DECISION AND REASONS FOR DECISION [2000] AATA 888

ADMINISTRATIVE APPEALS TRIBUNAL)
) No N1998/1702
GENERAL ADMINISTRATIVE DIVISION)

Re "FERMENTER"

Applicant

Re "DISTILLER"

Applicant

And INDUSTRY RESEARCH AND DEVELOPMENT BOARD

Respondent

DECISION

Tribunal Mr B.J. McMahon (Deputy President)
Date 10 October 2000
Place Sydney
Decision The decision under review is set aside and the matter is remitted to the respondent with the direction that the applicants are entitled to a favourable certificate under s. 39L of the *Industry Research and Development Act* 1986 in respect of all the activities outlined in exhibit F, except for activity K.

....
BJ McMahon
Deputy President

CATCHWORDS

INDUSTRY RESEARCH AND DEVELOPMENT – manufacture of ethanol from wheat starch waste by fermentation and distillation - whether systematic investigative or experimental activities – whether innovation – whether carried on for purpose of acquiring new knowledge or creating new or improved materials, products, devices, processes or services – activities carried out in accordance with a plan or organised method – evidence of innovation and technical risks - purpose to create a new or improved process or method – new process used in relation to a novel feed stock.

Income Tax Assessment Act 1936 – s 73B
Industry Research and Development Act 1986 – ss 39L, 39S, 39T
Industry Research and Development Board v Coal and Allied Operations Pty Ltd 2000 ATC 4477

Industry Research and Development Board v Unisys Information Services Australia Pty Ltd 97 ATC 4848
Re Charles IFE Pty Ltd and Industry Research and Development Board 95 ATC 2149
Re Confidential and Industry Research and Development Board 97 ATC 193
Re Confidential and Industry Research and Development Board 99 ATC 2237
Re Mobil Oil Australia Ltd and Industry Research and Development Board 95 ATC 2042
Re Philip Morris Ltd and Industry Research and Development Board 98 ATC 2001
Re The Applicant and Industry Research and Development Board 2000 ATC 173
The Applicant and Industry Research and Development Board 99 ATC 179

REASONS FOR DECISION

10 October 2000 Mr B.J. McMahon (Deputy President)

1. This is an application brought pursuant to section 39T of the *Industry Research and Development Act* 1986 (the Act) to review a decision made under section 39L which was confirmed on review pursuant to subsection 39S(4). Subsection 39T(4) provides that the hearing of a proceeding relating to a reviewable decision must take place in private. Following my past practice in this Tribunal, I have cast these reasons in such a way as to preserve the confidential identity of the applicants. So that these reasons may be identified subsequently, I have decided to change the way of describing the applicant so that any interested researcher may more easily distinguish these reasons from those in other cases where the applicant is simply described as *"confidential"* or *"the applicant"*. I have conferred *noms de lis* on the applicants. I will refer to them collectively as the group. I see no objection to referring to other witnesses not immediately connected with the group by their correct names.

2. The first applicant was concerned in a project for the development of the manufacture of ethanol from wheat starch waste by fermentation. The second applicant was involved in a similar development using distillation. I was informed that because of State licensing requirements relating to the distillation of alcohol, development of the fermentation process was kept separately from development of the distillation process. Both applicants, however, have a common ownership and are part of a larger group of companies. The use of the fermentation and distillation processes was an integrated use. For the purpose of these proceedings, both projects have been treated as one. I will refer to the applicants collectively as the group.

3. The applicants applied for a favourable certificate under section 39L of the *Industry Research and Development Act* 1986. The matter was referred to the respondent's delegate, The Tax Concession Committee, which made a decision on 6 November 1996 in the following terms:

> *"1. The activities listed above as research and development involved in the 'Development of Ethanol by products from Wheat Starch Fermentation project' that were undertaken in the 1991-1994 financial years comply with part (a) of the definition of R&D activities under S73B(1) of the Income Tax Assessment Act 1936 with the exception of:*
>
> > *a. Activities involved in the optimisation and stabilisation of the continuous fermentation process and;*

b. Activities associated with the development of a design for a commercial scale Plant;

The reason for recommendation 1(a) and (b) is that these activities seem to be more of a quality control and commercial nature rather than research and development and thus do not seem to involve innovation or technical risk.

2. The activities listed above as research and development involved in the 'Development of Ethanol by products from Wheat Starch Distillation project' that were undertaken in the 1991-1994 financial years comply with part (a) of the definition of R&D activities as defined under S73B(1) of the Income Tax Assessment Act 1936 with the exception of:

a. Activities involved in the optimisation and stabilisation of the distillation process and:

b. Activities associated with the development of a design for a commercial scale distillation plant;

The reason for recommendation 2(a) and (b) is that these activities had not been completed in the financial years 1991-1994 and thus do not form part of this assessment."

4. The Australian Taxation Office sought clarification of this decision which came in the form of a letter dated 23 December 1997 stating that:

"The activities involved in the optimisation and stabilisation of both fermentation and distillation processes are considered to have commenced on 1 June 1993."

5. The applicants had sought a certificate for the period concluding 30 June 1994 and commencing 1 July 1990, in the case of the first applicant, and 1 July 1991 in the case of the second applicant. No explanation was offered for the suggested cut-off date of 1 June 1993 in the clarification letter. Nothing in the evidence indicated a logical reason for the choice of this date.

6. Accordingly, when the matter first came to this Tribunal, the issue was whether the applicant companies had ceased on 1 June 1993 what were otherwise approved as research and development activities. By the time the matter came on for hearing, the issue had broadened. It was then the respondent's case that, from the expert reports obtained during the period prior to the hearing, the Board was then of the opinion that the applicants had at no time complied with the statutory test for research and development activities. It was therefore the respondent's submission to this Tribunal that it should set aside the respondent's own decision. The applicants, on the other hand, claimed to be entitled to a favourable certificate for the whole of the period originally requested.

7. There is an interrelationship between the Act and section 73B(1) of the *Income Tax Assessment Act* which defines research and development activities. That section has been amended from time to time. For the relevant period it defined research and development activities as follows:

"(a) systematic, investigative or experimental activities that –

(i) are carried on in Australia or in an external Territory;

(ii) involve innovation or technical risk; and

(iii) are carried on for the purpose:

(A) of acquiring new knowledge (whether or not that knowledge will have a specific practical application); or

(B) creating new or improved materials, products, devices, processes

or services; or

(b) other activities that:

(i) are carried on in Australia or in an external Territory; and

(ii) are carried on for a purpose directly related to the carrying on of activities of the kind referred to in paragraph (a);"

8. Activities which meet the definition of subparagraph (a) of the definition are referred to as core activities, whilst those that qualify under subparagraph (b) are often referred to as supporting activities. It is useful at this stage to analyse the terms of the definition. The use of the word *"or"* in the opening line of subparagraph (a) indicates the activities may qualify if they are systematic or if they are investigative or if they are experimental. The section does not impose the burden of showing that eligible activities have all three qualities. It was submitted by the applicant, however, that in fact its activities could be so described.

9. A literal reading of the section, however, leads to the view that if activities are either systematic or investigative or experimental and either involve innovation or involve technical risk and are carried on for an appropriate purpose, then the party carrying out those activities is entitled to its certificate. In the present case, the purpose alleged was the purpose of creating new or improved processes. It is clearly not necessary to comply with the terms of the definition, to have a purpose of acquiring new knowledge or to have a purpose of acquiring new or improved materials, products, devices or services if there is a purpose of creating new or improved processes.

10. The definition of supporting activities requires that they be carried on for a purpose that is directly related not to the object of the core activities, but to the carrying on of those activities. Thus, there must be a direct and close connection between the two types of activities.

11. The words *"systematic"*, *"investigative"* and *"experimental"* are to be given their ordinary meaning. In *Charles IFE Pty Ltd v Industry Research and Development Board* 95 ATC 2149 at paragraph 26 the ordinary meanings applied by the Tribunal obtained from the New Shorter Oxford Dictionary were as follows:

"Systematic	-	*arranged or conducted according to a system, plan or organised method.*
Investigative	-	*characterised by or inclined to investigation.*
Experimental	-	*based on, or derived from, or making use of experiment.*
Experiment	-	*an action or procedure undertaken to make a discovery, test a hypothesis or demonstrate a known fact."*

12. These and related terms have also been the subject of considerable attention by this Tribunal in previous cases that have come before it and on appeal by the Federal Court of Australia. The principal cases are as follows:

- *Re Mobil Oil Australia Ltd and Industry Research and Development Board* 95 ATC 2042
- *Re Charles IFE Pty Ltd and Industry Research and Development Board* 95 ATC 2149
- *Re Philip Morris Ltd and Industry Research and Development Board* 98 ATC 2001
- *Re Confidential and Industry Research and Development Board* 97 ATC 193 *which was the subject of the appeal next referred to*
- *Industry Research and Development Board v Unisys Information Services Australia Pty Ltd* 97 ATC 4848
- *Re Confidential and Industry Research and Development Board* 99 ATC 2237 *("the Bank*

case")

- *The Applicant and Industry Research and Development Board* 99 ATC 179*, which was the subject of the appeal next referred to*
- *Industry Research and Development Board v Coal and Allied Operations Pty Limited* 2000 ATC 4477
- *Re The Applicant and Industry Research and Development Board* 2000 ATC 173 *("the Budplan case")."*

13. Some of the principles which have emerged from some of these cases have particular application in the present circumstances. In the Bank case at paragraph 21, I pointed out that it was not a requirement of the section that the product of the research be income-producing or that the research be carried out by a taxpayer conducting an income-producing business. In that case, the software, which was the subject of considerable research and development activity, could not be sold as originally planned. It follows, in my mind, that there is no inhibition in the section against the sale of products which are the subject of research and development. The mere fact that such products are sold does not detract from the character of the activities as research and development activities. Whether the outcome of research and development activities is profitably exploited is irrelevant. Activities may be properly described as research and development activities whether their result is commercially fruitless or gainful. In the present case, the respondent made much of the fact that the ethanol produced by the applicants during the period in question was marketed commercially. From the point of view of characterising the activities which led to the manufacture of ethanol, it seems to me that this has no bearing. It may have some significance in considering the applicant's purpose. This, however, is a matter which I will deal with when discussing the question of purpose.

14. Another principle to emerge from these cases which has relevance here was discussed by the Federal Court in *Unisys* at 4855. Their Honours said:

> *"It is clear that, provided the condition of innovation or technical risk is not de minimis, the conditions will be satisfied by the presence of innovation or technical risk of whatever degree and not necessarily of any particular degree. One activity may be considerably more innovative and possessed of risk than another, but each may satisfy the conditions of the statutory language."*

15. The third decision to which I would refer at this stage is the judgement of Lindgren J in the *Coal and Allied* case. His Honour made clear that the subject of consideration under the statute was *"activities"* and not a *"project"*. I indicated otherwise at page 18 of my Reasons for Decision in that matter at first instance. What I said in paragraph 41 must therefore now be taken to be incorrect. However, whilst it is necessary to particularise and examine each of the constituent activities, it is necessary in order to understand the import of those activities, to deal with the background in which they were carried out.

16. The group, of which the applicants are members, operates a factory which processes wheat flour to produce starch and gluten. The starch is used in the paper and food industries, while the gluten is sold to the bakery industry as an additive. It provides increased volume, texture and nutrition in yeast-raised breads. Gluten is also widely used in animal and agriculture feeds.

17. The flour which the group receives comes from various mills and, accordingly, varies in its qualities. This variation is one of the factors that causes unpredictability in the waste stream. After the flour is unloaded, it is mixed with town water to make dough. Water is continually added until the gluten in the flour forms an off-white rubbery type compound. At this stage in the process, the starch remains in a white liquid form. The starch and gluten are then separated by screening. The gluten is subsequently dried, packaged and sold for use in bread or as a protein substitute.

18. At this stage of the process, the starch contains unwanted pieces of fibre which are then screened off. The starch is separated into varying grades based on particle size. The best grade is then sold either in wet or dry form to the glucose plant nearby, where it is converted into glucose for use in confectionery, brewer's syrup for beer manufacture and soft drink sweeteners. The lower grades of the starch, together with the unwanted and unpredictable fibre gums, gluten particles and soluble protein make up the waste stream which was previously disposed of as useless.

19. The operation of the starch/gluten factory resulted in a yield of approximately 67.5% starch and 15.2% gluten from the flour being processed. Due to technical limitations, the remaining 17.3% of solids could not be commercially recovered. The waste can be appreciated if one considers that three tonnes of water were used to process one tonne of flour. The solids and solubles which were not recovered and a large volume of water made up the waste stream from the starch factory.

20. This waste stream is exceedingly variable for a number of reasons. There are variations in the source and quality of the wheat flour. There are equipment operating problems from time to time in the plant and variations by various operators. There are also varying demands for different quantities and types of products from the starch gluten plant. Variations in the waste stream constitute an important feature of the feed stock used by the applicant eventually to manufacture ethanol.

21. Prior to 1985, this waste stream was simply discharged into the Shoalhaven River under licence. Since that time, environmental policy has precluded this practice. When it was stopped, the waste stream was then disposed by way of spray irrigation on to adjacent farm land. There were a number of disadvantages associated with this process, however. Spray irrigation does not recover the solids from the waste stream and therefore is itself a wasteful process. It is not possible to spray irrigate during wet periods, during which it must be stored in dams. Large quantities of solids in the waste stream are not always absorbed and form a crust on the surface. The waste stream has an unpleasant odour. For all these reasons, it was decided to abandon the practice of spray irrigation.

22. The group could have turned to full evaporation or could have used an anaerobic digestion system to convert solids to fertiliser. It considered and rejected both these courses. It finally decided to attempt the process of converting the fermentable solids to ethanol.

23. This decision was taken after small scale laboratory experiments were carried out into the ethanol option. When these proved encouraging, the applicants then sought to acquire a plant so that it could experience any production difficulties that might become apparent at the pilot stage before scaling up to full production. The use of the term *"pilot plant"* was the subject of some controversy in the hearing.

24. It was the applicants' case that the pilot plant had to be of sufficient size to

handle the continuously flowing, high-volume waste stream and to provide the applicants with sufficient confidence that the processes developed could ultimately work on a commercial scale. The applicants secured a second-hand still in Italy which had previously been used for the manufacture of ethanol from molasses. It had a notional capacity of 50,000 litres per day. The goal was not only to convert the highly variable wheat starch waste stream to ethanol, it was also to convert it using a continuous fermentation and distillation system. It is possible to use a batch system of fermentation where each batch is changed after the respective fermentation process has taken place. It is obviously more conducive to a better process to have a continuous combined system of fermentation and distillation. This combination of the two necessary ingredients was another distinguishing feature of the applicants' activities.

25. The conversion of starch to ethanol is not a new process. So far as the applicants were aware, however, no other company had developed a process for converting a highly variable waste wheat starch feed stock to ethanol using continuous fermentation and distillation. There were other starch gluten plants around the world, but none of them used an identical feed stock to the risky feed stock intended to be used by the applicant. There was one plant in the United States which used such a feed stock but only when blended with a major proportion of corn. The reason for this blending will appear later when the problem of foaming is discussed.

26. In 1988, the group purchased an ethanol plant in Hamburg, Iowa in the United States of America. The manager of that plant from 1988 to 1998 gave evidence at the present hearing. The plant operated on a feed stock of corn between 1988 and 1994. For the following four years, it blended 30% of wheat starch with 70% of corn. Following the success of the applicants' activities, it has now switched to waste wheat starch. In 1987, the group acquired a 49.9% interest in an Italian starch gluten plant. This, however, does not operate on a continuous basis but on a batch fermentation process. That plant, like the Hamburg plant, does not operate a molecular sieve (the significance of which will be again later discussed).

27. In order to understand the specific activities of the applicants, it is useful to know something of the general steps taken in the production of ethanol. The overall process of converting starch to simple sugars for fermentation is known as starch hydrolysis. Starch is converted to sugar by first making it soluble by cooking. This gelatinisation process breaks down the granular structure of the starch. An enzyme is then added to the gelatinised starch at a high temperature to convert the complex sugars in the starch to shorter chain sugars known as dextrins. This is called the liquefaction process. The mixture is then cooled and a second enzyme is added to convert the dextrins into simple sugars. This is known as the saccharification process.

28. The hydrolysed starch is then fermented to ethanol by the addition of an active yeast culture in either a batch or a continuous fermentation process. It may also be necessary to add other chemicals to the fermenter to meet the nutrient requirements of the yeast. The yeast is often separately propagated within the plant itself using a small amount of the hydrolysed starch and added chemicals.

29. Following removal of the yeast culture, the ethanol is recovered from the fermentation broth (or beer) by distillation to produce a hydrated ethanol containing a small percentage of water. This can be used as an industrial ethanol in solvents and paints. In a more purified form it can be used in pharmaceutical and cosmetic

preparations. A valuable market lies in the blending of ethanol with petrol. To achieve the required purity, it is necessary to produce an anhydrous form of ethanol, preferably with less than 0.2% of water by volume. This is achieved by various techniques. The older technique used a further form of distillation involving a third component such as cyclohexane to remove water. This process is called azeotropic distillation. The more modern technique is to use molecular sieve technology.

30. A feature of the applicants' activities was its use of waste wheat starch effluent as a feed stock. At the time when it commenced its program to produce ethanol, most industrial processes based on the conversion of starch involved corn starch as the primary raw material. This was particularly so in the United States, where there was a surplus of corn of a low grade and where there were tax subsidised markets for blends of ethanol and petrol. There are important differences between the various feed stocks used to produce ethanol. There is a difference in the architecture of the starch granules and other differences in the minor components that influence both physical properties of the starch and the processing and product qualities that use starch as a raw material. There are, for example, viscosity differences which will affect the mixing and heat transfer characteristics of starch, particularly in the gelatinisation and enzyme hydrolysis stages of the process. The diameter and shape of the corn starch granules and the wheat starch granules differ. There are, of course, many varieties of wheat, some of which are more commonly grown in one country rather than in another. Some effort was made to mount an argument that Australian wheat was unique. This was not supported by the evidence. According to Mr Brodl (a witness called on behalf of the respondent whose evidence, in large measure, I accept) there was no real difference between Australian wheat and American wheat in this context. Whatever variations there were in grain size for wheat marketing purposes, when broken down into granules for starch purposes, all wheats have a common diameter and shape.

31. Nevertheless, fermenting a wheat-based substrate is more difficult than fermenting a substrate based on corn (or milo as it is called) because of the volatility of the wheat which can result in foaming difficulties. The problem of foam is even worse with a waste wheat feed stock. This waste causes a number of problems not experienced with non-waste wheat. The waste stream will have a significantly lower concentration of starch, resulting from up-stream removal of much of the starch in the associated starch factory. In order to develop and operate a process using waste feed stock, it is necessary to understand the deficiencies and variability of the starch content in the waste stream. It is necessary to gain a knowledge of other compounds which are also present in the feed stock. It is necessary to establish the nutritional demands of yeast and the possible additional ingredients and it is necessary to establish yeast growth and timing optimisation. The activities of the applicants were directed to developing a process which involved these elements. The activities were complicated by the variability of the feed stock, where there was a difficulty in knowing what changes in the results of the activities were caused by process changes, and what changes in the results were caused by variations in the waste feed stock.

32. Continuous fermentation was another novel feature of the applicants' activities. Traditionally, methods of ethanol production and extraction involved storing the waste stream in batches, fermenting the starches and extracting the ethanol from each individual batch as a separate process. At the time the applicants began their activities,

there was no precedent of an industrial process for the continuous conversion of waste wheat starch to ethanol. What was being attempted was a world first. The development of the continuous process was likely to cause (and did cause) major foaming problems in fermentation and fouling problems in distillation. Both of these problems had to be addressed as the process was developed. Eventually, molecular sieve technology was introduced as will later be seen.

33. Contamination was also a problem which had to be addressed. Bacteria flourish in an environment containing an ethanol content of up to 6%. When the ethanol concentration is low, there is therefore a higher risk of contamination by bacteria in the fermentation process. Because the volume of water required to process the flour into starch and gluten in the starch plant meant that the solids content of the waste stream was very low, resulting in a low ethanol concentration from the fermentation process, there was likely to be, and in fact was, a real challenge facing the applicants in managing contamination. Plants in the United States which used corn or milo as a feed stock had much higher concentrations of ethanol and consequently lower risks of contamination.

34. The varying feed stock was also likely to present difficulties in the distillation process. Because of the foreign material consisting of de-natured proteins, fibre, fats and yeast contained in the waste, major fouling problems could be expected in the distillation column and heat exchangers. This was not a problem that was faced by other plants operating on cleaner and purer substrates.

35. The applicants set themselves goals. The process yield for the fermentation process was set at 0.2%. Contrary to submissions made by the respondent, this objective was not achieved during the period under review. A mistaken opinion was offered by one of the respondent's expert witnesses to the contrary, based on a misconception of the records which were kept of three sugars rather than two sugars.

36. There was a goal of 0.05% of the proportion of ethanol in the waste stream which was not recovered through the distillation process. As loading to the column was increased this target was frequently and significantly not reached, indicating that under increased loading the column was not working efficiently with this particular feed stock.

37. There was a goal to be achieved in producing pure, clear, odourless, colourless and anhydrous 96% ethanol to British Pharmacopeia standard. The setting of goals is a hallmark of systematic activities. The measurement of achievement in relation to those goals is a reflection of experimental activities.

38. Work in the laboratory commenced in 1988 with small scale fermenters. At the commencement of the period currently under consideration, a plant with a rated capacity of 50,000 litres of ethanol per day was constructed. It is convenient to deal here with the question of whether or not this constituted a pilot plant. It is not necessary for the purposes of the definition that research and development activities be carried out in a pilot plant. Nevertheless, if a plant can properly be so described, it helps to characterise the activities as research and development activities or otherwise. In my opinion, in the present circumstances, it can be properly viewed as a pilot plant notwithstanding its size. As I pointed out above, the plant was purchased second hand from an Italian vendor. To some extent, therefore, its capacity was accidental. There was no evidence that a range of other plants of smaller capacity were available for purchase at the relevant time.

39. The principal attack for the respondent was led by Associate Professor Pamment, whose evidence I will later discuss. It was his view, however, that the relevant plant was of a commercial size. On the other hand, it was the evidence of one of the applicants' experts, Mr Heuer, who actually operates three ethanol facilities in the United States, that in order to operate economically, a plant needs to have capacity in the order of 150,000 to 200,000 litres per day. Since the period under review, the applicants have constructed a full-scale manufacturing plant with a capacity of 270,000 litres per day. An argument based simply on size, therefore, would not assist the respondent.
40. It was Associate Professor Pamment's evidence that the pilot plant was, in fact, a disguised commercial plant and that the quantity of ethanol produced continued to increase. I accept the evidence of the applicants' witnesses that these increases were in order to determine the effects on the quality and quantity of the ethanol produced so as to reduce the risks associated with scaling up to a commercial scale plant. In fact, now that the principal manufacturing plant has been constructed, all the improvements developed during the pilot plant stage have been incorporated in the manufacturing facility. These can be summarised as follows:

Plant Feature	***Pilot Plant***	***Commercial Plant***
Production capacity	*2,100 litres/hr*	*11,250 litres/hr*
Fermenter volume	*1,500m3*	*9,400m3*
Litres of ethanol per m3 of fermenter volume	*34 litres*	*29 litres*
Beer column	*Bubble cap*	*Disc donut*
Dehydration	*Azeotropic*	*Molecular sieve*

41. There was some evidence that another company (CSR) had a smaller pilot plant. It does not seem to me to be logical to accept this as evidence of the ideal size of all pilot plants. There is, in fact, no defined appropriate size. It seems logical to me that a pilot plant designed to explore the operational and processing problems that are likely to arise in an industrial scale operation, and to test the maximum capacities of individual components of the plant to enable the proposed scale up to be undertaken, should be larger than one which (to use the respondent's witness' phrase) *"fits on the back of a truck"*. The size of the plant is not so important as the use to which the plant was put.
42. The evidence does not support the respondent's submission that the pilot plant was always operated to capacity. Between July 1992 and June 1995, input targets were systematically raised and ethanol production was increased. This was part of loading the pilot plant to determine its operational characteristics and the operation of the process under increasing loads and to observe what, if any, processing difficulties this caused.
43. The ultimate answer to the respondent's submissions, however, is the coming into existence of the present manufacturing facility in 1995. This stands side by side with the pilot plant. If the applicants were minded to manufacture as much ethanol as possible from the very beginning, why did they wait for so many years before embarking on the construction of a full-scale project?
44. The question of the terminology to be applied to the pilot plant was associated with the submissions made by the respondent as to purpose. The marketing of the ethanol produced from the beginning of the project was, in the respondent's submission, an indication that the applicant did not have the necessary statutory purpose. As I have

indicated earlier, the mere fact that the product of research and development is sold, does not detract from the research and development character of the activities which produced it.

45. As to the applicants' purpose, there is no evidence that disposal of the ethanol was profitable. Certainly there is evidence that apparently all of the substance that was produced was sold to various purchasers. There must have been gross income. Whether or not there was a profit at that stage is a matter for conjecture. What is certain, however, is that something had to be done with the ethanol. The activities upon which the applicants had embarked could not have taken place unless the ethanol had been disposed of.

46. Only two possible choices were available. The applicants either could store the ethanol or sell it. Long-term storage of such a quantity of ethanol was not a practical solution. In order to obtain the best market for the substance, the group sought to produce an anhydrous ethanol with a water content no greater than 0.2% so as to make it suitable for blending with petrol. This was one of the goals which the applicants set themselves. It also explains the sales to BP Australia of some of the product and to other companies of the lower value ethanol for other purposes. I accept that dealing with the ethanol was an integral part of the applicants' activities from the first day. I accept that what was produced had to be disposed of. No alternative means of disposing of the ethanol was suggested by any witness. In my view, the marketing of the product is not an indicator of the wrong statutory purpose. Disposal was an essential part of the implementation of a purpose of creating new processes. There could have been no progress made along this path unless the problem of dealing with accumulated ethanol was solved. The fact that the solution lay in commercial disposal does not, in my view, detract from the integrity of the purpose required by the statute.

47. I turn now to the twelve specific activities which the applicant particularised. Ample details are set out in a witness statement of Mr G, the technical manager for the group, which was tendered in evidence as exhibit F. He had a background in applied chemistry with a number of companies. He has been with the group as chief chemist since 1966. He first joined the group in order to assist in the construction and start up of a wheat and gluten plant. Since then, the group has constructed four new starch plants and is the largest producer of starch in the Southern Hemisphere. His current responsibilities include product and process development in the areas of starch, glucose, gluten and ethanol.

48. Evidence was also given by the substantial proprietor of the applicants and by the factory manager. Neither of them had technical qualifications. Although the proprietor's purpose would normally be taken to be the purpose of a company, in the present circumstances, it seems to me more appropriate to regard the purpose of Mr G as reflecting the group's purpose. He set out in detail twelve activities. These are conveniently summarised in submissions made by counsel for the applicant. I will reproduce those submissions for each activity and comment on them in the light of the submissions made on behalf of the respondent.

49. The first activity dealt with the starch cooking system and was summarised as follows:

> *"The bulk of the potential fermentables in the waste stream is in granule form. Yeasts cannot metabolise starch in this form. The granule form must be destroyed by heating in excess water.*

Waste wheat starch contains a high proportion of B starch granules. These are more crystalline and require higher levels of heat input to fully gelatinize.

At the time the technology which was available for cooking and processing pure starch solutions was directed to concentrations in the order of 30 to 40% starch by weight. However, the [the group] waste stream was neither pure nor concentrated.

At the time [the group] was building the pilot plant, it was well aware of in-line heater technology, having used this technology in its glucose plant. The deliberate decision was taken not to use this technology as it was anticipated that the increased temperatures associated with in-line heaters would cause greater fouling problems in conjunction with this particular feedstock. It was expected that a conventional cooker would work; it was not known that there would be uncooked starches if a conventional cooker was used.

The initial design of the starch gelatinisation system consisted of a tank with direct stream injection into the side near the bottom third of the tank. Side entry propeller type agitators were included in order to mix the tank contents. The feed entered and exited the tank at the top.

However, analysis of the output from the cooker showed the presence of some uncooked and partially cooked starch. This resulted in incomplete fermentation with significant losses of potentially fermentable product in the waste stream. Also, operation of the cooker in a continuous mode, with simultaneous feed and discharge, was proving to be unsatisfactory.

[The group] found the problem to be poor liquor circulation or mixing in the gelatinisation tank due to the presence of foam and also the viscosity of the hot paste which was formed.

[The group] redesigned the agitation system in the cooker and, in particular, modified the direct stream injection point to assist in circulation within the tank. These changes resulted in some improvement but the process was still unsatisfactory. Also, the operating temperatures were restricted to a maximum of 92C. At this temperature not all the starch (B grade starch) would convert or cook.

[The group] then installed an automatic in-line heater which, under slight pressure, operated at a higher temperature (100-105C). Mr Hill had originally suggested the use of an in-line heater, but he did not know whether this method of cooking the starch would work or not. This additional heat is achieved through the use of a venturi with a steam inlet where the substrate and the steam are intimately mixed at temperatures above 100C. There is a suggestion in the evidence that the use of an in-line heater would have been a designer's first choice. There are two reasons why this would not be so:

(i) *in-line heaters need a more expensive enzyme (a thermal stable enzyme) to withstand the higher operating temperature of the cooker; and*

(ii) *the use of in-line heaters leads to fouling in associated heat exchangers. This is due to the nature of the substrate (protein, fat and fibre) because at the higher temperature the protein in the substrate coagulates and the protein tends to pull with it the fat and fibre.*

The in-line heater proved to be the better choice because it could be operated at higher temperatures which ensured complete gelatinisation and dispersion of all starch present in the waste stream. It also gave an almost bacteria free substrate (an important consideration for full continuous fermentation).

These process modifications to the starch cooking system replaced what was found on trial to be an inefficient, poorly controlled process with a highly efficient easily controlled system which has become one of the foundations of [the group's] design of a fully continuous fermentation and distillation system for ethanol production. The higher operating temperature of the new cooker resulted

in the need to develop new enzyme systems which were effective at the higher temperature.
Professor Rogers stated that the "feedstock may have required some investigation to determine optimum cooking conditions, due to different viscosities and the effects of protein denaturation and pentosan polysaccharides."

50. The respondent dealt with this activity in a general way and I will come back the respondent's general submissions. In short, however, its contention was that relevant data was not recorded accurately enough to permit the analyses referred to. I accept the evidence of Mr G and accept that the analytical activities were carried out. Although there was some suggestion that this was not so, that suggestion was not put to Mr G, nor was any evidence to the contrary brought by the respondent. I have no reason to reject Mr G's evidence.

51. The second activity related to starch saccharification. This is summarised as follows:

"The pilot plant was originally designed without a separate saccharification stage, because it was believed that this could be accomplished concurrently with fermentation in the fermenters. This was the conventional wisdom. As Brodl said in oral evidence, you would try and do simultaneous saccharification and fermentation, and you would expect it to work.

However, [the group] found that the process was partially successful, but:-

(a) it used large quantities of enzymes; and

(b) saccharification was not completed at the end of the fermentation stage (in other words, there was a loss of potentially fermentable starch).

[The group] decided to add a separate saccharification tank stage to the process. It provided the higher temperature and optimum pH for the enzymes to almost completely convert the starch dextrins to simpler fermentable sugars. In short, this problem was solved but it also had flow on effects in that it led to a significant change in the mode of operation of the fermenters. One of the unwanted results was that the increased fermentation which was achieved exacerbated a problem of high foam levels in the fermenters which seriously affected the operation of the whole process.

Professor Rogers stated that "the determination of optimal enzyme loadings and conditions for a low start content, waste wheat starch stream which contained possible interfering proteins, pentosans, lipids and fibres would involve further investigation. To my knowledge such information was not available in the literature or from the manufacturer in 93/94.

Mr Hill stated that "there is no hard and fast rule on whether you do or do not have a separate saccharification tank. It depends on the process that is being dealt with at any particular plant. For example, at the Hamburg plant, which was built with a separate saccharification tank, it was found to be a source of contamination and it was by-passed in order to reduce the contamination problem. In my view this is a good example of one of those situations where a problem can only be solved in practice, and the solution will vary depending upon the particular plant in question."

52. Again, the respondent's principal objection to this claim was that there was no evidence as to the recording or analysis of, or research into, temperature and pH such as to support the contention that the applicant's research showed that these parameters were not optimum. The respondent further submitted that there was no evidence of planned variation and measurement with these parameters to determine optimum

conditions.

53. I will deal with these submissions when dealing with the respondent's general overview. It is sufficient to say at this stage, that on the evidence put before me, I accept the consequential engineering and operational changes as attested to by Mr G and accept them as falling within the definition of research and development activities.

54. The third class of activities dealt with the problem of foaming. It was described by counsel as follows:

> *"The waste substrate from the starch process contains a large amount of soluble protein and pentosan gums. Also, a large amount of gas (carbon dioxide) is also produced in the fermentation process (about one tonne of carbon dioxide is produced for every tonne of ethanol produced). The combination leads to the production of highly stable foams.*
>
> *The excessive fermentation led at times to foam shooting 30 feet into the air with the consequent spillage of liquor. [The group] was dealing with something in the order of 40,000 to 60,000 gallons of foam in a plant that simply could not be turned off. It was found that conventional defoamers were ineffective and uneconomic. The problem was serious. The fermenters had to be run at less than 50% liquid capacity in order to prevent the overflow of foam, but this had two serious consequences, as explained below.*
>
> *The original continuous flow fermenter design depended on a cascade overflow system; when no. 1 fermenter was full it overflowed into fermenter no.2 and so on until the fermentation cycle was completed. Running the fermenters at 50% liquid capacity meant no overflow was possible. The options were to switch to a batch of fermentation system or to install pumps and piping to transfer between the fermenters by pumping.*
>
> *[The group] did not want a batch system, which is not efficient. It wished to develop and use a continuous flow system. A continuous process offers the following advantages over a batch process:*
>
> *(a) It is inherently more efficient because it utilises 100% of the available fermenter volume. In a batch process you have to have time to fill, ferment, empty and refill the fermenters in sequence.*
>
> *(b) [The group] was dealing with a waste stream with a lot of variations. If it could run a continuous process with a substantial fermenter volume, it could damp out those variations.*
>
> *Because [it] had to use 50% less of liquid capacity in the fermenters, the retention time of the fermenters was halved and resulted in inadequate fermentation and incomplete attenuation of the fermentable carbohydrate, with excessive losses to the stillage.*
>
> *[The group] therefore constructed an additional fermenter (fermenter no. 1) with a volume of 1 million litres to accommodate the foam. As mentioned, it also installed pumps to facilitate liquid transfer between the fermenters. Pumping from the heat exchanger was also structured to assist with controlling the foam levels.*
>
> *There is an issue in the case which goes to the reason why additional fermenter capacity was added. [The group] say that the increased capacity of fermenter no. 1 was to deal with the foam problem. The respondent says that this was done to increase capacity for commercial sale. There is a simple answer to that suggestion; if [the group] wanted to increase ethanol production it did not have to install additional fermenter capacity. It could simply have included another process step of adding fermentable solids in the existing fermentation process if increased ethanol production was its concern. Also, its capacity to produce ethanol was limited by its capacity to distil ethanol. It did not match its increases in fermenter capacity by the installation of additional distillation capacity.*
>
> *Professor Rogers expresses the view that a wheat based feedstock with associated proteins, lipids and pentosans, and the "extent to which they influence foam formation*

under the operational conditions of the plant at [the group] would … justify investigation which may lead to fermenter modification."

55. The principal objections of the respondent to this claim were summarised by counsel for the respondent as follows:

"(i) it was done to maintain or increase plant production;

(ii) apart from the vague reference to conventional defoamers having "proved ineffective and uneconomic" there is no evidence of the foaming problem being researched, alternative solutions being considered and evaluated systematically, and the optimum or preferable solution being adopted;

(iii) there is no evidence of a systematic "structuring" of the pumping from the heat exchanger;

(iv) foaming is a universal problem in all fermentation systems;

(v) if wheat starch presented any particular foaming problems those could, and should, have been investigated earlier and at a smaller scale, possibly in consultation with the suppliers of anti-foam agents."

56. These submissions raise a recurring theme, namely an objection to what the applicants did because of the fact that they could have done something else. The respondent focuses on what the applicants did not do, or what they could have done, or what they should have done, even though it did not call one plant operator to give this evidence. It relied principally upon the theoretical evidence of Associate Professor Pamment, to which I will return. The point, however, is to determine what the applicants did, whether is was covered by the definition, and what was their purpose in doing it. The evidence that conventional defoamers had proved to be ineffective and uneconomic was unchallenged. The applicants adopted the solution, which was rational and effective, of increasing the capacity of foaming to number 1, running at less than 50% liquid levels. This is both experimental and innovative. Because the applicants had a pilot plant, they were able to observe a significant problem of unexpected magnitude which they investigated. They came up with a rational solution which introduced a major change in the way the process was carried out.

57. The fourth activity dealt with capacity and is described in these words:

"This problem concerned a consideration of what volume of the fermenter capacity was required to maintain continuous economic distillation. This is separate from the foam issue, which also required as a solution, increased fermenter capacity for fermenter no. 1.

There were many variables which had to be managed in the fermentation process (yeast genetics, yeast cells/ml, substrate concentration and saccharification, nutrition and time to reach attenuation of available fermentables).

Despite the best efforts to manipulate these variables to achieve a steady state of attenuation of all the fermentables, this could not be achieved in existing fermentation times.

Two solutions were considered:

(i) reduce the flow rate to allow longer fermentation, (this would be undesirable for the reason given immediately below); or

(ii) install additional fermenter capacity.

Because of the impact that a reduced flow rate would have on the distillation plant (the operational efficiency of the distillation plant is dependent on its hydraulic loading), the decision was made to install additional fermenter capacity. This allowed [the group] to

reach the goal of maximum utilisation of available starch and sugars on a continuous basis.
As a result [the group] constructed and installed fermenters 5 and 6 and carried out associated works.
The additional fermentation time introduced some much needed flexibility into the continuous fermentation train, and allowed [the group] to reach the goal of maximum utilisation of available starch and sugars on a continuing basis, without a negative impact on the distillation system.
This, together with other changes to cooking, yeast propagation and saccharification, resulted in a decrease in residual fermentables entering the distillation stage.
Professor Rogers expresses the following views concerning this activity:
"In my assessment, Activity D is likely to have had the effect of reducing the % fermentable sugars and increasing % ethanol from the fermenters as a result of increasing the residence time in the short term. This process enhancement assumes that the extent of foaming remains constant, although with feedstock variability, this could not have been guaranteed. In the longer term, with increases in input feed rates, the residence times would have again declined and the original problems identified by [Mr G] have recurred.
The strategy outlined by [the group] appears to have involved technical risk, as there is evidence of increased contamination in 94/95 which may well have been associated with the increase in residence times. This will depend on the particular growth characteristics of the contaminant microorganisms (typically Lactobacillus sp) and their relation to those of the yeast culture. For slower growing contaminants for example, the rate of washout will be slower at the longer residence times, and their population would increase. Once established in the process contaminants would be very difficult to remove as shown in attachment 8, even at faster flow rates."

58. The respondent contended that this did not constitute research and development because it was either undertaken for the commercial purpose of increasing capacity or was not such as to constitute innovation or technical risk. The solution to the applicants' problem, according to the respondent, was *"obvious"*. This submission was made again relying on the theoretical evidence of Associate Professor Pamment. It also relied on the more practical evidence of Mr Brodl. His evidence, however, appeared to be based on a misconception of the purpose of the increase in capacity.

59. In my view, the increase in fermentation capacity was obviously not undertaken for a commercial purpose. The fact that the distilling capacity was not simultaneously increased is a sufficient answer to that submission. Both processes were integrated and were essential in the production of ethanol. To increase the capacity of one without the other, would not have had any effect in increasing the ultimate volume of product. Associate Professor Pamment does not appear to have any basis to support the suggestion he made, except that his suggestion was consistent with his view of all aspects of the applicants' case. I have no reason to reject the evidence of Mr G and the reasons given by him for this particular activity.

60. The fifth activity particularised dealt with yeast propagation, summarised as follows:

"Viable yeast cells are added continuously to the fermenter system to maintain the required rate of ethanol production.
The yeast is grown in propagation tanks using substantially the same substrate which is fed to the fermenters from the saccharification process (this is done to acclimatise the

yeast to the conditions in the fermenter).
The problem which [the group] found was that the use of saccharified starch waste as a substrate for yeast propagation resulted in substantial foam due to the presence of soluble proteins.
The original pilot plant yeast propagation system had three tanks which were vented at the top to allow gas to escape. Overflows became a daily occurrence and design modifications became necessary.
The solution was to redesign the tank venting system to prevent the ingress of microorganisms to the tank through the venting system. This activity appears to have caused some confusion in the evidence. The tanks themselves have always been enclosed, it was the venting system that was redesigned. The solution not only fixed the problem but allowed the better evaluation of alternative yeast strains to be undertaken. It also improved yeast yield and activity, and dramatically reduced the incidental infection of the yeast with bacteria and foreign yeasts. Ultimately this led to better, more efficient, fermenter performance."

61. As the above submission indicates, this activity seems to have been misunderstood by the respondent's witnesses, who considered that the sealing of tanks could not be regarded as innovative or as involving technical risk. Mr Brodl made the point that yeast propagation tanks are almost always enclosed vessels if designed properly. The evidence of the applicant, however, was not that the tanks were sealed, but that the venting system was treated to prevent the ingress of micro-organisms. This is put forward by the applicant and supported by its expert as an innovative step. There is no evidence directly contradicting this and I have no reason to reject the claim.

62. The sixth activity particularised related to the chemical dosing system. This was summarised as follows:

"It is common practice to add a wide range of chemicals to the fermentation system in order to maintain the desired rate of yeast activity.
When batch fermentation is practised, a single addition of the required chemicals is all that is needed. However, when you have a continuous fermentation system, you have to work out the regime required for continuous chemical dosing in the various fermenters, where conditions change from fermenter to fermenter.
Therefore, the problem was how to build and operate a chemical dosing system to supply differing chemical regimes to multiple fermenter units, in order to obtain optimum fermentation conditions in each unit.
The installation of the chemical dosing systems resulted in improved control over fermenter operation. The pH and nutrient status were able to be matched to the requirements of each fermenter in the fermentation chain, and this reduced levels of unwanted by-products and also reduced an odour problem.
Professor Rogers expresses the view that the "determination of the correct rates of addition of enzymes in starch hydrolysis and chemicals in fermentation, particularly in response to variable feed rates and compositions, is very much an investigative activity. Without detailed investigation both in the laboratory and in the pilot plant it would not be possible to predict the effect of the various feedstock components (proteins, lipids, pentosans, fibres) on the levels of enzyme and nutrient additions."

63. The respondent contended that this did not constitute research and development. Associate Professor Pamment stated that the equipment was standard in the chemical industry and did not represent an innovation. This was supported by Mr Brodl.

64. Again, the evidence of the respondent's witnesses appears to have been based on a misconception of the nature of the claim made by the applicants. Professor Rogers has correctly referred to the innovative character of this process. It is the activity of experimentation with various mixtures of chemicals rather than the installation of tanks and pumps which constitutes research and development under this heading. Of course the cost of providing the tanks and pumps must be regarded as part of the cost of the activity. It could not be carried on without them. Nevertheless, the existence of such tanks and pumps elsewhere is not an answer to the innovative nature of the mixing activities carried out by the applicants. Again, I have no reason to reject their evidence.

65. The eighth activity particularised related to beer column modifications described as follows:

> *"For yield and efficiency purposes, it is essential that ethanol content in the stillage is as low as possible. As mentioned above, the process aim was 0.05% by volume.*
>
> *The beer column accepts feed from the final fermentation stage. It performs the initial separation of ethanol from the beer.*
>
> *The problem here was that the beer also contained all the non-fermentable components discharged from the waste stream. This included fibre, protein, fats, gums and yeast cells.*
>
> *These solids combined to foul the beer column surfaces and this led to a reduction in separation efficiency in the beer column. Ultimately, there are high losses of ethanol to the stillage.*
>
> *The solution was to make mechanical modifications to the beer column pipes, pumps, and heat exchangers, to restrict the opportunity for the fouling. A chemical dosing system was also introduced to reduce the requirement for boil outs (this is where hot caustic soda is pumped through the column and heat exchangers). The solution has been partially successful but column fouling remains a significant problem.*
>
> *Professor Rogers expresses the view that "the extent of fouling is likely to be much greater for a feedstock containing 35% non-fermentables (proteins, lipids, pentosans, fibres) than in a feedstock in the corn to ethanol industry for example, with a lower level of non-fermentables. The extent of this fouling, the frequency of column cleaning and associated process disruption represent … a discernible level of technical uncertainty."*

66. It was the respondent's submission that this activity did not constitute research and development because fouling was a problem common to all distillation columns and would have been expected. It submitted that the changes made to ameliorate this problem represent minor process optimisation, or *"troubleshooting"* activities, and were not in the nature of innovative research and development.

67. There is no question that fouling was expected. The evidence, however, was that the degree of fouling which was experienced was completely unexpected. This was unchallenged in the evidence. It was, in fact, one of the lessons that was learned by operating the pilot plant and trialing the process to see whether there would be operational problems. These lessons were translated into design changes in the commercial plant which has now been built.

68. It was also submitted by the respondent that the distillation in fact being used was inappropriate and employed obsolete technology. The evidence does not support an assertion that this was so simply because it has previously been used for molasses feed stock, or because it was expected that there would be some fouling. The issue for the applicants was the unexpected high degree of fouling that was experienced not only

in the column, but in the pipes, pumps and heat exchangers. Whilst evidence was given by Dr Brooks and Mr Brodl for the respondent on this subject, neither addressed the unexpected extent of fouling that was experienced.

69. Again, I have no difficulty in accepting Mr G's evidence and in holding that this was a research and development activity. What was done was part of the process of experimentation carried on for the purpose of creating a new process which was ultimately adopted in the later manufacturing facility.

70. The eighth particularised activity dealt with cyclohexane and is described in these terms:

> *"Cyclohexane is a component in the azeotropic distillation of ethanol to produce the anhydrous form of alcohol.*
> *A problem arose in relation to the location and installation of the leak detectors for cyclohexane vapour in the cyclohexane storage and handling installation.*
> *The specific problem was that the vapour sensors in the pit under the storage facility were affected by water accumulating in the pit. This led to frequent false alarms which triggered a water deluge system and callouts by the local fire brigade.*
> *The solution was to fit stainless steel floats to the sensors to keep the sensitive elements of the sensors above water at all times."*

71. The respondent submitted that this did not constitute research and development as the fitting of the leak detectors to floats was a very minor operation and was not innovative. According to Associate Professor Pamment (who had very little practical experience at all) small problems such as this one occur in the commissioning of any normal commercial plant. Mr Brodl (who had considerably wider practical experience) agreed that the changes made were simply to rectify malfunctioning instruments.

72. The evidence indicates that what was done was of a minor nature. Nevertheless, as I pointed out earlier, research and development does not have to be major in order to come within the terms of the definition. What was done here can be properly classified as a minor experimental activity involving minor technical risk but carried on for the appropriate statutory purpose.

73. The next topic related to dehydration involving activities described as follows:

> *"Cyclohexane is difficult to handle in an environmentally responsible manner.*
> *Also, it is impossible to produce anhydrous product that does not contain traces of cyclohexane. This limits the areas where the ethanol can be sold.*
> *Also, the process is comparatively energy intensive and therefore expensive.*
> *In December 1993 there was emerging technology involving the use of molecular sieves. These sieves contain zeolite beads which have microscopic holes which allow ethanol molecules to pass through the beads, but not the water molecules. The entrained water is removed from the beads with dry steam under vacuum.*
> *It was felt that molecular sieve technology, although emerging, would offer a superior technological solution to dehydration than azeotropic distillation. However, there were shortcomings.*
> *It was found that the internal design of the sieves (containing the beads) was inadequate. There was a high attrition of beads which led to suspended solids (ie bead dust) and turbidity in the de-hydrated ethanol.*
> *[The group] modified the internal arrangement of the beads in the absorption column to include an inert stone layer above and below the bead bed to prevent bead movement. Research was required to find the correct mass and size of the stone bed that would minimise attrition loss without prejudicing efficiency of the process. Several attempts*

were made to get the correct mass of stone on top of the bed which would control bead movement without unduly compressing the bed (which would restrict vapour passage).
It was also found that the vacuum system design was inadequate. Regeneration of the beads produced large volumes of wet ethanol vapour which had to be recovered and reprocessed by recycling through the rectifying column. This higher loading over the rectifying circuit required larger capacity heat exchangers.
Mr Brodl stated that "molecular sieve dehydration technology could be considered as an emerging technology in 1993." It was an activity that involved technical uncertainty."

74. Again relying on Associate Professor Pamment, the respondent submitted that the dehydration of aqueous ethanol by extractive distillation using cyclohexane was a well-established and proven technology that had been practised for some years. It was also submitted that molecular sieve technology was then no longer a new or emerging technology. This was also supported to some extent by Dr Brooks, who also had little practical experience in this field.

75. On the other hand, Mr Brodl (a witness brought to this country on behalf of the respondent) who had considerable practical experience in design took the opposite point of view. His evidence is to be preferred. The applicants' activities were essentially practical. Although some laboratory analysis was carried out, the systematic, investigative and experimental activities were largely encountered in a practical environment of training for full-scale manufacture. In characterising these activities, the evidence of a knowledgable, practical witness with extensive design experience, like Mr Brodl, is of more assistance than the theoretical evidence offered by other witnesses.

76. While there was general certainty that quality could be achieved, there remained even in 1994 and 1995 uncertainty regarding the relationship between quality and operational capacity. This is because the general belief at the time was that 99.5% dryness was the practical limit of large industrial scale.

77. The tenth area of endeavours concerned ethanol quality and was described as follows:

"The protein content of the fermentation substrate tends to generate additional, highly odorous fusel oils which are difficult to remove.
Changes had to be made to the rectifying process to achieve a better separation of the offending fusel oils. Also, carbon filters were obtained and fitted.
Professor Rogers expresses the view that to his knowledge, "these are both long-standing technologies which may have required some adaptation in the [Group] process in view of the unusual nature of the feedstock and its effect on yeast metabolism".

78. Again, the respondent relied upon Associate Professor Pamment, whose evidence was that these changes applied long-standing technology and were *"troubleshooting"* rather than research and development activities. To some extent, this is a view shared by the applicant's witness, Professor Rogers. In view of the unique nature of the substrate, however, it seems to me consistent to hold that what was done was experimental as it would not have been done in any other plant previously with such a substrate.

79. The eleventh topic (referred to as Activity K) dealt with bird control and described as follows:

"This was a problem with the distillation plant structure. Apparently hundreds of birds

(starlings) were attracted by the ethanol and roosted in large numbers. The design of the structure had to incorporate open ventilation and was not allowed to include roofing or protection from birds. This caused a significant bird dropping problem with occupational health and safety consequences for plant operators. The fact that this was a problem is something which seems to be ridiculed in the respondent's evidence. However, it was a real problem, and had to be dealt with. Successive measures were taken to deter the birds from roosting, including scare tactics. These did not have any long term success. Coating the perch surface with a sticky substance highly distasteful to the birds did work quite well, but the production of this substance has been discontinued and is now illegal. Accordingly, there is still a problem."

80. In my view, the applicant cannot sustain a claim that this is either a core or a supporting activity. All that was done was to purchase an unnamed *"sticky substance"*, no doubt of a commercial brand and readily available and to apply that substance with unsuccessful results. Lack of success is not inimical to research and development. The routine nature of the task, however, can hardly be said to be either systematic or investigative or experimental. It is no more research and development than cleaning the laboratory. Nor is it an activity carried on for a purpose directly related to the carrying on of any of the ten activities previously described.

81. The twelfth activity related to pressurisation in the fire control room and is described as follows:

"The ethanol distillation control room for the pilot plant was located next to the distillation columns. There was concern that vapour could penetrate and accumulate in the confines of the room, with potential consequences for fire and operator safety.
The solution was to provide a control room with a system that maintained a constant slight excess pressure to prevent entry of ethanol vapour."

82. Associate Professor Pamment calls this a *"minor tidying up of a problem"*. The minor nature of the activities may be conceded. However, to my mind, it was experimental and represented adjustments in the development of the pilot plant process. It is quite different from the bird control claim.

83. As was noted in *Unisys*, *"innovation"* should not be given a narrow meaning. The purpose of the statute should be in the forefront of the decision maker's mind at all times. Although not a substantial item, pressurisation in this context is part of the whole process of modification undertaken in order to isolate and deal with problems that might arise in the scale up to manufacturing. In my view, it qualifies as a research and development activity.

84. Apart from these specific objections to specific claims, the respondent made a number of general objections which can now be dealt with. The respondent objected to a claim for the cost of construction (as distinct from the cost of operation) of the pilot plant. I am not concerned with cost as such. I am concerned only to determine whether a certificate should be granted under section 39L. It seems to me, however, that objection should not be taken to the cost of construction merely because it is a capital cost. Such an outgoing was approved as part of a research and development activity by Lindgren J in *Coal and Allied*. If what was constructed here was merely a general purpose facility, then the situation might be different. As I understand what little evidence there was that was directed to this subject, the cost complained of was principally in the construction of the plant itself. It seems to me that there is no

difference in principle between the cost of construction of a pilot plant and the cost of construction of a four kilometre long cut-off wall and levee bank which was considered in *Coal and Allied*. If the construction was an integral part of the systematic, investigative or experimental activities, then there can be no objection to its cost, whether this is treated as a capital or revenue item in the applicants' accounts.

85. The respondent had general objections to the absence of documentation, as the respondent saw it. In fact, daily records were kept of measurements and of analyses. The applicants maintained a laboratory at the site which carried out the analysis work. The respondent complained about the absence of graphs of this data. To my mind, this is irrelevant. To those carrying out the analysis the data is quite intelligible without graphs. The records, in fact, were sufficiently extensive to enable the respondent's experts to use the data to illustrate for their own purposes the operation of the process in the pilot plant. The fact that such data was captured and maintained by the applicants and was able to be used by them to explain whether or not critical targets were being met is, to my mind, consistent with the applicants' activities being systematic, investigative or experimental.

86. The fact that the respondent's experts would have kept different records is not to the point. The fact is that a daily report and a daily analysis sheet was kept for almost every day over the entire period and contained sufficient data for Dr Brooks and Associate Professor Pamment to prepare three reports, each with numerous graphs and references to the data. Similarly, the applicant's expert, Professor Rogers, was able to provide an independent analysis of the operation of the pilot plant covering the relevant period by reference to this data.

87. The keeping of records, in itself, is not a research and development activity. The records, however, may indicate that the actions recorded were of a systematic, investigative or experimental nature. It does not follow, however, that the absence of records means that there were no such qualifying activities. This is to confuse actions with words recording those actions. The task of proving that research and development activities were carried out is certainly made easier if there is a contemporaneous appropriate record. The record, however, is in itself merely an evidentiary aid. In this case, however, one does not have to rely on the applicants' words alone. As I have pointed out, there were ample records made available both to the respondent's witnesses and to the Tribunal to substantiate the applicants' claims.

88. Another general submission by the respondent was that what was being carried out was mere quality control, an area specifically excluded from the definition of research and development activities. This objection cannot be sustained. Quality control assumes that there is a settled process which can be maintained or controlled at a particular state. In this case, the process was being trialed on the fermentation and distillation plants and because of the various technical difficulties which manifested themselves in the course of that work, the applicants undertook significant process development work to attempt to come up with the *"process"* which would handle the novel feed stock. The installation of new cookers, the installation of a separate saccharification system, the installation of additional fermentation tanks, and the making of structural modifications to distillation columns were not and could not be quality control.

89. It was generally submitted by the respondent that the activities did not involve

innovation or technical risk. The general answer to this general submission is that the use of the innovative feed stock, coupled with the innovation of a continuous process created a unique situation. The problems which it threw up required resolution which was both innovative and risky in the sense that the outcome was uncertain. The extensive fouling of the beer column, and the use of the molecular sieve technology combined with these processes, sufficiently underline the innovative nature of the activities so as to qualify them. At the commencement of these activities, no one had ever converted a 100% effluent waste wheat starch stream to ethanol. Indeed, the evidence was that the conventional thinking at the time was that it *"did not make sense"*. The conventional wisdom was to blend unstable waste streams with a more stable substrate such as corn in proportions of approximately 30% wheat to 70% corn, in order to stabilise the feed stock. The activities of the applicants were directed towards perfecting the process of dealing with the effluent waste stream from the starch gluten plant with all of its variability without alteration.

90. An attempt was made by the respondent to compare the facts in this case with the facts in the *Mobil Oil* case. In my view, a more appropriate comparison would be with the *Coal and Allied* case. In that case, settled methods of dealing with the problem were combined in a unique way for the first time to reach a solution. In the present case, systematic steps were taken to develop a process which could successfully deal with a situation which had never been squarely confronted in Australia or elsewhere.

91. The processing and operational problems were, in fact, observed, investigated and solved. This was done by reference to targets. Extensive and relevant data was collected by which the process was capable of being assessed. The plant was increasingly loaded in a systematic way to fulfil the legitimate research and development activity of exploring the operational limits of the plant under investigation. The understanding of the process and the developments that were made were possible only by investigating the process through the operation of a pilot plant. The fact that the applicants have now moved to the construction of a commercial scale ethanol plant shows the value of this earlier research and development.

92. The respondent commented on the particular evidence of particular witnesses. It is true that the proprietor and the factory manager did not advance the applicants' case significantly. They were not, however, technical people and were not called upon to deal with the principal issue in these proceedings, namely whether what was done was research and development.

93. On the other hand, the respondent relied to a large extent on two experts, Associate Professor Pamment and Dr Brooks. Neither of these was asked to vouch or verify the activities actually undertaken by the applicants. They were simply asked to comment on statements which the applicants' witnesses had made and, in some cases, to answer specific questions. Unfortunately, from time to time, they fell into the common error of expert witnesses and became advocates in their client's cause. Neither of them had any extensive experience in a practical sense. Associate Professor Pamment's evidence was largely compiled from computer searches. He had never visited a grain to ethanol plant. He had not visited any of the plants referred to in his reports or spoken to anyone who operates those plants. He did not know the operational difficulties at those particular plants. He did not know the variation in the feed stock in the various continuous ethanol plants that he investigated for the purposes of his reports. His

practical experience appeared to be limited to the building of a continuous cheese making operation in the late 1970s. He also expressed considerable knowledge about porcine cemetatrophyn, which has nothing to do with the conversion of starch to ethanol and the separation of ethanol from the liquefied feed stock. Nonetheless, it was significant that his reading in preparation for the case did not reveal the existence of any plant using waste wheat in an effluent stream as a feed stock for ethanol production.

94. The qualifications and experience of Professor Rogers who gave evidence for the applicant were not questioned. Where his views differ from those of Associate Professor Pamment, Professor Rogers is to be preferred.

95. Dr Brooks' evidence must be viewed in the context that he has no direct experience in processing wheat starch into alcohol. His principal experience is in molasses and beer. Furthermore, he has had no experience in managing or running a wheat starch to ethanol plant. This experience must be contrasted with that of Mr Hill and Mr Heuer, who gave evidence on behalf of the applicants.

96. For these reasons I am satisfied that the eleven activities outlined above (which do not include activity K, dealing with bird control) are research and development activities as defined. They were systematic because they related to achieving defined targets. The activities were characterised by regular and systematic data collection relevant to those targets. The activities involved an exploration of the process and the operating capacities and characteristics of the plant by a systematic, step-wise increased loading to the plant to the extent that it was reasonably possible to do having regard to the daily varying nature of the feed stock. The activities dealt with process and operational problems by rational and effective solutions which developed the process. That process was new or improved and the activities were carried on for the purpose of creating that process.

97. The activities were investigative because the applicants built a plant which could produce ethanol and operated that plant to trial a process which had never been used before in relation to a novel feed stock. What the applicants did went against conventional wisdom. The work was by reference to process targets and extensive data was collected which was relevant to those targets. The applicants observed the operation of the process in that plant and when the problems were observed, investigated those problems and provided rational and effective solutions in response. They investigated the process and operational capacities and characteristics of the plant under a systematic increase in load.

98. The activities were also experimental. Whether or not ethanol could be produced from a 100% waste wheat effluent feed stock in a fully continuous process in a way which was viable as an industrial process was simply not known. All these elements occurring together were confronted for the first time. When problems arose, the applicants identified the problems, their causes and determined what were appropriate solutions, carried out the process changes and evaluated the results.

99. It follows that the activities of the applicants met all the requirements of the opening words of section 73B(1). The activities need be merely systematic, or investigative, or experimental. As I have described them above, they meet all three criteria. Furthermore, the evidence supports a finding that they were carried on for the purpose of creating a new process which had not been undertaken anywhere else. The unique features of the process were the combination of a waste wheat substrate with a

continuous fermentation process. In my view, the applicants are entitled to succeed as to all the activities except one, without any of the qualifications appended to the original decision by the respondent Board.

100. I will therefore set aside the decision under review and remit the matter back to the respondent with the direction that the applicants are entitled to a favourable certificate in respect of all the activities outlined in exhibit F, except for activity K.

I certify that the 100 preceding paragraphs are a true copy of the reasons for the decision herein of Mr B.J. McMahon (Deputy President)

Signed:

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Dominika Rajewski, Associate

Date/s of Hearing	28-31 August, 01 & 04 September 2000
Date of Decision	10 October 2000
Counsel for the Applicant	Mr David Yates, SC
	Mr Gerard Horton
Solicitor for the Applicant	Ernst & Young
Counsel for the Respondent	Dr G.A. Flick, SC
	Mr Ian Harvey
Solicitor for the Respondent	Freehill Hollingdale & Page