

HANRAHAN

THE HIGH COURT

1982 No. 2138P

BETWEEN:-

MARY HANRAHAN, JOHN HANRAHAN AND SELINA HANRAHAN

Plaintiffs

and

MERCK SHARP AND DOHME (IRELAND) LIMITED

Defendants

Judgment of Mr. Justice Keane delivered the 7th day of August 1985

In these proceedings, the plaintiffs claim an injunction restraining the defendants from discharging noxious, toxic or deleterious smells, substances or fumes over and on to a farm belonging to the plaintiffs at Ballycurkeen, Co. Tipperary, from a factory owned and operated by the defendants at Ballydine, Co. Tipperary, in the immediate vicinity of the plaintiffs' farm. They also claim damages arising out of the same alleged discharge on to their lands.

The second named plaintiff is aged 37. He has spent virtually all his life on the farm. The farm was owned by his father who died in 1968 and his mother, the first named plaintiff, is still the registered owner of the land. He married the third named plaintiff in 1969 and they have two children, Ambrose and Charles, aged respectively 12 and 14.

Since the death of the late Mr. Hanrahan, the three plaintiffs, have all been involved in varying degrees in the running of the farm. John's sister, Dolly, was also actively engaged in the running of the farm and particularly in the management of the dairy herd on the farm until she married and left early in 1978. The only other member of the household at the relevant time has been Mary's sister, a Miss Quaide.

The defendants are a member of a group of companies engaged in the manufacture of pharmaceutical products in many parts of the world. The building of the Ballydine factory was completed early in 1976 and production began in March of that year.

The plaintiffs complain that, as a result of the manufacturing processes carried on at Ballydine, toxic gasses and vapours have escaped from the factory premises on to their lands. They say that, as a result, their health has been seriously affected and that the farming activities carried on by them have been gravely jeopardized. In this latter context, they complain particularly that the health of the daird herd, which has been for a number of years the principal agricultural activity carried on at Ballycurkeen, has been seriously impaired and has caused them significant financial loss.

All of these allegations are strenuously contested by the defendants. The action has been 47 days at hearing and a large number of witnesses, lay and technical, have given evidence as to the conditions at the farm at Ballycurkeen, other farms in the area and the factory itself in recent years.

The plaintiffs' action is founded on nuisance, trespass, negligence and the rule in Rylands -v- Fletcher, L.R. 3 H.L. 330

So far as the claim in nuisance is concerned, the law was stated as follows by Gannon J. in the following passage from his judgment in Halpin & Others -v- Tara Mines Limited (unreported; judgment delivered 16th February 1976):-

"A party asserting that he has sustained material damage to his property by reason of an alleged nuisance must establish the fact of such damage and that it was caused by the nuisance as alleged. It is no defence to such a claim, if established, that the activities complained of were carried out with the highest standards of care, skill and supervision and equipment or that such activities are of great public importance and cannot conveniently be carried out in any other way. In so far as the nuisance alleged consists of interference with the ordinary comfort of existence and enjoyment of the property of the plaintiff his evidence must show sensible personal discomfort, including injurious affection of the nerves or senses of such a nature as would materially diminish the comfort and enjoyment of, or cause annoyance to, a reasonable man accustomed to living in the same locality. To my mind the reasonable man connotes a person whose notions and standards of behaviour and responsibility correspond with those generally pertaining among ordinary people in our society at the present time, who seldom allows his emotions to overbear his reason, whose habits are moderate and whose disposition is equable."

It was accepted that the distinction drawn in this passage between an action for nuisance founded on interference with personal comfort and one founded on material damage to property

is well established in the law and supported by earlier authority. It was also accepted that the standard applicable in determining whether a nuisance exists in the former category of cases is as stated by Gannon J. in this passage. It is also clear, and was not in controversy, that in the case of material damage, proof of the damage is sufficient to establish the tort of nuisance and that the court is not concerned with the test of reasonableness applicable in the former category of cases.

In the present case, the plaintiffs' principal complaints are of material damage to their health and property. They have also complained of interference with their personal comfort caused by odours which they allege emanate from the defendants' factory and, in this area, the case falls to be determined in accordance with the principles referred to by Gannon J. in the passage just cited. It should be observed at the outset, however, that the overwhelming bulk of the evidence adduced on behalf of the plaintiffs was intended to demonstrate actual material damage either to their own health or the livestock on their farm.

The plaintiffs' case in negligence is that the defendants failed to take reasonable precautions to ensure that toxic, noxious and dangerous substances did not escape from their factory on to the plaintiffs' lands thereby causing them damage.

The plaintiffs, as already indicated, also rely on the rule in Rylands -v- Fletcher: they say that as a result of the non-natural use by the defendants of their land, dangerous and toxic substances have escaped from that land on to the plaintiffs' land and thereby injured them.

If the principles of law stated by Gannon J. were to be applied to this case, the burden of proving that dangerous substances escaped from the defendants' factory and injured the plaintiffs would rest on the plaintiffs. So far as their claim is founded in negligence, the burden of proving that the defendants had failed to take reasonable precautions to prevent the escape of such substances and that damage had thereby resulted to the plaintiffs would also rest on the plaintiffs. It was submitted, however, on behalf of the plaintiffs that, in the circumstances of the present case, the normal principles were not applicable. It is, accordingly necessary before dealing with the facts to consider this submission.

Mr. Gleeson, on behalf of the defendants, at the close of the case submitted that, if the plaintiffs could show that the quality of the air at their farm had been altered from its natural state by the defendants, the burden shifted to the defendants to establish as a matter of reasonable scientific certainty that the alterations which had been brought about were harmless to man and property, including beasts. He urged that, in a case such as the present, it would be unjust and unreasonable to impose on a farmer the atmosphere of whose farm was being admittedly contaminated to some degree by pollutants the burden of proving that the emissions in question were harmful. He urged that, since proof of these matters depended upon elaborate and expensive scientific monitoring, the burden of producing such evidence should be on the party who was responsible for altering the quality of the air in the first place. He said that a legal

system which required the plaintiff to discharge the onus of establishing that the air had been altered to a harmful degree as a result of emissions from the defendants' factory would not respect the constitutional right to bodily integrity recognised in Ryan -v- Attorney General, (1965) I.R. 294. He referred to the insistence by the Supreme Court in a series of cases, the most recent being Trimbole -v- Governor of Mountjoy Prison (unreported; judgments delivered 26th March, 1985) that the courts should be astute to vindicate and protect the rights enshrined in the Constitution in accordance with Article 40.3.

Mr. Gleeson also submitted that, where matters lay peculiarly within the defendants' knowledge, the onus of proof shifted to them, and he relied in this context on the decision of the Supreme Court in Minister for Industry and Commerce -v- Steele (1952) I.R. 304. He also submitted that the courts should consider, in cases of environmental pollution, adopting an approach of the nature indicated in a work entitled "Environmental Law in Japan" by Gresser and Others, published by MIT Press at Cambridge, Mass., at p. 224 as follows:-

"Perhaps the most significant aspect of the Japanese decisions is the courts' attitude towards the problem of scientific uncertainty. The defence of scientific uncertainty, they implied, had been long abused by polluters to subvert the victims' cause; courts must deal with scientific precision differently from the scientific world because other policies and objectives are at stake; and in law, justice at times must prevail over the disinterested quest for abstract truth."

At the close of the argument, Mr. Gleeson said that he accepted that his first proposition should be subject to a qualification that the burden of proof should shift only where a plaintiff had established a prima facie case that his health had been damaged as a result of a change in the quality of the air brought about by the defendant.

I cannot accept the submissions advanced by Mr. Gleeson which appear to me to be contrary to principle and unsupported by authority. They would permit of a far reaching and uncertain exception to the basic rule of our law that the legal burden of proof rests upon the party desiring the court to take action. To allow exceptions to that rule based on the individual difficulties experienced by particular plaintiffs in discharging the normal burden of proof would be to introduce a degree of uncertainty and confusion into the law, which is obviously unacceptable.

The Constitutional right of the plaintiffs to bodily integrity and to fair procedures in defence of that right is undoubted. The fact that they are subjected to the same requirement as to the burden of proof as other plaintiffs does not mean that the rights in question have been eroded in any way.

It was also clear that this case does not fall within any of the well established exceptions to the normal principle that the burden of proof in a case such as this rests upon the plaintiff. The decision in Minister for Industry and Commerce -v- Steele relied on by Mr. Gleeson is authority for the proposition that where the subject matter of an allegation lies peculiarly within the knowledge of a party, the burden of proving it lies upon that party. It has no

application to a case such as the present, where it was perfectly within the competence of the plaintiffs to establish by appropriate scientific measurements any degree of pollution that might exist on their lands. It is, of course, the case that the nature of the manufacturing processes carried on in the defendants' factory would be peculiarly within the knowledge of the defendants. Such a situation is by no means unusual, however, and does not call for the application of the principle relied on by Mr. Gleeson, since the plaintiffs in the present case were in a position to elicit before trial substantial information as to the manufacturing processes carried on by the defendants by means of discovery and interrogatories and did so. These processes, moreover, were investigated in detail during the course of this lengthy trial. In these circumstances, I cannot see that there are any matters peculiarly within the defendants' knowledge in respect of which the burden of proof should shift from the plaintiffs to them.

I accordingly propose to consider the evidence in the light of the burden of proof normally applicable to plaintiffs in cases of this nature. It seems to me that the vast mass of evidence adduced can be most conveniently considered under the following five headings:-

- (1) Evidence as to the health of the plaintiffs and other persons living and working in the vicinity of the defendants' factory;
- (2) Evidence as to the health of animals in the vicinity of the factory;

- (3) Evidence as to damage to plant life in the vicinity of the factory;
 - (4) Evidence as to damage to property in the vicinity of the factory;
 - (5) Evidence as to any causal connection between the processes carried on at the defendants' factory and any incidents of ill-health in humans or animals or damage to plant or property in the vicinity of the factory.
- (1) EVIDENCE AS TO THE HEALTH OF THE PLAINTIFFS AND OTHER PERSONS LIVING AND WORKING IN THE VICINITY OF THE DEFENDANTS' FACTORY

Mr. John Hanrahan gave evidence that on the 28th August, 1978 he was going out to milk the cows one morning, when he noticed a "brownish fog" coming over. He said that he felt a burning of his eyes and skin on that occasion. Subsequent to that incident, he said there were incidents of odours and smells and that on occasions he also suffered from burning of the eyes and of exposed skin. During the years 1979, 1980 and 1981 he continued to experience these problems and noticed the smells on average about three times a month. He said that there was one particularly bad incident on the 11th June 1981 when he and his aunt, Miss Quaide, were milking the cows. He said that a dreadful odour came over with a "dreadful burning effect". On that occasion he felt it burning his skin. The smells and odours became more frequent in mid 1981. He also said that his children at this time were complaining of chest pains, wheezing and burning eyes. He also said that

he was experiencing considerable tiredness and weakness, especially in the morning. Eventually he and Mrs. Selina Hanrahan left and went to live in Piltown, which is about 9 or 10 miles from Ballycurkeen. He visited the factory itself on the 26th February, 1982 and came in contact with what he described as a curious odour similar to the ones he had experienced on the farm which made him cough and wheeze. He found it hard to get his breath.

In cross-examination, he said that he also suffered on occasions from blisters on his tongue and on his head. At times he used to get a dreadful pain in his chest which would force him to lie down on the floor in his workshop. He said that he sought medical advice in relation to his complaints from his G.P., Dr. Roche-Nagle and the latter's wife who was also a doctor. He was referred by Dr. Roche-Nagle to a specialist.

Neither Dr. Roche-Nagle nor his wife gave evidence. The specialist referred to was Dr. Muiris Fitzgerald, Professor of Medicine in University College Dublin and a Consultant in respiratory diseases in Saint Vincent's Hospital. He saw Mr. Hanrahan first in March 1980 and found on examination that he had widespread wheezing throughout both his lungs which was consistent with the history given by him of respiratory difficulty. He also performed certain pulmonary function tests on him and was satisfied that these indicated that there was some degree of obstruction to the air flow from his lungs. Professor Fitzgerald thought that there were two main possibilities which might account for these symptoms, one being that there could be some dust, fumes or vapours in his environment and the other that he was asthmatic.

Professor Fitzgerald admitted him for more detailed investigations in October 1980 when one further abnormality was detected, i.e. his blood count indicated a reduction in the white cell count below normal. Since the problems were continuing, Professor Fitzgerald admitted him for further tests in November 1982 when blood and urine analysis were carried out. The urine analysis demonstrated that there was 1,000 milligrams of bromine per litre present, the normal being 4 milligrams per litre. He said that if it were the case that fumes, dust, vapours and chemicals were present in the botanical or animal life of the area and that acids and vapour were emanating from a source close to the plaintiffs farm, the probability was that his respiratory disease was attributable to a toxic substance.

Dr. Rory O'Moore, a Consultant Chemical Pathologist, gave evidence of the results of analyses carried out by him, or under his supervision, of blood samples given by members of the Hanrahan family, including John. In his case, the results indicated on two occasions a condition which he described as mild hyper chloraemic acidosis. He said that the actual levels involved, which were not dangerous to health could have been caused by a variety of factors and that, on the information available to him, he could not identify a specific cause.

Professor Ian Temperley, a Consultant to the Federation of Voluntary Hospitals and St. James's Hospital and a specialist in haematology gave evidence that an analysis of Mr. Hanrahan's blood indicated a mild decrease in the white cell count in the blood. He said that this was consistent with poisoning by solvents. He also said that it was consistent

with a lot of other things, the most common of which would be a virus infection.

Mr. Hanrahan was examined on behalf of the defendants by Dr. Luke Clancy, a consultant physician who specialises in respiratory medicine, on December 18th 1984. On that occasion, Dr. Clancy said that there were no wheezes or crackles from his chest. He also gave evidence of pulmonary tests which showed no abnormality.

Mrs. Mary Hanrahan said that from 1978 onwards she was occupying herself particularly with her garden. At this stage her son had taken over the management of the dairy herd. She said that, while working in the garden in 1978, she noticed horrible smells on some mornings. On many occasions she had to leave the garden because she was getting chest pains and sometimes the pain was so bad that she would have to go to bed. She stayed on in the house with her sister when Mr. and Mrs. John Hanrahan left to live in Piltown. She said there were still smells at Ballycurkeen, although they were not as frequent as before. She said that she no longer went outside, because if she did go for a walk, she got white blisters on the tip of her tongue. She said she had shown these to the County Medical Officer, Dr. De Sousa, and that he had told her that it was from chemical irritation. She said that she never had any skin trouble but did have some trouble with her eyes in the autumn of 1984.

Dr. O'Moore said there was no abnormality in Mary's blood samples. Professor Temperley said that the analysis showed the same degree of abnormality as was present in other members of the family.

She was also examined on behalf of the Defendants by Dr. Clancy. She gave him a history of having had an operation on the right side of her neck many years ago and a breast operation for a cyst. She also said she had been investigated in 1982 for passing blood from her rectum. She had also been treated for heart strain in the early 1960's. On examination, he found that there was a scar on the right side of her neck which was consistent with the previous operation and that there was a breast scar. Her chest was clinically clear and her heart normal. Her blood pressure was slightly elevated. A cardiograph showed a conducting defect which was of potential significance and would be related, in his view, to the strain for which she was treated at an earlier stage. A chest X Ray showed that the left diaphragm was relatively elevated, indicating previous trouble in that area, possibly associated with the heart strain.

Mrs. Selina Hanrahan said she first became ill on the 6th September 1976, when she was admitted to hospital in Waterford with uterine bleeding. She was in hospital for about six days. In 1977, she noticed her eyes streaming and she also had a sore throat and nose and felt nausea. She said that her health began to deteriorate in 1978, that she felt very weak and suffered from continuous nausea, tiredness and drowsiness. In 1979 she continued to be ill: her eyes were always streaming, mainly in the mornings when she woke up and when she went to bed at night. Her health continued to deteriorate and she regularly attended Dr. Roche-Nagle (the wife of the practitioner of the same name.)

Despite medication, her health continued to deteriorate and at Christmas 1980 she felt particularly ill. On the

11th January, 1981 she was admitted to hospital in Waterford with a uterine haemorrhage. While there she lost her speech and the use of her hands and legs. She was there for roughly seven days. For the rest of that year, she continued to suffer from very bad health, including the streaming eyes, sore nose and sore throat. During this time, there were terrible smells both inside and outside the house and she associated her illness with the smell. Her children at this time were also displaying symptoms of eye irritation and were on one occasion admitted to the Casualty Department of the hospital in Waterford. In 1982, she was again admitted to Auteven Hospital in Kilkenny with a uterine haemorrhage. She was there for about two weeks but was re-admitted shortly afterwards with another haemorrhage. She went to her sister in England to recuperate, remained there a month and went back to Piltown. She was then admitted again to the infirmary in Waterford in September 1982 and referred to the Mater Hospital in Dublin on the 22nd September, 1982 where she had a hysterectomy. By 1984, her health had began to improve somewhat, although she was again admitted to hospital, this time the Bons Secours in Dublin, for further gynaecological surgery. She said that since moving from Ballycurkeen she has had none of the problems she had experienced there, except pains in her arms and an inability to keep her legs steady.

She was seen by a number of doctors over the years in relation to these various complaints: Dr. Roche-Nagle, Mr. Gallagher, Mr. Power, Mr. Heffernan and Professor de Valera. None of these doctors gave evidence. She was examined on behalf of the defendants on February 1st, 1985, by Dr. Dermot McDonald, an Obstetrician and Gynaecologist, who is the Master of the National Maternity Hospital, Holles

Street. He said that he found no abnormalities on his examination. He said that her history indicated that she had suffered from excessive menstrual bleeding, but that there was nothing unusual in this.

Dr. O'Moore gave evidence that Selina was one of the members of the O'Hanrahan family whose blood analysis showed mild hyper chloraemic acidosis. Professor Temperley said that the figures found by him showed a tendency to macrocytosis, i.e. increased size of the red cells, in her case. He said that this was a relatively common finding in certain forms of anaemia, but that she had no evidence of anaemia throughout the period from 1983 to 1985. Dr. McDonald, while disclaiming expertise as a haematologist, said that he would not be concerned with macrocytosis of this nature which he described as "peripheral".

The two remaining adult members of the household, the former Miss Dolly Hanrahan, who was there until her marriage in 1978 and Miss Quaide, who was still there, did not give evidence. No other persons living in the locality gave evidence that they had suffered any illness serious enough to warrant medical attention which they attributed to emissions from the factory. Mr. Thomas Rockett, a farmer whose farm is about a mile and a half to the north east of the factory, said that towards the end of October, 1981, he saw a large cloud rising up from the factory at about 1 a.m. When he went to the immediate area of the factory, he found that his nose was "closed up" and that his lips became wooden. Thereafter he slept with his windows closed. He also remembered occasions in 1981 when he noticed a range of different smells in the field, some of which would "burn the eyes out of you". He also recalled an occasion in the autumn of 1981

when he was out in his fields and noticed a stream of something coming from the factory which "would cut the eyes out of you". Another farmer, Mr. John Wallace, who lives approximately six miles due north of the factory, but who has another farm. about two and a half miles in the same direction from the factory, said that he had experienced unpleasant smells in the immediate area of the factory on two occasions. On the second occasion, in April 1984, he said it was a "burning type of smell" which made him feel "a bit overcome".

Mr. Ger Clancy, one of the a number of Veterinary Surgeons who gave evidence in the case, visited the Hanrahan farm on many occasions from December, 1981 onwards in his capacity as an assistant to Mr. Tom De Lacy, who had been the family's regular vet for many years. He said that on a number of occasions when he visited the farm, he experienced a burning sensation affecting his throat which went "down deep into my chest". He said that it would leave a burning sensation in his throat for some time afterwards. He recalled in particular that when he was shouting at the cows to go up a chute for the purpose of carrying out a TB test on the herd, he was taking in deep breaths of air and had to stop doing so, because his throat was burning so much. He said that this seemed to coincide with a period at which many of the cows were coughing as well. He also recalled an evening when he went home after experiencing this irritation and saw, when he looked in the mirror, that his face was burned red. He said that in the autumn of 1984 he remembered being on the farm on a misty morning, and felt the water dripping off his rainproof on to his hand and stinging him.

Mr. Michael Armstrong, a nephew of Mary, lived on the farm at Ballycurkeen for about a year from September 1981. He said that on a number of occasions he was conscious of a burning sensation, a sore throat and drowsiness.

Dr. Ian Jameson, a senior research officer at An Foras Forbartha who carried out an investigation of ambient air concentrations in the Ballydine area for the benefit of the local planning authority, Tipperary (South Riding) County Council, and whose evidence will be referred to in more detail at a later stage in this judgment, said that on at least two occasions while in the area he was conscious of a feeling equivalent to sunburn which he was unable to relate to the prevailing weather conditions.

Dr. Michael Carey, a specialist in occupational medicine who provided medical services to the defendants, gave evidence as to the state of health of the employees of the defendants. The total number of persons employed in the factory is 256. He said that persons who were in what were described as "potentially exposed areas" were called to the Medical Department every six months for blood tests and were given a full examination every year. Others who would go to those areas from time to time were asked to fill in a questionnaire as to their health once a year and were seen by Dr. Carey every second year. He also attended regularly at the factory three days per week. He said that none of the blood tests at any stage disclosed any abnormality, save in two cases, one referable to a peptic ulcer and the other to the taking of pills known to cause bleeding. He had found no significant incidence of chest pains and lung tests also produced normal results. He said that there were occasional cases of dermatitis

with symptoms of burning and irritation, which had resulted from local contact with irritant substances. The dermatitis was not on a large scale and in a number of instances was due to lack of hygiene on the part of the affected employees. While some of the people worked inside the factory, others also worked outside. Thirteen of the people employed in the factory were living in its close vicinity.

A number of other persons living in the vicinity gave evidence, but while some of the them said that they had on occasions experienced unpleasant smells, none of them complained of any adverse effect on their health.

There was no other direct evidence of damage to the health of persons living or working in the area which could be related to atmospheric pollution. Mr. John Condon, the head of Personnel in the defendants, gave evidence that a formal method of recording complaints in relation to odours was introduced by the defendants in May 1979. This evidence may be summarised as follows. A total of 227 complaints were made by 18 households. By far the greatest number of individual complaints (108) came from a Mr. and Mrs. Perrigoe who own a licensed premises called "Ike and Mike's" near the entrance to the factory. Next on the list were Mr. and Mrs. Foley (34), Mr. John Hanrahan (33) and Mr. P. Hackett (24). The next highest total was from a Mrs. Ahearne (6). The overwhelming majority of these complaints were confined to complaints of smells. A complaint was made on one occasion by the Perrigoe's of irritated eyes, on another occasion of choking at night and, on a third occasion, of a "burning smell". The Foley's complained on one occasion of a choking odour and on another occasion of choking. Mr. Hackett complained on one

occasion of burning eyes, on another occasion of a "smothering effect" and on a third occasion of a "sinus cleaning sensation" Mrs. Ahearne complained on one occasion that the children were ill. There was one other complaint of suffocating, one of a breathing problem, one of a choking type smell and one of "burning".

(2) EVIDENCE AS TO THE HEALTH OF ANIMALS
IN THE VICINITY OF THE FACTORY

So far as animal health is concerned, the evidence related for the most part to cattle. This evidence may conveniently be grouped under different headings.

(1) Increased mortality in cattle.

In a reply to a letter for particulars dated the 6th of December 1984, the plaintiffs' solicitors gave the following details as to the alleged animal mortality:-

"1976 to 1980 incl.	Details of deaths were not kept but the evidence will be that animal deaths from all causes were under the national average in these years and in any one year did not amount to more than 10 animals.
1981	9 cows, 15 weanlings, 24 calves
1982	6 cows, 2 weanlings, 32 calves
1983	1 bull, 1 bullock, 6 cows, 7 weanlings 21 calves.
1984	4 cows, 3 weanlings, 14 calves."

Mr. John Hanrahan said in evidence that no details of cattle deaths were kept in the years from 1976 to 1981. From 1981 onwards, a list of deaths of cattle in each year

was compiled by his wife. He said that this list was based on pieces of paper or diaries in which cattle deaths and other incidents on the farm during those years were recorded.

Two lists of cattle deaths for the relevant years had been discovered prior to the hearing by the plaintiffs (items number 438 and 474 in the plaintiffs' discovery.) The figures in these, however, do not correspond precisely to the figures in the Notice for Particulars: the last mentioned gives a total of 48 cattle deaths for the year 1981, whereas document 438 gives a total of 43 for that year and document 474, 41.

Mrs. Selina Hanrahan said in evidence that these lists were compiled from pieces of paper and diaries. She said she had kept the diaries, but not necessarily the pieces of paper. Once the latter had been transcribed into the folders where she was keeping the lists, the pieces of paper could well have been disposed of. She referred to a number of diaries in which she said records had been kept by herself, her husband, Patrick Quinlan (an employee of the Hanrahan's on the farm) and occasionally the two Hanrahan children.

When these diaries were produced by Mrs. Hanrahan in the course of her direct evidence, Mr. Liston objected to their going into evidence on the ground that they had not been discovered by the plaintiffs, apparently on the ground that they were privileged documents which had been brought into being for the purpose of the litigation. The diaries had not been listed individually in the relevant part of the plaintiffs Affidavit of Discovery and, in the circumstances, I was satisfied that it would be unfair to allow the diaries to be introduced in evidence in this manner. Accordingly, I ordered

the plaintiffs to make a Supplemental Affidavit of Discovery setting out all the records relating to these matters during the relevant periods.

Diaries relating to events on the farm, including cattle deaths, were kept by Mrs. Selina Hanrahan for the years 1981, 1982, 1983 and 1984. Mr. John Hanrahan also kept diaries for these years, but the entries were concerned with a wide range of other matters and there are not many references to cattle deaths (some of the entries in his diaries are in fact made by Mrs. Selina Hanrahan.) Mr. Patrick Quinlan kept diaries during the years 1981, 1982, 1983 and 1984. They did not cover the whole of the relevant periods, however, and contain few references to cattle deaths.

It is clear, accordingly, that the principal source for items 437 and 474 in the plaintiffs' original Discovery (and, to the extent that it was based on them, the reply to the letter for particulars) were the diaries kept by Mrs. Selina Hanrahan. She said in the course of her evidence that she had obviously not witnessed herself the deaths of all the cattle referred to and would in many instances be dependent on information furnished to her by her husband or Mr. Patrick Quinlan, either orally or in the form of notes. In addition, she would transcribe entries from their diaries into her diaries in order to ensure that she had a complete record. She also said that on the occasions when she spent periods in hospital, it was not always possible for her to make the entries on a day to day basis. She said that normally when given the relevant information she would transcribe it into the diary within the next day or two. In cross-examination, however, she agreed that some of the entries in the diary had obviously been made by her several weeks after the events

which they purported to record, since in some instances the same matters were described twice and then one of the entries struck out. She also agreed that, although some at least of the cattle recorded as having died on the farm had in fact been sent to the factory for slaughter, there was no indication of this in the diaries themselves.

Certain of the entries in the photocopies of the original diaries taken by the defendants' solicitors did not correspond to the entries in the originals. Mrs. Selina Hanrahan agreed in cross-examination that, after the Supplemental Affidavit of Discovery had been sworn exhibiting her original diaries, she had herself in some instances inserted additional words in entries in the original diary where she thought these words must have been inadvertently omitted, since they did not correspond to the records subsequently compiled by her. She said she had not intended to mislead the court by doing this.

Messrs. KMG Reynolds McCarron, Chartered Accountants, prepared accounts in respect of the farming business for the period commencing on the 1st January, 1979 and ending on the 30th June, 1984. Evidence in relation to these accounts were given by Mr. Patrick McGuigan and Mr. Ted Newman of that firm. They were first retained by Mr. John Hanrahan in June, 1982. As part of their accounting procedure, they prepared for each year a livestock reconciliation account. This was based in the first instance on a stock-taking done by Mr. Hanrahan in June 1984. Using those figures and the records of sales and purchases of cattle since January 1st 1979 and making certain assumptions in relation to calving during the period, this reconciliation account produced certain figures for deaths in

the herd during this period. The total was 140, the total in the Notice for Particulars being 145.

Dr. Nicholas Bielenberg, the principal of Stewarts Limited, Farm Management Consultants, also gave evidence in relation to this matter. Dr. Bielenberg examined the same material as was available to the accountants, and in addition took into account the records of the numbers of animals produced for the TB test under the Department of Agriculture scheme in each year. The figure he arrived at, based on this material, was a total of 65 deaths for the whole of the period. The difference between the accountants' figures and Dr. Bielenberg's figures is accounted for by:-

- (a) A different figure for the opening stock as of 1st January 1981.
- (b) Different figures for the births in 1981 and 1982.
- (c) Different figures for the closing stock as of 30th June 1984.

Mr. Tom De Lacy, who has been the Veterinary Surgeon attending the farm for many years, said that from 1977/8 onwards, it seemed to him that the number of cattle deaths generally and of calves being born dead on the farm was on the increase. His view as to calf deaths was confirmed by one of his assistants, Mr. Martin O'Gorman, who joined the practise in 1970.

That summarises the position as to abnormal cattle mortality on the plaintiffs' farm in the period January 1st 1979 to June 30th 1984.

A number of farmers in the vicinity of the factory gave evidence. Mr. John Callanan, whose farm is about a mile to the east of the factory said that he had some problems with unusual cattle deaths in 1980 and 1982. His veterinary surgeon,

Mr. Brendan Walsh, who has a number of clients in the vicinity of the factory, also gave evidence, and said that he had not found any significant increase in cattle mortality in the area during the relevant period. He was aware of and had dealt with the cases referred to by Mr. Callanan but did not appear to regard them as requiring any qualification of his general opinion. Mr. Thomas Rockett whose farm is about a mile and a half to the north east of the factory, did not give any evidence of a rise in cattle deaths during the relevant period. Mr. John Widger, whose farm is about two and a half miles to the south east of the factory, said that in 1981 he lost approximately 13 calves, 2 cows and 12 or 13 weanlings, which he regarded as an unusually high number. His veterinary surgeon, Mr. Drummy, did not give evidence. Mr. John Wallace who owns two farms, one two and a half miles and the other six miles due north of the factory, gave no evidence of any increase in cattle deaths. The same applies to Mr. Martin Long, who is 300 yards east of the factory, Mr. John Kehoe, who owns two farms, one about three quarters of a mile from the factory and the other about three miles north of the factory, Mr. Edmond Hearn whose farm is about two to two and a half miles north-east of the factory, and Mr. Tom Kiely, whose farm is two miles north-east of the factory. Mr. Michael Hickey, a road-overseer, who lives about half a mile north-east of the factory and keeps a few calves, gave no evidence of an increase in cattle deaths.

Mr. Brendan Walsh, the vet already referred to, said that there was no evidence of any increase in cattle deaths in any of the farms which he visited in the area during the relevant

years, with the exception of one client who lost 27 calves in 1981. Mr. Walsh was satisfied that these deaths, which were unusually high, were due to a condition called white scour. He said he had a similar experience with another farmer in Piltown. Evidence to the same effect was give by Mr. Walsh's assistant, Mr. Martin Fitzgerald.

(2) Unusually high incidence of twinning

Mr. John Hanrahan said that the highest incidence of twinning that he could recall on the farm was three and the number was more usually one or two. He said that in 1981 there were more than 14 sets of twins. Mr. De Lacy said that the incidence of twinning in the herd subsequent to 1978 was "extraordinary" compared with the previous history. There was no evidence from any of the other farmers in the area or the veterinary surgeons practising in the area of an abnormal incidence of twinning in cattle herds.

(3) Births of deformed calves

Mr. John Hanrahan said that subsequent to the year 1978, an unusual number of deformed calves were born on the farm. Mr. De Lacy also said that from 1981 onwards quite a number of calves were born dead and deformed. There was no evidence from other farmers or veterinary surgeons in the area of deformed calves being born in any significant numbers during this period.

(4) Coughing, running eyes and nose

Mr. John Hanrahan gave evidence that from August, 1978 onwards there were numerous occasions of which he had no previous experience when nearly all the cattle in his herd were coughing and had running eyes and noses. The first occasion

on which this occurred to any significant extent was on the 27th August, 1978, the day on which he observed the brownish fog in his yard. He said that on that occasion he saw that the cattle closest to the milking parlour had a discharge coming from their eyes. There were many similar subsequent incidents, he said, but particularly on the 11th June, 1981, when he said that as he was milking the cows he was affected by a dreadful odour with a burning effect. He said that on that occasion all the cows in the yard started to cough and that their eyes were streaming. He said that on many occasions subsequently to that he had seen the same phenomena in his herd.

Mr. De Lacy and the three vets who assisted him in his practice, Mr. O'Gorman, Mr. Clancy and Mr. Keating, all of whom attended the farm on many occasions, gave evidence of having seen these phenomena on numerous occasions. It was also observed by Mr. Peter Dougan, a veterinary surgeon who acts for the Tipperary (South Riding) County Council and Mr. Patrick Crowe, another veterinary officer who is the senior officer in charge of the regional laboratory at Kilkenny. Mr. Clancy said that he had particularly observed the coughing on the day when he was conscious himself of a burning sensation and a feeling of irritation in his throat.

Mr. Rockett also said that his cattle began coughing in June of 1981. Mr. John Widger saw his cattle running from the eyes from September, 1980 onwards. Mr. John Wallace gave evidence to the same effect as to his cattle.

(5) Reduction in milk yield

Mr. John Hanrahan said in evidence that there had been a reduction in the milk yield from 1980 onwards. Mr. De Lacy also said that he thought the cows were not producing milk in the same quantity from 1980. Analyses of the milk yields for

the relevant years were made by a number of experts who gave evidence.

Mr. Michael English, the Chief Agricultural Officer for South Tipperary, produced the following table:

YEAR	NO. OF COWS	TOTAL MILK SOLD	AV./GALS COW	FED TO CALVES	AV/COW	CALCULATED YIELD	NATIONAL AVERAGE MILK YIELD
1978	+12	84022	750	108+ 40	(38.5)	788	643
1979	109	99314	911	115+ 40	(42.2)	955	662
1980	120	87072	725	138+ 40	(46)	771	665
1981	130	107839		Nil		829	671
1982	153	112612		Nil		736	701
1983	182	143711		Nil		790	925
1984	190	155584		Nil		818	-

The figures for total milk sold were based on the record of payments made by Avonmore Co-operative Limited for the relevant years. The number of cows in the herd at the relevant time was then divided in order to get an average of gallons per cow. For the first three years (1978 to 1980 inclusive) when some of the milk was being fed to calves, it was assumed that forty gallons a year were fed to each calf and this gave an addition to the average which is shown in the sixth column.

Mr. English said that the figures demonstrated that there was a sharp decline in the milk yield after the peak year of 1979.

These figures were disputed on behalf of the defendants who said that they disregarded the fact that in 1979 a total

of thirty-four in-calf heifers, which would have been part of the opening stock, would have calved down in the early spring, since this was an early calving herd. It was said that this would have resulted in one hundred and fifty one lactating animals for at least part of the year. It appeared that thirty-nine dairy cows had been sold during that year, but it was pointed out on behalf of the defendants that thirty of these calves would have been sold to the factory as brucellosis reactors in the months of November and December, and that they would accordingly have been absent from the lactating herd for a relatively short period only and when milk production would have been at its lowest. On this basis, Dr. Mark Lynch, an Agricultural Inspector in the Department of Agriculture who conducted an investigation, in association with the Regional Veterinary Laboratory in Kilkenny, of the problems being experienced by the plaintiffs, said in evidence that the figures should be revised as follows:

1978	1979	1980	1981	1982	1983
780 gals	794 gals.	761 gals.	829 gals.	721 gals.	789 gals.
643 gals.	662 gals.	663 gals.	671 gals.	701 gals.	(na)

(The second row of figures represents, according to Dr. Lynch, the national average for each of the relevant years).

There was no evidence as to a reduction on a significant level in milk yield of any of the other dairy herds in the area.

(6) Sore and cut teats

There was evidence from a number of witnesses that the cattle on the Hanrahan farm had an unusual incidence of sore and cut teats from 1980 onwards. Among the witnesses who said

that they observed this were Mr. John Hanrahan, Mr. Patrick Quinlan, Mr. De Lacy and Mr. O'Gorman. Mr. Douçan, the County Council vet, also gave evidence of a complaint affecting the teats, which he described as a form of pock or viral disease. He said he had not encountered it before.

There was no evidence from other farmers in the area as to cut or sore teats.

(7) Stampeding of cattle

Mr. John Hanrahan gave evidence that on occasions since 1979 the cattle stampeded in the fields, something which he had never observed before. Mr. Rockett also gave evidence that sometimes they would try to get out of a particular field. He also said that he thought that they were unwilling to eat the grass in some fields, a characteristic which he had never noticed before the year 1981. A number of other farmers living in the area who gave evidence and whose names have already been mentioned did not observe these phenomena.

(8) Lack of thrift

A number of witnesses gave evidence that from 1980/1981 onwards the herd on the Hanrahan farm appeared to deteriorate in quality and that the animals were showing lack of thrift. Among the witnesses who gave this evidence were Mr. John Hanrahan, Mr. Patrick Quinlan, Mr. De Lacy, Mr. O'Gorman and Mr. English. Dr. Bielenberg and Dr. Kevin Dodd, a lecturer in the veterinary faculty in University College, Dublin, inspected the herd in February 1985. Dr. Bielenberg said that they were in normal condition with the exception of between 7 and 10 older cows which were in poor condition. Dr. Dodd said that they were in moderate condition such as he would expect at the end of the winter period.

(9) Other complaints affecting cattle

Mr. John Hanrahan and Mr. De Lacy gave evidence that the skin of some of the cattle tended to be discoloured or hairless in recent years. The former also gave evidence that the hooves of a number of the cattle were overgrown. He produced a set of photographs which he had taken in order to illustrate these conditions.

There was also evidence from these witnesses of an abnormal incidence of cows in calf coming in heat, of cows dropping the cud and of a reduced libido in the bulls on the farm.

(3) EVIDENCE AS TO DAMAGE TO PLANT LIFE IN THE VICINITY OF THE FACTORY

Mrs. Mary Hanrahan gave evidence that in the spring of 1981 some tomato plants which she had been growing simply stopped developing. She also said that the ivy on a number of trees had a burnt appearance and that in one field the pasture had an abnormal colour, consisting of patches of green and yellow. She also said that the flower heads on the delphiniums in the garden were abnormally high. She gave the same evidence in relation to some vegetables, including artichokes and runner beans.

Dr. Paul Dowding, who has a degree in botany and a doctorate in forest pathology from Cambridge, is the director of environmental science in Trinity College, Dublin and is also a member of a number of meteorological societies. His principal area of research in recent years has been the movement of air and particles of air near the ground surface and the study of the weather. He has been responsible for the pollen count survey in Dublin for the past seven years. His principal teaching study during the past sixteen years has

been plant pathology.

Dr. Dowding visited the garden on the Hanrahan farm in September 1982 and was shown some plants by Mrs. Mary Hanrahan. These included a snowberry plant the leaves of which were damaged and some nettles which looked as though they had been dipped in boiling water. He had seen neither of these lesions before and removed samples of the plants for microscopic examination. He was subsequently sent further plant samples by Mrs. Hanrahan which were also damaged. His laboratory examination and tests did not reveal any of the wide range of bacterial or fungal organisms which grow in plants and cause disease. He concluded that they had been subjected to some non-biological agent which caused localised death in the plant but he was unable to deduce anything further as to the nature of the agent. He then supervised a research project by one of his students into the effect of ammonia gas for short periods on a dandelion plant and found that the symptoms in the leaves were very similar to those produced in damaged ash leaves from Mrs. Hanrahan's garden and in the damaged nettles. These were achieved after an exposure for 12 minutes at a concentration of 100 mg/m³. He concluded that the lesions in the plants from Mrs. Hanrahan's garden were due to their exposure to high concentrations of acid or alkaline gas.

There was also evidence from a number of the witnesses, including Mr. John Hanrahan, Mrs. Mary Hanrahan and Mr. De Lac, that the silage in some of the relevant years had a peculiar smell and a different appearance from what was usual.

(4) EVIDENCE AS TO DAMAGE TO PROPERTY IN THE VICINITY OF THE FACTORY

Mr. John Hanrahan said that in 1979 he began to observe a lot of "corrosion" on the farm. He said he noticed that this was particularly evident in a machine which he had on hire in

December of that year. He also said that he saw signs of corrosion on a barn belonging to Mr. Rockett on the adjoining land. Mrs. Selina Hanrahan said that she also saw evidence of corrosion on a farm sign which her husband had erected and also on the steel farm gates.

There was no evidence from any other persons living in the area of damage to property which was thought to result from emissions from the factory.

(5) EVIDENCE AS TO ANY CAUSAL CONNECTION BETWEEN THE PROCESSES CARRIED ON AT THE DEFENDANTS' FACTORY AND ANY INCIDENTS OF ILL HEALTH IN HUMANS OR ANIMALS OR DAMAGE TO PLANT LIFE OR PROPERTY IN THE VICINITY OF THE FACTORY

The logical and convenient method of dealing with this part of the case would seem to be to consider in turn

- (1) the evidence as to the presence of toxic gases, vapours or other substances on the Hanrahan farm or in the vicinity of the factory
- (2) the evidence of any emissions from the factory of toxic gases, vapours or other substances
- (3) the evidence indicating any connection between any toxic gases, vapours or other substances emitted by the factory and any injury to people or animals or damage to property on the Hanrahan farm or in the area generally
- (4) the evidence as to other possible causes of any animal ill health
- (1) Evidence as to the presence of toxic gases, vapours or other substances on the Hanrahan farm or in the vicinity of the factory

Dr. Geoffrey Buck gave evidence of having taken part in an environmental study which was undertaken by the Environmental Research Department in Trinity College, Dublin and An Foras Forbartha into the cause of air pollution in the Fallydine area. Dr. Buck holds an honours degree in applied biology from the University of Salford and subsequently did post graduate work in the Botany Department of the University of Bristol. Having obtained his doctorate in January 1981 he took up a post doctoral fellowship in Trinity College Dublin.

The first investigation of which Dr. Buck gave evidence was into lichen. He said that lichens provide a useful method of assessing air pollution and in particular the levels of sulphur dioxide in the atmosphere.

Dr. Buck said that the survey in which he participated established that there were chronic levels of air pollution in the area and that they indicated the factory as being a source of air borne sulphur. He also said that bromine was present above the average. His reasons for concluding that the lichen survey pointed to the factory as a source of atmospheric pollution can be summarised as follows:-

- (i) Discoloration of the lichen
- (ii) A slight change for the worse (i.e. a reduction) in the extent of the lichen as measured over a period of three years. (The extent of lichen in a particular area is graded on a scale from 0 to 10 with the centre of Dublin represented by 0 and the west coast of Ireland by 10). Dr. Buck found changes from 9 to 8 in the immediate area of the farm and to 5 coming nearer the factory.

Dr. Buck also gave evidence of having analysed the presence of bromine and chlorine in samples of hair taken from cattle on the Hanrahan farm, the tail of a pony on the Hanrahan farm and Mrs. Mary Hanrahan's hair. These were compared to control samples taken from a farm in County Meath and a pony at Knockeen, South Waterford. Dr. Buck said that the graphs showed additional peaks of bromine and chlorine in the Ballydine area as contrasted with the other areas in 1981. He said the graphs ruled out the sea as being a cause of these peaks. He also said that bromine as an element has toxic properties.

In cross-examination Dr. Buck agreed that there were certain deficiencies in his lichen study. The second survey had not precisely replicated the first and he accepted that this could make the results misleading. He also accepted that, although he had said in his direct evidence that he had taken one genus only (the ramalina), he had in fact taken another genus, the evernia. (The significance of his taking two genera instead of one is that, as Dr. Buck conceded, where the species are not comparable the conclusions reached by him have no validity). He agreed that a criticism contained in a subsequent report by Professor Richardson, the head of the Botany Department in Trinity College and Dr. Doff of the Geology Department of that University, that he had overstated the levels of bromine by a factor of 1.8 was correct. He also accepted that this latter report had made use of a herbage analysis carried out by An Foras Taluntais in 1978 which demonstrated that the mean values for sulphur, chlorine and bromine were actually lower in 1982 than in 1975.

Dr. Buck's methodology was criticised in a number of respects by Dr. Denis Brown, who is a lecturer in the Department of Botany in the University of Bristol and under whom Dr. Buck did some of his post graduate work. He said that on the basis of the elemental analysis carried out by Dr. Buck, the conclusion drawn by him of pollution in the Ballydine area was inappropriate.

Dr. Ian Jameson, a senior research officer in An Foras Forbartha, who has a primary degree in applied chemistry from the Harold Watts University in Edinburgh and a Ph. D. from the Witwatersrand University in Johannesburg, gave evidence of a number of investigations he had carried out into the question of air pollution in the Ballydine area from March 1980 onwards. This was done at the request of the Tipperary (South Riding) County Council. In the first instance, he carried out a programme of monitoring of ambient air concentrations in the Ballydine area over a ten week period from the 15th May to the 23rd July, 1980. As a result of this investigation, Dr. Jameson produced a report dated October 1980 entitled "Investigation into air pollution and associated aspects at Ballydine, Co. Tipperary". In this report, Dr. Jameson made a number of recommendations to the County Council for further monitoring and this was done for a period of thirteen months from April 1981. A further report was then made by Dr. Jameson in August 1982 entitled "Air pollution monitoring and investigations at Ballydine, Co. Tipperary (SR) 1981-1982: Interim Report".

Dr. Jameson's interim report contains a number of tables setting out the concentration of acid vapours and organic vapours in the ambient air at certain locations in the Ballydine area, including locations on the Hanrahan farm.

He said that the concentrations at all three locations were generally low, though relatively high daily average values at Ballydine occurred at times during May, June and August 1981. The highest daily average value, recorded on 19th June, was $159\text{mg}/\text{m}^3$ and a level of $100\text{mg}/\text{m}^3$ was exceeded on five occasions in June and once during August. He said that he also carried out a series of measurements to determine whether acid vapour concentrations were occasionally higher at certain times of the day than at others. The monitoring apparatus was accordingly altered at location 5 (on the Hanrahan farm) so as to operate every three hours instead of every twenty-four hours. Further measurements were taken on a day to day basis, i.e. where the contents of each of the vessels in the monitoring apparatus comprised vapours collected during one three hour period only. The results of these categories of tests are set out in Dr. Jameson's report at tables 1, 2 and 3 respectively.

Dr. Jameson said that the conclusion he drew from the results of the monitoring was that, in general, the acid vapour concentrations in the ambient air at Ballydine were very low and complied with air quality standards at all times. He said that the annual arithmetic mean of daily average acid vapours at location 1, on the Hanrahan's farm, at $22\text{mg}/\text{m}^3$ was well within accepted air quality standards. In the particular case of sulphur dioxide, he said that the acid vapour concentrations at Ballydine were particularly low during the winter months when emissions from the factory would be at their highest, leading to the conclusion that episodes of relatively high acid vapour concentrations during June and August 1981 were due to emissions from some source other than the factory's boiler

stack. The emissions at that time were in his view due to emissions from chemical processes in the factory. (It has to be borne in mind in this context that the conventional measurement of acid vapours is in terms of sulphur dioxide, although the actual acid vapour may consist of other acids, such as hydrogen chloride).

Dr. Jameson's monitoring was also intended to measure the presence of organic vapours in the area of the factory and specifically on the Hanrahan farm. The concentrations in the atmosphere of specific organics were determined by means of gas chromatography and the constituents thus isolated included some compounds which were used in the manufacturing processes at the factory including toluene, benzene, chlorobenzene and thioanisole. The concentrations found by Dr. Jameson are set out in table 4 of the interim report segregated between benzene, toluene and other organics. Of these organics, the highest concentrations observed were of toluene. This organic is normally present in the ambient air in the range 0.1-2.0 parts per billion, but the presence of concentrations in excess of this level at points outside the factory indicated to Dr. Jameson that the normal ambient concentrations could be augmented by solvent vapours from the factory. This appeared to be confirmed by the fact that concentrations were generally lowest at the level furthest from the factory and by the fact that relatively high toluene concentrations were found inside the factory area during the 1980 and 1982 investigations. Dr. Jameson said that the concentrations found were well within the guidelines used by many authorities.

In the case of both acid vapours and organics, the standards generally employed for chemical substances in the work environment in this country, the United Kingdom and the United States are the 'Threshold Limit Values' adopted by the American Conference of Government Industrial Hygienists, usually abbreviated to TLV. They are further divided into three other categories. The first is the Threshold Limit Value - Time Weighted Average (TLV-TWA), which is the time weighted average concentration for a normal eight hour work day and a forty hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The second is the Threshold Limit Value - Short Term Exposure Limit (TLV-STEL), the concentration to which workers can be exposed continuously for a short period of time without suffering from certain specified injuries to their health provided that the daily TLV-TWA is not exceeded. The third is the Threshold Limit Value - C (TLV-C) which indicates that, in the case of the particular substance, the TLV should never be exceeded.

It is, of course, clear that, since these standards are specifically designed for the work environment, they cannot be taken as a guide to safe levels for persons who are exposed on a 24 hour basis without being significantly modified. It was accepted that, for this reason, they are not intended for use in the evaluation or control of community air pollution nuisances, but Dr. Jameson said, and this was borne out by other witnesses, that it was generally accepted in the United Kingdom and this country, that a reasonable guideline for 24 hour exposure could be obtained by dividing the relevant TLV by a factor of 40. The concentrations of both acid vapours

and organics in the Ballydine area as measured by Dr. Jameson were within these guidelines. (It should be noted in passing that the TLV applicable to the work environment has to be reduced not merely because one is concerned with a 24 hour exposure as contrasted with an 8 hour exposure, but also because one is concerned with a wide range of people including the elderly and infirm who may have a lower resistance to the substances in question than workers in a factory).

Dr. Jameson agreed in cross-examination that his monitoring programme did not demonstrate what the concentrations of acids or organics would have been at particular points of time less than the three hour period at the Hanrahan farm or other locations. If, for example, all the hydrogen chloride measured in the course of a day arrived in the course of 15 minutes rather than throughout the day, the concentration of hydrogen chloride during the 15 minutes would obviously be significantly higher than the concentrations recorded by Dr. Jameson. It was suggested to him in cross-examination that this was of particular relevance, since the odours associated with emissions from the factory tended to be present for periods of not more than 15 minutes to 30 minutes. In his interim report, Dr. Jameson had in fact set out in table 9 the number of occasions when the concentration of acid vapours at the monitoring sites might have exceeded the TLV concentration for 15 minutes or more. This showed that in May, 1981 and June 1981 the TLV thresholds could have been exceeded on 6 and 15 occasions respectively. This, of course, is on the assumption that no other acid fumes were collected during the whole of the 24 hour period. Dr. Jameson said that it

was unlikely that there would be no other acid vapour collected over the remaining 23 hours and 45 minutes. He also said that if he were to revise the calculation in the case of table 9 and assume that the acid vapours arrived in 30 minutes rather than 15 minutes the result would be "dramatically" different. The number of times the TLV would be exceeded in all in that situation would be only twice.

Dr. Jameson also agreed that the concentrations measured of the acid vapours were in general terms $3\frac{1}{2}$ times higher on the Hanrahan farm than on an adjoining farm where another of the monitoring sites was located, but he emphasised that these were in both cases relatively low concentrations.

It was also clear that the TLV and other environmental health guidelines applied by Dr. Jameson were relevant to human health and were not intended to deal with the case of animals.

(2) Evidence of any emissions from the factory of toxic gases, vapours or other substances

Mr. Declan Buckley, the General Manager of the factory, said in evidence that there were three main sources of emissions. The first major source was the boiler-house stack. The emissions from this are the gases given off by the burning of heavy fuel oil to produce energy and heat in the factory. The gas principally emitted is sulphur dioxide. He said that the emissions were not specifically related to the manufacturing process carried on in the factory and would be the same as those produced by any large scale process industry. The second source of emissions was the process scrubber stack. He said that this was intended to deal with gases evolved

during the reaction process which was an integral part of the manufacturing of bulk drugs carried on by the company. The gases - which were either acid gases or organic vapours - were passed into two scrubbers. The scrubbing action was caused by the gas passing through a spray of caustic soda, which is an alkaline solution, and through a water spray. He said that this had the effect of neutralising acids, absorbing solvents which were soluble and knocking down the trace organic solvents which were not soluble. The scrubber system, which he said was a normal feature of modern chemical plants, was intended to ensure that only very low levels of organics or acids would be emitted from the process scrubber stack. The third source of emissions was an incinerator, which was used to burn waste solvents that were not going to be re-used or the residue of pot-still bottoms, i.e. what was left after the solvents had been distilled off from a mixture of solvents and other solids.

Mr. Buckley said that, in addition to these sources of emissions, there were vents in the building to enable steam generated in the process to be emitted from the process building. He said that such emissions were intermittent only and would contain only trace amounts of solvents. He said there were also vent stacks on the main process building intended to extract the air from the building as part of a normal air conditioning process.

Mr. Buckley produced the permissions granted by the Tipperary (S.R.) County Council for the erection of the factory under the Local Government (Planning and Development) Act 1963. The first permission incorporated a number of conditions recommended by the Institute of Industrial Research and Standard

intended to control air pollution resulting from emissions of sulphur dioxide. He said that as a result of discussions with the County Council in 1974, certain modifications were made to the plant with the approval of the County Council. He said that in 1976 as a result of the decision of the defendants to manufacture a product called sulindac, a further permission was obtained dated the 10th September 1976 containing additional conditions as to air pollution again recommended by the I.I.R.S.

Dr. David McSweeney, the head of the technical services at the factory, said in evidence that since 1978 there were records relating to the materials which were sent for incineration. He said that, in addition, since December 1981 there were records as to the emissions from the incinerator. He said that the data as to the emissions was also furnished to the planning authority. He also said that in 1983 the I.I.R.S. was commissioned by the planning authority to examine the operation of the incinerator and to test emissions. He said that they came in late 1984 and did a similar type of test. He said that in addition to the planning permission, it was necessary for the defendants to obtain a licence from the local authority under the European Communities (Toxic and Dangerous Waste) Regulations 1982 for the storage and treatment of toxic and dangerous waste. He said that such a licence was granted on the 8th March 1984. It contained the same limitation on the emission of acid vapours from the incinerator as was contained in the planning permission, i.e. $460\text{mg}/\text{m}^3$. It also contained a limitation on emissions of aromatic solvent vapours, i.e. 150 kilograms per day or

10 kilograms per hour, which had not been contained in the planning permission. Dr. McSweeney said that while the extent of the operation of the incinerator varied from year to year, it was never more than 18% or less than 6%. In the case of emissions from the scrubber stack, spot checks were carried out from 1977 until the end of 1981. Continuous monitoring of emissions from the scrubber stack took place from December 1981 onwards. The records as to scrubber stack emissions showed that limits imposed by the planning permission on emissions from the scrubber stack had been exceeded on a number of occasions in May and June 1980. The details are set out in the accompanying table.

DATE	FUME BEING MONITORED	ALLOWABLE EMISSION	ACTUAL EMISSION
22/05/1980	Hydrogen Chloride	46/mgs/nm ³	1796/mgs/nm ³
23/05/1980	Hydrogen Chloride	46/mgs/nm ³	1739/mgs/nm ³
29/05/1980	Hydrogen Chloride	46/mgs/nm ³	1157/mgs/nm ³
31/05/1980	Hydrogen Chloride	46/mgs/nm ³	1621/mgs/nm ³
04/06/1980	Hydrogen Chloride	46/mgs/nm ³	1741/mgs/nm ³

Dr. McSweeney said that bromine had been used in the manufacturing process at the factory in 1977/8 in the form of a compound called dimethyl dibromine hydroxine (DDH). Lithium bromide had been used in December 1981 and January 1982. Bromine had not been used in any form during 1981 except in December of that year.

The disposal permit required that the incinerator should operate at specific temperatures. A minimum "residence time" of one second was required under the terms of the permit at a minimum temperature of 750° centigrade. It was established from the records furnished by the defendants as part of the discovery process that, on a number of occasions, the incinerator had operated at temperatures significantly below this requirement. This happened particularly during the period 1980/1982 and Dr. McSweeney agreed in cross-examination that the temperature should have been raised during that period. He said that it would have led to increased emissions during those periods because of incomplete combustion but said that any increase in the emissions would have been harmless.

Dr. McSweeney was cross-examined at length in relation to the functioning of the incinerator. He agreed that the flow meter on the incinerator was too large and that the tracing machinery used for recording the temperature variations was not satisfactory. He did not, however, accept the incinerator ever operated at dangerous temperatures or that large volumes of half burned or unburned solvent were put out into the air.

Dr. McSweeney was also cross-examined at length as to the possibility of unknown compounds being incinerated. He said that the elemental compositions of the unused solvents being sent to the incinerator were all known. In addition there would be a residue - amounting to 1% in volume of the total sent to the incinerator - which would consist of residues left after the boiling off of the solvents. In respect of these he said that .01% would consist of the elements nitrogen,

fluorine, sulphur or chloride. In the course of cross-examination, Dr. McSweeney gave details of the molecular structures of the byproducts produced during the recovery of the solvents and fed to the incinerator.

Dr. McSweeney was also cross-examined in relation to the burning of chloroform in the incinerator. He said that chloroform represented a low level impurity in the fuel sent to the incinerator. He agreed that it represented 2% of the daily consumption of 7,000 litres by the incinerator, but said that 70 litres of chloroform dispersed over 24 hours from the stack of a building is not a significantly harmful factor to the environment or otherwise.

Further evidence in relation to the functioning of the incinerator was given by Dr. Ken Macken a Senior Scientific Officer in the Atmospheric Department of the I.I.R.S. He was the project leader of an investigation into the thermal efficiency of and emissions from the incinerator carried out from the 28th November 1983 to the 1st December 1983 at the request of the Tipperary South Riding County Council. His findings were embodied in a report dated the 31st January 1984. The particular section of the report for which Dr. Macken had responsibility was the emission study. Dr. Macken said that in the case of 7 organic components in the fuel - methanol, ethanol, isopropyl alcohol, tetrahydrofuran, chloroform, ethyl acetate, toluene and monochlorobenzene - no emissions were detected. On the first sampling period a total of 165 mg/m^3 of all the organics was measured. Spot readings were taken for phosgene - popularly known as mustard gas and a known product of chloroform in conditions of sunlight - but none was found.

Dr. Macken said that the measurement of acid vapours, using a peroxide absorption technique, gave much lower results (692mg/m^3) compared to the total chloride figures resulting from an analysis of condensate (1755mg/m^3). He said that, while the report concluded that the prime objective of the incinerator had been achieved by providing the necessary high temperatures and adequate residence time and that it had been properly maintained and operated, it was necessary, in view of the discrepancies just referred to, to carry out further tests. It was thought, he said, that the higher reading given by the peroxide method was the result of a reaction of the acid gases with the metal sampling probe near the mouth of the stack. It was also thought, he said, that the results indicated an inadequately mixed holding tank and a recommendation was made that a larger recycling pump be installed to ensure that a homogeneous feed was supplied to the incinerator.

Dr. Macken said that a further investigation was carried out with these recommendations in mind and a further report presented to the local authority in January 1985. In addition, on this occasion, sampling for dioxins was also carried out according to a method suggested by the Atomic Energy Research establishment at Harwell and the relevant analysis was carried out for the I.I.R.S. in the United Kingdom by the laboratory of the Government Chemist in London. (The reason why dioxins - organic molecules containing various structures with a number of chloride atoms attached - were tested for on this occasion was that while some dioxins are relatively non-toxic, others are highly toxic).

The result of the new acid vapour test gave a numerical average of 19.5mgs/m³. The numerical average of the chloride emission was 42mgs/m³. The measurement of both emissions was described by Dr. Macken as low and fairly constant. As contrasted with the earlier tests, moreover, the results were in essential agreement. This was because of the use of a cooled probe into deionised water in place of the previous techniques. No phosgene was detected nor were any dioxins. He said that the solvent fuel was well mixed with an average chloroform content of about 0.05%.

- (3) The evidence indicating any connection between any toxic gases, vapours or other substances emitted by the factory and any injury to people or animals or damage to property on the Hanrahan farm or in the area generally.

The evidence under this heading can be divided into two broad areas. First there was evidence from Meteorologists as to the likelihood of airborne emissions from the factory reaching the Hanrahan farm in significantly harmful quantities. Secondly, there was evidence from Toxicologists and other scientists as to actual injury or likelihood of injury to the health of humans and animals in the area generally and particularly on Hanrahan's farm resulting from airborne emissions of acids or organics from the factory.

Meteorological evidence

The meteorological evidence was given by Dr. Dowding and Mr. Richard Ruck. Mr. Ruck obtained his B.Sc. and M.Sc. in Meteorology from Pennsylvania State University and is the Department Manager of the Air Quality Control Section of a

company called Roy F. Weston in the United States which specialises in environmental engineering. The air quality management department of which Mr. Ruck is the head employs approximately 22 people including 15 graduates in science.

The evidence of both Dr. Dowding and Mr. Ruck made it clear that the dispersal of acid vapours and organic vapours from a chimney will be determined to a significant extent by whether the atmospheric conditions can be described as unstable, stable or neutral. Unstable conditions occur when the restriction on vertical movement in the atmosphere is at its lowest and as a result dispersal takes place closest to the point of emission. These conditions normally occur when there is a layer of warm air near the surface of the earth with a colder layer above it and relatively light wind speeds. Accordingly, these conditions are most likely to occur in conditions of strong sunlight during the early morning and light winds. Stable conditions, by contrast, occur when the restriction of vertical movement is at its maximum, i.e. when there is cold air nearest the earth surface and a layer of warmer air above it. In these conditions, which would normally occur at night-time with clear skies, the plume of gases or vapours from the stack will have a tendency to remain in position in the vertical and to fan-out slowly in the horizontal plane and down-wind of it. Where neither unstable nor stable conditions prevail, the atmosphere is described as neutral and this is in fact the most common condition. It generally occurs during daylight hours under overcast skies with relatively high wind speeds. The meteorologists identified a further atmospheric condition called "fumigation" which occurs during the rapid heating of the earth surface when the night-time stability or inversion is

giving way to unstable conditions. In such circumstances, the plume will touch the ground in the area of the stack in a random manner. The fumigation phenomenon lasts for a relatively short time, unlike stable or unstable conditions, and is generally experienced during the early hours of sunlight.

Dr. Dowding said that, in estimating the probable dispersion patterns of emissions from the factory, the topographical features of the valley were important. He said that, taking into account the heights of the sides of the valley and the heights of the principal sources of emissions, i.e. the incinerator, the process scrubber stack and the vents on the process building, the likelihood was that many of the emissions would fall below the height of the valley sides. He said that the climactic and topographical features of the area made it likely that stable conditions developed overnight relatively frequently throughout the year. He also said that, taking into account the fact that the factory was the largest single source of emissions of hydrogen chloride and organics in the valley and that the incinerator on occasions had been running at temperatures which would incompletely combust the materials fed to it, the likelihood was that evidence of injury to humans, animals and plant life on the Hanrahan farm were caused by these emissions.

Dr. Dowding laid emphasis in the course of his evidence on the importance of fogs and mists in relation to airborne pollution. He said that, while the effect of rainfall is mainly beneficial because it falls straight to the ground surface, a fog or mist consisting of a large number of small water droplets can be a source of considerable pollution, since

acid gases will dissolve in the water droplets and remain in the atmosphere in that form.

Mr. Ruck conducted a detailed investigation which was intended to establish the probable highest concentrations of acid gases and organic vapours on the Hanrahan farm resulting from emissions from the factory. He said that for this purpose he used what was described as an air quality model. This consists of a series of formulae and mathematical equations which are utilised to simulate how an effluent released from a stack would behave under atmospheric conditions and where it would impact. He said that this air quality model was used as a standard practice in the United States in order to satisfy the requirements of the Environment Protection Agency. The data necessary to carry out the analysis fall into three broad categories, the emission parameters, the meteorological data and the physical or topographical data. The necessary calculations are done by means of a computerised process. Normally five years data is fed to the computer to satisfy the regulations and the mathematical formulae and equations involved are of such complexity that large scale computers are needed to generate conclusions.

Mr. Ruck said that, so far as the meteorological data was concerned, he was given data over the previous five years by the defendants which was the product of monitoring carried out at the waste treatment plant in the factory. He said that having reviewed the data, his firm had come to the conclusion that it would not be adequate for the purposes of the model. Accordingly, his firm installed a portable weather station at the factory in October, 1984, which provided information

from November 1984 to March 1985 on wind speed, wind direction, air temperature, relative humidity and what is called standard deviation of the horizontal wind direction. He said that, since the usual standard for the model was five years of relevant data, he considered it important to determine whether the five months period of measurements could be regarded as typical of a longer period such as five years. For that purpose, he compared the data generated by this monitoring station with five years of meteorological data from the meteorological station at Kilkenny. He said that the details of the comparisons demonstrated that the five months data was a reliable guide.

In relation to the emission parameters, Mr. Ruck said that he was given information by Dr. McSweeney as to the nature of the emissions from the scrubber stack, incinerator and boiler-house stack. He said that the data used in the analysis consisted of both average conditions and "worst case" conditions. In addition, the model took account of the physical characteristics of the three major emission sources, i.e. the stack height, the stack diameter, the exit velocity and the exit temperature. It also took into account the fact that the incinerator was operating at particularly low temperatures at a time when there was not any measured emission rate.

Mr. Ruck said that the topographical data were derived from a grid network. This in effect meant that, taking the solvent waste incinerator as the centre of a grid, radii were plotted at every 10°. There were five receptor locations evenly spaced out to 2,500 metres at 500 metre intervals along the radius. Two of these receptor points were located on the Hanrahan farm.

One further factor, which was the subject of much discussion during the evidence, was also introduced as a factor in this model, i.e. 'downwash'. This occurs when because of the comparative heights of the emission point and a building in its immediate area the plume, as a result of the obstruction, is pulled down closer to the surface. Downwash, according to Mr. Ruck's evidence, was of particular importance in relation to emissions from the scrubber stack, having regard to the comparative height of the scrubber stack and the process building. The effect of the downwash factor would be to increase concentrations of emissions in the area of the emission source. He said that the model used, the Industrial Source Complex model, took account of this factor, unlike a model utilised at an earlier stage. It did not, however, take account of the short-term transient aspects of the fumigation phenomenon.

The results of Mr. Ruck's investigation and analysis were set out in a number of tables and diagrams which he produced in evidence.

Figure 1 demonstrated that the light winds which are a normal feature of stable conditions occurred most frequently when the wind was blowing directly from west to east along the valley of the Suir. Mr. Ruck said that, of the total of 3,600 hours for which wind conditions had been monitored, light winds in stable conditions blowing in the direction of the Hanrahan farm from the factory amounted to 1½%.

In addition to predicted concentrations at the Hanrahan farm for 'worst case' conditions, the tables also took into account the background concentration of acid vapours and organic vapours at the Hanrahan farm during the 19 day period when the factory was closed. (This information was derived by Mr. Ruck from the

measurements carried out by Dr. Jameson during his 1981 investigation). Mr. Ruck's table 5 - demonstrates the "worst case" predicted concentrations. These are on the assumption that all three emission sources are operating at their highest level, that the incinerator is operating at 200° centigrade, that there are stable conditions and that there are light winds blowing in the south-west or west south-west direction. The results in this table are set out below.

WESTON

TABLE 5

Predicted Air Quality Concentration Levels
At The Hanrahan Farm Associated with the
Highest Estimated Emission Rates and Lowest
Measured Exit Temperature for the Solvent Waste Incinerator
Based on on-Site Meteorological Data

Sources	Predicted Ambient Concentrations (ug/m ³)			
	Total Acids		Organic Solvents	
	1-Hour	24-Hour	1-Hour	24-Hour
Scrubber Stack	97	4	179	7
Solvent Waste Incinerator	279*	12*	157**	6**
Process Steam Boilers	<u>96</u>	<u>38</u>	<u>N/A</u>	<u>N/A</u>
Total:	472	54	336	1

* Lower exit temperature (200°C.) increases concentration by 5% due to reduced plume buoyance.

** The lower exit temperature in combination with the increase in organic emissions assumed by Dr. Dowding from 182 kg/day to 220 kg/day (i.e. 21%) increases the overall concentration by 27%

In cross-examination, Mr. Ruck agreed that his figures did not take into account the phenomenon of washout or wet deposit. He said, however, that one would have to have a combination of precipitation occurring with wind directions to

cause some washouts and that this would be a relatively infrequent event.

As none of the matters dealt with by Mr. Ruck in his evidence had been put to Dr. Dowding, I allowed him to be recalled at the conclusion of the case. He said that he had no experience of the particular model used by Mr. Ruck, but since the latter had given evidence had had access to the output from the computers employed in the investigation. He made some criticisms in detail of Mr. Ruck's methodology but accepted that these were based on a limited amount of the material generated by the investigation.

Toxicological and other scientific evidence

No toxicologist gave evidence on behalf of the plaintiffs. Dr. Andrew Salmon, who is a lecturer in Industrial Toxicology in the Department of Chemistry in the London School of Tropical Medicine, gave evidence on behalf of the defendants. He said that he was currently engaged in research into the toxicological effects of industrial chemicals and in particular hydrocarbon solvents. He said that he had seen the measurements produced by Dr. Jameson and had also seen the veterinary and medical evidence as to complaints by people in the area of the factory. He said that, in assessing the possibility of particular organic compounds being harmful to living organisms, it was necessary to take into account both the concentration at which the exposure occurs and the time for which it occurs. He also said that there was no relationship between the smell of a particular compound and its toxic threshold. The concentration at which the compound starts to be harmful to living organisms may be significantly

higher than the concentration at which it is detectable by smell and vice versa.

Dr. Salmon said that, looking at the evidence as to complaints by persons as to their health and the veterinary evidence as to the animals, he considered that there was no relationship between the animal and human health effects and the compounds in the concentrations at which they were reported by Dr. Jameson to occur. He said that he based his conclusions on the relatively low levels of organics detected by Dr. Jameson and the inconsistency between the observations in the case of human health effects and animal health effects. In the latter context, he said that this was unexpected because in his experience animal health effects and human health effects were usually similar, although not necessarily identical. He produced a table which he said demonstrated the effects of certain of the organics which had been identified and demonstrated in man and/or animals for the particular compound. This table is set out below.

Compound	Effect	No Effect Level	Reference
n-Hexane	CNS Depression	2000 ppm (man) Over 7 million (Ug/m ³)	Patty & Yant
	Peripheral Neuropathy	130 ppm (guinea pig) 468,000 Ug/m ³	Spencer & Schaumberg
n-Heptane	CNS Depression 2 million Ug/m ³	Approx. 500 ppm (rat)	American Petroleum Inst./Biodynamics
Aliphatic (mixed hydrocarbons)	CNS Depression (behavioural toxicity)	Approx. 100 ppm	Salmon et.al.
Toluene	CNS Depression (Human; rat) 1,125,000 Ug/m ³	300 ppm	Grasso et.al.

Compound	Effect	No Effect Level	Reference
Chlorobenzene	CNS Depression Acute Liver Effects	75 ppm 359,999 Ug/m3	NIOSH
Toluene	No Carcinogenic or Hematotoxic effect	(300 ppm)	Gibson & Hardisty
	No reproductive toxicity	(400 ppm)	API/Litton Biodynamics
Chlorobenzene	Liver nodules in mice only;	No effect at 60 ppm	NCI
	No major reproductive effects	Below 400 ppm	
n-Hexane n-Heptane	No Carcinogenicity or reproductive effects	approx 400 ppm (1,600,000 Ug/m3)	API/Litton Biodynamics

Dr. Salmon agreed in cross-examination that his conclusion as to the inconsistency between the complaints of ill-health in humans and in animals was not based on a complete reading of all the relevant passages in the transcript of the evidence of the witnesses concerned. He said he had "skimmed" or "thumbed" through the relevant portions and had also been supplied with information by the defendants.

Professor John Widicombe, the Professor of Physiology at St. George's Hospital Medical School in London, also gave evidence on behalf of the defendants. He said that he was engaged in research work on the pathology and physiology of the respiratory tract, the nose, the airways and the lungs and, in particular, the response irritation of parts of the body to inhaling irritants. He said that the gases with which he was particularly concerned were sulphur dioxide, ammonia and

hydrochloric acid or hydrogen chloride as a gas.

Professor Widicombe produced in evidence three tables setting out the concentrations of these gases, exposure to which would initially cause minor symptoms such as irritation of the nose and throat together with the level, in the case of sulphur dioxide and ammonia, at which they would be detectable by smell, then the concentrations exposure to which would cause more serious physical damage and finally the concentrations which would be lethal. These tables are set out below.

Hydrogen Chloride - HCl

<u>Endpoint</u>	<u>Concentration</u> (Ug/m ³)
Maximum possible daily concentration in Hanrahan's farm	51
TLV-ceiling	7200
TLV/40	125
IDLH	140000
Immediate irritation of nose and throat	7200 or above
Maximum concentration for prolonged exposure Intolerable for 1 hour	12000
No harm to monkeys, exposed 20 times for 6 hours	72000 or above
Slight irritation following 60 days in rats, rabbits and pigeons	39600
Lethal to laboratory animals	120000
	Over 3 million

1. Assumes chloride measured was all hydrogen chloride and ignores contributions from other sources (sea spray, soil, ammonium chloride).

Sulphur Dioxide - SO₂

<u>Endpoint</u>	<u>Concentration</u> (Ug/m ³)
Maximum possible daily concentration Hanrahan Farm	159
Annual daily threshold EEC	360
Amer. NAQS	365
TLV	5000
STEL	13000
IDLH	250000
TLV/40	125
Annual average concentration Hanrahan Farm	22
Annual threshold WHO	100
Annual threshold EEC	120
Annual threshold Amer NAQS	80
Least detectable odour	Over 25600
Respiratory changes (10 min)	Over 2500
Cough	10000
Nasal Changes	2000

Ammonia - NH3

<u>Endpoint</u>	<u>Concentration</u> (Ug/m ³)
Maximum daily concentration Hanrahan farm	96
TLV	18000
TLV/40	500
STEL	27000
Detection level	3500
Complaint level	18000
IDLH	350000
Least detectable odour	3500-37100
Maximum prolonged exposure	70000
Least amount causing irritation	Over 35000
Least amount causing coughing	Over 1 million
Dangerous for short exposure	Over 1.8 million
Rapidly fatal	Over 3 million

Professor Widicombe said that these tables were derived from various authorities such as the World Health Organisation, The European Economic Community and the American Air Quality Standards, as well as from published literature in the field. He said that the concentrations recorded by Dr. Jameson in his report were so much below generally accepted values that it was unlikely that either the complaints of ill-health by members of the Hanrahan family or ill-health among the farm animals was attributable to these concentrations.

Mr. James L. Neufeld, who is a graduate of the Ontario Veterinary College of the University of Toronto and has a diploma in Pathology from the American College of Veterinary Pathology gave evidence of having visited the Hanrahan farm in early 1984. He took blood samples and carried out a post mortem examination on one cow. He also received slides containing tissues from other animals from Dr. Dowding. He said that he conducted haematology and clinical pathology on these items and found that there was low thyroid function in two cows. He also carried out a histopathology examination of various organs. In the case of the liver, there appeared to be chronic active hepatitis with cell death and regeneration, which he thought to be an unusual finding in pathology. In the case of the spleen, he found massive deposits of a pigment called hemosiderin. He said that he had never seen this condition before in such magnitude. He also examined the thyroid and found low thyroid function. He found lesions in the lungs which he described as an eosinophilic bronchiolitis. He said that he would not normally expect to find these in the lungs of animals. He also examined the lymphnodes at the base

of the lung where he found some crystalline material which he found unusual. Mr. Neufeld said that these findings, taken in conjunction with his examination of the herd, led him to the conclusion that there was a high probability that some foreign substance or chemical or a number of foreign substances or chemicals were reaching the cattle and affecting their metabolism.

Mr. Patrick Crowe, who is a Veterinary Surgeon and the Senior Officer in charge of the Regional Laboratory in Kilkenny, said in evidence that an arrangement was entered into between the Department of Agriculture and Mr. John Hanrahan for the slaughtering of cattle on the farm for joint sampling purposes. This operation was carried on the 15th September 1983. The animals chosen to be put down were selected by the Veterinary Surgeon and Mr. John Hanrahan. Blood was taken from each of the animals and after they had been slaughtered post mortems were immediately carried out. Mr. Hanrahan and Mr. Crowe each took corresponding pieces of each organ. He said that various tests were carried out on the tissues and samples, histopathological, virological, serological and biochemical. There were also urine analyses, haematology and pesticide examination of the faeces. In addition to the post mortems carried out on this occasion, Mr. Crowe also carried out a number of other post mortem examinations during the year 1981 on animals from the Hanrahan farm. Mr. Crowe said that he identified a number of disease conditions as a result of these various post mortems which would be normal to a farm of this type. Like Mr. Neufeld, he found large haemosiderin deposits, which he said was not uncommon in older animals and could be the result of copper deficiency.

The investigation carried out by Dr. Mark Lynch has already been referred to briefly. This was done at the request of the Minister for Agriculture by a team one section of which was headed by Dr. Lynch and the other by Mr. Crowe. Dr. Lynch, whose doctorate is in physiology and biochemistry from Cornell University, is also a member of the European Society of Toxology and a founder member of the Irish Society of Toxology.

Dr. Lynch gave evidence of the results of analyses of milk samples from the Hanrahan farm. The specific object was to ascertain whether dioxins or related compounds were present. Accordingly, the milk was tested for the presence of

- (i) organo chlorines
- (ii) polychlorinated dibenzo dioxins (PCDD's)
- (iii) polychlorinated dibenzo furans (PCDF's)
- (iv) polychlorinated biphenyls (PCB's)
- (v) polybrominated biphenyls (PBB's)

(The PCDD's and PCDF's are of particular significance since it would appear from the evidence that they may be extremely toxic. They have come under particular scrutiny since episodes of serious atmospheric pollution such as that which occurred at Seveso in Northern Italy. One of the PCDD's, tetrachloro dibenzo dioxin, is regarded as the most toxic chemical known to man).

The samples of milk taken were found to be free of organo chlorines, PCDF's, PCB's and PBB's. Two samples of milk taken were found to contain traces of octachloro dibenzo dioxin in concentrations of 0.1 parts per billion and less than 0.1 parts per billion. It was thought that the most probable

source of this compound was pentachlorophenol, the active ingredient in some products used for timber preservation and dry rot treatment. Traces of the same compound were found in samples of fence posts from the Avonmore Creamery and Dr. Lynch said it provided a possible explanation of the presence of the particular dioxin. He also said that in any event octachloro dibenzo dioxin was of relatively low toxicity: it would need to be present at the level of 1000 milligrams per kilogram of body weight to be toxic, compared with aspirin, for example, where the required level was 558.

(4) Evidence as to other possible causes of any animal ill-health

A number of possible explanations for the various conditions affecting the cattle on the Hanrahan farm were discussed in the course of the evidence. This evidence ranged over a very wide field and any summary of it must of necessity be drastically abridged. It is again most conveniently done by relation to specific headings.

(a) Stocking rate, soil fertility, fertiliser use and animal feeding.

It was suggested by the defendants that many of the difficulties being experienced by the plaintiffs in relation to their cattle herd were due to bad husbandry. It was suggested to Mr. John Hanrahan in cross-examination that the stocking rate on the farm (which is measured as the number of acres per livestock unit) had risen from 1978 onwards and that this required good soil fertility and higher input of fertiliser to cope with the increased stocking. It was also

suggested to him that in fact his input of fertilisers had decreased and that the soil samples showed major deficiencies in phosphorus and pottasium. Mr. Hanrahan agreed that the stocking rate had increased, but said it was the result of his being unable to sell cattle because of their poor condition and that, in relation to matters such as soil fertility and the application of fertilisers, he had acted in accordance with expert advice.

Mr. English, the Chief Agricultural Officer, said that the farm was 'an exceptionally good farm' and was well planned and laid out. He said he never saw the animals with inadequate amounts of grass and that there always seemed to be plenty of foodstuffs to be eaten. In cross-examination, he agreed that a report which he had requisitioned from An Foras Taluntais in 1982 in relation to soil herbage and silage on the Hanrahan farm found that the phosphorus and pottasium levels in the soil were extremely low but said that this was not unusual on good farms. He also agreed that the findings in the report were that magnesium, zinc and copper levels were also low and that there was a high level of nitrogen in the sample of the manure slurry. He said that he had advised Mr. Hanrahan to top up his fertiliser as a result and to recycle the slurry, but was not sure as to whether his recommendations as to the increase in fertiliser had been carried out. He also agreed that in 1982 there was a considerable increase in the number of calves being reared on the farm and that he advised Mr. Hanrahan that, unless he got rid of a lot of animals, he would be 'grossly overstocked'.

He also agreed that it was possible that what he would have regarded as a reasonable culling rate was not taking place in the herd, i.e. approximately 15%. He did not think, however, that the presence of old cows in the herd of itself would present any significant problem.

Dr. Lynch said that with the aid of the herd file he had built up a picture of the herd between the years 1978 and 1983. This file, which is maintained by the Department of Agriculture in the District Veterinary Office, contains a record of the various tests done on the herd for brucellosis and T.B., the vaccination certificates issued, the movement permits issued for animals and restriction orders imposed on animals. He said that there was a large increase in the number of cows in the herd during this period in the order of approximately 62%. The other animals in the main remained relatively constant. He said that it was also apparent that the bulk of the additions to the herd were of home reared animals and that in the early years, i.e. 1978 and 1979, there was an extremely low level of culling from the herd, apart from such culling as took place for the purpose of removing reactors. He said there was over the period a tendency to retain older animals and that he would have expected a well managed dairy farm to have a culling rate of around 20% to 25% per annum.

Dr. Lynch also gave evidence in relation to the nutritional status of the soil and herbage on the Hanrahan farm in 1982. This evidence was based on information supplied to him by Avonmore Creameries as to the purchase of fertilisers and of the two soil studies carried out by An Foras Taluntais. Dr. Lynch said that, on the assumption that the fertiliser

purchased represented the total of fertiliser applied during the relevant period, the nitrogen application was excellent but the phosphate and potassium application was less than it should have been. He said, however, that it was also necessary to take into account the application of slurry from the livestock on the farm to the land. After taking into account what he estimated to be the production of slurry, 47% of the potassium required had been applied and 38% of the phosphorus requirement. He said that the deficiency in phosphorus was less critical than that in potassium. His view was, however, that the analysis indicated that the availability of grass for grass and forage was not satisfactory.

Dr. Bielenberg said that the quality of the land comprising the farm was excellent and that the farm looked well kept. The soil in the area, with which he was familiar, was prone to drought in dry years. For this reason, grass growth could be limited in very dry years such as 1983 and 1984. For the purpose of his calculations as to the stocking rate and fertiliser requirements, he took the same view as Mr. English as to the appropriate figure for the effective acreage of the farm, i.e. 255 acres out of a total of 265.

Dr. Bielenberg made a calculation as to the number of livestock units on the farm based on the stock lists discovered by the plaintiffs and the Department's herd file. This showed that on the 11th September 1978 the total of livestock units on the farm was 227. By the 25th April 1983 this figure had risen to 342. Thereafter it declined to a figure of 260 on the 14th February 1985. He said that these figures indicated that the stocking rate had increased from 1.14 acres per livestock unit in September 1978 to a peak of .81 acres per

livestock unit in February 1982. He said that the average stocking rate on good land was in the region of 1.5 acres per livestock unit and that the stocking rate on the Hanrahan farm from November 1981 to January 1983 would require an exceptional level of soil fertility and would also lead to a depression in milk yield.

Dr. Bielenberg said that, in view of the very low level of phosphorus and potassium revealed by the 1982 An Foras Taluntais report, he would have expected at least 14 kilograms of phosphorus and 35 kilograms of potassium per acre to have been applied in the succeeding year. In fact the application of phosphorus and potassium declined sharply in the years after 1980 going down to 2 kilograms per acre of phosphorus in 1982 and 8 kilograms per acre of potassium for the same year. He said that to attempt to remain at a stocking rate of 1.0 without adequate phosphorus and potassium was "looking for serious difficulty".

Dr. Bielenberg said that the culling rate was extraordinarily low in the herd: in 1978 it was 10.7%, in 1979 35.7%, 1980 8.3%, 1981 9%, 1982 5.8% and 1983 18.2%. He said that with the exception of 1979 (which he said was an exceptional year due to the sending of reactors to the factory) and 1983 the figures were all well below the culling rate which he would normally have anticipated in a herd of this nature and which he said would have been 19.8%. He said that, as a result, there must have been some very old cows in the herd.

The question was also debated in the course of the evidence as to whether poor quality silage could have been a contributory factor. Mr. English said that he had heard, possibly from

Mr. Hanrahan, that the silage was not palatable in 1981 and 1982. As a result, the ACOT service took samples of the silage. The dry matter digestibility (DMD) of the silage, which is the fraction of the dry matter in the silage which the animal can utilise, was 60.6%, which he said was normal for the relevant year, i.e. 1983. Dr. Bielenberg said that he found this view very surprising: he said that the 60% would have been an average figure for 1981, which was a bad year for silage, but that, while figures were not available for 1983, it was a significantly better year than 1981 and he would have regarded anything below 70% in 1983 an unsatisfactory. Referring to evidence (contained in Mr. Quinlan's diary) that a cutting of silage had been taken in October 1981, he said that he thought that was extraordinarily late: cuttings were normally taken in May and July and, if there was a third cutting taken, which was not usual, it would not be any later than September. He said that a cutting taken in October would be bound to result in poor quality silage, since at that time of the year one has very poor drying and the silage would have a high water content. He said that the photographs produced by Mr. Hanrahan in evidence of a silage clearly showed that it was over mature.

(b) Inadequate Breeding Records

It was suggested to Mr. Hanrahan in cross-examination that there might have been some degree of inbreeding in the herd in that the bulls could have been mating with their progeny. This was denied by Mr. Hanrahan. Dr. Lynch said that it was theoretically possible if there was not adequate control of mating. Dr. Bielenberg said that, in the absence of any

breeding records, there must have been a grave danger of inbreeding, particularly bearing in mind the age structure of the herd.

Dr. Bielenberg also said that the absence of proper breeding records would affect the quality of the herd. He said that, in the case of a properly managed dairy herd, one would expect to find records in the case of each cow showing her annual yield, her breeding and the bull by which she had been served. These records, he said, should then be subsequently used in order to maintain the quality of the herd. He said it was not practicable with a herd in excess of 100 dairy cows to recall which were the good ones and the bad ones. No such records were among the documents discovered by the plaintiffs from 1978 onwards.

(c) Diseases on the farm

A number of diseases were discussed during the course of the evidence as having been possible contributory factors to symptoms of ill-health in the herd from 1978 onwards. Of these, the most important were brucellosis, hoose or lungworm, mastitis, the paravicinia virus, IBR, IBK and moxorella bovis.

The evidence established that brucellosis is a very contagious disease which causes abortion in cattle. Mr. De Lacy agreed that a number of cattle on the Hanrahan farm had been sent to the factory for slaughter in 1979 as a result of brucellosis tests. He said, however, that the fact that they had been classified as reactors did not mean that there was brucellosis in the herd. He said that some at least of the reactors which had been slaughtered had been vaccinated with a particular strain of live vaccine called strain 19, which

had subsequently been abandoned, and that this could account for the positive reaction in the test. The three other members of his practice who regularly attended the farm gave evidence to the same effect. The Department records of the tests, as produced by Dr. Lynch, showed that thirty-five cattle had been removed from the farm as reactors in the year 1979. Of these two had been injected with the strain 19 vaccine. In respect of eleven other animals, which were subjected to what was called "the milk ring test" in that year, the test proved inconclusive. In respect of sixty animals who were subjected to a blood test in the same year, the test proved inconclusive and they were also retained in the herd. No milk ring test was performed in succeeding years, but blood tests were carried out and no reactors found. There were a reduced number of inconclusive results in each of the succeeding years.

The evidence established that hoose is caused by a parasite in the lung called dictocaulis viviporus. The adult worm is about five to seven centimetres long and lives in the bronchi of the animal. It lays eggs that are coughed up and hatched in the calves dung. At a certain stage of the disease, there can be a quick build up of larvae on the pasture. These develop over a period of about a week to become infective and when another animal comes along and eats the grass it picks up the infective larvae. It migrates from the calf's intestines back to its lungs and in migrating into the animal's lung, it causes bronchitis, i.e. the lung area becomes inflamed and thus causes bronchitis which is the main reason for the coughing associated with the disease. The adult worms are eventually shed about sixty days after the larvae are picked up. The animals may recover if sufficient larvae have been coughed up,

but can be killed by the infection. In a serious case, the animals develop emphysema which produces the respiratory symptoms with very pronounced coughing.

In its primary form, hoose usually attacks young cattle. But while most cases of the disease occur in the young animal, it may also affect older cattle in the form of re-infection hoose, where the immunity of an older animal has begun to decrease or where it is being exposed to the parasite for the first time.

Mr. De Lacy said that from 1977/1978, onwards there were a lot of respiratory problems on the farm, including hoose. He said, however, that he did not think anything of it at that stage. In 1981, although the animals had been dosed according to his usual practice they developed what he described as "hoose pneumonia" about a month afterwards. He said this was very unusual, since once they are dosed, they do not get re-infected. He said there were about six lost in that year which showed hoose pneumonia, but he considered this as being due to the fact that their resistance had been lowered to all types of infection.

Mr. De Lacy did not agree with the suggestion put to him in cross-examination that the appropriate way to control hoose was by the use of a vaccine called Dictol. He said that his system was to leave the cattle out on grass until any symptoms of coughing developed. If they did develop any symptoms of coughing they were then dosed with worm dose, left in for a fortnight and then left out on the pasture again.

Mr. O'Gorman, Mr. De Lacy's assistant, said that while the cough that he heard among the cows was similar to the kind of cough from cattle with lungworm, he thought that it would be

very rare to have lungworm affecting adult cows and had only come across it in calves.

Mr. Crowe said that two sets of bovine lungs from weanlings which were examined by him at the Kilkenny Laboratory showed that very extensive parasitic pneumonia with heavy lungworm burden was present. There was a similar finding in relation to two sets of bovine lungs on the 21st October, 1981 and again in respect of a further two sets on the 26th. He said that in respect of five of the six cattle involved there was a definite diagnosis of hoose. He also said that in circumstances where there is an outbreak of hoose among the weanlings in a particular herd, there is a likelihood of re-infection hoose existing in the cows of that herd.

Mr. Crowe said that the ideal way in which to treat hoose is to vaccinate calves before they are turned out to pasture in the spring and keep them off the pasture for a number of weeks until they develop an artificial immunity and can then be turned out on to relatively clean pasture. He said, however, that this was not always practicable and that a more adaptable approach was to turn calves out in the spring and after about three or four weeks give them a recognised worm dose and repeat the same dosing treatment at three week intervals. He was not in favour of Mr. De Lacy's practice of waiting until the calf or weanling started to cough before treating for hoose since there was a danger that by the time the coughing manifested itself the hoose would already have developed and done a lot of damage. He also thought that at that stage a contamination of pasture might have built up leading to a heavy burden of hoose and a more contaminated farm. He said that in October 1981 he had noticed during a visit to the Hanrahan

farm that some of the animals were coughing in a manner which reminded him of hoose. Mr. Hanrahan and the vet who was present on the occasion, however, told him that it could not be hoose as the animals were regularly dosed and he accepted that explanation. Again on the 15th December 1981 he found on a histological examination of two sets of bovine lungs chronic broncholitis and interstitial pneumonia which could be the result of parasitic infection. He said that one of the five animals put down on the 15th of September 1983 showed pathological changes which were consistent with re-infection hoose. (This was a cow aged between ten and eleven years). He also said that a large lymphatic nodule which he had observed in a four year old bullock on the same occasion was a classical lesion for re-infection hoose.

Dr. Hugh Pirie, the Professor of Veterinary Pathology in the University of Glasgow, said that his duties concerned routine investigation and diagnostic work on all kinds of animal problems in the British Isles and included research into cattle diseases and particularly respiratory diseases. He said that he had published over a hundred papers on animal diseases and approximately half of them were on respiratory diseases. He said that he had been retained by the defendants before the commencement of the action and had heard or read the evidence of all the veterinary witnesses and been furnished with data and information from the Kilkenny Laboratory. He was also furnished with information on Mr. Neufeld's post mortems on three cows.

Professor Pirie said that enzootic pneumonia was a very common problem in young animals in many parts of the world.

He said that findings by Mr. Crowe in post mortem examinations in September 1981, October 1981 and September 1983 were characteristic of enzootic pneumonia.

So far as re-infection hoose was concerned Professor Pirie said that adult calves which were out on pasture contaminated by the lungworm could undoubtedly contract hoose giving rise to coughing and lack of thrift. He said that a high stocking rate, in a case where there was presence of lungworm, could affect adversely the prevalence of the illness among young cattle.

Professor Pirie said that there was no doubt from these findings and from the widespread coughing among the young stock that the herd was infected with hoose in 1981 and he considered it very likely that re-infection hoose did occur in a situation where the disease was so widespread among the younger cattle. He said it was ninety-nine per cent certain that the adult cattle would have been exposed to lungworm and would develop pulmonary diseases of varying degrees of severity.

Reports were also produced in evidence from the Department of Veterinary Pathology of University College Dublin on three cattle from the Hanrahan farm. In two cases the diagnosis was of "diffuse fibrosing alveolitis". There was no specific finding in any of the three cases of hoose, but Professor Pirie said that this would not in any way alter his view that re-infection hoose was present in the herd at that stage. (The dates of the post mortem certificates were 19th November, 1981, 2nd December, 1981 and 22nd March 1982).

The evidence also established that there are two recognised diseases which can produce lachrymation, i.e. excessive tears or fluid in the eyes of cattle. The first is infectious bovine

rhino tractitis (IBR) and the second infectious bovine keratitis (known as IBK). Mr. Neufeld found antibodies to IBR in his analyses and Professor Pirie, who had considered Mr. Neufeld's results, said that there were clearly antibodies to IBR in four of the eleven animals and trace amounts in two others. He said that the situation with IBR was that it did not stimulate the production of a lot of antibodies so that a low level could be significant. Mr. Neufeld and Professor Pirie both said that IBR could lead to nasal discharge and coughing.

Mastitis is an infection of a cow's udders which affects her milk yield. The frequent appearance in the accounts furnished by Mr. De Lacy, which had been discovered by the plaintiffs, of bills for a preparation called Multi-mast was suggested to him and his assistants in cross-examination as indicative of a high level of mastitis in the herd. They said however, that the incidence of mastitis in the herd was in no way out of the ordinary.

Moraxella Bovis is a germ which causes a disease known as "pink eye". Mr. Crowe said that he found evidence of this organism in a swab taken from a cow's eyes on 30th March 1981.

Paravaccinia virus is a disease which produces a redness of the skin of the cow's teats together with a thickening. This virus was isolated in two of the five samples taken by Mr. Crowe on the 30th April, 1981. These samples had been taken as a result of a visit by Mr. Dougan to the farm when he noticed some of the cows with bad blotches on their teats. He had taken samples as a result of that inspection and sent them to the Regional Laboratory in Kilkenny.

CONCLUSIONS

It is clear beyond doubt that there was a deterioration in the health of the herd on the Hanrahan farm in the years from 1977 onwards. The vastly increased number of visits by Mr. De Lacy and his assistants and the evidence from them and a wide range of other witnesses, including the Chief Agricultural Officer, Mr. English, and the County Council Veterinary Office, Mr. Dougan, put this beyond doubt. This deterioration manifested itself in the form of frequent outbreaks of coughing, accompanied by streaming eyes and running noses. The cattle showed less thrift from those years onwards and there were also outbreaks of other symptoms, such as soreness of the teats.

The evidence as to a significant increase in cattle mortality from 1978 onwards is not so clear. It is regrettable in this context that an accurate and reliable guide as to cattle deaths on the farm was not maintained by members of the Hanrahan family from the year 1981 onwards. There is indeed abundant evidence in this case that the keeping of such records should be a feature of a well run dairy farm of any size, but apart altogether from that consideration, from 1981 onwards the members of the family were increasingly attributing the blame for the difficulties they were encountering to the defendants' operations. Accordingly, one would have expected that a meticulously accurate record not merely of cattle deaths but of all other significant incidents on the farm would have been maintained from that time onwards. Such a record would obviously be significantly reduced in value if it was not contemporaneous with the events it was purporting to record.

It became clear during the evidence that some at least of the entries made by Mrs. Selina Hanrahan which purported on their face to be contemporary records in a diary had in fact been inserted by her some weeks after the events they purported to record. This, coupled with her admission in cross-examination that she had altered entries in the original diary after it had been exhibited with her husband's Affidavit of Discovery, renders the diaries, and the summaries of cattle deaths based on them, an unreliable guide, in my opinion, to the actual level of cattle deaths on the farm during the relevant period.

The attempts by Mr. Newman and Dr. Bielenberg to reconstruct the numbers of cattle deaths from the documentary material available to them necessarily suffers from the inadequate nature of that material. I would incline to the view that Dr. Bielenberg's estimate is more reliable than Mr. Newman's, since it takes into account, not merely all the stocktakings recorded by the Hanrahans, but also the information derived from the Department of Agriculture's herd file.

Dr. Bielenberg's figures would indicate that the level of cattle mortality was in fact lower on the farm during the relevant years than was claimed by the members of the Hanrahan family. The position is rendered more difficult by the fact that there are no records at all available as to cattle mortality before the period when Mr. John Hanrahan took over the management of the dairy herd in 1978. His sister Doreen, who had been primarily responsible for the management of the herd in the years before her marriage in early 1978, did not give evidence and, although it was said that she had records in her possession, they were never produced during the course of the hearing.

At the same time, I cannot disregard the evidence of Mr. De Lacy and his assistants that there appeared to them to be an increase in cattle mortality in the years from 1978 onwards. I accordingly approach the case on the basis that there was some evidence of an increase in cattle mortality during those years, which it is not possible to quantify with any precision. It would also appear from the evidence of Mr. De Lacy and his assistants that there was some increase in the number of abortions in these years but again it was not possible to quantify it.

So far as the unusually high incidence of twinning is concerned, I accept the evidence of Mr. Hanrahan and Mr. De Lacy that it was unusually high from 1978 onwards. Dr. Lynch said that the highest incidence recorded - of 14 sets of twins in 1981 - would not have been significantly above average figures, but he agreed that his views on this were based on the findings of other experts as to what the average twinning rates in Ireland were and this evidence was not produced. I also accept the evidence of Mr. Hanrahan that subsequent to 1978 an unusual number of calves were born either dead or deformed. I also accept the evidence from a number of witnesses that there was an unusual incidence of sore and cut teats from 1980 onwards. However, while there were incidents of cattle stampeding and of overgrowth of their hooves, I do not think that the incidents were of such significance as to justify any specific conclusions being drawn from them.

I do not think that the evidence established that the milk yield of the herd had in fact suffered a significant reduction during the years in question. The crucial year is 1979 where, on the figures supplied by Mr. English, the

calculated yield was 955 gallons compared with the national average milk yield of 662 gallons. (I am assuming that the figure for the national average milk yield is correctly calculated: there was a considerable debate during the evidence as to the correct method of determining that figure.) The figure given by Mr. English is, however, seriously affected by the failure to take into account the reactors who would have been lactating for a significant part of the year and, accordingly, I prefer the adjusted figure given by Dr. Lynch of 794 gallons for that year. When that revision is made, there appears to be no particularly significant fluctuation in the figures over the succeeding years.

I now turn to the evidence as to the health of the members of the Hanrahan household during the relevant years. It is a remarkable feature of that evidence that, although Mr. Hanrahan and Mrs. Selina Hanrahan were seen by a number of doctors over the years in question, only one has given evidence. The general practitioner who saw them regularly, Dr. Roche-Nagle, and his wife who is also a medical practitioner and who attended Mrs. Hanrahan in particular regularly, did not give evidence and no explanation as to their failure to give evidence was at any stage offered on behalf of the plaintiffs. The total absence of medical evidence is even more noteworthy in the case of Mrs. Selina Hanrahan: on her own evidence she was seen by no less than five doctors or surgeons during those years. The only medical evidence in her case was given by Dr. McDonald, who examined her on behalf of the defendants and who said that neither her present condition nor the history of her complaints suggested that she had suffered from any abnormal or inexplicable illness during those years. I can only conclude

that, in her case, had her own doctors given evidence, they would have been unable to say that Mrs. Hanrahan had suffered from anything other than gynaecological problems of a distressing but well established nature.

I entirely accept the evidence of Professor Fitzgerald that Mr. Hanrahan in 1980 was suffering from some degree of obstruction to the air flow from his lungs. The significance that can be attached to this is, however, greatly reduced by the fact that his regular general practitioner, who would have been in a position to indicate his previous medical history, did not give evidence.

There is, again, in the case of Mrs. Mary Hanrahan, no medical evidence as to her complaints other than that given by Dr. Clancy, who examined her on behalf of the defendants, and who found nothing abnormal. The remaining adult member of the household Miss Quaide, did not give evidence and, again, there was no explanation of this.

I conclude that there is no reliable evidence of significant ill-health during the relevant years in the case of any of the members of the Hanrahan household other than Mr. Hanrahan himself. In his case, the value of the evidence is significantly reduced by the absence of any evidence from his general practitioner. There was, however, no basis for the suggestion advanced in the closing stages of the case that he might himself have taken quantities of bromine in some form in order to produce misleading results.

I accept the evidence of Dr. Dowding that there was evidence of some unusual damage to plant life on the Hanrahan farm. There is, however, no scientific evidence whatever to suggest that the corrosion of buildings referred to by

Mr. Hanrahan and Mrs. Selina Hanrahan was in any way unusual and the discussion of it by Dr. Jameson in the course of his report indicates quite clearly that no significance should be attached to it.

The next question that arises, accordingly, is whether the plaintiffs have established as a matter of probability that the deterioration in the cattle herd, the degree of illness suffered by Mr. John Hanrahan and the damage to plant life observed by Dr. Dowding is attributable to the emission of toxic gases or vapours from the defendants' factory. In this context, the evidence as to the detection of such gases or vapours on the Hanrahan farm or in its immediate vicinity is, of course, of crucial importance.

The evidence of Dr. Buck as to the inferences which could be drawn from the lichen study is seriously reduced in value, in my view, by his admissions as to the manner in which the study was conducted. I accept, moreover, in this matter the evidence of Dr. Brown, who was not in any way moved during cross-examination from his clearly expressed opinion that Dr. Buck's methodology was such as to render any conclusions based on his survey of doubtful value. Again, the reliability of Dr. Buck's investigation of the presence of bromine and chlorine in the samples of human and animal hair on the Hanrahan farm must be seriously eroded by the revelation during the evidence that for much of the critical time bromine was not used in the manufacturing processes in the defendants' factory. I would in any event have viewed Dr. Buck's evidence on this and indeed other matters with considerable reserve in view of his failure during his direct evidence to make any

reference to the fact that a subsequent survey by his colleagues in Trinity College had demonstrated that he had overstated the incidence of bromine by a factor of almost 2. I find Dr. Buck's failure to mention this in his direct evidence and his apparent readiness, unless challenged in cross-examination, to leave the court under the impression that his figures in this context were entirely reliable, when he must have known they were not, somewhat disquieting.

Accordingly, the only evidence in the case of measurements of toxic gases, vapours or other substances on the Hanrahan farm during the relevant period on which reliance can be placed is the evidence of Dr. Jameson. The methods used by him for the determination of acid vapours in the ambient air at the farm was by means of air sampling. Air was drawn through an inverted PVC funnel and transparent PVC tubing, a metal manifold, a filter assembly and a dreschel bottle containing a hydrogen peroxide solution, an eight-part sequential switching mechanism, a gas meter and a suction pump. The function of the filter assembly was to ensure that only acid vapours were collected: any particulate matter suspended in the atmosphere and, in particular, smoke would be collected on the filter and the amount of smoke measured by reference to the stain left on the filter. Towards the end of the case, Dr. Dowding criticised this monitoring device on the ground that in conditions of damp or misty weather hydrogen chloride would be taken up in water droplets which would be absorbed by the filter and that in such conditions a significant quantity of hydrogen chloride would not pass into the collection vessel.

The monitoring technique used by Dr. Jameson for the determination of acid vapours was in accordance with "Methods for the Measurement of Air Pollution, Part Three" published by the

British Standards Institute (BS1747: Part 3 1969 London).
Dr. Dowding conceded that his expertise in this area related particularly to the measurement of particulate matter suspended in the atmosphere rather than the measurement of acid vapours. I think that Dr. Dowding's criticisms - which in any event are of a limited nature, confined as they are to the possible underestimation by the technique of hydrogen chloride in damp or misty conditions - are not sufficient to outweigh the fact that the uncontradicted evidence in this case is that this is the approved method for determining the concentration of acid vapours in the atmosphere.

It was repeatedly urged on behalf of the plaintiffs that, while the concentrations of acid vapour and organics measured by Dr. Jameson on the Hanrahan farm were low, the possibility could not be excluded that all the acid vapours and/or organic compounds measured on a particular day might have arrived in the course of a very limited period such as 15 minutes and that, in that event, the concentrations would have reached a peak during that time which if repeated sufficiently often on other days over a period of years would have involved the exposure of the plaintiffs and their livestock to injury.

Dr. Jameson himself did not consider this particularly likely and he pointed out in the course of his evidence that, even making that assumption, the relevant TLV levels would have been exceeded on only a limited number of occasions and would not have been exceeded at all if one extended the assumed peak period to an hour. Of even more significance, however, in this context is the meteorological evidence. Mr. Ruck's evidence, which was based on detailed monitoring of the wind conditions over a five month period and of the use of sophisticated computer

techniques, in contrast to Dr. Dowding's more general approach, demonstrated, as has been seen, that given the worst possible combination of conditions - i.e. the incinerator operating at low temperatures, all three emission sources working at the same time and the appropriate combination of atmospheric stability together with relatively light winds - the total amounts at the Hanrahan farm would not over a one-hour period have exceeded 472mg/m^3 in the case of acids and 336mg/m^3 in the case of organics. Even these concentrations are far below the levels indicated by other expert witnesses as the minimum levels at which any damage to animal or human life could be expected (see in particular the evidence of Dr. Salmon and Professor Widicombe).

Even if the evidence of Mr. Ruck were to be discounted in its entirety, the court would be left with Dr. Jameson's testimony as the only evidence of actual measurements of the concentrations in the atmosphere of acid gases and organic vapours at the Hanrahan farm. Those measurements quite simply lend no support to the plaintiffs' case: on the contrary, Dr. Jameson repeatedly stressed in the reports and in his evidence that the concentrations found were relatively low. The plaintiffs' case depends on the making of assumptions as to the occurrence of peak concentrations at 15 minute periods at the farm. To make such assumptions where there is no evidence that such peaks actually occurred is to ignore totally the legal burden of proof which rests on the plaintiffs and this, for the reasons already stated, I am not prepared to do. It may be added that the evidence disclosed that continuous monitoring which would have confirmed or disproved conclusively the existence of such peaks could have been carried out for a sum in the region of £5,000, an insignificant amount in the

context of this litigation. I am not concerned, however, with the reasons why such monitoring was not carried out on behalf of the plaintiffs: it is sufficient to say that in its absence the plaintiffs are faced with insuperable difficulties in discharging the burden of proof which rests on them. It also cannot be without significance that there is virtually no evidence in this case of injury to human beings or animals which has been scientifically linked to any chemicals emanating from the defendants' factory. Dr. O'Moore and Professor Temperley said that the minor blood abnormalities detected by them in tests of the Hanrahan family were explicable for a variety of reasons other than chemical poisoning. Professor Fitzgerald found evidence of respiratory difficulty in Mr. John Hanrahan, but readily agreed that he could say no more than it seemed to him to be linked to some form of atmospheric pollution. I have already expressed my view that, in the absence of evidence from his general practitioner, this evidence is of little value. Most significant of all, however, is the almost total dearth of any clear evidence from the various necropsies carried out on the animals on the Hanrahan farm that they had been subjected to any form of chemical poisoning which could be associated with the factory. The evidence of Mr. Crowe was that an exhaustive range of tests - histological, serological, biochemical etc. - had been carried out on each of the animals selected for the joint slaughtering and yet no evidence of this nature emerged. The solitary instance of the finding of amphitrempyline in one of Mr. Neufeld's sample is clearly a wholly inadequate basis on which to found such a conclusion and, indeed, it was not seriously relied on as such.

The evidence certainly established that on a number of occasions in 1980 the emissions from the scrubber stack had exceeded the limits prescribed by the planning permission. But this fact, while it is to be deplored, does not of itself support the plaintiffs' claim that the emissions caused actual injury to health or damage to the animals.

In contrast, there is clear evidence to indicate that the undoubted deterioration in the quality of the herd on the Hanrahan farm could have had other explanations. In the first place, the evidence established beyond any doubt whatever that the serious and potentially lethal disease of hoose was present on the farm in 1978. This was the evidence of Mr. De Lacy himself; and that the hoose was still there in 1981 and again in 1983 is clearly borne out by the results of the necropsies carried out in those years. It has been repeatedly urged on behalf of the plaintiffs that the five experienced veterinary surgeons who gave evidence that they considered the cattle were suffering from complaints which were associated with toxic poisoning from the factory could hardly have mistaken the presence of hoose on the farm at the relevant time. Where, however, the uncontradicted evidence of Mr. De Lacy himself and of the necropsies establishes beyond any doubt that there was in fact hoose on the farm between the years 1978 and 1983, the plausibility of this contention inevitably begins to fail. The coughing observed by the vets who attended the farm during these years is consistent with the proven existence of hoose on the farm. Equally, the findings of sore or cut teats, streaming eyes or nasal discharge are indications of the paraviciinnia, morexellabovis, IBR and IBK disclosed by other evidence.

The prevalence of hoose would also, of course, explain the higher incidence of cattle mortality.

The evidence also demonstrated that the management of the farm since the year 1978, the only period for which documentary records were available, left much to be desired. I accept the evidence of Dr. Lynch and Dr. Bielenberg that there were clear indications of over-stocking, inadequate fertiliser input and poor quality silage during the relevant period, all of which together with the hoose, would go some way to explain the lack of thrift which many observed in the cattle. In addition, the inadequate breeding records may well explain the phenomenon of higher twinning rates and occasional calf deformities. It is right, however, to say that I do not think that the evidence established that either brucellosis or mastitis was a significant contributing factor to the difficulties being experienced on the farm.

Repeated stress was again laid on the fact that the pattern of life on the farm had changed from 1978 onwards and that the problems experienced by the plaintiffs were not paralleled in previous years. It has to be borne in mind, however, that the management of the farm changed significantly in 1978, when Mr. John Hanrahan took over the management of the dairy herd of which he had no previous experience. It was singularly unfortunate that these responsibilities of which he had no previous experience devolved upon him not long before he and a number of other residents in the area began to experience unpleasant smells clearly emanating from the defendants' factory. It is all too clear that Mr. John Hanrahan's belief that the troubles he was experiencing were in some way associated with the processes carried on in the factory

developed into something of an obsession which can only have diverted his time and energies away from the very real problems he was facing on the farm.

Again, it cannot be without significance that, while there is some evidence of other farmers in the general area of the factory suffering from animal health difficulties, the overwhelming volume of evidence is to the effect that the Hanrahan experience was a unique one. This is coercively established by the evidence of the veterinary surgeons, Mr. Brendan Walshe and Mr. Martin Fitzgerald, whose practice encompasses a large number of farms in the area and who said that they had encountered no problems in the course of their practice which were not attributable to known and well established causes. Even more remarkable is the total absence of any evidence of ill health attributable to the factory suffered by anybody other than the members of the Hanrahan family. On the contrary, the evidence of Dr. Carey, who provided medical services for the factory, establishes conclusively that the very people who might have been most consistently exposed to toxic damage, the employees of the factory, did not present any such symptoms at any time over a prolonged period of years. No scientific explanation has been advanced as to why the air pollution alleged by the plaintiffs to emanate from the defendants' factory should so selectively attack the Hanrahan farm and, indeed, all the evidence indicates that, if the defendants' factory was a source of toxic gases, the effects would be felt at other locations, e.g. Mr. and Mrs. Perrigoe's premises. Yet, although there is undoubtedly evidence that complaints as to the odours were received from Mr. and Mrs. Perrigoe and although they also complained on occasions of irritation to their eyes and of choking, they did

not give evidence in this case and there is no suggestion that their complaints were serious enough to warrant any form of medical attention.

The plaintiffs have, accordingly, wholly failed to discharge the onus of proof upon them of establishing that the injury to health, animal and plant life of which they complain was caused by emissions from the defendants' factory. There is undoubtedly evidence that on a number of occasions the processes carried on in the defendants' factory were responsible for offensive odours which were legitimately and reasonably objected to by the plaintiffs and many others living in the area of the factory. I have also no doubt that it was the insensitive and cavalier manner in which these well justified complaints were initially dealt with by the local representatives of the defendants that ultimately led to this litigation. The smells in question appear to have largely resulted from a substance called thioanisole and the manner of its disposal in the waste treatment plant of the defendants. It appears that the measures taken by the defendants to deal with these odours have been relatively more successful in recent times and it does not appear that they were ever on such a scale or intensity as to justify the award of damages, still less of an injunction, having regard to the principles I referred to at the outset of this judgment.

It follows that the plaintiffs' claim must be dismissed.

Roan Keane