

**IN THE HIGH COURT OF NEW ZEALAND
WELLINGTON REGISTRY**

CIV-2003-091-143

BETWEEN	AMANDA PICKARD First Plaintiff
AND	TROY GEORGE TAYLOR Second Plaintiff
AND	CHAS AMBROSE First Defendant
AND	RINNAI NEW ZEALAND LIMITED Second Defendant

Hearing: 27 October to 18 November 2009

Appearances: M D Lloyd for Plaintiffs
I G Hunt and A R Armstrong for First Defendant
P J L Hunt and G D Simms for Second Defendant

Judgment: 21 December 2009 at 4.15pm

I direct the Registrar to endorse this judgment with a delivery time of 4.15pm on the 21st day of December 2009.

RESERVED JUDGMENT OF MACKENZIE J

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Introduction

[1] In 1998, Ms Pickard had a gas heater installed in her home in Waikanae. She used it until 2001. She alleges that, due to faults in the heater and its installation, combustion gases containing carbon monoxide (CO) were leaked into the living room. She and her son Troy allege that they suffered serious short term and long term health problems as a consequence of exposure to CO. In this proceeding they seek damages totalling approximately \$1 million from the first defendant, Mr Ambrose, the gasfitter who installed the flue system and the heater and the second defendant, Rinnai, the New Zealand agents of the manufacturer and the ultimate supplier of the heater.

The installation of the heater

[2] In early 1998 Ms Pickard and her then husband, Mr Matthew Taylor, relocated at 100 year old character home from Taihape to a vacant section at 3 Kakariki Grove, Waikanae. Ms Pickard managed the project which involved remodelling the inside areas of the house, using the shell of the original building. The intention was to restore the house to its historic best in a modern context. Ms Pickard and her young son Troy, who was then six years old, moved into the house in August 1998. Work was then substantially completed, but ongoing.

[3] The refurbishment project involved the installation of heating for the house. Mr Ambrose was engaged, in 1998, in connection with the installation of heaters. Ms Pickard wanted to install identical gas fire appliances in both the front and back lounges of the house. She wanted old fashioned looking fires with a grate and coals. Mr Ambrose arranged for her to be shown a range of available appliances and she chose the Cannon UK Colonial K38 living flame gas fire for both lounges. Mr Ambrose ordered, obtained, and supplied and fitted two flues, in the front lounge and back lounge respectively, suitable for the K38 fire. The K38 requires a 100mm diameter flue. Mr Ambrose purchased flues which were a combination of round 100mm flue pipes, and rectangular channels of an equivalent cross-sectional area for installation into the wall cavity. At the bottom end of each flue there was a circular opening, of 100mm diameter, to which it was intended that the K38 heater, with its round spigot, would be attached. The flue was fitted internally, but not at that stage taken through the roof. That work was carried out in about June/July 1998.

[4] In July 1998 Mr Ambrose advised Ms Pickard that the K38 fire was no longer available. After discussions with Mr Ambrose and with Plumbing World in Paraparaumu, the retailer of the heater. Ms Pickard selected the Cannon Coalridge deluxe living flame gas fire. She states that in selecting that fire she relied upon Mr Ambrose's advice that that fire had the same features and style as the K38.

[5] The two heaters arrived in early August 1998 and Mr Ambrose took one of them to Ms Pickard's property in his van. He only took one because the front lounge had not been closed in at that stage and the second heater could not be fitted in that

room at that stage. His intention was to put the heater for the back lounge into place, see how it was going to fit, and what would need to be done to connect the heater to the flue he had already installed. The Coalridge deluxe heater would not fit directly into the flue, because that heater had a rectangular spigot for attachment to the flue, not a round spigot as the K38. Ms Pickard's evidence is that as soon as Mr Ambrose took the fire out of the box he realised there was a problem. Mr Ambrose says that he knew that there would have to be modifications to enable the Coalridge to be fitted to the K38 type flue and that it was not a surprise to him as Ms Pickard suggests. He said that he was conscious that he would need to speak to Rinnai or possibly to the suppliers from whom he had bought the flue system components, about what to do to transition the Coalridge to the K38 type flue. His experience in dealing with Rinnai had been that requests for technical advice had to be precise and well prepared with details of sizes, locations, dimensions and so on. He therefore considered there was no point in having a conversation with the Rinnai technical people unless the heater was on site and the exact nature of the problem was clear.

[6] While Mr Ambrose was at the property, he used Ms Pickard's telephone to call Rinnai. There is a record of that call in Ms Pickard's telephone records. Her telephone account records a call of 15 minutes 15 seconds to the Rinnai number in Auckland at 1.47pm on 13 August 1998. Mr Ambrose's evidence is that in the course of that call he spoke to a person in the technical department of Rinnai whose name, as best he can recall, is Ray. He explained to Ray the nature of the problem: the Cannon K38 heaters originally ordered were no longer available and he had already installed flues for those heaters. He asked if Ray could come up with a solution. His evidence is that Ray suggested removing the spigot on the Coalridge heaters and installing a spigot from a Cannon K38 heater. He explained to Ray that there were two heaters and flues involved. Ray said that Rinnai would send the necessary pieces to him. Ms Pickard's evidence is that after the call Mr Ambrose told her that Rinnai would send him the parts necessary for him to fit the fire to the flue and that he then took the fire away with him. Later that afternoon Mr Ambrose made a second call to Rinnai from his cellphone but does not recall the reason for that call. He says that some days later he received a courier package from Rinnai with two sets of parts. They consisted of two rectangular pieces of metal (which I will call transition plates) and two Cannon flue spigots.

[7] Mr Ambrose's recollection of his conversation with Rinnai was challenged in cross-examination. It was put to him that on an earlier occasion he had said that the conversation with Rinnai took place while he was at Plumbing World the retailer of the heater. He had said that he remembered having a conversation from the Plumbing Worlds manager's office to Rinnai. He said that it was a review of Ms Pickard's phone records that had caused him to reconsider whether that was the case. He said that he did definitely have a conversation from Plumbing World, but the call which was made to Ray was made from Ms Pickard's house. It was pointed out to him that the phone records had been available at the time he made his earlier statement but Mr Ambrose maintained his evidence that the call to Ray took place from Ms Pickard's house and that his earlier evidence that the call from Plumbing World was the call to Ray was incorrect.

[8] Mr Ambrose's evidence on his discussions with Rinnai is contested by Rinnai. Rinnai denies that any advice such as Mr Ambrose asserted was given by any person within Rinnai. It further denies that any parts were supplied by Rinnai.

[9] There was at the time a person by the name of Ray working at Rinnai, taking service calls on the technical help line. He was Mr Ray Mills. He gave evidence. He says that he thinks Mr Ambrose is wrong. He does not remember giving any advice to him or sending him any parts and he says that he would never have given the advice that Mr Ambrose claims or sent out the parts. He cannot say that he never spoke to Mr Ambrose but he does not remember doing so. He says that he would, in the course of his work on the help line, answer general inquiries and help with questions about the manufacturer's instructions but usually did not give advice to gasfitters about how to carry out any particular installation. He says that it is the gasfitter's responsibility to make sure the installation is correct and complies with standards and if he did give advice about a particular issue it would have been in writing and signed. He says that if a flue suitable for the K38 had already been installed the Coalridge would not have been compatible. He says that if a call came through as Mr Ambrose describes he would not have been able to discuss anything without knowing the size of the flue that was installed, and the size of the flue required for the heater. He would then have looked up the manufacturer's instructions. He is certain that he would never have told Mr Ambrose that a

Coalridge deluxe heater could be fitted to a 100mm flue. If Mr Ambrose had asked him if he could fit a Coalridge deluxe heater to a 100mm flue he would definitely have said no. As to the parts which were supplied, he recognises one of the parts as a round flue spigot that looked like a Cannon spigot, but not the other part, which looked like a flat piece of metal that had been folded. It did not look to him like a manufactured part. He says that he would not have sent anything like it to anyone, with or without a round spigot as well, so that a heater could be adapted to fit a flue.

[10] I find that Mr Ambrose did make a call to Rinnai from Ms Pickard's house, and that that call was taken by Mr Mills. I accept Mr Ambrose's evidence on that point, supported by Ms Pickard's evidence. I further find that Mr Mills did give advice as described by Mr Ambrose as to a solution for the problem over the transition from the heater to the flue. I accept Mr Ambrose's evidence on that point. It is clear that a 15 minute call took place. Both Mr Ambrose and Ms Pickard have given evidence to the effect that at the conclusion of that call a solution had been found. That solution could only have come from the telephone call. Mr Ambrose's actions, at the end of the call, confirmed by both his own evidence and that of Ms Pickard, would necessarily have been different if Mr Mills had given the advice he says he should have given. Mr Mills' evidence is given with benefit of hindsight. The method used for connecting the heater to the flue has subsequently assumed enormous significance. I accept Mr Mills' evidence that the advice should not have been given. But I am satisfied that it was given.

[11] On the supply of the parts, the evidence is more equivocal. The two round flue spigots supplied are clearly Cannon manufactured parts. It seems entirely possible that those parts would have been held by Rinnai in stock and could have been supplied. Rinnai's evidence is that no invoice was ever issued for the parts, and that they would not be sent without an invoice. However, the parts were small and of relatively low value and it is possible that they might have been supplied without cost, given the somewhat unusual circumstances and problem which had arisen. The transition plates, however, do not have the appearance of manufactured parts. The evidence suggests that the two transition plates have been made up from sheet metal, probably a backing plate supplied with a heater. I consider it improbable that Rinnai would have gone to the trouble of manufacturing a part to send to Mr Ambrose. The

transition plates could easily be made by a plumber/gasfitter. The plates supplied were incomplete, in that there was no central hole for fitting the spigot, and no holes for affixing to the heater. I think the more likely scenario, on the evidence, is that, having given the advice, Mr Mills arranged for spigots to be sent, but that Mr Ambrose arranged to make the transition plates. However, I do not consider that a finding on that point is essential. The important aspect is the advice which was given. To implement that advice, both a transition plate and a flue spigot were necessary. It does not, in my view, make any real difference to the respective responsibilities of Mr Ambrose and Rinnai whether the parts necessary to implement the advice were supplied by Rinnai, or obtained by Mr Ambrose from elsewhere.

[12] Mr Ambrose returned to Ms Pickard's house and fitted the fire sometime in September 1998. Her father had built the hearth for the fire to sit on and that was done after he returned from holiday in the United Kingdom in the last week of August 1998. Ms Pickard's evidence is that Mr Ambrose set up the fire for her to use and told her that the installation of the fire was complete and it was safe to use. She says that he never told her not to use the fire and he did not tell her about servicing or maintaining the fire. The instruction manuals were left, but she says that her attention was not drawn to these, and that they were unopened. Mr Ambrose's evidence is that he removed the oblong spigot out of the back of the Coalridge heater and fitted the transition plate to the back of the fire by drilling and pop riveting the plate to the back of the heater box with a sealant to ensure an airtight seal between the transition plate and the heater. Prior to that, he must have drilled a hole in the transition plate to take the round spigot, and fitted that. He also extended the flue for the fire through the roof and fitted the flashing and a cowl to it. The height of the flue above the roof was limited by the length of flue pipe which he then had available. Mr Ambrose says that after fitting the heater, he did the checking he was required to do in order to commission the heater. He checked the gas pressure in the regulator and adjusted it to the specified pressure as provided in the installation instructions. He also carried out a spillage test, by turning the heater on and holding a paper taper near the vents at the back of the heater which draw in air for the flue. Smoke from the taper should be drawn through the vents and up the flue. He found on carrying out the spillage test that it operated satisfactorily. Ms Pickard was

present when he did this work, and he says that he showed her how to operate the heater and left the installation instructions and user manual.

[13] Mr Ambrose's evidence is that while the heater and some other appliances also installed were commissioned by him as far as possible, he was not able to fully complete all tests, particularly a spill test. The conditions required for such a test included that the doors and windows be closed and this condition could not be satisfied. He said that at that time there were no skirting boards or architraves fitted and adjacent rooms could be seen into behind the heater. He did not recall whether a door had actually been fitted to the room or not. He could also see ground through gaps where the flooring ended which made the house particularly draughty. The extent of draughts was such that it was not possible to carry out an effective spillage test in accordance with the manufacturer's instructions. His evidence as to the state of completion of the room is at variance with that of Ms Pickard and Mr Pickard. They both say that the room was substantially complete and that skirting boards and architraves were fitted. Mr Pickard's evidence is that at the stage he built the hearth, the back lounge of the house was finished; with gib, skirting, scotias, a chimney breast built, and the flue pipe for the gas fire had been installed.

[14] I prefer the evidence of Ms and Mr Pickard on this point. Other evidence establishes that the installation should not have been connected to a gas supply until it had been certified by Mr Ambrose, and that certification should have been supplied to the Plumbers Gasfitters and Drainlayers Board (PGDB), the gas supplier and the owner within five days. The heater was connected without that being done. Mr Ambrose's evidence does not explain why, if the proper test to enable certification could not be done, he connected the heater and allowed its use. I do not find his explanation satisfactory.

[15] Ms Pickard called Mr Ambrose on several occasions shortly after the installation of the heater to complain of a smell of gas. Mr Ambrose investigated but could find nothing wrong. Mr Ambrose's evidence is that on one of those occasions he told Ms Pickard that a full spillage test could not be completed until the building was complete with rooms sealed and all draughts in the vicinity of the heater removed. He said that on about the third occasion that he was called Ms Pickard told

him that she was not happy about the gas smell and that she refused to use the heater at all and would instead use a portable gas heater. Ms Pickard denies that. She says that on no occasion did she tell him she intended not to use the fire. Again, I prefer Ms Pickard's evidence on these points. I am satisfied that Mr Ambrose knew that the heater was being used after installation, although he had not yet certified that commissioning was complete. I find that at no stage did Mr Ambrose take steps to ensure that the heater was not used pending certification or further work on it. I further find that it would not have been appropriate for him to assume that the heater would not be used, and that he was not given any satisfactory basis for such an assumption.

[16] As I have earlier noted, Mr Ambrose had initially installed two flues, one in the front lounge as well as the one in the back lounge to which the heater had been connected. Work on the front lounge was much less advanced than in the back lounge. The room had not been gibbed, so that the flue system was still exposed and accessible in the wall cavity. At some stage in 1999, Mr Ambrose removed the flue from the front lounge, with Ms Pickard's permission, because he needed a similar flue for another installation which he was carrying out.

Problems with the heater

[17] Ms Pickard used the heater from September 1998 until July 2001. It was the only source of heating in the back lounge and she relied very heavily on it for warmth during this time, especially in winter. She used the fire on a daily basis from late September until November 1998, between about March and November in 1999, and 2000, and from about March 2001 until July 2001. The heater would be on all day when she was in the house. It was turned off when she went to bed at night.

[18] Ms Pickard was concerned that she could smell gas in the lounge and Mr Ambrose returned on a number of occasions to investigate, without success. It is unnecessary to detail the steps which were taken in the period from installation until May 2001.

[19] Ms Pickard's evidence is that she will never forget the day of 31 May 2001. In the morning, after taking Troy to school, she returned after the heater had been on a low setting, with the lounge door closed, for approximately three and a half hours. When she returned home with her parents there was an overwhelming gas smell in the lounge. She contacted the gas supplier and was advised that their records showed that she did not have any appliances installed. She learned in that way that no gas certification certificate had been lodged for the appliances. She telephoned all of the Kapiti gasfitters listed in the yellow pages and explained the seriousness of the level of gas but none of them were available to come that day. On 1 June she telephoned Mr Jackson, and insisted that he come that day. He arrived at approximately 5pm but did not have the right testing equipment to test the fire for a gas leak and recommended that she contact Mr De Kort. Mr Jackson went into the loft space and said that the flue pipe was not riveted. On about Monday, 4 June, Ms Pickard was requested to send a letter of complaint to allow the PGDB to investigate.

[20] Mr De Kort came to inspect the heater on about 7 June 2001. Ms Pickard's evidence is that he moved the fire away from the chimney breast and showed Ms Pickard and her parents all the soot present in the flue pipe. She says that as he moved the fire away from the chimney breast, hail stone sizes of soot fell onto the hearth and she saw heavy streaks of soot on the back of the fire. She says that Mr De Kort took the glass front off the fire and it was black with soot and the inside of the fire was also badly sooted. She said that Mr De Kort also told her that there were some problems with the flue pipe in that it was not riveted in the attic and the terminal in the roof was too near the surface of the roof and that he recommended extending the flue pipe. Mr De Kort's evidence on the events of 7 June, which was first set out in a report dated 24 July 2001, is substantially in accord with Ms Pickard's evidence. Mr De Kort returned on 13 June 2001 and carried out the flue extension and the flue riveting work. He also moved the heater forwards to check the flue and tested the gas pipe with the gas disconnected but found no leak. The heater was put back in its position. The following day, 14 June, Ms Pickard again contacted Mr De Kort informing him that she could smell gas. He visited again and on entering the room noticed a smell of natural gas. He tested the installation and found that a connection on the back of the heater was not tight and

leaked gas. The connection was not leaking when the heater was moved forwards which explained why the test the day before was sound but the leak had recommenced when the heater was moved back. He repaired that leak and the installation was retested and found satisfactory. On 4 July 2001 Mr De Kort visited again to investigate a smell of gas noticed by Ms Pickard. He checked extensively but did not find any leak. He also checked the working of the flue system with smoke pellets and found the flue working very well. About a week later Ms Pickard rang Mr De Kort again because she could still smell gas. He suggested taking the fire away for testing but she did not want the fire removed. At Ms Pickard's request he left the heater in position and fixed a sticker onto the glass front explaining that the heater should not be used due to a gas leak in the appliance. The heater has not been used from that point on. He reported to Ms Pickard on 24 July 2001 indicating that he was awaiting further instructions and confirming that the heater should not be used until the leak had been repaired.

[21] From July 2001, there have been extensive inquiries and investigations. There has been an investigation by the Energy Safety Service (ESS) of the Ministry of Economic Development, a complaint to the PGDB, and other investigations. It is unnecessary for me to record the detail of those investigations. Where relevant, I address issues arising from them elsewhere in this judgment. It is however important to emphasise that, in this litigation, it is the evidence adduced in these proceedings which is relevant. Also, the focus of this judgment must be on the issues which are relevant in these proceedings. This is not an occasion for a review of the investigations which have been conducted by other persons, institutions, or authorities.

Breaches of requirements

[22] Mr Ambrose's installation of the flue system and the heater was not in compliance with relevant requirements, in several respects. First, as I have already noted, he connected the heater to a gas supply without completing the required certification. Second, the flue which he had installed, initially for the K38 heater, did not meet the requirements specified by the manufacturer. The manufacturer's

instructions provide that the appliance is suitable for installation into a pre-fabricated flue, with a minimum diameter of 125mm. This flue had, as I have noted, a diameter of 100mm (or equivalent for the rectangular section). Additionally, in fitting the heater to the flue the heater was altered by the fitting of the transition plate and round spigot in place of the rectangular spigot.

[23] I am satisfied that the manufacturer's instructions were not followed with respect to the size of the flue. The flue was not of the minimum size specified. I do not consider that Mr Ambrose's discussions with Rinnai provided any proper basis for a departure from the manufacturer's instructions. I have accepted Mr Ambrose's evidence that he told Rinnai that a flue suitable for a K38 heater had been installed. However, Mr Ambrose does not say that he asked Rinnai whether such a flue was suitable. His inquiry was as to the way in which the heater could be adapted to fit that flue. It was not an inquiry as to whether the flue was itself suitable. I do not consider that it would be reasonable for Mr Ambrose to assume that the person at Rinnai would be familiar, over the telephone and without reference to the manuals, with the different flue sizes. Mr Ambrose was, or ought to have been, aware of those different requirements.

[24] The second respect in which the manufacturer's instructions were clearly not followed was in respect of the transition plate and spigot. I refer to those items, as assembled, as the transition piece. That was an alteration to the appliance which would have required specific consideration. I do not consider that the call to Rinnai can have the effect of making, for this heater, a one off change to the manufacturer's instructions to permit that alteration.

[25] There are other respects in which the question of whether manufacturer's instructions were complied with is less clear cut. This heater was fitted directly to a pre-fabricated flue. The manufacturer's instructions say, in the section dealing with pre-fabricated flues, that the fire can be fitted to a pre-fabricated twin wall metal flue box. Counsel for the plaintiff submits that the use of a flue box is mandatory with a pre-fabricated flue. I do not consider that the position is so clear cut. The provision is expressed in permissive, not mandatory terms. This fire place is one which was apparently designed to be suitable for installing into existing fire places. I do not find

that manufacturer's instructions entirely clear as to whether the use of a flue box is permissive where there is an installation into a pre existing fire place or similar recess, into which a pre-fabricated flue is inserted, or whether it is a universal requirement. The evidence of Mr O'Shaughnessy in particular, satisfies me that installation of these heaters against a wall, rather than into or in front of an existing fire place, is a common practice in New Zealand. Interpretation of the provision as to a flue box as a mandatory requirement would render that form of installation impractical.

[26] Under reg 12 of the Gas Regulations 1993, as they stood at the relevant date, gas installations were required to be installed with accordance with Part 1 of the relevant New Zealand standard for the installation of gas burning appliances and equipment, NZS5261: 1996. It is plaintiffs' case that compliance with the manufacturer's instructions is an essential component of compliance with Part 1 of NZS5261. I do not find the position to be quite so clear cut as counsel for the plaintiffs submits. There is no specific provision in Part 1 of NZS5261 which states in so many words that the manufacturer's instructions must be adhered to. The most relevant reference is Cl 108.7.1 which provides that: "the safety of the gas appliance and its installation, and its conformity to this standard and the design specification, shall be verified before commissioning commences". That is a somewhat indirect means of providing that, as a matter of law, the manufacturer's instructions must prevail over any specific provision in the standard or the regulation, or that, where the manufacturer's instructions specify a requirement that is more stringent than that imposed by the standard or the regulations, compliance with that more stringent standard is an express requirement of the standard itself.

[27] It is unnecessary to determine whether the breach of manufacturer's instructions was also a breach of the standard. The contract between Ms Pickard and Mr Ambrose for the installation of the flue system and heater would be subject to the usual condition, for work carried out by a tradesman, that the work be carried out in a proper and workmanlike manner and in accordance with the proper standards of the gas fitting trade. Failure to follow instructions given by the manufacturer as to the installation of appliance would prima facie constitute a breach of that condition. I find that Mr Ambrose has failed, in at least the two respects discussed in

paragraphs [22] and [24], to meet the standard required, and consequently is in breach of his contract with Ms Pickard. I consider that the crucial issue in this case is whether the breach by Mr Ambrose of the contract with Ms Pickard, by reason of the failure to adhere to manufacturer's instructions, has caused the harm for which damages are sought in this action.

Production of carbon monoxide

[28] The expert evidence on the extent to which the heater has produced CO is, for the plaintiffs, that of Mr Cruickshank and (to a lesser extent on this aspect) Dr Penney. Mr Cruickshank was at the time of trial a senior academic staff member at Unitec Applied Technology Institute in Auckland, responsible for the assessment of gasfitting apprentices. He is a qualified gasfitter and an associate member of the Institute of Gas Engineers. He has extensive experience in the gas industry since 1970. I discuss Dr Penney's qualifications later. For the first defendant, the principal expert witness on this aspect is Mr Gilmour. He holds an ME degree in clinical and process engineering and has extensive experience as a combustion engineer and process engineer and holds and has held university lectureships. The second defendant called Mr Howell, the principal of GasLab, a gas appliance testing laboratory. He has a UK Higher National Diploma in Mechanical Engineering and has worked in the gas industry in various roles for some 20 to 30 years. He is qualified and experienced in designing, testing, producing, installing and maintaining a variety of mechanical and gas products and components.

[29] CO may be a by-product of the combustion of carbon containing compounds such as the natural gas used to fuel the gas heater. Complete combustion of the hydro-carbons will produce carbon dioxide, water vapour and heat. Where there is incomplete combustion, CO may also be produced. Incomplete combustion will occur if the correct amount of combustion air is not available to allow for complete combustion of the fuel gas. There is a stoichiometric relationship between the quantity of fuel and the quantity of air required for complete combustion of the fuel. For methane (natural gas) the required air/gas ratio is 10:1 by volume. The achieving of that ratio requires control of the amount of gas, by the correct setting of

the pressure on the regulator on the heater, and control of the amount of air, by the design and installation of the heater and burners, to ensure an adequate flow of available air for complete combustion.

[30] The gas pressure setting for this heater as stated in the manufacturer's instructions, is 17.7 +/- 1.0 Mbar (1.77 +/- 0.1 kPa). The plaintiffs contend that Mr Ambrose may have set the pressure above that specified. I find no evidence to support this allegation. Mr Ambrose said that he set it at the correct pressure. In his written brief, he referred to a tolerance of +/- 0.5 kPa, which he corrected in evidence in chief to 1 Mbar (0.1 kPa). He was cross-examined on that change. He said that he was aware of the correct tolerance when he set it. However, even if he had, when he installed the heater, thought that the tolerance was +/- 0.5 kPa, there is no evidence that he set the pressure at the upper end of that tolerance. The setting of the pressure involves a mechanical adjustment. The regulator was described as being coarse and difficult to set accurately. There is however no evidence that such difficulty led to the pressure being set too high. Mr De Kort checked the pressure setting when he tested the appliance and flue in April 2002. He found it to be set at 1.63 kPa. There is no evidence to suggest that anyone had changed it, or that it could by some other means have altered from the setting initially set by Mr Ambrose. I find that there is no evidence that the gas pressure was wrongly set.

[31] As to the availability of sufficient air for complete combustion, there must be both sufficient primary air to be pre-mixed with the gas prior to combustion, and sufficient secondary air at the point of combustion. Burners may be either non-aerated or aerated. On this heater the front burner was non-aerated and the main or rear burner was aerated. There is some discrepancy in the instruction manual as to whether the front burner should be aerated or non-aerated. The form of manual produced in evidence has a drawing which indicates an aerated burner. This was queried with the manufacturer during the investigation into this matter. The evidence of Mr Ferner, managing director of Rinnai, is that these inquiries have established that the correct burner is non-aerated. I accept that evidence. Mr Gilmour's opinion is that a non-aerated burner is more sensitive to draught conditions and more prone to soot formation than an aerated burner. His view is that

it would have been less prone to problems if both burners had been aerated. Mr Howell does not believe that the type of front burner is of concern in this case.

[32] The availability of secondary air is also dependant, at least in part, on the correct level of aggregate in the fire box. Mr Cruickshank suggests, on the basis of a photograph taken in 2001, that the aggregate was below the correct level. Mr Ambrose's evidence did not directly address that point. Mr Cruickshank's opinion is also that incomplete combustion may have been caused in part by vitiation of the combustion air by inadequate flueing.

[33] I am unable to determine the cause of incomplete combustion. I am able to determine that, at least on occasion, incomplete combustion has occurred. There is physical evidence that, at least at some times during the operation of the heater, CO has been produced. That is shown by the presence of soot. There is a soot build up in the adaptor and in the flue, and there are streaks of soot down the back of the heater. That soot would not have been produced unless there were, at the same time, CO in the flue gases. There is no evidence of any correlation between the soot deposits evident, and the quantities of CO which must have been produced. Nor is there any evidence on which to base any correlation between the amount of the soot deposits and the time period over which CO must have been a component of the flue gases.

[34] The plaintiff relies principally on Mr Cruickshank's evidence. He said in evidence in chief: "It is clear from inspecting the heater, flue and adaptor that soot was being produced by the heater. If you have soot, you have combustion characteristics which mean that significant quantities of CO are present." Mr Cruickshank's evidence in chief quantified the extent of CO only by saying that "significant" quantities of CO were produced. In cross-examination he elaborated on that. Mr Cruickshank also at one point described the level of CO as massive

[35] Mr Cruickshank said that he used terms like significant because there were no reliable numbers to work with from actual data taken at the time. The only evidence he had was photographs, witness statements and the heater itself. He used the word significant because once a gas flame is producing soot then the minimal

amount of CO being produced is probably about 500 to 600 parts per million because you cannot get less than that. .

[36] Mr Cruickshank relies upon a photograph taken shortly after the problems were discovered, and the evidence of Ms Pickard and Mr Pickard describing the main flame as being elongated and yellow as evidence of the production of CO. He said that an elongated yellow flame is not normal for this type of heater; that an elongated yellow flame usually indicates that the heater over gassed or under aerated, or both. His opinion is that the long yellow flame indicates the heater gas pressure was set too high, pushing too much gas in to the combustion chamber and the amount of secondary air is restricted by the size of the combustion chamber and that too much gas, as a result of this combination of circumstances has led to the elongated yellow flame observed. He said that as soon as there is a long yellow flame it is inevitable that CO was being produced. He says that the quantum of CO is proportional to the type of flame, with significant quantities inevitably produced from the time yellow tipping is evident.

[37] The type of flame which is designed to be achieved by a gas heater is in part influenced by aesthetic considerations. Mr Cruickshank notes a distinction between effect fires, which imitate a solid fuel burning heater for aesthetic effect; and decorative fires, which are designed to look attractive, but not produce useful heat. He notes earlier descriptions of this heater as a decorative fire, and says that that is incorrect. I do not find, on the evidence, the clear distinction which Mr Cruickshank makes between an effect fire and a decorative fire. This heater was designed to produce useful heat, and was intended to be the sole heat source for the room. It was also designed to imitate the appearance of a solid fuel fire. It was intended to provide both effect and decoration. It was not intended to burn with an entirely blue flame. The production of a blue flame with yellow tips was a normal and intended consequence of the combustion of gas in this heater.

[38] Mr Cruickshank said under cross-examination that yellow flames do not start sooting until they get really bad and you can get yellow flames producing 300 to 500 parts per million with no soot and that once soot appears that is an indication of between 700 to 900 maybe more parts per million. He was asked in cross-

examination how to correlate large quantities of CO with any amount of soot and said that there are tables which give a rough indication of roughly how much CO will be produced depending on flame appearance. He said that in the course of his work at Unitec teaching apprentices he was experienced at knowing what a flame looks like and how much it will be producing and he can tell from the appearance of the flames in the photograph and the descriptions of the witnesses if that was the case. He produced a table from his Unitec teaching material. That showed varying levels of CO, from different flames, the largest being “lazy elongated and wavy yellow with soot deposited”, and said to give an approximate CO level of 600 to 1000ppm.

[39] I do not attach significant weight, in assessing the likely extent of CO, on the evidence as to the appearance of the flame. In particular, I find there is an insufficient evidential basis for the application of Mr Cruickshank’s table (even if that were accepted, and I note that Mr Howell did not necessarily accept it). There is only one photograph showing the flames. That is of an instant in time. Mr Cruickshank is also reliant upon the evidence of others, in particular Ms Pickard, for a description of flame. This heater was designed to produce a partially yellow flame. The assessment of a flame for the purposes of applying Mr Cruickshank’s table is, in my view, an exercise of judgment requiring some expertise, and would require the person making the assessment to view the flame personally, and not rely on the descriptions of others, not trained or experienced in flame assessment. Mr Howell did not consider flame appearance is a reliable quantitative guide to CO levels in combustion gases.

[40] Mr Gilmour’s opinion is that soot has been generated by the front burner when the heater was first started from cold, and only when the heater has been run at the two lowest settings. This is in his view a consequence of poor aeration due to a non-aerating front burner, possible over gassing as a result of incorrect gas pressure setting, and back pressure from the restricted flue transition with the heater on low setting.

[41] Mr Howell’s opinion is that there is evidence of incomplete combustion. He notes that the evidence of incomplete combustion relied upon by Mr Cruickshank is

the presence of an elongated yellow flame and sooting. He notes that there should not be a very yellow flame, but some yellow can be expected in the flames of an effect heater. He says that an elongated yellow flame does not necessarily mean that there has been incomplete combustion it may also be an indication of slow combustion. He said:

8.22 In my opinion, the elongated yellow flame in Ms Pickard's heater was likely to have been produced by flame vitiation due to the inefficient flue. Basically, the inefficient flue slowed the escape of combustion products from the combustion chamber, and therefore slowed the combustion process. This could have resulted in slow combustion or incomplete combustion.

[42] He agreed that in ideal conditions a properly functioning heater will not produce soot, but says that it is not uncommon for a heater to produce a small amount of soot and still operate safely. He believes the real issue is not whether CO was being produced but rather how much CO was being produced. He agrees with Mr Cruickshank that "where there is soot there is always CO". He notes that all effect gas heaters always produce some CO and some will do so without sooting and some produce soot. He says soot is not evidence of large or significant quantities of CO, it is simply evidence that some level of CO was being produced. He believes that as soot was produced it is likely that incomplete combustion occurred at times. He cannot say how often or how badly the incomplete combustion would have occurred. He notes that Mr De Kort's test appears to be the only guide to the operation of the heater and flue in their installed condition.

[43] The only measurements of the composition of the combustion gases from this heater were those carried out by Mr De Kort on 23 April 2002. Those tests were conducted in accordance with a proposal dated 17 March 2002 from Mr Howell to Mr Smith of the ESS. That proposal followed a request by Mr Smith to GasLab for advice on further tests that should be carried out, in the context of the ESS investigation. The results which are relevant to the question of the production of CO are those contained in items 5, 6, 7, and 8 of his test report. He checked the CO/CO² ratio and temperature for all burners and for the front burner only. The test was done at a point identified by Mr De Kort in evidence, as inside the appliance before the downdraught diverter. That showed ratios ranging from 0.0041 to 0.0071. Under 7, he tested for smoke with a Bacharach smoke tester as close as possible to the

appliance in the flue. He tested with the front burner only operating, and separately with both burners operating. He obtained readings of 0 with no detectable soot in both tests. In items 8, he checked the gas pressures; both the supply pressure and the burner pressure. The supply pressure was at 2.34 kPa and the burner pressure at 1.63 kPa.

[44] It is clear that some CO must have been produced, by this heater. I consider that the production of CO is more likely to have been intermittent than continuous, as I prefer Mr Gilmour's evidence on that issue. The totality of the evidence leaves me unable to quantify with any precision the extent to which this heater has produced CO either as to quantity, or as to the period or periods of time over which it has been produced.

Discharge of combustion gases into room

[45] The most important question, however, is not how much CO was produced by the heater, but how much of the CO produced was discharged into the living area of the room. The heater was flued. The purpose of the flue is to remove the combustion gases without entry to the living space of the room. To the extent that the combustion gases, containing CO, were exhausted through the flue, no harm to occupants of the room could result. That point was made by Mr Cruickshank in cross-examination:

- Q. Because it is pretty important to know whether, even if there was carbon monoxide, it is going into the lounge?
- A. Yes and those are the two issues. As I said, people who looked at it initially only looked at why it was producing and got the answer wrong and didn't particularly look at why it was spilling, which is the real issue. It may be producing bad things for a whole variety of reasons, over a period of time but the fact is if the flue was working properly, it wouldn't have mattered because all those would have been taken outside and the fact that it spilt into the lounge is the function of the bad flueing.

[46] The flue is not (and is not designed to be) fully enclosed. The heater has a downdraught diverter. There is an opening at the base of the downdraught diverter. The purpose of that is to ensure that, if the flue is affected by a reverse draught,

gases will not be forced back into the combustion chamber. The downdraught diverter also allows air to be drawn into the flue during normal operation, creating a venturi effect. If combustion gases are not exhausted through the flue, they may enter the room through the downdraught diverter. The issue therefore is how much of the combustion gases may have not been exhausted as intended through the flue, but entered the room through the downdraught diverter opening.

[47] The efficacy of the flue system, including the transition piece, was the subject of considerable focus at trial. I have already discussed its compliance with the manufacturer's instructions, the regulations, and acceptable gas fitting practice, I have found that there are defects. Those matters are relevant to whether there has been a breach of duty on the part of Mr Ambrose. On the crucial issue of whether that breach of duty has caused damage, the relevant issue, at this stage of my consideration of the evidence, is the effect of the defects on the efficacy of the flue system.

[48] The only tests conducted on this flue, and on the heater with the transition piece in place, were carried out by Mr De Kort, on two occasions. In a letter to Ms Pickard dated 24 July 2001, he recorded that, on a visit on 4 July 2001, "I also checked the working of the flue system with smoke pallets and found the flue working very well." In cross-examination he confirmed that every time he checked the flue it was draughting. Although Mr De Kort's evidence is not specific as to where the smoke test was conducted, it is apparent that the heater was still installed at that stage, so that the test must have been conducted at the base of the downdraught diverter. That would have tested the entire flue system, including the transition piece. By that stage the flue system had been altered, in that, as Mr De Kort confirmed in his letter of 24 July 2001, on 13 June 2001 he had extended the flue outside the roof, and had riveted the flue in the attic.

[49] On 23 April 2002, as part of the tests conducted by him in accordance with Mr Howell's proposal, Mr De Kort tested the flue, with the heater and transition piece in place. That part of the testing is described in items 3 and 4 of appendix 2 to that report. He tested the flue using (in separate tests) both the terminal outside the roof which he had extended on 13 June 2001, and the terminal with the extension

removed, so that the flue was in the form originally installed. The latter test was of the heater and flue system substantially as installed by Mr Ambrose. After correction of an error in the original reporting of the results of those tests, the correct results show that, on all conditions tested, the extended flue produced good draught, and the original flue terminal produced medium to low draught. In his supplementary evidence in chief Mr De Kort described the method of testing. He used an instrument which produced smoke, placed under the draught diverter, so that the smoke would be drawn into the flue. He said: "If it draughts well, it falls straight in, if it is a medium to low, it will go in, but not, it will take time to get into it." Mr Cruickshank was critical of those tests, on the grounds that they were insufficiently precise, and that a better test is one which measures the difference in barometric pressure between the top and bottom of the flue. They are, however, the only tests available of the heater and flue substantially as installed.

[50] Apart from those tests, the available evidence is the opinions of the experts. Mr Cruickshank's opinion as to the effectiveness of the flue was expressed in his brief in these terms:

73. When first lit, the products of combustion would hit the first flue restriction (the small diameter and shape of the adapter) and spill into the room as they could not all escape up the flue. They need to be unrestricted to do so. If the wind and atmospheric conditions were favourable, the flue may have worked for a while. This is shown by the fact there was some soot present at the top of the flue and is also shown by Arie de Kort's testing of the appliance, which was done on a fine day 20 degrees and little wind. If the air cools, or there is some rain, or change in wind direction, then there is little chance this flue would work properly. Considering heating is generally used in winter time, which is when this flue is least likely to work, there is a high chance of the flue not working at all for extended periods.

[51] Mr Gilmour accepted that the flue system as installed would operate less efficiently than a flue system properly installed in accordance with the regulations and with the manufacturer's instructions. He considered that the flue system had several deficiencies which had varying levels of significance in their effect on flue draught and the heater performance and safety. He rated their percentage influence as follows:

The sharp transition section	40 %
No insulation in loft	20
Non aerated front burner	8
Flue terminal below roof line	7
Crooked flue section in loft	5
Second transition piece	5
Smaller diameter flue	5
Lack of flue box	5
Anti draught cowl	5

[52] Those figures are of the percentage contribution of each of the defects to that lesser efficiency. Mr Gilmour did not attempt to quantify the extent of the lesser efficiency of this flue system in comparison to a properly installed flue system. The extent of the lesser efficiency is a critical aspect for determining the likely extent of spillage of exhaust gases into the room.

[53] Mr Howell's opinion is that the flue was likely to have been inefficient, but he thinks Mr Cruickshank has exaggerated the chances of the flue not working at all. He was cross-examined as to how he would rate the factors listed by Mr Gilmour. He would rate the sharp transition section as high as 60% of the total lowered efficiency. He would attribute about 10% to 15% to the smaller diameter flue.

[54] Mr Cruickshank's opinion on the amount of discharge into the room is summarised in his brief as follows:

It can therefore be seen that the fact that soot was present, and that this soot was dribbled down the outside of the heater **must** mean that significant quantities of CO were being discharged into the room. The quantum of CO is proportional to the type of flame, with significant quantities inevitably produced from the time yellow tipping is evident. This must have taken place over a period of time, as the thing that causes spillage is inadequate flueing, and the flueing did not change from day one until Arie de Kort extended it on 13 June 2001. If it ever discharged into the room (and there is still visual evidence that it did) then it must have done so from the beginning. In short, due to poor installation practices and an inappropriate adapter, the Cannon Coalridge Deluxe produced CO in large quantities. Due to poor flueing installed, much of this CO was inevitably discharged into the room.

[55] His response to counsel for the first defendant in cross-examination on the amount of spillage into the room was in the following terms:

Q I'm not necessarily accepting of anything you say about that Mr Cruickshank, but just so that we at least understand the sort of positions we're coming from, would you accept that whatever levels of carbon monoxide there may have been produced by the heater, would not be the same as the levels of carbon monoxide going into the room, if they were at all. There has to be some lesser level because some of it's going up the flue?

A. Yes, obviously that spilt into the room was minus that going up the flue, what I've said in my brief.

Q. Sure.

A. And I think I've hopefully made it clear, is that that would have changed depending on the circumstances and some occasions the heater may – the flue may well have worked very well and gone out, other occasions I believe it probably worked either not at all, or extremely badly, in which case, either all or a significant amount of that would have come into the room at that point and, again, no testing done at the time so we can't tell the exact amount and it differed from day to day, in circumstance to circumstance.

[56] Mr Gilmour's opinion as to the extent of spillage into the room must reflect his opinion, noted above, that soot (and as I interpret his evidence, CO) was produced only when the heater was first started from cold, and only when run on the two lowest settings.

[57] Mr Howell's comments on Mr Cruickshank's opinions on the issue of the likely spillage into the room were expressed in his brief in these terms:

8.23 As soot was produced, I believe it is likely that incomplete combustion occurred at times. Mr Cruickshank is correct when he describes that water vapour condenses in the flue, runs down and leaks out the back of the heater, leaving sooty dribble marks (his paragraphs 76 and 77). Water vapour also condenses in the appliance when first lit. Mr Cruickshank does not point out that this will happen in all heaters that produce soot, and that it does not mean large or significant quantities of CO are being produced. Mr Cruickshank says this is caused by the flue temperature dropping. But actually, this will happen to all appliances when first lit, before the flue has warmed sufficiently.

8.24 I cannot say how often or how badly the incomplete combustion would have occurred. I cannot say how much CO spillage there may have been into the room. Mr Cruickshank describes that "*when first lit, the products of combustion would hit the first flue restriction (the*

small diameter and the shape of the adapter) and spill into the room as they could not all escape up the flue” (his paragraph 75). This is true, but is it also true that most heaters produce CO spillage when first lit. It always takes time for the flue to heat up and begin to draw properly.

- 8.25 Mr Cruickshank says he thinks there was little chance that Ms Pickard’s flue would work properly in poor weather conditions, and a high chance of it not working at all for extended periods in winter (his paragraph 75). I believe the flue was likely to have been inefficient but I think Mr Cruickshank has exaggerated the chances of the flue not working at all
- 8.26 Mr Cruickshank believes that CO “must” have been discharged in “large” or “significant” quantities. In my opinion, he does not have a proper basis for reaching those conclusions. I believe that the inefficient functioning of the flue, combined with the presence of the elongated yellow flame and soot, indicate it was possible that elevated levels of CO were being discharged. But I cannot say that the CO levels were likely to have been “large” or “significant”. It is certainly not true that they “must” have been.
- 8.27 Arie de Kort’s correspondence indicates that he carried out several tests on the installation at the house. He says that on 4 July 2001 “*I also checked the working of the flue system with smoke pellets and found the flue working very well*”. On 23 April 2002 he undertook several tests and found “*good draught*” with an extended flue terminal and “*medium-low draught*” with a low terminal, both with the windows open and closed.
- 8.28 Mr Cruickshank criticises Mr de Kort for not using correct terminology or scientific measurements using proper instruments (Mr Cruickshank’s paragraph 81). It is true that the field tests used by Mr de Kort’s tests used appropriate field equipment, and do provide a guide to the operation of the installation. Mr de Kort followed the manufacturer’s instructions. He recorded that “*No smoke was detected with the Bacharach smoke tester. The tester was used as recommended by the manufacturer*”.
- 8.29 Mr de Kort’s tests were undertaken in mild weather conditions. It is possible that the results could have been different in poor weather. Mr Cruickshank thinks there was little chance that the flue would work properly in poor weather conditions, and a high chance of it not working at all for extended periods in winter (his paragraph 75). I believe Mr Cruickshank is exaggerating. While it is possible the results could have been worse in poor weather, they may not have been worse by much.

[58] The plaintiffs’ case and Mr Cruickshank’s evidence rely heavily on the proposition that there is evidence of spillage of exhaust gases into the room from the presence of soot. If there were evidence of airborne soot within the living space of the room, then that would be cogent evidence of a spillage of exhaust gases into the

room. I find no evidence of any airborne soot within the room. There is clearly evidence of airborne soot within the flue system (including the transition piece). That is, as I have held, evidence of the existence of CO, but it is evidence only of the presence of CO within gases contained within the flue. It is not evidence of gases entering the room.

[59] The only evidence of soot outside the flue system, and below the base of the downdraught diverter, are streaky soot marks down each side of the downdraught diverter on the back of the appliance. I have already set out Mr Cruickshank's opinion that the fact that soot was present and that this soot has dribbled down the outside of the heater must mean that significant quantities of CO were being discharged into the room. I do not accept Mr Cruickshank's view that the streaking soot marks are evidence of discharge of CO into the room. Those are clearly marks made by soot borne in condensed water vapour. The soot has clearly been carried out of the flue system by condensate, not by combustion gases. Mr Gilmour's opinion is that these stains were caused by soot depositing and condensation forming on the downdraught diverter and draining down the back. They are more indicative of soot carried and deposited by liquid than by gas. He observes that the area below the gas outlet is quite clean. Mr Gilmour's evidence on this point accords with my own observation and views, and I prefer his opinion.

[60] Several of the witnesses for the plaintiffs have relied upon suggestions that soot had been found on the windows of the lounge. There is no evidence to that effect. The suggestion of soot on the windows originated from some ambiguous remarks attributed to Mr Jackson in some notes of unknown provenance by an unknown author. Mr Jackson gave evidence. He denied having found soot. I find that there is no evidence of any airborne soot at any point outside the flue system, below the outlet of the draught diverter. As Mr Gilmour noted, the area below the outlet is quite clean.

[61] Another matter relevant to whether CO has entered the room in significant quantities is the Oxygen Depletion Sensor (ODS). That safety device is designed to shut down the gas supply to the heater in the event the oxygen level in the room drops below a certain preset point. It is supposed to activate if there is excess

spillage of combustion gases into the room. It would be expected to activate in the event of spillage and a consequent build up of carbon dioxide (a major component of the combustion gases). There is no evidence that this sensor ever activated so as to shut down the heater. Mr Gilmour's opinion is that there are two possible reasons. The first is that there was nothing to cause it to do so; the second is that it was not working properly. He had seen no evidence to suggest it was not working and, in the light of his conclusions as to the likely amount of CO spilling into the room, the more likely explanation is that it did not operate because there was nothing to cause it to do so. Mr Cruickshank suggested that the way the ODS operates, means that it may not cut off the supply of gas if sufficient heat is retained, even in circumstances where the sensor has activated to the extent of extinguishing the pilot light which operates the ODS. He says that these devices are not foolproof or failsafe and they do sometimes continue to operate even if the oxygen depletes below the level set.

[62] I consider that the lack of any evidence that the ODS has operated to shut down the heater on any occasion weighs against a finding that it is more likely than not that there have been frequent and substantial discharges of combustion gases into the room.

[63] Assessing all of the evidence, I find that the plaintiffs have failed to establish that it is more likely than not that frequent and substantial discharges of combustion gases containing CO into the room, from the draught diverter outlet, have occurred.

Levels of carbon monoxide in the room

[64] Assuming that there was some discharge of combustion gases containing CO into the room, it is necessary to consider what effect that would have on the levels of CO in the air in the room as breathed by the occupants. Mr Cruickshank's evidence is that any combustion gases entering the room would mix quite readily with the air in the room and that it would be well mixed within about five minutes. Mr Gilmour undertook some calculations to estimate the extent to which spillage of combustion gases containing CO would convert to CO levels in the air within the room. His calculations were necessarily theoretical, because of the absence of reliable data as to

the composition of the combustion gases, and the extent of spillage of combustion gases into the room. He calculated the volume of combustion gases which would be produced by the operation of the heater, with both burners operating and with only the front burner operating. His calculations indicated that with both burners operating the heater would produce 7.39 cubic metres of combustion gases in one hour. With one burner operating, the figure would be 3.23 cubic metres.

[65] He assumed a room volume of 108.3 cubic metres. That figure was apparently based on some information in an earlier report prepared by ESS. Mr Gilmour did not himself measure the room. Mr Cruickshank did measure the room. His measurements of the room gave a total volume of 66 cubic metres, plus 4.68 cubic metres in an alcove which was, for air circulation purposes, effectively part of the room. That gave a total volume of 70.68 cubic metres, some of which would be displaced by furnishings and other items in the room. There is no evidence to suggest that Mr Cruickshank's measurements are not correct and I accept them. I consider it appropriate, in applying Mr Gilmour's calculations and methodology, to use a room volume of 70 cubic metres rather than his figure of 108.3.

[66] Mr Gilmour made some assumptions about the composition of the products of combustion, (which I have termed the combustion gases). He assumed a CO content of the combustion gases of 1090 parts per million (ppm) at setting 5 on the heater (that is, the highest setting, with both burners operating) and 552ppm for setting 2 (a low setting with only the front burner operating). Those figures represented the highest CO content for combustion gases from a Coalridge heater which were available to Mr Gilmour. They were derived from tests which Mr De Kort had conducted on another Coalridge heater in Waikanae, where problems had been experienced. They are theoretical, in that they do not purport to represent a likely level of CO in the combustion gases from Ms Pickard's heater. Mr Gilmour describes them as assuming a worst case. Mr Gilmour then calculated what the CO levels in the air in the room would be on various different assumptions as to, first, the proportions in which the combustion gases were vented into the room and up the flue and, second, the rate of change of air within the room as a result of adventitious ventilation, with all doors and windows closed.

[67] Mr Cruickshank was critical of Mr Gilmour's calculations as being unrealistic in certain respects. It is true that the calculations are not realistic, in the sense of illustrating a likely actual level of CO in the room from the combustion gases of Ms Pickard's heater. However, as I have said, there is no evidence of the actual levels of CO in the combustion gases from that heater at any point in time. Nor is there any evidence of the actual level of spillage of combustion gases into the room at any point in time. The only purpose for which I find that Mr Gilmour's figures are of assistance is to indicate the relationship between the CO content of the combustion gases and the CO content of the air in the room. I regard his calculation as a helpful aid to understanding the likely order of magnitude of that relationship. In the absence of any better information, I consider that Mr Gilmour's use of the levels measured at Greenaway Avenue is useful for that purpose.

[68] Mr Cruickshank also criticised the figures which Mr Gilmour used, in the spreadsheet he developed for his calculations, for the percentage of carbon dioxide in the combustion gases, and the ratio between those two gases, derived from the carbon dioxide and CO figures used by him. Mr Cruickshank's evidence is that, if the CO content was 1090ppm, the CO₂ content must necessarily be less than 6.5%, so the two figures cannot both be correct. The figure of 6.5% CO₂ in the products of combustion was the percentage measured by Mr De Kort in his testing at Greenaway Avenue. The ratio figures of 0.168 and 0.0085 represent the ratios of 6.5% CO₂ to 1090ppm CO and 6.5% CO₂ to 552ppm CO respectively. Mr Cruickshank's criticisms appear to me to be valid. However, they do not affect the calculations for the purpose for which I find Mr Gilmour's figure useful. The CO₂ content, and the ratio, although included in Mr Gilmour's spreadsheet, are not used in the calculation of the CO emission figure, nor are they used in the calculations to determine the way in which a CO emission figure would convert to CO in the room. The relevant figure for Mr Gilmour's calculations is the CO content of the combustion gases. He used figures of 1090ppm and 552ppm. Based on the other evidence which I have discussed, there is no evidence from which a reliable estimate could be made. I regard a CO content at those levels in the combustion gases as representing worst case scenarios as to the production of CO by Ms Pickard's heater at the settings used by Mr Gilmour in his calculations.

[69] Mr Gilmour's calculations are very sensitive to changes in the rate of air change in the room (which is affected by the amount of adventitious ventilation and if air used in combustion by the heater) and in the spillage rate (which reflects the effectiveness of the flue). In his spreadsheet gave alternatives for the rate of air change in the room, ranging from 0.1 to one volume change per hour. This was an old house which had been relocated onto the site. Mr Gilmour said that he had chosen one because that is about the order of air change likely for the heater running on full setting and pulling in dilution air. Mr Howell said in response to a question from me that, from a range of 0.1 to 1 volume change per hour, he thought that in the case of the older house it would be towards the top end of the range. In assessing Mr Gilmour's calculations, I think that it would be appropriate to look at the results which apply for a rate of air change of one volume change per hour.

[70] Mr Gilmour included alternative spillage rates from the flue, ranging from 10% per hour to 100% per hour. I have discussed the evidence as to the effectiveness of the flue. There is no test evidence which provides a useful assistance in assessing the likely spillage rate per hour. In Mr De Kort's tests, results of low to medium draught were obtained. Mr Howell of GasLabs conducted tests on three different types of flueing system. Those showed spillage at relatively high rates in the first four or five minutes after start up until the flue system had heated so as to become effective, those then dropped to very low rates. Those tests were not conducted on the flue system installed in Ms Pickard's house, nor with Ms Pickard's heater with the transition piece. The only tests which Mr Howell carried out on Ms Pickard's heater were done with a different flue and, importantly, with a new flue transition piece. I am unable to draw any conclusion as to the likely rate of spillage from Ms Pickard's heater from those tests. The test results do, however, make it clear that the effectiveness of the flue system would have to be very significantly lower than the intended efficiency to produce spillage rates of even 10% over one hour. A spillage rate of 10% over one hour would mean that the flue was totally ineffective for six minutes, or that its efficiency was so reduced as to allow 10% of the flue gases to escape, for the whole hour. A spillage rate of 20% over one hour would be extremely high, and a rate of 100% over one hour would mean that the flue was totally inoperative. I consider that, in assessing Mr Gilmour's calculations, it would be more realistic to look at a spillage rate of 10%.

[71] Mr Gilmour's figures (corrected to a room volume of 70m³) suggest that if the CO content of the combustion gases was 1090ppm, the spillage rate was 10% and the room ventilation rate was one room volume change per hour, the steady level of CO in the room with the heater operated on the high setting, would reach 11.5ppm. If the spillage rate was 20 percent, the steady level of CO in the room would reach 23ppm.

[72] Mr Gilmour's figures demonstrate to me that, for CO levels in the air in the room to reach levels which might be harmful to health (as I later discuss), the heater would have to be producing high levels of CO for long and continuous periods, the efficiency of the flue would have to be reduced to very low levels for long and continuous periods, and the room would have to remain enclosed, with levels of adventitious ventilation at lower levels than might be expected, for long and continuous periods.

[73] The plaintiffs have failed to adduce evidence sufficient to lead to findings that such a combination of circumstances is more likely than not to have occurred. I consider it unlikely on the evidence that, on a worst case scenario as to the amount of CO produced, harmful levels of CO in the room air would have resulted.

Dr Penney's evidence

[74] The principal expert evidence called on behalf of the plaintiff on the mechanism and effects of CO poisoning is that of Dr Penney. The defendants objected to the admissibility of his evidence. In a ruling given at the start of the trial, I ruled that his evidence could be given, but in doing so I made no formal ruling as to its admissibility. I reserved the question of the admissibility of all or part of his evidence for consideration and determination in this judgment. The defendants' objections challenged Dr Penney's qualifications to give expert evidence on the topics on which he has expressed opinions. They further submitted that the opinions proffered by Dr Penney did not meet the substantial helpfulness test in s 25 of the Evidence Act 2006. I must have regard to both of those aspects when considering his evidence. In addition, I must, if his evidence is admissible, make the usual assessment of the weight which I should attach to his evidence, and whether I accept

his evidence or not. Those three issues: expertise, substantial helpfulness and weight, are separate, but closely related. In considering Dr Penney's evidence, I have regard to all three considerations.

[75] Dr Penney holds a BSc degree from Wayne State University, Detroit, Michigan in 1963, and MSc and PhD degrees from the University of California in 1966 and 1969. From 1969 to 1976 he was an Assistant Professor in the Department of Biological Sciences at the University of Illinois. From 1977 to 1991 he was an Associate Professor at Wayne State University School of Medicine and held short-term adjuncts appointments in other university and hospital posts. From 1991 until 2006 he was a Full Professor in the Department of Physiology in the School of Medicine at Wayne State University. From 1994 until 2006 he was also Director of General Surgical Research for the Departments of Surgery, Physiology and Research and Medical Education at Providence Hospital in Southfield, Michigan. He is a member of a number of professional bodies including the American Physiological Society, the Society of Toxicology and the American College of Surgeons. He has a particular interest in specialisation in the physiological effects of CO, hypoxia and cyanide since the early 1970s. His first peer reviewed paper on CO was published in 1971. In 1974 he obtained a research grant to study the chronic effects of CO on the heart and he has also undertaken extensive research and study on all aspects of CO and in particular CO toxicity. Since then he has published 65 peer reviewed research articles on the subject of CO toxicology, other non-peer reviewed papers and articles and has edited and been the major contributing author to four books on the subject of CO toxicology. He has been, and is, an advisor to national and international government and non-governmental agencies in matters involving CO. He has been a consultant for 30 years to the US Environmental Protection Agency providing advice on appropriate CO standards for outside air and other aspects. He has since 1997 been assisting the WHO in setting internationally accepted CO standards for both outdoor and indoor air. He is currently a member of the Indoor Air Quality Committee of the WHO, the function of which is to set international standards for indoor air quality. He has provided advice and opinions to a range of entities and has given evidence in many cases. He says that it would be not an exaggeration to say that all of his professional life has been and still is focused on CO and CO toxicity.

[76] Dr Penney was first contacted by Ms Pickard in May 2003 and he gave some preliminary advice. He heard from her again in 2008 and she requested an opinion. He considered a good deal of material which was supplied to him. He visited New Zealand in July 2009 and conducted clinical interviews of Ms Pickard and Troy and also personally interviewed Ms Pickard's parents, her ex-husband, and Troy's former school teacher and headmaster. He visited the site and spoke with Mr Cruickshank. He also discussed the case with a colleague, Dr Helffenstein, a neuropsychologist in Colorado, USA, a colleague with whom he has collaborated on many occasions in the past. The material which Dr Penney has reviewed, includes the various medical reports and records for Ms Pickard and Troy, including reports from the various medical experts called by the defendants.

[77] Dr Penney described the methodology by which toxicologists such as himself set about proving or disproving causation in cases of alleged toxic exposure or poisoning. Dr Penney's methodology is based upon the work of Bradford-Hill. In his evidence, Dr Penney draws a distinction between the methodology which he adopts and diagnosis and differential diagnosis under the traditional medical approach. He expresses the opinion that the determination of cause is more appropriately conducted in the realm of science, in disciplines such as physiology, toxicology and epidemiology, rather than in the realm of clinical medicine. On these topics his evidence is at odds with that of Dr Gorman and it is appropriate to defer an examination of Dr Penney's evidence on this aspect.

[78] Dr Penney explained his methodology when requested to provide toxicological opinions concerning CO exposure. He obtains a personal and situation history from the person who claims to have been exposed to CO, reviews all available records - including medical, educational, work social, vocational records - as well as records in documents concerning the possible sources and nature of the alleged exposure. He interviews the person concerned and has that person, and other close to them, complete detailed questionnaires which have been developed by him over many years of experience in the field of toxicology. In this case, his investigations comprised reading and analysing a considerable amount of written material, and visiting New Zealand in July 2009. He conducted clinical interviews with Miss Pickard and Troy and interviewed Miss Pickard's mother and father, her

ex husband and Troy's former school teacher and headmaster. He also spoke with Mr Cruickshank at Miss Pickard's home. He showed him where the gas fire had been located and demonstrated how Mr Cruickshank alleges it was improperly installed and how CO and other toxic gases were released into the room over the period 1998 to 2001. He saw the allegedly undersized flue and allegedly inappropriate adaptor and saw the soot build up evident in the flue and in heavy streaks down the back of the heater. Dr Penney states that careful analysis of the evidence as to how and to what extent it is alleged that Miss Pickard and Troy were exposed to CO₂ is crucial to coming to any meaningful conclusion about causation of symptoms and is critical of the defendant's medical evidence for apparently not having done that analysis.

[79] Dr Penney's analysis of the evidence is, necessarily, based upon his discussions with others. Some of those whom he has interviewed, and whose reports he has reviewed, have given evidence in this case. Any opinion expressed by Dr Penney based upon that material is dependent upon whether their evidence is accepted. I discuss the evidence of other witnesses elsewhere. For Dr Penney, the relevant question is whether the expression of an opinion on whether or not there has been an emission of CO from the heater into the room, and the extent, both in time and in level of concentration, is a matter which falls within the range of matters on which he is qualified to express an opinion based on his own specialised knowledge or skill based on training, study, or experience. To the extent that any opinion which he expresses on this issue is based on facts outside the general body of knowledge that makes up his expertise, that fact must be proved by other evidence.

[80] I find that Dr Penney is not qualified to express an opinion on whether there has been any emission of CO from the heater. Dr Penney does not profess any specialist expertise in the operation of gas fires, or in the combustion of the natural gas by which this heater was fuelled. His knowledge of circumstances is almost entirely dependent upon what he was told by others. His own examinations have not been directed to the observation of issues which are within any field of expertise which Dr Penney professes. The only physical sign upon which he relies, from his own observation, is the presence of soot on the heater itself and in the flue. In response to questions from me at the conclusion of his evidence, it was clear that the

only statement which he was able to make from that is that one cannot have the production of soot without there having been CO produced at the same time. He was unable to assist on the question of whether there is any scientific method by which the rate of production of soot and the rate of production of CO can be correlated.

[81] I also find that Dr Penney's expertise in relation to the health effects of CO does not qualify him to express any opinion as to whether there has been an emission of CO from the gas fire. His evidence is that the symptoms of CO poisoning are non specific: that is, the symptoms are such that there may be other causes, apart from CO poisoning. The only measurable "marker" of CO poisoning is an increase in the level of carboxy haemoglobin (COHb). COHb has a half life of only some hours, and it is not possible to measure COHb levels more than a few hours after an exposure to CO has ended. There are no other measurable "markers" of an exposure to CO. In the course of questioning at the end of his evidence I asked Dr Penney if whether, in his analysis of a case of potential CO poisoning, it might be possible or permissible to reach a conclusion as to whether there had been an exposure to CO by reference to the health effects suffered by the person concerned. He confirmed that that was not his approach.

[82] I consider that it must clearly be the case that it is not possible to determine, from the symptoms exhibited by Miss Pickard and Troy, that they have been exposed to CO. Because, on Dr Penney's evidence, the symptoms and health effects of CO poisoning are non specific, the most that could be drawn from the symptoms and health effects is a conclusion that those were consistent with CO poisoning. Dr Penney agreed, in response to a question from me, that it would be necessary to have evidence which established independently of the state of health of the person concerned that that person had been exposed to CO. For these reasons, I consider that Dr Penney is not qualified by reason of any specialist expertise which he has to express an opinion on whether or not Miss Pickard and Troy have been exposed to CO emanating from the gas fire in their home.

[83] The question whether the plaintiffs have suffered from CO poisoning requires an examination of the symptoms suffered by the plaintiffs, and a consideration of the cause of those symptoms. The defendants submit that, in venturing an opinion on

the symptoms exhibited by the plaintiffs, Dr Penney is venturing into the field of medical diagnosis. They submit that that is a field in which he is not qualified to express opinions. They go further and submit that in undertaking a diagnosis Dr Penney will be in breach of the regulatory framework governing medical practice in New Zealand.

[84] In his methodology, Dr Penney had the plaintiffs complete questionnaires in which they answered quite detailed questions about their health history. His opinions as to their symptoms are based in large part upon the answers to those questionnaires.

[85] I do not consider that there is a valid distinction, on the aspect of his methodology which is directed to ascertaining the symptoms exhibited by the plaintiffs, between Dr Penney's investigations, and a medical diagnosis. In my questions to Dr Penney at the conclusion of his evidence I asked him to clarify in what way his examination of the question of whether the symptoms which may be the result of CO poisoning but may have other causes, differ from the process which a medical practitioner would undertake in seeking to identify the cause of those symptoms so as to make a diagnosis. Dr Penney said that he does not think that most medical practitioners actually think about cause but said that he was not sure that it would be any different in that respect. I consider that the objection made by counsel for both defendants is a valid one, in so far as it relates to Dr Penney's identification of the symptoms exhibited by the plaintiffs. I consider that that exercise does involve undertaking a diagnosis, which is a matter within the proper province and expertise of a medical practitioner. On that basis, Dr Penney's expression of an opinion on this evidence is outside the scope of his expertise and is not an opinion which he is qualified to proffer.

[86] If I am wrong in that, then I would, if the evidence were properly admissible, attach limited weight to Dr Penney's opinion. Dr Penney's questionnaires presume that there has been an exposure to CO, and are directed towards obtaining answers from the subject as to the subject's state of health before and after that point in time. The results are dependent on the accuracy of the description of the symptoms. For the reasons I later give, I do not have confidence in Ms Pickard's self-reporting.

Harmful levels of carbon monoxide

[87] The evidence as to the level of exposure which may cause harm is equivocal. The only reliable marker for an exposure to CO is the level of COHb in the blood. The absorption of CO into the body by the formation of COHb is temporary. The elimination of CO from the body is measured as a half life, which is the time it takes for half the gas in the body to be eliminated. The half life is only a few hours. Measurement of levels in cases of chronic exposure is difficult as a result.

[88] Dr Penney's evidence is that there is no reliably established or generally recognised dose response relationship for CO effects on human health. He says that there is a poor relationship between COHb symptoms and prognosis. In cross-examination a study was put to him which it was contended showed that there is a good correlation between COHb levels and the outcome for the persons exposed. He responded that other studies have shown the correlation is not good.

[89] Dr Richardson's evidence is that the CO levels required to give overt symptoms of CO poisoning are usually about 70ppm. He says that the first symptom usually complained of is a headache and these are commonly experienced with levels of around 70ppm.

[90] In referring to COHb levels as a guide to the level of CO exposure, Professor Gorman notes that COHb levels measured at the time a person is treated often do not correlate well with reported symptoms. He gives several reasons for that. There is usually a time lag between the exposure and the measuring of the COHb levels. Oxygen therapy, often used to treat CO exposure impacts on COHb levels, and symptoms are frequently caused by other inhaled and ingested agents in addition to CO (particularly in cases where the CO exposure has resulted from an attempted suicide). He expresses the opinion that despite those issues COHb levels do remain a guide to the level of CO exposure. Professor Gorman says that increasing sedation is seen in people at levels of COHb of greater than 12% to 15% and consciousness is lost at about 20%.

[91] The WHO Environmental Health Criteria 213 Carbon Monoxide (Second Edition) published in 2004 provides:

Carboxyhaemoglobin levels below 10% are usually not associated with symptoms. At higher carboxyhaemoglobin saturations of 10-30%, neurological symptoms of carbon monoxide poisoning can occur, such as headache, dizziness, weakness, nausea, confusion, disorientation and visual disturbances. Exertional dyspnoea, increases in pulse and respiratory rates and syncope are observed with continuous exposure, producing carboxyhaemoglobin levels from 30% to 50%. When carboxyhaemoglobin levels are higher than 30% coma, convulsions and cardiopulmonary arrest may occur.

[92] It is difficult to correlate COHb levels with the level of CO exposure required to cause those levels. The WHO document provides recommended guidelines as follows:

The following guideline values (ppm values rounded) and periods of time-weighted average exposures have been determined in such a way that the carboxyhaemoglobin level of 2.5% is not exceeded even when a normal subject engages in light or moderate exercise:

100 mg/m³ (87 ppm) for 15 min
60 mg/m³ (52 ppm) for 30 min
30 mg/m³ (26 ppm) for 1 h
10 mg/m³ (9 ppm) for 8 h

[93] The WHO guidelines appear to be formulated at a precautionary level, in that they are fixed at a level which would avoid COHb levels which are only one-quarter of the minimum likely to be associated with symptoms.

The mechanism of carbon monoxide poisoning

[94] Dr Penney gives an overview of CO and CO poisoning in general and the science of CO poisoning, in particular chronic poisoning. CO is a colourless odourless non-irritating gas with about the same specific gravity as air, produced as a by-product of the combustion of carbon containing compounds. It is undetectable by humans. Exposure to CO concentrations of 500 parts per million in air can be lethal over a period of several hours. Dr Penney's evidence is that levels of CO higher than 9 parts per million over 8 hours are known to cause health harm to some percentage of the human population. CO exposure is generally termed either acute

or chronic. Acute CO exposure is one that occurs for 24 hours or less, chronic CO exposure is for more than 24 hours whether continuous or discontinuous.

[95] The mechanism of CO poisoning is not well understood and the experts disagree on important aspects of it. Dr Penney's evidence is that the binding of CO with haemoglobin, to form COHb, reduced the uptake of oxygen in the blood, resulting in a decrease in arterial oxygen saturation, leading to hypoxic stress. He says that the toxic effects of CO cannot be explained by this process alone. He says:

37 ... this hypoxic process is hard pressed to account for the phenomenon of damage at low CO levels or for the well-known phenomenon of delayed neurological sequelae.

38 Research suggests that the intracellular uptake of CO is a major cause of neurological damage (i.e. brain damage). When CO binds to cytochrome oxidase, it causes mitochondrial dysfunction. The release of nitric oxide (NO) from platelets and endothelial cells inside blood vessels, forming the free radical peroxynitrite, further inactivates mitochondrial enzymes and damages the vascular endothelium (i.e. lining of blood vessels) of the brain.

39 The end result is lipid peroxidation of the brain, which starts during recovery from CO poisoning. With reperfusion of the brain, leukocyte adhesion and the subsequent release of destructive enzymes and excitatory amino acids all amplify the initial oxidative injury. Recent studies suggest that such endovascular inflammation may be a major mechanism leading to organ dysfunction. The general name for these mechanisms of cell/tissue damage is referred to as "oxidative stress".

...

42 The newly discovered pathologic mechanisms, involving cascades of biochemical reactions, mainly and initially inside blood vessels, that results in inflammation of the endothelial lining, interference with blood flow, then leading to embolism and even total blockage of large and small arteries/arterioles, as well as autoimmune reactions. The operation of these pathways and their products explain the effects of CO at very low CO and COHb levels, or during extended CO exposure, and the seeming lack of a dose-response relationship between the concentration of CO inhaled (also blood CO level), and the immediate symptoms-signs and resultant long term health effects.

43 It is well accepted that acute high-level CO poisoning frequently produces gross neurological (movement, sensory, etc) sequelae, neurocognitive (learning, memory, judgment, etc) impairments and affective (psychiatric) changes.

44 A similar does of CO (dose equals concentration multiplied by duration of exposure) occurring over a longer period of time at a lower, non-lethal CO concentration, would be expected to and does produce similar health damage.

[96] Professor Gorman disagrees. He says that the hypoxic theory of CO poisoning has long been refuted. His evidence is that the body has a reflexive protective response to the hypoxemia caused by CO. As the oxygen content in blood reduces, the heart increases cardiac output to maintain oxygen supply to cells. That response is well regulated, and will prevent hypoxemia from causing hypoxia until the response is overwhelmed, at COHb levels of up to 70% to 80%, where unconsciousness and death is then sudden. Professor Gorman also says that the other theoretical mechanisms are not accurately described by Dr Penney, and that they are speculative. Of Dr Penney's evidence at paragraph 43 and 44 (set out above) Professor Gorman says:

This is incorrect. As I have explained brain injury and sequelae of the nature described by Dr Penney are rare even in cases of severe poisoning. Exposure to a lower CO concentration over a longer period of time is not known to produce effects equivalent to a severe acute exposure. I have already given the example of smokers, who are exposed to lower CO concentrations over time and are not known to suffer the syndrome described by Dr Penney

...

In paragraph 53 Dr Penney says: "It has been shown again and again that loss of consciousness is not required for the developments of brain damage or persistent neurological sequelae (PNS) following CO poisoning." Dr Penney does not say where this has been shown. In fact it is implausible that a brain injury would occur without loss of consciousness. I have already discussed the very high levels of CO required to overcome the body's protective response and cause brain injury. Such levels would be expected to result in deep unconsciousness.

Generally Dr Penney puts forward a theory that chronic low level CO exposure causes brain injury, in particular neuro-cognitive sequelae. This is not an accepted theory. It is inconsistent with my clinical experience of CO cases, and is not recognised in the leading publications in this field. Dr Penney's theory is not supported by the publications that he cites. I believe Dr Penney has misinterpreted these publications.

Potential health effects

[97] Dr Penney's evidence is that: "Symptoms and signs such as headache, nausea, vomiting, mental confusion, lethargy, and mood changes are experienced with both acute and chronic CO poisoning." Professor Gorman refers to the symptoms reported and seen in people who inhale CO as including fatigue, drowsiness, nausea, headache and dysarthria (difficulty forming speech). Dr Richardson describes the symptoms of chronic CO poisoning as vague and like symptoms common to viral infections. He says that they include headache, odd chest pains, sleep and memory disturbances, palpitations, blocked or runny nose, increased tiredness, nausea, vomiting, diarrhoea and dizziness. I find that symptoms of the sort described are a possible consequence of exposure to harmful levels of CO which are less than a level which may cause loss of consciousness or death.

[98] There is disagreement on the extent to which these symptoms may persist beyond the exposure to CO. Dr Penney says that headache, fatigue, tiredness, dizziness, balance problems and shortness of breath frequently continues for weeks, months and years after termination of exposure. He says that this is also true for chest pain and muscle and joint pain. Professor Gorman's evidence is to the effect that symptoms such as those which he describes as consistent with those reported and seen in people who inhale CO will resolve very quickly once the person is away from the source of CO. He expressly disagrees with Dr Penney's opinion that the symptoms described by him may continue for weeks, months and years after termination of exposure. He says that the effects of CO are present and at their worst when the CO is actually being inhaled and that even in a case of severe poisoning and deep unconsciousness, withdrawal of the gas usually results in awaking and a rapid and complete recovery. In his opinion, the case of smokers illustrates the absence of sequelæ from chronic low level exposure. He notes that cigar smokers frequently have COHb levels of greater than 10% and heavy cigarette smokers frequently 5-10%. He notes that neurocognitive syndrome (ongoing brain effects) are not seen in smokers at what he says are essentially sub-sedating and anaesthetic levels of CO exposure.

[99] I consider that the evidence establishes that an exposure to a level of CO which is of the order of magnitude described in the previous section of this judgment dealing with harmful levels is capable of causing the type of symptoms described in [97], so long as the exposure persists and for a short time thereafter. These symptoms, if suffered, would not result in significant pain or suffering, or significant loss of function, such as would lead to any significant award of damages if liability for the exposure could be established. I do not consider that the evidence establishes on the balance of probabilities that such relatively minor symptoms would lead to long term sequelae which persisted for a lengthy period after the exposure had ceased.

[100] Dr Penney suggests there may be more serious long term consequences from chronic exposure to CO by reason of potential neurological and cognitive impairment. His evidence refers to residual cognitive deficits found in memory, ability to focus attention and concentrate on the work at hand, in following directions, and in making decisions. He also refers to behavioural, emotional and personality changes including anxiety and panic attacks, sleep problems, depression and mood swings, irritability and problems flowing from those. He also refers to a spectrum of visual and hearing changes, taste and smell, and proprioceptive changes and gross neurological changes including gait disturbance, speech impairment, tremor, and seizure which he says frequently occurs.

[101] Professor Gorman disagrees with Dr Penney. He says that the incidence of brain injury which can cause residual neurocognitive effects is very rare and probably no more than 5% of cases, even in cases of severe poisoning. His opinion is that sequelae of the nature described by Dr Penney would only be expected in a case of severe poisoning causing brain injury. Professor Gorman's evidence is that brain injury and sequelae of the nature described by Dr Penney are rare even in cases of severe poisoning, and that exposure to a lower CO concentration over a longer period of time, is not known to produce effects equivalent to a severe acute exposure.

[102] I am not persuaded, by Dr Penney's evidence, that it is more likely than not that long-term neurological or cognitive impairment may result from an exposure to CO which is at a level which may cause the short-term effects I have discussed. I

consider that cogent evidence would be necessary to establish that an exposure which was sufficient to cause only the relatively minor symptoms referred to in paragraph [97] might nonetheless have long-term sequelae in the form of neurological damage. I do not regard the studies upon which Dr Penney relies as establishing a proper scientific basis for the proposition that such damage is possible. I prefer Professor Gorman's evidence on this issue.

Health effects for Ms Pickard and Troy

[103] It is necessary to examine closely the evidence as to Ms Pickard and Troy's health. I consider that the most relevant period is that during which the alleged exposure to CO existed. The heater was installed in September 1998. It was not used after Mr De Kort had directed that it should not be used in July 2001. Accordingly, the focus must be on that period between September 1998 and July 2001.

[104] The primary evidence of their health in that period is derived from two categories of evidence. The first is the evidence of Ms Pickard, Troy, and Mr Pickard as to their health in that period. The second is the contemporary medical records of consultation with medical practitioners in that period. It is desirable to set out in some detail the medical records for Ms Pickard's and Troy's attendances over that period. This proceeding necessarily places their medical histories in the public arena, to some extent. I consider it desirable to preserve, to the extent possible, the privacy of Ms Pickard and Troy on medical matters. For that reason, the details are set out in an appendix to this judgment. That appendix is to be made available only to the parties. I direct that the appendix is not to be made available publicly. Any request for access to it must be the subject of an application under r 3.13 of the High Court Rules. For completeness, I give a similar direction in respect of access to all medical records of the plaintiffs produced in evidence, whether in the agreed bundle of documents or otherwise. My reasoning in respect of the records is set out in abbreviated form in this section of the judgment.

[105] The medical records were not supported by oral evidence from any of the attending doctors. Dr Tyler was not called. Counsel explained that she had retired

from practice. In opening, counsel for the plaintiff indicated an intention to call Dr Smith, but he was not called by the plaintiff. Counsel explained that the reason was that there were enough doctors saying they had CO poisoning, they did not need another. He was called by the first defendant, to address a specific point which I address in paragraph [108].

[106] The recitation of the principal medical records in the appendix needs to be read alongside Ms Pickard and Troy's evidence as to their medical situation over the period. In this case, it is very apparent to me, having listened to Ms Pickard for well over two days in the witness box, that she has a fixed and unshakeable view that she has suffered CO poisoning, and that a wide range of adverse health effects have resulted. Ms Pickard believes, with absolute certainty, that their health problems are the result of exposure to CO from the heater. She developed that conviction at a very early stage. In a letter to Mr Bowkett, the paediatric surgeon who had attended to Troy, dated 28 July 2001, she said:

We are very fortunate to be alive. It is quite obvious to me that what I have been making excuses for over the past 3 years where mine and Troy's health is concerned is that we have both been suffering the effects of the carbon monoxide in the lounge.

[107] Her conviction as to the cause of their health problems has dominated her approach to the essential question of causation. She is unable to conceive of the possibility that the health problems may not have been caused by exposure to CO. She regards any medical records which might suggest otherwise as irrelevant or wrong. That approach has bedevilled the discovery process in this case, to the extent that discovery issues remained outstanding up to and including trial. They remained unresolved necessitating a pre-trial application only two months before trial, resolved only by a judgment of the Court of Appeal very shortly before trial. Discovery issues remained live even at trial.

[108] The extent to which her conviction as to cause has affected her approach was dramatically illustrated by an incident at trial. The records of PMC originally discovered commenced with an entry on 16 August 1999. A follow up by counsel for defendant with Dr Smith, as part of the discovery process directed by the Court of Appeal, indicated that there were two earlier entries on 17 March and 22 June

1999. These records are described in the appendix. Dr Smith was called (under subpoena) to explain that discrepancy. His evidence was:

On about 14 September 2004 I received a letter from Ms Pickard's then legal advisors, Phillips Fox, requesting copies of Ms Pickard's medical notes.

I subsequently sought Ms Pickard's permission to send the medical notes requested to Phillips Fox. Ms Pickard requested that I first send to her the copies of her medical records that I was proposing to send to Phillips Fox.

Ms Pickard advised me that she felt that it was not relevant to send the consultation notes relating to her marital separation, i.e., the notes that I made of her attendances on me on 17 March and 22 June 1999. These are the notes that appear in the bundle.

I then sent Ms Pickard's medical notes to Phillips Fox, up unto, but not including those made, on 17 March and 22 June 1999.

[109] Ms Pickard might initially have thought that not all of her medical records for the relevant period were relevant in the proceeding. She could not reasonably have retained that view until trial. A dispassionate and objective consideration of the lengthy interlocutory battles over discovery could have left no doubt that all medical records had to be disclosed. The fact that Ms Pickard was prepared to go to the lengths of suppressing details of her medical history is a matter of significant concern to me in considering the extent to which I may properly place reliance on her evidence on their health aspects. Ms Pickard's conviction as to the cause of her health problems is so strong that it must necessarily affect the reliability of her evidence, and the weight which I can properly attach to it. I can have no confidence whatever that Ms Pickard's evidence as to her and Troy's health problems is not significantly coloured by her conviction.

[110] This is illustrated by her evidence concerning the level of stress imposed by her separation. There are references in the records of three medical centres, JMC, PMC and KCAMC, to anxiety and stress from Ms Pickard's domestic and marital situation. Ms Pickard believes, with absolute certainty, that her marital situation was not responsible for any health issues. When she was cross-examined on references to her marital situation in her medical records, her answers suggested that the records did not accurately record what she had intended to convey to the doctors. The following exchange in cross-examination by counsel for the first defendant illustrates that:

- Q. All Dr Bolton's doing is recording what you must have told him. There'd been a recent marital separation?
- A. No, he's written his words hasn't he, so I think we'll leave it there. These are other people's words aren't they, they've typed up their notes.

Ms Pickard's responses on other aspects of the medical notes where possible alternative causes for particular conditions were suggested were to similar effect.

[111] Another reason for my lack of confidence in the reliability of Ms Pickard's evidence is that there are references by several doctors to the difficulty in obtaining an accurate medical history from her, and to her inability to describe symptoms in an objective way. Medical reports from 1987 to 1989 record reactions to symptoms and discomfort as "a little inappropriate" and "a little excessive"; a reference to it being "hard to separate the psychological overlay from what is probably genuine complaint"; a reference to "probably a large functional component" and "I think Ms Pickard rather tends to exaggerate in a rather grandiose manner her symptoms, but I am sure there is an organic basis to her problem". There are instances in the records of the possibility that all available information has not been made available to treating doctors. It would be inappropriate to attach weight to these necessarily second hand comments, on their own. But I am required to make my own assessment of Ms Pickard's reliability in her description of symptoms and medical conditions. The impression which I have formed as I have described gives rise to similar concerns to those which the doctors have raised. I have taken that into account in reaching the views which I have about Ms Pickard's reliability on these matters.

[112] A further relevant factor is that Ms Pickard in her brief said that she found it difficult to recall exactly how she was feeling, and that her memories are based mainly on flashbacks and medical records.

[113] These factors, and particularly my own assessment of Ms Pickard as a witness, lead me to place very limited reliance on Ms Pickard's own descriptions of her health issues in the relevant period. For these reasons, I find the medical records

more reliable than Ms Pickard's evidence. Where there is a conflict, I prefer the medical records.

[114] The reservations which I have expressed about the reliability of Ms Pickard's evidence do not extend to the entirety of her evidence. In some areas, I have found her a credible witness. As this judgment shows, I have accepted her evidence on some aspects, sometimes in preference to that of other witnesses.

[115] Ms Pickard's evidence concerning Troy's state of health is similarly affected by her strong views on the matter. By way of illustration, I refer to the evidence concerning Troy's projectile vomiting. A temporal relationship between the projectile vomiting and the use of the heater was suggested. Ms Pickard and Troy both indicated that this had continued throughout the period when the heater was operating. The medical records do not support the contention that the problem began when the heater was installed. There are several records of episodes of vomiting in medical consultations before the heater was installed. Ms Pickard asserts that those episodes were quite different in nature. Her conviction as to the cause of Troy's problems leads me to doubt her evidence on that point. There are also records of consultations over headaches before the heater was installed.

[116] The medical records also do not support the proposition that the projectile vomiting continued to the end of that period. They indicate that this had resolved in January 2000. Ms Pickard's explanation is that Troy was so traumatised by testing that no further tests were done. I do not accept her evidence on that point. I do not consider that, in the light of Ms Pickard's tenacity in pursuing other unresolved medical issues, such as the eye problems which followed her accident in 1988, she would have allowed Troy to continue to suffer severe projectile vomiting without seeking further medical assistance. I find it more likely that the medical records correctly record that that problem was resolved by January 2000. I am unable to discern a temporal relationship between Troy's symptoms of headaches and vomiting and the use of the heater.

[117] Another feature of the difference between the medical records and Ms Pickard and Troy's evidence that his health problems persisted throughout the

use of the heater, is that, after January 2000, there is only one substantive entry in the medical records, of a visit to PMC on 28 December 2000 (a time when the heater is unlikely to have been in use). This absence of medical consultation throughout 2000 and 2001 is in contrast to Ms Pickard and Troy's description of ongoing medical problems throughout the period.

[118] Troy in his evidence described symptoms of a range of incidents after the use of the heater had stopped in July 2001. He described incidents such as panic attacks while travelling to school, and loss of energy and breathlessness on the sports field. These health problems in that period cannot be the direct result of an exposure to CO, since the use of the heater had ceased. I do not find any reliable evidence that physical consequences of this sort may be a delayed consequence of CO exposure. I have earlier discussed the respective opinions of Dr Penney and Professor Gorman on the possible long term consequences. On this aspect, I prefer the evidence of Professor Gorman.

[119] The only other eye witness evidence of Ms Pickard's and Troy's state of health over the period when the heater was operative is that of Mr Pickard, and Troy. Ms Garberra, who gave evidence by video link of her knowledge of Ms Pickard over some 40 years, was not in New Zealand at any time in that period. Mr Pickard's evidence of health effects is of a general nature, and is not sufficiently specific to provide what I could regard as a useful and reliable supplement to the medical records. Troy was aged between seven and nine years at the time. His evidence of his own and his mother's health is, on my assessment, so likely to be influenced by the extremely strong views which his mother holds on the topic that I do not place reliance on it.

[120] An important plank in the plaintiffs' claim that they are victims of CO poisoning is the proposition that they both suffered similar symptoms, at times when the heater was in operation, and that these resolved over the summer months. The medical records do not on my analysis of them disclose such a pattern. Any evidential support for that proposition must therefore be based on Ms Pickard's and Troy's evidence. For the reasons I have given, I do not find their evidence reliable as establishing such a pattern. The extent of Ms Pickard's conviction as to the cause

of their health problems, and the extent to which Troy is likely to share his mother's conviction, are such that their perceptions of a pattern in their health issues are not, on my assessment, reliable. Professor Gorman, in his extensive review of the medical records, did not discern a temporal relationship. His review indicated to him that the medical records show pre-existing patterns of illness in Ms Pickard and Troy which predate the putative CO exposure. I agree with that assessment.

[121] It is necessary at this point to mention the cat. Dr Penney's evidence suggests that a pointer to CO poisoning may be that several occupants (including pets) of a house with a CO exposure may demonstrate similar symptoms. Troy's evidence is that the household got a kitten in April 1999, that it suffered health problems, and that it died in November 2003. There is no evidence as to the cause of the health problems. The cat died long after the use of the heater had ceased. It would be pure speculation to find any connection between the ill-health and subsequent death of the cat and CO poisoning.

The Expert Medical Evidence

[122] A number of medical practitioners were called. For the plaintiff, I heard evidence from Dr Newburn, a neuropsychiatrist who had examined and reported on both Ms Pickard and Troy in June 2007. I also heard from Ms Cunningham, a clinical psychologist and neuropsychologist who conducted a neuropsychological assessment on Troy in October 2004. Dr Richardson is a specialist paediatrician who saw Troy and Ms Pickard in June 2002 to review Troy's possible CO poisoning. Dr Dodwell is a registered medical practitioner and occupational physician who was asked to give an opinion in respect of Ms Pickard and Troy's claim regarding alleged chronic CO poisoning.

[123] Several medical practitioners gave evidence for the defendants. They had examined Ms Pickard and Troy pursuant to orders made by this Court under a judgment delivered on 14 April 2008. Dr Marks is a psychiatrist who examined Ms Pickard. Professor Gorman had earlier be instructed by the defendants and reported in June 2004, without at that stage having the benefit of consultation with Ms Pickard or Troy. He saw them both in May 2008 and reported on their medical

condition, in particular the suggestion that they have suffered injury by CO. Dr Hosking is a psychologist and neuropsychologist who saw Ms Pickard and Troy in May 2008. She administered assessments and reported on them. Dr Moir is a consultant child, adolescent, and general psychiatrist. He saw Troy and Ms Pickard in May 2008 and provided a report on Troy.

[124] I review the evidence of those medical practitioners as appropriate below. Some general preliminary observations are however appropriate.

[125] As I have noted, there are no clear “markers” for CO poisoning. All of the potential health consequences are non specific. They are of a nature which may have causes other than CO exposure. That means that the most that any practitioner can say about Ms Pickard and Troy’s symptoms is that they are consistent with CO poisoning. Whether that is in fact the cause must depend upon whether there is evidence to establish that there has been exposure to CO.

[126] All of the practitioners were given information by Ms Pickard to support her contention that she and Troy had been exposed to CO from the heater. I consider that in large measure the different opinions expressed by the practitioners on issues of causation are reflective of the extent to which the practitioners have, or have not, accepted her descriptions and the evidence given to them as establishing that there had been an exposure to CO. Speaking very generally, the experts called by the plaintiffs have accepted the descriptions, and have accepted as a fact that there was an exposure to CO. The practitioners called by the defendants have been less accepting of that proposition.

[127] In saying that, I do not intend to imply any criticism of any of the experts involved. Medical practice is heavily reliant upon patient histories and the usual source of such history for a medical practitioner will be the patient. However, the question of whether there was or was not CO exposure is squarely in issue in this case and it is one which must be decided by me. To that extent, I am in a better position than any of the medical experts to assess whether or not that has occurred.

[128] Another broad area of difference between the medical experts is that the witnesses for the defendants have been more focused on other possible causes than those for the plaintiff. For a diagnosis to be made, it is appropriate for the practitioner to be concerned to look at all possible causes, and to eliminate other possible causes before a diagnosis can be made. Before this process could be undertaken in this case, it is necessary to establish CO poisoning as one of the possible causes. Because the symptoms are non specific, the existence of the symptoms themselves cannot establish CO poisoning as a possible cause. That must be established by other evidence. I have held that the other evidence fails to establish CO poisoning as more likely than not.

[129] My conclusion that exposure to CO at a level sufficient to cause health effects has not, on the balance of probabilities, been established, renders the medical evidence largely irrelevant. The medical diagnosis of CO poisoning rests upon a factual foundation which is not made out. However, I do not consider it is in this case appropriate to deal with the matter on that basis. I consider that it is desirable in all the circumstances to undertake a review of the evidence. That will however, be at a level less extensive than would have been necessary had I concluded that there had been an exposure to CO, and it were necessary for me to determine whether that exposure had been the cause of the various health effects alleged.

[130] Dr Dodwell expressed the opinion that there is evidence satisfying the balance of probabilities that Ms Pickard and Troy were exposed to excessive levels of CO from a gas fired heater in their home and that as a consequence they suffered a variety of short term and long term disorders consistent with this exposure having been the cause. That is an opinion going to the essential issues in this case. Under s 25 of the Evidence Act, the fact that it goes to an ultimate issue does not render it inadmissible, but it does mean that I must for myself assess very carefully the validity of the opinion. To do otherwise would be to abdicate my responsibility to make the appropriate findings. It is sufficient to note that Dr Dodwell's opinion as to exposure must necessarily be entirely dependent upon the evidence of others. I do not regard that conclusion as being one which Dr Dodwell is able to reach from any expertise specific to his own field of practice. His consequent conclusion that they suffered a variety of short term and long term disorders consistent with the exposure

having been the cause is also necessarily not an opinion on which I may properly place reliance.

[131] Dr Richardson's opinion is that the symptoms displayed by Ms Pickard and Troy are fully in keeping with chronic CO poisoning. That goes no further than establishing that they are consistent with that. It is clear from cross-examination of Dr Richardson that his opinion was influenced by his understanding both mother and child seemed to have symptoms when they were in the house that improved when they left the house. That was based on what he was told by Ms Pickard. My review of the medical records does not lead me to the conclusion that there is such a pattern to their symptoms.

[132] Dr Newburn assessed Ms Pickard on the basis that there had been an exposure. He said: "Specifically, my report addresses the issues of the consequences, from a neuropsychiatric perspective, of Amanda Pickard's exposure to elevated levels of CO over a period of approximately three years from 1998 to 2001." He examined Ms Pickard against the criteria in DSM-IV and reached the conclusion that she was suffering from post traumatic stress disorder. The diagnostic criteria for that condition are as follows:

- A. The person has been exposed to a traumatic event in which both of the following were present:
 - (1) the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others
 - (2) the person's response involved intense fear, helplessness, or horror. **Note:** In children, this may be expressed instead by disorganized or agitated behaviour

[133] One of these criteria is that the person has been exposed to a traumatic event. I raised that with Dr Newburn in these terms:

- Q. Can you define for me what, in your view, is the traumatic event to which Ms Pickard was exposed.
- A. The traumatic event is the exposure to carbon monoxide poisoning and the consequences of that, which of course is a post hoc awareness of the event.

[134] That answer neatly encapsulates the difficulty which I see in assessing Ms Pickard's condition after July 2001. Her conviction that she has been subject to CO poisoning is so strong that it is impossible to distinguish between the consequences of CO poisoning and the consequences of her belief in CO poisoning. Dr Marks, who examined her on behalf of the defendants pursuant to an order to that effect, diagnosed Ms Pickard as having a generalised anxiety disorder, panic disorder without agoraphobia and unexplained cognitive impairment. He did not consider that she has post traumatic stress disorder, essentially because of the absence of a traumatic event. He also said: "Her apparent post trauma symptomatology is possibly caused by her anxiety and beliefs rather than actual trauma."

[135] My conclusion that it is impossible to distinguish between CO poisoning and a belief in CO poisoning means that I do not find it necessary to discuss the other evidence concerning Ms Pickard's condition after July 2001. I am left in no doubt that Ms Pickard has suffered consequences from these events which have dramatically affected her life, and significantly disabled her. My conclusion that an exposure to CO has not been established, coupled with my conclusion that Ms Pickard's conviction that she has suffered CO poisoning is deep and unshakable, lead me to conclude that to the extent that her disabilities are attributable to the events surrounding the heater, they result from her perception that she has been subject to CO poisoning, not from the actuality of an exposure to CO.

[136] Ms Cunningham assessed Troy, and found him to have an impairment of his cognitive skills. She found the impairment consistent with brain injury caused by exposure to neurotoxins. Her testing showed that on tasks requiring perceptual analysis and reasoning abilities, Troy had above average skills. On simpler tasks requiring those abilities his performance became less effective and showed subtle impairments as task requirements increased in complexity. On planning and reasoning tasks he was able to complete them to within an average to above average range. Subtle difficulties were evident with more abstract visual reasoning tasks requiring him to perceptually analyse and integrate information. Difficulties were evident on some aspects of attention abilities with his achieving only average scores of some tasks. On tasks which provided an overall measure of working memory capacity and processing and response speed he only achieved mid average scores.

This reflected a relative impairment or different in comparison to other skills and is consistent with brain injury effects from neurotoxicity. In response to a question from me, Ms Cunningham said that the test results were outside the normal variation of what one would find in the normal population with some cause, or without a specific disorder.

[137] Dr Hosking is also a neuropsychologist. She assessed both Ms Pickard and Troy pursuant to the order made on the defendants' application. Because Troy was several years older at the time of her testing, she undertook tests appropriate to an adult rather than to a child. That makes a direct comparison between her testing and that of Ms Cunningham more difficult. She found that on formal testing he demonstrated fluctuating attention and concentration evident on tasks. Examining sustained attention alternating attention and working memory. Her conclusion was that his current neuropsychological profile reflects subtle cognitive difficulties. She considered that the subtle difficulties demonstrated by him in the course of the neuropsychological assessment may be attributable to another cause such as psychological factors or possible could reflect his pre-morbid neuropsychological profile.

[138] I find both Ms Cunningham and Dr Hosking to be reliable witnesses whose opinions are entitled to considerable weight. I do not consider that, on essential aspects, there is a great difference in their views as to the extent, as opposed to the cause, of any disability which Troy has. Whether or not there was CO exposure is a matter on which they have no expertise or personal knowledge. I have particular regard to their opinions on the nature and extent of Troy's disabilities. The deficits indicated by testing were subtle. They are at the margin between the normal range of differences within a normal psychological profile, and a mild psychological disorder. Dr Moir in his consideration of the reports of both Ms Cunningham and Dr Hosking, expressed the opinion that the variability did not differ from the pattern seen in the testing of normal individuals. The assessment of Troy's pre-morbid condition, by both Ms Cunningham and Dr Hosking, was to some extent influenced by their understanding that Troy had attended a school for gifted children. It appears however, that there was no aptitude testing requirement for enrolment, so that the assessment of a child as gifted was not based on objective criteria. The uncertainty

as to his pre-morbid condition adds to the difficulty in determining whether there is any impairment.

[139] My conclusion that the plaintiffs have not established, on the balance of probabilities, an exposure to harmful levels of CO precludes any finding that any impairment which Troy may have is a result of CO poisoning. Such limited impairment as may be shown by the testing by both neuropsychologists is explicable by other causes or, potentially, depending on the assessment of his pre-morbid condition, as not the result of any specific neurological impairment. Having carefully considered the evidence I am unable to find that Troy has any clearly identifiable neuropsychological impairment.

[140] The symptoms displayed by Troy may have a psychological origin. Dr Moir, a child, adolescent and general psychiatrist who examined Troy under the Court order for the defendants, considers Troy to have suffered from a Generalised Anxiety Disorder and Panic Disorder without Agoraphobia. He considers that to be a more accurate diagnosis than PTSD. Dr Moir refers to Troy's strong conviction that his symptoms were caused by CO exposure. Given Troy's age at the time, and the strength of his mother's conviction on this point, that is not surprising. As in Ms Pickard's case, I do not consider that it is possible to make a meaningful distinction as to the nature of the psychological consequences based on whether there was actual exposure, or an absolute and complete conviction that there was exposure.

[141] Dr Moir says that a finding that Troy will be prevented from working will be horrifying, and a grave disservice to Troy. Based on the evidence I have heard, I would go further. I consider that a finding that Troy has a permanent psychological or neurological impairment would be a grave disservice to him. Troy is clearly an intelligent young man, capable of succeeding in life to a high level. He has clearly been seriously traumatised by the events of the past eight or nine years. But a finding that the trauma has led to a permanent loss of his ability to function at the level inherent in his natural abilities would be unjustified. It would blight Troy for life. That would be wrong.

[142] Professor Gorman's opinion is that overall, the nature of the symptoms in Ms Pickard and Troy is inconsistent with CO poisoning. The plaintiffs criticise Professor Gorman as lacking independence or impartiality, and requiring too high a standard of proof. I did not find Professor Gorman to be lacking in independence or impartiality. I have found his opinions helpful. The standard of proof is for me. My consideration of the evidence leads me to the same conclusion as Professor Gorman, namely that the symptoms are, overall, inconsistent rather than consistent with CO poisoning. That would, if it were necessary to make a finding, lead me to a finding that Ms Pickard and Troy had not established that it was more likely than not that any health problems have been caused by CO poisoning.

[143] I have reached that view after taking into account the evidence of the medical experts called by the plaintiffs in support of the proposition that Mr Pickard's symptoms, and Troy's, are the result of CO poisoning. I have found that the plaintiffs have failed to establish, on the balance of probabilities, a harmful level of exposure to CO. None of the symptoms which are described by any of the medical practitioners are specific to CO poisoning. The most that any of the medical practitioners can properly say is that they are consistent with CO poisoning. The symptoms are incapable, by themselves, of proving that there has been exposure. Nor are they capable of supplementing evidence of exposure which falls below establishing, on the balance of probabilities, that there has been exposure, so as to take the case above the requisite level of proof. All of the doctors who have expressed that opinion are doctors who first saw Ms Pickard or Troy after she had come to believe, with the level of certainty I have previously discussed, that she had been exposed and that her symptoms were the result of that exposure. The medical witnesses are almost entirely reliant upon descriptions by Ms Pickard. For the reasons I have given, I regard those descriptions as unreliable.

[144] I therefore do not find anything in the medical evidence which might, if added to the other evidence concerning possible exposure to CO, assist in taking the plaintiffs' contention that there has been spillage of CO from the heater into the room at harmful levels from a point well below the balance of probabilities to a point where the balance of probabilities is satisfied.

Conclusions

[145] From the foregoing discussion a number of propositions can be summarised. First, there were breaches by Mr Ambrose of his obligations to Ms Pickard to perform the work in a proper and workmanlike manner. Second, these breaches may have led to combustion gases escaping into the room on some occasions, but I am unable to determine, on the balance of probabilities, that this has occurred, or the extent of any such escape. Third, the combustion gases would, and at least at times, have contained CO, but I am unable to determine these levels. Fourth, the quantity of CO possibly emitted into the room would not, on the balance of probabilities, be likely to have reached levels which might cause harmful health consequences. Fifth, the evidence does not establish, on the balance of probabilities, that Ms Pickard or Troy have suffered a pattern of symptoms or sequelae of a type known to be consistent with CO exposure throughout the period of use of the heater. Sixth, the long-term consequences which they have suffered after use of the heater ceased are equally consistent with a belief in exposure to CO.

[146] In the light of these conclusions, it is not possible to find, on the balance of probabilities, that Ms Pickard or Troy have suffered any damage from Mr Ambrose's breaches which give a remedy in damages.

Result

[147] For these reasons, the plaintiffs' claims must fail. There must be judgment for the defendants.

[148] Costs are reserved.

“A D MacKenzie J”

Solicitors: M D Lloyd, Barrister, Auckland, for Plaintiffs
Young Hunter, Christchurch, for First Defendant
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