Tuesday, 4th November 2008

(10.36 am)

MR MARTIN: My Lord, the order of proceedings as intimated when we broke for today is Dr Roger King will be the first witness. Mr Betts, who my Lord will recall had questions for and others will be recalled after that and then Mr Brian Fullam of the Health and Safety Executive will begin today if there is sufficient time, which I certainly hope there will be.

So if I can call Dr King now, please.

DR ROGER ANTHONY KING (called)

Examined by MR MARTIN

Q. Thank you, Dr King, if you just make yourself comfortable and if I could ask you to have, please, the final version of the Inquiry statement which should have been provided to you and also your report which was prepared for the Procurator Fiscal originally and which begins, for our purposes, on page 9163. I will ask you questions about that. Perhaps I can have 9163 up on the screen just to confirm we have the right document.

Dr King, we can see that your full name is Roger Anthony King and you have degrees in chemical engineering and corrosion science and engineering and your doctorate related to soil corrosion with particular reference to the activity of sulphate reducing bacteria.



Over the past 30 years you have been hired by government departments and research centres and others to provide them with specialist advice on material selection and corrosion management. You are a member of the National Association of Corrosion Engineers and a founder member of the UK section of what I take to be the National Association of Corrosion Engineers, an ex-council member of the UK Institute of Corrosion Science and Technology and a member of the Pipeline Industries Guild and you have written a number of papers.

I wonder if I could take you through then, please, without reading any more of it than is necessary at length -- and I will ask you to look at your report and one or two other documents at various times. In the section beginning at page 4 you say under the heading of "The pipeline.

"The LPG pipeline at Grovepark Mills was fabricated using carbon steel pipe. Parts of this pipe were coated in a layer of zinc. Zinc provides cathodic protection but this is largely irrelevant in this case as it was a very thin layer of zinc and so would not have lasted long, perhaps a number of months. The zinc is essentially a red herring."

We are going to talk about cathodic protection later



as a means of inhibiting corrosion in buried pipework but I wonder if you could just explain at this point how it is that a zinc coating, however thin, around a steel pipe provides cathodic protection. What actually is the mechanism of that cathodic protection and what is the corrosion that it is protecting against?

A. Good morning, ladies and gentlemen. Cathodic protection is essentially very simple. If you are used to buying toys for children, we put little batteries in them and the battery is made of two dissimilar materials interconnected with something that conducts electricity and when we short circuit these we get electric currents passing. Cathodic protection is essentially the same.

The zinc has a different thermodynamic potential to the steel so when they are combined electric currents pass between the iron and the zinc and the zinc corrodes to provide sufficient electricity to suppress corrosion reactions on the steel. In that process the zinc is consumed.

Q. I think that makes it very clear. In order to have what is called cathodic protection, a current, no doubt a very minuscule electric current, is formed between the two different metallic materials, in this case zinc and steel?

A. Yes.

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Q. Correct me if this is the wrong phraseology: because the steel is more resistant to corrosion, the zinc corrodes rather than the steel where zinc is being used as the protective coating?

A. That's correct.

Q. But of course as you imply, in the latter part of the paragraph, sooner or later the zinc is all exhausted by corroding itself and then the protection would be lost?

A. That is correct.

Q. If you have a pipe which is entirely steel, Dr King, does it have any electrical current either in it or between it and something else so that it corrodes?

A. The problem with most engineering materials is they are not completely homogeneous. So if we take a piece of pipe, steel pipe, there will be areas on it which are a little bit more active than other areas. So the metal sets up little galvanic cells on itself so electric current cycles through the steel and through the soil and these areas which are more active start to corrode.

Q. So that the existence of electrical current is essential to the corrosion mechanism that we are talking about?

A. It is indeed.

Q. Even in an apparently uniform piece of steel there will be minuscule currents passing which then lead to corrosion in one part, in a sense protecting the other

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part if I understand the mechanism?

A. That is correct.

Q. We will come back to that because I think it is important when we discuss the application of what we have called cathodic protection.

You then say:

"The pipes were interconnected by non-galvanised, mallable cast iron fittings, particularly at the elbows. The fundamental problem is the fact that the pipe was not protected by any means at all."

I will not trouble you with that evidence.

You then talk about oxygen corrosion and you say that is what in ICL we are concerned largely with.

"Oxygen corrosion is the most common soil corrosion process. The more oxygen that reaches the metal the more rapid will be the corrosion. The presence of salts in the soil increases the extent of corrosion but it is the oxygen concentration which determines the rate of corrosion."

Now, again, please forgive me if I am wrong, Dr King, but as I understand it for what you are referring to as oxygen corrosion -- and of course it is distinguished from other forms of corrosion in your report -- what you are saying is that one needs to have oxygen but one also needs to have soil for the corrosion

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process to occur because the obvious question is that

the evidence has revealed that by and large pipework, steel metallic pipework which is exposed to the atmosphere, does not corrode as quickly as that which is buried in soil.

A. You must be careful there. It depends on the atmosphere.

Q. Forgive me, that is what I am looking for. The question I am asking is that for the purposes of what we are talking about, one needs both oxygen and soil?

A. Yes.

Q. What I was going to say is if you have only oxygen, in normal atmospheric conditions such as exist in the West of Scotland, would exposed pipework corrode more quickly or less quickly than soil buried pipework?

A. A lot depends, as I mentioned earlier, on the atmosphere. We all know for example that if we have steelwork that is exposed to the sort of humidity that you normally get in this part of the world, unpainted steel will corrode in the atmosphere. That's because thin layers of water form on the metal surface and then the corrosion process starts in that thin film and we see that as the brown and orange rusts that form on metal surfaces. The process is worse in soil because there are other things in the soil which tend to

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accelerate the corrosion slightly.

Q. In other words, and again if I understand it correctly, you must have the oxygen?

A. Yes.

Q. But you must also have something else. It may be moisture simply adhering to the steel work in a damp exposed location or it may be soil which includes moisture and no doubt other things?

A. Yes.

Q. You then talk about the failed bend as having been a particular risk in the soil compared to the main section of pipeline because it was less deeply buried in the soil than the remainder of the pipeline. Oxygen diffusion will be higher at the location of the failed bend.

Is that purely a function of depth and the fact the soil will be less compacted closer to the surface, therefore, there will be more oxygen in it?

A. Yes.

Q. You then say:

"In addition to oxygen diffusion through the soil there woulds appear to be an additional oxygen diffusion path from the building to the failed bend."

That, as you reveal in your report and has been dealt with in the evidence, that is thought to be the

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path whereby the LPG entered into the basement. What you are talking about of course is prior to that it was a path for oxygen to get to the pipe from inside the building?

A. Yes.

Q. Under the heading of "Additional pressure in the pipeline", you deal with the raising of the level of the yard in about 1972 and you say:

"This would impose an additional load on to the pipeline. It also covered the end section of the LPG pipeline where it entered the building. Soil corrosion would have initiated from this date. Prior to burial some atmospheric corrosion would have occurred.

"The loading would be more severe than a straightforward soil overburden because construction

debris, eg a concrete slab, had been placed on to the pipeline. The additional overburden is reported to have distorted the final buried elbow by about 5 degrees."

We heard from Dr Hawksworth ultimately summarising that could have happened. You say:

"Heavy loading could eventually have led to mechanical failure of uncorroded material in the pipeline. This could offer because as the length of the flaw in the pipe increases, the load on the pipeline would be carried by the smaller remaining section of

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uncorroded pipe ..."

I wonder if I could ask you to look, if they could be put up on the screen, please, at some photographs.

The first is 13269. This is a photograph of the piece of the pipework which failed critically according to the evidence before it was separated. Incidentally, it is lying on the floor of the Inquiry room in front of you after separation but the elbow that we are talking about is the elbow that is approximately in the middle of the photograph.

Could I have the next photograph, please.

In this one, this is a close-up of the elbow and the threaded fitting which is referred to in your report and what we see in yellow -- it is slightly difficult to read -- is:

"Bridge of corrosion products across opening after removal of reinforcement."

I will just ask you to note that at the moment. Could we have the next photograph, please.

That is a photograph of the two parts separated and then the final one I want to look at, which is 13272.

This is looking downwards on to the aperture of the union where it had broken and what we have heard otherwise and what you are familiar with, Dr King, is that the corrosion had reached an extent of 71 per cent

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around the circumference. It was at the point of thread -- I do not need to trouble you with that -- and latterly the clean metal, as it were, (that is to say, what had not fractured as a result of corrosion) was the 29 degrees which we see at the top of the photograph. That is pretty clear.

As I understand the evidence that you are giving in your Inquiry statement at the point that I have just described to you is that the loading, the weight on the top, the 5-degree angle created, would tend to cause the weakening caused by corrosion to take place as the actual piece has suggested; that is to say, it fractured, as it were, with a weight above and the last piece of uncorroded metal was towards the top. But at some point the loading became too much, the extent of corrosion became too much, the gap appeared and the gas then escaped.

Is that a reasonable summary?

A. Yes.

Q. At paragraph 12 you talk about:

"One further effect of additional strain is blow-out of the adherent blanket. The build-up of corrosion adheres to the surface of the pipe, creating plugs of corrosion."

By that what I understand is that for a period,

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potentially quite a lengthy period, although the pipe surface had failed through corrosion, little, if any, gas escaped because the seal was kept by the corrosive

materials in the gap. Is that right?

A. To an extent, yes. We wouldn't know how much gas may have permeated through because of course these rust plugs tend to be slightly porous.

Q. But it is only at a point perhaps relatively soon before the build-up of gas in the basement which caused the explosion, for whatever reason, whether the loading or whether the corrosion simply reached a point where the pipe could no longer sustain itself, the seal as you call it, the plug of corrosion, for whatever reason was displaced and the gas was then able to escape --

A. Yes.

Q. -- in a more significant quantity.

In 13 you say:

"The increased burden caused by the raising of the yard and the concrete slab on the elbow of the pipe may have been of importance in the ICL case as contributing factors. However, in general the biggest problem is corrosion. The unprotected pipes would have corroded despite raising the yard or adding the concrete slab. There is not any particular need to focus on the leading or any precise mechanism."

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If I understand you correctly, Dr King, what you are saying is that simply by virtue of it being in the ground in this location with the ambient conditions that existed for a sufficient length of time, this pipe was going to fail sooner or later?

A. Yes.

Q. It may have been the loading which actually brought it about at a particular time but that was simply, as it were, a circumstance which brought the critical event into existence; it was not the cause of the corrosion?

A. That's correct. In fact, the pipe was corroded in other areas we also discovered.

Q. Taking it summarily, if I look at paragraph 14 you talk about the weather, in paragraph 15 you talk about evidence which had been given that the day before the building shook, and you also refer to the possibility of lightning striking the pipework. That is paragraph 17. In paragraph 18 you are asked whether the geology of the site had any potential significance and in each of these cases, as I understand it, whilst it is impossible to rule anything out, these were not critical factors. They could have caused this but on the evidence the cause was the corrosion. Thank you very much.

We then come to cathodic protection in the sense of what might be done to inhibit the corrosion of a pipe

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such as this. I wonder if I could ask you to look at your report, please, and in particular I think it will be page 9170.

This is the page, Dr King, where you are discussing cathodic protection and to some extent what you say in your Inquiry statement is a summary of that. I would like just to discuss it with you if I could in a little bit more detail.

In paragraph 19 of your Inquiry statement you say:

"Cathodic protection is very efficient particularly for small pipelines. It is a well established technique that is widely used to prevent corrosion of buried and submerged pipelines. Cathodic protection works by shifting the corrosion of the steel pipeline to another sacrificial material that is electrically connected to the steel. The steel and the sacrificial material form a battery similar to a conventional primary battery

normally for buried pipelines magnesium is used as the sacrificial metal.

"The caveat to this is when a pipe is buried but at some point comes through the ground into the air, for example when it enters a building, it is exposed to corrosion. At this point the pipe should be wrapped."

If I understand this, and if we look at page 9170 of your report, as you have said in the second paragraph:

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"CP works by shifting the corrosion of the steel pipeline to another sacrificial material. The steel and the sacrificial material form a battery similar to a conventional primary, for example 1.5 volt battery. The usual sacrificial materials used are zinc or magnesium. In the present case magnesium anodes are used."

As I understand it following the evidence that you gave a few moments ago how this works is that rather than allowing the currents to flow either within the metal itself or perhaps between the metal and a zinc coating thus bringing about a weakness at one point of the cycle all of the electrical current in the metal is taken off and put into the sacrificial material which I think is called the anode is that right?

A. That's true.

Q. And if that sacrificial material is buried not far away in the same soil, then the circuit that is formed leads to the corrosion of the sacrificial material, the zinc or magnesium?

A. Yes.

Q. These are used in the case of a steel pipe because they corrode easier than steel?

A. That's correct.

Q. In other words, as the word is used in your Inquiry statement the anode is sacrificed in the sense that it

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is encouraged to corrode by this mechanism so to preserve the pipeline?

A. That's correct.

Q. What that means by logic obviously is that sooner or later the anode will be used up completely and will disappear and at that point the protection will cease?

A. Yes, that's correct.

Q. So that if you are wanting to provide protection to a particular identified piece of pipework you can do a calculation to work out how much of the anode you are going to need to protect what is there for a predicted period?

A. That is exactly correct, yes.

Q. If we look at the next paragraph of your report that is what you do, you say:

"The underground pipework had an external diameter of 33 millimetres (1.25 inches) and a length of, give or take, 55 feet. The nominal area of the pipeline would have been 18 square feet. [That is just a calculation of surface area] Allowing for the slight diameter increases for the fittings this would be approximately 20 square feet. Cathodic protection current to protect corrosion is typically 5 milliamps per square foot. For a corrosion free service life of 30 years, the total current required would be 3 amp years."

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That is just a calculation of the quantity of electricity which would be necessary for the predicted period or the calculated period.

"Magnesium anodes provide 900-amp hours per pound. Allowing for leap years, this would equate to 10-pounds

of magnesium per amp year. Consequently about 30-pounds weight of magnesium would have been sufficient to prevent corrosion of this pipeline for 30 years. Small magnesium anodes are fabricated as 3-inch diameter rods by 3 feet long with a weight of 16-pounds and cost about £30. Two 16-pounds anodes would have prevented corrosion of this pipeline beyond the 30-year service life. The magnesium anode would be buried roughly 1 meter from the pipeline, probably adjacent to the building, to afford protection to the anode and an electrical connection made with the lead from the anode to the pipeline. This connection could be an earthing type mechanical connector or a spot weld. In some cases the electrical connection is made above ground in a junction box so that the state of the CP system can be checked to ensure all is well."

Do I understand it, Dr King, that assuming that is done in a hypothetical situation, then the system in the atmospheric and other conditions which are around it acts as a protector without any further human or other

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intervention, as long as the circuit remains connected?

A. The section of the pipe that is buried, yes.

Q. When you say earthing type electrical connection, by that do I understand simply one of these clamp-type fittings that can go round a metal pipe or as you say spot weld, connect a wire to the anode, put the anode into the ground about a meter away obviously sufficiently protected and the circuit then exists at least as long as the anode is --

A. That's right.

Q. Is it possible to have perhaps -- you mention two 16-pounds anodes being commercially available. Would you have two separate anodes or put one in after 15 years of the first one?

A. You could do either, whatever is the most convenient thing to do. If you put one anode in it roughly lasts 15 years and then you could replace it or you could fit and forget. If you wanted the thing to last 30 years you put two anodes in at the same time.

Q. You then say in the next paragraph of your report:

"Additional costs would have been incurred, however, in ensuring that the pipeline was electrically continuous. Usually this is done by spot welding the pipe to the fittings. It may be, however, that the threaded fittings were sufficiently tightened such that

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there was electrical continuity. This would be easily checked using a standard voltmeter in the ohmmeter function."

I will come back to that issue in a moment:

"The use of cathodic protection for small diameter pipelines saves the requirement of attempting to coat or wrap the pipeline. In most cases pipelines are protected by the combination of coating and cathodic protection but this would not have been necessary for this small pipeline. Coatings alone are an alternative to CP but it is expected that the cost of wrapping or coating this pipeline would have been much higher than the application of CP."

As we discussed at the beginning, zinc around the steel pipe, zinc coating, can also or does also provide a cathodic protection --

A. Yes, it does.

Q. -- but eventually because of the mechanism that disappears.

Is it possible to say, first assuming a perfectly installed zinc coated pipeline, is it possible to say how long that would survive in normal conditions buried in the ground?

A. We have --

Q. Sorry, I should say without corrosion beginning to

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affect the steel?

A. We have some figures on that in research work has been done at our National Physical Laboratory here and also American work. I think somewhere in the report I've given some figures for the rate of corrosion of zinc in soils and I think it's in table 1 of the expert opinion. One can realise rapidly from that the demands of zinc that was applied to this initial pipeline was really very modest. So the period of time the zinc would protect the pipe would be quite limited.

Q. That is what I want to come to, the calculation that you have done would not really have an equivalent in the using of coated pipework because the coating would not provide the quantity of anode, if you like, equivalent to the buried magnesium anode?

A. That's correct.

Q. The second question I am going to put to you is, of course, as we have heard, particularly with screw fittings and so on, it is not always possible to ensure that the coating protection is properly continuous or indeed --

A. That is correct. Where the threads are cut very often of course the zinc coating would be damaged anyway.

Q. But am I right that if one is applying this external cathodic protection, the connection of a wire to an

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anode buried elsewhere, these difficulties do not arise as long as electrical continuity is identified in the pipework?

A. That is correct.

Q. I think in paragraph 20 and 21 you really are repeating what I have taken from the report so I do not need to do that.

In 22 you say:

"The ideal point to situate the anodes is for one to be buried by the tank and one at the entry of the building."

That is obviously assuming you have two.

"If it is a case of digging a hole, inserting the anode, connecting the anode lead to the pipe and filling in the hole, this avoids corrosion at the edges as it protects the whole length of the pipe."

Talking there about digging a hole, is it necessary to dig any hole into the pipework itself in order to attach the wire to the anode?

A. No, not that --

Q. You can simply use the piece of pipe that is exposed?

A. Yes.

Q. As long as there is an efficient properly made electrical connection it works underground?

A. Yes, electricians do it all the time for grounding of

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pipelines. We have earthing mats essentially in case there's a stray current on pipework. So these things work very efficiently.

Q. We say stray current in that sense, is that the possibility of a stray current causing a spark?

A. Yes.

Q. At the end of paragraph 23 you talk about the

calculation and you then say:

"British Gas systems previously were protected in this way using standard anodes."

What sort of British Gas systems are we talking about? Are we talking about large mains or are we talking about small potentially industrial or domestic pipework?

A. All major Transco pipelines, for example, and the previous British Gas pipelines were all cathodically protected. These are the big transmission pipelines that carry the high pressure gas.

Many, many years ago, 40 plus years ago the domestic -- the lines supplying houses, the domestic lines, were generally carbon steel lines and it was the policy of British Gas at the time to actually install tiny little anodes on those pipelines. Remember these pipelines were only very short. They were just run under the garden from wherever the low pressure main is

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and these were protected by cathodic protection system to give them additional life. The anodes they used to use were specifically made for British Gas. They would have an elbow where the pipe rose to enter the house which had a socket on it, essentially a screw fit, and the little anodes were just screwed in and that was sufficient to protect the pipe, these domestic lines, for a long period of time.

Q. In terms of character you are aware of the pipeline from the description that existed at ICL. It was from an LPG tank over about 15 metres to a wall. In principle, is there anything different about that line of pipe than the ones you have talked about?

A. No, not at all. This just happened to be a bit longer, that's all. These anodes will throw electricity for several hundred metres. So this is well within the range of anodes to protect, this pipeline is very small.

Q. In paragraph 24 of your inquiry statement you say:

"Cathodic protection can easily be retrofitted and it will work straight away. If it is applied to an old pipe one would need to provide more anodes."

Why is that?

A. This is because if the pipe is rusty the rusty is slightly active. So what we are trying to do is suppress electrical current flowing on the pipe and rust

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provides a larger surface area, essentially. So because of that we have to supply slightly more electricity to stop the corrosion.

Q. You then say:

"Prior to applying cathodic protection a pipe should undergo a proper pressure test at high pressure."

I will come back to ask you about that later if I may. You say:

"If it is tested at 50 per cent higher than working pressure that would pop out any corrosion plug. If the pipe is faulty, replace it. If you then apply cathodic protection you would stop further corrosion. If you were being absolutely safe you would dig it up but this is not always practical.

"The caveat to this is that it gives some short-term protection to avoid having to do something in a hurry. The user can be informed that this affords short-term protection but that there are further measures to ensure the safety of the installation. If you can plan to do something over six months to a year you can get quotes in, et cetera. The measure is more cost effective

without putting too much pressure on the owner of the pipe. For example, if the pipe had been in service less than ten years do a pressure test and add cathodic protection. If the pipe was over ten years one could be

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required to do X, Y and Z. If you do not know the age of a pipe in a high risk location, for example near a school, look at the consequences and decide the procedure based on potential damage."

As I understand your evidence there, Dr King, what you are saying is cathodic protection is not a magic ingredient which solves all problems of potential corrosion in underground buried pipeline about which you do not have detailing knowledge, it is part of a perhaps wider strategy to address an overall replacement of metal pipes ultimately or what are we talking about?

A. If cathodic protection is applied correctly it will stop corrosion. The problem is, of course, if you have a pipeline that is essentially corroded and you apply cathodic protection you will stop further corrosion but if there is already a leak on that pipe sooner or later you are going to the gas escaping. You can't return metal once it is corroded of course. We can only stop further corrosion occurring. But I agree with you. I see that the application of cathodic protection should be one of the tools we have in our tool box, so to speak, for protection of the pipeline.

Q. Thank you very much.

Then you say in light of that in 26:

"Can all risk from LPG pipes be eliminated?

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"The only way to eliminate risk is to dig pipes up regularly."

Then you:

"Say digging up pipes could be an option where it is a high risk area."

That begs the question of how that assessment is carried out but again I will come to that.

I think again in 27 you are repeating what you have just said:

"Occasionally cathodic protection might not prevent leakage even if a pressure test had been passed."

That is in a situation where there is already a badly corroded pipe as you described in oral evidence.

You talk about wrapping of pipe. I do not need to ask you about that and the weaknesses of that. I think we have heard evidence about that otherwise.

In 32 you say:

"Cathodic protection systems require some monitoring, however that would not be onerous. After the first year in service the user should dig up and check the anodes."

That is the point about ensuring that there has been an electrical current because, as I understand it, if for some reason the circuit did not exist, it had not been made or had been broken then of course the

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corrosion would not occur in the anode?

A. That's right.

Q. So it is easy to identify that.

I can leave the rest. You say at the end of 33 there is an onus on the user to monitor the system and some people might require training. 34 and 35 again I think I can take as read.

I would like to put to you, Dr King, three issues that have been raised about cathodic protection. It has

been explained by certain witnesses that in the situation which exists of a large number of underground metallic pipes of varying vintages of which details are not necessarily available, three reasons why it might not be appropriate. The first of these is that we have heard evidence, in particular from a witness from Calor Gas. That although steel pipework continuous steel pipework was used, for example, at the time of the installation at ICL (that is the late 1960s into the 1970s), there was a period when the horizontal element of the pipework underground was polyethylene but that there were steel risers and reasons for that were physical protection of the risers. Of course now since the 1992/93 it is thought that virtually every installation is PE in its entirety.

If we have a situation where there is polyethylene,

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as it were, in the middle of the pipeline, then of course there will not be electrical continuity.

Does that suggest either that cathodic protection would be inappropriate in principle if it was suspected that you had mixed steel and PE system or might the cathodic protection be applied in a different way?

A. We really only use cathodic protection to protect the metallic section of the pipeline and because the pipeline is essentially isolated by a polyethylene centre section, if you wish to protect the risers, on the buried section of the risers, one would have to put a little anode at that location. So, in that particular case if you had a steel riser that went from the tank into the ground where it connected the polyethylene pipe and at the other end of the pipeline we have a steel riser coming up from the polyethylene pipe up to the building or whatever one would have to put little anodes at both ends for each of the metallic sections.

Q. So, in effect, you would have two separate cathodic protection circuits being created?

A. Exactly.

Q. I suppose it occurs to me that if the pipework is not continuous from one point underground -- from one point above ground and then underground to another point above ground, you cannot necessarily be sure that there is a

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circuit through all of the metal in a vertical riser, could you?

A. I fail to see how it would be isolated in that sense because the riser, the steel riser that comes up from the polyethylene pipe, would be continuous from the junction with the polyethylene.

Q. Yes, but unless you dig a whole you are not going to be able to check that because you are not going to be able to get to the other end of the pipe, the metal length of pipe, to ensure that there is a continuous circuit from the point above ground.

A. I'm not following ...

Q. Maybe I am not explaining this very well. It may well be my lack of knowledge of the principle.

As I understand it, assuming you have an entirely metallic system, you would put your volt meter circuit from one end of the pipe to the other?

A. Yes.

Q. You would identify there was a sufficiently continuous circuit and you could be confident because the pipe was underground but also because the electricity was flowing there was a continuous circuit throughout the metalwork.

A. Yes.

Q. If, however, the pipe is not continuous, if it has the polyethylene centre section, as you explained, you could

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have a separate cathodic protection at each end with its own anode. That makes sense. But my point is would it not be difficult without digging up all of the metallic riser to know if the circuit was continuous along the entire length of the metallic riser?

A. Yes, I agree with that, yes. In that particular case but I find it difficult to see that you would have a piece of metal, then some isolation, then another metallic section. It is possible, yes.

Q. It may be that ... I am sorry, my Lord, I thought there was a reference there that would help on this. Perhaps I will leave it just now.

The second reason why it may not be appropriate, why a cathodic protection in the manner being applied that you have described it, Dr King, in such systems, is that if it the case that you have to dig up the pipe to any significant extent, then frankly you might as well dig it up and replace it. Now of course if you have the continuous metal pipework we have just described, you do not actually dig up any of it --

A. That's right.

Q. -- because you can make sure, if you have a sufficient continuous circuit, the cathodic protection will cover the entire length of pipe?

A. That's correct.

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Q. But is it fair to say that if you are having to dig up the risers just to make sure that there is a sufficient circuit along the vertical length of the riser, you might as well replace the riser?

A. I totally agree, yes.

Q. Therefore, does that tend to suggest that unless in a situation where you could get a continuous circuit of sufficient current so that you are confident that it was a continuous metallic system, albeit buried underground, then probably cathodic protection, in practical terms, although it would still work at each end, in order to ensure that it was working sufficiently you dig it up, you have to dig up to the point where you might as well replace the pipe?

A. Yes, I agree with that and this is why I said cathodic protection is only one of the tools that we have available to us.

Q. The third concern which has been expressed derives from what you say about the carrying out of a higher pressure test in paragraph 24. You say that if the pipework is tested at 50 per cent higher than working pressure then that will pop out any corrosion plug. That makes perfect physical sense.

What has been said by those familiar with existing installations is that although you might carry out a

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high pressure test, which I believe is referred to as a proof test, on a new installation that the installer was aware of all the characteristics and therefore knew what existed, you would not carry out a high pressure test on an existing system because the danger of catastrophic failure of the system, danger to the person carrying out the test, danger to others, meant that that would be a health and safety risk; in other words, their view, as I understand it, would be that your suggestion of a high pressure test would not be appropriate on existing systems.

Do you have any comment to make on that?

A. I can understand the concern but I think the term "high pressure" here is possibly misleading. These systems work at very modest, very low pressures. What we are looking for here is something that is slightly above that. I do not think that that would constitute any significant hazard to personnel. For example, people handle bicycle tyres all the time which operate probably at higher pressure than you would need to check the pipe out. People drive around in cars which operate at much higher pressures in the tyres than you probably need to test out an underground pipeline. So we are quite familiar with this type of thing. Therefore, it's very unlikely there would be anything catastrophic that would

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occur.

Q. Based on your scientific knowledge and experience, what sort of pressure are we talking about that will be sufficient to blow-out the kind of corrosion plug that you are envisaging in your evidence?

A. I would think probably between 50 per cent and twice the actual operating pressure.

Q. So if it was a domestic system which is limited to 37 mBar above, we are talking, what, about 50 mBar?

A. Yes, probably. Whatever would be a convenient number. You can see the pressure we're talking about is extremely low.

Q. In paragraph 38 of your evidence and 36 you talk about the Bilbao incident and you explain the catastrophic consequences of that where people were killed and you say that the pipe had been protected by wrapping but not effectively because it was damaged during installation.

We have already heard evidence it is quite a skill to wrap in Denso tape appropriately and it is quite possible for it to be disturbed or inadequately wrapped and you then get a characteristic corroding pattern on the surface of the pipework.

Then you talk about establishing the scale of the LPG programme. We have heard evidence that, as I referred to earlier, Calor Gas and now in consultation

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with the Health & Safety Executive are carrying out an assessment based on 500 domestic installations which are being excavated. It takes into account the age of the pipework, whether they are all steel metal risers with PE horizontal or central section or potentially PE and takes into account soil data based on postcode sectors and comes up with identified areas which are at highest risk, identified types of installation which are at highest risk.

Without troubling you with the details of that, Dr King, I take it that is the sort of strategy that you would see as one of the other elements in the tool box, as I think you call it?

A. Yes, I would be tempted to think there that risk is the multiplier of the probability of an occurrence times consequences and generally it's much easier to evaluate consequences than it is to evaluate the actual hazard and a lot of things, commercial and domestic soils are not homogeneous. If you buy a new house you spend the first five years digging up bricks that the builders left behind in the garden. Soils are very poor in that sense. I don't think there's any point in doing that. We just have to assume that there will be a degree of corrosion of all buried materials, some more rapid than others, so I wouldn't be for that.

It is quite clear that if there is, for example, a gas leak, the areas one would be concerned about are properties that have spaces below ground where the gas can accumulate, cellars or foundations of some form, that are open to collect the gas and these would be essentially the sort of thing one would be looking for to evaluate consequences and hazard in that sense.

Q. I can tell you the statistical model does take account of --

A. I'm sure it does.

Q. -- opportunities for accumulation in small spaces and so on.

I am just trying to get really, as it were, a summary of the value of your evidence to this Inquiry, Dr King.

Perhaps it is what you have already said. While there may be value in a statistically-based model being used to identify highest risk installations and concentrate on, frankly, removing these as quickly as possible and replacing them with PE or whatever it may be to make them satisfactory in modern conditions, would you say there was also room in those that are identified as perhaps less at risk for cathodic protection to be applied even as a temporary measure while the programme moves towards these lower risk locations?



A. Yes, I think there is value in that because we know that the application of cathodic protection to these older steel mains will arrest the corrosion so essentially we are buying time at a very low cost.

Q. Obviously, we have explored the potential shortcoming of metallic risers and the horizontal or central section of PE without digging up you cannot be entirely sure you have got a continuous circuit throughout the metalwork, but let us suppose as part of our risk evaluation you take the risk in 90 per cent of cases that you will be covering the metallic riser if you cannot get a continuous circuit across the system as a whole. Is there any downside in applying cathodic protection to a metallic riser, even if it does not in fact have a continuous circuit right to the foot of the riser in that particular case and, therefore, it does not necessarily arrest the corrosion that it might have been done?

A. I think this is really a case like Google: at first do no harm. So applying the cathodic protection will not actually do any -- well, it won't do any damage at all to the system but, as you point out, if there is lack of electrical continuity it may not protect all of the pipework that you wish -- but it certainly will not do any harm.



Q. That was going to be my next question. It would not do any harm?

A. No.

Q. It is conceivable that in some situations it might not afford the protection which it could do if you dug it up but it would not do any harm and it is relatively inexpensive and apart from checking it is operating there is no maintenance to the system as long as it is not damaged?

A. That's right.

MR MARTIN: You talk about soil type in the next section of your evidence, Dr King, and you talk about assuming that soil will be mixed. Again, as I have indicated that has

been taken into account by the use of postcode data for both England and Scotland.

Then in paragraph 45 you talk about underground pipes and so on. In fact, as I understand it, what you are saying is that, like everybody else, balancing risks and advantages, underground pipes are safer from damage, which in another situation, a vehicle cutting or a machine cutting into it or whatever is one of the other risks of pipework.

I have no further questions. The Chairman and others may have some questions for you. Please remain if you would.

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THE CHAIRMAN: Dr King, there are some questions for you from Calor and also from the HSE. Calor first, please?

MR SHELDON: My Lord, I think most of the material which Calor proposed to put to this witness has now been covered and the answers given. Yes, I have no questions, my Lord.

THE CHAIRMAN: Thank you very much, Mr Sheldon.

Mrs Stacey, please.

Examined by MRS STACEY

Q. Dr King, can I just check with you I think you said earlier on that in a section of metal pipe above ground, the cathodic protection does not work, putting it bluntly?

A. That's correct.

Q. I have understood that correctly, have I?

A. Yes.

Q. Then can I ask you about the soil. You say, I think, in paragraph 18 of your Inquiry statement that you have been asked to think about geology and whether that has any significance.

A. Yes.

Q. You say that it could only be of significance, for example, in connection with clay which may be potentially corrosive.

A. Yes. When we were discussing this, clearly these notes

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were taken down. We did actually speak around this a little bit more. I think for most installations we have to assume that soil may be very well mixed. If you look at soils as a generality, it's clay soils that give most problems to pipelines rather than sandy soils or loam-type soils.

Q. What I wanted to ask you about was whether it is any part of your expertise to consider what happens after there is corrosion and there is gas escaping.

Is it relevant to think about the soil into which it is escaping?

A. That is a very good point. One might argue that, for example, consolidated soils such as clay might in actual fact act as a way of preventing major release of gas from a corroded pipeline, yes. That is possible.

Q. So there could be perhaps a paradoxical effect that some types of soil are more likely to create the corrosion but then are more likely to stop the gas, if I can put it as crudely as that, from going through?

A. Yes, that's quite possible. In fact, we see that, for example, in things like nuclear waste content where we are relying on the low permeability of things like clay soils to contain waste and other things.

Q. So would you think it sensible, Dr King, that if one wants to look at risk rather than hazard one would be as

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well to look at the kind of soil for the reason I have

just mentioned?

A. Yes. I think that might be possible to take into account but the difficulty comes though that generally when small pipelines like this are buried, people don't take particularly great care in how the soil is replaced.

If you were building, for example, large diameter oil or gas pipelines, I am talk about serious pipelines here, it is practice to remove the topsoil, dig the trench put the pipeline in and then return the soil in the strata that was built up. When a little pipeline is built like this very often of course they just dig a trench, stick a pipe in and bang the soil back in any old way so it is not replaced in a structured way; in which case though, the subsoil might be clay, you have no guarantee of course that that clay will be replaced. It might be mixed with topsoil, it might be mixed with all sorts of things. So I think it would be very fraught to rely on the fact that this is a clay area, that the clay will contain a gas emission.

Q. Absolutely. I would not wish to rely on it.

A. That's right.

Q. Actually that brings me to my last question, I think: if you were going to do this retrospectively, to fit it to

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a pipe that is there already, then you would want to know something about the ground into which you were putting the protection, would you not?

A. It would help but I don't think that's essential. When we look at the major cross-country pipelines, for example, we don't do foot-by-foot surveys along there and worry about it. We apply cathodic protection and it protects the pipeline in more or less all of the soils.

Q. Would you need to find out, for example, if there was any stray current in the soil already?

A. If there were the pipeline's probably got a very high chance of having corroded extremely badly already in that case. In soil, in terms of protection, in many ways might reduce the risk of stray current damage to the actual steel pipe itself because the anode then acts as essentially an earthing path for the stray currents to leave. So your anode would corrode a little bit more but that would of course be protecting the steel pipe. So I don't see that the stray currents essentially are very significant to us.

Q. What about the proximity of other buried metal structures? Would you want to know about that?

A. In cathodic protection systems for major structures where the electric current is provided from the National Grid through a transformer rectifier system, yes, you do

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get stray currents. With these sacrificial systems the voltage difference is extremely small so stray currents are exceptionally rare to occur with a sacrificial system.

Q. I do appreciate, Dr King, you say that this is one item to be in the tool box.

A. Yes.

Q. Are you agreeing in that that while you may be correct it is indeed one item in the tool box but if one knows that there are underground buried metal pipes of the small variety that we are concerned with here, it might just be a priority to get them out and replace them with polyethylene?

A. I agree but, for example, if you take the case here, the pipeline went underneath a car park. Digging that pipe

out and replacing it would be quite an undertaking because you would have had to remove the tarmac, you'd have to Kango hammer. It would be a big undertaking.

Applying cathodic protection is very, very straightforward. You can actually get a degree of protection on the pipe for extremely little effort and this is where we were discussing this as one of the tools. Everything depends on circumstance of course.

Q. Yes.

A. When we look at the number of these installations that

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are around and quite old, one has to look at the different options you have to try to make things -- to provide protection.

MRS STACEY: Give me just a moment, please. (Pause)

Thank you, Dr King.

I have no further questions, my Lord, thank you.

THE CHAIRMAN: Mrs Ferguson, I think you mentioned cathodic protection in one of your written comments. Is there anything you would like to ask Dr King.

MRS FERGUSON: No thank you.

THE CHAIRMAN: Mrs Smith?

MRS SMITH: No thank you.

THE CHAIRMAN: Mr Macauley? What about you?

Could I just be clear about this, Dr King -- I will be corrected if I am wrong -- but it looks as though this pipe was originally laid in the 1960s. Can I take it that the risk of corrosion to an unprotected steel pipe of this kind would be well known and well understood in those days?

A. Yes, I'm sure that's the case.

THE CHAIRMAN: It appears that the level of the yard was then raised in the early 1970s, I think. I take it then that it would be known to anyone raising the level of the yard that the pipe was there because the riser would be visible?

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A. Yes.

THE CHAIRMAN: Would it be known at that time that there would be risks if you added to the loading that was on top of the pipe?

A. That's a difficult question to answer in any sensible way. Generally this type of pipe, steel pipes, the amount of loading that occurs is very often irrelevant. I think in this particular case, because of the particular geometry of the pipe, it had an effect. Normally that would, in most cases, that probably would not have applied.

I might have been more concerned if this was polyethylene pipe and they put an additional loading on it because then there would be risk of course of ovalisation and collapse of the plastic pipe. Polyethylene pipes are very good but there are negative sides to them as well as the positive sides.

THE CHAIRMAN: My layman's understanding of this has always been that where you are backfilling over a pipe, the fill material has to be very carefully applied and there should not be any boulders or rubble, masonry or anything like that in the backfill material.

Am I right about that?

A. That's generally a good case but the reason that is generally done is because pipelines are coated. So they

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are covered in plastic layer of some form, either an organic coating or a wrap of some form which is of course fragile so dumping boulders and half bricks on it

will make holes in the coating. Then were the holes are corrosion will start. If you've got a bare pipe as in this case that really would be less relevant.

THE CHAIRMAN: But then if you have a bit of concrete slab on top of it, then surely that must effect the position?

A. I assume that was put there by the builder to hold everything in place while he sort of did other things and then of course was just neglected and left there.

THE CHAIRMAN: So really then does it come down to this: the whole source and origin of this disaster can be traced right back to the very day when the pipework was laid?

A. Yes. You bury something in the ground, a metallic material in the ground, steel, it's going to corrode. Sooner or later you are going to get a hole in it. It was just unfortunate that this pipeline essentially corroded at the area where the gas could easily enter into the building. But we know this pipeline had corrosion areas elsewhere along the length of the pipe but that was sufficiently remote, one assumes, for the gas not to actually enter the basement of the building.

THE CHAIRMAN: So is the sequence this then: there is first of all the laying of the pipe, which appears to have

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been plainly wrong not to protect it; then there is the raising of the level of the yard above it; then there is the failure to seal the entry point of the pipe into the building?

A. Yes.

Q. That is one chain of events and then there is a parallel chain of events within the building with the laying of the steel floor which then creates the void?

A. Yes.

THE CHAIRMAN: Do I have that right?

A. Yes, it's just a succession of sort of suboptimal operations.

THE CHAIRMAN: Then, finally, there is a third parallel stream is there not and that is the failure to appreciate the risk at the time when the risk assessments were being made?

A. Yes, very sad.

THE CHAIRMAN: Maybe that is a huge oversimplification but does that really sum up all the various factors that all came together in this?

A. Yes.

THE CHAIRMAN: Thank you very much for your evidence, Dr King.

(The witness withdrew)

THE CHAIRMAN: I think we will have a break for the

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shorthand writers.

(11.42 am)

(A short break)

(12.03 pm)

MR MARTIN: My Lord, the next witness is the recall of Mr Betts to be asked questions by your Lordship and others.

There are two particular matters, I think, which require to be addressed but, having discussed the matter with my learned friend Mr Sheldon, he is going to ask particular questions and, with your Lordship's leave, I can, if necessary, address any further questions in re-examination.

HENRY BETTS ^ full name (recalled)

THE CHAIRMAN: Mr Betts, one of the questions that, there is obviously a straightforward answer to it but it has not really been explored yet, is why is it that when the LPG

comes out of the tank at pressure why is it reduced in two stages? Why can you not just have a regulator that reduces it in one stage?

A. Such regulators do exist and if you look at many LPG cylinders, the smaller canister applications, they often do have a regulator that reduces the pressure in one stage.

The reason that the industry has developed with

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typically two but increasingly with three stages in some applications, is due to, I think, one, it reduces it in such a way to enable you to fit on these various safety devices, the overpressure and the underpressure shutoff devices. They work best on a twin stage system.

As I mentioned when I was here last, the system very much is going to put in all the regulators close coupled on the tank so effectively it is having that same effect.

THE CHAIRMAN: The next thing wanted to ask you about was if you are going to have two pressure regulators, would you consider that having the configuration we see there with both of them on the tank, is that the optimum configuration in your opinion?

A. Very much so, yes. One of the key reasons for that, and Calor has updated its guidance and recommendations to its salesforce to, wherever possible, go for that orientation is the big difference we found between having low pressure pipelines and medium pressure pipelines. So wherever possible, we recommend a low pressure pipeline.

THE CHAIRMAN: There was one point that I did not fully understand and that was that you a classified pipework system into four phases. There is the tank pipework; is that right?

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A. Yes.

THE CHAIRMAN: That is to the first stage regulator; am I right?

A. Yes. In this case obviously there isn't any because the regulators screw directly into the fitting, but I think we saw examples where the regulator is fixed further down the line.

THE CHAIRMAN: The next section of the pipework then is the service pipework.

A. That's correct.

THE CHAIRMAN: That ends at the --

A. The emergency control valve.

THE CHAIRMAN: -- emergency control valve, which would normally be outside the building.

A. Yes.

THE CHAIRMAN: From the emergency control valve to the appliance itself: is that appliance pipework?

A. It's not. It's installation pipework. These are the -- our descriptions are the ones that are used in GSIUR regulations as well. Then each appliance has, or should have, a valve to enable it to be isolated for servicing, et cetera. So any pipework beyond that valve we then call the appliance pipework.

THE CHAIRMAN: That is the point I did not fully understand. So the appliance pipework would run from the isolation

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valve to the point where the vapour emerges at the --

A. Into the appliance, absolutely, generally it would be a very short section pipe, possibly even just a flexible hose or something.

THE CHAIRMAN: I wonder if you could help me more on this

subject of the responsibility of the supplier because it seems to me that, as this Inquiry has gone on, this has emerged as quite an important point. You are quite clear that the decided policy of Calor is that their responsibility ceased at the first stage regulator and that is that.

A. Or specifically at the outlet of the valve on the tank. So the vapour valve of the tank is up to that point. In this case, in this example, that is the inlet of the regulator. If, for instance, there was tank pipework, that would then belong to the customer.

THE CHAIRMAN: From other evidence it does appear that that is not universal practice in the industry.

A. No.

THE CHAIRMAN: Would you consider that any issue arises as to the desirability of there being a universal criterion for responsibility?

A. We would be more than happy with that, yes.

Q. Then the next question obviously is: what is the right approach? Is it Calor's or is it the other

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approaches that other suppliers take? What really I am asking is can you argue the case for Calor's policy?

A. I think Calor's approach is -- the phrase I used previously was it gets rid of any ambiguity because every tank has to have a vapour valve and we can therefore say that up to that valve is the responsibility of the supplier, anything beyond it is the responsibility of the customer.

The difficulty with saying up to the first stage regulator or the outlet of the first stage regulator is that that may or may not include tank pipework if the regulator is mounted possibly at the end of the tank and not as it is as shown on the model.

So I think purely from trying to get a very black and white definition, that's why we've stuck with our definition.

THE CHAIRMAN: That does give us a very hard and fast easily understood definition, but it does raise another problem, does it not, and that is that from the vapour valve onwards, the pipework becomes the responsibility of an inexpert body; namely, the customer.

That does seem to raise a safety issue, does it not?

A. I think we've -- basically, the way we've looked at that traditionally is by giving the customer information about what their responsibilities are via the welcome

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pack we mentioned and our assumption for customers is that they wouldn't attempt to do something that they are not qualified to do. They would call an expert. Now that expert may well be, you know, Calor themselves who can provide some of that expertise or it may provide a CORGI registered engineer who is experienced.

So a bit like with their gas appliance where they would own the appliance and have a handbook that says it has to be serviced, they wouldn't attempt to do it; they would get someone in who has the knowledge to do so.

THE CHAIRMAN: You protect yourself in this regard with contract conditions.

A. That's correct.

THE CHAIRMAN: Nowadays we are all used to contracts with pages of small print. I never read them and I am a lawyer. What confidence could you have that the customer would appreciate the extent of this responsibility?

A. Well --

THE CHAIRMAN: Or something that is perhaps buried on the back of a form. Do you know what I mean?
A. I understand the point, your Lordship. I think that is why it is part of our process. It's not just on a whim that any new customer is given this welcome pack as well which attempts to put their responsibilities in very
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clear English.
THE CHAIRMAN: Obviously, any system that one introduced to try to enhance the safety of this would have to be straightforward and not overcomplicated.
Could you see any merit in, as it were, when installing a new system reading the customer their rights or something like that to bring it to the forefront of their minds that they are undertaking what could be a potentially very onerous responsibility?
A. I think that's very important and certainly our salesforce are, as part of their processes, asked to go through the responsibilities of the customer and the responsibilities of Calor as the supplier in detail. So there is that knowledge.
THE CHAIRMAN: As you know, Mr Sylvester-Evans has given us a recommendation that there should be a sort of dossier that would accompany every installation.
Could you see any merit in including in that some form of signed acceptance by the customer that they both understood the extent of the liabilities and understood also what those liabilities entailed by way of action on their part?
A. I think that would be an excellent idea as part of the dossier, yes.
THE CHAIRMAN: Because it just occurs to me, you see, that
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if there were to be an incident involving a fracture further along the line that there could be all sorts of arguments about who said what and what did the salesman say and it may be very difficult to reconstruct the mystery of the matter.
From Calor's point of view you think the industry could --
A. We think the dossier is an excellent idea and the suggestion of having a statement of responsibilities within it again would be an excellent idea.
THE CHAIRMAN: Obviously everything you have said clearly implies that you see that there are dangers in the contrary situation where the supplier takes responsibility all the way to the emergency control valve?
A. Yes.
THE CHAIRMAN: I think you broadly indicated what those are. Is the main one the absence of control in your view?
A. Yes, in our view it is, not being there all the time.
THE CHAIRMAN: I suppose if that were to be the responsibility that you would undertake then I take it there would be serious cost implications --
A. There would be serious cost --
THE CHAIRMAN: -- which would presumably be reflected in the cost of supply?
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A. Yes, and I think insurance issues as well.
THE CHAIRMAN: Thank you very much. That is all I wanted to ask about.
Mr Sheldon?
Examined by MR SHELDON
Q. Mr Betts, can I ask you, first of all, about some questions you were asked on the first day that you gave

evidence about Calor's connection to existing pipework. It is just to clarify certain matters in that regard.

First of all, can I just ask: do Calor assume when they connect to existing pipework on a particular supplier's premises that the owner of the premises and the owner of the pipework has complied with his duties to inspect and maintain the pipework?

A. Yes, we do but --

Q. Sorry.

A. Obviously, as we've previously discussed, our policy is to inspect and tightness test the pipe as well.

Q. On the particular day you gave evidence you were asked about this particular matter and in particular connection to pipework which might be underground and the following proposition was put to you:

"So you connect the tank to the supply into the pipework and you fill the tank with potentially hazardous LPG simply assuming that the customer will

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have carried out his responsibilities as you see them to ensure that the pipework is in a safe condition."

You agreed with that.

It was then put to you:

"We know that in one tragic situation that led to loss of life and serious injury. Can we agree, Mr Betts, that that is, therefore, not an adequate situation in which to ensure public safety."

Your response to that was:

"I can agree but, as I said, the purpose of us inspecting the pipe is if we suspect there was a potential of such a similar situation which we would then need to investigate further."

So I just want to ask you this, Mr Betts, what were you agreeing to in relation to that answer?

A. Sorry, could I ask you just to repeat the --

Q. Yes, the question you were asked was:

"We know that in one tragic situation that led to loss of life and serious injury. Can we agree, Mr Betts, that that is, therefore, not an adequate situation in which to ensure public safety."

A. Right. So I was agreeing in that case it wasn't adequate.

Q. Yes. What was it that you were agreeing was not an adequate insurance of public safety?

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A. Yes.

Q. What was it? What was it that you were saying --

A. Really, what I was saying is in that case the inspection or whatever that had occurred was not sufficient to prevent the event.

Q. The inspection by the duty holder or the inspection by Calor?

A. The inspection by the duty holder, of course.

Q. Moving to some questions that were raised with the Mr King earlier today. He was asked some questions about the testing of pipework at sufficient pressure to blow-out a corrosion plug. I think you were here.

Do you recall those questions being asked?

A. I do, yes.

Q. Do we understand that that type of test, an over pressure test, is a proof test?

A. Yes.

Q. Whereas a pressure test would be a test carried out at normal pressure?

A. We would call it a tightness test rather than a pressure test, yes.

THE CHAIRMAN: Mr Sheldon, can you just raise your voice a little, please, the writers are having difficulty.
MR SHELDON: I am sorry, my Lord.
THE CHAIRMAN: Mr Betts, if you would not mind moving closer

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to the microphone. Thank you very much.
MR SHELDON: Does Calor have a view about the appropriateness of proof tests?
A. Yes, proof tests, as I think was mentioned before, are best done on a new pipeline which can be done on a new pipeline up to its designed pressure, et cetera.

I think Dr King was suggesting putting in double the working pressure which isn't the requirement of a proof tests and in a medium pressure supply that can actually lead to a pressure test suggestion of 4 bar which is higher than the industry recommendation. So the industry recommendation is for a pneumatic test. You shouldn't test higher than 3 barg and if it goes above 3 barg you then use a hydraulic medium such as water.

So I think possibly a little differing experience of gas pipe testing was indicated there.

Q. Moving perhaps to more substantial matters and, in particular, to Calor's position on the way forward at this stage, do we understand Calor's position is that a phased replacement of pipework is the appropriate way forward?
A. We do, yes; that's correct.
Q. Why does Calor take the view that a replacement strategy is appropriate as opposed to excavation or cathodic protection, for example?

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A. Our belief is that the safest method of underground pipework is polyethylene pipe and we therefore believe, with what we know now, that we should replace any steel pipe underground wherever possible with polyethylene pipe systems. So we believe a replacement strategy is better than a maintenance strategy or a cathodic protection strategy, partly because the requirements of a maintenance strategy with the guidance available now from the HSE is that we should uncover the pipe. Similarly with cathodic protection; it does involve quite a lot of physical work, uncovering pipe to bury anodes and connect connections and we believe that time is better spent replacing it with a non-corroding pipe such as polyethylene.
Q. Before we go on, Mr Betts, I wonder if it might be helpful if you directed your answers towards the shorthand writer and the Chairman. I think the shorthand writer is straining to hear.

Continuing to think about replacement, Mr Betts, why must replacement be phased?
A. The issue for phasing it is due to a shortage of skilled labour to actually do that replacement.
Q. What sort of numbers of pipes are we talking about in relation to such a strategy?
A. The industry believes, having extrapolated some of the

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data from Mr Tomlin's work, that we looking at a figure around 50,000 installations.
Q. Can you give us an idea of the number of appropriately qualified people available to carry out such work?
A. There are tens of such people at the moment we believe are suitably qualified.
Q. Tens?
A. Yes.
Q. Would we be right in assuming that other means of

testing by means of excavation, cathodic protection and so on, would similarly be subject to labour shortages?

A. Again, I'd agree with that, yes.

Q. Moving on slightly, we heard evidence from Mr Shuttleworth about an UKLPG survey of underground pipework. Is that something in which Calor take part?

A. It is, yes.

Q. What is Calor's role in that?

A. We are carrying out a physical inspection of domestic installations, which is identifying which installations have metallic risers, what pressure the installations are operating at and what the age of the installation is at as well.

Q. According to the evidence of Mr Elliott of J Gas, who we also heard from, J Gas appear to have a rolling replacement programme or at least of recommending

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replacement in relation to sites serviced by them. I think Mr Elliott suggested that all the mechanism pipework at installations they service could be replaced by July or August of next year.

On that basis, are J Gas further down the line of replacement than Calor?

A. In that sense, they are but I think the reason for that is the amount of installations they actually have --

Q. I am sorry, that is my next question. Could Calor have carried out such a quick rolling replacement programme given the numbers of pipes involved?

A. No, we have far greater numbers.

Q. So perhaps you can just take us through the steps you have taken thus far to address this problem.

A. I think you have already heard our approach is to adopt a risk-based strategy so we can prioritise the order in which the pipes will be replaced. So our efforts are focused on establishing which of the installations are in the high risk category and then we will target those for replacement first.

Q. What is the approximate cost to Calor of the steps which have been taken so far?

A. I believe we've spent just over £200,000 to date and, in fact, the expenditure is ongoing obviously with our surveys.

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Q. Thinking again of replacement of pipework, what is the likely cost to the consumer likely to be of the replacement strategy?

A. The costs were mentioned in Mr Tomlin's presentation and I believe we're looking at a range, depending on the size and type of installation, of somewhere between £200 and £2,000.

Q. Moving on then to Mr Tomlin, if Mr Tomlin's model to allow the prioritisation of pipework replacement is approved and adopted, what is the next step as far as Calor are concerned?

A. There was actually a meeting with members of the industry via UKLPG and the Health & Safety Executive yesterday where approval was given for the approach from the Health & Safety Executive. So the idea is now that the whole of the industry is carrying out a survey similar to that that Calor is undertaking, checking out their domestic installations for metallic risers, et cetera. The idea is that these surveys should be completed by next Easter at the latest and then we, as an industry, will be able to apply the model, identify the high risk installations and start dealing with them from that point and obviously involving the

Health & Safety Executive along the way.
Q. So is it envisaged that customers at premises which are
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assessed as being of high risk will be advised of that and invited to replace the pipework?
A. Sorry, I didn't catch that.
Q. Is it envisaged that customers at premises which are assessed as being of high risk would be advised of that and invited to replace?
A. I think, yes, Calor's approach will be probably a bit heavier-handed than that. We feel that we will have to have a process which manages the change. So rather than just advice, we would not only be giving advice but making sure that it is taken so actually the high risk installations are actively replaced.
Q. What steps do Calor propose to take to ensure that these measures are taken?
A. Obviously we will outline the risk to the customer, we will offer assistance to carry out the work. Obviously the ultimate sanction, if we don't get any assistance from the customer, is that we stop supply and in this case we would consider that grounds for ceasing supply.
Q. I want to move on to another topic, Mr Betts, and that is in relation to responsibility for any particular installation. I wonder if we can have ICL page number 573, please. That is the Health and Safety at Work Act 1974. Can we move down two pages to 575, please, to section 3. Of course that provides that:
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"It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons in his employment are not [reading short] exposed to risks to their health or safety."
Is Calor's interpretation of that section that it covers only the undertaking and that pipework not owned by Calor is not part of Calor's undertaking?
A. That's correct.
Q. Moving on to section 4 of these, in particular section 4(2), to what extent does Calor take the view that they have control of pipework, not an ownership?
A. We don't have control. That's our view.
Q. So that so far as Calor's view is concerned, the view is that section 4 does not apply beyond the vapour offtake valve?
A. That's correct.
Q. If we move to the next page, please, 576, and section 6 and in particular section 6(4):
"It shall be the duty of any person who manufactures, imports or supplies any substance: (a) to ensure, so far as is reasonably practicable, that persons will be safe and without risk ..." and so on.
Insofar as that section is concerned, is it Calor's view that that is concerned principally with the safety
page 64
of the substance itself?
A. Again, that's correct, yes.
Q. In relation to that, is it fair to say that Calor do regard themselves as being under a duty to provide all the necessary information and support in relation to the substance?
A. Again, yes, we agree with that and we do so by again reference in the welcome pack, the provision of hazard data sheets to customers both in a paper form and via our website.
Q. So these are matters also dealt with in the information

pack, the welcome pack, that you have described?
A. They are.
Q. So just thinking about these sections and the view that Calor takes of them, would it be likely or unlikely that Calor would carry out any, as it were, risk assessment of parts of an installation beyond what it regards as being part of its undertaking?
A. We wouldn't possibly unless instructed by the customer to do so.
Q. What in practice would happen if Calor became aware that pipework at a particular installation was unsafe?
A. We would not supply to it.
Q. Presumably you would inform the customer of the reason for that?

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A. Of course. I think I mentioned in my previous evidence that if we did become aware of such a thing, let's say as the driver making a delivery, he would cease the delivery, turn off the tank and the policy is for the driver to contact our emergency line, who would then take the matter up directly with the customer.
Q. Moving on to another related topic, and that is the demarcation between the responsibilities of the supplier and the customer, you were asked a number of questions about that by his Lordship a moment ago.
I think Calor agree that a common demarcation line between suppliers' and customers' responsibilities would be desirable; is that fair?
A. That's correct.
Q. Of course there are discussions as to whether the first stage regulator or the vapour offtake valve, as far as industry is concerned, would be the appropriate demarcation line?
A. In Calor's opinion, that is the best demarcation line.
Q. Sorry, we understand that Calor's view is that it is the vapour offtake valve that is the clearest demarcation; is that right?
A. That is right.
Q. Would it cause Calor any particular difficulty if the Inquiry were to recommend that the downstream end of the

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first stage regulator were to be taken to be the demarcation line?
A. Apart from a couple of practical issues, such as the need for Calor to change all its contracts with its commercial customers (which would be not an overnight process), Calor could live with that. But we believe, as previously said, a more black and white definition is that of the vapour offtake valve.
Q. I think you agreed with the Chairman that the principal disadvantage of using the ECV as the demarcation line is the lack of control then over the intervening part of the premises?
A. That's correct.
Q. Is it Calor's position that the duties for the safety of the customers' employees are best met by the customer?
A. That's our position, yes.
Q. Looking to the future, that metal pipes will be replaced by polyethylene pipes, in that situation would the main danger to the integrity of the pipes be the activity on site?
A. Again, that would be our viewpoint, yes.
Q. Rather than the type of slow degradation of pipes in relation to metallic pipework?
A. Yes.
Q. Would the customer then be in a better position than

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suppliers to know whether dangers have arisen because they know what the activities on the site actually are?

A. Yes. That's our main reason for suggesting they are better to have control of the pipe.

Q. Is it fair to say that once pipes are replaced the maintenance requirements for PE pipes is a lot less onerous than it is for metallic pipes?

A. It is.

Q. We understand that Calor are in agreement with the view that customers ought to keep a safety dossier.

A. Yes, we are.

Q. Do you understand that that would be likely to involve a risk assessment by a competent person, CORGI qualified or equivalent person?

A. In our opinion, that would certainly be part of the dossier.

Q. Would such a requirement ensure that appropriate skills are available for the purposes of such risk assessment?

A. Indeed, yes.

Q. Just in relation to the possibility that suppliers might be made responsible for the pipework up to the ECV, would there be particular transitional problems if they required to take over underground existing pipework?

A. We believe there would. I think the whole process would be very labour-intensive and, due to the shortages of

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labour at the moment, it couldn't happen overnight. It would be a staggered transition which would again lead to a period of uncertainty.

Q. Why particularly do you say very labour-intensive?

A. Well, because I think if the suppliers were to take over the pipe, they would then have a duty to ensure how it was laid, in what conditions. So there would be a requirement to survey the pipes probably to a more extensive extent than we are currently undertaking and, therefore, you would need a labour pool of qualified CORGI engineers to undertake some of this work.

Q. Essentially it would be an unknown risk that you were taking on?

A. Yes.

Q. I think you mentioned briefly possible problems with insurance. What do you anticipate those problems might be?

A. Having spoken to our insurers, they are of the opinion that if we were to inherit a pipeline we hadn't installed, they wouldn't be able to insure it.

Q. Given where the industry is now and the stage at which the industry is now, does the fact that Calor might take over an underground pipe from another LPG supplier give Calor any comfort as to the state of the pipe?

A. No.

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Q. So, even in that event, there would be a requirement to investigate and check?

A. Yes.

Q. You have mentioned that this would be a labour-intensive task and given reasons for that. There would presumably be cost implications of that also?

A. Indeed. As we referred to earlier there, would be substantial costs to it.

Q. In that event, who would be likely to bear that costs?

A. Ultimately, some of those would be passed on to the customer.

Q. So is it your view that in those circumstances the resources are better spent simply replacing the pipes?

A. That's certainly Calor's view, yes.
Q. I want to move on to another topic and that is the possibility of extending the GSIUR regulations to factories. I think we understand that, broadly speaking, Calor are in favour of the extension of the GSIUR regs; is that right?
A. We are.
Q. I think you set out the various advantages to that in your statement?
A. Yes, that's correct.
Q. Do we understand that the intention of the regulations, so far as Calor are concerned, essentially means that

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there should be a requirement for pipework to be installed, maintained and altered, if necessary, by a properly qualified person?
A. That's Calor's main driver for suggesting it is sensible to extend the GSIUR.
Q. Just thinking the use of such persons, would that fit well or badly with the type of verification scheme such as that proposed by Mr Sylvester-Evans?
A. Potentially if we could. I think our concern is a verification scheme, that people doing the verifying would be CORGI engineers. So again it's possibly diluting the labour pool which we would prefer to be preparing safety dossiers, carrying out update work, et cetera.
Q. So just thinking briefly about the verification scheme, is it fair to say that Calor's position is that they have no difficulty with the verification scheme provided it does not interfere with the priority of replacing the pipework?
A. That's broadly our position. I think we can also say if the safety dossier is constructed in such a way that requires it to be signed off by a CORGI engineer, it almost in that sense is its own verification scheme. So we could possibly streamline that process without diluting the labour pool.

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Q. Just going back to the GSIUR regulations for a moment, if there was to be an extension of those regulations, would Calor regard it as necessary to ensure that there was also an obligation to inspect and maintain pipework within those regulations?
A. We don't think that's part of the GSIUR, but --
Q. I quite accept that but if there was to be an extension of that, would that be a useful additional provision to make?
A. Indeed it could be, yes.
Q. Do we assume that the requirement would be for the customer to inspect and maintain?
A. The customer using a suitably qualified engineer.
Q. If there was to be an extension of GSIUR, would it make sense for any industrial premises to be, as it were, covered by GSIUR from, in relation to this type of installation, the vapour offtake pipe up to and including the appliance or the appliances?
A. Again, I think that would applied implicitly with the extension of Gas Safety Use and Installation regs.
Q. I think you have made Calor's position about the proposed verification scheme clear, Mr Betts, but I just want to ask you one final thing in relation to the prioritisation scheme for replacement. Clearly in a prioritised scheme, there will be some sites dealt with

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more quickly than others. How do Calor propose that low

risk sites, which might be some way down the priority list, should be managed until they can be replaced?

A. I think the key thing for our model, our risk-based approach, is that it's not a static set of data. We firstly mentioned a survey of all the installations, et cetera, and that will then itself, using the model, will generate a priority of replacement. But as we get into the replacement strategy, it is our plan to continue to review the model, the findings that we are finding and that could well lead us to reclassify installations into the high risk category as we proceed with the replacement strategy.

So our feeling is if we can maintain this model as an active thing, rerun data if necessary, redefine what is high risk, that will give us a good platform to replace the pipes in a sensible priority order.

Q. One final question about that: does Calor propose to pass the whole cost of the replacement programme on to consumers and customers?

A. We haven't fully explored how we do that but certainly our initial proposal is that we would look to do that. But of course there are other ways of funding it by various schemes deferring payments over a number of years and whatever.

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Q. Just thinking about the total cost to Calor of the devising and implementing of the replacement strategy, are you in a position to tell us what that cost is to Calor?

A. I don't have a figure, I'm afraid.

Q. Moving on to an issue which arose from Mr Tomlin's evidence about pipes with metallic risers, we understand that over the years Calor has had a particular policy about the installation of pipes with metal risers and otherwise.

A. We did, yes. Calor, I believe, had a document release in 1982 which was there to clarify the position of using polyethylene pipe and the document basically refers to various practices that have been used throughout the country, some using wrapped metallic pipe, some using all polyethylene pipe systems, and the policy document was attempting to have a common standard across the company. In that policy document, it decided that the best approach was to have polyethylene underground with metal risers at either end.

Q. I want you to look at page 14929, please. I wonder if there is a previous page that we could see the date of that. Is that the document --

A. It is 83.

Q. Is that the document you were talking about?

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A. That's the one.

Q. Do we understand that up to that time most or all of the underground pipes were metallic?

A. Yes. I think if you go to the following page we just saw, it does mention in paragraph 1 and then it also mentions other types: the plastic coated steel tube, steel tube entirely Denso wrapped, and then in paragraph 2 it mentions polyethylene plastic tubes. So this was just about when the polyethylene was being introduced.

Q. Paragraph 19, please. We see that under a heading "action required" that:

"Polyethylene should only be used below the surface of the ground. The only exception to this should be where meter boxes are used which require termination."

So we do understand that underground pipes under

this action point were to be polyethylene?
A. That's correct, yes.
Q. Do we understand from this time, from 1983 up to about 1992, the standard policy was the installation of polyethylene pipes with metal risers?
A. Yes.
Q. Then after that that the whole of the installation was to be polyethylene?
A. Yes and, as you say, 1992/93 that's when it was decided that the better system was to have all polyethylene,
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including risers.
THE CHAIRMAN: Mr Sheldon, it is getting near to 1.00. If you wanted to think about this over lunch --
MR SHELDON: I am perfectly content, my Lord. I was about to move on to a substantial section so it might be appropriate to break there if my Lord is content to do that.
THE CHAIRMAN: It is a little bit early but let us just stop at this point. 2.00, please.
(12.54 pm)
(Luncheon Adjournment)
(2.00 pm)
MR SHELDON: I am grateful. During the break I may have been able to cut down slightly the number of questions I may have to ask this witness during this time.
So if I could move on, Mr Betts, to some questions in relation to the applicable guidance for underground pipework, you were asked some questions in your evidence by Counsel to the Inquiry about a document FIC25643. That is ICL page number 1040.
Apart from the occasion that you gave evidence previously, Mr Betts, had you seen that document before?
A. I think I'd seen it the day before when Mr Tomlin was giving his evidence, but not prior to that.
Q. What do you understand the origin of this document to
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be?
A. I understand it to be an internal Health & Safety Executive document.
Q. One, in other words, that would not be put in the public domain?
A. Correct.
Q. So do we understand that Calor, at any rate, were not aware of that document during the 1980s?
A. We weren't, no.
Q. Look at paragraph 7, please.
Do you see that that paragraph refers to the inspection of pipes carrying LPG, particularly those not installed to current standards should, if reasonably practicable, be uncovered and physically examined.
So that internal document appears to suggest that there ought to be uncovering, presumably excavation, of LPG pipes. Do you see that?
A. I do, yes.
Q. If I can ask you to look at the next page --
THE CHAIRMAN: Sorry, before you go any further, excuse me a moment me, Mr Sheldon.
Mr Betts, it seems to be primarily concerned with pipes that are conveying liquid LPG rather than vapour, although it does mention vapour pipes.
A. Yes.
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THE CHAIRMAN: I take it that a pipe that is conveying liquid LPG is an altogether more dangerous thing.
A. Yes. The potential for gas release is much higher from

a liquid line, yes.
THE CHAIRMAN: We are talking here about pipes that are conveying vapour that has been reduced to very low pressure.
A. Yes.
THE CHAIRMAN: But, subject to that, the advice is about uncovering them and it does say it could be applied to pipes conveying vapour only.
Does it not say that right at the start?
A. It does, paragraph 1, I think, yes.
THE CHAIRMAN: Sorry, Mr Sheldon.
MR SHELDON: If we look at the next page, 1041, do we see that that appears to be an updated version of FIC28643, issued 4th November 1983?
A. Yes.
Q. If we look at paragraph 1 does it appear again that it applies principally to LPG in the liquid phase?
A. Yes, I can see that, yes.
Q. If we look at paragraph 16, please, is that a paragraph that deals with periodic inspection and that requires that pipes should be inspected by a competent person at certain intervals and a new date set? Do you see that?

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A. I can see that, yes.
Q. If you look at the next paragraph, paragraph 17, there is a specific reference to the possibility of a leak:
"If for any reason a leak or severe corrosion is suspected then the line should be taken out of service", and then re-certified by a competent person.
A. I can see that, yes.
Q. So with respect to the inspection of underground pipework, does it appear that the HSE's view had changed at 1983?
A. It appears so from that document, yes.
Q. At least on the face of the document?
A. On the basis of the document.
Q. If I can ask you, please, about another document, guidance document, this is HS(G)34 and that is page 001272, please.
We see that that is another guidance document in relation to storage of LPG.
If we can look at the maintenance provisions of that, please, at page 1306.
Please look at paragraphs 187 and 188 in particular, do we see that that requires:
"Examination of underground or mounded vessels should include tests for corrosion, eg detailed ultrasonic thickness checks. If internal access is not

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possible the external surface of the vessel will need to be exposed to enable examination to take place."
Do you see that?
A. I see that, yes.
Q. So does that suggest that the vessel may require to be excavated and its surface exposed?
A. It does indeed, yes.
Q. Let us look at paragraph 188.
Do you see again that, on the face of it, is a paragraph regarding carrying liquid. We are told that:
"... should be examined for corrosion or tested in such a way as to establish continuing integrity at least once every ten years."
Do you see that?
A. I see that, yes.
Q. No mention to exposure or excavation or anything of that sort?

A. No.
Q. So, again, does it appear that the HSE view, as it appeared in the original version of FIC286, was not on the, face of it, carried over to this document?
A. I agree, yes.
Q. Just in relation to 188 and the phrase "tested in such a way as to establish continuing integrity", is Calor's position that in 1988 their understanding was that a
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pressure test was an acceptable way of doing that?
A. In 1988 it was, yes.
Q. Does it therefore follow that if that practice was acceptable in relation to pipes carrying liquids, would it be likely that it would be regarded as acceptable for vapour-carrying pipes?
A. Again, I would agree with that, yes.
Q. Just to be clear about this, do we understand that Calor at any rate were not aware of the internal guidance that appeared in FIC286 in 1980?
A. No.
Q. One final question about guidance. If we could look, please, at page 001409, I think that is the LPG ITA Code of Practice first printed in 988.
Do you see that?
A. I see that, yes.
Q. Look, please, at page 1422. Looking at the section entitled "External Pipework" and the last paragraph on that page 5.2.3:
"Consideration should be given to means of leak testing buried pipelines without requiring disconnection, eg the use of plug tees."
A. Yes.
Q. So the reference there appears to be to leak testing without requiring excavation or disconnection or
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anything of that sort?
A. That's correct, yes.
Q. I think you gave evidence that certainly as at 1988 it was certainly known within the industry that underground metallic pipework might corrode?
A. It was, yes.
Q. So given that this appears to be the industry guidance at that time, why in your view was there no recommendation to uncover or excavate?
A. I think the view at the time was that the soundness check was satisfactory to establish the integrity of the pipe. As you said, corrosion was known and I think we have now, with Mr Tomlin's research in particular, found various things that maybe made some -- disproved various assumptions that were in the play at that time. Firstly, I think the view at the time was that underground pipes were generally corrosion-protected -- certainly Calor made that assumption. Pipeline risers were Denso protected. That was included in that document that we looked at briefly before lunch and also the mechanism if a pipeline did fail would be that it would be detectable outside and wouldn't track into a building.
I think Mr Tomlin's recent research has proved, one, there had been some inadequacies of the Denso protection
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and, secondly, we gained a much greater understanding of a failure mechanism of a pipeline in which it can track to a building.
So I think that at the time those assumptions or sorry that knowledge wasn't known and it was assumed

that the pressure test would be satisfactory for continued integrity.

Q. I can move on to some miscellaneous questions.
You mention in the annex to your statement certain problems associated with excavating a live pipe. If a pipe is drained of gas, is it then no longer live or regarded as live?

A. That's correct, yes.

Q. But does an excavation, whether of a live or a drained pipe, still carry with it a danger of damage to the pipe?

A. We believe excavation of a pipe, even when it's been de-gassed so it no longer is live, probably presents two risks. The first is of physical damage the pipe that you might not recognise in the part of the pipe you have been excavating; therefore, you can cause some physical damage that wasn't there before. Secondly, by disturbing the soil, you are oxygenating it and therefore potentially introducing higher risk of corrosion than before you excavated it.

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So for these reasons this is why Calor believe excavation of metallic pipes as a way of continued use is less appropriate, introduces more risks than actually the replacement strategy with polyethylene.

Q. So the difficulties or dangers associated with excavation would provide a further reason for Calor to recommend or suggest that replacement would be more appropriate --

A. That's correct.

Q. -- than methods of testing requiring excavation?

A. Absolutely, yes.

Q. I think just two final questions, Mr Betts.
The first is another question in relation to costs. I think you gave evidence earlier today that costs to each individual user of replacement would be in a range depending on the type of installation and the range that you gave was £200 to £2,000.
Do you recall that?

A. That's correct, yes.

Q. Do we take it then that in order to estimate or extrapolate the total cost of a replacement programme one would simply multiply that by the number of pipes which potentially require to be replaced?

A. Broadly speaking, yes. I think the industry has estimated a cost to the industry of circa £45 million to

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carry out the replacement based on the extrapolated figures that Mr Tomlin's researches has assumed.

Q. Finally, can I just ask a question in relation to timescale.
I think you mentioned that there were around 50,000 installations that might require to be looked at; is that right?

A. That's correct.

Q. And the number of qualified fitters available was numbered in the tens at the moment?

A. That's also correct.

Q. So, again, can we extrapolate from that a likely total timescale for the whole replacement programme?

A. Again, the industry has estimated the total time of replacement is in the order of ten years. Having said that, there is obviously a requirement for the high risk installations to be replaced much more rapidly and the industry is suggesting circa a year to replace the high risk pipelines.

Q. So once one identifies the high risk pipelines they clearly take priority for replacement.
A. Of course, yes.
MR SHELDON: Thank you, my Lord. I have nothing further.
THE CHAIRMAN: When you are talking about this 45 million, Mr Betts, that really refers to the total cost of

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replacing all metallic underground pipes?
A. Including the lower risk pipes, yes.
THE CHAIRMAN: Mr Martin, do you have any questions?
Re-examined by MR MARTIN
Q. I have one or two additional questions if I may be permitted to ask them, my Lord.
Mr Betts, just one or two matters, first, of clarification. In the context of what Dr King said this morning about a pressure test as part of a preliminary before attaching cathodic protection, his evidence, as I recall it, was that the pressure test which would be sufficient to blow-out a plug of corrosion and thus to reveal a pipe which had corroded sufficiently seriously was one carried out at about 50 per cent above working pressure.
Would that be regarded as a proof test or a tightness or soundness test?
A. That would be a proof test.
Q. He explained the pressure involved, particularly when I asked him about a domestic low pressure system operating at 37 mBar, he said that the pressure involved, in realistic terms, would be equivalent to the pressure in a bicycle tyre or the pressure possibly in a car tyre.
Do you consider applying such a pressure to such a system would give rise to any significant risk of

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hazard?
A. It really is against all principles of gas engineering to over-pressurise a pipe, even at those low pressures. So I would maintain you would want to carry out a tightness test at the 37-mBar mark rather than any higher.
Q. This is not what Dr King said but what he also said was that it would do no harm to apply cathodic protection, even have you could not, for example, be satisfied of complete electrical continuity.
Do I take it that even if Dr King's pressure test was thought to be inadvisable, nevertheless there might still be benefits as part of an overall strategy to apply cathodic protection to pipes which were not to be replaced immediately?
A. I think if you are going to the extent of installing a cathodic protection system it would involve excavation to insert the anode into the ground. It couldn't just be left on the surface and I think our point is that if you are digging holes near a pipe why not dig down and actually replace it rather than install cathodic protection system.
We haven't done comparative costings but I'm pretty sure the costings would be very similar to actually replace the risers with polyethylene compared with

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actually installing cathodic protection.
So I would agree it would do no harm but I think it would be more sensible to just proceed and replace the riser with polyethylene.
Q. As I understood it, there is no need for any excavation of the risers. The excavation would take place about a metre away to insert the anode. So you are not

excavating in the vicinity of the pipe or at least the immediate vicinity --

A. Absolutely but the actual act of excavation is, broadly speaking, the same. So in terms of costs, to excavate a metre away or by the riser is very much the same. So if you are going to the trouble of excavating to insert cathodic protection why not excavate and replace the riser?

Q. Obviously, Dr King was not -- it was not put to him. My understanding is that the placing of the anode simply involves digging a hole and placing the anode in. It does not involve digging around the pipework, disconnecting the riser from the horizontal or the centre section, replacement by presumably polyethylene and recovering that. It's not the same in terms of an operation, is it, Mr Betts?

A. No, I'm sure the actual work involved when on site would be -- it would take longer. As I think we explained

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when I gave evidence previously, the high cost of the engineer is actually getting them to the site. So incremental time on the site is relatively inexpensive and I think if you just spend that extra small amount of money you have cured the problem for good.

Q. But you have already explained, not least in the sums of money referred to and the availability of manpower you cannot solve the problem immediately so there are going to be a large number of installations which are going to remain by and large in their existing state for a period until the programme reaches them?

A. That's correct but the principle of available labour is the same for whichever way we approach the problem. So we couldn't instantaneously just retrofit cathodic protection, I don't think.

Q. May I take it, Mr Betts, Calor is against cathodic protection being fitted as a precaution?

A. We believe it's far better to just replace the risers if we're sending a man to do work on the site.

Q. Just one other small matter. You said, I think, that you had spoken to your insurers and if the supplier was to take responsibility for the service pipework, then your insurers said that you could not get insurance. Is that right?

A. Yes. Just to be clear, that would be if we are

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inheriting a pipeline rather than installing a new pipeline.

Q. Do we assume that every old pipeline at the moment is not insured by anybody?

A. I don't know. I think some premises would have some insurance to cover it but certainly not by the gas supplier.

Q. I understand that but it is reasonable to assume, is it not, that the occupier will have occupier's liability insurance cover which will include existing pipework?

A. I would imagine so.

Q. Yes, therefore, if that liability were to be transfer to the insurer of the gas supplier it is only a matter of who is paying the premium, is it not?

A. I'm not sure -- as I understand it, from our insurers and I haven't had the conversation with them myself so I am just passing on information, is they have basically said to us that they wouldn't be happy to insure that as a risk if we took on an unknown pipeline.

Q. Perhaps I do not need to labour this, Mr Betts, but if somebody is insuring that pipework at the moment, then

logically if it is to be insured in the future the only difference would be who would pay the premium. That may be a commercial disadvantage to Calor and, apart from anything else, one of the logics of insurance is that it

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is ultimately only a matter of how much it costs, is it not?

A. It is but the insurers' interpretation is they wouldn't be prepared to insure it.

Q. I will leave that matter.

May I just ask you about the verification scheme approach put forward by Mr Sylvester-Evans.

Ultimately, what is Calor's position? Are you in favour of that or not and, if so, why?

A. The verification scheme: we are not opposed to it. We can see that having a verification scheme is a useful mechanism. It can give the suppliers some confidence that they are supplying into a pipe that is under the scrutiny of a maintenance regime, et cetera.

I think our -- objection may be too strong a word -- but our objection to it is that as laid out or as we understood it to be laid out in Mr Sylvester-Evans' report, it appeared to almost double up what was required.

Our view is that with the safety dossier -- that if the safety dossier is constructed in such a way by a competent person they can actually make that verification as part of the safety dossier and, therefore, the safety dossier could be, if you like, the verification of the pipeline.

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Q. Would that include periodic certification?

A. Absolutely, yes.

Q. I am not sure there is anything between us, Mr Betts, on that. Mr Sylvester-Evans will be returning but thank you for that.

The last matter I want to ask you about arises out of the questions which my learned friend put to you about the legislation.

I wonder if I could ask you first to look at the Health and Safety at Work Act, in particular section 6. This is on page 576 and 577.

This morning you were asked by my learned friend about section 6(4) and as I understood your evidence it was that Calor accepted themselves as being under a duty to provide necessary information and support in relation to the supply of the substance, which is LPG and you replied:

"We agree with that and we do so by again reference in the welcome pack the provision of hazard data sheets to customers both in a paper form and via our website."

The question was:

"So these are matters also dealt with in the information pack, the welcome pack that you have described.

"A. They are.

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"Q.. So just thinking about these sections and the view that Calor takes of them, would it be likely or unlikely that Calor would carry out any, as it were, risk assessment of parts of an installation beyond what it regards as being part of its undertaking?

"A. We wouldn't, possibly unless instructed by the customer to do so."

Am I right, Mr Betts, that your evidence this morning was that Calor complied with the obligation

which it accepted it was under in accordance with section 6(4) by providing appropriate information to the customer?

A. That is the way we fulfil that obligation, as far as the customer sees it. We obviously have other obligations that I think I may have mentioned when I was giving evidence that we obviously have a duty to make sure the substance is what we say it is. So that involves us testing gas quality as it arrives and leaves our site bound for customers. So we do have some other duties which involve us quality assuring the product that we distribute.

Q. Could we look, please, at subsection 4.

I wonder if it could be brought up on the screen, please. If I could have subsection 4 (a) and (b) which is on 576.

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It says:

"It shall be the duty of any person who manufactures, imports or supplies any substance [and my learned friend read this is to you this morning] (a) to ensure as far as reasonably practicable that the substance will be safe and without risks to health at all times when it is being used, handled, processed, stored or transported by a person at work or in premises to which section 4 above applies."

May I take it that what you just said about Calor's testing of the substance to ensure that it is what it says it is would be a fulfilment of that obligation?

A. That's correct, yes.

Q. Could I have up subsection 4 (c) and (d) please.

(c) is:

"To take such steps as are necessary to secure that persons supplied by that person with a substance are provided with adequate information about any risks to health and safety for which the inherent properties of the substance may give rise about the results of any relevant test which have been carried out on or in connection with the substance and about any conditions necessary to ensure that the substance will be safe and without risk to health at all such times as are mentioned in paragraph (a) above and when the substance

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is being disposed of."

May I take it that the provision of information that you have just described and mentioned earlier, Mr Betts, is Calor's fulfilment of that?

A. Again, yes, that's correct.

Q. (d):

"To take such steps are necessary to secure so far as is reasonably practicable the persons so supplied and provided with all such revisions of information provided to them by virtue of the preceding paragraph as are necessary."

I take it that that would be fulfilled by Calor providing any revised information to be taken into account based on the original welcome pack or whatever?

A. That's correct, yes.

Q. Does Calor do that?

A. On point (d) specifically we haven't changed the product so we haven't had to cross that.

Q. Could we then go back to paragraph (b), subsection 4 (b), please. This is:

"It shall be the duty of any person who manufactures, imports or supplies any substance.

(b) to carry out or arrange for the carrying out of

such testing and examination as may be necessary for the performance of the duty imposed on him by the preceding

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paragraph."

Mr Betts, you fulfil the first paragraph by testing the gas, the LPG, to make sure it is what it is and you fulfil paragraph (c) and (d) by providing information and, if necessary, revised information.

What do you do to fulfil the duty under paragraph (b)?

A. Again, I think this is where our tests to make sure the product is in accordance with the British Standard for, in this instance, commercial propane is applied. So we basically purchase the gas to a specific standard and then we verify the purchases by testing gas as it is received and despatched.

Q. So would you accept that paragraph (b) includes the carrying out of testing, a risk assessment procedure, for example, at the location where gas is to be supplied or applies only to the testing of the gas itself?

A. It relates just to the testing of the gas itself.

Q. When I asked you questions about this on 23rd October, which is day 15 of this Inquiry, and for the record this is beginning at page 76 into page 77 of the transcript, I referred to Regulation 3 of the Management of Health and Safety at Work Regulations 1999 and before that referred to section 6 of the Act that we have just looked at.

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I wonder if I could ask you to look at those regulations which are on page 4503.

"Risk assessment."

I quoted to you, Mr Betts, paragraph 1 of Regulation 3:

"Every employer shall make a suitable and sufficient assessment of the risks to the health and safety of his employees to which they are exposed whilst they are at work", and:

"(b) the risks to the health and safety of persons not in his employment arising out of or in connection with the conduct by him of his undertaking for the purpose of identifying the measures he needs to take to comply with the requirements and prohibitions imposed upon him by or under the relevant statutory provision."

I put to you and I quote:

"If we accept that under the primary legislation, that is to say the 1974 Act itself, there may be a potential risk to persons not in Calor's employment as a result of Calor Gas filling a tank with LPG, can we agree that Calor Gas should carry out a risk assessment of that risk in order to satisfy regulation 3?"

Your response was:

"Sorry, you lost me. Could I ask you to repeat the question, please."

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I then responded:

"Yes. Can we agree that if Calor Gas is aware of a potential risk to persons not in its employment as a result of Calor Gas filling a tank with LPG then in order to comply with the obligation under the Act itself you have referred to in your answer to the question, Calor Gas ought to have carried out a risk assessment under regulation 3?"

Your answer was:

"Yes."

I then asked you:

"Has Calor Gas carried out a risk assessment with a view to identifying what risks there are to people who might be killed or injured as a result of their filling of the tank with LPG when the pipework is either not been inspected or not been adequately inspected?"

You said:

"I can't answer that definitively."

What is the position of Calor on this matter, Mr Betts? Is there a duty to carry out a risk assessment in a situation where the condition of the pipework has not adequately been ascertained or not?

A. I think for the purposes of Management of Health and Safety at Work Act we have carried out risk assessments of the filling operation. For the purposes of section 6

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that we have just been looking at, we believe that's down to the actual product itself. So they are slightly two different things, I believe.

Q. In the exchange I have just referred to there was reference to Calor possibly having carried out a risk assessment dealing with the tank and connections and all the things that are obvious to the process. I then asked:

"But are you able to say whether or not Calor has carried out the risk assessment as a consequence of inadequately inspecting or inadequately identifying the condition of the pipework downstream?"

You said:

"I can't say definitively, no."

You have raised this matter in the initial questions that my learned friend asked you, Mr Betts. What I would like to know for the benefit of this Inquiry is particularly with regard to section 6(4) (b) and the duty to carry out tests or examinations, does Calor believe that there have been situations in which it should carry out a risk assessment of downstream pipework which has not adequately been verified?

A. Not in relation to that specific clause. As I said, we believe it refers simply to the substance as supplied.

Q. We know the substance as supplied is hazardous by its

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nature.

A. Yes.

Q. So logic would suggest that if the substance that you are supplying is hazardous by its nature, then you need to do something to satisfy yourself that the conditions in which the substance will be either stored or used are such that they will not give rise to undue hazard.

A. Again, I think we have the obligation to make sure the substance is what we say it is. We have the obligation to maintain the safety of our -- in our undertakings as defined in section 3, which we have defined, as you are aware, the tank and its valves, et cetera.

The obligation to have -- there isn't an obligation for us to have an awareness of the condition of someone else's pipework.

Q. Even though you know that by filling the tank the gas, the hazardous LPG, is going to go into that pipework. Is that Calor's position?

A. No, our position is if we are aware of a problem with that pipework we clearly wouldn't supply it.

Q. I accept that but if you are unaware of whether or not there was a problem with the pipework, what is Calor's position?

A. No, that isn't our obligation.

Q. So Calor is content to fill a tank with LPG in the

knowledge that it will be fed, without further control, into pipework of which Calor is unaware of the condition?

A. In a yes or no situation I'd say yes, but that's within the context of, we hope, the customer being aware of their obligations for the pipe, which we have, as we have said, we are trying to ensure that customer is aware of those obligations.

Q. Other than providing the customer with the welcome pack and the other equivalent information, does Calor take any step to ascertain that the customer has satisfied itself of the condition of the pipework?

A. As I said, previously we do carry out pressure tests at certain times -- sorry, soundness tests of the pipework at certain times in the life-cycle of the tank.

MR MARTIN: Thank you very much, Mr Betts.
Thank you, my Lord.

THE CHAIRMAN: Mr Betts, that concludes your evidence. I am very grateful to you for the help you have given the Inquiry. I am sorry you have been inconvenienced.

MRS STACEY: My Lord, I am sorry to interrupt. I wonder if I might ask Mr Betts about something that came up today?

THE CHAIRMAN: Certainly, Mrs Stacey.

MRS STACEY: I am obliged for that, my Lord, thank you.

Examined by MRS STACEY



Q. Mr Betts, you spoke earlier on today about the situation that you say pertains now with your knowledge from research about the propensity of a pressure test not to be a sufficient test.
Do you remember talking about that?

A. Yes, I do.

Q. I think you said that at Calor or at least the industry's knowledge previously was that metal pipes could corrode?

A. That's correct.

Q. We are agreed about that? Everybody would know that?

A. Yes.

Q. You went on to say earlier on today that certain assumptions had been shown not to be true.

A. Yes.

Q. Do you remember referring to assumptions.

A. Yes.

Q. The first one I think was an assumption that pipes were protected by tape?

A. That was an assumption of Calor, yes, but that's correct.

Q. If you just think about that, is that clear then that Calor would know that the pipes have a propensity to corrode and the tape would be a measure taken to mitigate that?



A. Calor's, the reason for -- the reason for Calor's policy for installing pipework to either wrap the pipe in Denso tape or to have it coated in plastic was as a means of corrosion protection.

Q. That is what it is for.

A. Yes.

Q. So you identify the trouble, which is corrosion, and you see what you can do to prevent it happening?

A. That's correct, yes.

Q. You went on to say in the same passage in your evidence that you thought that the risers were also protected?

A. Again correct, yes. The document that we looked at just before lunch was effectively the specification for

installing a polyethylene system with risers, which did refer to wrapping the risers in Denso tape.

Q. So would that mean then that in 1988/89, that sort of time, that Calor would know that pipes might corrode and that a measure that was taken to prevent that was the wrapping of the pipes and the wrapping of the riser pipes?

A. That's correct, yes.

Q. So if Calor could see that there was no Denso tape on a riser pipe at that time then Calor might wonder if there was any protection against corrosion, might it not?

A. Potentially, yes.

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Q. You went on in the same passage of evidence to say that another assumption was that LPG would not track into the building.

A. That's correct.

Q. Did Calor and the industry in general not know in 1988 that LPG is heavier than air?

A. It did.

Q. Therefore, if there is some way for it to track into a building there is a risk that it will do just that?

A. As I said, at the time -- and obviously I was only there at the end of that sort of period -- I don't think that knowledge was accepted. I think they didn't think it would happen.

Q. I have some difficulty with that if everybody who is of a scientific or technical mind knows that it is heavier than air then why would it not track into a building if there was the physical set-up to allow that?

A. I believe it was thought it would permeate through the soil upwards rather than go sideways into a building.

Q. Would it not need to be lighter than air to permeate upwards?

A. No, as is proved, that is what happens with an LPG leak.

Q. What do you say happens with an LPG leak?

A. An LPG leak will, in soft ground, permeate upwards through the ground and be detectable above the ground

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above the leak and I think we mentioned, I think Mr Tomlin mentioned about pipeline surveys and going above the pipeline with boreholes, et cetera. That is a method of establishing a gas leak.

Q. I understand. You are referring to soft ground as you said?

A. Indeed, yes.

Q. If it was not in soft ground but was in ground covered in some sort of hard standing then that would not happen?

A. It depends on the hard standing but possibly not.

Q. Can I ask you when you were giving your evidence this morning, Mr Betts, were you reading from something?

A. No. I had some notes but I wasn't reading from them.

Q. So were these just notes of your own?

A. Yes.

Q. Were they there as an aide-memoire, if you like?

A. Yes.

Q. Had you thought about what you had said last time round and made some notes?

A. Basically, yes.

Q. So that is not something which has been lodged on behalf of Calor then?

A. No.

Q. Your own private notes, are they?

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A. Yes.

Q. May I ask you a little bit about the matter that counsel for the Inquiry, Mr Martin, was asking you about and that is the legislation.

I think you will remember that when you were here before objection was taken by your counsel, Mr Ellis, to you being asked about the law on the basis that you are not a lawyer, although of course you are well conversant with what Calor does. Do you remember that?

A. I remember the point, yes.

Q. So today when Mr Sheldon was asking you questions you seemed to be happy to tell us what Calor's position is?

A. In regard of the interpretation of various sections of the Health and Safety at Work Act, I am, yes.

Q. You are content to do that, are you?

A. Yes. I think the matter Mr Ellis referred to was a specific interpretation of a paragraph. I think the way he described it was a legal point rather than a general point.

Q. Perhaps you can answer something for me then. Am I right in thinking that one of the things that Calor does, because I appreciate it is a large company, but one of the things it does is that it sells LPG to industrial customers?

A. It does.

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Q. Not only does it sell LPG it delivers it?

A. It delivers it, yes.

Q. We have spent a lot of time of course hearing about how it delivers it with the tank coming and the lorry and then it gets transferred into the tank and so on.

A. That's correct.

Q. So would you agree with me that when Calor is going about that task of selling LPG to an industrial customer and delivering it to him that Calor, at that time, its undertaking is the supply of LPG to that industrial customer?

A. Sorry, can you repeat that?

Q. I am trying to get at what Calor actually does and I do not think there is any dispute between us at all that Calor sells LPG and it delivers it?

A. It does, yes.

Q. In order to deliver it it has got to turn up with a lorry with LPG in a tank and it has got to get it from tank into the vessel which we can see sitting before us as an example.

A. That's correct, yes.

Q. Once it has done that, the driver has completed what he set out to do?

A. That's correct, yes.

Q. So it may be a matter of law, Mr Betts, and you may with

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not wish to comment on it, but do you understand that one might argue that Calor's undertaking is that of selling and delivering LPG?

MR SHELDON: Do not answer that question at the moment, please.

My Lord, I wonder if my learned friend might clarify whether she intends the use of the word "undertaking" in the technical sense in which it is used in the legislation or in a broader sense, for example the sense of it being Calor's business.

THE CHAIRMAN: I think it is perfectly clear Mrs Stacey is referring to the undertaking in the context of the statutory provisions.

MRS STACEY: Yes. That is so, my Lord, because we did hear something about this this morning.

THE CHAIRMAN: I will not stop you, Mrs Stacey. I rather think Mr Sheldon has brought avalanche on his own head by the questions he asked, but that is just my impression that the moment.

MRS STACEY: That is why I raised it, my Lord, because I did hear something about it this morning and I wanted to be sure I had understood the witness.

THE CHAIRMAN: At the end of the day, I suppose, it will be a matter for discussion what the undertaking is that these provisions refer to.

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MRS STACEY: Yes.

THE CHAIRMAN: Your point is that it is the supply and distribution of LPG to customers' sites; that is what Calor do, that is their undertaking.

MRS STACEY: Yes. That is right, my Lord. I just want to be fair and give notice that that may be the position taken by HSE when it comes to evidence and closing submissions and if this witness disagrees with me perhaps I had better give him the chance to tell me why that is wrong, but I am not certain if Mr Betts wants to say something about what he may regard as a legal matter.

A. Well, yes. It seems to have gone into an area I'm not too clear about.

THE CHAIRMAN: I got the impression that your idea was, Mr Betts, that the undertaking meant the installation and that once you had supplied the tank, that was that. Whether that is right or not, I do not know.

A. We consider the vessel and the calves the undertaking in as far as section 3 of the Act is ...

MRS STACEY: Sorry, I just did not hear that.

A. The vessel and its valves connected to it, that's what we consider our undertaking.

MRS STACEY: I understand that from the witness. I am grateful to him for that clarification, my Lord.

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When you were asked some little time ago by Mr Martin about what you had said ten days ago --

A. Yes.

Q. Mr Martin suggested to you ten days ago that if Calor Gas is aware of a potential risk to persons not in its employment as a result of Calor Gas filling a tank with LPG, then in order to comply with the obligation under the Act itself you have referred to in your answer to the question, Calor Gas ought to have carried out a risk assessment under regulation 3 and you answered:

"Yes."

I know it is difficult, Mr Betts, to understand what I am saying to you but perhaps I can put it this way: do you want to change the evidence you gave before or was it correct?

A. Maybe I can ask you to repeat the question just so I understand what --

Q. I understand the problem. I have the advantage of you because I have the transcript. Counsel said:

"Can we agree that if Calor Gas is aware of a potential risk to persons not in its employment as a result of Calor Gas filling a tank with LPG, then in order to comply with the obligation under the Act itself you have referred to in your answer to the question, Calor Gas ought to have carried out a risk assessment

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under regulation 3?"

You said:

"Yes."

A. Yes, I'd go along with that. Just to make it clear, if I can expand on that, our undertaking is the tank and valves on it. The act of filling it, we have obligations to make sure it is safe for our employee to do so and it is safe for the people nearby the tank when they are doing so.

The way we do that is by risk assessment. So we have risk assessments for the operation of the bulk tank.

Q. You see, that sounds to me like a risk assessment that somebody does in the office when think they, "Right, how do you fill a tank", and there will be all sorts of things that the driver has to do?

A. Mm-hm.

Q. Make sure that he has got the right hose in the right place, to put it at its bluntest. But do you mean that a risk assessment is done at each site or do you mean it is something done in the office before he leaves?

A. So the risk assessment is in itself a generic risk assessment. So it would refer to the act of filling the bulk tank, not at a specific site. The risk assessment also refers to driver procedures and the drivers are all

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trained and possess a driver manual, and that does include a visual assessment of the tank and its surrounding prior to filling, which we call our bulk installation defect reporting system, which I believe the Health and Safety Executive are familiar with.

Q. Absolutely. So what you are telling me about there -- and it is an acronym, is it not -- being the Health and Safety Executive it is BIDR, that means, I think that if the driver sees something wrong with the tank he reports back?

A. Yes. It depends what is wrong with the tank. He would either report back and he has a number of categories to report back in or if it was something considered immediately dangerous he would not even fill the tank and he would report back immediately.

Q. You see that is not really what I had understood you to be talking about last time round. I thought that you were agreeing with counsel that Calor do have an obligation under one of the regulations, as it happens Regulation 3, to think about the place and setup to which they are delivering LPG and I would just like to know if you agree with that or not.

A. I think, as you read out my transcript, I at the time and I think now believe it's the act of us filling our tank I was referring to.

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Q. Perhaps if I can be more specific so I am making sure that I am being clear from what I am saying, does the risk assessment include any valuation of the maintenance regime operated by the customer?

A. No.

MRS STACEY: Just give me a moment, Mr Betts, if I may. Thank you, Mr Betts.

My Lord. I have nothing further for this witness.

THE CHAIRMAN: Thank you, Mr Betts.

Mr Sheldon, I should not be troubled if I were you about the statutory interpretation point. We can discuss that in due course. It is sufficient I think for me to know what Calor understand to be the position.

MR SHELDON: That was the sole purpose of my questions, my Lord.

THE CHAIRMAN: Thank you so much, Mr Betts.

(The witness withdrew) ^^

MR MARTIN: My Lord, the next witness is the first of the final tranche of officers from the Health & Safety Executive, Mr Brian Fullam.

BRIAN WILLIAM FULLAM (called)

Q. Good afternoon. You should have before you for the purposes of my questions three Inquiry statements. The first is headed, "History of employment and education", and obviously it covers other matters. The second is

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headed -- and this is the order that, in a sense, I will be looking at them -- "Supplementary statement commentary on the factual report expert evidence and ICL Inquiry statement by Penny Taylor". The third is again a supplementary statement headed, "Development of the joint working with HSE, UKLPG and Calor on underground LPG pipework".

Do you have these?

A. I don't appear to have the third one.

Q. I can leave that because it is not the first topic I am going to turn to and we will make sure you have it when I get to it.

A. Can I correct that. I do have the third one.

Q. The other items that I would like you to have to hand are the two reports by Penny Taylor, one simply entitled "Guidance" which begins on page 9736 of the Inquiry bundle, if I could have that, please, dated 27th November 2006, revised September 2008 and the second looks similar on the cover sheet, it is somewhat longer, "Factual report on guidance", beginning at page 9742.

I should just explain, my Lord, that Miss Taylor also produced an original report for the Procurator Fiscal of which the larger at least of these is a revisal. That is at 8815 but I do not intend to ask any

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questions about that because Miss Taylor's Inquiry statement, although it is not technically before the Inquiry, explains that what we have now is a revisal of that original version in various respects.

Mr Fullam, if I can begin then with your Inquiry statement, please. You have set out your history of employment and education. We can see that you have been with the Health & Safety Executive since January 1977, you have a doctorate in chemistry and for the first two and a half years after leaving university you worked at Royal Ordnance Factory at Bishopton, Renfrewshire.

After 18 months undergoing training in a general Inspectorate group dealing with chemicals and printing you began work as a specialist fire and explosion inspector in the Leeds Field Consultant Group.

I assume that would be in or about the middle of 1979; would that be right?

A. That's right.

Q. Subsequently, you moved into headquarters in Bootle and took up the post in LPG duty in October 1984. The role involved representing HSE as the national specialist in LPG. It also involved developing national standards and providing advice to both the industry and field inspectors.

We can see by reference to a later paragraph, 11,

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that might be entitled topic specialist in LPG. Is that a fair description of the post that you held from 1984 to 1988?

A. Yes, it is.

Q. Then I think I am right in saying and please correct me

if I am wrong you then held various posts which were not so directly related with LPG -- is that correct -- although in 1996 you moved to the Chemical and Hazardous Installations Directorate, thence in 2002 to the Corporate Science Knowledge Unit and in 2006 you returned as head of the Process Safety Corporate Topic Group.

Am I right these various intermediate posts perhaps did not have such direct relationship to LPG as you had had between 1984 and 1988?

A. Yes, that's correct.

Q. Then you are now working on the standards for the safe storage and use of LPG. Since 1988 you were a superintending specialist inspector and again I hope you will forgive me if I take your qualifications as read.

You are then asked about various matters concerning knowledge hub on LPG and prior knowledge hub. I am not going to ask you any questions about that but you may take it they are part of your evidence.

The first matter I would like to ask you about is

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the review of guidance and I think, just as a formality, we can see that in addition to what you have said in your own Inquiry statement -- and forgive me I should have called you Dr Fullam -- in your reference to Penny Taylor's factual report and Inquiry statement you, in effect, are giving the evidence that she would have given about the report that she has prepared.

Is that correct?

A. That's correct, yes.

Q. So if you could have that report before you, please. It is the longer one which begins at 9742. I have no questions to ask you on the shorter one, although clearly it is before the Inquiry.

This is a document which covers, as I understand it, called "Factual report on guidance", both external guidance and guidance issued by the Health and Safety Inspectorate and, indeed, I think I am right its predecessor the Factory Inspectorate. Is that correct?

A. Yes, that is.

Q. If I could ask you to go, please, to what is page number 5 of the document, we can see that the period of external guidance which is covered is from 1959 to 2004. Is that right?

A. That's right.

Q. If we then go to the section on HSE and its

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predecessor's guidance at section 2.8, which is on page 33 of the document, that is the beginning of the HSE guidance section, Dr Fullam.

Although I have not identified from this document the date of the original Safety Health and Welfare Booklet new series number 30 that you were talking about, that dates from the 1960s itself. Is that correct?

A. That's correct?

Q. So, in other words, we are looking in both the external guidance and the HSE guidance being referred to at a period which goes back beyond the installation of the LPG equipment at Grovepark Mills which took place in 1969?

A. Yes.

Q. Thank you very much.

If we look at the HSE guidance, if you could go, please, to paragraph 174 of the document on page 9776, we see that in 1981 HSW30 was republished by the

Health & Safety Executive as guidance note CS5. Is that right?

A. Yes, that is right.

Q. I am sorry, maybe I have gone slightly too far ...

A. The Home Office Code was revised as CS5. (Pause)

Q. If I could have 1095, please.

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If we go to paragraph 174 of Miss Taylor's report, the page we were at, am I right that HS(G)15 does not provide any detailed guidance on maintenance or routine inspection of pipework?

A. Yes, that is correct.

Q. If we then go to paragraph 186, this is CS5, and if I could ask for page 1168 to come up on the screen, please, and if I look at paragraph 186 of Miss Taylor's report, in referring to this document which came in in May 1981, she quotes and it is in italics in the middle of the paragraph:

" ... nor is it the intention that the recommendations should be applied rigidly to existing premises where, for a variety of reasons, it may not practicable to comply with them. Only such alterations as are considered to be reasonable or essential for the public safety should be made."

Then the introduction goes on by saying:

"The guidance note does not include detailed guidance on the design, construction and maintenance of LPG equipment."

Is that right?

A. That's right.

Q. Then just going chronologically through the documents, the next is 192 in Miss Taylor's note, please. This is

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reference to the document HS(G)34 which is at 1272, if I could have that on the scene, please.

We see in paragraph 192 of her report that HS(G) was the replacement of CS5. It was published in 1987 and it was drawn in 2000 after being superseded by the LPGA guidance starting with the LPG Code of Practice 1 published in 1998 and of course that is dealt with in the other part of the report.

So over the period that we are concerned with, Dr Fullam, am I right that the sequence is SHW30, after reprinting replaced by HS(G)15, HS(G)15 replaced in 1981 by CS5, CS5 replaced in 1987 by HS(G)34 and HS(G)34 withdrawn in 2000 to be are placed by LPGA and LPGA Code of Practice?

A. I don't think your scheme is quite correct with HS(G)15 and CS5. CS5 replaced the old Code of Practice and the two, in essence, ran in parallel until I wrote HS(G)34 and one of my tasks was to combine those into the single document, which is what I did. So the reality is we had two of those running in parallel and they were certainly used in parallel by inspectors at that time.

Q. Thank you for that clarification.

Am I right that all of these documents were published by the HSE for use by third parties?

A. Yes, they were.

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Q. Not least, no doubt, LPG suppliers and users?

A. Yes, they were.

Q. Were they also used by inspectors?

A. They were, indeed.

Q. Look at paragraph 199 of Miss Taylor's report. This is under reference to HS(G)34. We see the guidance states that:

"The mechanical integrity of vessels will not initially be assured unless the correct design criteria are adopted."

I think I am right in saying the subsequent paragraphs of her report up to 201 are dealing with vessels. Is that correct?

A. That's correct.

Q. At 202 she begins dealing with fittings and as I read her report on page 40 at paragraph 202, page 16 deals with the suitability of fittings.

"Each vessel should be fitted with a pressure relief valve", et cetera, et cetera.

As I understand what is being said there and by reference to the contents of HS(G)34, that is a reference to the fittings to be used, in effect, at installation?

A. Yes, that's right.

Q. She begins to deal with piping at paragraph 203 and at

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page 19 of HS(G)34 it is said:

"Page 19 deals with the suitability of pipework. Pipework should be properly designed and constructed with due regard to low temperature service, the materials used ...", et cetera.

Then in 204 there is a reference to the then LPGITA Code of Practice 22 and 205 joints should be kept to a minimum. 206:

"... to prevent the accumulation of static electricity, metal piping should be electrically continuous ...", et cetera.

207:

"Piping should be sized and routed to keep restrict contents to a minimum thus reducing potential hazard."

208:

"Routing of piping containing liquid LPG or vapour at a pressure above 37 mBar gauge in buildings should be avoided."

Again am I right that these are all references, as it were, to the specification of the installation at the time that it is being created?

A. That's correct.

Q. Then paragraph 209. Perhaps we are coming closer to what we need to talk about.

Could I have up paragraph 79 of page 1293 of

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HS(G)34.

I will just read what Miss Taylor has said:

"Paragraph 79 refers to underground piping carrying liquid and requires first correct piping design ..." that is to do with design.

"2. Correct design of trench and backfill."

Is that, again, obviously a matter of design and specification, the specification of the trench and the backfill?

A. Yes.

Q. 3:

"Corrosion protection where necessary, wax tape, bitumen over-wraps, cathodic protection and the need to seek specialist advice."

Again, can we agree that is about the specification of the installation?

A. It is.

Q. At 210:

"Route of pipe-run should be recorded and where practical permanently marked."

211 deals with polyethylene pipes. 212, paragraph

80, which is numbered in error, deals with the LPG pipes carrying vapour which it states:

"... may be buried in an open excavation, back-filled with a material which is noncorrosive."

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Again, without taking time, is that again a specification of the installation of a system?

A. Yes, it is.

Q. Then the following paragraphs of Miss Taylor's report dealt with security, vehicle damage and fire precautions, loading and unloading facilities, and commissioning. That is up to paragraph 217 of her report which is up to, I think, certainly dealing with other parts of the HS(G).

Again, can we agree that all of these are about the nature of the installation?

A. They are.

Q. Then if we come to what begins at paragraph 18 of her report under the heading of "Maintenance and examination", if we go then to page 1306, please, can we agree that this is the section in HS(G)34 which is dealing with the circumstances relating to, for example, a buried steel pipe carrying LPG?

A. Yes, it is.

Q. Perhaps just leaving Miss Taylor's report to the side at the moment, if we look at what is actually said in the HS(G), in 182 it says:

"The installation should be properly maintained to acceptable standards determined and overseen by a competent engineer of appropriate discipline with the

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objective of maintaining the established safe operating limits. Emphasis should be placed on features affecting the integrity of the installation or the ability to take emergency action. For installations rented from the gas suppliers this work may be carried out by the company owning the vessel."

Who did the HSE foresee as the competent engineer? What qualifications would that person have, as envisaged by this paragraph?

A. The person would be a mechanical engineer, probably a graduate mechanical engineer, who had an understanding of pressure vessels.

Q. Was this paragraph directed solely at the vessel or at the entire installation?

A. It was really dealing with the whole installation but the installation was not clearly defined in the document.

Q. It refers in the last sentence to installations rented from the gas suppliers. Is that referring only to the vessel or is it potentially at least referring to more than the vessel?

A. It could refer to more than the vessel.

Q. Does that suggest that the HSE, in accordance with this guidance, saw it as being the case that an LPG installation should be properly maintained and overseen

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by a competent engineer?

A. Yes.

Q. Then in 183 it says:

"A maintenance scheme should be prepared which includes protective devices and instruments, the form and detail of which should reflect the needs of the particular installation. Servicing and maintenance handbooks may be adequate for simple installations."

Then it goes on in 184:

"Suitable records should be kept so that all maintenance schemes are properly monitored. All significant repairs or replacement should be recorded."

By whom would the maintenance scheme be prepared? That is the opening words of 183.

A. I would expect that to be prepared by the competent person.

Q. Then by whom would the suitable records be kept?

A. The records would be kept by the occupier of the establishment.

Q. By whom would the maintenance scheme be monitored?

A. I would expect it to be monitored by the competent person.

Q. By the ...?

A. Competent person.

Q. So in order for these paragraphs to be complied with, we

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need to have a competent engineer who is going to be responsible for the maintenance regime, maintenance scheme; we are going to have suitable records being kept of matters, including the maintenance scheme; and we are going to have the company monitoring that maintenance scheme. Is that right?

A. That's right.

Q. Where would the supplier fit in to that regime, the person who was actually coming along from time to time to fill up the tank?

A. The supplier -- if a supplier had provided the tank, a small installation like the one in front of us, then they should be providing sufficient information to the occupier that they were aware that the legal obligations were being met, that the tank was being properly maintained.

If they were just supplying gas to a tank owned by the occupier, then the obligations on maintenance belong to the occupier and they would just be providing the gas in the appropriate way.

Q. So forgive me, that was my mistake, Dr Fullam. The regime would be, as I understand what you have just said, the responsibility of the user of the LPG who I assume would be responsible for employing the competent person, the competent engineer?

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A. Yes.

Q. Would be responsible for keeping the suitable records demonstrating the maintenance scheme?

A. Yes.

Q. Why would they then be monitoring the maintenance scheme? Would that not imply someone else carrying out the monitoring?

A. No, I think if they have a competent person, which of course they may subcontract out, but if they have a competent person then they should monitor their scheme, the competent person should monitor the scheme and be able to advise them about the adequacy of what has been done and the maintenance of the vessel and its fittings.

Q. Is it not conceivable the monitoring would be carried out by HSE inspectors?

A. No.

Q. Why not?

A. Because we are not -- (a) we do not have responsibility for the vessel or any control over its use and operation and (b) because we're not there enough.

Q. With respect, the fact you are not there enough does not prevent you from monitoring a written scheme to make sure on the face of it it is being complied with, does

it?
A. We would certainly examine that scheme when we were
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making an inspection but would not monitor it in the formal sense of doing that on a regular basis.
Q. You see, we have evidence of the installation at Grovepark Mills during the period in this guidance (that is to say 1987 through to 2000) and we have the records of Health and Safety Inspectors during that period, Dr Fullam.
Would you expect to see within those records fulfilment of an obligation on the part of HSE inspectors to make sure that there was a regime such as we have just been discussing so that it could be seen that HS(G)34 was being complied with?
A. I would expect them on occasions but not at every visit because it would depend on the subject matter of the visit, to check on the compliance of the installation with HS(G)34 and, therefore, with the law. But I wouldn't expect them to do that on every visit.
Q. I did not ask about every visit. Would you expect them to do it on some visits?
A. On some visits, yes.
Q. Would you expect them to be asking the user to provide, to demonstrate, to display a copy of the maintenance scheme?
A. I would expect them to ask for and see a maintenance scheme, which may or may not be in paper form of course.
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At 1988 I guess it was.
Q. I was just about to say it could be on a computer nowadays but possibly not in 1988. But something of that sort, paper or virtual paper, is what they would look for.
185 says:
"A scheme for examining the installation should be drawn up by or be endorsed by a competent person and reviewed after each examination."
Would that form part of the written record, the suitable record, being kept?
A. Yes.
Q. "Vessels should be examined at intervals as required by a competent person."
Of course that would be the certificate that goes with the vessel under PSSR; is that right?
A. Yes. But it would also a requirement of the standard of the code upon which the vessel was built.
Q. 186:
"The cope of any particular examination and the inspection techniques to be used should be decided by the competent person."
Does that mean that in order to be satisfied that the regime is properly in existence and being fulfilled there would need to be an identification of who was a
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competent person?
A. There needs to be identification that a competent person was being employed but whether or not it needed to name the individual, I'm not sure.
Q. It talks about examination of the --
"Vessels should be examined at intervals, as required, by a competent person. Direct heated vapourisers should be thoroughly examined at intervals not exceeding one year. The scope of any particular examination and the inspection techniques to be used should be decided by the competent person. Examination

of pressure vessels should include support structure, holding down arrangements and foundations."

187:

"Examination of underground or mounded vessels should include tests for corrosion, for example, detailed ultrasonic thickness checks. If internal access is not possible the external surface of the vessel will need to be exposed to enable examination to take place."

Is that, in effect, self-evident in what it is implying, Dr Fullam, that if you have a buried tank which I think had come in in the period then in order to fulfil 187, if you could not carry out an ultrasonic thickness check, which I assume, indeed, I think we

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heard some evidence about this a while ago, is a device put into the tank to check on the integrity of the tank from inside, if that could not be done there would need to be excavation to some extent?

A. Yes, that's correct.

Q. Then 188 is:

"Underground piping carrying liquid which is laid in a back-filled trench should be examined for corrosion, or tested in such a way as to establish continuing integrity, at least once every ten years."

To what extent do you take personal responsibility for that paragraph because I want to ask what it means and I want to be clear about where you were in the drafting and publication of this document.

A. I was responsible for the development and ultimately the publication of this document after clearance from others. I would not necessarily have produced the first draft of this section. In fact, I didn't. It was done by a mechanical engineer but I would then have discussed any possible amendments and I am aware -- my memory of that time is partial at best and somewhat episodic but I do remember that I was very keen to have those words "continuing integrity" in because I thought they were very important as a way of ensuring the continuing maintenance of the integrity of a tank over time or, in

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fact, any of the other fittings over time.

Q. I understand that but what steps did you envisage as being either the examination for corrosion or the test in such a way as to establish continuing integrity being carried out at least once every ten years?

A. I put the requirement for continuing integrity in, I put the words "tested in such a way to establish" because whilst examination was the standard way of examining for corrosion, to determine whether corrosion was taking place, of course it is quite possible that over time another technique could be introduced that would be equally as effective if not possibly even more effective. I didn't want to prevent that and cause extended difficulties with people questioning the guidance under those circumstances. So it allowed the introduction of new methodologies but it maintained those words about continuing integrity.

Q. I understand, Dr Fullam, you may have wanted a form of words which did not preclude new technology and I quite accept that, but what I am asking you is what were the actual steps, when this document was published in 1987, which were envisaged to satisfy paragraph 188?

A. At that point, for vessels it could be an internal examination using ultrasonic methodologies.

Q. Forgive me that is 187. I am asking about 188 which is

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underground piping carrying liquid.

A. Sorry, for piping there really was only one methodology that we were aware of at that stage, certainly for small pipes, and that was examination. For very large pipes, you could actually put a machine down to do your thickness examination, thickness tests.

Q. Is that because the internal diameter was large enough to get some sort of probe inside?

A. That's right. The probes are called pigs that you push down into pipes.

Q. But you could not do that with a 1.25 inch pipe?

A. It's too small.

Q. Right.

Are we saying that with the sort of small bore pipework with which this Inquiry is concerned, the only step which was being contemplated in accordance with paragraph 188 was examination for corrosion?

A. Yes, that's right.

Q. One assumes logically that if it is underground piping, then that would require excavation to a sufficient extent to carry out the examination?

A. Yes, it would.

Q. So does paragraph 188 require excavation at least every ten years?

A. It does.

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Q. Do you think that HSE inspectors knew that?

A. I would say, yes, they did.

Q. Because -- and we may come to this later, Dr Fullam -- the events of 1988/1989, in connection with the pipe at Grovepark Mills, involved an inspector recommending excavation, involved Calor Gas then responding that they would carry out an examination of the riser pipe and also a pressure test at the next vessel exchange and the HSE inspector accepting that.

A. I would have said that if somebody said to me, "I'm going to examine the riser pipe", I would expect the riser pipe to be examined. That's from the base to the top. So there would be underground as well as above ground and I would expect common sense would say that it should be the bit underground that is examined particularly because, as we've heard earlier, corrosion can be expected to be greater underground.

Q. Then we see in 189 that:

"Any significant deterioration or defects found in any remedial work undertaken should be recorded on the examination report with particulars of the inspection techniques used, the effect of such deterioration defect or repairs should be assessed by the competent person and the safe working limits endorsed or modified accordingly."

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Then 190 and 191 go on to deal with what the examination report should specify and refer to any repairs and modifications.

So does that mean, Dr Fullam, that in accordance with this guidance which was published in 1987 for every LPG installation, at least carried liquid because there is that qualification to be made, there should have been in existence a maintenance scheme, including an examination report of piping having been carried out at least every ten years?

A. That's correct.

Q. Could you look, please, at page 3827. This is a document headed FIM1987/48.

Am I right that FIM, perhaps not technically by then but indicated Factory Inspectorate memorandum?

A. Yes -- or minute. I'm not sure which.

Q. It may be minute. I am much obliged.

What we can see is that this is a document which at the top of the page has "cancellation date February 1988". If we look at the very last page -- that is 3833 -- we see that it is dated at the bottom August 1987.

Going back to the first page -- you are quite right it is Factory Inspectorate Minute -- issue of prints, it says:

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"The following prints have been or are about to be issued. The list should be used as a means of checking receipt."

There is a list of various titles and other items. In the right-hand column, there is something that are figures headed "SF number". What does that mean?

A. I'm afraid I can't tell you.

Q. If we go on to the second page -- that is 3828, please --

A. Actually, now that I see it it probably jogs my memory. We had this catalogue of guidance and it fell into certain categories and the categories were given numbers and I think that refers to those numbers.

Q. If we go on to the second page, what is item 7? HS(G) and HSR booklets. We see HS(G)34 is the document we have just been looking at. On the right-hand column, the SF number is 286 and then underneath there is another reference number which I think is 2/IES -- is it 2861988?

A. Yes.

Q. From what I can see -- and we are going to look at other documents in a moment, Dr Fullam -- 286 was, as a topic, LPG?

A. Yes.

Q. So we know from this document that HS(G)34 was coming in

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and its date of distribution or distribution date was 28th July 1987.

If you then go on, please, to page 3831, towards the bottom of the page you see cancellation of prints and instructions. It says:

"Cancel and destroy the following: any reports returned and special procedures required by cancelled items should cease."

Under the titles again, the location at the right-hand side. If we go to the next page, 3832, the penultimate page, the third item is number 25:

"Underground steel pipes conveying LPG as a liquid FIC28643 (REV)."

Then we see the location is SF286. So can we agree that what this document did with affect from a date in 1987 was that it introduced HS(G)34 and it cancelled a previous document entitled FIC28643 (REV)?

A. Yes, that's correct.

Q. If you go, please, to page 1041, is this the document FIC28643 (REV)?

A. It is.

Q. If we look at the bottom of the page, the final page, it is dated in, I think, September 1982 -- 27th September 1983.

A. That's correct.

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Q. Was this a document that you had any responsibility for

authorship, either direct or indirect?
A. No, I had no responsibility at all for this document.
Q. As we understand it, Dr Fullam, this is a document which was not published guidance but was presumably some sort of internal advice created by the HSE?
A. It was internal advice for our inspectors but it was not held in a form that -- we would have handed it out. We would have made it known to the industry. We did not hold these as secrets as such, even though we didn't have the same disclosure practices as we do now.
Q. You see, Miss Taylor's report does not, so far as I have seen, refer to it. Is that because it was not published guidance or guidance as such?
A. Yes.
Q. We know that it was published or dated September 1983. It is headed, going to the first page, 1041, "underground steel pipes conveying LPG as a liquid" and it says:
"This FIC replaces FIC28643 dated 10th November 1980 on underground pipes conveying LPG ..." et cetera.
It says in the third sentence:
"Underground pipes conveying only LPG vapour are not covered by this FIC but the standards recommended here are good practice and are suggested for all underground

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perhaps conveying LPG."
If we then go to paragraph 14, under the heading of commissioning and inspection, it read:
"Before being brought into service, the pipeline system should have been tested in accordance with the appropriate design code, paragraph 6 [which I do not need to trouble you with] and certified by a competent person that it is suitable for its intended service. If the test pressure in excess of the design standard is imposed, deformation or fracture of the pipeline may result. Inspectors should check that someone on site is familiar with the safe working parameters of the pipeline and that documentation exists to confirm that the pipe meets the appropriate design code."
Perhaps without the detail which its successor HS(G)34 provides, does that nevertheless imply a similar regime with a pipeline system designed and certified by a competent person and with records being kept which could be checked?
A. That's correct.
Q. Indeed, is it quite clear that the records kept in this situation could be checked and indeed should be checked by an HSE inspector?
A. Yes, they should be examined by an HSE inspector if that is what they were inspecting.

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Q. The HSE inspector, had in this paragraph at least, a role in checking that the documentation existed to confirm that the pipeline met the appropriate design code.
A. They were checking that the company was complying with the law by keeping the right records. They would not then do an examination of the pipe to make sure that it complied with the design codes. That would have been outwith their duties.
Q. But they should at the very least have been checking the documentation to ensure that the pipe met the appropriate design code?
A. Yes.
Q. Then in paragraph 15 under the heaving "surveying for leaks":

"Underground pipework should be surveyed for leaks at least every three months, depending on their location and environment. The survey mentioned above should include a visual inspection of the run of the line and a method to detect flammable gases in the soil above the pipe. Gas detectors with remote sensing head or detectors with mechanical attachments can be used for this purpose."

We know that technically that did not apply to pipework in the vapour phase but, nevertheless, can we

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agree that in accordance with pipe 1 that should have been applied with advantage to underground pipes conveying LPG vapour?

A. Examining the run of the line is probably -- well, is not helpful or very valuable when it comes to low pressure vapour lines. If you are operating a high pressure line which has got liquid, then you get disturbance of the ground when you get a release because of the pressure, the momentum of the vapour leaving the pipe. So that's why you examine the run of the line because you can actually see some disturbance. But the use of a flammable gas detector would have been helpful.

Q. Then paragraph 16 under the heading periodic inspection:

"Plans should be inspected by a competent person at intervals not exceeding five years. After inspection, the competent person should set the date of the next periodic inspection and any improvements which may have to be carried out on the pipeline."

I am assuming that that must mean that the competent person should record his or her inspection in the paperwork for the pipework and identify the date of the next inspection to be carried out?

A. That's right and that date may, of course, not be five years; it might be a shorter period.

Q. Absolutely, but anyone who wished to consider the state

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of the pipework, including an HSE inspector, should then be able to seek out the paperwork and identify whether or not there had been an inspection by the competent person and when the next periodic inspection was to take place?

A. That's correct.

Q. Then paragraph 19 under the heading "existing installations":

"When an underground pipe has been installed to a low standard (that is design standard of pipework unknown, absence of concrete lined trench, unsuitable backfill material, high loading due to vehicular traffic, history of leaks, et cetera), inspectors should press for the pipeline 9 to be inspected by a competent person to confirm that it is suitable for its intended service. FI8 should be consulted by the FCG where enforcement action is being considered."

Leaving aside the technicalities of the initials used in the last sentence, that clearly implies that an inspector, an HSE inspector, who is looking to see if a pipeline has been inspected by a competent person ought to take that task sufficiently seriously because it is possible that enforcement action might result?

A. Yes, and that was particularly so for liquid pipelines where the hazard was so high.

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Q. I did not hear what you said.

A. For liquid pipelines where the hazard was so high.

Q. I understand. Thank you.

Again, does it appear to suggest that an HSE inspector had as part of his or her duties satisfied themselves that a pipeline which ought to be inspected at a suitable period, given its design standard or whatever, satisfied himself that that was being carried out?

A. Yes.

Q. We then see in paragraph 20 that FIC 28643 dated 10th November 1980 was to be cancelled and destroyed.

Fortunately for us, it was not because on page 1040 we have an example of 28643. This is dated 10th November 1980 and again I assume, it being an FIC28643 document, it was for internal use within the Health & Safety Executive?

A. It was.

Q. You can see the layout is not dissimilar to its successor. Under the heading "underground pipes conveying LPG":

"(1) This FIC describes the recommended standards for the installation, commissioning and inspection of underground pipes conveying LPG primarily in liquid form, although similar standards could be applied with

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advantage to underground pipes conveying LPG vapour."

So again can we agree, Dr Fullam, that it was desirable that these standards were applied to LPG vapour pipes?

A. Yes, they would certainly control the risks of leakage from those pipes.

Q. Paragraph 3 says:

"For convenience, LPG is often supplied to the relevant process via underground pipes. These pipes have often been laid in an earth trench, not always protected by lagging and/or wrapping tape and covered with sand. At least four such installations are known to have failed resulting in the release of substantial quantities of gas. In one case, an explosive concentration was created in a cellar 400 metres from the leak and such concentrations have also occurred in cellars, drains, wells, electrical main conduits and other underground cavities. In all cases, the leak has been caused by corrosion from outside the pipe, as LPG itself non-corrosive. Protective coverings have been penetrated by sharp stones, particularly under the influence of vibration from overhead traffic, and corrosion has eventually penetrated the pipe wall. The resulting leak may not be discovered for a period of weeks or months."

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Just stopping there, can we agree, Dr Fullam, that these two paragraphs demonstrate the state of knowledge of the Health & Safety Executive about the risks of corrosion to underground LPG pipes in November 1980?

A. Yes, they do.

Q. Given that there was a reference to historical matters there, including the four events in which there had been leakage of LPG, can we assume that in the period of 24 years between 1980 and 2004 that knowledge did not disappear?

A. I don't think you can assume it in its totality. The knowledge that pipes corrode when they are in the ground is actually a matter of general knowledge, in my view. But the four incidents that are referred to in that document, I suspect the detail of those were lost over time.

Q. We know at least in this series of documents that they

were lost between 1980 and 1983 because, as far as I can see, there is not a similar direct reference in the later FIC28643.

A. I don't think they were lost. I think at that point, by 1983, the assumption was that they were now part of the lexicon, part of the understanding and knowledge base of certainly specialist inspectors dealing with this subject matter.

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Q. For somebody coming, as I have done, to these documents from outside, I find specific information in the original document in 1980 which is not repeated in the subsequent document.

A. And that's correct. They were not written, of course, for somebody coming from the outside.

Q. Under the heading "commissioning and inspection", paragraph 6:

"Before being brought into service, the pipe should be pressure tested to 1.5 times its maximum working pressure. It is also recommended that the run of the line, both existing and new pipes conveying LPG should be visually inspected annually, with a further pressure test to the standard given above where reasonably practicable. After five years in service, annual pressure tests should be carried out."

That suggests, Dr Fullam, quite a strict regime in the sense that there is to be not only pressure testing to 1.5 times maximum working pressure at commissioning, but also at five years after five years after service beginning annually?

A. Yes, that's correct.

Q. As well as the run of the line you talked about earlier and the visual inspection?

A. Yes.

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Q. Then paragraph 7:

"After ten years all pipes carrying LPG, and particularly those not installed to current standards, should, if reasonably practicable, be uncovered and physically examined. If this is not reasonably practicable, then a survey, including pressure testing, should be carried at annually."

That again is quite a strictly described regime, is it not?

A. It is.

Q. It would apply in 1980 to a pipe, a metal LPG pipe, albeit carrying LPG in the vapour phase, it would apply to such a pipe which had been installed in 1969 when this document was created?

A. Yes, though if I could just mention, I think there's a degree of discretion by the inspector as to how much of this can be applied to a vapour pipe; whereas it would all be applied to a liquid contained in the pipe.

Q. So would you expect to find a document recording where the inspector in question had exercised that discretion and explaining why he had exercised the discretion in a particular way?

A. No, I wouldn't.

Q. You see, on the face of it, Dr Fullam -- and I accept that what this says is that the regime could be applied

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with advantage to underground pipes conveying LPG vapour -- it is self-evident that it could be applied and could have been applied to the pipe which existed not only at Grovepark Mills but probably a significant number of other pipes which were already ten years old

by 1980.
A. That's correct; it could have been.
Q. If it had been applied to such pipes, then inspectors would have been saying, if it had not already been done, that the pipe should be uncovered and physically examined?
A. That's right, though at that time there was some debate about how much of that was enforceable on vapour pipelines, though we felt it was enforceable for liquid pipelines.
Q. Obviously if such a regime actually was carried out in a situation where a pipe was at risk of corrosion and was actually corroding, then, if corrosion was sufficiently significant, the corrosion would be identified and appropriate steps taken?
A. One would hope so, yes.
Q. Of course, that would require to be done every ten years?
A. Yes.
Q. In addition, of course, if we take paragraph 6, there

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was a regime which would come into effect after five years?
A. That's correct.
Q. And annual pressure testing to be carried out to 1.5 times the maximum working pressure again was something which, on the face of this document, and leaving aside the qualification between vapour and liquid pipes, was something that could have been applied with advantage to a pipe such as at Grovepark Mills and, as I have said, again no doubt many locations.
A. For vapour pipes, certainly one running at lower pressures, that is unlikely to have a significant impact because the pipe is manufactured and designed to operate at pressures much higher. It can withstand pressures, internal pressures, much higher than it is carrying in the form of vapour. So if you apply 1.5 times its maximum working pressure and its actual maximum working pressure may only be 75 mBar, then you are actually applying a very low pressure to a pipe which is capable of withstanding much greater. So you get very little sensible information from that test. It eventually becomes a leak test, ie is there a normal leak, the sort of test that Calor has referred to in earlier evidence.
Q. Of course, the leak test or the pressure test or whatever standard might be applied was only one of the

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elements of the regime which is being described here?
A. That's absolutely right.
Q. I wonder if I could just explore the rationale of this distinction between vapour and liquid pipes. I think Miss Taylor has said or in HS(G)34 the corrosion of the pipework is not caused by the LPG inside the pipe.
A. That's correct, yes.
Q. I take it that is irrespective of whether it is liquid or vapour?
A. LPG is non-corrosive. In certain circumstances you can get water vapour in the LPG -- that is very rare these days. That in itself could be corrosive, but not the LPG.
Q. As I understand what you said a moment ago, if you have LPG in the liquid phase in a pipe, then it may very well be at a higher pressure than would be the equivalent vapour?
A. That's correct.
Q. Does that logically suggest that the liquid phase LPG

pipe is likely to be thicker in terms of the thickness of the material around the circumference, thicker than a vapour pipe?

A. For a pipe carrying propane, that's correct. For a pipe carrying butane, then they may well be the same.

Q. May we take it that the effect of the external elements

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which caused the corrosion is not affected by whether the LPG is in liquid or vapour phase within the pipe?

A. That's correct.

Q. The logic, is it not, Dr Fulham, is that actually a vapour pipe is at greater risk of earlier catastrophic corrosion than a liquid phase pipe?

A. Where it has a thinner wall, yes, that's correct.

Q. So although the guidance appears to imply that vapour phase pipework is less of a hazard than liquid phase, because of course it does not apply the guidance in terms but simply says it could be applied with advantage, a logical analysis might suggest it is the other way round and that vapour phase LPG metal pipework is likely to corrode to a critical extent earlier than vapour phase pipework?

A. I think that the risk from a vapour phase pipe leak still remains less than the risk from a liquid pipe and that's because the risk we're determining is probability of a particular harm occurring from a particular event. So the risk remains lower but the probability or the chances that a pipe, a vapour pipe, will leak sooner if they are both laid in the same ground at the same time is greater.

Q. Is ...?

A. Is greater.

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Q. For vapour?

A. For vapour.

Q. What you are saying is that because liquid phase LPG when it vapourises enlarges to a factor of 250 to 1 --

A. Yes.

Q. -- then the quantity of LPG released from the equivalent leak would be much greater if it were liquid phase as opposed to vapour phase in the pipe?

A. Indeed, it expands to 12,000 to 1 to the lower flammable limit of the gas which is the point at which it can get dangerous.

MR MARTIN: My Lord, it is just after 4.00.

THE CHAIRMAN: We will stop there. Dr Fullam, I am sorry; you will have to continue your evidence tomorrow. I am sorry you have been inconvenienced.

(4.02 pm)

(Adjourned until 10.30 am the following morning)