Minutes.

71. 71st meeting of Bureau, dated 8.7.1942, ESRB Minutes.

72. 72nd meeting of Bureau, dated 15.7.1942, ESRB Minutes.

73. 66th meeting of Bureau, dated 3.6.1942, ESRB Minutes.

74. 72nd meting of Bureau, dated 15.7.1942, ESRB Minutes.

75. 150th meeting of Bureau, dated 22.3.1942, ESRB Minutes.

76. 156th meeting of Bureau, dated 10.5.1942, ESRB Minutes.

77. 147th meeting of Bureau, dated 1.3.1944, ESRB Minutes.

78. Murphy, Prof T, was the principal physicist appointed by the Bureau. His work with the ESRB during the period under review was discussed in detail with the author on 14.2.1985. Prof Murphy provided the author with a copy of his magnetic survey report; this report had been finally compiled in December 1953 but was never published or distributed.

79. Letter from Federation of Irish Manufacturers to ESRB, dated 4.3.1941, S12322, D.T., N.A.

80. 26th meeting of Bureau, dated 15.8.1941, ESRB Minutes; 5th Progress Report covering period 17.7.1941-3.9.1941, S12322, D.T., N.A.

81. 35th meeting of Bureau, dated 5.10.1941; 36th meeting, dated 22.10.1941; 38th meeting, dated 5.11.1941, ESRB Minutes; 6th, 7th and 8th Progress Reports covering the periods 4.9.1941-22.10.1941, 23.10.1941-19.12.1941 and 18.12.1941 - 31.3.1942, S12322, D.T., N.A.

82. 52nd meeting of Bureau, dated 18.2.1942, ESRB Minutes.

83. 81st meeting of Bureau, dated 7.10.1942; 91st meeting, dated 16.12.1942; 97th meeting, dated 3.2.1943, ESRB Minutes.

84. 109th meeting of Bureau, dated 6.5.1943; 144th meeting, dated 9.2.1944; 153rd meeting, dated 19.4.1944; 170th meeting, dated 30.8.1944; 182nd meeting, dated 22.11.1944, ESRB Minutes.

Chapter 10 The Bureau, its operational parameters and Termination

1. Summary of activities extracted from records of special Cabinet Committee on Emergency Problems, S11903, D.T., N.A.

2. *Ibid.*

3. Memorandum on the supply situation from S Lemass to Cabinet, dated August 1943, S11394, D.T., N.A.

4. 174th meeting of Bureau, dated 27.9.1944, ESRB Minutes.

5. 178th meeting of Bureau, dated 25.10.1944, ESRB Minutes.

6. Note prepared by Secretary to the Department of the Taoiseach summarising discussion Taoiseach had with Prof Dowling, Chairman of the ESRB, dated 16.10.1944,S13581, D.T., N.A.

7. Letter from Dr Lennon to Secretary, Department of the Taoiseach, dated 2.11.1944, S13581, D.T., N.A.

8. Agenda of conference between the Taoiseach and representations of the ESRB held on 7.11.1944, annotated with decisions arrived at in respect of the matters under discussion, confirmatory report of meeting prepared by Secretary to Department of Taoiseach, dated 9.11.1944, S13581, D.T., N.A.

9. 180th meeting of Bureau, dated 8.11.1944, ESRB Minutes.

10. 175th meeting of Bureau, dated 4.10.1944, ESRB Minutes.

11. 180th meeting of Bureau, dated 8.11.1944, ESRB Minutes.

12. *Ibid.*

13. *Ibid.*

14. 181st meeting of Bureau, dated 15.11.1944, ESRB Minutes.

15. 59th meeting of Bureau, dated 15.4.1942; 165th meeting, dated 12.7.1944, ESRB Minutes.

16. Letter from Secretary, Department of Taoiseach to Secretary, Department of Industry & Commerce, dated 21.2.1945, S13581, D.T., N.A.

17. *Ibid.*

18. Irish Times 2.3.1945, 3.3.1945; Irish Press 3.3.1945.

19. Draft of statement to be issued announcing the termination of the activities of the Bureau on 31.3.1945, S13581, *D.T., N.A.*

20. Letter, initialled by the Taoiseach, sent to Prof Dowling, dated 13.4.1945, S13581, D.T., N.A.

21. Handwritten letter from Prof Dowling to Taoiseach, dated 17.4.1945; annotations indicate that it was seen by De Valera on 26.4.1945, S13581, D.T., N.A.

22. Extract from the record of the 17th meeting of the Inter-Departmental Emergency Preparation Committee, DATED 19.3.1951, S12282B, D.T., N.A.

23. *Ibid.*

24. Dáil Debates, 28,1980.

25. Memorandum from McEntee to the Taoiseach, dated 5.6.1941, S12282, D.T., N.A.

26. *Ibid.*

27. *Ibid.*

28. *Ibid.*

29. Typed draft of letter from Taoiseach to Prof Dowling, dated 29.4.1941; notes written by Secretary of Department of the Taoiseach, dated 7.6.1941. and 12.7.1941; S12282A, D.T.,N.A.

30. Letters from Taoiseach to Universities, dated 17.2.1941, S12282, D.T., N.A.

31. Letter from O'Rahilly to President of University College Cork sent to Taoiseach, dated 21.2.1941, S12281, D.T., N.A.

32. Personal interview by author with Dr Lennon on 26.10.1983.

33. Letters from Federation to Taoiseach; dated 30.1.1941 and 20.7.1943 article on 'Science Research Bureau' in Irish Industry Vol. 13 No 2, February 1945, S12282, D.T., N.A.

34. Scientists and engineers awarded higher degrees from University of Dublin and the National University of Ireland listed in relevant calendars include: Grove-White, C W, The Production of Anhydrous Ammonia under Emergency Conditions in Eire, thesis submitted to TCD for degree of MSc 1942;

O'Driscoll, W G, Recovery of Zinc from used Primary Cells, thesis submitted to TCD for degree of MSc 1943;

Lund, A A, Industrial Utilization of Clare Phosphates, thesis submitted to NUI for degree of MSc 1943;

Leahy, Patrick, Investigation of the Flow of Fluids Past Solid Bodies, thesis submitted to NUI for degree of PhD 1944; Note: This thesis is incompletely titled for the work consists of four separate sections; the first section (pages 1-36) deals with the title above while the other sections concern different work undertaken on behalf of the Bureau, i.e. - Design and construction of an electrothermic plant for the production of phosphorus, - Design and construction of carbon dioxide generating and liquifying plant, - Design and construction of an anhydrous ammonia generating and liquifying plant.

35. 1st meeting of Bureau, dated 21.2.1941, ESRB Minutes.

36. 87th meeting of Bureau, dated 18.11.1942; 120th meeting, dated 28.7.1943; 121st meeting, dated 11.8.1943; 126th meeting, dated 29.9.1943; 127th meeting, dated 6.10.1943; 146th meeting, dated 23.2.1944, ESRB Minutes; Irish Engineers' Handbook (Dublin,1945).

37. 168th meeting of Bureau, dated 2.8.1944, ESRB Minutes.

38. 172nd meeting of Bureau, dated 13.9.1944, ESRB Minutes.

39. ESRB available records of the Bureau. Letter from Dept of Taoiseach to Dept of Finance, dated 31.5.1946, S12997, D.T., N.A.; ESRB Records.

40. Technical Report No 1 - Manufacture of Formalin, a photograph of the actual apparatus is supposed to be included but appears to be missing, S12297, D.T., N.A.

41. Various items of correspondence particularly letters dated 13.3.1946, 25.3.1946 from the Dept of Defence, letter dated 17.4.1946 from Lennon to Secretary, Dept of the Taoiseach and notes of amendments agreed to following consultation, S12997, D.T., N.A.

42. Confidential sources of information.

1. Moynihan, M.(ed.), Speeches and Statements by Eamon De Valera 1917-1973, (Dublin,1980), 131; confirmed also at Fianna Fail Ard-Fheis, 12.10.1937, 331,337,342.

2. 172nd meeting of the Bureau, dated 13.9.1944, ESRB Minutes; Memoranda drawn up for Committee on Economic Policy Towards Eire, dated 6.11.42, 1.3.43, CAB72/25,P.R.O.(UK).

3. Minutes of sixth meeting of Committee on Economic Policy to Éire, dated 30.12.1942, CAB72/25, P.R.O.(UK).

4. Dail Debates, 28, 1980.

5. Statement by Taoiseach in Dáil Éireann, 17.7.1941, S12282A, D.T., N.A.

6. Letter and memoranda from Dr L J Kettle to the Taoiseach, 7.2.1941; similar sentiments can be found in other memoranda particularly those dated 18.10.1937, 23.10.1937 and 23.12.1938, S12282, D.T., N.A.

7. Correspondence between Depts of Taoiseach and Industry & Commerce, dated July 1939, 25.11.1939, 28.6.1940, 21.8.1940, 9.10.1940 and 29.8.1940, S6413A, D.T., N.A.

8. Extracts from Cabinet minutes of 19.10.1945 and 25.6.1946, S6413A, D.T., N.A.

9. Summarised from documents relating to the Bill, S6413A, D.T. N.A..

10. Industrial Alcohol Act, 1938 and Industrial Alcohol (Amendment) Act, 1947.

11. Meenan, J., *op.cit.*,84.

12. Meenan, J., *op.cit.*, 105-106.

13. Lyons, F S L, *op.cit.*,628-630.

14. Meenan, J., *op.cit.*,259-261.

15. Stationery Office, Programme for Economic Expansion, (Dublin,1958); Second Programme for Economic Expansion, (Dublin, Part I, 1963 and Part II, 1964); Fitzgerald, G., 'The First Programme for Economic Expansion', Irish Banking Review 1963; Meenan, J., The Irish Economy; Fanning, R., The Irish Department of FInance, 506-519.

16. OECD, Science & Irish Economic Development, report of the Research and Technology Survey Team appointed by the Minister for Industry and Commerce in November 1963, volume 1, main report, (Dublin, 1966), xiv-xv.

17. Science & Irish Economic Development, *op.cit.*, xv.

Note: The Organisation for Economic Cooperation and Development (OECD) was set up under a Convention signed in Paris on 14.12.1960; the remit of the OECD was to promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the World economy;
- to contribute to sound economic expansion in member as well as non-member countries in the process of economic development;
- to contribute to the expansion of World trade on a multilateral, non-discriminatory basis in accordance with international obligations.

18. *Ibid*, xv-xvi.

19. *Ibid*,176-190, details the proposed structure, role, functions and responsibilities of the National Science Council.

20. National Science Council Progress Report, 1969-1971,11.

21. OECD, Reviews of National Science Policy - Ireland, (Paris 1974),76-77.

22. Statement issued by Government Information Bureau on 14.7.1972.

23. The National Board for Science and Technology Act (1977) details the function and responsibility of the Board, the members of which, appointed by the Government, are drawn from industry, the Universities and the public sector.

24. Summarised from the Science & Technology Act 1987.

APPENDIX 1

saorstat eireann

ROINN UACHTARÁN
SAORSTÁT
28. D.F. 1933
EIREANN
NA hARD-CHOMHAIRLE

ROINN TIONNSCAIL AGUS TRÁCHTÁLA
(DEPARTMENT OF INDUSTRY AND COMMERCE)
BAILE ÁTHA CLIATH
(DUBLIN)

27th October, 1933.

Proposal for the Establishment of an Industrial Research Council.

.. chara,

I am desired by the Minister for Industry and Commerce to forward copies of a memorandum on the above subject which he would be glad if you would circulate for the next meeting of the Executive Council.

Mise, le meas,

RUNAIDHE AIRE.

Secretary,
Department of the President.

Proposal for the Establishment of an Industrial Research Council.

1. Within recent years rapid progress has been made in other countries in the encouragement and organisation of Industrial Research. In some cases special Departments of State have been established and in others the work is centered in the Department of Trade and Commerce. A statement is attached giving a brief account of the functions of the various bodies which have been set up to control industrial research work in certain foreign countries.

2. Since the Commission of Enquiry into the industrial resources of Ireland was appointed by the Dail about the year 1919, no co-ordinated effort has been made to undertake anything approaching a scientific investigation of industrial problems. A few of the larger industrial concerns, e.g., Messrs. Guinness, Messrs. Jacob, Chemical Manure Manufacturers, etc., have their own establishments for research work in connection with their particular industries. The Royal Dublin Society, the Universities and some of the County Councils have taken some practical interest in the encouragement of work of this nature. There is no central body, however, charged with the responsibility of co-ordinating the results of these various efforts.

3. Under the Vote for Miscellaneous Expenses a sum of £650 is provided for research grants for students; but it is understood that scientific industrial research is not undertaken by students who receive these grants. Apart from this there is no financial assistance given from public funds towards the promotion of Industrial Research.

4. It will be noted that in some countries, e.g., Canada, research work, the object of which is to improve conditions for agriculture, is included in the duties of the National Research Council. It is not intended, however, that the present proposals should interfere with the existing practice by which certain sums are borne on the

Department of Agriculture vote for research work in connection with Agriculture.

5. The Minister for Industry and Commerce is satisfied that there is room for industrial development in the Saorstat and if such development is to be intelligently planned and successfully carried out scientific industrial research must form a definite feature of the Government's programme. The cost of such research should in ordinary circumstances be borne to some extent by those engaged in industrial enterprise; but under existing conditions in the Saorstat it is regarded as inevitable that the Government should take the initiative and should provide from public funds any expenditure involved.

6. Proposals for the establishment of an Industrial Research Council have been under consideration in the Department of Industry and C Commerce for some time and it is now suggested that such a body, with powers and resources to direct and encourage industrial research in the Saorstat, should be set up under the control of the Minister.

7. It is proposed that

(i) The Research Council should be financed by an annual Grant-in-aid made from State funds;

(ii) The Council should consist of about ten persons to be nominated by the Executive Council. The membership would include such persons as Professors O'Reilly, Dillon, Purcell, T. Nolan, Dr. Drumm, the President of the Institute of Engineers, the Director of Geological Survey, etc.;

(iii) The Council should have a permanent secretary, a small staff and a library;

(iv) The functions of the Council would include:-

(a) Intelligence: studying and recording the results of scientific industrial investigation in other countries and their bearing on Saorstat industries; and bringing to the attention of the Government and interested industrial

organisations the results of such investigations as appear to have a direct bearing on the industrial situation in the Saorstat, etc.

(b) Special Investigations: At the request of the Government or on its own initiative the appointment of qualified persons carrying out particular investigations directed to the development of Saorstat resources should be made. The specialised study of the more extensive use of native materials in the home industries should be undertaken and reports on the results of such investigations made.

(c) Research work in connection with the establishment of new industries or the extension of existing industries in the Saorstat.

(d) Research work in connection with the improvement of technical processes and methods of production in Saorstat industries.

(e) The granting of financial assistance to Saorstat inventors whose investigations appear to the Council to be likely to have beneficial national results.

(f) At the request of particular industrialists and subject to payment by them, the carrying out of particular investigations into the utilisation of waste products, etc.

(g) The awarding of scholarships to selected students showing a capacity for research work.

8. It is estimated that the annual cost to the State based on the activities as outlined above of the proposed Council should be approximately £6,500 per annum, made up as follows:-

(a) Secretariat	£1,000
(b) Records	£1,000
(c) Special investigations	£2,500
(d) Aids to inventors	500
(e) Scholarships	£1,000
(f) Travelling expenses, etc. of members of Council.	500
TOTAL:	£6,500

9. At a later stage the Council might be asked to prepare and supervise industrial standards and, when financial conditions permit, a research laboratory might be established.

10. The following investigations might be undertaken immediately :--

(1) The extract of wax from peat in continuation of investigations recently undertaken by Professor O'Reilly.

(2) The possibility of commercial development having regard to home requirements, quality of the deposits, competitive prices of similar material from outside sources and other relevant factors of the following mineral deposits :--

(a) Phosphate deposits in Co. Clare.

(b) China clay deposits in Portacloy, Co. Mayo.

(c) Copper and Sulphate deposits in Avoca, Co. Wicklow, Allihies, Co. Cork, and elsewhere.

(d) Gypsum deposits at Farney, Co. Monaghan.

(3) The possibility of the production of fuel oil from coal and shale deposits in the Saorstat and the suitability of the application of processes developed in other countries to such deposits.

(4) The possibility of the production of iodine and other products from seaweed in pursuance of certain experiments already conducted by Professor Dillon of University College, Galway.

(5) Canning industry. Three Saorstat firms have recently commenced the canning of fresh vegetables and the results to date are regarded as satisfactory. There are very large imports of other canned goods, e.g., fruit, fish, etc., and as the raw materials are available it would appear to be desirable to explore the possibility of establishing this industry on a large scale in this country.

(6) Since the Clondalkin Paper Mills closed down about 10 years ago, several attempts have been made to have them re-opened but without success. Newsprint was the principal class of paper produced in these mills; cardboard, millboard, etc., were also produced. There are no other firms engaged in the production of these materials in the Saorstat. There are 4 firms engaged in the production of wrapping paper, notepaper, etc. The imports of newsprint alone amount to about £200,000 per annum and the fact that the industry was carried on successfully at one period suggests that it should be possible to revive it. An enquiry into the conditions under which the industry is carried on in other countries would assist in arriving at a decision in the matter.

(7) The further developments in the use of Peat and Coal as fuels and as the source of power or for the manufacture of chemical products. Experiments have already been made at the Carlow Sugar factory in the direction of using Castlecomer Anthracite Duff or slack for boiler purposes.

Department of Industry and Commerce.

~~27 September 1933~~

27th October 1933

APPENDIX 2

Most Secret

WP (40) 475

6 December 1940

WAR CABINET

Payments to Éire

The attached minute by the Chancellor of the Exchequer is circulated to the War Cabinet by direction of the Prime Minister.

Signed: E E Bridges
Secretary
War Cabinet

Richmond Terrace SW1

6 December 1940

Source : P.R.O.(UK),CAB 66/14

Prime Minister, in accordance with your request I have discussed with the President of the Board of Trade, the Ministers of Shipping, Agriculture and Food and the Secretary of State for the Dominions the measures which might be taken to reduce the burden on our shipping and finances in consequence of the heavy sinkings off the Irish Coast and our inability to use the Irish Ports.

I describe below two plans, the second more drastic than the first, both of which could be put into effective action as soon as it was decided to proceed. Both would hit Éire considerably worse than ourselves. An estimate of the quickness of the results on Éire is given with the plans.

The first plan would, apart from one or two items, rest on the argument that so long as we are subject to difficulties in the supply of certain things, we cannot in present circumstances, go on giving Éire the general share of them that we have so far allowed her. The items in this plan would be as follows:-

SHIPS

There is at present an unwritten understanding that Éire charters ships through the Minister of Shipping's Charter Office. In addition Éire gets shipping space in liners and other ships chartered to us, the cargoes being the main trans-shipped in the United Kingdom. Éire's needs in both kinds of shipping space put together are estimated at the equivalent of forty whole time ships. Owing to the reduction on our arrivals, Éire has been feeling short of the second kind of shipping space and the Ministry of Shipping

has had semi-official notice of this from Éire officials. But there is no sign yet of a Ministerial approach which Éire officials have been told is the only one would be considered. We do not think it would be enough to wait for such an approach and we think that on our first plan a notification should be given by our officials to Éire's that the unwritten understanding referred to above can no longer be observed, the Minister of Shipping's Charter Office would no longer give facilities to Éire. The Minister of Shipping would tell the Greeks and the Norwegians that in present circumstances they should not charter ships except to allies or co-operators. The result would be, (on the assumption which the Minister of Shipping hopes will shortly be fulfilled, that he gets all the Greek and the remaining free Norwegian tonnage on time charter) that Éire might get if she were very lucky ten ships which would give her 25% of her needs.

COMMODITIES

The export licencing arrangements should be altered so as to shut out the export or re-export to Éire of food, feeding stuffs and fertilizers, agricultural and other machinery, spare parts of all kinds, iron and steel, non ferrous metals, chemical and electrical goods, paper and cardboard. Small exceptions might be made for instance in the case of tea for which the Irish could be cut to something below the English ration. This would deprive Éire almost entirely of space in ships bringing goods to the United Kingdom.

COAL

Éire takes some three million tons a year which employs some ten thousand men, about one-fifth comes from South Wales. As in the case of cotton piece goods and other textiles, leather manufacturers etc. in which there is an export drive we shall not have the same ground for starving Éire as in the commodities previously mentioned.

DOLLARS

Éire at present exercises an exchange control fairly well in line with ours and we allot them dollars for sterling. We could cease to do so and then Éire's control would get out of line with ours and in order to stop a drain on our gold (since Mr de Valera might buy things in the United States of America which he could not ship to spite us) we might have to freeze her balances of sterling. This freezing would dislocate Éire's imports including the export trade in cotton textiles etc. (see above) from Great Britain and Northern Ireland. We should be treating Éire in very much the same way as Rumania, this would inevitably lead on to the second plan. Dollars might perhaps be left out of the first plan on the ground that their connection with their difficulties with Éire is not so close as that of the other items, but it would probably be dangerous for us to leave them out.

EFFECT OF THE PLAN ON EIRE

The Éire government would immediately feel difficulties because

they would see their future supplies of feeding stuffs, food and if we took action on its coal, endangered. On food we have no precise information about stocks except that those of sugar are probably high but the population would probably begin to feel uncomfortable in a few weeks. On feeding stuffs the Government would certainly have to impose a rationing scheme without delay and the small farmers would feel an immediate pinch. On coal the population generally would be affected in the same way but there are probably substantial stocks.

OIL

Éire's requirements could be met by the full time use of a single tanker which she might be able to get. The only serious effect on us would be felt possibly on our coal (see above) and certainly by the coal miners in South Wales. The other coal districts supplying Éire would not suffer substantially. We could not on this plan consistently refuse to take imports of live stock which might cause difficulties at the ports, slaughter houses and cold stores. But, as the Minister of Food is the sole buyer, these difficulties could be thrown back on the Éire farmer and thus greatly enhance the efficiency of the plan.

The second plan would be in effect economic war. The Minister of Shipping could withhold facilities for the insurance of ships going to Éire and this would mean that they would get no ships. No further action by any other Minister would add to the plan but it might be necessary to refuse convoy to shipments made by sympathisers in the United States.

The effect on Éire would be the same as described above in a more drastic form but the psychological effect would of course be much greater. The effect on us would be as follows. We should lose exports of some 24 million pounds a year but these exports are in the same currency and except for coal already mentioned, the short term economic effect on us would not be serious. The minister of Food would not be embarrassed. Éire might expropriate Guinness and the National Stud. For bacon, we have a contract of purchase which is terminable on two weeks notice on either side, we should not mind if Éire give notice. On our side it has been the practice to make import restrictions over-ride existing contracts.

(INTLD) KW 11 Downing Street, SW1

6 December 1940

CAB 66/14

Most Secret

WP (40) 493

30 December 1940

Payments to Eire

The attached minute by the Chancellor of the Exchequer is circulated to the War Cabinet by direction of Prime Minister. A note by the first Lord of the Admiralty is annexed as an appendix.

Signed: E E Bridges

Secretary

War Cabinet

Prime Minister, I have had a further discussion today with the Secretary of State for the Dominions, the Ministers of Shipping, Agriculture and Food, and the Parliamentary Secretary to the Department of Overseas Trade. We are agreed upon the following reports:-

1. When the word is given to take action the Board of Trade will exclude from the existing open general licence the following exports to Éire: food (including tea), feeding stuffs, fertilisers, agricultural and other machinery, spare parts of all kinds, iron and steel, non ferrous metal, chemical and electrical goods, paper and cardboard. These exports will thus be placed in the same category as exports to the other Dominions and will require separate licences. Such licences will then be withheld at the instance of the Departments severally concerned. No major decision of his Majesty's government need be announced. The separate departments will simply explain to the Irish Government, as the occasion arises, that their own supply position is such as to preclude exports of the commodities in question to Éire, and that, therefore, they are unable to grant the necessary export licences. The Ministry of Food may be under some obligation to allow the shipment to Éire of consignments which it has already brought to this country as agent of the Irish Government and which are technically the property of the Irish Government. The Ministry of Food is looking into this point. In any case, the Ministry of Food will not undertake further purchases as agent of the Irish Government.

2. The Ministry of Shipping which is already finding it difficult to meet the shipping requirements of Éire will continue to do so. It will find itself unable to fix ships for Éire without, for the moment, making any official announcement. But as soon as the word for action is given the Ministry of Shipping will inform the Irish Government that its own shipping difficulties are so great that it can no longer undertake to provide Eire with ships through its own Chartering Office. Accordingly it releases Éire from its undertaking to charter only through us and leaves the Irish free to charter in the open market. To make this effective the Ministry of Shipping will tell the Norwegians and the Greeks that they must not charter any of their free ships to Éire. The Norwegians are expected to accept this without difficulty. The Greeks may make some difficulties by the Ministry of Shipping can bring them to heel by the threat of refusing space and convoys for any ships except those coming to the United Kingdom. Since the Ministry of Shipping has still not been able to complete its charter negotiations with the Greeks and the Norwegians it would be convenient if the announcement of the ban on shipping for Eire was postponed until these negotiations are finished.

3. It is a corollary of the curtailment of exports to Éire that the controls of the Ministry of Supply must keep a careful watch on Exports to Northern Ireland and to guard against smuggling across the border.

4. No action can be taken in the sphere of exchange control without going beyond the ambit of the plans now envisaged. This

plan is based on our own shortage of supplies and is intended to be carried through by amicable approaches from the departments concerned to the Eire Government. If the Treasury placed a ban on dollars to Eire for such imports as would still be left to her under the plan, this could only be construed as an act of open hostility.

5. It is possible that the Americans may decide to send goods to Éire in their own ships if so this will need careful watching. If the Americans send munitions for our own use as well as food and if we are able to arrange transhipment from the Irish ports the net affect might be beneficial to us. But if they only send food for the use of the Irish we ought to try to persuade them to make the sending of food conditional upon the Irish opening their ports to us.

(INTLD) KW

27 December 1940

Listed as Appendix 4

Most Secret

27 December 1940

1. Prime Minister, in accordance with your request, I have had examined the question of putting pressure on Éire by the withdrawal of British shipping facilities. I apologise for its length but it was important to cover every possible contingency. On the third of December, Éire by express regulation banned all our warships from her six major ports and anchorages yet, nine-tenths of her imports and exports are carried in British controlled ships under protection of British war ships and at considerable sacrifice and inconvenience to ourselves.

2. Eire's Present Use of British Facilities

   (a) Almost all her transocean imports, amounting to one and a half million tons per annum, are carried in British controlled vessels sailing in our convoys.

   (b) Her imports from the United Kingdom, amounting to three and a half million tons per annum, are carried mostly in British owned coastal vessels.

   (c) Her export trade is mainly with the United Kingdom and carried in British coastal vessels.

3. The Disadvantages Resulting From the Grant of These Facilities

   (a) The equivalent of some 40 British controlled ships of eight thousand tons each have been exclusively engaged in carrying transocean cargoes to Éire with consequent loss to our own carrying capacity for essential supplies.

(b) A proportion of Éire's transocean trade and all her United Kingdom trade passes through the ports on our western seaboard adding materially to the heavy congestion in those ports.

4. Withdrawal of Facilities

There appears to be three possible courses.

(a) Merely to withdraw from Éire all British or British controlled vessls, putting them into our own service, subject perhaps to the special requirements of particular British trades such as the Welsh coal export trade. This could be effective without great difficulty and could be explained as a direct result of our own shipping losses. British-owned ships on Eire registry would be transferred to the British flag and employed to carry British cargoes.

(b) To go further and to exclude from our convoys any Eirean or neutral ship engaged in Éire trade, this might also perhaps be explained as a consequence of the shortage of convoy escorts which makes it essential for us to confine our protection to our own trade and that of our allies.

(c) To try openly to strangle Éire trade by re-inforcing the withdrawal of tonnage and convoy escort with the refusal of insurance facilities to any ships engaged in carrying cargo to and from Éire. The ship warrant system could also be used to dissuade neutrals from engaging in the service of Eire and rigourous contraband and export control could be applied to such seaborn trade as remained to Éire.

5. Policy

It seems important that Éire should not be given the opportunity of representing herself as persecuted and that our pressure on Éire should be made as pallatable as possible to the Irish element in the United States. I therefore suggest that, at any rate to begin with, we should confine our measures to (a) in my preceeding paragraph. Éire is already finding it difficult to satisfy her requirements owing to the shortage of free shipping and the withdrawal of almost all British controlled tonnage from her service would have the most serious effect on her economy. Éire would not only suffer the disorganisation consequent upon the loss of a large part of her tonnage but under present shipping conditions would find it almost impossible to obtain enough free ships to satisfy even her bare necessities. If, however, the adoption of course (a) proved insufficient, pressure would be further increased by proceeding to (b) and (c).

6. Éire's Reaction

It is quite possible that even if we only proceeded to course (a) Éire might refuse to accept our explanations and become actively hostile. She might even play with German fire but without going to that length. She might well as a reprisal seek to divert her exports elsewhere and send such shipping as she had available to Spain and to Portugal or even to France. Her ships sailing to and from the mainland or Europe would however be subject to contraband and enemy export control so that both ships and cargoes would be liable to seizure unless covered by a ships navicert. The ships navicert would not of course be

given unless the cargoes were innocent and the ships carried no mails so that at last Éire mails to Europe would be brought under examination.

7. Naval Patrols for Eire Trade

In practice, Éire would probably have difficulty in obtaining both new markets and new ships so that sailings from Éire would be few and it would probably not be worthwhile to maintain patrols of Éire's ports except when special intelligence had been received. Our existing dispositions for the interception of enemy trade should suffice to intercept all Eire trade except that to Spain and Portugal, the routes of which pass between the areas covered by the western patrol and by our submarine patrols in the Bay of Biscay. The latter patrols should however be able to prevent any trade with France through the Biscay ports.

8. The adoption of economic measures against Éire may react upon our chances of obtaining supplies from the United States in United States convoys escorted by United States war ships, since the State Department could more easily open a route through the combat zone to neutral Éire than to a belligerent port. I assume that we should not take any of the measures suggested without being reasonably sure of American goodwill and that in particular, we should be careful not to prejudice our chance of persuading the United States Government to send supplies to this country in United States convoys either directly or via Éire. I suggest that, if, United States convoys

are considered to be practical politics within the near future, it might be better to apply pressure to Éire by even slower stages than those suggested at paragraphs (4) and (5) above. Thus, if, to begin with only transocean tonnage were withdrawn, a serious deficiency in Éire tonnage created thereby might provide the State Department with the necessary excuse to open Éire ports to United States ships. Even if at first, United States ships were only permitted to carry supplies for Éire, this might lead to more favourable developments. If, on the other hand, no United States convoys at all were forthcoming, we could proceed to more drastic measures to achieve our other objectives. It seems reasonable to exclude the possibility that the United States would stultify our pressure on Éire by merely providing Éire with ships under the Éire flag.

9. Conclusion

Whether or not economic pressure leads to naval and air bases or induces in Éire a greater spirit of cooperation, we still stand to gain. In depriving Éire of shipping, we not only increase our own carrying capacity but relieve our Western Ports of the transhipment of Éire cargoes. Moreoever, less of our convoy effort would be wasteed on unproductive shipping, there is of course the danger that the anti-British elements in Éire might be driven to give greater underhand assistance to Germany. Such elements in the Government are, however, even more anxious to keep Éire out of the war than to hurt us and they are unlikely to risk giving any assistance to the enemy which might provoke us to infringe their neutrality.

(INTLD) AVA

War Cabinet

Committee on Economic Policy Towards Éire

Membership

CR Atlee Esq	Secretary of State for Dominion Affairs
Sir Kingsley Wood	Chancellor of the Exchequer
Hugh Dalton Esq	President of Board of Trade
Lord Leathers	Minister of War Transport
Sir Andrew Duncan	Minister of Supply
RS Hudson Esq	Minister of Agriculture & Fisheries

Also Present

Geoffrey Lloyd Esq Secretary for Petroleum	JE Stephenson Deputy under Secretary of State Dominions Office
and from 5/6/1942	Lord Selborne Minister of Economic Warfare
from 19/10/1942	Minister of Fuel & Power

Source: P.R.O.(UK), CAB 72/25

The War Cabinet's special Committee on Economic Policy towards Éire first met on 5 March 1942 in 11 Downing Street and continued to meet up until 6 June 1944 to give effect to and monitor the consequences of the economic sanctions being imposed. These sanctions, because of their harshness, meant in effect economic war and were deemed necessary to persuade Ireland to depart from her stated policy of neutrality. The official record of the deliberations of this committee are detailed in CAB 72/25 in the British Public Records Office; the summary given below has been based on these records.

This Committee met six times during 1942, twice in 1943 and finally in June 1944. The minutes and related memoranda, of which there are twenty six, clearly indicate the extent to which the British War Cabinet was committed to remind Ireland of its dependence on the United Kingdom for the supply of commodities, vital raw materials and fuels; as a consequence the sanctions imposed were designed to force Ireland into a position of abandoning neutrality.

Not only did this committee carefully monitor imports into Eire on a regular basis but it also approved of arrangements for the utilization of Éire's surplus industrial capacity when such arranagements were clearly to Britain's advantage.

A number of examples of this type of arrangement are cited. The first involved the import to Irish Dunlop of 38 tons of rubber weekly. The products from 26 tons of this imported raw material had to be re-exported to Britain and the company was allowed to retain the balance of 12 tons for home use.

A second example relates to the shipment of coal. Ireland was permitted only to import only such coal as was not required by Gt Britain. Even with this concession, the coal was of such inferior quality that some public utilities, i.e. Gt Southern Railways and the Dublin Gas Company were experiencing great difficulties in maintaining their operations. However, approval was given on 19.8.1942. to ship an additional 5,000 tons of coal per month for use at the Drogheda cement works on the understanding that Ireland exported 12,500 tons of cement per month to Nr Ireland; this cement was mainly required for aerodrome construction.

A third example was the offer of 30,000 tons of wheat, in monthly instalments, in exchange for approximately 1,000,000 barrels of beer; Ireland had stopped all exports of beer early in 1942. As the British Government was concerned at the effect of this on industrial output in Nr Ireland which had obtained 80% of its beer supplies from Ireland, it was decided to barter wheat for beer. Indeed to ensure continuance of these supplies, it was agreed to supply Guinness Ltd with 300 tons of slack coal weekly.

The Committee was totally aware of the harshness of the economic sanctions being imposed particularly the effects of the drastic reductions in supplies of basic fuels. Nevertheless, the Committee decided that there should be 'no modification in the present policy notwithstanding that this might have a serious effect on public service utilities'.

Other commotities and goods were equally effected and imports were generally well below normal trade as indicated by the figures given below in respect of two such commodities.

(a) Metric Tons of Tea Imported in

1935/37	1942	1943	1944 (9 months)
10,389*	3,785	2,355	2,157

*average annual figure

(b) Tonnage of Oil Products Imported

	1938	1941	1942	1943
Motor spirit	133,000	66,500	42,700	32,025
Kerosene	65,000	39,000	36,000	27,300
Gas & Fuel Oils	53,000	31,800	26,800	20,100
TOTAL	251,000	137,000	105,900	79,425

The monitoring of all exports to Ireland was carried out with extreme thoroughness. It is difficult to justify the measures taken to support the sanctions being imposed against a neutral country; however, the British took the view that it was essential to British interests

> to open the eyes of the Irish people to their true situation. Since the outbreak of war they have been living in a world of illusion, they thought that their goodwill was essential to Gt Britain, and that she could not afford to let them go short, much less to quarrel with them. ... They were confident that, if they became short of any commodity, the British Navy would convoy fresh supplies safely into their harbours. They need themselves do nothing. As a neutral, they would enjoy the protection which neutrality gives. As a member of the British Commonwealth, they could claim the special advantages which such membership confers; and they could do so without any unpleasant feeling of gratitude to the hated Englishman. ... It was a very happy situation, and they saw no reason why it should not continue indefinitely.
>
> It can at any rate be claimed of the new policy that it has brought that frame of mind to an end. The bubble of Irish complacency has effectively and we may hope finally

> been pricked. The Southern Irish now know that England is not dependent on them and that on the contrary, it is Ireland that is dependent on England..... Today Southern Ireland is very uncomfortable, and she is going to become progressively more uncomfortable. But for this she is not able to blame us. The blame rests, first on Germany and secondly on herself. It is a direct result of her policy of neutrality.[1]

During the lifetime of the committee, an appraisal of the minutes and the related memoranda clearly indicates how dedicated the British Government was in its intentions to wage economic war on Ireland to a successful conclusion, i.e. the abandonment of neutrality. Of particular interest in this regard are the memoranda which quantify precisely the level of all imports into Eire sanctioned by the War Cabinet[2]

REFERENCES

1. Extracts from memorandum dated 19.3.1941 drawn up by Lord Cranborne summarising the effects of the economic sanctions on Ireland,P.R.O.(UK), CAB 66/15.

2. The memoranda are referenced EPE (42) 20, dated 6 November 1942 and EPE (43) 3, dated 1 March 1943, P.R.O.(UK): CAB 72/25).

Manufacture of Chemicals at the Parkgate Plant for the Match-making Industry

As already indicated in the main text, Sir Alexander Maguire and members of the Bureau had discussed the possibility of setting up an organisation for manufacturing the chemicals required for the match industry; this discussion resulted in a Conference being held in the Department of Industry and Commerce on the 6 March 1945, to discuss the commercial development of a plant to produce these chemicals. The conference was chaired by the Secretary of the Department of Industry and Commerce and attended by Prof J J Dowling, Prof M A Hogan, Dr T S Wheeler and Dr J J Lennon, representing the ESRB; the Department of Defence was represented by Mr J B Carr, Major J O Flanagan and Comdt V de Valera while Mr J A Cassidy and Mr C Fitzpatrick attended on behalf of the Department of Industry & Commerce.

The Secretary of the Department of Industry and Commerce advised those present that while 'it would appear to be a natural development for Maguire and Paterson to undertake the manufacture of chemicals for the match industry on their own account'[1] the Minister was not disposed to encourage the establishment of such industries by private enterprise because of their monopoly basis; he would prefer to have any industry established operating under Government control.

The Secretary stated further that Sir Alexander Maguire had recently indicated to the Minister that he would be prepared to put

up half the necessary capital of £20,000-£25,000 to acquire the premises and plant at Parkgate as a going concern. While those present thought that a figure of £40,000-£50,000 for the plant appeared exhorbitant, it was noted that, while the value of the physical assets of the plant was worth not more than about £10,000, a very large sum had been spent on research work connected with the development of manufacturing processes for the chemicals. It was noted also that, while the plant was originally designed to last for one year, it would probably give three years' service subject to annual renewal of some items, such as furnaces and cells, pending the acquisition of more modern plant. As regards the use of the Parkgate premises, Comdt de Valera indicated that the Secretary of the Department of Defence had intimated that he would have no objection to such a proposal until suitable alternative arrangements could be made.

In discussion the constitution of the proposed company, the Secretary advised that 'it would be essential to have the control [of the company] in the hands of the Government nominees'[2] the proposal to have three Government nominees as directors on the board and two nominees of Maguire & Paterson would, he stated, go a good distance towards satisfying the Minister's aims. However, he cautioned that any intention of Maguire & Paterson to produce other chemicals, in addition to those required for the match industry, 'would not meet with the Minister's approval'[3].

The Secretary advised those present in confidence that, 'for some time past the Minister had been giving consideration to the feasibility of establishing a company to undertake the full range of chemicals';[4] presumably this referred to chemicals then being

imported. The formation of such a company would of course require a special statute; the Minister intended to merge the Alcohol Co into this general company which could cover the production of chemicals for the match-making industry in addition 'to the manufacture of an unlimited range of materials of a chemical and allied nature'[5] The Secretary invited those present to consider this proposition as an alternative to a Government Company allied to Maguire & Paterson, for the production of chemicals for the matchmaking industry alone.

There was general acclaim for this alternative proposition which, by virtue of employment of a larger number of technical staff, could cater for the efficient production of a wide range of chemicals; this would include those chemicals where the demand would be relatively small, e.g. chemicals for the match-making industry. It was noted that, if the proposal was accepted by the Government, it would take some time to have the necessary legislation drawn up and passed by the Dail. However, in the meantime those present were satisfied that the production of chemicals for the match-making industry could be supplied from the Parkgate Plant under the existing arrangements with the Department of Defence.

It should perhaps be pointed out that, up to this time, private firms had made little or no progress in any branch of basic chemical production. The firm Albright & Wilson Ltd had, with the Minister's approval, made a beginning in 1936 with the establishment of an industry at Dun Laoghaire aimed at the eventual production of a range of chemicals. However, up to the beginning of

World War II, this firm had made little progress in the direction of manufacture; it was engaged mainly in carrying out certain grinding and allied processes and the packing of products for distribution. At the same time several other firms had been engaged in the preparation and semi-manufacture of certain chemical products; however, their activities were not regarded as constituting the basic manufacture of chemicals.

The chemical plants at Parkgate were originally designed to meet defence requirements during the Emergency; as the war in Europe drew to a close, the plants were operated from the beginning of 1945, almost exclusively for the benefit of the match industry. Up to November 1945, Messrs Maguire & Paterson Ltd had been supplied with:

(a) Potassium chlorate - 129,920 lbs (58 tons) which was required at a rate of 2 tons per week;

(b) Phosphorus sesquisulphide - 3,618 lbs with a projected delivery of 500 lbs per week;

(c) Amorphous (red) phosphorus - 420 lbs with a projected production rate of 60-80 lbs per week.

While in the initial stages of production, Messrs Maguire & Paterson were prepared to pay two or three times the current British prices for the same chemicals, the price charged was such that, in a letter to the Taoiseach on the 4 April 1946, Sir Alexander Maguire stated that 'it was a great shock to us to find that instead of 2 or 3 times (the British price), the increase is £45,000 which of course we cannot face'[6] The actual costs which are compared below dramatically re-inforced this statement made by Sir Alexander Maguire.

Table : Comparison of prices for chemicals required for matchmaking charged by the Parkgate Plant and by a UK supplier

Chemical	Total used up to 31.12.45.	Average Price (UK) per lb.	Total Cost	Irish Price per lb.	Total Cost
Red Phosphorus	2,924	2/5d	£353	£3.10.1	£10,242
Phosphorus Sesquisulphide	11,606	1/9d	£1,015	£1. 9.6	£17,118
Potassium Chlorate	119,776	10/8d	£5,404	4/1d	£24,454
Total Cost:			£6,772		£52,814

The extra cost being £45,042

On the 8 April 1946, Sir Alexander Maguire wrote to the Taoiseach in connection with his firm's account with the Department of Defence in respect of chemicals supplied which had been the subject of a directors' meeting held that same day. He informed the Taoiseach that they had come to the conclusion that:

> in the interests of the efficient conduct of our business ..... on a commercial basis, it will not be possible for us to purchase the three chemicals in question at such a great disadvantage compared with the prices charged by general manufacturing concerns [and] to advise you [the Taoiseach], with great regret, that we cannot take any further deliveries of these chemicals from the Department of Defence at the present prices ... should a chemical organisation be set up ..... to produce these chemicals at reasonably competitive prices, we shall be only too glad to consider the question of purchasing from that source.[7]

Subsequently, Messrs Maguire & Paterson Ltd forwarded a cheque for £28,338.7.1. to the Department of Defence in final settlement of the account for chemicals supplied up to and including 1 April 1946.

Following the firm's refusal to accept delivery of a ton of potassium chlorate on the 9 April 1946, all further deliveries were suspended. The Minister for Defence, Oscar Traynor, subsequently wrote to the Taoiseach on the 18 April 1946 about

the plants at Parkgate. In his letter, he indicated that, while he had ascertained from the Department of Industry & Commerce that negotiations had opened for the acquisition of a site for a new chemical factory at Arklow, there was no information available to suggest that the plants at Parkgate were going to be taken over by the Irish Alcohol Factories Ltd; as a consequence he asked the Taoiseach for 'an early intimation as to the future operation of the Parkgate plants'[8]

Subsequently on the 24 April 1946, Lieut Gen P McMahon wrote to the Secretary of the Department of Industry & Commerce advising him that Messrs Maguire & Paterson had 'definitely decided not to purchase any further supplies of the chemicals' from the Department of Defence. Because of this

> arrangements have been made for the cessation of production at the Parkgate plants and the termination of the employment of the civilian and military personnel hitherto engaged in connection with the manufacture of the chemicals[9]

He went on to add that the equipment and stock of materials held would be sold off as soon as possible thereafter. A short stay of execution of this decision was made pending the outcome of discussions on the possible taking over of the plants by Irish Alcohol Factories Ltd. However, when it was decided that the Parkgate plants should not be taken over, the plants were closed down; by the beginning of July 1946, arrangements were made for the immediate termination of the services of the staff concerned and the disposal of the equipment and materials held.

REFERENCES

1. Memorandum sent on 22.3.1945 to Dept of Taoiseach, S13588A, D.T., N.A.

2. Ibid, memorandum

3. Ibid, memorandum

4. Ibid, memorandum

5. Ibid, memorandum

6. Letter dated 4.4.1946 from Sir Alexander Maguire to Taoiseach, S13588A, D.T., N.A.

7. Letter dated 8.4.1946 from Sir Alexander Maguire to Taoiseach.

8. Letter dated 18.4.1946 from Minister for Defence to Taoiseach, S13588A, D.T., N.A.

9. Letter dated 24.4.1946, referenced 2/90691 from Lieut Gen P McMahon to Secretary of Dept of Industry & Commerce, S13588A, D.T.,N.A.

APPENDIX 5

Centrifugal Gas Specific Gravity Meter

By JOHN J. DOWLING, M.A., F.Inst.P., University College, Dublin

[*MS. first received 12th February 1945 and in final form 17th May 1945*]

ABSTRACT. When a tube containing a gas is rotated about one end a measurable pressure difference, depending upon the length of the tube, the rate of rotation and the density of the gas, is set up between its ends. The instrument utilizes this principle to compare the densities of gases.

In the course of an investigation into the carbonization of peat, the need arose for a rapid method of determining the specific gravity of fuel gas; for, as is well known, this serves as an indirect indication as to the constitution of a gas mixture. The problem is not new and various devices are already in use for the purpose(1). This work had, however, to be carried out under rather unfavourable conditions (the plant was actually situated in a peat bog), and it did not seem likely that any delicate form of apparatus, even the displacement balance of Hales and Moss(2), would be suitable. The alternative now to be described was tried and proved successful. It is a dynamic method and appeared more suitable to the working conditions than other dynamic methods described by Blackie and Williams(3) or Searle(4).

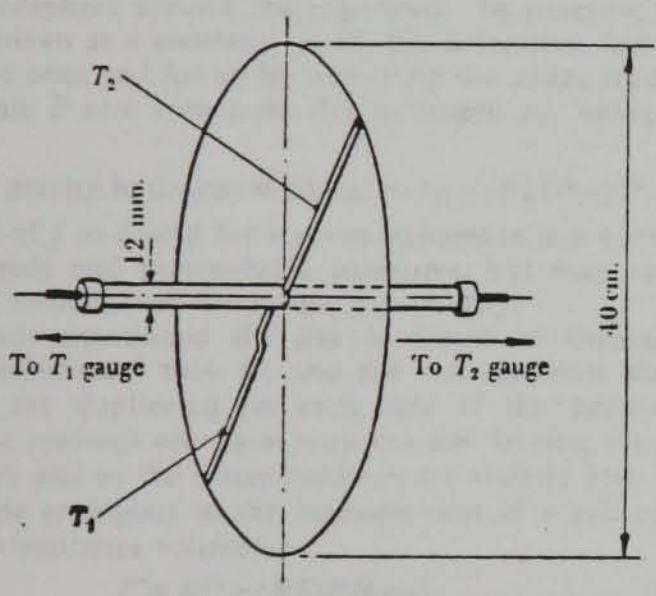

Fig. 1. Principle of centrifugal gas specific gravity meter. (Bearings, etc., are omitted)

The underlying principle is simple. If a tube filled with gas is revolved about one end, a pressure difference, approximately equal to $\frac{1}{2}\omega^2 l^2 \rho$, is developed between the ends of the tube, where l = length of tube, $\omega = 2\pi$ (frequency of rotation) and ρ = mean density of gas. With reasonable values of l and ω, the pressure difference amounts to several centimetres of water and can be accurately measured on a sloping tube gauge filled with an oil of low density, vapour pressure and viscosity.

The apparatus is shown diagrammatically in Figs. 1 and 2. There are two rotating tubes T_1, T_2 in this model, connected each to its own separate oil gauge, etc. If one tube T_1 is supplied with dry air and the other with the gas, the specific gravity of the gas can be immediately determined by the simple formula

$$\text{specific gravity} = \frac{p - fP}{P - fP} \qquad (1)$$

where p and P are the pressure-gauge readings for the gas and for dry air; and f is an instrumental factor, which will be explained later.

The two tubes T_1, T_2 are of copper, each about 3 mm. bore and 20 cm. long, and are sweated into the shaft. They are supported by a wooden disk, which is attached to a brass pulley P (Fig. 2) fastened to the hollow shaft. The bearings of this shaft are not shown. Each end of the shaft is furnished with a brass screw-cap R. A large hypodermic needle H_1 (no. 16, about 2 mm. bore), which enters R through an

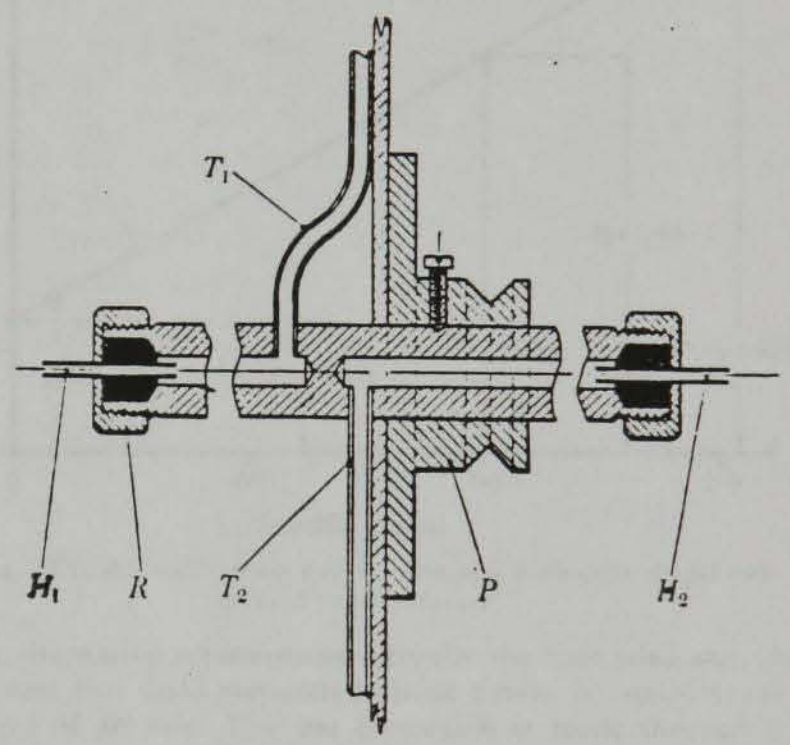

Fig. 2. Details of rotating part of apparatus

accurately centred hole, passes through a greased cork (shown in black) which is under slight compression; the needle H_2 is similarly arranged. For the small pressures concerned this gives a perfectly leak-proof gland while permitting speeds of 25 rev. sec. As shown diagrammatically in Fig. 3, the gas is drawn in from the source AB through a drying tube D, a two-way tap E and a 50 cm. length of 1 mm. bore capillary C. A T-piece G provides a connexion to the oil gauge and the flow proceeds *via* the hypodermic needle H_1 (or H_2) to the rotor R. It will of course be obvious that the rotating tube itself produces the necessary suction.

With gases which are denser than air a sort of streaming effect occurs with the result that the tube T_1 (or T_2) does not become completely filled with pure gas. To prevent this a plug

Journal of Scientific Instruments, Vol. 22,
August 1945, pp.145-146.

of solder is applied to the outer extremity of the tube and a tiny hole bored therein. The exact size of this hole is not critical and it is best found by trial (it is of the order of 1 mm.). The gauge reads too low both for holes which are too large and too small.

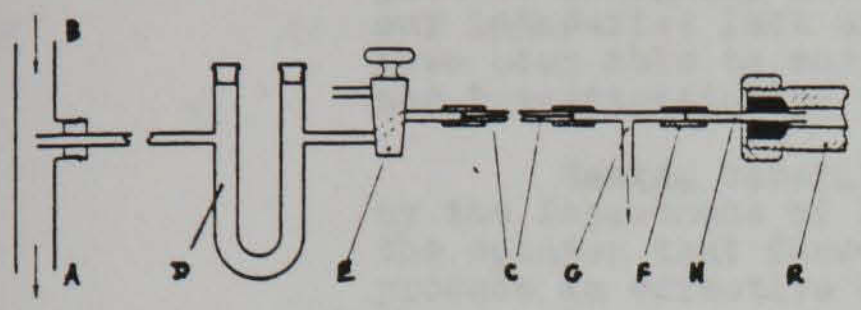

Fig. 3. Method of supplying gas to be tested

The specific gravity of the gas is not given by the *ratio* of the pressures p and P, but a factor f has to be introduced as indicated in equation (1). The reason is that the peripheral open end of the rotating tube is not in free air, but is within a sort of air vortex where the pressure is less than that of the static atmosphere. The pressure defect observed is therefore augmented for both air and gas by an amount depending on ω^2, on the dimensions, etc., and on the density of the atmosphere around the apparatus. In practice, with the disk driven at a constant speed, the correction factor is determined once and for all by observing the gauge readings with dry air P and with pure dry hydrogen p_H, using the equation

$$\text{specific gravity hydrogen} = 0{\cdot}0695 = (p_H - fP)/(P - fP). \quad (2)$$

The value of f so found for a given apparatus is a constant for all speeds and atmospheric pressures, but may vary a very small amount with atmospheric humidity.

As already mentioned the gas is drawn in through a capillary 'resistance' tube C, and the arrangements shown in Fig. 3 are duplicated on each side of the apparatus. Usually the readings are taken with the gas flowing through the capillary and so the gauge readings are slightly low. The case is quite analogous to the measurement of a cell e.m.f. with a low-resistance voltmeter

$$V' = RC = (RE)/(R + r), \quad (3)$$

where E is the centrifugal pressure head; R and r the resistances of the capillary and rotator respectively, and V' the measured pressure. This effect does not vary significantly with the nature of the gas, and the reduced pressure readings may still be used in calculating the specific gravity. A capillary offering greater resistance may possibly be desirable with gases of unusually low viscosity.

Attention must be called here to a point of vital importance. Care must be taken that the pressure at the point where the gas is drawn into the system is almost exactly atmospheric. As shown in Fig. 3 this is done by having the inlet situated near the open end A of a comparatively wide tube BA through which the gas being sampled is allowed to bleed away to the atmosphere.

In any case a perfectly correct result can be obtained if the tap E be closed while the reading is being taken.

Fig. 4 shows a typical calibration curve, the pressures being in centimetres of oil along a sloping (1:5) gauge tube using oil of density 0·64 g. c.c. The rotator tubes were 20 cm. long and 3 mm. bore, and revolved at 1500 r.p.m. These readings are consistent to one or two parts per thousand provided the speed is constant during the observation.

With one or more of these gauges, each drawing its supply through suitable absorbing agents, it is possible rapidly to analyse a gas mixture by an obvious method of differences. The author has confined his observations in this direction to carbon dioxide content and found it worked quite well.

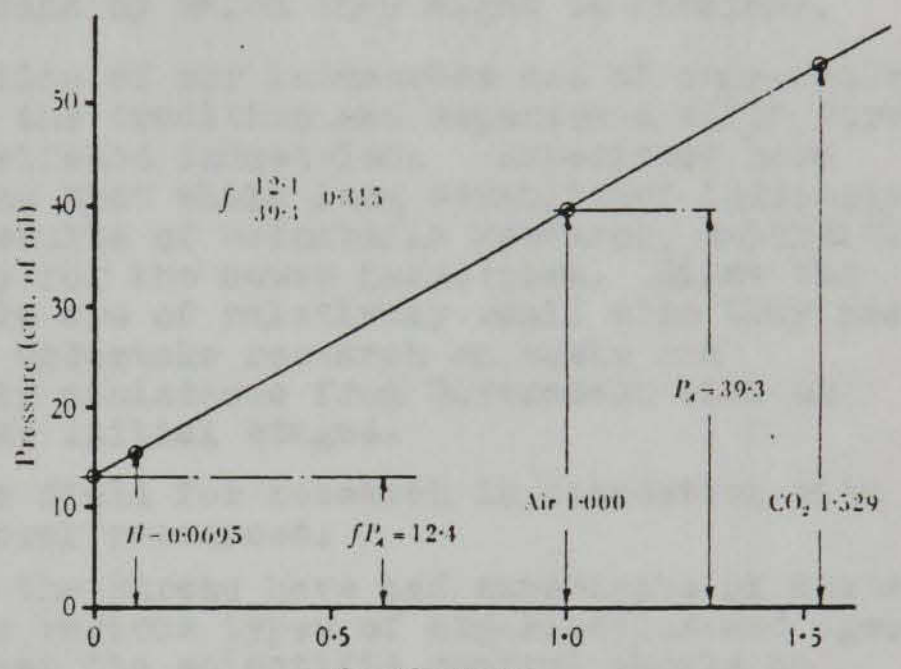

Fig. 4. Typical calibration curve, obtained with centrifugal gas specific gravity meter

An alternative arrangement, actually the first tried out, is to mount two disks (separated about 2 mm. by spacers) on the end of an axle. The gas connexion is made through a gland at the centre. In this form the apparatus lends itself to operation where there is danger of clogging by dust or spray in narrow tubes, since the 'disk resistance' is so low that a quite wide 'resistance tube' may be employed.

This work was carried out in conjunction with the Emergency Scientific Research Bureau and publication has been sanctioned by the government of Eire.

REFERENCES

(1) Barr and Pearson. *J. Sci. Instr.* **22**, p. 3 (1945).
(2) Hales and Moss. *J. Sci. Instr.* **12**, p. 309 (1935).
(3) Blackie and Williams. *J. Sci. Instr.* **6**, p. 157 (1929).
(4) Searle. *Proc. Phys. Soc.* **53**, p. 681 (1941); **54**, p. 278 (1942).

APPENDIX 6

EMERGENCY SCIENTIFIC RESEARCH BUREAU.

Memorandum on proposed National Institute for Industrial Research.

Their experience of the past year in the application of scientific investigation to industrial problems in Eire has convinced the members of the Emergency Scientific Research Bureau of the need for a satisfactory permanent organisation for the promotion of scientific and industrial research. The present emergency has emphasised the extent to which many of our industries lack sciantific guidance; in some instances we have been able to assist them by bringing scientific knowledge and investigation to their aid.

Having carefully considered the draft scheme prepared by the Department of Industry and Commerce the Bureau is of the opinion that fundamental changes are required therein to produce an effective organisation. The following general observations are submitted on the objects of the proposed organisation and the means by which they might be attained.

A large proportion of our industries are of comparatively recent growth and lack the tradition and experience which serve to guide the long established industries. Experience here and elsewhere, has shown that while long established industries can benefit from the results of scientific research, scientific guidance is a necessity for the newer industries. Since the industrial units in Eire are of relatively small size they are unlikely to be able to undertake research on their own initiative, consequently assistance from Government will be required at least in the initial stages.

There is a wide field for research in connection with the utilisation of natural resources.

The members of the Bureau have had experience of State-provided research under various types of organisation and agree that it is essential that the scientific control should be entrusted to a small body of scientific and technical men. The members of this body (which will henceforth be called the Committee) should be selected for their personal ability and not as representatives or delegates for particular interests. For this reason they should be appointed by the State and not elected by outside bodies. In order to secure continuity of policy the members of the Committee should retire on a rota system. It is suggested that the Committee should consist of a permanent Director of Research and five other members working on a five year rota for retirement. As a rule retiring members should not be eligible for immediate re-appointment, though provision should be made for re-appointment in special cases.

It is felt that great care will be needed in working out the relations between the Committee and the Minister or Cabinet Committee to whom it is to be responsible. Experience has shown that scientific research cannot be effectively carried out under the administration of one of the ordinary Departments of State because the departmental organisation and procedure which may be excellent for the purpose for which they were designed are unsuited for dealing with the organisation of research.

To put the matter in brief, once the State has chosen a small number of highly qualified scientists and technicians and given them a sum of money to spend on research they should be trusted to see that the work is properly done. Above all matters should be arranged so that the details of scientific schemes should not be subject to criticism by persons lacking scientific competence.

The higher authority would of course require to be satisfied that the lines of investigation being pursued were not at variance with public policy and that suitable precautions were taken in the spending of public money; apart from this, the work should be left to the Committee.

The size of committee proposed is so small that the six members are unlikely to be able to do justice to all the branches of science in which investigation may be required. This difficulty might be overcome in some instances by the appointment of sub-committees but we think it may be desirable to retain the services of up to ten other persons as Advisors to the Committee. These Advisors will be experts in subjects not covered by the members of the Committee and would be invited to attend meetings and assist generally in matters within their field.

To maintain effective liaison with Government Departments it is proposed that each Department should nominate an Assessor. This Assessor would be a senior scientific or tehnical officer, who would receive the Committee papers and attend when matters of interest to his Department were to be discussed. The Assessor would be the normal channel of communication between the Committee and the Department and would supply information required for the work of the Committee.

The Director of research should be a scientist of high academic standing with experience in the application of science to industry. The success of the scheme will depend to a large extent on the energy, ability, and tact of the director and it is essential that he should be able to appreciate and deal sympathetically with industrial problems. In our view this post is of great national importance and should, we suggest, carry a salary of the order of £2,000 per annum. The appointment should be made by the State presumably through the machinery of the Appointments Commission. We suggest that the Director should be Chairman of the Committee and, as such, should have a casting vote.

The Committee's terms of reference should not exclude the carrying out of 'pure' scientific research as distinct from industrial research. Experience has shown that many of the most important industrial developments have resulted from investigations begun without any idea of possible industrial applications. It is also true to say that there can be no healthy development of applied science except in association with a live school of research into the fundamental problems of pure science. For these reasons, the Committee should have powers to assist investigators of ability to carry out original investigations in pure science. This work might be carried out at the Universities, in the research institute, or elsewhere. In appropriate cases financial assistance might be made available to Colleges or other bodies to aid approved researches.

Some of the work may be carried out in the University laboratories, and some in the works of the industries concerned. However, the main work of the Committee will be in the nature of industrial research, and for this special premises will be required to allow of experiments on a semi-commercial scale. The Committee

should be empowered to carry out work for individual firms on a re-payment basis where the subject to be investigated was not of general interest. As time goes on it may be found possible to induce groups of manufacturers to combine and establish a research organisation, provision should be made to enable this work to be assisted by the State. As the main object is to bring science into industry the Committee will endeavour to increase the number of scientifically trained workers in industry and should be enabled to demonstrate the value of such assistance by lending trained workers to individual firms for an educational period.

In all its activities the Committee should take care not to undertake work which is adequately handled by native consultants.

At the present time there is a lack of trained workers for industrial research and an important duty of the Committee will be to encourage young graduates in science to undergo a training in research. To make this action effective, it is essential that there should be (a) students grants of about £100 a year to enable a student to undergo two years post graduate training (b) senior research grants of about £400 a year to enable scientists who have had some industrial experience to carry out independent research (c) travelling fellowships to enable persons of outstanding ability to spend not less than two years in research in industry abroad. The cost of such a fellowship need not exceed £700 a year.

It is to be emphasised that the grants under (b) and (c) would only be made in cases where candidates of exceptional promise were forthcoming. From our experience we are convinced that the money spent would be a good investment.

When working under peacetime conditions the Committee will probably meet fortnightly, and when account is taken of sub-committees and conferences, it will be seen that heavy demands will be made on the Members time. We suggest that the Members should be paid at the rate of £300 per annum. The Advisors will have less onerous duties, and for them we suggest a retaining fee of £50 per annum. Acceptance of this fee should not prevent an Advisor from carrying out a specific research under the Committee.

The Committee should present to the Government an Annual Report on its activities. This report should be published without delay.

The Bureau feels that a body on the lines of the Grand Council proposed in the draft scheme should fulfil a useful purpose by furnishing a platform for the discussion of the work of the institute. The number of Councillors need not be limited but should be sufficiently large to allow of as wide representation as possible of both scientific and industrial interests. The Council would have one function only, to discuss and submit to the Government comments on the Annual Report of the Committee after it has been submitted to the Government. This discussion should take place at an Annual Meeting lasting two days if necessary and the Director should be allowed to reply to the points raised. It would be proper for the Council to suggest subjects of research for consideration by the Committee.

In any future research organisation it is essential that the library, information, and translation service begun by the Industrial Research Council should be continued and developed.

The general policy should be to encourage the prompt publication of the results of the investigations the only restrictions being where confidential trade information is

involved, or in the case of patentable discoveries. A generous policy should be adopted with regard to discoveries made by persons working under the Committee.

The Bureau does not feel called upon to examine the financial provisions in the draft scheme in much detail but would remark that the proposed grant of £22,500 for the institute and its equipment is very small even in terms of pre-war costs. They think, however, that the development might best be made gradually, making use of existing premises in the first instance and acquiring plant and equipment as called for by the researches.

It will be seen from the foregoing that the Bureau envisages an organisation which will have for its field the whole range of pure and applied science. Such an organisation must play its part in matters concerning National Standards. In this connection care must be taken to distinguish between the three separate functions which a Standards Institute should fulfil:

1. The establishment, Maintenance, and checking of the fundamental legal standards which are the basis of ordinary commercial measurements.

2. The preparation of standard specifications of quality or performance for natural materials or manufactured articles of commerce.

3. The checking of materials and commodities to see if they conform to the standard specifications.

The first of these functions might well be carried out in a laboratory under the Committee. The second, requires the co-operation of manufacturers and users, but the Director of research might well undertake the organisation of this work, acting as convener of the committees drafting the specifications.

The Bureau is reluctant to suggest that the proposed research organisation should permanently undertake any work under the third heading. Such work would be of routine nature such as the chemical testing at present carried out for the Government Services by the State Laboratory. It is realised however that the facilities disposed of by outside laboratories in Eire are limited and consequently it may be necessary to allow of a certain amount of routine testing (which other laboratories are not able to carry out) being done in the Committee's laboratories.

Signed (John J. Dowling CHAIRMAN
(J. J. Drumm.
(M.A. Hogan.
(J.H.J. Poole.
(T.S. Wheeler.

J. J. Lennon.
SECRETARY
1st April 1942.

FORM B.

SUBMISSION TO THE GOVERNMENT

A copy of this Form signed and completed so far as may be relevant should accompany each submission to the Government.

Department of Industry and Commerce Dept. Ref. Number T.I.D.1906/93.

Subject Proposed Industrial Research Bill, 1945.

---

1. (a) State whether specific or general sanction of Minister for Finance has been obtained.
   (b) If such sanction has not been obtained state whether Minister for Finance has been notified of submission of proposals to Government and been furnished with a copy of accompanying memo.

   (a) General sanction has been obtained
   (b) Yes. Labhras le Seán Ó Muireadhaigh Roinn Airgeadais. Níl aon nó ag an Roinn aon i gcoinnibh an measraim seo do chur timpeall. 1/10/45.

2. Indicate (a) what other Departments are concerned and (b) whether their agreement has been secured.

   (a) All Departments.
   (b) Yes.

3. If action by the Government is required under the Constitution or Statute, indicate the relevant Article or Statute and the Section and Sub-section.

   --

4. In the case of Orders, etc., state whether it is necessary or desirable that the Order or other Instrument when made should be
   (a) Presented to either or both Houses of the Oireachtas.

   (a) --

Seo leat M. F. 1/10
L. Runaí, I gceart. An ceart glacadh leis led thoil don chéad chruinniú oiriúnach eile?
Dón 1/10/45.

[OVER

APPENDIX 7

364

(b) Gazetted in Iris Oifigiuil and
(c) If so, by whom and pursuant to what, if any, statutory requirements.

(b) --
(c) --

5. If the answer to 4 (a) is "necessary" state

(a) period for which Order should be laid before either or both Houses of Oireachtas.

(b) whether days of session or sitting days.

(c) whether a motion or resolution of approval by either or both Houses is necessary. If so, the statutory requirement should be cited.

(a) --
(b) --
(c) --

6. Indicate any other statutory requirement which must be attended to by the Department of the Taoiseach in order to implement the decision if the proposals are approved.

The proposals are submitted for decision and for authority to have a Bill drafted accordingly.

Signed: [signature]

Date: 29/9/'45.

(876) U.10712. Wt.5651. D.4833. 1,000. 4-43—F.P.—G.28.
(1118) A8497. Wt4282. D5147D.F. 1,000. 1-44—F.P.—G28.

S.36

Department of Industry and Commerce.

MEMORANDUM FOR THE GOVERNMENT.

Proposed establishment of an
Irish Institute for Industrial Research and Standards.

1. The Minister for Industry and Commerce has had under consideration the position of Industrial Research in this country. In his view, the importance of research and standardisation for industry calls for the establishment of a body with more facilities and greater freedom of action than are possessed by existing research organisations, such as the Industrial Research Council and the Building Research Committee. The experience during the emergency of the Emergency Scientific Research Bureau has strengthened and confirmed this view.

2. The Minister accordingly recommends that a corporate body, to be known as the Irish Institute for Industrial Research and Standards, should be established by an Act of the Oireachtas, for the purposes of undertaking, carrying out, encouraging and fostering researches and investigations for the development of the national economy; of assisting such researches and investigations; and of promoting standardisation of industrial products. The nature and scope of such activities are set out in detail in paragraph 10 of the attached Scheme.

3. The Minister proposes that the Institute should supersede the Industrial Research Council and the Building Research Committee (the Emergency Scientific Research Bureau ceased at the end of March, 1945). The proposed Institute would be so constituted as to preserve the advantages of all of these bodies and to include certain other features found in research institutes in other countries and considered desirable in the circumstances of this country. The Minister considers that the work of the Institute should be directly related to industrial development. He accordingly proposes that the Institute should be responsible to the Minister for Industry and Commerce.

4. The Minister proposes that the Institute should consist of

(i) a Council,

(ii) a Committee,

(iii) a Director.

5. The Minister proposes that the Council should be an advisory body, limited in number to fifty. The composition, the method of appointment, the tenure of office, and the functions of the proposed Council are set out in paragraphs 6 and 17 of the attached Scheme. The first Council would include as many of the members of the existing Industrial Research Council as might be willing to act, and such other persons as might be regarded as eligible. No remuneration would be payable to members of the Council as such, but travelling expenses of members would be reimbursed. The function of the Council would be to assist the Committee in the general direction of the Institute, by offering criticism and advice on research programmes and their results, and by making observations on the Committee's draft annual report. The Council would meet at least once a year; its meetings would be in public, and might ultimately take the form of a scientific convention which, by providing an occasion for the reading of special papers, etc., would help to arouse interest in the work of the Institute.

6. The Minister proposes that the Committee for Industrial Research should be the body charged with the general government of the Institute and the administration of the affairs thereof, subject to the reservations to the Director. The constitution, method of appointment and tenure of office of the Committee are set out in paragraph 7 of the attached Scheme. The Minister proposes that the Committee should have power to appoint sub-committees, and that the Building Research Committee should be a permanent sub-committee of the Institute (paragraph 7 (10) of Scheme). The Minister proposes that the Committee for Industrial Research shoul have power to make regulations to govern its procedure and operations, such regulations to be subject to the consent of the Minister for Industry and Commerce (paragraph 7 (11) of Scheme).

7. The Minister proposes that there should be a Director of Industrial Research, to be appointed by the Minister for Industry and Commerce, and to hold office at such remuneration and on such conditions and for such term as the Minister for Industry and Commerce in consultation with the Minister for Finance may determine (paragraph 8 of Scheme). The view of the Department of Finance "that provision should be made for the concurrence of the Minister for Finance in the remuneration and conditions of service of the Director" is not accepted by the Minister, who feels that the provision for consultation with the Minister for Finance is sufficient.

The Minister considers that the Director should have a status independent of the Committee in all matters relating to the conduct of research, including the appointment of subsidiary staff, the functions of the Committee being the determination of the subjects of research activity and the control of expenditure. The Director would have the right to attend and speak (but not to vote) at all meetings of the Committee. The Committee would have power to recommend the removal of the Director, and the Minister for Industry and Commerce would have power to remove him for reasons stated.

8. The Minister proposes that such staff as may be necessary for the carrying out of the work of the Institute should be appointed by the Director; and that every person so appointed should be paid by the Committee such remuneration, and should hold office on such conditions as the Director may determine (paragraph 9 (1) and (2)).

The following observations have been made by the Department of Finance: "The numbers, grades and remuneration of the permanent staff, and of staff proposed to be employed for a period of 12 months or longer, should be subject to the approval of the Minister for Industry and Commerce given with the concurrence of the Minister for Finance (see e.g. Sections 17, 18 and 20 (4) of the Institute for Advanced Studies Act, 1940)".

The Minister is not prepared to agree that the staffing arrangements of the proposed Institute should be subject to detailed control either by the Minister for Industry and Commerce or by the Minister for Finance. In the light of the experience gained in the functioning of the Industrial Research Council on the one hand, and of the Emergency Scientific Research Bureau on the other, the Minister considers it desirable that the proposed Institute should be allowed as great a measure of freedom as possible in its establishment generally, and particularly in the recruitment of its technical personnel.

A.

9. The Minister proposes that provision for a superannuation scheme should be made as in paragraph 9 (3) of the attached Heads. The proposed scheme is on the lines of that embodied in the Institute for Advanced Studies Act, 1940. The Minister for Finance "is disposed to the view that a pensions scheme should not be introduced until some years experience of the working of the Institute have been gained. He feels that the creation of vested interests would be highly undesirable until it is reasonably established that the proposed Institute will meet the requirements of industrial research". The Minister, however, feels that these considerations are outweighed by the desirability of making provision at the outset for a superannuation scheme so as to attract the services of highly-qualified personnel for the permanent whole time posts in the Institute.

10. The Minister proposes that there should be made available out of moneys provided by the Oireachtas, funds for the purposes of the Institute in the form of

(a) a Grant of such amount as the Minister with the concurrence of the Minister for Finance may consider necessary towards defraying the capital cost of the provision and equipping of a building to house the Institute (paragraph 12 of Scheme);

(b) an Annual Grant-in-Aid in respect of the administrative expenses of the Institute, such grant to be expended solely at the discretion of the Committee (paragraph 13 of Scheme);

(c) other Grants of such amounts as the Minister with the concurrence of the Minister for Finance may consider necessary towards defraying the costs of special investigations (paragraph 14 of Scheme).

The Minister proposes that the Annual Grant-in-Aid should be of fixed minimum amount, and he contemplates a minimum of £15,000. The Minister for Finance "is unable to agree that the administrative charges of the Institute should be defrayed by way of Grant-in-Aid. It is in his view obvious that it would not be possible until considerable experience has been gained of the work of the Institute to estimate with any reasonable degree of precision what the cost of administration will be". The Minister for Finance "is prepared to agree to a grant of £15,000 for the first year and to an increase later if he is satisfied that the moneys made available are usefully applied for national development". Generally, the Minister for Finance "sees objection to giving the Committee unfettered discretion in the matter of fees and salaries." The Minister is not prepared to accept these views. He holds that the provision of the proposed Annual Grant-in-Aid is an essential measure of that financial autonomy which he regards as necessary for the proper working of the proposed Institute.

11. The Minister proposes that the Committee should have power to accept gifts of money, lands or other property (paragraph 15) and to charge and receive fees (paragraph 16) in connection with the work of the Institute. The Minister proposes that accounts of all moneys received and expended by the Committee should be kept in approved form, and submitted annually for audit by the Comptroller and Auditer-General (paragraph 18). The Minister proposes that such accounts, and also an Annual Report of the work of the Institute, should be duly presented to the Minister, and copies laid before each House of the Oireachtas (paragraphs 17 and 18). The Minister proposes that as regards results of researches carried out by the Institute, the furnishing of information to the Minister by the Institute, and the publication of information by the Institute, provision should be made as in paragraphs 19, 20 and 21 respectively, of the attached Scheme.

12. The Minister for Industry and Commerce accordingly seeks the authority of the Government to have legislation drafted on the lines of the Scheme submitted herewith.

29th SEPTEMBER, 1945.

Draft Heads of proposed

INDUSTRIAL RESEARCH BILL, 1945.

1. Short Title.
2. Definitions.
3. Establishment of Institute.
4. Constitution of Institute.
5. Common Seal of Institute.
6. The Council.
7. The Committee.
8. The Director.
9. Staff.
10. Researches, investigations and standardisation.
11. Standard specifications.
12. Capital Grant.
13. Annual Grant-in-Aid.
14. Other Grants.
15. Donations.
16. Fees.
17. Annual Report.
18. Accounts.
19. Discoveries and inventions.
20. Information to Minister.
21. Publication of information.

INSTITUTE FOR INDUSTRIAL RESEARCH AND STANDARDS

DIRECTOR:- MR. D.T. FLOOD, M.Sc., F.R.I.C.

COMMITTEE FOR INDUSTRIAL RESEARCH

1. Professor T.S. Wheeler, D.Sc., Ph.D., F.R.C.Sc.I.
   Professor of Chemistry U.C.D.
   Emergency Scientific Research Bureau.

2. Professor J.J. Dowling, M.A., F. Inst. Phys.
   Professor of Technical Physics U.C.D.
   Emergency Scientific Research Bureau.
   Industrial Research Council.

3. Professor M.S. Hogan, B.E., D. Sc., Ph.D., D.I.C.
   Professor of Mechanical Engineering U.C.D.
   Emergency Scientific Research Bureau.
   Building Research Committee.

4. Professor F.E.W. Hackett, M.A., M.Sc., Ph.D.
   Professor of Physics and Electrical Engineering U.C.D.
   Industrial Research Council.

5. Mr. E.T.S. Walton, Ph.D., F.T.C.D.
   Lecturer in Experimental Physics Dublin University.
   Building Research Committee.

6. Mr. L.J. Kettle, D.Sc., M.Inst. C.E.I., M.I.Mech.E., M.I.E.E.
   Chairman, Industrial Research Council.

7. Mr. P.J. Beddy, Secretary, Industrial Credit Company.

8. J.P. Twohig, President, Woollen Manufacturers' Association.

9. Mr. T.J. Monaghan, B.Sc., M.I.E.E.
   Department of Posts and Telegraphs.
   Industrial Research Council.

COMMITTEE ON STANDARDS

1. Professor Dowling. (named above)
2. Professor Hackett. Do.
3. Professor Wheeler Do.
4. Professor Smiddy; Formerly of Central Purchasing Section, Dept. of Local Government & Public Health.
5. J. Ingram: Department of Industry & Commerce
6. N. O'Dwyer, B.E., Consulting Engineer, Building Research Committee.
7. A. Woods: Director, Bórd na Móna, and Mianraí, Teo.

ÉIRE.

AN BILLE TAIGHDE AGUS CAIGHDEAN TIONSCAIL, 1946.
INDUSTRIAL RESEARCH AND STANDARDS BILL, 1946.

EXPLANATORY MEMORANDUM.

1. The Bill is intended to provide for—

(1) the promotion of industrial research, and

(2) the standardisation of industrial commodities, processes an practices.

For these purposes, provision is made in the Bill for the establishment and maintenance of an Institute for Industrial Research and Standards. The proposed Institute will be a body corporate with perpetual succession and the Institute's functions are detailed in Section 5. The Institute will be able to undertake and encourage scientific research to promote the use of natural resources ; to deal with technical processes and practices and to carry out tests on commodities intended for sale. The constituent parts of the Institute will be—

(i) the Council of the Institute,

(ii) the Industrial Research Committee,

(iii) the Standards Committee, and

(iv) the Director of Industrial Research and Standards,

whose separate functions are explained hereafter.

The Institute will supersede the existing Industrial Research Council (the Emergency Scientific Research Bureau ceased at the end of March, 1945).

2. *The Council* will consist of the members of the Industrial Research Committee and the members of the Standards Committee who shall be ex-officio members of the Council, and, in addition thereto, not more than 50 other members, each of whom shall be appointed for his special attainments. To the first Council shall be appointed as many members of the Industrial Research Council as are willing and able to act. The first Council shall be appointed by the Government and succeeding Councils quinquennially by the Minister.

3. *The Industrial Research Committee.*—This Committee will consist of nine members, each of whom shall be appointed for his special scientific attainments applied to industry, or because he is capable of giving substantial practical assistance in the work of the Institute. The Committee shall be appointed triennially by the Minister. The Committee will act in the name and on behalf of the Institute on all matters except as otherwise expressly provided in the Act, and the acts of the Committee shall be the acts of the Institute.

4. *The Standards Committee.*—This Committee will consist of seven members of whom three shall be members of the Industrial Research Committee. The seven members will be appointed by the Minister. The functions of the Standards Committee are set out in detail in Section 20 of the Act, and the acts of the Committee in exercise of the powers conferred by this Section shall be the acts of the Institute.

5. *The Director of Industrial Research and Standards.*—This officer will be appointed by the Minister for Industry and Commerce and his remuneration and other conditions of service shall be such as the Minister, after consultation with the Minister for Finance, shall determine when appointing him. The Director may be removed by the Minister on the Minister's initiative or on the recommendation of the Industrial Research Committee for stated reasons. The functions of the Director shall be to direct and supervise—

(*a*) the conduct of research decided upon by the Industrial Research Committee, and

(*b*) subject to the directions of the Standards Committee, the formulation of specifications in accordance with Section 20 of the Act,

but subject thereto he may, independently of the Industrial Research Committee, conduct such researches as he thinks proper on behalf of the Institute. The Director may attend and speak at all meetings of the Council, the Industrial Research Committee and the Standards Committee, but he shall not have the right to vote at any such meetings. The Director will have power to appoint Advisory Committees to consult with and advise him in relation to any of his functions, subject, in the case of functions with which the Industrial Research Committee or the Standards Committee is concerned, to the prior consent of the Committee concerned.

6. Section 18 of the Bill specifies the nature of researches to be carried out by the Institute. Discoveries or inventions resulting from researches undertaken by the Institute shall be the property of the Minister, save a discovery or invention of the type mentioned in subsection 2 of this section.

7. Provision for *Standardisation* is made in Part VIII of the Bill. Under Section 20 a specification would be prepared by the Institute at the request of the Minister for Industry and Commerce, who may then by order declare such specification to be a standard specification. Provision is made in Section 22 whereby the Minister may by order prescribe a Mark (e.g. " Irish Standard " or " I.S.") for use in connection with a specified commodity, process or practice, to indicate that it conforms to a particular standard specification. The prescribing of standards for commodities, etc., for which another Minister is otherwise empowered to prescribe standards, would be subject to the consent of the Minister concerned (Section 20 (4) and 22 (6)). Provision is made for the keeping by the Minister for Industry and Commerce of registers of standard specifications and standard marks (Section 23), for the registration of standard marks abroad (Section 24), for restriction on the registration of standard marks (Sections 25 to 27 inclusive), for the grant of licences for the use of standard marks (Section 22, subsections 5 to 8), for protection against misrepresentation (Section 21) and for the prosecution of offences in relation to standard marks and standard specifications (Section 28).

8. *Administration of the Institute.*—It is proposed that there be made available out of moneys provided by the Oireachtas :—

(*a*) Grants of such amounts as the Minister, with the concurrence of the Minister for Finance, might sanction towards defraying the whole or any part of the capital cost of land, buildings and equipment for the Institute (Section 30).

(*b*) An annual grant of £15,000 towards the expenses of the administration of the Institute (Section 34 (1)).

(*c*) Grants of such amounts as the Minister, with the concurrence of the Minister for Finance, might sanction for defraying the whole or any part of the costs of special investigations undertaken by the Institute, including the cost of any special equipment (Section 34 (2)).

9. *Staff.*—Under Section 31 the Institute will have power to employ such staff as is necessary for the performance of its functions. The members of the staff will be appointed and removed by the Director, with the approval of the Industrial Research Committee which by Section 37 is charged with the administration of the financial affairs of the Institute. The numbers, grades, remuneration, tenure of office and conditions of service of the staff of the Institute will be determined by the Director with the approval of the Minister, given after consultation with the Minister for Finance. Approval would not, however, be required in respect of persons proposed to be employed for a period of less than twelve months. Section 32 is intended to provide for a superannuation scheme for the staff of the Institute.

10. *Scholarships, fees, donations, etc.*—Section 33 (1) will allow the Institute, subject to the approval of the Minister, to provide scholarships and other awards for the training of persons in industrial research. Under Section 33 (2) the Institute will have power to render such assistance, financial or otherwise, as it thinks proper to persons undertaking research of a kind which the

Institute is itself authorised to undertake. Section 35 empowers the Institute to charge, receive and recover fees for researches, tests, or investigations undertaken by the Institute on behalf of any person, other than the Minister. Section 36 would allow the Institute to accept gifts of money, land or other property.

11. *Accounts and annual report.*—Under Section 37 the financial affairs of the Institute will be administered by the Industrial Research Committee, which will have the duty of keeping accounts in approved form, and of submitting such accounts for audit by the Comptroller and Auditor-General, to be duly laid before each House of the Oireachtas. Under Section 38 an annual report of the work of the Institute will be prepared by the Industrial Research Committee and duly laid before each House of the Oireachtas.

12. *Information to Minister.*—Section 39 provides that the Industrial Research Committee and the Standards Committee must submit to the Minister such information regarding their activities as the Minister may from time to time require. Each of these Committees may, with the approval of the Minister, publish scientific information in the name of the Institute.

13. *Legal proceedings.*—Section 40 is designed to protect the Institute, its members and staff against legal proceedings.

14. The first and second schedules to the Bill make provision for the appointment, resignation and removal of members of the Council and of the two Committees, their terms of office, the filling of vacancies, and procedure. Provision is also made for the appointment of sub-committees.

ROINN TIONNSCAIL AGUS TRÁCHTÁLA,
Meitheamh, 1946.

Wt. 18—981. 550. 6/46. C.&Co. (4170).

National Science Council : Summary of Activities

The work which was undertaken by the National Science Council may be classified into three broad categories:

(a) The Preparation and Commissioning of Studies Aimed at Developing a National Science Policy

Under this category work was undertaken to determine priority areas for R and D which might be expected to lead to profitable innovation of products and processes in existing industry and in potential future science-based industry in Ireland. This work led to the preparation of several valuable overall studies and subsequently to a more detailed analysis of two main sectors, engineering and metals and fine chemicals.

Other work undertaken in this category was:

- the examination of the long-term plans of An Foras Taluntais (The Agricultural Institute) and the Institute for Industrial Research and Standards (IIRS), and the preparation of substantiated analyses and critiques of these plans;
- the preparation of studies on scientific and technical information;[1]
- the preparation and commissioning of reports among which were the development of the national resources of scientific and technological manpower;
- the publication of a significant initial report on marine resource development;
- the preparation and continual updating of statistical data on national R and D activities.

Finally, the National Science Council prepared a provocative report for the Minister for Finance under the title Science Policy Formulation and Resource Allocation proposing the establishment of a statutory body with *inter alia* resource allocation reponsibilities as the successor body to NSC itself.[2]

(b) Participation in the Preparation of Two State-sponsored Schemes to encourage the development and use of new and improved technology by industry

These two schemes were:

(i) a scheme of Industrial R and D Grants administered by the Industrial Development Authority (IDA);

(ii) a scheme for Scientific and Technological Awards administered by the Department of Industry and Commerce.

The first scheme is worthy of special mention because it represented a first attempt on the part of the IDA and the NSC to evolve new policy instruments in the field of science and technology; the scheme was designed to encourage the development of existing and new technologies by Irish industry and to assist firms to undertake projects which would contribute to the viability and competitiveness of their manufacturing operations.

(c) Resource Allocating Responsibilities

The National Science Council had responsibility also for the administration of a modest but highly significant scheme of grants to universities and to the other third level establishments, set up

since 1969, for assisting research and development activities.[3] Other funds at the disposal of the NSC enabled the promotion of university/industry cooperation in science and technology, which was a logical development of the university research grants scheme. Projects (and the funds provided for these projects) under the EEC-administered European Cooperation in Science and Technology Programme (COST) were monitored by the NSC. Participation by various Irish bodies (Government departments, research institutes and other organisations) in this COST programme and the related interaction with the European Economic Community and other participant countries was organised by the NSC.[4]

In conclusion, the National Science Council acted as a general forum for the discussion of problems relating to science and technology at the national level, and was involved in interaction with the EEC in the science and technology field at a general policy level as well as with other European bodies, e.g. UNESCO. It also participated or interacted with other Irish bodies in the activities of various committees appointed by the EEC to deal with topics in this field.

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2. OECD, Reviews of National Science Policy - Ireland (Paris,1974), 68-69.

3. National Science Council Progress Report, 1969-1971, (Dublin,1972),28.

   The National Science Council established also the Science Policy Research Centre at University College Dublin in 1969, under the directorship of Professor Patrick Lynch, as part of the College's Department of Political Economy. The centre provided facilities, in conjunction with other departments, for postgraduate studies in the economics of education and science.

   The centre worked in close collaboration with the National Board for Science and Technology (in the formation of science policy). In addition the Centre undertakes specific research projects mainly on the economic aspects of research and development.

   Funds in support of research studies undertaken in the Centre were provided by the National Board for Science and Technology as well as the Industrial Development Authority and the Department for Economic Planning and Development. The programme of the Centre is directed on an honorary basis by the academic staff who supervise the studies of the fellows engaged on the commissioned research projects. A major study prepared by the Centre concerns the effectiveness of resource allocation to Irish universities in support of research and development.

   The Centre monitors development in science policy in other countries and has established close links with corresponding units in the Universities of Sussex and Manchester and with the Bulbenkian Foundation in Lisbon. The Centre has briefed delegates to OECD meetings and members of the Centre have participated in the Irish Government's Bilateral Aid Programme.

4. OECD, Reviews of National Science and Policy - Ireland, (Paris,1974),58-70.

NATIONAL BOARD FOR SCIENCE & TECHNOLOGY

In discharging the range of responsibilities assigned to it, the Board had available three statutory instruments:-

(a) A Statement to Government

This device enabled the Board to give its observations and recommendations to the Government on the requirements and proposals of institutions in receipt of monies from the State for science and technology. These recommendations were contained in a Statement which was prepared by the Board in parallel with the annual estimates procedures for public expenditure. The Statement was not published, but in accordance with the statutory requirements, it was presented to Government by the Taoiseach, following consultation with the Minister for Finance. The Board's first Statement, based on the 1980 estimates, was submitted to the Government in September 1979.

(b) A Science Budget

The Science Budget contained details of the financial allocations finally agreed in respect of Government support for science and technology for the year, together with the Board's commentary on national policy for science and technology. The Science Budget prepared by the Board, was presented each year to both Houses of the Oireachtas by the Taoiseach. It was therefore a published record of final decisions on the estimates for science and technology along with the Board's analysis and comments on relevant policy issues. The first Science Budget was published in 1980. In

this Budget, the Board estimated that the total expenditure by Government departments and agencies in science and technology in 1980 would amount to £M170. Some £M58 was allocated to education and training, £M14 to scientific and technical information and documentation, £M14 to scientific and technical information and documentation, £M14 to specific technology transfer programmes and incentives, £M43 to scientific and technical services with £M11 to other activities.

(c) National Programme for Science and Technology

A draft document titled The National Programme from Science and Technology - A framework for Science and Technology Planning in the period 1984-88 was prepared in June 1983. It was intended to use this device to help align investment in science and technology with national needs as well as identifying areas where greater effort was required. It was hoped to include comparisons of private and public investment, thus aiding the balanced development of the national scientific and technical infrastructure. It was intended also to include details of longer term programme plans, priorities and funding requirements. This draft was in two volumes and received limited circulation to interested parties for consideration and comment. It was anticipated that a final version would b e prepared following receipt of comments and reactions. The final version of the document was never issued.

All of the above statutory devices were obviously interdependent elements of a process which culminates in the publication each year of the Science Budget and its presentation to the Oireachtas.

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3. Newspapers and journals.
4. Published contemporary memoirs and documents.
5. Works of reference.
6. Specialist studies on science and technology.

Secondary Sources

7. Relevant general historical studies.

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1. PUBLIC AND PRIVATE ARCHIVES AND MANUSCRIPTS.

Eolas

The records of the Emergency Scientific Research Bureau were deposited with the IIRS in 1948. These records have not been preserved in their entirety but the available archives provide a comprehensive and authoritative picture of the work of the Bureau.

(i) Minutes of Meetings of Emergency Scientific Research Bureau

Volume 1: 21 February 1941 - 15 April 1942.

Volume 2: 22 April 1942 - 22 September 1943.

Volume 3: 29 September 1943- 28 March 1945.

The above volumes contain over one thousand pages of text and give summaries of discussions, recommendations and progress of activities.

(ii) Index for ESRB Minutes and a general index in three parts.

The general index consisted of a Names and Numerical Index, a Subject Index A-J, and a Subject Index K-Z.

(iii) Other documents

These include files on Clare phosphate and its industrial utilization, Portacloy clay and silica, activated charcoal, the manufacture of phosphorous and arrangements with Irish Alcohol Company for use of premises, facilities and staff at the Cooley factory.

In addition there is a copy of the initial draft report on the activities of the Bureau, Emergency Scientific Research Bureau, Report on Activities, 1941-45, together with a copy of the final printed version published under the same title by the Stationery Office in 1948.

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