Commonwealth of Australia
Patents Act 1990 (Cth)
Regulation 22.13 of the Patents Regulations 1991

IN THE MATTER of Australian Patent Application 2016202508
in the name of DOW AGROSCIENCES LLC

- and -

Opposition thereto by NUFARM AUSTRALIA LIMITED

DECLARATION

I, Phillip Maxwell Hay, of 42 Cooloongup Crescent, Harkness, in the State of Victoria, Australia, declare as follows:

1. I made a previous Declaration in this proceeding on 28 May 2018 together with annexures "PMH-1" to "PMH-31" thereto ("**my First Declaration**"). I make this further Declaration on behalf of Nufarm in support of its opposition against the grant of a patent on Australian Patent Application 2016202508 ("**the opposed Patent Application**"). The numbering for the annexures referred to in this Declaration follows on consecutively from the numbering used for the annexures of my First Declaration. In addition, I use the defined terms from my First Declaration in this Declaration.

MY EXPERIENCE

2. My experience remains unchanged from my First Declaration and I remain an employee of Nufarm.

MY INSTRUCTIONS

3. I have been provided with a copy of evidence filed by Dow Agrosciences LLC being a Declaration of Terry R. Wright dated 23 August 2018 together with Exhibits "TRW-1" to "TRW-14" thereto ("**the Wright Declaration**"); a Declaration of David G. Ouse dated 27 August 2018 together with Exhibits

"DGO-1" to "DGO-4" thereto ("**the Ouse Declaration**") and a Declaration of Norman R. Pearson dated 23 August 2018 together with Exhibits "NRP-1" to "NRP-4" thereto ("**the Pearson Declaration**"). I have been asked to read these Declarations and provide my views.

4. In making this Declaration I will seek to address the Wright; the Ouse and the Pearson Declarations to the extent that I consider it relevant to the main issues in dispute in this proceeding. My decision not to comment on all the statements made in the Declarations either in part or in full should not be taken as an indication of my agreement with that evidence generally or the comments made therein.

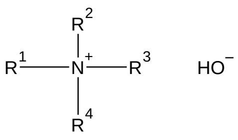
5. The publications and other documents to which I refer in this Declaration and which are identified by the designation "**D-[numbered]**" are annexed to the Statement of Grounds & Particulars dated 28 February 2018.

6. Arcadia Intellectual Property has reminded me of my obligations in respect of my engagement as an expert witness to give evidence in this proceeding. In so doing I have reread Annexure A to the Expert Evidence Practice Note as issued by Chief Justice Allsop of the Federal Court of Australia on 25 October 2016 titled "Harmonised Expert Witness Code of Conduct" which is marked Annexure PMH-2 to my First Declaration.

PRELIMINARY COMMENTS ON THE WRIGHT, THE OUSE AND THE PEARSON DECLARATIONS

7. At the outset I believe that it is again worth noting that the claims of the opposed Patent Application are directed to an herbicidal composition comprising the reaction product produced by the process of:

- combining 2,4-dichlorophenoxyacetic acid and a (tetraalkyl) ammonium hydroxide; in which the (tetraalkyl) ammonium hydroxide is compound of the formula



$$R^1\text{—}\overset{\overset{R^2}{|}}{\underset{\underset{R^4}{|}}{N^+}}\text{—}R^3 \qquad HO^-$$

wherein when R^1, R^2 and R^3 are methyl, R^4 is not methyl; and

- isolating the reaction product, thereby producing the herbicidal compound.

8. The structure of the (tetraalkyl) ammonium hydroxide in Claim 1 encompasses all conceivable (tetraalkyl) ammonium hydroxides in combination with 2,4-dichlorophenoxyacetic acid, with the sole exception of (tetramethyl)ammonium hydroxide (which is excluded by the statement that when R^1, R^2 and R^3 are methyl, R^4 is not methyl). Conceivable quaternary ammonium hydroxide compounds that can be combined are those where the substituent groups bonded to the nitrogen atom are sterically compatible and the rules of chemical bonding and strain energy are satisfied.

9. The structure in Claim 1 extends well beyond the description at line 21 on page 3 to page 4, line 3 of the opposed Patent Application which limits the (tetraalkyl) ammonium hydroxide structure to one in which:

   - R^1, R^2 and R^3 independently represents $(C_1\text{-}C_{16})$alkyl or any two of R^1, R^2 and R^3 represent $–(CH_2)_n$- where n is an integer from 3-5;
   - R^4 represents a $(C_1\text{-}C_{16})$alkyl or arylalkyl

   where “alkyl” groups may be substituted by any group including halogen, hydroxy, alkoxy or alkylthio and “arylalkyl” refers to a C_1-C_4 alkyl group substituted with an aryl group (the aryl group being phenyl, indanyl or naphthyl). Further the “aryl” groups may be substituted by one or more substituents selected from halogen, hydroxyl, C_1-C_6 alkyl or C_1-C_6 alkoxy (see page 2, lines 21 to page 3, line 4 of the opposed Patent Application). The structure claimed in claim 1 includes (tetraalkyl)ammonium hydroxides which do not fulfil these limitations. Further, I note that the reference to any two of R^1, R^2 and R^3 represent $–(CH_2)_n$- where n is an integer from 3-5 as defined in claim 2 is unclear.

10. When I first considered the clarity of claim 1 (and claims 3 and 7) in my First Declaration it was my view that the claim was unclear. In particular it was not clear to me whether the claim was directed to:

- a) a composition of matter, being for a herbicidal compound comprising the reaction product produced by combining 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium hydroxide, of specified structure, and isolating the reaction product, thereby producing the chemical compound but which could be manufactured by any method including the methods provided at page 9 of the opposed Patent Application, or

- b) a product by process whereby the reaction product is produced by a specific method of combining 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium hydroxide of a specified structure, and isolating the reaction product, thereby producing the chemical compound, and not by any alternative method of manufacture.

11. To the extent that the evidence of Dr. Wright, Dr. Pearson and Mr. Ouse relies on the proper understanding of Claim 1, I believe that it is necessary to decide which of the alternatives described in paragraph 10 apply to claim 1 before responding to the Applicant's evidence.

12. When I consider the responses of Drs. Pearson and Wright and Mr. Ouse to paragraph 230 of my First Declaration it is my view that the Applicant's experts do not address the issue with any clarity. If it is the case that Dr. Pearson and Mr. Ouse consider that alternative 10(b) is what the claim is directed to then for the reasons provided below this will raise other issues regarding what are the limitations on the claim.

13. In respect of Dr. Wright's evidence I note that he was not asked to comment on paragraph 230, and I find nothing in his evidence which sheds any light on the issue.

14. Dr. Pearson, a named inventor of the opposed Patent Application, answers the question posed in my paragraph 230 in his paragraph 31. Dr. Pearson states that he is unable to understand the distinction I have made in

paragraph 230 of my First Declaration because when he reads claim 1 he does not consider that it includes alternatives. This is agreed. It is either alternative (a) or alternative (b) but not both. Dr. Pearson repeats the text of claim 1 which does not answer the question. Dr. Pearson does state that there is no additional limitation on the method used to prepare the reaction product and makes it clear with reference to page 8, lines 20 and 21 that the preparative methods provided on page 9 are for "illustrative purposes only and not to be construed as a limitation on the claims". So based on Dr. Pearson's comment, the question is what is the limitation on the claim. The only limitation on the claim is that a reaction product is produced by a process which is then isolated. For this process to occur, there must be a reaction and the only reaction that can possibly be described in the claim is a reaction of a (tetraalkyl)ammonium moiety with 2,4-D. So whilst in the claim 2,4-dichlorophenoxyacetic acid is combined with a (tetraalkyl)ammonium hydroxide, the hydroxide dissociates from the (tetraalkyl)ammonium moiety on addition to solvent (as any salt will do in solution) and does not take part in the actual process of making the final reaction product. It seems to me therefore that the only limitation on the claim is that a herbicidal compound comprises the reaction product of the reaction of 2,4-dichlorophenoxyacetic acid and a (tetraalkyl)ammonium moiety. Further, it also seems to me that by choosing to quote the passage from page 8, lines 20 and 21 in direct response to my paragraph 230, Dr. Pearson is saying that the claims are not limited to any of the methods shown in the Examples but includes all the methods described. It is noted that all of the methods on page 9 describe the reaction product of the reaction of 2,4-dichlorophenoxyacetic acid and a (tetraalkyl)ammonium moiety. Further methods 1 and 3 on page 9 describe isolation of the reaction product. This is reinforced when I consider Dr. Pearson's comments in paragraph 28 where in response to my statement in paragraph 229 of my First Declaration, Dr. Pearson makes it clear that he does not see there to be a need to identify which of the three methods on page 9 is the "best mode". From this I conclude that claim 1 (claims 3 and 7) is intended to have the meaning I have described in paragraph 10(a) whereby the claim is directed to a product by process being a chemical compound comprising the reaction product produced by the chemical reaction of combining 2,4-

dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety and isolating the reaction product, thereby producing the herbicidal compound; and which reaction product could be manufactured by any of the methods provided at page 9 of the opposed Patent Application or by any other method which produces the same chemical compound by reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety.

15. With respect to the Ouse evidence I see that in paragraph 45 Mr. Ouse, another named inventor of the opposed Patent Application, identifies the three preparative methods provided on page 9 and notes that "*<u>at least</u> the first method described on page 9, lines 2-8 of the Patent Application would result in a compound according to claim 1"* (my emphasis added). By using the words "at least" it seems to me that Mr. Ouse is not suggesting that the third preparative method described on page 9, lines 13 to 20, which includes an isolation step and reacts a 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety, cannot be used to make the chemical compound of claim 1 or that any other method which produces the same chemical compound by the same reactive process cannot be used.

16. When I consider claim 1 I note the opening words "herbicidal compound". The adjective "herbicidal" is derived from "herbicide" which is defined on page 4, lines 13-19 of the opposed Patent Application. The Chambers Dictionary of Science and Technology (Revised Edition) (1974) defines the term "compound" in the chemical sense as being a substance composed of two or more elements in definite proportions by weight, which are independent of its mode of preparation. Now produced and shown to me and marked **PMH-32** is a copy of the relevant extract from Chambers Dictionary of Science and Technology. This definition again leads me to conclude that claim 1 (and claims 3 and 7) is intended to have the meaning I have described in paragraph 10(a).

17. Thus by considering both the construction of Claim 1 and the evidence provided Mr. Ouse and Dr. Pearson I conclude that Claim 1 is directed to a chemical compound comprising a reaction product of the process of reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety and

isolating the reaction product, thereby producing the herbicidal compound; but which could be manufactured by any of the methods provided at page 9 of the opposed Patent Application, or by any other method which produces the same chemical compound. I note this construction of the claims offers the broadest protection to the Applicant.

18. In my evidence I use the common name 2,4-D to refer to 2,4-dichlorophenoxyacetic acid.

THE PEARSON DECLARATION

Scope and Overview of Dr. Pearson's Evidence

19. I note that Dr. Pearson was asked to comment on my evidence without limitation.

20. At the outset I believe that it is worth noting that Dr. Pearson appears to suggest in some parts of his evidence such as paragraph 57 that the herbicidal compound of the alleged invention may only be made by reaction of 2,4-D with a (tetraalkyl)ammonium hydroxide and not by the alternative "third" method. I have problems with this statement and refer to my comments in paragraph 14 above. The reaction to produce the reaction product is between 2,4-D and a (tetraalkyl)ammonium moiety. The presence of the hydroxide does not limit the process since it plays no part in the formation of the final product but merely dissociates in solution from the (tetraalkyl)ammonium moiety. It follows that the actual reactive process in method 1 and method 3 on page 9 is exactly the same and they both include isolation of the reactive product. The resulting reaction product produced by the preparative methods 1 and 3 on page 9 would be the same. In addition Dr. Pearson's view is contrary to the evidence of Mr. Ouse in particular paragraph 45 and contrary to the proper construction of the claims.

21. With the above in mind I turn to Dr. Pearson's evidence I make the following comments. My decision not to comment on all the statements made in the Pearson Declaration either in part or in full should not be taken as an indication of my agreement with that evidence generally or the comments made therein.

"Isolating"

22. I note that in paragraph 25 Dr. Pearson agrees with my description of "isolating" in paragraph 82 of my First Declaration. Dr. Pearson also accepts that the claims do not require the reaction product to be pure. I agree with Dr. Pearson's reliance on page 9, lines 6 to 8 that the reaction product "*may* be purified by known methods" if there is a need to do so. My comments equally apply to paragraph 33.

23. Therefore, it appears to me based on Dr. Pearson's comments in paragraph 25 that the phrase "isolation of the reaction product, thereby producing the reaction product" as provided in claims 1, 3 and 7 simply involves a process step that would be generally known and understood by those skilled in the art. I agree with Dr. Pearson's comments.

24. In response to Dr. Pearson's comments in paragraph 26 I note that the third preparative method on page 9 lines 13 to 22 which includes a step of isolating the reaction product could also be used to prepare a herbicidal compound of claims 1 to 7. I refer to my comments above in paragraph 20 for example.

25. I reject Dr. Pearson's comments in paragraph 27 that my assertions in paragraphs 74, 75 and 83 of my First Declaration are not relevant. In paragraph 31 Dr. Pearson makes it clear that the claims do not include an additional limitation on the method used to prepare the reaction product. I have already established above what those limitations are. Dr. Pearson also makes it clear with reference to page 8, lines 20 and 21 that the preparative methods provided on page 9 are for "illustrative purposes only and not to be construed as a limitation on the claims". In paragraph 27 Dr. Pearson states that it is generally understood by those in the art as to what is meant by isolating, and the opposed Patent Application includes "*an example of the reaction and isolation step, in addition to alternative methods*". In paragraph 28 Dr. Pearson makes it clear that he does not see there to be a need to identify which of the three methods on page 9 is the "best mode". Accordingly it follows that if my discussion in paragraphs 74, 75 and 83 of my First Declaration concerning the methods on page 9 is not relevant, then it seems to me that Dr. Pearson accepts that any of the three preparatory methods on

page 9 may be used to produce the herbicidal compound of claims 1, 3 and 7 or any other method which produces the same chemical compound by reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety. As stated this construction of the claims offers the broadest protection to the Applicant.

26. I have noted Dr. Pearson's comments in paragraph 30 in relation to what he considers to be the "evaporative removal" of the methanol solvent under vacuum. I simply note that the general method on page 4, lines 6 to 12 and the first and third method on page 9 all use the same isolation step to separate the reaction product from the methanol (and any water present).

27. I have made comments on paragraph 31 of Dr. Pearson's declaration above. My understanding is that Claim 1 is directed to a chemical compound comprising a reaction product of the process of reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety and isolating the reaction product, thereby producing the herbicidal compound; which could be manufactured by any of the methods provided at page 9 of the opposed Patent Application, or by any other method which produces the same chemical compound by reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety. I note this construction of the claims offers the broadest protection to the Applicant. In response to Dr. Pearson's comments, I agree that the general method provided on page 4, lines 6 to 12 and the first preparative method on page 9, lines 2 to 6 of the opposed Patent Application describe methods to prepare a herbicidal compound reaction product according to claims 1 to 7. However, for the reasons outlined above, equally the other methods of page 9 provide instructions on how to prepare the reaction product. In fact in paragraph 28 Dr. Pearson makes it clear that he does not see there to be a need to identify which of the three methods on page 9 is the "best mode" and therefore it must follow that if no particular preparatory method is to be preferred over another then the third preparatory method on page 9, which includes the same isolation step as the general method on page 4, lines 6 to 12 and the first method on page 9 can also be used to produce the herbicidal compound according to claims 1 to 7. Both

produce a reaction product by reaction of 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety.

Synthesis of 2,4-D salts

28. In response to paragraphs 37 to 39 of the Pearson Declaration whilst it is agreed that n-tetradecylamine is not a quaternary ammonium, I stand by my comments in paragraphs 54, 73 and 93 of my First Declaration. The first paragraph of the section entitled “B. Amine Salts” on page 117 of the “Phenoxyalkanoic Herbicides” text (PMH-16) footnotes “188-220” and pages 143 to 144 list relevant references to these footnotes. Reference 189 on page 143 is “Harwood, J., US 2,900,411” (PMH-18 to my First Declaration). As stated in paragraph 109 of my First Declaration, PMH-18 describes the development of compositions being the reaction of an aliphatic amine having at least 6 carbon atoms in an aliphatic radical with a plant hormone carboxylic acid such as 2,4-D to form the salt. PMH-18 describes the use of very routine standard laboratory techniques wherein equimolar amounts of the amine and the acid are reacted in a compatible solvent to precipitate the salt. Column 2, lines 26 to 33 of PMH-18 describes the amines which may be used as including “quaternary compounds, such as trimethyloctylammonium hydroxide and trimethyldodecylammonium hydroxide”. Likewise the reference 214 on page 144 is “May & Baker Ltd., Netherlands Patent 6,506,449, 1965” (PMH-17 to my First Declaration). As stated in paragraph 102 of my First Declaration page 5, lines 72 to 86 of PMH-17, being the GB equivalent of Netherlands Patent 6,506,449 and published in January 1967, describes a method of preparing the tetramethylammonium salt of 2,4-D which again involved the use of standard laboratory techniques. It follows that PMH-16 includes a reference to 2,4-D quaternary ammonium salts. I therefore stand by my comments in paragraphs 54, 73 and 93 of my First Declaration that it was very well known before February 2007 that as with like other amines, quaternary ammonium compounds could be readily formulated to form the corresponding salt of 2,4-D using standard laboratory techniques.

Vapour drift

29. I disagree with Dr. Pearson's comments in paragraph 40. Table 4 on page 317 of the paper by Que Hee and Sutherland (1974) (PMH-15 of my First Declaration) reports the vapour pressure of methylamine, dimethylamine (a secondary amine), n-butylamine, n-dodecylamine and n-tetradecylamine salts of 2,4-D and the volatilisation of these salts after 48 hours at 38°C, 0% relative humidity, based on measurements of ^{14}C ring labelled 2,4-D. I note that the volatilisation of the 2,4-D amine salts was measured using a similar bell jar experiment to that reported by Mr. Ouse at paragraph 59 of the Ouse Declaration. Most importantly, the concluding paragraph of PMH-15 states:

> "*The results in this paper show if vapor drift is important for 2,4-D type compounds, that this can essentially eliminated by the use of amine salts instead of esters, as the volatilities of salts measured here even with no formulation materials present, and using unrealistically high Q values, are less than 10% after 48 hr, by which time most of the salt impacted on plant leaves will have been absorbed".*

Accordingly the Que Hee and Sutherland paper showed that in 1974 the problem of vapour drift associated with 2,4-D esters had been addressed by the use of amine salts instead of esters. It is my view that the reference to amine salts in PMH-15 which refers to primary and secondary salts would include tertiary and quaternary ammonium salts as they are all ionic in nature. By contrast, 2,4-D esters are covalently bonded and do not dissociate to form ions in aqueous solution. In any event, other papers also teach minimization of vapour drift using quaternary ammonium salts. One such example is PMH-17 which describes the application of a herbicidal composition containing at least one quaternary ammonium compound of a benzonitrile derivative and a quaternary ammonium salt of 2,4-D to a crop-growing area as referred to above at page 2, lines 84 to 87 and the crops not suffering any substantial permanent damage (see page 2, lines 84 to 87; claims 23, 24 and 32).

Molecular weight of amine compounds

30. In paragraphs 41 to 46 Dr. Pearson discusses the volatility of amine salts of 2,4-D. I note that Dr. Pearson accepts that increasing the molecular weight within a class of compounds is a general trend known to reduce volatility (see paragraph 42).

31. It is my view that Dr. Pearson's analysis is flawed as he has only considered the behavior of quaternary ammonium salts of 2,4-D in solution. Dr. Pearson has not considered the effect of molecular weight on the vapour pressure of quaternary ammonium salts of 2,4-D *per se*. That is, Dr. Pearson discusses equilibria considerations in aqueous solution however he has ignored the spray application process described in the opposed Patent Application in which the herbicidal compound is dissolved in water and sprayed as fine droplets. The opposed Patent Application describes the application of the compounds and their compositions to kill and control undesirable vegetation by application of an herbicidal amount of the compound to the vegetation or to the locus of vegetation as well as soil prior to emergence of the vegetation and the compounds of the alleged invention are said to be generally applied as a spray (see page 4, lines 23 and 24 and page 11, lines 3 to 7). These droplets settle on either plant foliage or bare soil in proportions which depend on the foliage canopy of the area sprayed. At one extreme, a crop such as 2,4-D tolerant soybean may have a dense canopy which captures the majority of the applied droplets while at the other extreme an application on fallow involves application onto essentially bare soil with sparse remnant dried stalks or straw and young emerging weeds.

32. That is herbicides applied in water as described on page 8 line 12 of the opposed Patent Application and the examples forms droplets on the plant surface. This is described in Que Hee & Sutherland (1974) in column 1 (PMH-15). Water evaporates from the droplet, gradually concentrating the dissolved herbicide in solution. In dilute solution, as applied to the plant and before evaporation of water the salt is dissociated into the 2,4-D anion and the amine cation. Depending on pH a small amount of the 2,4-D anion may associate with a hydrogen ion (proton) to form 2,4-D acid. 2,4-D acid which

migrates to the air-water interface may evaporate. Likewise, primary, secondary and tertiary amines may lose a proton (hydrogen ion) to form the undissociated amine which may also evaporate from the air-water interface. As the droplet loses water the salt becomes more concentrated and eventually precipitated as the solid salt. Substantial quantities of free acid are not present in the dried deposit.

33. In the first case the spray droplets land predominantly on leaf surfaces and rapidly dry to form a solid deposit of 2,4-D primary, secondary, tertiary or quaternary amine salt, as described in D3 on page 1, lines 73 to 78. As a crystalline deposit, the dissociation mechanism described by Dr. Pearson would not occur. It would be the 2,4-D amine salt *per se* that evaporates.

34. In the second case, the droplets land on the bare soil and dissolve in soil moisture. At this point a large number of complex simultaneous equilibria occur, including

a) adsorption of 2,4-D anions and quaternary ammonium cations onto the charged sites on soil particles,

b) pH dependent absorption of non-dissociated 2,4-D acid onto soil organic matter,

c) reaction of 2,4-D with dissolved metal ions, such as calcium, magnesium and iron, to form insoluble salts of 2,4-D, and

d) ionic equilibria with other herbicides applied in conjunction 2,4-D (tetraalkyl)ammonium salts as described at lines 8 to 20 of page 5 of the opposed Patent Application. That is in soil there are many different ions, including metals such as iron, sodium, and calcium and charged particles (both anionic and cationic). Each charged entity will form equilibria with oppositely charged entities. The net effect of these many competing equilibria is that the volatility from soil is independent of the nature of the spray composition and also largely driven by environmental conditions (see Que Hee and Sutherland 1974 – PMH-15).

35. It is my view that the mechanism described by Dr. Pearson is not plausible in the environment envisaged by the opposed Patent Application, of spraying crops or fallow fields in the open air. I stand by my comments that the volatility of 2,4-D salts can be reduced by increasing the molecular weight of the amine base, including an ammonium base.

PMH-17

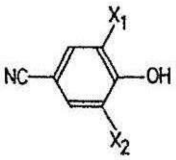
36. I disagree with Dr. Pearson's analysis of PMH-17 and it my view that he has conveniently ignored the fact that the opposed Patent Application including the claims (see claim 9) makes it clear that the claimed herbicides can be used in a mixture with one or more other herbicides *"to control a wider variety of undesirable vegetation"* (see page 5, lines 8 to 10). I also note Dr. Wright's comments in paragraph 29 of the Wright Declaration where he makes it clear that *"certain herbicides may exhibit two or more of the attributes identified in categories (a) to (h). For example, 2,4-D is translocated (category a), is selective (category c) in certain crops, is usually sprayed post-emergent (category g) and <u>is often in mixtures with other herbicides (category h)</u>"* (my emphasis added).

37. I also note the passage at lines 15 to 18 on page 5 of the opposed Patent Application states that *"[i]t is generally preferred to use the compounds of the invention in combination with herbicides that are selective for the crop being treated and which complement the spectrum of weeds controlled by the compounds at the application rate employed"*. I further note that the choice of "other herbicides" in these passages on page 5 is not restricted in any way to particular herbicides nor are any "other herbicides", such as for example hydroxybenzonitrile compounds, specifically excluded. This is also the case in respect of claim 9. With these comments in mind I turn now to Dr. Pearson's assertions in paragraphs 47 to 60 with respect to PMH-17.

38. GB1056235, which was published in January 1967 and which was referenced in the standard text "Phenoxyalkanoic Herbicides"; Chemistry, Analysis, and Environmental Pollution Volume 1 of (Pesticide Chemistry Series) S.S. Que Hee & R.G. Sutherland, CRC Press, 1981 (PMH-16), is directed to quaternary ammonium salts of benzonitriles and herbicidal compositions containing them.

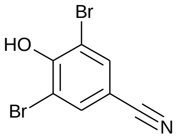
Page 1, lines 15 to 18 states that it was known that 4-hydroxybenzonitrile derivatives *"possess valuable herbicidal properties, particularly in the control of broad-leafed annual weeds in graminaceous crops*".

39. The structure of the 4-hydroxybenzonitrile compounds of PMH-17 is shown at line 12 as:

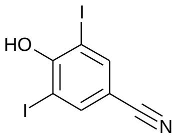


wherein X_1 and X_2 are the same or different, and each represents a bromine or iodine atom

40. I note that the two 4-hydroxybenzonitrile compounds of this structure specifically described in PMH-17 are bromoxynil and ioxynil. These have the following structures:



bromoxynil



ioxynil

I further note that both these herbicides were well known in the art well before February 2007.

41. Page 2, lines 78 to 87 of PMH-17 describes the quaternary ammonium salts of benzonitriles being particularly suitable for application to "crop-growing areas" i.e. areas on which crops are, or will be, growing and being applied at a rate such that the crops *"do not suffer any substantial permanent damage"*. Lines 88 to 98 describe the crops suitable for treatment as including graminaceous crops such as *"grasses, for example Poa species, Festuca species, Dactylis species, Lolium species and Agrostis species, sugar-cane and cereals, for example wheat, oats, barley, rye, maize, rice, millet and sorghum; legumes such as peas, beans, lucerne (alfalfa) and red and white*

clovers; flax; linseed; carrots, onions, and cruciferous crops such as kale, rape and cabbage."

42. I further note that Example II on page 4 commencing at line 60 describes the addition of *"quaternary ammonium derivatives of known phenoxyalkanoic acids"* (a second component) being mixed with the quaternary ammonium salts of 4-hydroxybenzonitrile. The known phenoxyalkanoic acids are described in PMH-17 as including *"MCPB [ɣ -(4-chloro-2-methylphenoxy)butyric acid], 2,4-DB [ɣ-(2,4-dichlorophenoxybutyric acid], MCPA (4-chloro-2-methylphenoxyacetic acid), 2,4-D (2,4-diclorophenoxyacetic acid, CMPP [α-(4-chloro-2-methylphenoxy)propionic acid]*(also known as mecroprop), *2,4-DP [α-(2,4-dichlorophenoxy)propionic acid]* (also known as dichlorprop), *2,4,5-T (2,4,5-trichlorophenoxyacetic acid), 2,4,5-TP [α-(2,4,5-trichlorophenoxy)propionic acid], α,α-dichloro-propionic acid and trichloroacetic acid"* (see page 4, lines 74 to 87 of PMH-17). I note that each of these herbicides are specifically recited on page 3, lines 5 to 15 of the opposed Patent Application.

43. Page 5, lines 1 to 8 of PMH-17 describes the second component as being used to control perennial broad-leafed weeds such as *Coltsfoot (Tussilargo farfara), Creeping Thistle (Cirsium avense), Perennial Sowthistle (Sonchus aervensis), field bindweed (Convolvulus avensis) and Docks (Rumex spp*.). I note that the Dock species (*Rumex obtusifolia*) was the broad-leafed weed used in the efficacy tests shown in Table II on page 11 of the opposed Patent Application.

44. Page 5, line 28 onwards makes it clear that the phenoxyalkanoic second component has the same quaternary group as the benzonitrile first component for ease of preparation and in this respect Example III of PMH-17 identifies the first component as the tetramethylammonium salt of 3,5-diiodo-4-hydroxybenzonitile (3,5-diiodo-4-hydroxybenzonitile is also known as ioxynil) and the second component as the tetramethylammonium salt of 2,4-D.

45. As stated in my First Declaration in PMH-17 the tetramethylammonium salt of 2,4-D was prepared by adding a solution of tetramethylammonium chloride

(2.8 g.; 0.026 mole) in 20 ml ethanol to a refluxing solution of sodium 2,4-dichlorophenoxyacetic acid (6.2 g.; 0.026 mole) in 200 ml ethanol. After refluxing for 2 hours the reaction mixture was cooled and filtered to remove sodium chloride. Evaporation of ethanol gave the solid tetramethylammonium salt of 2,4-dichlorophenoxyacetic acid (6.7 g) with a melting point of **"212-214ºC"**. It is important to note here that when the tetramethylammonium chloride is added to the refluxing solution, the chloride dissociates and a reaction occurs between a tetramethylammonium moiety and the 2,4-dichlorophenoxyacetic acid.

46. As stated in my First Declaration the third method of preparation of the opposed Patent Application (page 9, lines 13 to 20) states the samples may be prepared by combining equimolar amounts of the carboxylic acid herbicide, an N-((C_1-C_{16}) alkyl or alkylaryl) tri((C_1-C_{16}) alkyl)ammonium halide and a metal hydroxide in a solvent such as methanol. The product is then isolated by evaporative removal of methanol (and any water present) at room temperature to 50ºC and removing metal halide salt by selective dissolution in water. The melting point of the tetramethylammonium salt of 2,4-D is given in Table I as 213-216ºC "dec".

47. I note that the melting point of the tetramethylammonium salt of 2,4-D reported in PMH-17 is the same as the melting point reported for composition 1a (2,4-D tetramethylammonium salt) reported in Table 1 on page 10 of the opposed Patent Application and which was prepared by the first method on page 9 of the opposed Patent Application. I further note that this fact has been conveniently ignored by Dr. Pearson.

48. Dr. Pearson's statement in paragraph 51 that he would not have considered PMH-17 relevant to the issue of "preparing a herbicidal carboxylic acid with reduced volatility" is simply nonsensical particularly when the opposed Patent Application makes it clear on page 1 that volatility is linked to damage to highly susceptible crops and the primary objective of the alleged invention as stated on page 2, lines 1 to 4 is to provide

> *"an herbicidal carboxylic acid derivative that is at least as active as the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops.* (my emphasis added)

PMH-17 makes it clear that the two herbicide product mixture of a benzonitrile ammonium salt and 2,4-D (tetramethyl)ammonium are applied at a rate sufficient to control the growth of weeds but "avoid causing substantial permanent damage to nearby sensitive crops" (see page 2, lines 78 to 85 and lines 102 to 113, claim 18 and claim 32 of PMH-17). Accordingly, there is simply no basis for Dr. Pearson to dismiss PMH-17 as not being relevant to preparing a herbicidal compound with reduced volatility. In response to Dr. Pearson's comments in paragraph 51 and 53 and the implication that PMH-17 is not relevant on the basis that it describes a "two herbicide product mixture including a benzonitrile ammonium salt and 2,4-D (tetramethyl)ammonium", I refer to my comments above in paragraphs 36 and 37 above. As stated the opposed Patent Application including the claims (see claim 9) makes it clear that the claimed herbicides can be used in a mixture with one or more other herbicides *"to control a wider variety of undesirable vegetation"* (see page 5, lines 8 to 10). The passage at lines 15 to 18 on page 5 of the opposed Patent Application also states that *"[i]t is generally preferred to use the compounds of the invention in combination with herbicides that are selective for the crop being treated and which complement the spectrum of weeds controlled by the compounds at the application rate employed"*. I further note that the choice of "other herbicides" in these passages on page 5 is not restricted in any way to particular herbicides nor are any "other herbicides" such as for example hydroxybenzonitrile compounds specifically excluded. This is also the case in respect of claim 9. Accordingly, and in reference to Dr. Pearson's suggestion in paragraphs 51 and 53 that PMH-17 is not relevant simply because it refers to a herbicidal mixture is wrong. PMH-17 is therefore relevant because it relates to the combination of an auxinic herbicidal carboxylic acid, which is the same class of compound described in the opposed Patent Application, together with a phenolic benzonitrile compound. The opposed Patent Application clearly covers such combinations.

49. At paragraph 54 Dr. Pearson describes the purported differences between PMH-17 and the opposed Patent Application. In response I note the following:

(a) I have already established, based on the evidence of both Dr. Pearson and Mr. Ouse (see paragraphs 14 to 18 and paragraph 26 above), that claim 1 (and claims 3 and 7) is directed a reaction product defined as the chemical reaction of 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety and isolating the reaction product, but which can be manufactured by any of methods provided at page 9 of the opposed Patent Application, or by any other method which produces the same chemical compound by reacting 2,4-dichlorophenoxyacetic acid with a (tetraalkyl)ammonium moiety.

(b) In dot point (i) Dr. Pearson appears to draw a distinction between the method in PMH-17 and the opposed Patent Application on the basis that the “2,4-D starting material used in PMH-17 is 2,4-D <u>sodium salt</u>, not 2,4-D <u>acid</u> as required by the claims”. It is my view that this distinction is scientifically flawed. As any chemist would appreciate that both the 2,4-D acid of the opposed Patent Application and the sodium salt of 2,4-D referenced in PMH-17 would dissociate on dissolution in water. It is the dissociated form of 2,4-D which takes part in the reaction process to make the final reaction product. Thus the reaction mixtures in both PMH-17 at page 5, lines 72 – 86 and the third method of the opposed Patent Application (lines 11-20 of page 9) would comprise 2,4-D anions, chloride anions, sodium cations and (tetra-alkyl)ammonium cations, the 2,4-D anions and (tetra-alkyl)ammonium cations reacting to form the reaction product. Accordingly Dr. Pearson’s suggestion that this is a point of difference is without any scientific foundation.   My comments here equally apply to paragraph 58 of the Pearson Declaration.

(c) In response to dot point (ii) I restate my earlier comments that any chemist would appreciate both the (tetraalkyl)ammonium hydroxide of the opposed Patent Application and the (tetramethyl)ammonium chloride referenced in PMH-17 would dissociate on dissolution in water. It is the dissociated form of the (tetraalkyl)ammonium which takes part in the reaction process to make the final reaction product. Thus the reaction mixtures in both PMH-17 at page 5, lines 72 – 86 and the third method of the opposed Patent Application (lines 11-20 of page 9) would comprise 2,4-D anions, chloride anions, sodium cations and (tetra-alkyl)ammonium cations, the 2,4-D anions and (tetra-alkyl)ammonium cations reacting to form the reaction product. There is simply no point of difference.

The reaction product of both PMH-17 and the opposed Patent Application are the same irrespective of the method of manufacture. In PMH-17 the chloride is removed as sodium chloride and in the opposed Patent Application the hydroxide is removed as sodium hydroxide. The end result of both reactions is the quaternary ammonium derivative of 2,4-D. This is evident from the melting points. That is the melting point of the tetramethylammonium salt of 2,4-D composition 1a of the opposed Patent Application (prepared using tetramethylammonium hydroxide and 2,4-D) is recorded in Table I as 213-216ºC “dec” and the melting point of the tetramethylammonium salt of 2,4-D (prepared using tetramethylammonium chloride and 2,4-D) is reported in PMH-17 as 212-214ºC.

It is well understood that every solid chemical compound has a fixed melting point which can be used to determine purity of the compound and to aid identification. The melting point depends only on the structure (arrangement of atoms and bonds) irrespective of how it is prepared. Now produced and shown to me and marked **PMH-33** is an extract from the organic chemistry text “Elementary Practical Organic Chemistry”” Part 2, Qualitative Organic Analysis by Arthur I Vogel 2nd Edition (1966). Page 4 of this extract states that in addition to the use of melting point determination as a criterion for purity, “*an equally valuable application is for identification of organic compounds. If the melting point is known within one degree, the major proportion of possible substances is immediately eliminated from consideration*. *The study of the general chemical properties of the compound and a mixed melting point determination will largely establish the identity of the compound*.”

Further, it is also widely understood that the measurement of a melting point alone is sufficient characterization of a synthesis product for a report of a new synthesis to be indexed by the Chemical Abstract Service of the American Chemical Society. Now produced and shown to me and marked **PMH-34** is a copy of the relevant extract from "Chemical Nomenclature" Edited by K.J. Thurlow (1988) making it clear that this is indeed the case.

It follows from the above that the quaternary ammonium derivative of 2,4-D of PMH-17 and the opposed Patent Application are the same and there is nothing that Dr. Pearson has put forward in paragraphs 54 to change my view. In fact as noted above Dr. Pearson has remained silent on the issue of the reported melting points.

(d) In response to dot point (iii) I note that the claims of the opposed Patent Application including the recent amendment to Claim 6 proposed by the Applicant, has the effect of excluding (tetramethyl)ammonium salt of 2,4-D from the opposed Patent Application. Following this amendment, it is not clear to me how the properties of the remaining quaternary ammonium salts of 2,4-D differ from the properties of (tetramethyl)ammonium salt of 2,4-D now excluded especially when I consider the experimental data provided in the opposed Patent Application and the results of the additional experiments reported by Mr. Ouse in paragraph 58 of the Ouse Declaration. I note that Dr. Pearson does not say how the properties of the remaining quaternary salts of 2,4-D differ or are improved over the (tetramethyl)ammonium salt of 2,4-D.

As already stated I regard the principal objective of the alleged invention to be that as described on page 2 lines 1 to 4 of the opposed Patent Application namely:

> *"Thus it would be desirable to have an herbicidal carboxylic acid derivative that is at least as active the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops"*

If the properties of the now claimed herbicidal compounds are that they are (i) at least as active as the commercially used carboxylic acid herbicide salts; and (ii) less volatile so that its use would not damage nearby sensitive crops, then for the reasons I have already provided in my First Declaration this is not borne out by the results reported in opposed Patent Application. This issue is further compounded when the results reported for the excluded herbicidal compound tetramethylammonium salt of 2,4-D as well as the triclopyr quaternary ammonium salts, which do not fall within the scope of claims 1 to 7, are compared with those herbicidal compounds that are considered to part of the invention. It is my view that from the results reported in the opposed Patent Application and based on the evidence from Mr. Ouse, the herbicidal compounds of the prior art including the tetramethylammonium salt of 2,4-D and the triclopyr quaternary ammonium salts are no different from the quaternary ammonium salts of 2,4-D that fall within the scope of claims 1 to 7 both in respect to their (a) herbicidal effect and (b) volatility in an enclosed test system.

In terms of herbicidal activity I have reproduced Table II of the opposed Patent Application noting that compound 1a (2,4-D tetramethylammonium salt) has been specifically excluded from the claims and compounds 2a to 2c do not fall within the scope of herbicidal compound of claims 1 to 7:

Compound	Treatment number	Rate g a.e / ha	Broadleaf Dock *Rumex obstusifolia*	Kochia *Kochia scoparia*
			****%Control****	
2,4-D dimethylamine salt	***Commercially used herbicidal salt***	**560**	**77**	**86**
2,4-D tetramethylammonium salt	**1a** ***(excluded herbicidal compound - not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	**560**	**77**	**83**
2,4-D tetraethylammonium salt	1b	560	79	89
2,4-D tetrapropylammonium salt	1c	560	73	83
2,4-D choline salt	1e	560	68	86
Triclopyr triethylamine salt	***Commercially used herbicidal salt***	**560**	**81**	**91**
triclopyr tetramethylammonium salt	**2a** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	**560**	**85**	**79**
Triclopyr tetraethylammonium salt	**2b** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	**560**	**79**	**88**
triclopyr tetrapropylammonium salt	**2c** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	**560**	**79**	**95**

The results of above Table show that the excluded compound 2,4-D tetramethylammonium salt and the commercially used dimethylamine salt of 2,4-D had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) at 77% than compound 1c being 2,4-D tetrapropylammonium salt at 73% and the herbicidal compound of claim 7 - compound 1e (2,4-D choline salt) at 68%. Likewise, the known herbicidal salt triclopyr triethylamine had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) at 81% and 91% respectively compared to quaternary ammonium salt forms of 2,4-D of the alleged invention including relevantly the 2,4-D choline salt.

The results of above Table also show that the quaternary ammonium salt forms of the herbicide triclopyr had a significantly better herbicidal activity against both Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) than the corresponding quaternary ammonium salt forms of 2,4-D. As noted in the above Table the triclopyr quaternary ammonium salts do not fall within the scope of claims 1 to 7.

As it stands therefore the claimed herbicidal compounds do not exhibit a herbicidal activity that is in any way as active as the commercially used carboxylic acid herbicide salt or the tetramethylammonium salt of 2,4-D.

In terms of volatility in an enclosed test system I have reproduced the Table presented by Mr. Ouse in paragraph 58 of the Ouse Declaration, which is said by Mr. Ouse to be results of volatility experiments conducted by the method described at page 12 of the opposed Patent Application:

	Compound	**% grape injury**
Prior Art compounds	2,4-D diethylamine (DEA)	20
	2,4-D triethylamine (TEA)	11
	2,4-D dimethylethanolamine (DMEA)	33
	2,4-D diethylethanolamine (DEEA)	83
Compounds of the invention	**1a (2,4-D tetramethylammonium hydroxide)**	**0**
	1b (2,4-D tetraethylammonium hydroxide)	0
	1e (2,4-D choline hydroxide)	0

I note that in this table Mr. Ouse describes compound 1a being 2,4-D (tetramethyl)ammonium salt as a "compound of the invention" when as noted by Dr. Pearson in paragraph 54, the claims specifically exclude (tetramethyl)ammonium.

The results of above Table show that on the basis of the volatility experiment conducted by Mr. Ouse, 2,4-D (tetramethyl)ammonium salt cannot be distinguished from compounds 1b and 1e. That is the claimed herbicidal compounds do not show less volatility and less injury to nearby sensitive crops than other quaternary ammonium salts of 2,4-D that fall outside the scope of the claims, including the (tetramethyl)ammonium salt.

50. In response to Dr. Pearson's comments in paragraphs 55 and 56, I note that page 4, lines 24 to 33 of PMH-17 reports the reaction of a (tetraalkyl)ammonium hydroxide with the herbicidal compounds bromoxynil or ioxynil. The evaporation of the reaction solvent (in that case water) to isolate the solid quaternary salt is also described. A tetramethylammonium salt of 2,4-D having the same melting point as that reported for compound 1a in Table 1 of the opposed Patent Application is also described in PMH-17 at

page 5, lines 72 to 86. I also note that for the preparation of the herbicidal composition in PMH-17 the document describes the use of (tetraalkyl)ammonium hydroxide and (tetraalkyl)ammonium halide as being equally suitable. In addition page 5, lines 24 to 31 of PMH-17 indicates that it is preferred that the second component (such as 2,4-D) has the same quaternary group as the benzonitrile first component.

51. That is the teachings in PMH-17 provide a clear direction for the second component to be manufactured in a similar fashion to the first component using a hydroxide form of the quaternary ammonium compound. There is nothing in PMH-17 to indicate that the quaternary hydroxide form would not work for 2,4-D in the same way as the halide form. In fact this is entirely consistent with the views that I have expressed above. As with the halide the hydroxide would simply dissociate from the (tetraalkyl)ammonium moiety on addition to solvent (as any salt will do in solution) and would not participate in the reaction with 2,4-D to form the reaction product.

52. In response to paragraphs 57 and 58 I note again the PMH-17 does suggest changing the chloride counter ion of the quaternary ammonium compound to a hydroxide counter ion. I also refer to my comments above specifically that the only limitation on the claim is that a reaction product is produced by a process which is then isolated. For this process to occur, there must be a <u>reaction</u> and the only reaction that can possibly be described in the claim is a reaction of a (tetraalkyl)ammonium moiety with 2,4-D. So whilst in the claim 2,4-dichlorophenoxyacetic acid is combined with a (tetraalkyl)ammonium hydroxide, the hydroxide dissociates from the (tetraalkyl)ammonium moiety on addition to solvent (as any salt will do in solution) and does not take part in the actual process of making the final reaction product. It follows that the third method described on page 9 does fall within the scope of the claims since it describes the same reactive process. The chloride counter ion and hydroxide counter ion to which Dr. Pearson refers do not take part of the reaction to produce the reaction product. Likewise the sodium cation of the 2,4-D sodium salt does not take part in the reaction. Nothing is changed. I again note that Dr. Pearson has not made in comment on the reported melting point of the

tetramethylammonium salt of 2,4-D in PMH-17 being identical to the melting point reported for composition 1a (2,4-D tetramethylammonium salt).

53. In response to paragraph 59 I direct Dr. Pearson's attention to GB 1339315 (D3) which as stated in my First Declaration was published in 1973. This prior art document describes the use of a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a quaternary ammonium salt where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl". D3 describes the herbicidal composition being used to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops. As accepted by Dr. Wright in paragraph 82 of his evidence the options for the quaternary ammonium radicals R, R_1, R_2 and R_3 would "encompass choline". Page 2, lines 60 to 65 of D3 describes the method of preparing a herbicidal salt composition as involving

> *"reacting the <u>bases</u> with the [at least one herbicidally active] acid to form a mixture of salts …"* (my emphasis added).

Page 2, lines 109 to 113 further describes the salts which may be employed as including the

> *"alkali metal salts and the salts formed by the reaction of <u>other bases such as ammonium hydroxide</u>, with the appropriate acids"* (again my emphasis added).

Accordingly, Dr. Pearson is not correct in his assertion that it was not known prior to February 2007 that a quaternary ammonium hydroxide could form a salt with 2,4-D. As stated above this is evidenced by the teachings in PMH-17 which states that the chloride counter ion of the quaternary ammonium compound can be changed to a hydroxide counter ion (see page 4 lines 24 to 30 and claim 21) and that the second component (such as 2,4-D) has the same quaternary group as the benzonitrile first component (see page 5, lines 24 to 31). My comments here equally apply to paragraph 60.

54. The suggestion by Dr. Pearson that simply because he was unaware of anyone in the industry making quaternary ammonium salts of 2,4-D that this

somehow suggests that the alleged invention is new and not obvious is, with respect, a nonsensical argument. The so-called problem of volatility/vapour drift/crop damage associated with the ester form of 2,4-D had already been considered in the *Weed Science* paper in 1974 (PMH-15) and "essentially eliminated" through the use of amine salts of 2,4-D. As already stated in my First Declaration Nufarm was already selling a non-volatile 2,4-D amine salt product that met the market need.

55. In response to Dr. Pearson's suggestion in paragraph 60 that by combining a quaternary ammonium hydroxide with 2,4-D produces a herbicide with a "beneficial result" I simply state that for the reasons provided in my First Declaration the so-called "beneficial result" is not borne out by the results presented in Tables II and III of the opposed Patent Application. I also refer to my comments above in paragraph 50(d) which show that the properties of quaternary ammonium salts of 2,4-D that fall within the scope of the claims do not differ from the properties of (tetramethyl)ammonium salt of 2,4-D, which has been excluded by the claims.

PMH-18

56. There is nothing that Dr. Pearson has put forward in relation to PMH-18 which would in any way change the views that I have expressed in my First Declaration as to the relevance of the disclosure in PMH-18.

57. I do however note that PMH-18 along with PMH-17 are specifically referenced in the standard text "Phenoxyalkanoic Herbicides" published in 1981 (PMH-16 to my First Declaration). As already stated page 5, lines 72 to 86 of PMH-17 describes a method of preparing the tetramethylammonium salt of 2,4-D being a quaternary ammonium salt of 2,4-D. I also note that PMH-18 is referred to on page 2, lines 30 to 44 of GB 1339315 in the name of the Ciba-Geigy Canada Ltd (published in April 1981) (**D3**). As stated above D3 describes a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a quaternary ammonium salt where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl" and the use of herbicidal composition to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops.

THE OUSE DECLARATION

Scope and Overview of Mr. Ouse’s Evidence

58. Mr. Ouse was asked to comment on paragraphs 66 to 88 and 206 to 230 of my First Declaration.

59. In my opinion Mr. Ouse’s evidence

    i. introduces new matters to be considered in the form of new experimental data;

    ii. consists primarily of opinions which are unsubstantiated; and

    iii. offers objections to the evidence in my First Declaration which are, in many instances, simply incorrect, not factual and/or not scientifically based.

60. In my opinion, when read as a whole, Mr. Ouse’s opinions on the opposed Patent Application particularly the experimental results are based on a misunderstanding of the claim language and the erroneous application of a 10% margin of error for the results reported in the opposed Patent Application. Detailed reasons for this will be provided below.

61. Turning now to relevant paragraphs of Mr. Ouse’s evidence I make the following comments. My decision not to comment on all the statements made in the Ouse Declaration either in part or in full should not be taken as an indication of my agreement with that evidence generally or the comments made therein.

Alleged aim of the invention

62. In paragraphs 24 to 28 Mr. Ouse states that it is not “critical” for the herbicidal compound of the opposed Patent Application to be “at least as active” as commercially used carboxylic acids and to have a reduced volatility. Whilst Mr. Ouse appears to rely on the language such as “desirable” at page 2, line 1 it is my view that he has completely ignored the background discussion provided on page 1 and the opening words to the particular paragraph on page 2, lines 1 to 4 being

> *"Thus it would be desirable to have an herbicidal carboxylic acid derivative that is at least as active as the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops."* (my emphasis added)

63. Mr. Ouse has also ignored the following paragraph on page 2 where at lines 5 to 9 it states:

> *"It has now been found that compounds formed by combining a carboxylic acid herbicide with either a tetraalkylammonium or an (arylalkyl)trialkylammonium hydroxide have herbicidal activity on an acid equivalent basis at least comparable to the commercially used carboxylic acid herbicide salts, but with reduced volatility"* (my emphasis added)

as well the language in the Abstract which makes it clear that the

> *"Compounds formed by combining a carboxylic acid herbicide with N-((C_1- C_{16}) alkyl or arylalkyl) tri((C_1-C_{16}) alkyl)ammonium hydroxide have herbicidal activity on an acid equivalent basis at least as active as the commercially used carboxylic acid herbicide salts, but are less volatile"* (my emphasis added).

64. It is my understanding that the claims must be read in light of the specification as a whole and not in isolation as Mr. Ouse appears to have done. Also, without the aim of the invention as being what I have set out, it is unclear what the aim of the invention is. I note that Mr. Ouse does not provide an alternative aim based on what is written in the specification merely that the claimed compound must act as a "herbicide". It is my view that the aim of the invention must be something more than the herbicidal compound merely acting as a herbicide. As has already been outlined above, tetraalkyl ammonium salts of carboxylic acid herbicides were known before February 2007 to act as herbicides (see PMH-17). In addition, 2,4-dichlorophenoxyacetic acid starting material which is combined with the (tetraalkyl)ammonium hydroxide is a known herbicide (see PMH-17).

65. My position is supported by Dr. Pearson's comments in paragraph 51 where he dismisses the disclosure in PMH-17 on the basis that he would not have considered it *"relevant to the issue of preparing a herbicidal carboxylic acid with reduced volatility"* (my emphasis added). Clearly Dr. Pearson regards reduced volatility as important.

66. Likewise in paragraph 60 Dr. Pearson states that the combined effect of adding a particular quaternary ammonium compound with 2,4-D is to produce a herbicidal compound with a "beneficial result". When read in light of paragraph 59 of the Pearson Declaration it appears that the so-called beneficial result is a herbicidal compound that overcomes the issues of "*volatility/drift/crop damage"*. Whilst I do not believe that Dr. Pearson's contentions are correct when careful consideration is given to the results reported in Table II and results of additional experiments reported by Mr. Ouse in paragraph 58 of the Ouse Declaration (see my comments above in paragraph 50(b)), it is clear that Dr. Pearson does not support Mr. Ouse's assertions in paragraphs 24 to 28.

67. It also appears that Dr. Wright has formed a view contrary to that reached by Mr. Ouse. In paragraph 49 Dr. Wright appears to recognize the importance of the herbicidal composition of the opposed Patent Application having sufficient herbicidal efficacy and in so doing seeks to rely on the disclosure in JP51106728 (identified as D2 in my First Declaration) in support of this. Dr. Wright also states that he and others in the field would deem a level of herbicidal activity that still produces the outcome of controlling unwanted vegetation to be a "retention of sufficient herbicidal activity". In paragraph 50 Dr. Wright makes it clear that a "primary consideration" when preparing a herbicidal formulation is to minimize vapor drift is to "ensure that the herbicidal efficacy is retained". Dr. Wright relies on the statement at page 2, lines 1 to 3 of the opposed Patent Application.

68. I disagree with Mr. Ouse's statements in paragraphs 29 and 30. It is my view the fact that the alleged herbicidal compounds of the opposed Patent Application may exhibit herbicidal activity is not the test that has been set by the Applicant as being its objective. It remains that the clear aim of the alleged invention that the claimed herbicidal compounds must exhibit a herbicidal activity that is "at least as active" as commercially used carboxylic acids. This point is accepted by Dr. Wright (see paragraph 50 of the Wright Declaration). In any event Mr. Ouse's contentions are not supported by the results reported in Table II on page 11 to which he refers. As stated above in

paragraph 49(d) the herbicidal activity of the commercially used salt 2,4-D dimethylamine (DMA) was significantly better against Broadleaf Dock (*Rumex obstusifolia*) at 77% compared to the activity of compound 1c being 2,4-D tetrapropylammonium salt at 73% and the herbicidal compound of claim 7 - compound 1e (2,4-D choline salt) at 68%. Likewise, the known herbicidal commercially used salt triclopyr triethylamine (TEA) had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) at 81% and 91% respectively compared to the quaternary ammonium salt forms of 2,4-D of the alleged invention. In particular the results reported in Table II for the herbicidal activity of the 2,4-D choline salt against the two weeds Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) reported as 68% and 86% respectively was significantly less than the commercially used herbicidal salts 2,4-D DMA and triclopyr TEA and well outside any so-called "variance of activity" suggested by Mr. Ouse in paragraph 31.

69. At this point I believe that it is worth noting Mr. Ouse's error in referencing compounds 1a, 2a, 2b and 2e as being "compounds of the invention". As clearly stated in paragraph 54 (dot point 3) of the Pearson Declaration the claims specify that when "R^1, R^2 and R^3 are methyl, R^4 is not methyl, which excludes (tetramethyl)ammonium." Likewise, the claims of the opposed Patent Application are directed herbicidal compounds derived from the herbicidal carboxylic acid 2,4-D only. Accordingly, the triclopyr based herbicidal compounds are not part of the alleged invention.

70. Mr. Ouse's statements in paragraphs 31 and 32 are scientifically flawed. A 10% variation between individual plants is often observed and for this reason it is universal practice to apply the same herbicide treatment to a number of plants and to calculate the mean (average) response to the treatment. I disagree that a person skilled in the art would consider a 10% difference in the means of different treatments to be "comparable".

71. It remains that the clear objective of the alleged invention that the herbicidal compounds (being specific quaternary ammonium salts of 2,4-D and not including the tetramethylammonium salt of 2,4-D) be "at least as active as" not

"comparable to" commercially used carboxylic acids. However even if one were to accept the lesser of the two i.e. that the herbicidal compounds of the alleged invention having a herbicidal activity which is "comparable to" commercially used carboxylic acids, a point that I do not concede, then this is not reported in the results in Table II on page 11 of the opposed Patent Application.

72. In the experiment described on pages 10 and 11 of the opposed Patent Application, several seeds (actual number not specified) of each of the weed species (*Rumex obtusifolia* and *Kochia scoparia*) were planted in 10 cm square pots. At line 8, page 11 the treatments are said to be "replicated 3 times". Thus, the person conducting the experiment has compared the visual appearance of "several plants" in three separate pots with the control. Well known statistical procedures are available to determine if two or more treatments are statistically the same or different. However, these statistical procedures rely on knowing the value of each of the three replicate treatments which have not been reported in either the opposed Patent Application or in the evidence presented by Mr. Ouse. Absent the data to conduct a statistical analysis, all that can be said with any degree of certainty is that a treatment is the same, more efficacious or less efficacious on average.

73. To examine Mr. Ouse's proposition that all results are "comparable", I have reproduced Table II of the opposed Patent Application with prior art treatment normalised to 100% as shown in the following Table.

Compound	Treatment number	Rate g a.e / ha	Broadleaf Dock *Rumex obstusifolia*	Kochia *Kochia scoparia*
2,4-D dimethylamine salt	***Commercially used herbicidal salt***	**560**	**100**	**100**
2,4-D tetramethylammonium salt	**1a** ***(excluded herbicidal compound - not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	560	100	96.5
2,4-D tetraethylammonium salt	1b	560	102.6	103.5
2,4-D tetrapropylammonium salt	1c	560	94.8	96.5
2,4-D choline salt	1e	560	88.3	100
Triclopyr triethylamine salt	***Commercially used herbicidal salt***	**560**	**100**	**100**
triclopyr tetramethylammonium salt	**2a** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	560	104.9	86.8
Triclopyr tetraethylammonium salt	**2b** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	560	97.5	96.7
triclopyr tetrapropylammonium salt	**2c** ***(not within the scope of the herbicidal compound of claims of the opposed Patent Application)***	560	97.5	104.4

74. The above Table shows that the reported activity for compound 1e (claim 7) differs from its respective control by more than 10% and is not “comparable” based on the criterion used by Mr. Ouse. Specifically, the Table shows that the average % weed control for 2,4-D choline salt was 11.7% less than the average % weed control for the reference product 2,4-D DMA against the weed Broadleaf Dock. I also note that % weed control for 2,4-D choline salt was 11.7% less than the average % weed control for the reference product triclopyr TEA as well as excluded herbicidal compound 2,4-D tetramethylammonium. Accordingly, Mr. Ouse is not correct in his assertion that the herbicidal activity of so-called inventive compounds is “comparable” to commercially used herbicidal salts. In any event, as I have already outlined, the test is that the herbicidal activity of the so-called inventive compositions is **at least as active** as the commercially used herbicidal salts. This is not shown by the results reported in Table II. As a final point, it is noted that for compound 1e the claims are not limited to treatment of Kochia.

Prevention of injury – Paragraphs 33 to 40 of the Ouse Declaration

75. I disagree with Mr. Ouse’s assertions in paragraph 34 (and his comments in paragraphs 41 and 42). Whilst Mr. Ouse is correct that the claims do not say anything about the volatility of the herbicidal compounds/compositions or their impact on neighboring crops it is my strong view the claims must be read in the context of the specification as a whole and not in isolation as Mr. Ouse appears to have done. In fact, when I carefully consider the “background discussion” provided on page 1 of the opposed Patent Application and the language on page 2, lines 1 to 4 it seems to me that the central problem sought to be addressed is volatility of known 2,4-D formulations and their impact on neighboring sensitive crops. Specifically, page 1, lines 8 to page 2, line 4 of the opposed Patent Application states as follows:

> *Acid herbicides such as 2,4-dichlorophenoxyacetic acid (2,4-D) have long been used to control unwanted vegetation. 2,4-D is normally converted into liquid formulations by conversion to water soluble salts or emulsified esters. The ester formulations have been found to be more effective than the salts on an acid equivalent basis in the control of noxious vegetation but have the unwanted characteristic of migrating to*

> *adjacent desirable vegetation because of the volatility thereof, resulting in unacceptable damage to sensitive plants.*
>
> *Efforts to solve the volatility problem, including preparation of water soluble salts such as the dimethylamine salt of 2,4-D, have not been totally satisfactory because, upon volatilization of the amine, the herbicide reverts back to its initial acid form, which, in itself under certain unfavorable conditions, has sufficient volatility to cause damage to sensitive crops.*
>
> *2,4-D ester or 2,4-D dimethylamine formulations applied during the warm summer months can lead to vapor drift from the evaporation of the herbicide from sprayed surfaces and subsequent damage to highly susceptible crops such as tomatoes, cotton, soybeans, sunflowers and grapes. This may occur within hours after the herbicide application.*
>
> *Thus it would be desirable to have an herbicidal carboxylic acid derivative that is at least as active as the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops."* (my emphasis added)

In the first three main paragraphs on page 1 of the opposed Patent Application there is a clear reference to the impact of known 2,4-D formulations on neighboring crops and in the opening paragraph on page 2 the Applicant makes it clear that there is need for the herbicidal carboxylic acid derivative of the alleged invention to be at least as active as the commercially used carboxylic acid herbicide salts and "less volatile so that its use will not damage nearby sensitive crops." The results reported in Table III are said to be directed to the extent of injury to the sensitive grapes crops resulting from vapor exposure to various forms of 2,4-D, Triclopyr and Dicamba. It is noted that Triclopyr and Dicamba do not form part of the invention (see paragraph 68 above) and Mr. Ouse has incorrectly referred to compounds 2b and 4a as being compounds of the invention. It is noted that the only compound which caused "0% injury" in Table III is compound 1b (which is the only "compound of the invention" referred to in Table III). Based on the teachings in the specification it is not clear to me how Mr. Ouse can legitimately suggest that volatility, the impact of the herbicidal compounds/compositions in preventing injury to neighboring sensitive crops and the associated data reported in Table III is not relevant to the alleged invention.

76. I note that my position is supported by Dr. Pearson's comments in paragraphs 59 and 60 of the Pearson Declaration. In refuting my comments in my First Declaration concerning the selection of a quaternary ammonium compound was obvious Dr. Pearson asserts that the combined effect of adding a particular quaternary ammonium compound with 2,4-D is to produce a so-called inventive herbicidal compound with a "beneficial result" i.e. one that overcomes the problem of "*volatility/drift/crop damage"*. Clearly therefore according to Dr. Pearson the volatility of the herbicidal compounds/compositions and their impact in preventing injury to neighboring crops is relevant to assessing the so-called inventiveness of the claims.

77. Likewise, in paragraph 49 Dr. Wright states that it is his understanding that the problem sought to be addressed in the opposed Patent Application is identified at page 1 as "vapor drift". When I consider this in the context of Dr. Wright's statement in paragraph 35 where he acknowledges that "spray drift/droplet drift and vapor drift may cause damage to susceptible plants at some distance from the locus of application" and in paragraph 50 where Dr. Wright makes it clear that in addition to ensuring that the herbicidal efficacy of the herbicidal formulation is retained "minimizing vapor drift" is also a "primary consideration", it seems to me that volatility and the impact on the claimed herbicidal compounds/compositions in preventing injury to neighboring crops is relevant. My comments in paragraphs 74 to 76 equally apply to Mr. Ouse's assertions in paragraphs 41 and 48 to 52 of the Ouse Declaration.

78. Mr. Ouse is not correct is his assertion in paragraph 36 that the term "preventing" is not an absolute term and that it does not require 0% injury. It is my view that for the following reasons it cannot mean anything else:

(a) the specification as filed;

(b) the dictionary meaning of the term "preventing"; and

(c) the Applicant's amendments made to the claims of associated application Australian Patent Application 2016203677 during examination.

I will address each of these reasons in turn.

79. As stated above the "background discussion" provided on page 1 of the opposed Patent Application makes it clear that the central problem sought to be addressed is the volatility of known 2,4-D formulations resulting in unacceptable damage to neighboring sensitive crops. The objective of the alleged invention is described on page 2, lines 1 to 4 as being

> *"an herbicidal carboxylic acid derivative that is at least as active as the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops.* (my emphasis added)

In using the words "would not damage" the Applicant is clearly intended there to be no damage to neighboring crops. Had the Applicant meant anything less than 0% injury to cover herbicidal compounds/compositions which show "significantly less injury to sensitive crops compared to herbicidal standards", as asserted by Mr. Ouse in paragraph 40, then they would have chosen different language in setting out the objective of the alleged invention.

80. The dictionary meaning of "preventing" is the "act or practice of keeping or stopping something from happening". On its dictionary meaning it is an absolute term meaning 0% injury, nothing less. It is my view that the description in the opposed Patent Application supports this as well as Mr. Ouse's additional data provided in the Table in paragraph 58 which is said to be "supportive of the data in the opposed Patent Application". I note relevantly that the so-called "compounds of the invention" all show a "**0%** grape injury" which, in my view, is an alleged "prevention" in injury to the neighboring sensitive crop not a "reduction". Further compound 1b (a "compound of the invention") in Table III of the opposed Patent Application showed "0% injury".

81. In respect of the results presented by Mr. Ouse in paragraph 58 I note that he describes compound 1a (2,4-D (tetramethyl)ammonium salt) as a "compound of the invention" when, as noted by Dr. Pearson in paragraph 54, the claims specifically exclude (tetramethyl)ammonium. I also note most relevantly that on the basis of results of this volatility experiment presented by Mr. Ouse, 2,4-

D (tetramethyl)ammonium salt cannot be distinguished from compounds 1b and 1e being “compounds of the invention”.

82. I have been informed by Arcadia Intellectual Property that the claims of the associated application Australian Patent Application 2016203677 were amended during prosecution to address the Examination Report dated 29 November 2016 in which the Examiner maintained his objection in respect of JP51106728 (identified as D2 in my First Declaration). Specifically, I note that it was the Examiner’s view that D2 disclosed

> *“the use of a combination of 2,4-D (DCP) and choline in a manner that would inevitably infringe the claims of the present application. D1 employs choline to increase the selectivity of phenoxy herbicides including 2,4-D. The result of an increased selectivity would be a reduction in injury to any non-selected (non-target) plants nearby. Indeed, paragraphs 2 and 3 of page 5 discuss the reduction in damage to non-target plants. This falls within the scope of the said claims”*.

In response to this Examination Report the Applicant amended claim 1 to remove the words “*reducing … injury to non-target plants or crops nearby a locus of unwanted vegetation that requires herbicidal treatment”* which had the effect of limiting the claim to “a method of preventing injury to nearby crops”. The Applicant also added a second reference to the word “preventing” at the end of claim 1. Had the Applicant wished to cover compositions which show “significantly less injury to sensitive crops compared to herbicidal standards”, as asserted by Mr. Ouse in paragraph 39, then the amendment to remove the word “reducing” would not have been made to the claims of associated application Australian Patent Application 2016203677. The 6% and 12% injury referred to by Mr. Ouse in paragraph 39 does not relate to any “compound of the invention”.

Substituted (tetraalkyl) ammonium hydroxide salts – Paragraphs 41 to 56 of the Ouse Declaration

83. In response to Mr. Ouse’s comments in paragraphs 45 to 46 I note with interest the following points:

(a) Mr. Ouse clearly states that the reaction product formed by combining herbicidal carboxylic acids and unsubstituted or substituted N-alkyl/arylalkyl ammonium hydroxide can be prepared using the “general method” described on page 4, lines 6 to 12.

(b) Mr. Ouse describes the methods provided on page 9 as being *“three more descriptive preparative methods”* (my emphasis added).

(c) Mr. Ouse also notes that “*at least the first method described on page 9, lines 2-8 of the Patent Application would result in a compound according to claim 1”* (my emphasis added). As stated above in paragraph 15 it is my view that by using the words “at least” Mr. Ouse is not suggesting that the third preparative method described on page 9, lines 13 to 20, which includes an isolation step, cannot be used to make the chemical compound of claim 1 or that any other method which produces the same chemical compound cannot be used. In any event, as I have outlined above earlier in my declaration, the reaction product is the reaction of a (tetraalkyl)ammonium moiety and 2,4-D. As the hydroxide in the first method described on page 9, lines 2 to 8 and the halide in the third preparative method described on page 9, lines 13 to 30 do not take part in the reaction to form the reaction product, it follows that the third preparative method must be included.

84. As stated above in paragraph 14 this is consistent with the views expressed by Dr. Pearson in paragraph 31. Dr. Pearson makes it clear that there is no additional limitation on the method used to prepare the reaction product citing page 8, lines 20 and 21 to support his view that the preparative methods provided on page 9 are for “illustrative purposes only and not to be construed as a limitation on the claims”. In paragraph 28 Dr. Pearson states that he does not see there to be a need to identify which of the three methods on page 9 is the “best mode”. Further, when looking at claim 1 the only limitation on the claim is that a reaction product is produced by a process. For this process to occur, there must be a reaction and the only reaction that can possibly be described in the claim is a reaction of a (tetraalkyl)ammonium moiety with 2,4-D. The mere combination of 2,4-D with (tetraalkyl)ammonium

hydroxide as described in claim 1 and the first method on page 9 has no bearing on this reaction as the hydroxide merely dissociates in any reaction mixture(as any salt will do in solution) and does not take part in the process of forming the reaction product. Likewise in the third method the halide dissociated in any reaction mixture and does not take part in the process of forming the reaction product.

85. I disagree with Mr. Ouse's assertions in paragraph 48. As stated above in paragraph 49(d) the herbicidal activity of the commercially used salt 2,4-D dimethylamine (DMA) was significantly better against Broadleaf Dock (*Rumex obstusifolia*) at 77% compared to the activity of compound 1c being 2,4-D tetrapropylammonium salt at 73% and the herbicidal compound of claim 7 - compound 1e (2,4-D choline salt) at 68%. Likewise, the known herbicidal commercially used salt triclopyr triethylamine (TEA) had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) at 81% and 91% respectively compared to the quaternary ammonium salt forms of 2,4-D of the alleged invention. In particular the results reported in Table II for the herbicidal activity of the 2,4-D choline salt against the two weeds Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) reported as 68% and 86% respectively was significantly less than the commercially used herbicidal salts 2,4-D DMA and triclopyr TEA and well outside any so-called "variance of activity" suggested by Mr. Ouse in paragraph 31.

86. I agree with Mr. Ouse comments in paragraph 53 when he says that it is well understood in the art that that the testing methods utilized in the laboratory do not need to be identical to the commercial processes applied to vegetation. I also agree there are many methods available to simulate what happens in the field. The post-emergence application method for herbicide evaluations provided on pages 10 and 11 of the opposed Patent Application is an example of a laboratory method that can simulate field conditions. However, I disagree with Mr. Ouse's assertions in paragraph 54. When I consider the method on page 12 and compare it with the method on pages 10 and 11 of the opposed Patent Application there is, in my view, a number of problems.

An obvious and unexplained component of the procedure on page 12 is that exposure to the vapour was over a 24 hour period at 40^{o}C. Consideration of the method on page 10 and 11 of the opposed Patent Application suggests an exposure temperature of 26–28^{o}C would more closely simulate what happens in the field. Another important difference between the experiment on page 12 and the method on page 10 and 11 of the opposed Patent Application is that vapours are confined within a humidome of undefined dimensions and the dispersion effects of wind and atmospheric stability are absent. Accordingly, Mr. Ouse is not correct in his assertion in paragraph 54 that the method on page 12 "simulates a sensitive crop being grown downwind from treated unwanted vegetation".

87. Mr. Ouse's suggestion in paragraph 55 that my request in paragraph 212 of my First Declaration for vapor pressure data in respect of the salts in Table III as well as the salts encompassed by the claims as being is on some way unreasonable is, with respect, scientifically unsound. As noted by Dr. Wright in paragraphs 46(d) and 47 of the Wright Declaration vapor pressure is a *"measure of substance's relative potential to volatilize. At a given temperature, a substance with a higher vapor pressure vaporizes more readily than a substance with a lower vapor pressure".* In paragraph 51 of his Declaration Dr. Pearson makes it clear that the relevant issue being addressed by the alleged invention is to "prepare a herbicidal carboxylic acid with reduced volatility". This is consistent with the stated objective on page 2, lines 1 to 4 of the opposed Patent Application. Accordingly, Mr. Ouse's statement that vapor pressure or reduced volatility is not relevant to any of the claims is simply nonsensical.

88. In response to paragraph 56 I note with interest Mr. Ouse's assertion that his additional data in paragraph 58 "proves him right" that substitution of the (tetraalkyl)ammonium hydroxide would "*substantially influence the general principle described in the Patent Application <u>that the reaction product of a herbicidal carboxylic acid and a (tetraalkyl)ammonium hydroxide exhibits reduced volatility</u>*" (my emphasis added). As stated above in paragraph 49 I note that in the table presented in paragraph 58 Mr. Ouse describes the 2,4-D

(tetramethyl)ammonium salt as a “compound of the invention” when it is not. If Mr. Ouse is correct in his assertion concerning the substitution of the (tetraalkyl)ammonium hydroxide then it is not clear to me how the volatility results for the 2,4-D (tetramethyl)ammonium salt, which does not fall within the scope of the alleged invention, can be distinguished from compounds 1b and 1e which are “compounds of the invention”. That is, the claimed herbicidal compounds do not show less volatility (and less injury to nearby sensitive crops) then other quaternary ammonium salts of 2,4-D that fall outside the scope of the claims. In addition, there are many substituted (tetraalkyl)ammonium moieties covered by the claim for which no data is provided.

Additional data to support in the Patent Application – Paragraphs 57 to 62 of the Ouse Declaration

89. With respect to the experiments reported in paragraphs 57 and 62, I note that these experiments are not part of the opposed Patent Application nor is this evidence from Mr. Ouse in response to anything I have said in my First Declaration. It is my view that these experiments constitute new evidence. I am informed by Arcadia Intellectual Property that the Applicant has not filed an application for leave to introduce this new evidence.

90. In any event with respect to the additional experiment conducted by Mr. Ouse and reported at paragraphs 59 and 60 it is my view that the problems I have identified in respect of the method on page 12 (see paragraph 84) equally apply to this experiment. Specifically, the solvent used to prepare the solutions of 2,4-D acid, 2,4-D DMA, 2,4-DMEA and 2,4-D choline salt was not reported. Whereas 2,4-D DMA, 2,4-DMEA and 2,4-D choline salt are freely soluble in water, 2,4-D acid is only sparingly soluble in water. It follows that a solvent other than water was used to prepare the 2,4-D acid sample. The sprayed petri dishes were allowed to dry for 10 minutes; however, it is not stated if this was sufficient time for all solvent to be removed from the sprayed deposit. It is well understood that any solvent remaining after drying for 10 minutes will affect the observed volatility.

91. Further, the quantity of spray of each sample is not shown. It is known from the work of Que Hee and Sutherland in 1974 (PMH-15 to my First Declaration) that the rate of volatility is an inverse function of the ratio of initial surface area to applied mass. If this ratio was not the same for each sample tested, no conclusions regarding difference in volatility can be inferred from the experiment.

92. In addition, the samples were collected at times varying from 144 to 240 hours. It is not possible to compare the volatility of samples collected after various time periods. A test sample measured at 144 hours may show greater volatility if measured after 240 hours.

93. As stated above in paragraph 75 the “background discussion” provided on page 1 of the opposed Patent Application makes it clear that the central problem sought to be addressed is the volatility of known 2,4-D formulations resulting in unacceptable damage to neighboring sensitive crops. The objective of the alleged invention is described on page 2, lines 1 to 4 as being

> *“an herbicidal carboxylic acid derivative that is at least as active as the commercially used carboxylic acid herbicide salts, but which is less volatile so that its use would not damage nearby sensitive crops”* (my emphasis added)

94. By using the words “would not damage” the Applicant has set a requirement for nothing less than 0% injury in respect of the claimed herbicidal compounds/compositions. Had it intended something less than that the Applicant would have chosen different language in setting out the objective of the alleged invention. It is my view that the additional experiments reported by Mr. Ouse at paragraph 59 do not address prevention of damage or injury to sensitive plants. The additional experiments purport to measure the rate of evaporation of different salts in a laboratory apparatus and it is my view that no conclusions can be drawn from those results.

95. With respect to the experiment on the exposure of vapour from triclopyr ester and triclopyr salts to tomato plant in a humidome and the results reported in paragraph 61 it is not clear to me why this experiment is relevant. As stated above the claims of the opposed Patent Application are directed herbicidal

compounds derived from the herbicidal carboxylic acid 2,4-D only. Triclopyr based herbicidal compounds are not part of the alleged invention. Accordingly, the statements made by Mr. Ouse in paragraphs 61 and 62 are simply not relevant.

Operating conditions, Selective herbicidal properties & Selective administration – Paragraphs 63 to 75 of the Ouse Declaration

96. In response to Mr. Ouse's comments in paragraphs 63 to 75 I note that according to the opposed Patent Application, the herbicidal compounds of the purported invention are applied to vegetation or soil to achieve both a herbicidal effect and lower volatility. The problem of volatility, as noted in the opposed Patent Application at page 1, lines 14 to 21, is damage to highly susceptible crops to which, by inference, it has not been applied.

97. In the same way that the efficacy of a herbicide depends on the specific application rate (g/ha) as described at page 5 lines 3 to 7, the herbicidal effect of a vapour will also depend on the quantum of application and spatial relationship between the locus of the unwanted vegetation and the non-target plants. The opposed Patent Application does not show how to administer to achieve a lower volatility.

Clarity and Succinctness – Paragraphs 76 of the Ouse Declaration

98. In response to Mr. Ouse's statements in paragraph 76 I simply note that the claims need to be understood by what is written, not by what Mr. Ouse may understand it to mean. Claims 2 and 3 do not explicitly state that R^1, R^2 or R^3 are alkyl. The description of the formula in claims 2 and 3 is *"…wherein R^1, R^2 and R^3 independently represent $(C_1$-$C_{16})$alkyl or any two of R^1,R^2 and R^3 represent $–(CH_2)_n$ where n is an integer from 3-5 and R^4 represents $((C_1$-$C_{16})$alkyl or arylalkyl "* (my emphasis added). Thus, the second definition of R^1, R^2 and R^3 are not explicitly stated to be alkyl groups.

99. In view of the above it is therefore not clear to me whether, within the second definition of R^1, R_2 and R_3 in Claims 2 and Claim 3, which of the following alternative meanings apply:

a) The “$-(CH_2)_n$” repeating units are terminated by a group other than $-CH_3$,

b) The intended meaning is, as suggested by Mr. Ouse, “$-(CH_2)_nCH_3$” where n is an integer from 3 – 5, which describes a (C_4-C_6) alkyl group,

c) The intended meaning is “$-(CH_2)_{n-1}CH_3$” where n is an integer from 3–5, which describes a (C_3 –C_5) alkyl group; or

d) The intended meaning is that two of R^1, R^2 combine to form a (C_3 –C_5) cyclic group given that the definition of “alkyl” includes cyclic moieties.

100. Further if, as Mr. Ouse suggests, “any two of R^1, R^2, and R^3 represent $-(CH_2)_n-$ where n is an integer from 3 – 5” refers to alkyl groups then these alkyl groups are encompassed in the first part of the definition, being within the scope of “(C_1-C_{16}) alkyl.

101. I also note that the definition of “alkyl” provided on page 2, lines 21 to 27 of the opposed Patent Application encompasses more than just carbon and hydrogen atoms:

> *“Unless specifically limited otherwise, the term "alkyl", as well as derivative terms such as "arylalkyl", as used herein, include within their scope straight chain, branched chain and cyclic moieties. Unless specifically stated otherwise, each may be unsubstituted or substituted with one or more substituents selected from but not limited to halogen, hydroxy, alkoxy or alkylthio, provided that the substituents are sterically compatible and the rules of chemical bonding and strain energy are satisfied.”*

102. Accordingly, Mr. Ouse‘s assertion in paragraph 76 that claims 2 and 3 are clear is simply not correct.

Scope and Overview of Dr. Wright's Evidence

103. Dr. Wright was asked to comment on paragraphs 24-53, 59-65 and 115-145 of my First Declaration.

104. I make the following comments in relation to Dr. Wright's evidence. My decision not to comment on all the statements made in the Wright Declaration either in part or in full should not be taken as an indication of my agreement with that evidence generally or the comments made therein.

Instructions

105. In paragraph 26 Dr. Wright he criticizes my focus on the "volatility of 2,4-D formulations, and the issue of vapor drift" noting that he does not "consider the issue of volatility or vapor drift relevant to the claims". It is my view that Dr. Wright's statement is at odds with the views he expressed in

(a) paragraph 49 where he made it clear that it was his understanding that the problem sought to be addressed in the opposed Patent Application was identified at page 1 as "vapor drift" and his earlier statement in paragraph 36 where he acknowledges that *"spray drift/droplet drift and vapor drift may cause damage to susceptible plants at some distance from the locus of application"*; and

(b) paragraph 50 where Dr. Wright makes it clear that in addition to ensuring that the herbicidal efficacy of the herbicidal formulation is retained "minimizing vapor drift" is a "primary consideration" (citing page 2, lines 1 to 3 of the opposed Patent Application).

Dr. Wright's comments in paragraph 26 are also at odds with Dr. Pearson's statements in paragraph 51 where he seeks to rely on a "*herbicidal carboxylic acid <u>with reduced volatility</u>"* as a basis to dismiss the disclosure in PMH-17 as well as the stated objective on page 2, lines 1 to 4. Accordingly, it is not clear to me as to the basis of Dr. Wright's assertion in paragraph 26.

Herbicides; 2,4-D; Modifying the chemical structure of 2,4-D into a useful product - Paragraphs 27 to 31 of the Wright Declaration

106. In response to Dr. Wright's comments in paragraphs 29 and 30 I simply note that there are many different ways in which herbicides may be classified. For example, by the mode of application, pre-emergent (generally meaning application to soil before seeds germinate) or post-emergent (generally meaning application to the foliage of plants which have emerged from soil). Further, herbicides may be classified as either total herbicides, which have an adverse biological effect on essentially all plants or selective herbicides which have an adverse effect on a specific subset of plants.

107. I also note and agree with Dr. Wright's comments in paragraph 29 that 2,4-D is often used in mixtures with other herbicides. I add that it was known and in fact common practice in the field well before February 2007 to combine two or more herbicides in order to control a wider spectrum of weeds/unwanted vegetation. I further note that this is consistent with the description on page 5, lines 8 to 20 of the opposed Patent Application and is consistent with the views I have expressed above in paragraphs 37 and 38.

Spray Drift - Paragraphs 33 to 36 of the Wright Declaration

108. In response to paragraph 36 I agree in part with Dr. Wright's comments that the susceptible plants may be "at some distance from the locus of application" however the opposed Patent Application provides no dimension for the locus of unwanted vegetation or the spatial relationship between the locus of unwanted vegetation and the neighboring crop. As it stands therefore the neighboring crop or susceptible plants may be "nearby" (as stated at page 2 lines 3 and 4 of the opposed Patent Application) or even "adjacent" (page 1 line 12 of the opposed Patent Application) to the unwanted vegetation.

Alternative forms of 2,4-D - Paragraphs 37 to 50 of the Wright Declaration

109. In response to Dr. Wright's statements in paragraphs 37 to 46 where he seeks to question the characterizations in the technical literature that amine salts of 2,4-D are "non-volatile", I simply refer to PMH-15 of my First Declaration

which is the paper published by S.S. Que Hee and R. G. Sutherland published in *Weed Science*, Vol. 22, No. 4, (Jul., 1974) and titled "Volatilization of Various Esters and Salts of 2,4-D". The final paragraph on page 318 states as follows:

> *"The results in this paper show that if vapour drift is important for 2,4-D type of compounds, that this can be essentially eliminated by the use of amine salts instead of esters, as the volatilities of salts measured here even with no formulation materials present, and using an unrealistically high Q value, are less than 10% after 48 hr, by which time most of the salt impacted on plant leaves will be absorbed".*

PMH-15 shows that although the presence of 2,4-D amine vapours can indeed be detected using highly sensitive laboratory techniques, the quantity of vapour was insufficient to cause damage to sensitive plants.

Accordingly, Dr. Wright's criticisms of my evidence and his assertion in paragraph 47 that amine salt forms of 2,4-D are not "non-volatile" is certainly not supported by the established literature dating to the early 1970s. I reiterate my earlier comments that from a practical agricultural perspective, amine salt forms of 2,4-D are non-volatile. Also, Dr. Wright's statement in paragraph 48 that the potential problem of vapour drift still existed at the Relevant Date, even with the use of amine salts, is also <u>not supported</u> by the findings in the *Weed Science* paper (PMH-15).

110. In paragraph 35 Dr. Wright states that vapor drift is a problem associated only with volatile herbicides. At paragraph 47 he further states, "a substance that has a non-zero vapor pressure therefore exhibits some degree of volatility" and in paragraph 48 Dr. Wright continues: "I disagree that the amine salts of 2,4-D are totally non-volatile; there is no absolute zero of volatility." It appears that it is Dr. Wright's view that all amine salts of 2,4-D are volatile and are associated with vapor drift. This view is contradicted by the established literature (see the Weed Science paper PMH-15).

111. Before specifically addressing Dr. Wright's assertions in paragraphs 41 to 45 I think it is important for me to note the following point. It is well understood

that the term "volatility" does not have a fixed meaning and is dependent on the particular context. Specifically in a physical chemistry or thermodynamics context, volatility is the measured concentration of a substance in the air. The introduction section of the paper by Que Hee and Sutherland (1974) (PMH-15) provides a good definition. "Vapour pressure" by contrast has a very precise definition and is defined at equilibrium in a closed system. In the agricultural context (which is the context of the opposed Patent Application) the "volatility" is understood to mean or relate to the movement of vapor and its adverse impact on non-target plants. As widely reported in the literature before February 2007, esters of 2,4-D are seen as having a greater volatility and as such a significant impact on non-target plants than the amine salts of 2,4-D.

112. Turning now to Dr. Wright's assertions in paragraph 45 I reject the contention that the development of the AMICIDE L0*-500A or the AMICIDE 625-Low Selective Herbicide was to solve the product of volatility in respect of vapor drift. As already stated the problem of volatility/vapour drift/crop damage associated with the ester form of 2,4-D had already been considered in the *Weed Science* paper in 1974 (PMH-15) and "essentially <u>eliminated</u>" through the use of amine salts of 2,4-D. AMICIDE L0*-500A or the AMICIDE 625-Low Selective Herbicide were developed by Nufarm to address the issue of volatility in the physical chemistry or thermodynamics context that manifested as an odour. Nufarm was able to address the issue of odour by replacing odorous dimethylamine (boiling point 7ºC) with bases of less odour with higher boiling point such as diethanolamine (boiling point 269ºC).

113. Finally, Dr. Wright asserts in paragraph 48 that there is "no absolute zero of volatility" and that, as a consequence, the problem of vapour drift still existed at the Relevant Date, even if amine salts were utilized. In making this assertion Dr. Wright is saying the presence of vapour in the air, in any amount, may cause the problem with vapour drift which is the damage to sensitive plants after movement of the vapour. I reiterate my earlier comments that a sufficient quantity of vapour is required to damage sensitive plants. The notion that the presence of any amount of vapour, however

minute, will cause damage is not supported by the established literature (see PMH-15).

114. In response to Dr. Wright's assertions in paragraph 46 and his subsequent assertions in paragraph 48 concerning the existence of a "potential problem of vapour drift at the Relevant Date" I comment as follows. The problem purported to be solved by the opposed Patent Application is described on page 1, lines 9 -15 as being:

> *"Acid herbicides such as 2,4-dichlorophenoxyacetic acid (2,4-D) have long been used to control unwanted vegetation. 2,4-D is normally converted into liquid formulations by conversion to water soluble salts or emulsified esters. The ester formulations have been found to be more effective than the salts on an acid equivalent basis in the control of noxious vegetation but have the unwanted characteristic of migrating to adjacent desirable vegetation because of the volatility thereof, resulting in unacceptable damage to sensitive plants."*

This passage makes it very clear that the opposed Patent Application is about the use of 2,4-D, <u>in agriculture</u>. D5 is a document prepared by Agriculture Western Australia to explain the problem of volatility to farmers. D6 is a document prepared by a task group of the World Health Organization (D6 at page 3) which discusses the environmental aspects of 2,4-D. Section 2.3 on page 7 of D6 describes the volatility of 2,4-D derivatives as follows:

> *"2,4-D esters with short-chain alcohols are highly volatile. This influences the effectiveness of their application to target crops, their effects on neighbouring crops, and the degree of contamination of the atmosphere. 2,4-D alkali salts or amine salts are much less volatile than esters, and these products are to be preferred when the use of 2,4-D esters might lead to evaporative 2,4-D losses and to crop damage or damage to the surrounding environment."*.

D7 is a document prepared by NSW Agriculture to explain the problem of spray drift, as droplets, particles or vapours, to farmers.

PMH-11 is a review of the environmental effects of 2,4-D esters by the Australian Pesticides and Veterinary Medicines Authority (APVMA), the Australian government entity responsible for regulating the use of pesticides, including herbicides, in Australia. The scope of the document is explained at page 9:

> *“Products containing 2,4-D (a phenoxy herbicide) are used for control of broadleaf and grass weeds in an extensive range of crops and non-cropping situations. Aerial, handheld and ground methods of application are used. Major agricultural uses of 2,4-D include pasture, stubble and fallow maintenance, cereal crops (including wheat, oats, barley, rye, triticale), grain crops (including sorghum, millet, maize) and oilseed crops (safflower, canola, rape). Other agricultural uses include cotton, citrus crops (particularly to inhibit post harvest abscission of buttons), sugar cane, sweetcorn, peanuts and control of banana suckers. 2,4-D is also used extensively for weed control in non-cropping situations, including commercial and industrial areas, turf and aquatic areas.*
>
> *The active constituent 2,4-D, all products containing 2,4-D and their associated labels were placed under review because of concerns over toxicological, occupational health and safety and environmental issues (including impacts on waterways, non-target animals and plants).*

From the above it is clear that D5, D6, D7 and PMH-11 discuss the comparative volatility of salts and esters of 2,4-D from the perspective of practical agriculture which is concerned with damage to sensitive non-target plants caused by vapour, not from the perspective of academic physical chemistry. Collectively these references, which were published well before February 2007, show that problem of damage to off-target plants as a result of vapour drift caused by 2,4-D esters could be eliminated by the use of various amine salts of 2,4-D.

115. Nevertheless, if Dr. Wright wishes to consider the issue of whether damage to off-target plants as a result of vapour drift caused by 2,4-D esters can be eliminated by the use of various amine salts of 2,4-D. from a pure academic perspective, then I simply say that I have already addressed the relevant physical chemistry in my First Declaration. Table 4 on page 317 of the paper by Que Hee and Sutherland (1974) (PMH-15 of my First Declaration) reports the vapour pressure of methylamine, dimethylamine (<u>a secondary amine</u>), n-butylamine, n-dodecylamine and n-tetradecylamine salts of 2,4-D and the volatilisation of these salts after 48 hours at 38^{o}C, 0% relative humidity, based

on measurements of ^{14}C ring labelled 2,4-D. I note that the volatilisation of the 2,4-D amine salts was measured using a similar bell jar experiment to that reported by Mr. Ouse at paragraph 59 of the Ouse Declaration. Most importantly, the concluding paragraph of the paper states:

> “*The results in this paper show if vapor drift is important for 2,4-D type compounds, that this can essentially eliminated by the use of amine salts instead of esters, as the volatilities of salts measured here even with no formulation materials present, and using unrealistically high Q values, are less than 10% after 48 hr, by which time most of the salt impacted on plant leaves will have been absorbed”.*

Thus, the Que Hee and Sutherland paper showed in 1974 the vapor pressures of 2,4-D amine salts were known and that the volatile loss of these salts could be measured, albeit under laboratory conditions. In the decades that followed the Que Hee and Sutherland paper, Australian Agricultural departments regarded the class of 2,4-D amines salts to be “non-volatile” because the problem of damage to non-target sensitive plants was simply not observed following application of herbicides comprising 2,4-D amines. These same government sources differentiated the class of 2,4-D amines from the class of 2,4-D esters.

116. As already noted Dr. Wright is not correct in his assertion in paragraph 48 that the potential problem of vapour drift still existed in February 2007. The findings in the Que Hee and Sutherland published in 1974 (PMH-15) concluded that this problem had already been “essentially eliminated by use of amine salts”. That is PMH-15 showed that amine salts of 2,4-D including the dimethylamine salt form were not sufficiently volatile for damage to occur. Accordingly the problem of vapour drift identified on page 1, lines 21 to 25 of the opposed Patent Application had already been addressed well before February 2007.

117. In response to Dr. Wright’s comments in paragraph 49 it appears that he has not read or comprehended my earlier evidence. D7 is referenced in my paragraph 41. In D7 spray drift is sub-divided, or categorized, as having three types, droplet drift, vapour drift or particle drift. The need to maintain effectiveness is apparent for all three modes of drift described in D7.

118. In paragraph 50 Dr. Wright appears to recognize the importance of the herbicidal compound/composition of the opposed Patent Application having sufficient herbicidal efficacy whilst minimizing vapour drift and in so doing seeks to rely on the disclosure in the opposed Patent Application at page 2, lines 1 to 3, 8 to 9 and on the disclosure in JP51106728 (identified as D2 in my First Declaration) in support of this. Dr. Wright also states that he and others in the field would deem a level of herbicidal activity that still produces the outcome of controlling unwanted vegetation to be a “retention of sufficient herbicidal activity”. I agree that this is indeed the case although I note with interest that Mr. Ouse does not agree (see paragraphs 24 to 28 of the Ouse Declaration). Mr. Ouse considers that merely acting as a herbicide is enough.

119. Further, whilst the compositions of the invention are said to have a herbicidal activity that is “*comparable to the commercially used carboxylic acids”* as I have already noted the results in Table II on page 11 do not show that the compounds of the alleged invention have a comparable herbicidal activity compared to commercial controls or even excluded compound 2,4-D tetramethylammonium salt. In fact the results of above Table showed that the excluded compound 2,4-D tetramethylammonium salt and the commercially used dimethylamine salt of 2,4-D had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) at 77% than compound 1c being 2,4-D tetrapropylammonium salt at 73% and the herbicidal compound of claim 7 - compound 1e (2,4-D choline salt) at 68%. Likewise, the known herbicidal salt triclopyr triethylamine had a significantly better herbicidal activity against Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) at 81% and 91% respectively compared to quaternary ammonium salt forms of 2,4-D including relevantly the 2,4-D choline salt.

120. The results of Table II also showed that the quaternary ammonium salt forms of the herbicide triclopyr had a significantly better herbicidal activity against both Broadleaf Dock (*Rumex obstusifolia*) and Kochia (*Kochia scoparia*) than the corresponding quaternary ammonium salt forms of 2,4-D. As already noted the triclopyr quaternary ammonium salts do not fall within the scope of claims 1 to 7.

121. As it stands therefore the claimed herbicidal compounds do not exhibit a herbicidal activity that is in any way as active as the commercially used carboxylic acid herbicide salt or those quaternary ammonium salts that do not fall within the scope of the claims such as the tetramethylammonium salt of 2,4-D.

122. I note that in paragraph 41 Dr. Wright agrees with me that D5 describes dissociation of 2,4-D dimethylamine salt in aqueous solution to the 2,4-D anion and dimethylammonium anion at Table 1, however he does not agree that the dissociation is “rapid”. Dr. Wright is clearly wrong on this point. In this regard I refer to Section 4.3.3.1 of PMH-11 on page 28 which states:

> *“Direct evidence of the stability of 2,4-D amine salts in soil and aquatic environments is difficult due to the lack of analytical methods. The US EPA point out in their report that based on maximum application rates for 2,4-D amine salts (@ 4.5 kg ai/ha), 2,4-D amine salts are expected to fully dissociate in soil environments because their theoretical concentrations in soil solution does not exceed water solubilities. Additionally, dissociation studies indicate the time for complete dissociation is rapid (< 3 minutes). Reim (1989) considered the dissociation of 2,4-D and 2,4-D DMA in water. Analytical grade 2,4-D and 2,4-DMA, in HPLC grade water had dissociation times of ≥120 minutes and <1 minute, respectively. Complete dissociation was determined through a comparison of theoretical and estimated electrical conductance measurements at infinite dilution. For 2,4-D DMA, plots of equivalent conductance vs. concentration*$^{1/2}$ *(Onsager equation) are linear indicating it is a strong electrolyte while that for 2,4-D is non-linear indicating it is a weak electrolyte. Conductivity data are consistent with the premise that 2,4-D DMA completely dissociates in aqueous solution to form dimethylammonium ion and the conjugate base of 2,4-D.”*

123. In response to Dr. Wright’s assertions in paragraphs 45 and 70 it is not clear to me what point he is attempting to make. It cannot be disputed that herbicidal formulations containing diethanolamine and triethanolamine had been produced and sold since the early 1980s. It cannot be disputed that a

person skilled in the art at that time would know, by reference to standard chemical reference works readily available at the time, that the boiling points of diethanolamine (271^{o}C at atmospheric pressure) and triethanolamine (277^{o}C at 150 mm Hg) were significantly higher than the boiling point of dimethylamine (7^{o}C at atmospheric pressure). It should not come as any surprise to Dr. Wright that the person skilled in the art would refer to standard chemical reference works rather than Agriculture Department notes published 20 years in the future. It seems to me that Dr. Wright has confused the broad classification of 2,4-D amine salts as being “non-volatile” in the sense used in practical agriculture, such as in D5, D6, D7 and PMH-11, and the concept of volatility as used in physical chemistry or thermodynamics context. See my comments above in paragraph 111.

Quaternary ammonium salts – Paragraphs 51 to 68 of the Wright Declaration

124. In paragraphs 51 to 59 Dr. Wright discusses the volatility of amine salts of 2,4-D. He accepts that increasing the molecular weight within a class of compounds is a general trend known to decrease volatility (see paragraph 56 of the Wright Declaration). It is well understood that the molecular weight goes up in the homologous series. For example methylamine < dimethylamine < trimethylamine< tetramethylammonium hydroxide and therefore quaternary ammonium salts have a higher molecular weight than the primary, secondary or even tertiary salts.

125. It appears to me Dr. Wright’s analysis is flawed as he has only considered the behaviour of quaternary ammonium salts of 2,4-D in aqueous solution. Dr. Wright has not considered the effect of molecular weight on the vapour pressure of quaternary ammonium salts of 2,4-D *per se*. That is, Dr. Wright discusses equilibria considerations in aqueous solution however, he has ignored the spray application process described in the opposed Patent Application in which the herbicidal compound is dissolved in water and sprayed as fine droplets. Page 3 lines 17 – 20 describes the application of the compounds and their compositions to kill and control undesirable vegetation by application of an herbicidal amount of the compound to the vegetation or to the locus of vegetation as well as soil prior to emergence of the vegetation

and the compounds of the alleged invention are said to be generally applied as a spray (see page 4, lines 23 and 24 and page 11, lines 3 to 7). These droplets settle on either plant foliage or bare soil in proportion which depend on the foliage canopy of the area sprayed. At one extreme a crop such as 2,4-D tolerant soybean may have a dense canopy which captures the majority of applied droplets, whilst at the other extreme an application on fallow involves application onto essentially bare soil with sparse remnant dried stalks or straw and young emerging weeds.

126. In the first case the spray droplets land predominantly on leaf surfaces and rapidly dry to form a solid deposit of 2,4-D primary, secondary, tertiary or quaternary amine salt, as shown in D3, page 1 at lines 73 to 78. As a crystalline deposit, the dissociation mechanism described by Dr. Wright would not occur. It would be the 2,4-D amine salt that evaporates.

127. In the second case, the droplets land on the bare soil and dissolve in soil moisture. At this point a large number of complex simultaneous equilibria occur, including

(a) adsorption of 2,4-D anions and quaternary ammonium cations onto the charged sites on soil particles,

(b) pH dependent absorption of non-dissociated 2,4-D acid onto soil organic matter,

(c) reaction of 2,4-D with dissolved metal ions, such as calcium, magnesium and iron, to form insoluble salts of 2,4-D, and

(d) ionic equilibria with other herbicides applied in conjunction 2,4-D (tetraalkyl)ammonium salts as described at lines 8 to 20 of page 5.

128. I conclude that the mechanism outlined by Dr. Wright is limited in scope to the evaporation of 2,-4D amine from aqueous solution, such as may be observed in a laboratory setting, and is not relevant to the many competing equilibria found in soil water or to the evaporation of dried 2,D salt deposits from plant surfaces.

129. In response to paragraph 62 I note that Dr. Wright agrees with me that the reactivity of quaternary ammonium hydroxides is comparable to sodium hydroxide and are therefore expected to react with carboxylic acids in a similar way. It follows that as a strong base the quaternary ammonium cation will readily dissociate in aqueous solution.

130. For the reasons provided above in paragraphs 126 to 129 it is my view that Dr. Wright is not correct in his assertions in paragraph 63. It is my view that Dr. Wright is considering volatility in a very artificially limited manner. Ionic dissociation is not relevant for dried deposits on plant surfaces, and multiple complex equilibria exist in soils.

131. In response to Dr. Wright's criticisms (in paragraph 64) of my statements in paragraph 52 to 57 of my First Declaration, I reiterate my earlier comments that I would not have ruled out the use of other amine salts such as quaternary ammonium salts. There is simply no basis to do so particularly given that the processes used to prepare a quaternary ammonium salt form of 2,4-D by neutralization of 2,4-D with a quaternary ammonium hydroxide in aqueous solution would not involve complicated laboratory techniques. In my opinion **<u>all</u>** salts of 2,4-D, including quaternary amine salts, would have been considered in any research program. In fact, it would be highly unusual to reject a class of salts simply because they may not have been in wide use or even in commercial use or more expensive or more difficult to make. Quaternary ammonium salts of 2,4-D were widely known before February 2007 as I have already established in my First Declaration. In this regard I rely on the disclosure in the extract from the elementary organic chemistry text from M.F. Grundon and H.B. Henbest 5th Edition (1971) (PMH-14 of my First Declaration); the extract from the text "Phenoxyalkanoic Herbicides" (PMH-16 to my First Declaration); JP51106728 with a publication date of 21 September 1976 (D2), GB 1339315 with a publication date of 5 December 1973 (D3); DD203677 with a publication date of 2 November 1983 (D1). I also rely on US 2,900,411 (PMH-18) and GB 1,056,235 (PMH-17). My comments here equally apply to Dr. Wright's assertions in paragraph 71 of the Wright Declaration.

132. Dr. Wright’s assertion in paragraph 64 (and again in paragraph 71) that simply because I may not have made quaternary ammonium salts of 2,4-D that this somehow undermines my statement in my First Declaration, is with respect, a nonsensical argument. Nufarm was already selling a non-volatile 2,4-D amine salt product that met the market need and there was no perceived need to change.

133. In response to paragraphs 66 to 68 of the Wright Declaration whilst it is agreed that n-tetradecylamine is not a quaternary ammonium, I stand by my comments including that the synthesis and properties of quaternary ammonium cations were clearly well known before February 2007. As stated in paragraph 49 of my First Declaration the extract from the elementary organic chemistry text from M.F. Grundon and H.B. Henbest 5th Edition (1971) (PMH-14 of my First Declaration) shows the synthesis of the tetraalkylammonium halides and the conversion into the corresponding base. The example shown is butyltrimethylammonium hydroxide, which is a quaternary ammonium. I note that my comments in respect of this extract have not been questioned by Dr. Wright. I further note that Dr. Wright agrees with me that quaternary ammonium hydroxides are strong bases and that they have a base strength which is comparable to sodium hydroxide (paragraph 62 of the Wright Declaration). In any event PMH-16 does disclose 2,4-D quaternary ammonium salts as outlined below.

134. Dr. Wright is not correct in his assertion in paragraph 66 that the text “Phenoxyalkanoic Herbicides” (PMH-16 to my First Declaration) does not disclose a 2,4-D quaternary ammonium salt. The first paragraph of the section entitled “B. Amine Salts” on page 117 of PMH-16 in particular footnotes **“188-220”**. I refer and repeat my comments above in paragraph 29 in response to paragraphs 37 to 39 of the Pearson Declaration. It follows that PMH-16 includes a reference to 2,4-D quaternary ammonium salts.

Discussion as to a non-volatile 2,4-D formulation - Paragraphs 69 to 73 of the Wright Declaration

135. The reasons provided above Dr. Wright is not correct in his assertion in paragraph 69 as to the volatility of the amine salts of 2,4-D. His position is not supported by the established literature dating to the early 1970s (PMH-15).

136. For the reasons provided above Dr. Wright is not correct in his assertion in paragraph 70. As already noted all the references are to the agricultural literature. As Que Hee and Sutherland (PMH-15) showed, in practical agriculture the various 2,4-D salts cannot be distinguished because adverse effects on plants as a consequence of 2,4-D salt volatility was simply not observed. In agriculture, all salts of 2,4-D were considered “non-volatile”, as distinguished from the “volatile” esters.

137. As noted above it is important to distinguish between the meaning of “volatility” in the agriculture context being one that is essentially defined by effect on non-target plants and the meaning of volatility in physical chemistry which describes a quantitative measure of a substance in air. The two contexts are completely different.

138. In response to Dr. Wright’s criticisms (in paragraph 71) of my statements in paragraph 63 of my First Declaration and for the reasons provided in paragraph 131 I reiterate my earlier comments that I would not have ruled out the use of other amine salts such as quaternary ammonium salts. There is simply no basis to do so. In my opinion **all** salts of 2,4-D, including quaternary amine salts, would have been considered in any research program.

139. Dr. Wright is not correct in his contention in paragraph 71 that quaternary ammonium salts of 2,4-D are more difficult to produce than primary, secondary or tertiary amine salts. It is my view that production starting from the quaternary ammonium hydroxide is no more difficult than production from any other amine. It would merely involve mixing the quaternary ammonium hydroxide with 2,4-D in water. In fact this is evident from the disclosure in GB 1339315 (D3) which describes the use of a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a

quaternary ammonium salt where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl" which encompasses choline hydroxide, to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops. On page 5 lines 37 to 57 D3 describes the active salt ingredients being prepared using *"techniques and procedures well known to those skilled in the chemical art"* such as *"merely admixing the appropriate ingredients in a liquid polar carrier (preferably water)."* This is consistent with Mr. Ouse's comments in paragraph 45 where he makes it clear that as general method for preparing a reaction product formed between herbicidal carboxylic acids and unsubstituted or substituted N-alkyl/arylalkyl ammonium hydroxide is described on page 4, lines 6 - 12 of the opposed Patent Application and that three more descriptive preparative methods are provided on page 9. All the preparative methods provided in the opposed Patent Application are not, with respect to Dr. Wright, particularly complex. Even if I were to accept Dr. Wright's contention as to difficulties of preparing the quaternary ammonium salts of 2,4-D, a point that I do not concede, this is certainly not a reason to rule them out. Further it is noted that if, as Dr. Wright says, quaternary ammonium salts of 2,4-D are more expensive, which Dr. Wright has not established and which I do not agree considering the ease of manufacture, it is my view that this is not a reason not to rule them out.

140. In response to Dr. Wright's final assertion in paragraph 71, I repeat my earlier statements that the process used to prepare a quaternary ammonium salt form of 2,4-D do not involve complicated laboratory techniques. This is clear from Dr. Pearson's evidence. That is in paragraph 31 of the Pearson Declaration Dr. Pearson makes it clear that the claims do not include an additional limitation on the method used to prepare the reaction product. As I have said before, all that is required to produce the reaction product is a reaction of a (tetraalkyl)ammonium moiety and 2,4-D. Dr. Pearson also makes it clear with reference to page 8, lines 20 and 21 that the preparative methods provided on page 9 are for "illustrative purposes only and not to be construed as a limitation on the claims". In paragraph 27 of the Pearson Declaration, Dr. Pearson states that it is generally understood by those in the art as to what is meant by isolating, and the opposed Patent Application

includes “*an example of the reaction and isolation step, <u>in addition to alternative methods</u>*”. In paragraph 28 of the Pearson Declaration Dr. Pearson makes it clear that he does not see there to be a need to identify which of the three methods on page 9 is the “best mode”. Accordingly there is simply no reason to reject the quaternary amine salts based on the preparatory process. It would also be highly unusual to reject a class of salts simply because they may not have been in widespread use or even in commercial use. It is my view that **all** salts of 2,4-D, including quaternary amine salts, would have been considered in any research program and it is, with respect, a nonsensical argument for Dr. Wright to suggest otherwise.

141. In response to Dr. Wright’s assertions in paragraph 73 my comments in paragraph 65 of my First Declaration as to water solubility I simply state that it relates to practical utility of the resultant amine. It is a common feature of the commercial amine salts of 2,4-D and triclopyr that they are readily soluble in water. This has advantages in the application of the resultant product. Readily soluble products may be stored and transported as a concentrated aqueous solution and be easily diluted in water for application as a spray.

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142. Concerning Dr. Wright’s comments in paragraphs 74 and 75, I refer to my comments in paragraphs 127 and 128 above. The use of amine salts including quaternary ammonium salts to eliminate vapor drift caused by 2,4-D esters was well known before February 2007 (see PMH-15). As stated in paragraph 72 of my First Declaration the paper by S. Que Hee and R. G. Sutherland published in *Weed Scien*ce in July 1974 is referenced in the text “Phenoxyalkanoic Herbicides” (PMH-16).

143. I disagree with Dr. Wright that PMH-16 merely describes the use of primary amine salts to “minimize vapor drift”. As noted above the results in PMH-15 showed that if vapour drift is important for 2,4-D formulations that *“this can be <u>essentially eliminated</u> by the use of amine salts instead of esters”.* Accordingly, the problem of vapour drift associated with 2,4-D esters had

been addressed by the *Weed Science* paper (PMH-15) in 1974. PMH-15 is referenced in PMH-16.

144. Dr. Wright's comments in paragraph 75 that PMH-16 provides no information regarding the herbicidal activity of 2,4-D n-tetradecylamine are nonsensical. It should go without saying that 2,4-D by its very nature is a herbicide and therefore the n-tetradecylamine salt form of 2,4-D would have herbicidal activity.

145. Further Dr. Wright's assertion in paragraph 75 that PMH-16 only describes the "use of *primary* amine salts to minimize vapor drift" is incorrect. Not only do the results reported in PMH-15 show that the problem of vapour drift is "essentially eliminated" (not "minimized" as suggested by Dr. Wright) but PMH-15 uses both a secondary amine (dimethylamine) salt of 2,4-D and the primary amine salt form. If a secondary amine 2,4-D salt such as dimethylamine, which I note is the amine formulation specifically referred to on page 1 line 18 of the opposed Patent Application, is shown by PMH-15 to be not sufficiently volatile for damage to occur, then the problem sought to be solved by the opposed Patent Application in respect of the quaternary amine salt did not exist at the Relevant Date.

F. COMPARISON OF THE PATENT APPLICATION AND THE PRIOR ART

D3: GB 1339315 – Paragraphs 76 to 84 of the Wright Declaration

146. I remain of the view that D3 describes the use of a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a quaternary ammonium salt where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl" which encompasses choline hydroxide, to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops. There is nothing that Dr. Wright has put forward in paragraphs 82 to 84 to change my view.

147. In response to paragraph 82 I note that Dr. Wright accepts that the options for the quaternary ammonium radicals, R, R_1, R_2 and R_3, would encompass of the quaternary ammonium anion "choline", however, I disagree with Dr.

Wright that D3 does not describe the nature of the counter ion. Page 2, lines 60 to 65 of D3 clearly describes the method of preparing a herbicidal salt composition as involving

> *"reacting the bases with the [at least one herbicidally active] acid to form a mixture of salts …"* (my emphasis added).

I further note that page 2, lines 109 to 113 describes the salts which may be employed as including the

> *"alkali metal salts and the salts formed by the reaction of other bases such as ammonium hydroxide, with the appropriate acids"* (again my emphasis added).

It is my view that this description in D3 could not be any clearer that the counter ion is "hydroxide" and that this prior disclosure does encompass "choline hydroxide".

148. Finally in response to Dr. Wright's comments in paragraphs 76 to 81 I note that he has curiously omitted reference to the statement at line 59 to 64 on page 1 that compared to an ester derivative *"a salt of a herbicidally active acid (the amine salts being the most widely used group of salts) is substantially always non-volatile due to ionization of the salt in an aqueous carrier"*. As stated in my First Declaration D3 has a publication date of 1973.

149. As a final point, the reaction product of the claims of the opposed Patent Application is the reaction product of the reaction of a (tetraalkyl)ammonium moiety such as a choline cation and 2,4-D. D3 clearly describes such a reaction. The hydroxide does not take part on the reaction.

D2: JP 51-1 06728 – paragraphs 85 to 131 of the Wright Declaration

150. In response to Dr. Wright's comments in paragraph 93 I note that D2 describes "greatly reducing the risk of chemical damage to the crop" and therefore it is not clear to me how Dr. Wright can suggest that D2 does not consider the problem of volatility.

151. Dr. Wright's comments in paragraph 94 are contrary to what is actually demonstrated in D2. As stated in paragraphs 132 and 133 of my First Declaration the results of the use of the herbicide of practical embodiment (1) being a mixture of 2,4-D, choline hydroxide, a surfactant and water reported in Table 2 on page 8 of PMH-27 (D2) showed that at concentrations ranging from 30 ppm to 1000ppm there was maximum herbicidal effect against the Daikon and beans and **no** i.e. 0% chemical damage to the maize and wheat crops after 17 days. On my reading of Table 2 of D2 the results clearly show that the herbicide of practical embodiment (1) demonstrated no injury to neighboring sensitive crops. This must equate to the composition of D2 having a reduced volatility.

152. I disagree with Dr. Wright's assertions in paragraphs 95 and 96 that D2 does not disclose choline hydroxide. According to D2 the characteristics of "choline" are:

    i. It is <u>not</u> a "salt of choline" (page 3, line 18). In fact, according to D2 "choline salts" are said to be for example salts of choline with organic acids such as such as oxalic acid and ascorbic acid or salts of choline with inorganic acids such as phosphoric acid and carbonic acid (page 3 lines 18 to 21);

    ii. It reacts with phenoxy substituted lower aliphatic acids to form a choline salts of phenoxy substituted lower aliphatic acids (page 3, lines 22 to 24) which are water soluble (page 3, lines 33 to 39).

    iii. That if the molar ratio of cholines to phenoxy compound is greater than 1.2 then the herbicide becomes highly alkaline and risk of harm increases (see page 3, lines 31 and 32).

It is my view that the term "choline" in D2 is "choline hydroxide" and there is nothing that Dr. Wright has said to change my view.

153. To confirm my view that the term "choline" in D2 is "choline hydroxide" I instructed Dr. Jason McKerrow to conduct a series of experiments where each of choline hydroxide, choline chloride and choline bitartrate were reacted

with 2,4-D acid to compare the results with those reported in D2. The experiments were as follows:

(a) Experiment 1, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline hydroxide (90 mmol, molar ratio 1:1).

(b) Experiment 2, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline chloride (90 mmol), a choline salt with an inorganic acid (molar ratio 1:1).

(c) Experiment 3, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline bitartrate (90 mmol), a choline salt with an organic acid (molar ratio 1:1).

(d) Experiment 4, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline hydroxide (117 mmol, molar ratio 1:1.3)

(e) Experiment 5, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline chloride (117 mmol, molar ratio 1:1.3).

(f) Experiment 6, a slurry of 2,4-D (90 mmol) acid in water was reacted with a 10% aqueous solution of choline bitartrate (117 mmol, molar ratio 1:1.3).

154. Dr. McKerrow’s results are summarized in the following table.

Expt #	T (°C) Initial	T (°C) after addition	T(°C) 20min after addition	pH	Comments
1	19.0	20.6	20.3	6.9	Mixture changed from slurry to almost clear immediately after addition to clear 20min after addition. Obvious temperature increases due to addition.
2	19.2	19.1	19.3	2.8	No increase or decrease in total solid content of mixture
3	19.2	19.2	19.3	3.4	No increase or decrease in total solid content of mixture
4	20.0	21.4	21.2	12.7	Mixture changed from slurry to almost clear after addition to clear 20min after addition. Obvious temperature increase due to addition.
5	20.0	20.3	20.3	2.7	No increase or decrease in total solid content of mixture
6	20.2	20.3	20.4	3.4	No increase or decrease in total solid content of mixture

155. Dr. McKerrow’s experiments showed that 2,4-D acid reacts with choline hydroxide in equimolar proportions immediately to form a clear aqueous solution, with the evolution of heat, to form a solution of pH 6.9. This is consistent with the behavior reported in D2 for the choline at page 3, line 22 and lines 36 to 39.

156. Dr. McKerrow’s experiments show that 2,4-D acid reacts with choline hydroxide in a molar ratio of 1:1.3 to form a clear aqueous solution, with the evolution of heat, to form a solution of pH 12.7. This is consistent with the behavior reported in D2 for the choline (see page 3, line 22, lines 31 to 32 and lines 36 to 39).

157. Dr. McKerrow’s experiments show that a 2,4-D acid does not react with a choline salt of an inorganic acid (choline chloride) or a choline salt of an organic acid (choline bitartrate) in either equimolar proportion or in molar ratio 1:1.3. Specifically, 2,4-D acid does not dissolve and there was no evolution of heat.

158. As the herbicides envisaged by D2 are water soluble chemicals comprising phenoxy substituted lower aliphatic acids and choline (PMH-27 in the

sentence bridging pages 3 and 4), Dr. McKerrow's experiments clearly demonstrate the "choline" of D2 is choline hydroxide.

159. I reject Dr. Wright assertions in paragraphs 101 and 102 that the terms "choline" and choline hydroxide" in documents D8 to D14 have been "carelessly and incorrectly used interchangeably." I have revisited these documents and it is my view that the term "choline" has been defined in very clear and precise terms as denoting the chemical entity $[(CH_3)_3NCH_2CH_2OH]^+OH^-$ - being the hydroxide salt of choline and that there is simply no basis for Dr. Wright's assertions. In any event, the reaction product of the claims of the opposed Patent Application is the reaction product of the reaction of a (tetraalkyl)ammonium moiety, such as a choline cation. and 2,4-D. D2 clearly describes such a reaction. The hydroxide does not take part in the reaction.

D1: DD203677 – Paragraphs 132 to 149 of the Wright Declaration

160. Whilst I agree with Dr. Wright's comments in paragraph 138 as to the difference between the use of 2,4-D to promote plant growth and the use of 2,4-D to kill plants centres around the amount of 2,4-D used and the sensitivity of the plant towards 2,4-D, I stand by my comments in my First Declaration concerning the relevance of the teachings in D1.

161. I disagree with Dr. Wright's comments in paragraph 141 that amount of the 2,4-D choline used in D1 is not sufficient to result in plant death "*as a herbicide would*". I note that the term "herbicide" is defined in the opposed Patent Application on "*an active ingredient that kills, controls or adversely modifies the growth of plants*" (page 4, lines 13 and 14). I also note that the opposed Patent Application differentiates the term "herbicide" from "*an herbicidally effective or vegetation controlling amount*" (page 4, line 15). That is, the property of being a "herbicide" is different to being in a herbicidally effective or vegetation controlling amount. Finally, I note that in addition to "killing", the herbicidal effect may be "non-lethal" such as "causing deviation from natural development, regulation, desiccation retardation and the like" (see page 4, lines 16 and 17).

162. Accordingly whilst I agree that the growth regulation effect shown in D1 results from the amount of 2,4-D applied, it does not follow that application of the composition of D1 to any other plant species, over the range of application rates of “1 – 2,000 g/Ha” described in the opposed Patent Application at page 5, line 3 would not result in herbicidal effect as described at page 4 line 14 namely as causing a deviation from natural development, regulation, retardation, desiccation and the like.

163. In response to Dr. Wright’s comments in paragraph 149 I reiterate my comments in my First Declaration that the meaning of choline in D1 must be understood in context of the document being considered. The term “cholin” was used in the original German text of D1. Page 720 of *Beilstein Handbuch der Organische Chemie* (PMH-25) identified *“cholin”* as *“Trimethyl-[β-oxy-äthyl]-ammonium hydroxid”* with the chemical structure “$C_5H_{15}O_2N = (CH_3)_3N(OH)CH_2CH_2OH$”. Now produced and shown to me and marked **PMH-35** is a copy of the Beilsteins Handbuch der Organischen Chemie, Vierte Auflage: Zweites Ergänzungwerk Band III/IV (E-II 4) Springer-Verlag (1942) pp 720 – 729 (in German). At the time D1 was published *Beilstein Handbuch der Organische Chemie,* was the definitive reference for chemistry in the German language. I further note that page 719 of RÖMPP CHEMIE LEXIKON also confirms that the reference to “cholin” in D1 is choline hydroxide. Now produced and shown to me and marked **PMH-36** is a copy of the page 719 of RÖMPP CHEMIE LEXIKON Prof Dr Jürgen Falbe (Herausgeber) and Prof. Dr. Manfred Regitz (Herausgeber), Georg Thieme Verlag, Stuttgart–New York (1989) (in German). In any event, the reaction product of the claims of the opposed Patent Application is the reaction product of the reaction of a (tetraalkyl)ammonium moiety such as a choline cation and 2,4-D. D1 clearly describes such a reaction. The hydroxide does not take part in the reaction.

H. COMPARISON OF THE PATENT APPLICATION AND THE PRIOR ART – SUMMARY – Paragraphs 150 to 154 of the Wright Declaration

164. I reject Dr. Wright's assertions in paragraph 151 that I have not provided any examples of prior art documents which disclose a herbicidal composition comprising the reaction product of a herbicidal carboxylic acid and a tetraalkylammonium hydroxide, or more specifically 2,4-D and choline hydroxide. D3 is one such example. This prior art document clearly describes the use of a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a quaternary ammonium hydroxide where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl" which encompasses the hydroxide form of choline (see page 2, lines 109 to 113 of D3), to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops. As stated in paragraph 119 of my First Declaration D3 provides field examples showing no injury to the cereal crops. Example XIV on pages 10 and 11 demonstrates the biological effectiveness of the herbicidal compositions of D3 on several hard to control weed species with no injury or damage to the adjacent wheat crop. The disclosure in D3 could not be any clearer.

165. Likewise, the disclosure in D2 and its relevance to the claims of the opposed Patent Application is also clear. This prior art document describes the reaction product of 2,4-D, choline hydroxide, a surfactant and water to form a "herbicide" and its use to eradicate broad-leaved weeds. As stated in paragraphs 132 and 133 of my First Declaration this herbicide is applied to a mixture of Daikon, beans, maize and wheat with the Daikon and beans being used as the undesirable broad-leaved plants in the intended cereal (maize/wheat) crop. The data set out in Table 2 of PMH-27 (D2) shows that, at a concentration of 1000ppm the herbicide was completely effective in eradicating the Daikon and beans as there was 0% green growth (Indicator 5 = 0% mass of green growth) and there was most importantly no chemical damage to the neighboring maize or wheat crops.

166. Also stated in paragraph 102 of my First Declaration page 5, lines 72 to 86 of GB 1,056,235 (PMH-17) describes a method of preparing the tetramethylammonium salt of 2,4-D and its use as a herbicide.

167. In response to Dr. Wright's assertions in paragraph 152 I stand by my comments in my First Declaration at paragraphs 62 to 65. To address the adverse effects of volatility arising from the <u>ester form of 2,4-D</u>, <u>not</u> an alternative to 2,4-D amine salts as Dr. Wright has suggested, I stated that I would have certainly looked at an amine salt form as it was certainly known well before February 2007 that volatility could be "essentially eliminated" by the use of such salts (PMH-15). With a base strength that is comparable to sodium hydroxide (NaOH) (which has been accepted by Dr. Wright – see paragraph 62 of the Wright Declaration) I would have considered quaternary ammonium hydroxides knowing that they react with carboxylic acids including herbicidal carboxylic acids to form salts in the same way sodium hydroxide reacts with a carboxylic acid. I would not have ruled out other bases such as sodium hydroxide (caustic soda) to form a sodium salt. As stated in my First Declaration my choice of a base would have been simply a function of using water soluble compounds that would be easy for us to formulate and easy for the user to mix.

168. In response to Dr. Wright's assertions in paragraph 153 I have, as already noted, provided examples of prior art documents which disclose the use of a herbicidal composition comprising the reaction product of a herbicidal carboxylic acid and a tetraalkylammonium hydroxide. D3 and PMH-17 are two such examples.

169. In response to paragraph 154 I make the observation that Dr. Wright has "acknowledged" that the subject matter of the following claims was "generally known" before February 2007:

(i) That herbicidal carboxylic acids, particularly 2,4-D, are selective for broadleaf weeds (claims 12 and 13); and

(ii) genetic manipulation and selective breeding may be used to reduce the damage from accidental spray drift (claims 14 and 15.

170. In response to Dr. Wright's comments that "it was not known how to prepare or use a compound/composition of Claims 1 to 11", I strongly disagree with both these assertions. The preparatory methods used to prepare a reaction product of an herbicidal carboxylic acid and a tetraalkylammonium hydroxide including the three alternative methods provided on page 9 of the opposed Patent Application were certainly well known before February 2007. I have already shown that the disclosures in D1, D2 and D3 each describe a herbicidal composition comprising the reaction product of the quaternary ammonium compound choline hydroxide with 2,4-D, prepared by the second of the three methods described on page 9, line 8 of the opposed Patent Application. I have also showed that PMH-17 describes on page 5, lines 72 to 86 a method of preparing the tetramethylammonium salt of 2,4-D using a method similar to the third preparatory method described on page 9 of the opposed Patent Application. I am therefore very surprised by Dr. Wright's comments to the contrary. A careful reading of PMH-17, albeit using the benzonitrile, describes a process similar to the first preparatory method described on page 9 of the opposed Patent Application. In any event as I have outlined above the reaction is between 2,4-D and a (tetraalkyl)moiety and this reaction is definitely described in D1, D2, D3 and PMH-17.

171. Dr. Wright's position that "it was not known how to use a composition of Claims 1 to 7" before February 2007 is also contradicted by the clear teachings in prior art documents D1, D2 and D3 and PMH-17. For instance as was made clear in my First Declaration D3, which was published in December 1973, describes the use of a herbicidal composition resulting from mixing a herbicidally active compound such as the 2,4-D acid and a quaternary ammonium salt where the radicals R, R_1, R_2 and R_3 may be a "hydroxy-substituted alkyl" to treat the locus of unwanted vegetation and to prevent injury to neighboring cereal crops. As stated above, in response to Dr. Wright's comments in paragraph 116, D3 describe the nature of the

counter ion of the quaternary ammonium anion as including *"the salts formed by the reaction of other bases such as ammonium hydroxide, with the appropriate acids"* (page 2, lines 109 to 113 of D3). D3 clearly encompasses a choline salt of 2,4-D. D3 describes the herbicidal compositions as being *"non-volatile and thus, do not possess a most undesirable characteristic of esters which as previously mentioned has been eliminated their use in certain areas due to the fact that upon volatilization, esters will kill or severely injure adjacent susceptible crops. Tests have shown that the present compositions do not possess this negative feature".* (page 5, lines 80 to 88) Again I question the basis of Dr. Wright's assertions.

I make this declaration conscientiously believing the statements contained in this declaration to be true and correct.

Declared at Laverton North

this 29th day of October 2018

Phillip Hay
(Signature of person making declaration)