

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NEW NGC, INC. d/b/a NATIONAL GYPSUM COMPANY
Petitioner

v.

UNITED STATES GYPSUM COMPANY
Patent Owner

Case IPR2017-01352
Patent No. 8,142,914

DECLARATION OF ROBERT B. BRUCE, PH.D.

Mail Stop PATENT BOARD
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	1
II. BACKGROUND AND QUALIFICATIONS	2
III. MATERIALS CONSIDERED	5
IV. PERSON OF ORDINARY SKILL IN THE ART	6
V. APPLICABLE LEGAL STANDARDS	8
VI. RESPONSE TO MR. HARLOS' CHARACTERIZATIONS REGARDING BACKGROUND TECHNOLOGY	12
VII. OVERVIEW OF THE '914 PATENT	25
VIII. CLAIM CONSTRUCTION	33
"enhancing materials"	34
"accelerator"	38
"set gypsum"	39
IX. RESPONSE TO MR. HARLOS' CHARACTERIZATIONS OF THE ASSERTED REFERENCES	41
A. Summary Of Graux	41
B. Summary Of ASTM C473-95	47
C. Summary Of Hjelmeland	48
D. Summary Of Satterthwaite	51
E. Summary of Sucech.....	55
F. Summary of Summerfield	56
X. THE CLAIMS ARE NOT OBVIOUS BASED ON THE COMBINATION OF GRAUX, ASTM C473-95, HJELMELAND, SUCECH, AND SUMMERFIELD	56
A. Mr. Harlos Has Not Established Any Motivation To Use Or Combine The Asserted References	58

B. The Identified Disclosures Of Graux, ASTM C473-95, Hjelmeland, Sucech And Summerfield Do Not Result In The Claimed Inventions.....	63
Claim 1a: A gypsum board comprising:	64
Claim 1b: a core of material sandwiched between cover sheets, wherein the core comprises an interlocking matrix of set gypsum,.....	65
Claim 1c: the board has been prepared by a method comprising:	65
Claim 1d: forming or depositing a mixture between the cover sheets, wherein the mixture comprises a calcined gypsum, water, an accelerator, and one or more enhancing materials selected from the group consisting of: sodium trimetaphosphate, tetrapotassium pyrophosphate, tetrasodium pyrophosphate, aluminum trimetaphosphate, sodium acid pyrophosphate, ammonium polyphosphate having 1000-3000 repeating phosphate units, and acids, salts, or the anionic portions thereof, and,	66
Claim 1e: maintaining the mixture under conditions sufficient for the calcined gypsum to form the interlocking matrix of set gypsum,.....	67
Claim 1f: the enhancing material or materials having been included in the mixture in an amount such that the gypsum board has greater sag resistance than it would have if the enhancing material had not been included in the mixture, said board having a sag resistance as determined according to ASTM C473-95 of less than about 0.1 inch per two foot length of said board,	67
Claim 1g: the accelerator having been included in an amount such that the gypsum board has greater strength than it would have if the accelerator had not been included in the mixture.	70

Claim 2: The gypsum board of claim 1, wherein the concentration of the enhancing material in the mixture is from 0.004 to 2.0 percent by weight, based on the weight of the calcined gypsum.	70
Claim 3: The gypsum board of claim 1, wherein the calcined gypsum comprises one or more of: calcium sulfate anhydrite; calcium sulfate hemihydrate; or ions of calcium and sulfate.	72
Claim 4: The gypsum board of claim 1, wherein the enhancing material comprises one or more of the following salts, or the anionic portions thereof: sodium trimetaphosphate and ammonium polyphosphate having 1000-3000 repeating phosphate units.	72
Claim 6: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch.	72
Claim 8: The gypsum board of claim 1, wherein: the core has voids uniformly distributed therein; and the mixture further comprises an aqueous foam.	73
Claim 10: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch and an aqueous foam.	74
XI. THE CLAIMS ARE NOT OBVIOUS BASED ON THE COMBINATION OF SATTERTHWAITE, ASTM C473-95, HJELMELAND, SUCECH AND SUMMERFIELD	75
A. Mr. Harlos Has Not Established Any Motivation To Use Or Combine The Asserted References	76
B. The Identified Disclosures Of The Asserted References Do Not Result In The Claimed Inventions.....	82
Claim 1a: A gypsum board comprising:	83
Claim 1b: a core of material sandwiched between cover sheets, wherein the core comprises an interlocking matrix of set gypsum,.....	83

- Claim 1c: the board has been prepared by a method comprising:85
- Claim 1d: forming or depositing a mixture between the cover sheets, wherein the mixture comprises a calcined gypsum, water, an accelerator, and one or more enhancing materials selected from the group consisting of: sodium trimetaphosphate, tetrapotassium pyrophosphate, tetrasodium pyrophosphate, aluminum trimetaphosphate, sodium acid pyrophosphate, ammonium polyphosphate having 1000-3000 repeating phosphate units, and acids, salts, or the anionic portions thereof, and,86
- Claim 1e: maintaining the mixture under conditions sufficient for the calcined gypsum to form the interlocking matrix of set gypsum,.....88
- Claim 1f: the enhancing material or materials having been included in the mixture in an amount such that the gypsum board has greater sag resistance than it would have if the enhancing material had not been included in the mixture, said board having a sag resistance as determined according to ASTM C473-95 of less than about 0.1 inch per two foot length of said board.88
- Claim 1g: the accelerator having been included in an amount such that the gypsum board has greater strength than it would have if the accelerator had not been included in the mixture.91
- Claim 2: The gypsum board of claim 1, wherein the concentration of the enhancing material in the mixture is from 0.004 to 2.0 percent by weight, based on the weight of the calcined gypsum.91
- Claim 3: The gypsum board of claim 1, wherein the calcined gypsum comprises one or more of: calcium sulfate anhydrite; calcium sulfate hemihydrate; or ions of calcium and sulfate.93

Claim 4: The gypsum board of claim 1, wherein the enhancing material comprises one or more of the following salts, or the anionic portions thereof: sodium trimetaphosphate and ammonium polyphosphate having 1000-3000 repeating phosphate units.	93
Claim 6: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch.	94
Claim 8: The gypsum board of claim 1, wherein: the core has voids uniformly distributed therein; and the mixture further comprises an aqueous foam.	95
Claim 10: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch and an aqueous foam.	96

I, Robert B. Bruce, do hereby declare as follows:

I. INTRODUCTION

1. I have been retained on behalf of United States Gypsum Company (“USG”), and its counsel, Fitch, Even, Tabin & Flannery LLP, as an expert in this proceeding. I am personally knowledgeable about the matters stated herein, and am competent to make this declaration.

2. I understand that New NGC, Inc. d/b/a National Gypsum Company (“NGC”) filed a Petition for *Inter Partes* Review regarding certain claims of U.S. Patent No. 8,142,914 (“the ’914 patent”) (Paper 2), which was accompanied by the Declaration of Gerry Harlos (Ex. 1001).

3. I have been asked to provide my conclusions and bases thereof regarding several aspects of the issues in dispute. Based on my investigation in this matter, I conclude that NGC and Mr. Harlos have not shown a reasonable likelihood that any of issued claims 1–4, 6, 8 and 10 of the ’914 patent are invalid based on the two asserted theories:

- Ground 1, which relies on the following alleged prior art references: Graux, ASTM C473-95, Hjelmeland, Sucech and Summerfield; and
- Ground 2, which relies on the following alleged prior art references: Satterthwaite, ASTM C473-95, Hjelmeland, Sucech and Summerfield.

4. I receive compensation at an hourly rate of \$375 per hour for my time working on this matter, plus expenses. I have no financial interest in USG or in the '914 patent, and my compensation is not dependent on the outcome of this proceeding. The conclusions I present are due to my own judgment.

II. BACKGROUND AND QUALIFICATIONS

5. I have over 35 years of professional experience in technology development and business growth in the gypsum industry. I earned a Ph.D. in Chemistry from McMaster University in 1977. My Ph.D. research was in the area of sulphur nitrogen chemistry. I graduated with an Honours Bachelor of Science in Chemistry from McMaster University in 1972.

6. After obtaining my Ph.D., I did post-doctorate research at the University of Calgary regarding the release of hydrogen from hydrogen sulphide, a major contaminant found in natural gas wells. I held this research position from September 1976 to April 1977.

7. In 1977, I began work as an assistant research scientist for Ontario Research Foundation and conducted applied research for industrial clients. My first client was USG. I worked with USG on reducing water demand in gypsum board production and increasing sag resistance of gypsum board. My other projects at the Ontario Research Foundation focused on other gypsum-related projects and then later included fine particle research and thermal analysis for a wide range of

companies. I worked with several gypsum companies from around the world during this time. In 1979, I was promoted to manager of the Non-Metallic Minerals Group of the Ontario Research Foundation.

8. In 1981, I left the Ontario Research Foundation and joined BPB Westroc (now known as CertainTeed) in Mississauga, Canada. BPB Westroc was the Canadian branch of British Plasterboard plc (BPB plc). At that time, BPB plc was the world's leading manufacturer of gypsum-containing products. Beginning as a Process Development Manager, I worked on aspects of the gypsum board making process, including cost reduction, quality improvement, energy cost reduction, board weight reduction, and additive cost. I also worked on other projects and products. In 1982, I was promoted to Development Manager. In 1984, I was promoted to Technical Manager. My duties at that time included overseeing research and development, engineering, logistics, and safety. In 1986, I was promoted to Operations Manager and was in charge of factories and mines. In 1990, I was promoted to Vice President, Manufacturing. In 1993, I was promoted to Vice President, Strategic and Technical Development.

9. In 1994, I joined the home office of BPB plc in Slough, U.K. as a Technical Manager. In 1996, I became Director of Technical Services. During my time in the UK I was responsible for operations, research and development,

engineering, mineral resources, capital spending, benchmarking, intellectual property, technology exchange, and environmental concerns.

10. In 1997, I returned to Canada and founded Innogyps Inc., an internationally recognized mine-to-market gypsum consulting firm. I was the Chief Executive Officer in charge of business development and all operations. In 2013, I sold the business assets, and the work now continues under new management as Innogyps Ltd.

11. In 2008, I jointly formed The NuGyp Corporation to develop technology to reduce the water demand of beta plasters with significant cost and environmental benefits to the gypsum industry. I am chairman, president and shareholder, and in charge of technology, intellectual property and finance. The intellectual property from this company was sold to a major gypsum equipment supplier in February 2017.

12. In 2014, I renamed the original Innogyps Inc. company as GypsumInfo Inc. and continue to operate a service organization to promote innovation and growth in the global gypsum industry. I am president and owner of GypsumInfo Inc.

13. A true and correct copy of my curriculum vitae is included at the end of this declaration.

14. Since 2003, I have delivered numerous presentations at annual Global Gypsum Conferences and to other gypsum industry groups throughout the world. A brief summary of each of these presentations is disclosed on my CV.

15. I am a named co-inventor on numerous patents and pending patent applications pertaining to gypsum-containing products and methods of their manufacture. These patents and applications are disclosed on my CV.

16. The '914 patent concerns set gypsum-containing products and compositions and methods for manufacturing such products. I recognize this technology as being well within the sphere of my experience and expertise, and I understand the technology described in the '914 patent fully. I believe my expertise and education in this industry qualifies me to explain this technology and to address the issues of patent validity from the perspective of a person of ordinary skill in the art. I am qualified to submit expert analyses in this proceeding.

III. MATERIALS CONSIDERED

17. I have reviewed and considered the following documents:

- U.S. Patent No. 8,142,914 to Yu et al. (“the '914 patent”) (Ex. 1038);
- The prosecution history file for the '914 patent;
- NGC’s Petition for *Inter Partes* Review of the '914 patent (Paper 2), including the exhibits cited therein including:

- Declaration of Mr. Harlos (Ex. 1001);
- U.S. Patent No. 5,932,001 to Graux et al. (“Graux”) (Ex. 1006);
- U.S. Patent No. 3,234,037 to Satterthwaite (“Satterthwaite”) (Ex. 1007);
- ASTM C473-95 entitled *Standard Test Methods for Physical Testing of Gypsum Board Products and Gypsum Lath* (“ASTM C473-95”) (Ex. 1009);
- U.S. Patent No. 5,980,628 to Hjelmeland et al. (“Hjelmeland”) (Ex. 1008);
- U.S. Patent No. 5,643,510 to Sucech (“Sucech”) (Ex. 1036);
- U.S. Patent No. 2,985,219 to Summerfield (“Summerfield”) (Ex. 1017); and
- The additional background materials mentioned below in this declaration.

IV. PERSON OF ORDINARY SKILL IN THE ART

18. I have been asked to address the issues from the perspective of a person of ordinary skill in the field relevant to '914 patent. Mr. Harlos contends that a person having ordinary skill in the art at the time of invention would have had “a bachelor’s degree in chemical engineering or organic or physical chemistry and 3 to 5 years of experience in gypsum board manufacturing or a master’s degree

in chemical engineering or organic or physical chemistry and 2 to 3 years of experience. Additional education might substitute for some of the experience, and substantial experience might substitute for some of the educational background.” (Ex. 1001 ¶ 12.)

19. I can accept Mr. Harlos’ description of one of ordinary skill in the art except that I would include inorganic chemistry (along with organic and physical chemistry) as the fields of study. I also believe that someone with less academics could qualify as a person of ordinary skill if they had several years of experience in gypsum board manufacturing and had studied the technology related to the industry. However, for purpose of this proceeding I am willing to accept the work experience and education level mentioned by Mr. Harlos.

20. I consider myself to have at least the credentials of a person of ordinary skill in the art. As a result of my education, academic experience, and industrial experience, I am familiar with the technology in the field of the ’914 patent and also with the state of that technology in August 1997, when the earliest application related to the ’914 patent was filed. Throughout my career, I have worked with and supervised those of ordinary skill in the art, and I am capable of addressing the issues from the perspective of such a person.

V. APPLICABLE LEGAL STANDARDS

21. As a technical expert, I am not offering any legal opinions. Rather I am offering technical assessments and opinions. In rendering my analysis, I have been informed by counsel regarding various legal standards for determining patentability. The standards provided by counsel that I was asked to apply in forming the opinions expressed in this declaration are summarized below.

22. The patent claims describe the invention made by the inventors and describe what the patent owner owns and what the owner may prevent others from doing. An independent claim sets forth all the requirements that must be met in order to be covered by that claim. A dependent claim does not itself recite all of the requirements of the claim but refers to another claim and incorporates all of the requirements of the claim to which it refers.

23. A prior art reference is anticipatory only if it discloses each and every element of the claim (as properly construed) at issue. For a claim to be anticipated, each claim element must be disclosed in a single prior art reference and the claimed arrangement or combination of those elements must also be disclosed in that same prior art reference. If a claim element is not expressly described, a prior art reference may disclose the element inherently if the missing descriptive matter is necessarily present in the thing described in the reference, and it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by

probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.

24. A prior art reference must be enabling to be anticipating. A prior art reference is enabling when it describes the claimed invention sufficiently to permit a person of ordinary skill to make the invention without undue experimentation.

25. A claimed invention is unpatentable if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. In determining whether a claimed invention is obvious, one should consider the scope and content of the prior art, the level of ordinary skill in the art, the differences between the claimed invention and the prior art, and whether the claimed invention would have been obvious to one of ordinary skill in the art at the time of the invention in light of those differences.

26. When evaluating obviousness, one must not consider whether the claimed invention would have been obvious to a layman or to an expert. One must put oneself in the place of a person of ordinary skill at the time the invention was made and consider only what was known before the invention was made. One must avoid the temptation to read into the prior art the teachings of the patent at issue and guard against the use of hindsight. In other words, one should avoid using the

challenged patent as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims at issue.

27. Obviousness should be considered in light of the problem facing the inventor(s) and the complexity of the alternatives for solving the problem. A patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. It is important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. One should therefore also consider whether there was a teaching, suggestion or motivation to combine the references. The evaluation of a motivation to combine references allows recourse to logic, judgment, and common sense, but any such motivation to combine references must still avoid the improper application of hindsight. There must be some logical reason apparent from concrete evidence that justifies a combination of the references.

28. It is improper to combine references where the references teach away from their combination. A reference may be said to teach away when a person of ordinary skill would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the inventor. A reference teaches away, for example, if (1) the combination would produce a seemingly inoperative result, or (2) the references leave the impression that the

product would not have the property sought by the inventor or would no longer achieve the intended purpose(s) of the references being modified or combined.

29. I understand that the first step in determining validity is to properly construe the claims. Mr. Harlos has offered interpretations of two terms found in the claims at issue. The claim construction principles that I have been asked to follow are summarized below.

30. The claim terms are given their ordinary and customary meaning, as would be understood by a person of ordinary skill in the art at the time of the invention. The person of ordinary skill is considered to read the words used in the patent documents with an understanding of their meaning in the field, and to have knowledge of any special meaning and usage in the field. The ordinary meaning of a claim term is its meaning to the person of ordinary skill after reading the entire patent, including the patent specification. The specification may reveal a special definition given to a claim term by the inventor, which then governs the meaning of the same term in the claims.

31. The claims themselves provide substantial guidance as to the meaning of claim terms, and the context in which a term appears in the claim can be highly instructive to its meaning. Difference among claims can also be a useful guide. For example, the presence of a dependent claim that adds a particular limitation suggests that the limitation in question is not present in the independent claim.

32. The patent's prosecution history should also be considered, which includes the record of the proceedings before the U.S. Patent and Trademark Office and the prior art cited during the examination of the patent. The prosecution history may inform the meaning of the claim language by demonstrating how the inventor understood the invention and whether the inventor limited the invention in the course of prosecution, making the claim scope narrower than it would otherwise be.

33. My opinions regarding the meaning that a person of ordinary skill in the art would give to certain disputed claim terms are also addressed below.

VI. RESPONSE TO MR. HARLOS' CHARACTERIZATIONS REGARDING BACKGROUND TECHNOLOGY

34. Mr. Harlos makes several assertions regarding the background of technology and the knowledge of persons skilled in the art as of August 1997 that are not correct, or, at minimum, have not been supported by evidence. The following addresses these inaccuracies and provides additional relevant background regarding the state of the art and the knowledge of persons skilled in the art at the time of the invention.

35. Gypsum is a mineral composed of calcium sulfate dihydrate having the chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (i.e., having two water molecules). It is primarily used as the main constituent in many forms of plaster and wallboard. Significant quantities are also used in agriculture as fertilizer and for improving soil drainage.

Heating gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) to about 300°F drives off water as steam to produce calcined gypsum. Calcined gypsum can take several forms depending on the process used for calcination. The most common commercially used products are alpha calcium sulfate hemihydrate ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$), beta calcium sulfate hemihydrate ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$), water-soluble calcium sulfate anhydrite (CaSO_4), or mixtures thereof.

36. Gypsum wallboard is commonly used to make interior walls and ceilings. It is produced by mixing calcined gypsum with water and optional additives to form an aqueous slurry. When calcined gypsum is slurried with water, it dissolves and then re-crystallizes into calcium sulfate dihydrate crystals which interlock to form a solid/set product, which is generally referred to as “set gypsum.”

37. The slurry is typically continually deposited onto a paper cover sheet (or other facer material) on a moving belt, and another paper cover sheet is placed on top, effectively sandwiching the gypsum slurry into a gypsum core. The aqueous gypsum slurry is maintained at controlled conditions to allow it to set or harden by rehydration of the calcined gypsum, followed by heat treatment in a dryer to remove the water over and above what was needed for rehydration of the gypsum. The gypsum wallboard is cut into panels, typically four feet wide and eight feet long.

38. Calcined gypsum sets by a process of dissolving the calcined gypsum in water followed by recrystallization of the gypsum as needle-like gypsum crystals,

which form a network to give the board its physical integrity. The crystals are closely interwoven, which provides strength to the core. The overall core is porous as a result of the extra water having been removed by drying once the crystals have formed. After drying, the random entanglement, crystal twinning, and frictional forces between these brittle crystals increase the strength of the core. The crystals also interlock with the paper fibers at the paper/core interface, mechanically increasing the paper/core strength.

39. Additives are commonly used in gypsum board-making to achieve certain desired board characteristics. A wide range of additives are available, such as foam, accelerators, set retarders, re-calcination inhibitors, binders, adhesives, dispersing aids, leveling agents, thickeners, bactericides, fungicides, pH adjusters, colorants, reinforcing materials, fire retardants, water repellants, fillers, etc. (*See, e.g., Ex. 1038 at 9:6–13.*)

40. The chemistry and interactions between the components within the gypsum slurry are rather complex. Making gypsum panels having desired characteristics requires controlling several variables that can impact the interactions among the various ingredients, such as ingredient source and concentration, solubility, temperature, pH, etc. The formulation must be carefully designed and the process closely controlled to ensure that the correct conditions are maintained to produce the desired end product in an efficient, cost-effective manner.

41. For example, foam is a common additive in gypsum boards. Adding foam enables manufacture of a lighter-weight board by replacing part of the gypsum core with air voids, reducing density. (*See, e.g.*, Ex. 1020 at 1:18–24.) However, as would be expected, decreasing density also typically corresponds to a general decrease in strength of the board as well as a decrease in core-to-paper bond integrity. (*Id.* at 1:27–38.) Thus, introducing foam to a gypsum board formulation requires balancing the amount of foam with other ingredients to ensure an acceptable product is produced.

42. Mr. Harlos make various vague assertions about “strength” of set gypsum products throughout his declaration. Gypsum has an inherent ability to generate a certain amount of strength, depending on the overall density of the gypsum slurry and how the gypsum crystals come into contact with one another. If more gypsum crystals grow into and interconnect with one another, this results in a tighter, stronger set gypsum. The resulting strength is in part dictated by the water:gypsum ratio, which will affect the overall volume percent that is gypsum rather than voids left from evaporated water. When an agent added to the water/gypsum slurry interferes with natural crystal growth, the tendency is for strength to be reduced from the “baseline” strength otherwise achievable from crystal growth. Poorly-managed manufacturing process steps can also interfere with this crystallization process also resulting in reduced strength characteristics. In some

cases, the reduced strength can be offset by using another additive to bring the strength back up to that baseline.

43. Mr. Harlos also uses several terms interchangeably when referring to how the gypsum containing products may behave, or deform when wet. It is necessary to distinguish what is meant by sag, creep, slump, spread, warp, etc. The main uses of gypsum are primarily the result of the calcined gypsum being mixed with water and the resultant slurry hydrating as it recrystallizes to gypsum. The flow properties of the water/calcined gypsum slurry are of great importance in the manufacture and use of the various gypsum products, and vary significantly depending on the product. Each product is manufactured and used differently, and each requires different flow characteristics as a result.

44. Ever since gypsum wall plasters were used centuries ago, its flow properties were very important as the slurry needed to be thick so it would not run when placed on a wall. Great effort is made to formulate modern plasters to make sure this plaster slurry will not run when placed on the wall, but is easy to spread when pushed by a trowel. A slurry made for use in manufacturing gypsum board, on the other hand, requires very different flow characteristics. It must be fluid enough to flow on its own.

45. Tests have been developed to measure the fluidity of slurries, often being as simple as placing the slurry in a ring and, upon lifting the ring, seeing how

far the slurry will spread. This is often referred to as a “slump” test. For the sake of clarity this behavior is commonly referred to as “slump.”

46. The Graux patent describes a test of thickened plasters whereby the plaster slurry is placed in a brass ring and the “spread” of the plaster upon lifting the ring is measured. (Ex. 1006 at 9:32–48.) A similar test to that described by Graux is found in ASTM C472, *Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete*. (See Ex. 1014.) A gypsum slurry used to make wall plasters needs to have a low spread in the slump test, whereas a gypsum slurry used to make wallboard is very fluid and would have a high spread in a slump test.

47. A unique property of gypsum is that under conditions of high atmospheric humidity, it will change shape over time. When this takes place in gypsum mineral deposits it is usually referred to as “creep,” but with gypsum board the phenomenon is typically called “sag.” It is the result of the gypsum crystals slowly and irreversibly changing shape as a result of the force of gravity in the presence of absorbed moisture. This sag or creep behavior takes place faster under conditions of high humidity. Lighter weight boards and boards with high salt content are more susceptible to sag. A standard test for measuring the sag of gypsum board under humid conditions is found in ASTM C473-95 entitled *Standard Test Methods for Physical Testing of Gypsum Board Products and Gypsum Lath*. (Ex.

1009.) Obviously, this sag/creep phenomena for the fully-set gypsum board is much different than the slump/spread performance of an unset gypsum slurry.

48. Mr. Harlos refers to Hjelmeland, which discusses alleged “creep.” However, the action underway is really the slump/spread of the not-yet-set plaster as it is being used as a wall surface plaster or to stabilize mining cores.

49. Similarly with Satterthwaite, reference is made to the warp/sag of ceiling tile while being dried. In this case, the ceiling tiles contain no set gypsum and are made by allowing a wet starch-based binder to dry out such that the starch fibers can bond to one another and to the other fillers in the mixture. The sag/warp phenomenon described by Satterthwaite occurs when uneven drying prevents the adhesive effect of the starch from reaching the level needed to hold the tile ingredients together to keep its shape. Contrary to Mr. Harlos’s suggestions, the warping associated with the starch-drying process step addressed in Satterthwaite is not analogous to the sag/creep phenomenon associated with gypsum board formed by the gradual recrystallization of gypsum board slurries.

50. Any person familiar with the use and testing of gypsum board will understand that the “warp/sag” of the wet starch-based tiles of Satterthwaite, the “creep” of the unset slurry referred to by Hjelmeland, and the “spread/slump” of the unset gypsum slurries in Graux are completely different than the rather unique sag performance of a fully-set gypsum board.

51. Another common additive used in gypsum board manufacturing is an accelerator. Accelerators promote faster setting times. There are two main types of accelerators, those that provide seed crystals for the gypsum to grow on and those that change the overall solubility properties of calcium sulfate in water. Adding seeds crystals, such as fine particle size ground gypsum, provides much more surface area for the dissolved calcined gypsum to crystallize upon resulting in faster crystal growth and a finer network of gypsum crystals.

52. Accelerators that affect the solubility of the crystallizing gypsum can act in many ways, but the most common are other salts that contain common ions such as potassium sulfate or ammonium sulfate. These more soluble sulfates increase the sulfate concentration in solution and force the recrystallization of calcium sulfate hemihydrate to take place more quickly.

53. Note that the accelerators that result in a finer matrix of interconnecting crystals will generally result in higher strength. Accelerators that cause the set to take place faster but do not cause more crystal interaction will generally not result in strength increase. It is important in the setting of gypsum to allow the crystals to entangle without disruption so that the crystals can grow into one another and generate maximum strength. If the crystals are moved during this process, this random entanglement is disturbed and strength can be reduced. In these cases it may

be advantageous to use a retarder to delay the setting process until after process steps that disturb the slurry are complete.

54. Retarders slow down the setting process by either interfering with the surface area of the growing gypsum seed crystals or by reducing the overall solubility or rate of solution of the calcined gypsum. In general, retarders will interfere with the crystallization process and cause the crystals to form as blocks or flakes rather than as long needles, resulting in less interconnectivity between crystals and reduced strength. However, if setting is taking place too quickly while the slurry is still being moved, then there may be some strength improvement if a small amount of retarder is used to delay set until after all process steps are complete so that the recrystallization process can take place undisturbed. In this case, there can be an apparent increase in strength with the use of retarder, but only back to the point where it would have been if the slurry had not been affected by mixing it too soon and interfering with the setting process.

55. If the manufacturing process is such that the calcined gypsum slurry is beginning to set, then the slurry will become more viscous (will stiffen). In this case, a small amount of retarder can be used to enhance the fluidity of the slurry during processing by delaying the setting process long enough for the process steps to be completed. Care needs to be taken not to add too much retarder because this will

generally result in crystal habit modification, which will likely result in strength reduction.

56. Boric acid has also been used as an additive in gypsum boards. In small amounts, it is useful to improve sag resistance of gypsum panels. However, boric acid also causes the board to become more brittle. This effectively limits the amount of boric acid that can be introduced in order to counteract the effects of moisture uptake that results in sag.

57. Mr. Harlos states that a particular type of starch, known as crosslinked starch, was used for its improved binding properties. He states that it was known to crosslink starch with sodium trimetaphosphate (“STMP”) to increase the strength of set gypsum products. However, these statements are not supported with any evidence.

58. Mr. Harlos also assert that compounds such as orthophosphoric acid, monosodium orthophosphate and sodium metaphosphate were known to increase strength in set gypsum products. (Ex. 1001 ¶ 45.) However, he only cites to a reference (not included in the combination of references used in either asserted ground) for treating raw mineral gypsum before calcining to temperatures well in excess of those relevant to the set gypsum of the ’914 patent (1800°F–2300°F) (Ex. 1019 at 1:1–5, 1:41–51, 5:54–6:20, 10:41–47), and Satterthwaite, which concerns

crosslinked starches and does not deal with the setting of gypsum, only the use of gypsum as filler.

59. Mr. Harlos characterizes STMP as being “a common additive in the manufacture of set gypsum-containing products that has been well-known in the art since at least 1961.” (Ex. 1001 ¶ 48.) He also asserts that “STMP has been known for decades to increase core strength in set gypsum-containing products.” (*Id.*) Mr. Harlos does not cite any evidence that supports the accuracy of those statements.

60. Mr. Harlos erroneously describes Satterthwaite as teaching “that the inclusion of STMP ‘increase[s] wet strength, increase[s] density and increase[s] resistance to warp or sag.’” (*Id.*) However, Satterthwaite does not deal with the production of set gypsum-containing products nor methods of increasing the core strength or sag resistance of set gypsum-containing products.

61. Satterthwaite relates to the production of ceiling tile products containing various ingredients held together by a crosslinked starch binder composition. (Ex. 1007 at 1:13–23.) Satterthwaite does not disclose adding STMP to calcined gypsum slurries in the production of set gypsum-containing products. Satterthwaite discloses treating an aqueous alkaline starch solution with reagents such as STMP to form a crosslinked starch material. (*Id.* at 2:8–13.) Mr. Harlos acknowledges that the crosslinking reaction consumes the STMP. (Ex. 1001 ¶¶ 49–50.) According to the method disclosed in Satterthwaite, the crosslinked starch is

filtered, washed and dried prior to being added as a binder to the ceiling tile composition. (Ex. 1007 at 1:48–60, 2:29–31.) Therefore, there is no STMP available to interact with the ceiling tile composition.

62. In paragraph 51, Mr. Harlos characterizes U.S. Patent No. 2,346,999 to Sandford (Ex. 1021) as disclosing the use of sodium metaphosphates such as STMP as enhancing materials to improve the core setting strength of set gypsum-containing products. (Ex. 1001.) That is an inaccurate characterization. Sandford is directed to the problem of getting better adhesion at the interface of the gypsum core and the paper liners of gypsum wallboard. (Ex. 1021 at 3:72–4:36.) Sandford proposes coating the liners with an aqueous mixture of a water setting plaster and a water soluble adhesive to secure a good bond between the gypsum core and the liners. (*Id.* at 4:11–43.)

63. In paragraph 51 of his declaration, Mr. Harlos cites to column 8, line 39 through column 9, line 4 of Sandford, which discloses that a coating composition of stucco (calcined gypsum), Dextrin, retarder and water improved the bonding between the core and liners. Mr. Harlos also relies on Sandford's Example 7 at column 10, line 38 through column 11, line 3, in which a coating composition containing stucco, Dextrin, water and Calgon promoted quick initial bonding of the coating to the liner, followed by binding of the core mix to the coating. "Calgon" is

a mixture of several components, including sodium hexa- and metaphosphates. (Ex. 1021 at 10:52–54.)

64. Mr. Harlos assumes that sodium hexametaphosphate dissociates into STMP in water, but he does not cite any evidence to support that assumption. (Ex. 1001 ¶ 51.) Regardless, the Calgon contained in the coating composition allows water to wet the paper so that gypsum crystals can grow into the paper. This use of Calgon in a coating to improve the bond between the core and the paper liners does not disclose that Calgon or any other phosphate materials should be added to the core gypsum mix to increase core strength or sag resistance of gypsum wallboard.

65. In fact, Sandford describes the core mix of the Example 7 as having been “retarded” by the addition of 0.03% of Calgon. (Ex. 1021 at 10:52–54.) This reflects the conventional understanding of persons of ordinary skill in the art that condensed phosphate compounds may retard the gypsum setting process. This understanding was prevalent throughout the industry leading up to the 1997 timeframe of the invention of the ’914 patent.

66. I therefore disagree with Mr. Harlos’ description of the state of the art as it pertains to the use of STMP and other phosphate materials in the production of set gypsum panels. These compounds were not known or used as additives to gypsum slurries for the purpose of enhancing the strength or sag resistance of set

gypsum panels, and Mr. Harlos has not provided any evidence that actually supports his assertions.

67. Instead, the common belief at the time was that phosphates were retarders, which slow the rate of formation of set gypsum and decrease the strength of the set gypsum. (Ex. 1038 at 4:45–54.) In my opinion, Graux and Satterthwaite only show that STMP and other phosphate materials were used for purposes such as set retardants in gypsum pastes or to form crosslinked starch complexes. They do not show that it was known to use the claimed phosphate materials to increase sag resistance, despite decades of research and development relating to set-gypsum products.

VII. OVERVIEW OF THE '914 PATENT

68. I understand that the '914 patent relates back to a prior application filed August 21, 1997. (Ex. 1038 at 1:4–22.)

69. The patented technology of the '914 patent relates to methods and compositions for making set gypsum products having increased resistance to sag and other improved properties. The '914 patent specification observes that it is “the desired hydration of the calcined gypsum that enables the formation of an interlocking matrix of set gypsum crystals, thus imparting strength to the gypsum structure in the gypsum-containing product.” (Ex. 1038 at 2:18–22.)

70. The specification explains that gypsum containing products, such as wallboard for interior walls and ceilings, could be made more resistant to encountered stresses if the strength of their component set gypsum crystal structures were increased. (*Id.* at 2:23–26.) It notes efforts in the industry to make lower density, lighter weight products, and explains that in such products “there is a need to increase the strength of the set gypsum above normal levels just to maintain overall product strength at the levels of the previously higher density product, because there is less set gypsum mass to provide strength in the lower density product.” (*Id.* at 2:27–34.)

71. The specification also describes a need for gypsum products that are resistant to permanent deformation over the useful life of the products, especially under conditions of high humidity and temperature. (*Id.* at 2:35–38.) It explains that products having insufficient sag resistance may sag between points of attachment to the underlying structure. Gypsum wallboard products must also be able to carry loads, such as from insulation or condensation, without noticeable sag. (*Id.* at 2:43–53.) Sag can also occur during storage and transportation of the panels, or when water-containing surface treatments are applied to gypsum panels. Other additives such as water-resistant emulsions often made the boards sag even more than normal. Periodic instances of salt impurities in the gypsum raw material could result in boards that sagged excessively. Warped panels are not only unsightly, but are more

easily damaged as they are not supported evenly on all sides and by all fasteners. It is also more difficult to install other services (lighting, etc.) as the ceiling elements are no longer straight and level.

72. Previous approaches to combating sag include using a thicker, heavier panel or including additives such as boric acid. Thicker, heavier panels are more expensive to manufacture and transport. As explained above, boric acid has the detrimental effect of making gypsum panels more brittle.

73. The specification also describes a need for greater dimensional stability of set gypsum products during their manufacture and use. (*Id.* at 2:57–59.) Moisture take up can cause boards to expand when exposed to high humidity. (*Id.* at 2:59–61.) Also, when unreacted water is driven off by heating set gypsum products, the gypsum core may shrink as the set gypsum crystals of the matrix move closer together as the water evaporates. (*Id.* at 2:65–3:6.) Gypsum wallboard production could achieve higher yields if the boards did not shrink during drying. (*Id.* at 3:7–13.)

74. The '914 patent discloses a particular class of condensed phosphoric acid and condensed phosphate compounds, denoted using the short-hand “enhancing materials,” that provide superior sag resistance when compared to other known methods of providing sag resistance. The '914 patent specification introduces enhancing materials generally:

A set gypsum-containing product of the invention having increased resistance to permanent deformation is prepared in accordance with the invention by forming a mixture of a calcium sulfate material, water, and an appropriate amount of one or more enhancing materials chosen from: condensed phosphoric acids, each of which comprises 2 or more phosphoric acid units; and salts or ions of condensed phosphates, each of which comprises 2 or more phosphate units.

(*Id.* at 3:65–4:5.) The '914 patent further explains:

In the example of the preferred embodiments previously discussed, the enhancing material is trimetaphosphate ion. However, in general, any enhancing materials that fall within the general definition of enhancing materials previously discussed will produce beneficial results (e.g., increased resistance to permanent deformation) in treatment of calcined gypsum. The generally useful enhancing materials are condensed phosphoric acids, each of which comprises 2 or more phosphoric acid units; and salts or ions of condensed phosphates, each of which comprises 2 or more phosphate units.

(*Id.* at 27:37–47.)

75. The related '284 patent (whose disclosure is incorporated by reference into the '914 patent, *see* Ex. 1038 at 1:4–22) indicates that the defined enhancing materials also include phosphoric acids with 1 or more phosphoric acid units (as opposed to 2 or more) as well as monobasic salts or monovalent ions or orthophosphates:

In cases where treatment of calcium sulfate dihydrate is desired, the enhancing materials can be chosen from the group consisting of: phosphoric acids, each of which comprises 1 or more phosphoric acid units; salts or ions of condensed phosphates, each of which comprises 2 or more phosphate units; and monobasic salts or monovalent ions of orthophosphates.

(Ex. 1003 at 4:3–9.) The '914 patent specification also gives examples of compounds that fall with the defined category of compounds referred to as “enhancing materials.” (Ex. 1038 at 27:48–66.)

76. The specification indicates that STMP is a preferred enhancing material. (*Id.* at 4:17–21.) It reports that when trimetaphosphate ion is added to a mixture of calcined gypsum and water in the production of set gypsum products, the set gypsum was unexpectedly found to have increased strength, resistance to sag, and dimensional stability compared with set gypsum formed without using trimetaphosphate ion. (*Id.* at 4:27–41.) This is especially surprising, because it has been generally thought in the gypsum art that phosphoric or phosphate materials retard the rate of formation of set gypsum and decrease the strength of the gypsum formed. (*Id.* at 4:43–54.) This discovery that STMP and certain other phosphate materials could enhance these properties of set gypsum products without retarding the rate of setting was highly significant in the gypsum wallboard industry.

77. The specification discloses a range of gypsum compositions that can be used to form set gypsum products that can benefit from inclusion of the disclosed enhancing materials. For example, wallboard slurry compositions containing pregelatinized starch in addition to an enhancing material is reported to also have improved paper to core bonding. (*Id.* at 5:4–22.) Compositions containing foam to generate air voids for a lighter weight product also benefit “because of the increased strength provided by the inclusion of the trimetaphosphate ion in the mixture used to form the inventive board.” (*Id.* at 5:30–5:44.) The specification makes clear that a variety of other additives may be utilized in combination with the inventive enhancing materials to impart other desirable properties and to facilitate production of a wide range of set gypsum-containing products. (*Id.* at 9:6–13.)

78. The specification also discloses several techniques for incorporating these enhancing materials into the production of gypsum products. The enhancing materials may be added to the gypsum slurry at various stages of the process (*id.* at 8:19–42), or may be added at a later stage by spraying an aqueous solution of the enhancing material on the set gypsum (*id.* at 8:55–9:61).

79. The '914 patent specification also provides a considerable amount of data demonstrating the benefits of STMP and other representative enhancing material phosphate compounds relative to controls and other comparative samples. Table 1, for example, illustrates how samples containing STMP showed increased

compressive strength relative to comparative samples. (*Id.* at 13:1–32.) Table 2 shows that gypsum wallboard samples made with STMP were much more resistant to sag compared to samples containing only conventional sag resistance additives. (*Id.* at 14:44–67.) Table 3 presents the results of nail pull resistance testing, which is an ASTM C473-95 test that reflects the combination of the strengths of the board’s gypsum core, its paper cover sheets and of the bond between them. (*Id.* at 16:44–53, 17:6–20.) The nail pull resistance increased in proportion to the concentration of STMP. (*Id.*) Table 5A presents sag resistance data as measured by the standard ASTM C473-95 test protocol. (*Id.* at 18:58–67.) The results demonstrate significant improvement in sag resistance with increasing addition of STMP. (*Id.* at 19:1–14.) Table 6 shows that STMP also improved the dimensional stability, i.e., reduced the length and width shrinkage, of the boards. (*Id.* at 19:15–39.)

80. Additional results are set forth in the other tables and figures. The reported test results demonstrate both that the class of phosphate materials defined as being “enhancing materials” in the specification are effective to improve one or more of sag resistance, strength and dimensional stability of gypsum boards, and are more effective in doing so than other previously-used additives such as boric acid, wax, fibers, etc.

81. The '914 patent mentions the conventional practice of producing lower density gypsum-containing products using foaming agents to create bubbles in calcined gypsum slurries that yield corresponding voids in the set gypsum product. (Ex. 1038 at 3:20-25.) The specification reports that when gypsum board is cast from a composition comprising water, calcined gypsum, trimetaphosphate ion and an aqueous foam, the overall strength of the resulting board is higher than conventional boards made using aqueous foam due to the inclusion of the trimetaphosphate ion. (*Id.* at 5:30–44.) The specification also reports that including trimetaphosphate ion in mixtures containing aqueous foam provides the additional benefit of creating more air voids per unit amount of aqueous foam. (*Id.* at 5:50–56.) This lowers production costs and reduces the risk of adverse effects of chemical foaming agents on other components or properties of the product. (*Id.* at 5:56–62.)

82. The '914 patent also provides an approach for improving the integrity of the bond between the gypsum core and the cover sheets of gypsum panels, which can lose strength or fail when a board becomes wet or was not completely dried during production, even when the board contains an acid-modified starch to improve paper-to-core bond integrity. (*Id.* at 5:4–15.) The specification teaches that this problem can be avoided by including a pregelatinized starch in the production slurry, which avoids the weakening of the bonding between the core and the cover sheets. (*Id.* at 5:16–22.)

83. When this series of patents was first published, my first reaction in looking at the data was that there was something special about the polyphosphates and how they interacted with the growing gypsum matrix. Since I was in contact with several other gypsum companies and was often used as a general technical resource, I was often questioned about whether I thought this really worked and whether the data in the patents supported the benefits that the patents describe. I had no reason to suspect the accuracy of the data and felt that the board performance characteristics described were impressive. It was certainly surprising to me that compounds that were widely considered to be retarders with negative crystal-modification properties could somehow be beneficial. I would certainly not expect this to have been obvious to a person ordinarily skilled in the art at the time that this patent was written, or even today.

VIII. CLAIM CONSTRUCTION

84. Mr. Harlos proposed a construction for the terms: “enhancing materials(s)” and “accelerator.” (Ex. 1001 ¶¶ 70–77.) This section provides my opinions regarding the meanings of these terms as understood by a person of ordinary skill in the art. I also address the term “set gypsum,” which needs to be understood to properly address certain of the invalidity arguments asserted by Mr. Harlos and the Petitioner.

“enhancing materials”

85. The term “enhancing materials” does not have an ordinary or customary meaning in the field of set gypsum products. When I first read the patents describing these very specific phosphoric acid and phosphate condensates and their salts, my understanding was that the patents were talking about a specific group of compounds having certain specific properties, with STMP being preferred.

86. I was asked to address how a person of ordinary skill in the art would understand the term “enhancing materials” in the context of the ’914 patent, and to do so following the guiding legal principles summarized above. I conclude that a person of ordinary skill would understand the term “enhancing materials” in the ’914 patent to mean any of the following compounds: “phosphoric acids, each of which comprises 1 or more phosphoric acid units; salts or ions of condensed phosphates, each of which comprises 2 or more phosphate units; and monobasic salts or monovalent ions of orthophosphates.”¹ In my opinion, this is the full scope of compounds that a person of ordinary skill would understand to be “enhancing materials” as that term is used in the ’914 patent.

¹ The simplest form of phosphoric acid, having the chemical formula H_3PO_4 , is also referred to as orthophosphoric acid. Orthophosphate refers to the ion PO_4^{3-} formed when orthophosphoric acid loses its three H^+ atoms.

87. The Field of Invention introduces enhancing materials generally as providing dimensional stability (non-shrinkage during drying), deformation resistance (sag resistance) and increased strength. (Ex. 1038 at 1:24–40.) However, the specification as a whole makes clear that the enhancing materials that are the subject of the invention are the specific phosphate materials within the stated definition. The '914 patent specification consistently uses the term “enhancing materials” only to refer to one or more of these phosphoric acid, condensed phosphate compounds or orthophosphates. It does not use the term “enhancing materials” to refer to all materials that potentially may enhance one or more properties of gypsum products. Boric acid and the other conventional additives are disclosed only for comparative purposes. Consistent with this, those conventional additives are never characterized as being enhancing materials.

88. The specification of the '914 patent incorporates the disclosure of the related '284 patent by reference. The '284 patent specification indicates that “enhancing materials” are the compounds that I mentioned above, specifically: “phosphoric acids, each of which comprises 1 or more phosphoric acid units; salts or ions of condensed phosphates, each of which comprises 2 or more phosphate units; and monobasic salts or monovalent ions of orthophosphates.” (Ex. 1003 at 4:3–9.) The additional passages appearing directly in the '914 patent describing enhancing materials are all consistent with the definition provided in the '284

specification. The '914 patent only uses the term enhancing materials to refer to compounds that are within the definition incorporated by reference from the '284 specification. (*See* Ex. 1038 at 3:65–4:5; 5:67–6:4, 6:14–16:19, 6:28–33; 6:39–44, 6:50–54, 6:61–62, 27:37–47.) All of the preferred and alternative embodiments discussed in the specification as illustrating examples of the invention use STMP or one of the other condensed phosphoric acid, condensed phosphate, or orthophosphate compounds are within the definition mentioned above.

89. The data in the examples and tables confirm that the compounds characterized in the specification as being enhancing materials are particularly effective sag resistance additives. For example, Table 2 compares the sag resistance of gypsum board containing STMP with a control board (no additive) and with other comparative samples containing only conventional additives such as boric acid, sodium aluminum phosphate, wax emulsion, and glass fiber. The specification states:

The data in TABLE 2 illustrate that the board (STMP) prepared in accordance with the invention was much more resistant to sag (and thus much more resistant to permanent deformation) than the control board and the noninventive comparative boards.

(Ex. 1038 at 14:60–64.)

90. Tables 13 and 16 also include a boric acid sample for comparison purposes. The sag resistance of the boric acid samples are more similar to the control samples than to the inventive enhancing material samples. Tables 14 and 15 present data showing significant sag resistance provided by polyphosphoric acid and polyphosphate materials. The specification sums up the tables as follows:

The results in Tables 13, 14, and 15 show that all materials tested that are within the definition of enhancing materials above, when used to treat calcined gypsum in the production of set gypsum-containing products, cause the products to exhibit significant resistance to permanent deformation compared with the controls.

(*Id.* at 28:62–67.) A similar comment appears before Table 16. (*Id.* at 31:30–35.) The specification demonstrates to the person of ordinary skill that, although conventional additives such as boric acid may increase strength and also effect a modest increase on sag resistance, the inventive phosphate enhancing materials are capable of effecting a very significant increase in sag resistance.

91. Mr. Harlos proposes that the term “enhancing material” should be construed as: “an additive that improves at least one of resistance to permanent deformation, strength, and dimensional stability in set gypsum-containing products.” (Ex. 1001 ¶ 75.) I disagree with this assertion. Mr. Harlos defines enhancing materials well beyond the particular additives that the term enhancing

materials is intended to describe in the specification. As explained, the term “enhancing materials” does not have an ordinary meaning in the industry, Mr. Harlos does not provide any evidence of such an ordinary meaning. But the ’914 patent specification makes very clear that this term only refers to the phosphoric acid, condensed phosphate and orthophosphate compounds described above.

“accelerator”

92. The term “accelerator” has a well-accepted meaning in the field to refer to agents that increase the rate of gypsum crystal setting. In my opinion, the term “accelerator” should be construed to mean “any reagent or combination of reagents effective to increase the rate of formation of set gypsum.” This definition comports with its ordinary meaning in the field of set gypsum products, and is consistent with how the term is used in the ’914 patent.

93. The ’914 patent specification refers multiple times to using a “set accelerator.” (*See e.g.*, Ex. 1038 at 12:36–39.) The related ’284 patent refers to a set accelerator prepared according to the method disclosed in U.S. Patent No. 3,573,947. (Ex. 1022 at 12:53–61.) The ’947 patent is entitled “Accelerator for Gypsum Plaster,” (Ex. 1022) and is listed on the face of the ’914 patent as a reference considered (Ex. 1038). Table 2 of the ’947 patent demonstrates that the disclosed accelerator has the effect of reducing the setting time. (Ex. 1022 at 7:16–

29.) This confirms that the specification uses the term “accelerator” in its ordinary sense to refer to an agent that increases the rate of formation of set gypsum.

94. The Harlos Declaration proposes to construe accelerator as being a “reagent or combination of reagents known to be useful to influence the rate of formation of set gypsum.” (Ex. 1001 ¶ 77.) However, “influence” is too imprecise because it would also include agents that slow down the rate of set gypsum formation, which are called “retarders” not “accelerators.”

“set gypsum”

95. Independent claim 1 refers to “set gypsum.” The hydration process to convert calcined gypsum through dissolution and then crystallization of interlocking gypsum crystals has been described above. The term “set gypsum” has a well-accepted ordinary meaning of calcium sulfate dihydrate formed by the rehydration of calcined gypsum into a crystalline structure. A person of ordinary skill in the art would understand that the term “set gypsum” refers to “the crystallized gypsum structure produced from the rehydration of calcium sulfate hemihydrate into calcium sulfate dihydrate by mixing with water.”

96. The '914 patent specification confirms that a set gypsum is formed from the setting of aqueous calcined gypsum slurries. It states, for example:

Most such gypsum-containing products are prepared by forming a mixture of calcined gypsum . . . and water . . . , casting the mixture into

a desired shaped mold or onto a surface, and allowing the mixture to harden to form set (i.e., rehydrated) gypsum by reaction of the calcined gypsum with the water to form a matrix of crystalline hydrated gypsum (calcium sulfate dihydrate). . . . It is the desired hydration of the calcined gypsum that enables the formation of an interlocking matrix of set gypsum crystals, thus imparting strength to the gypsum structure in the gypsum-containing product.

(Ex. 1038 at 2:9–22.)

97. Mineral gypsum also has the chemical name calcium sulfate dihydrate, but a person of ordinary skill in the art would not consider it to be “set” gypsum. Mineral gypsum has a density of close to 2.32 g/cc because there is very little void space between the gypsum crystals making up the rock material. Set gypsum, on the other hand, has a significant void space between gypsum crystals resulting in a solid density of perhaps 1–2 g/cc. Most set gypsum board core is even lighter because of voids formed when water dries off as well as the foam voids.

98. In paragraph 34 of his declaration, Mr. Harlos confirms that “set gypsum” is the term used to describe calcium sulfate dihydrate produced by the rehydration of calcined gypsum. (Ex. 1001.) That paragraph also refers to a comment at column 4, lines 27 to 42 of the ’914 patent indicating that “set gypsum” and “hydrated gypsum” refer to calcium sulfate dihydrate. That comment clarifies that “set gypsum” is used interchangeably with “hydrated gypsum,” and that it is made

up of calcium sulfate dihydrate. It does not indicate that all calcium sulfate dihydrate is set gypsum. The same passage indicates that set gypsum is calcium sulfate dihydrate that forms when water reacts with calcined gypsum. (Ex. 1038 at 4:35–41.)

IX. RESPONSE TO MR. HARLOS' CHARACTERIZATIONS OF THE ASSERTED REFERENCES

99. The Harlos Declaration cites several passages from the asserted references that he alleges are relevant to the invention of the '914 patent. I find many of his descriptions of the references to be incomplete or inaccurate. The summary below responds to the descriptions provided by Mr. Harlos by noting important details and identifying aspects of the references that I believe Mr. Harlos has overlooked or assessed incorrectly. I also explain my points of disagreement with Mr. Harlos in the claim-by-claim analysis that follows later.

A. Summary Of Graux

100. The disclosures of the Graux reference are not particularly relevant to the subject matter of the '914 patent. Graux relates to using starch compounds, such as potato starch, to thicken gypsum pastes used as plasters, coatings or adhesives. It makes a passing reference to using some phosphates (including trimetaphosphates) solely for the pretreatment of certain starches to crosslink them before the starches

are used in these plasters. There is no disclosure or suggestion that any of those phosphates alone were added to or used in the gypsum pastes.

101. In paragraph 81, Mr. Harlos acknowledges that the primary objective of Graux is to improve the thickening characteristics of gypsum plasters, coatings and adhesives. (Ex. 1001.) Thickening ability is a property of interest for gypsum compositions that are applied as a fluid or paste before hardening into a set gypsum form. For example, a plaster paste for finishing walls should be easy to spread while having sufficient thickness so that the paste does not migrate along the wall surface before hardening.

102. Graux specifically discloses adding particular types of “amylaceous” starch compounds to a plaster, coating or adhesive composition as a thickener. (Ex. 1006 at Abstract.) Graux indicates that “amylaceous compound” refers to a broad range of starches of natural or hybrid origin, as well as starch mixtures and mixtures containing starch(es) and vegetable proteins. (*Id.* at 4:49–67.) Graux points out certain disadvantages associated with hydroxypropyl and carboxymethyl potato starches previously used in plasters and coatings. (*Id.* at 2:19–62.) Graux proposes the use of amylaceous compounds that are cationic and have a fixed nitrogen content of about 0.15% and a solubility in water of at least about 50%. (*Id.* at Abstract, 3:40–45.) According to Graux, the disclosed amylaceous compounds: (1) are widely applicable to plaster compositions of various kinds, compositions and intended uses;

(2) can be used in plaster compositions at pH values of about 10.5–11; (3) are inexpensive to produce; and (4) remain effective during storage. (*Id.* at 2:63–3:7.)

103. Graux also discloses using an amylaceous compound that has been subjected to chemical treatment such as crosslinking. (*Id.* at 5:30–38.) Graux explains that crosslinking is “any process in which a starch (or cationic starch) is caused to react with an agent such as adipic acid or one of its derivatives, a halohydrin (for example, epichlorohydrin), a trimetaphosphate (for example, sodium)” (*Id.* at 5:46–51.)

104. Graux also discloses that the amylaceous compound may undergo a physical treatment such as cooking-extrusion, continuous steam cooking, drum gelatinization, etc. (Ex. 1006 at 6:22–29.) Such physical treatments make it possible to increase the solubility in water of the cationic amylaceous compounds to the desired levels. (*Id.* at 6:45–52.)

105. Graux states that his thickening agents may be applied to plaster compositions in the form of powders, fluid pastes, hardened pastes or finished articles. (Ex. 1006 at 1:24–34.) The plaster compositions may include other additives such as accelerators, retarders, fillers, water retaining agents, water-repelling agents, lightweight additives and anti-foaming agents. (*Id.* at 7:28–59.)

106. The mention of “hardened pastes or finished articles” would not be understood to refer to gypsum panels. Graux contains no suggestion that the

disclosed thickened gypsum pastes could be used to make a gypsum panel having improved sag resistance. In fact, Graux mentions the use of other chemically modified amylaceous compounds for improving the bond between the gypsum core and cardboard cover sheets of plaster board or plaster tiles. (*Id.* at 1:43–54.) Graux states that the disclosed starch compounds should not be used to thicken gypsum slurries in the manufacture of gypsum board:

For the preparation of these articles, it is compulsory that the amylaceous compounds have no detrimental influence on the fluidity, the hardening or the setting of the plaster body. These amylaceous compounds first must have no thickening effect so that the plaster composition present a sufficient fluidity to spread uniformly on the cardboard coating.

(*Id.* at 1:55–61.) A person skilled in the manufacture of gypsum board would understand that reducing the thickness back to an acceptable fluidity range requires using more water, which adds manufacturing cost and time by increasing the required evaporation load.

107. Several other passages indicate that Graux is concerned primarily with thickening agents used in plaster compositions having a pH of more than 10.5. (*Id.* at 2:27–34; 2:50–54; 2:63–3:3.) This also teaches away from the use of such compounds in gypsum panels, which are typically manufactured using gypsum slurries having a pH in the range of 6.5–8.5.

108. Graux provides no information at all regarding improving the strength, sag resistance or dimensional stability of set gypsum panels. In this regard, Mr. Harlos only asserts generally that “any additional ingredient that was added to the composition was done for the specific purpose of improving some characteristic of the product.” (Ex. 1001 ¶ 92.) He does not even try to suggest that the product characteristic of interest to Graux is sag resistance. And his assumption ignores that additives may be incorporated in gypsum slurries to change properties or reactivity of the slurries, or to counteract the effects of other additives, but not necessarily to improve the finished product.

109. In any event, the only product characteristic of interest to Graux is the gypsum paste thickness. There is no information in Graux from which to determine the impact of any such additives on the properties of set gypsum cast as panels. Mr. Harlos has not provided any independent test results or other evidence to establish any such effect. A person of ordinary skill would conclude that there is insufficient evidence to demonstrate what impact, if any, whether enhancing or detrimental, the starch additives disclosed in Graux may have on strength, sag resistance or dimensional stability of set gypsum-containing products.

110. Mr. Harlos also states that Graux discloses a plaster composition containing calcined gypsum, water and STMP. (Ex. 1001 ¶ 92.) Mr. Harlos is mistaken at a rather fundamental level. Graux’s description of adding starch that was

previously crosslinked by reaction with STMP is not disclosing adding STMP to a gypsum composition. Graux describes the crosslinking process as a reaction between the starch and STMP, and refers to European patent EP 603,727 for its description of such crosslinked starches. (Ex. 1006 at 5:46–53.) The EP 603,727 reference describes the preparation method as involving neutralizing, filtering, washing and drying the crosslinked starch. (*See e.g.*, Ex. 2002 at 5:44–47 (Example I); 6:51–55 (Example II); 7:41–43 (Example III).) The crosslinked starch is then jet cooked (*see e.g., id.* at 5:48–50 (Example I); 6:56–58 (Example II); 7:54–55 (Example III)), which involves continuously heating starch using direct steam injection under shear and pressure to disperse and cook the starch. (*Id.* at 4:47–49.) The crosslinked starch composition prepared according to this method, using STMP as a crosslinking reagent as suggested by Graux, would necessarily not include any STMP. The STMP is consumed in the reaction, and any excess STMP is removed during the washing step.

111. Mr. Harlos acknowledges this by explaining that the STMP reacts with the starch molecules to create a di-starch orthophosphate. (Ex. 1001 ¶ 49.) Mr. Harlos describes the resulting starch polymer as having “permanent crosslinks between starch molecules,” which he indicates “require a large amount of energy to break.” (*Id.*) In paragraphs 49 and 50, Mr. Harlos describes the reaction involved, referencing U.S. Patent No. 2,884,413 to Kerr (“Kerr”). (*Id.* (citing Ex. 1010 at 2:55–

69).) The STMP reacts with the ROH starch groups to produce a di-starch orthophosphate and tetrasodium pyrophosphate. This di-starch orthophosphate is not STMP, and is a very different compound than STMP. Kerr also confirms that the conventional practice involves washing and drying the crosslinked starch. (Ex. 1010 at 4:48–50.) This would remove any residual STMP and the tetrasodium pyrophosphate, which are both soluble in typical solvents.

112. Therefore, Graux does not disclose adding STMP to a gypsum composition. Nor does it disclose any gypsum composition or gypsum board product containing STMP or any of the other enhancing materials recited in the claims of the '914 patent.

B. Summary Of ASTM C473-95

113. ASTM C473-95 specifies fourteen standard test methods for physical testing of gypsum board products. (Ex. 1009 § 1.2.) One of these methods test for humidified deflection, i.e., how much the board creeps or sags when exposed to controlled humidified conditions for 48 hours. This standard does not disclose any information regarding gypsum product compositions, or how such compositions can be modified to achieve desired product characteristics or test results. The ASTM test methods add nothing to knowledge of how to achieve improved sag resistance or any other property of gypsum board products. Note that the ASTM test methods that would normally apply to the products described in the Graux and Hjelmeland patents

are best described in ASTM C472-93: *Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete*, which of course has no test for sag resistance as this does not apply to these products. (Ex. 1014.)

C. Summary Of Hjelmeland

114. I am advised that the Hjelmeland reference does not qualify as prior art to the '914 patent. I nevertheless address its disclosure for sake of completeness.

115. Hjelmeland concerns curable gypsum-based compositions for use in casting molds and finishing walls. (Ex. 1008 at Abstract, 1:12–14.) It discloses using a retarder in a mixture of calcined gypsum and water to stop the gypsum from curing until it is ready to use. The retarder can be a compound containing at least two organic acid groups, among which can be a phosphate or phosphonate, or can be a polyphosphate ion. To complete the setting process, an accelerating component is added to the mixture to eliminate any further action of the retarder by forming stable, insoluble salt precipitates or chemical complexes with the retarder. (*Id.* at 4:4–10 and 4:17–28.)

116. The reference explains that typical compositions will have a “pot life,” described as the “time to gelation,” that is about one half of the time required to obtain full strength of a set product. (*Id.* at 1:16–19.) Retarders may be used to extend the pot life. In other words, the product stays fluid for a longer period of time so that it can be pumped, moved, spread, etc. But retarders may also cause the composition

to spread or slump after application to a wall or into a mold if they delay the hardening process too much. (*Id.* at 1:19–25.) Adding set accelerators to such compositions prematurely may result in problems such as hardening in mixer units, pump or other equipment. (*Id.* at 1:25–31.)

117. Hjelmeland discloses an approach for providing a curable gypsum-based composition having a long time to gelation but short setting time after application. (*Id.* at 1:32–36.) This approach involves using a set retarder that is an organic acid containing at least two acid groups selected from carboxyl, sulphate, sulphonate, phosphate or phosphonate; or is an inorganic anion selected from polyphosphate and polyborate. (*Id.* at 3:60–4:3.) Examples are citric acid, fruit acid or polyphosphate. (*Id.* at 4:11–12.) Hjelmeland also teaches that Grahams salt (sodium hexametaphosphate) is particularly effective at extending the hardening time. (*Id.* at 8:22–25.)

118. Hjelmeland's disclosed approach also involves using set accelerators that form complexes and precipitate the set retarding substances, thus preventing or eliminating the effect of the set retarder on the hydration reaction between water and calcined gypsum. (*Id.* at 4:4–10, 4:24–28.) The pot life of the retarded gypsum suspension can thus be controlled to about an hour or more, followed by addition of the accelerator whereupon the composition sets within 2–15 minutes. (*Id.* at 4:46–53.)

119. Note that in a typical gypsum board application the gel time needed to get the slurry through the mixer and formed into a board (as per the pot time in Hjelmeland) is well under 15 seconds, and the total time to achieve complete recrystallization and setting is under 10 minutes. These “pot times” in gypsum board manufacture are far faster than those associated with the wall finishing and mold casting plasters described in the Hjelmeland patent.

120. Hjelmeland does not indicate that the disclosed retarders are effective to enhance the strength, sag resistance or dimensional stability of set gypsum panels. The conventional knowledge was that retarders reduce the core strength of set gypsum panels by changing the size and/or shape of the gypsum crystals and thus reducing the beneficial intergrowth in the gypsum crystal matrix. Also, Hjelmeland requires the neutralization and effective removal of the retarders from the mixture to allow the completion of the curing of the gypsum matrix. Thus, Hjelmeland discloses that the polyphosphates should be prevented from having any effect on the cured gypsum matrix, not that they have the effect of increasing the strength, sag resistance or dimensional stability of a panel made using the Hjelmeland mixture. (Ex. 1008 at 4:17–28.)

121. Mr. Harlos asserts that the retarders disclosed in Hjelmeland would increase core strength only in the sense that they can prevent crystal growth from occurring prematurely when the solution is being mixed, and thereby avoid

damaging the crystals. (Ex. 1001 ¶ 88.) In other words, Mr. Harlos argues that the delayed set products are stronger than they would have been if the crystal growth had been damaged by the mixer. Mr. Harlos does not establish, however, that the full strength has been fully reinstated or, indeed, that the mix will not suffer from the normal overall weakening effect of the retarder.

D. Summary Of Satterthwaite

122. Satterthwaite does not relate to set gypsum-containing products at all. It relates instead to ceiling tile and other tile products in which a thick starch paste is used as a glue to hold together other components of the tile.

123. Satterthwaite states that the tile products of interest are made from a mixture of starch, water, gypsum, mineral wool and other ingredients. (Ex. 1007 at 1:13–18.) The only other suitable tile composition described includes starch binder, water, gypsum, boric acid, paraffin wax and mineral wool. (*Id.* at 3:32–41.) Satterthwaite explains:

Starch and starch products have been used for many years as adhesives to bind together the various ingredients of the tile to form a plastic mass. The resulting plastic mass is then formed into a sheet, after which it is scored, dried in an oven and processed for sale.

(*Id.* at 1:18–23.) As this passage reflects, the manufacture of these starch-based tile products does not involve setting a composition of calcined gypsum. Rather, the composition of starch and other ingredients is subject to a drying process in an oven.

As water is removed in the oven, starch ribbons start sticking to each other and to other mix components through hydrogen-bonding of hydroxyl groups to create a firm structure. This mechanism is quite different than the mechanism involved in stimulating growth of gypsum crystals in calcined gypsum slurries to form set gypsum products.

124. Satterthwaite relates to an improved starch binder for use in such compositions:

The starch binder of my invention, when gelatinized, has a greater viscosity and a greater viscosity stability than other starches, and is therefore particularly suitable for use in the manufacture of acoustical ceiling tile and other tile products made from a mixture of water, gypsum, mineral wool and other ingredients.

(*Id.* at 1:12–18.) A person of ordinary skill would understand that “gypsum” in these compositions is a mineral gypsum filler rather than a calcined gypsum hemihydrate that is allowed to set. As the Harlos Declaration acknowledges, gypsum was commonly used in its raw mineral form (essentially ground gypsum rock) in such starch-based tile products as a filler. (Ex. 1001 ¶ 169.) Satterthwaite does not characterize the gypsum as being calcined gypsum (or the equivalent terms calcium sulfate hemihydrate and/or calcium sulfate anhydrite), and contains no discussion of forming set gypsum products from the hydration of calcined gypsum.

125. Mr. Harlos asserts that the mention of “gypsum” in Satterthwaite “could include calcined gypsum to form set gypsum-containing acoustical tiles.” (*See, e.g.,*

Id. ¶ 168.) However, this is contradicted by his concession that calcined gypsum would only be used when the gypsum functions as a binding agent. (*Id.* ¶ 169.) In Satterthwaite’s tile compositions, a “starch binder” functions “to bind together the various ingredients of the tile to form a plastic mass.” (Ex. 1007 at 1:9–12, 1:18–21.) Gypsum is one of the “various ingredients” bound together by the starch. It serves as an inert filler, not as a binder.

126. Satterthwaite explains that the thick-boiling starches conventionally used as binders in such tile products absorb and retain more water than unmodified starches. (*Id.* at 1:29–34.) A high percentage of tiles do not dry completely during the first pass through the oven, and must be reprocessed in a second drying operation. (*Id.* at 1:38–43.) Satterthwaite addresses this problem by combining a thick boiling starch and a polyhydric alcohol fatty acid ester. (*Id.* at 1:9–12.)

127. Satterthwaite states that tiles formed using this binder composition dry faster resulting in less wet tile produced. (*Id.* at 1:54–60.) Satterthwaite also states that “the finished tile shows increased wet strength, increased density and increased resistance to warp or sag.” (*Id.* at 1:60–62.) “Wet strength” implies that these observations relate to the tiles at some intermediate wet state during production. Consistent with that understanding, Satterthwaite also comments that “my starch composition improves the wet tile characteristics, increases the wet tile strength and density, and increases the resistance to sag or warp.” (*Id.* at 4:24–27.) As discussed

above, the “sag” failure in Satterthwaite relates to the failure of the starch binder to dry, whereas the sag problem addressed in the '914 patent has to do with the slow reshaping of the gypsum crystal structure from the force of gravity in the presence of absorbed moisture in the board core, a completely different process.

128. Satterthwaite does not disclose any test data or other information quantifying how much the starch composition impacts the product characteristics mentioned, and does not even report how these characteristics were assessed. There is no disclosure suggesting that the sag resistance observed by Satterthwaite was measured using any method comparable to the ASTM C473-95 test discussed in the '914 patent. And because Satterthwaite's findings relate only to tile products formed by oven cooking a mixture to solidify a thick starch core, it discloses nothing relevant to the set gypsum panel sag resistance problems addressed by the '914 patent.

129. Satterthwaite does not disclose adding STMP or any other polyphosphate compound to the tile mix or that the tile mix composition contains any amount of such compounds. Satterthwaite only discloses STMP for use as a reagent for making thick boiling starch compositions comprising crosslinked starch. (*Id.* at 2:8–13.) It describes a preferred procedure in which the starch is allowed to react with a crosslinking agent, followed by filtering, washing and drying the crosslinked starch product. (*Id.* at 2:18–31.) Satterthwaite indicates that the starch

binder composition is first prepared in this manner and then added to the tile mix.
(*Id.* at 1:48–60.)

130. It is not entirely clear whether Mr. Harlos believes that Satterthwaite discloses forming a gypsum composition containing STMP. Regardless, the Satterthwaite reference does not disclose such a composition. As explained above in relation to the Graux reference, the crosslinking reaction between STMP and starch produces a di-starch orthophosphate complex and consumes the STMP. A person of ordinary skill would understand that because STMP is water soluble, any excess STMP is removed in the washing and drying steps of making the crosslinked starch composition.

E. Summary of Sucech

131. As mentioned, the '914 patent acknowledges the conventional use of foaming agents to create voids resulting in lower density set gypsum products. The Sucech reference discloses a process for producing gypsum board having large foam voids using a controlled mixture of first and second foaming agents. (Ex. 1036 at Abstract, 1:42–51.) Sucech does not disclose that the use of trimetaphosphate ions or other enhancing agents of the '914 patent could improve the sag resistance or strength of foamed gypsum board, or would reduce the amount of foam required to create the desired amount of voids.

F. Summary of Summerfield

132. The Summerfield reference proposes a technique for producing gypsum wallboard having enhanced strength and hardness at edge portions of the gypsum core. Summerfield discloses forming a foamed gypsum slurry using a conventional mixer that gently blends the slurry so that the foam is not broken. (Ex. 1017 at 3:43–48.) Next, a portion of the foamed slurry is intensely mixed in a supplemental mixer under conditions that break the foam, followed by adding additional foam to replace the broken foam. (*Id.* at 3:48–54.) The slurry subjected to the supplemental intense mixing is used for the edge portions of the board, and the central core portion is formed of the slurry from the conventional initial mixer. (*Id.* at 3:65–71.) The resulting set gypsum wallboard has essentially the same density in the central and edge core portions, but the edge portions have enhanced strength and hardness to resist damage during handling and installation. (*Id.* at 3:71–4:1.)

133. Summerfield does not relate to improving strength, sag resistance or other properties of gypsum wallboard through the use of any of the enhancing materials disclosed and claimed in the '914 patent.

X. THE CLAIMS ARE NOT OBVIOUS BASED ON THE COMBINATION OF GRAUX, ASTM C473-95, HJELMELAND, SUCECH, AND SUMMERFIELD

134. I disagree with Mr. Harlos' analysis and conclusion in paragraphs 78–136 that the subject matter of the challenged claims of the '914 patent would have

been obvious to a person of ordinary skill in the art based on the disclosure of Graux, in view of ASTM C473-95, Hjelmeland, Sucech and Summerfield. Mr. Harlos has overlooked important aspects of what these references disclose in attempting to piece together their disclosures in a way that he contends demonstrates obviousness of the claimed inventions.

135. In my opinion, Graux, ASTM C473-95 and Hjelmeland are each largely irrelevant to the specific gypsum board products described in the challenged '914 patent claims. None of these references address the same problems as the '914 patent, or even similar problems. Their disclosures as a whole would not have led a person of ordinary skill in the art to the claimed compositions or gypsum wallboard products, and, in my opinion, the subject matter of the claims is not obvious in view of these references.

136. Sucech and Summerfield relate to the use of foaming agents in the manufacture of set gypsum products, but do not in any way suggest using any of the enhancing materials of the '914 patent to improve the sag resistance, strength or dimensional stability of gypsum panels or other set gypsum products. In my opinion, they add little beyond what the '914 patent already describes as the state of gypsum wallboard production technology as of the August 1997 timeframe of the original filing date. These references also do not disclose or suggest the use of enhancing

materials to improve characteristics of set gypsum products as described and claimed in the '914 patent.

137. In the discussion that follows, I first address why none of these references would have provided useful guidance to a person of ordinary skill in the art who was attempting to solve the problems addressed by the '914 patent. I then show why even the disclosures of these references as combined by Mr. Harlos would not have led to the particular gypsum wallboard products claimed.

A. Mr. Harlos Has Not Established Any Motivation To Use Or Combine The Asserted References

138. In paragraphs 91–102, the Harlos Declaration asserts that a person of ordinary skill in the art would have been motivated to combine the disclosures of Graux, ASTM C473-95, Hjelmeland, Sucech and Summerfield and would have had a reasonable expectation of success in doing so. Mr. Harlos appears to reason along the following lines:

- i. Graux's gypsum paste supposedly includes calcined gypsum, water, and STMP. The STMP was added for a reason which, Mr. Harlos assumes was for strength and sag resistance. (*Id.* ¶ 92.)
- ii. One of ordinary skill would have been motivated by the ASTM C473-95 standards to use the Graux paste to make gypsum panels that meet the requirements of those standards, including the sag

resistance standards, which was predictable from Graux. (*Id.* ¶¶ 94–95.)

- iii. One of ordinary skill would glean from the amount of set retardant disclosed in Hjelmeland how much STMP should be used in the Graux gypsum paste. (*Id.* ¶ 96.)
- iv. One of ordinary skill would have understood from Sucech that foaming agents are used to lower the weight and density of set gypsum containing products and would have found it obvious to add such a foaming agent to the gypsum past compositions disclosed by Graux. (*Id.* ¶ 97.)
- v. One of ordinary skill would have also found it obvious to use Graux's gypsum paste composition to form the core of gypsum wallboard having paper cover sheets because Summerfield and the '914 patent specification demonstrate that the basic process of manufacturing gypsum wallboard was known. (*Id.* ¶ 98.)
- vi. These references are supposedly all directed at the same problems, and the same problems as the '914 patent, and the '914 patent acknowledges that gypsum wallboard manufacturing and the use of foam and host particles was known. Therefore, combining the asserted references would have produced predictable results. Any

required modifications would have been routine for the person skilled in the art because the products disclosed by the reference are all “compatible.” (*Id.* ¶¶ 99–102.)

139. This analysis is flawed at every level. Graux, which is the primary reference asserted by Mr. Harlos, does not disclose adding STMP (or any other enhancing material) to its gypsum paste mixture. The portion of Graux relied on by Mr. Harlos for that supposed disclosure, column 10, lines 29–30, refers to a potato starch that was crosslinked using STMP. (Ex. 1006.) As discussed above, that crosslinking was completed before the starch was added to the Graux paste, and the starch as added to the paste did not include any STMP.

140. The gypsum paste disclosed in Graux is formulated with thickening agents to make the paste viscous and suited for sticking on walls, etc. Graux specifically states that such thickened pastes would have no application for the preparation of plaster board or plaster tiles with a cardboard coating. (Ex. 1006 at 1:46–61). In fact, Graux states that if amylaceous compounds were used in gypsum panels, “it is compulsory that the amylaceous compounds have no detrimental influence on the fluidity, hardening or setting of the plaster body.” (*Id.*) This, of course, would dissuade a person of ordinary skill from using the thickened Graux pastes in making gypsum panels. Thickening the slurry/paste is exactly the opposite of what needs to be done to make a gypsum board.

141. A person of ordinary skill would have no reason to look to Graux as a starting point for solving the problems addressed by the '914 patent claims. Graux does not provide any data, examples or information showing or indicating to one of ordinary skill how the Graux gypsum pastes could be cast into gypsum panels that could be tested under the ASTM C473-95 standards. It also does not provide any data or examples allowing one of ordinary skill to predict any of the properties of such gypsum panels under the tests from those ASTM standards, let alone the sag resistance properties required by the '914 patent.

142. The ASTM C473-95 standards do not provide any procedures or disclosures regarding the formulation of gypsum slurries for use in making gypsum panels. They are limited to test procedures for determining certain properties of premade panels. These standards do not provide any information relating to how to achieve improved sag resistance in set gypsum products, or about any particular additives that are effective in that regard.

143. One of ordinary skill in the art would not look to Hjelmeland for guidance regarding the amount of STMP to add to the Graux gypsum paste composition. Graux does not involve adding any STMP to the set gypsum-containing products. It only uses STMP in a chemical reaction that consumes the STMP and produces crosslinked starch compounds, which are washed and dried before being added to the paste mix. Hjelmeland uses retarding agents having

phosphate or phosphonate acid groups, or anions of polyphosphates or polyborates, to inhibit the setting of gypsum solutions. A person interested in using STMP as a starch crosslinking agent, as in Graux, would gain no useful information from the disclosures of Hjelmeland.

144. If one of ordinary skill did attempt to supplement the Graux paste mixture by adding the Hjelmeland retarder, in the amounts disclosed by Hjelmeland, the retarder would have inhibited the gypsum paste from curing, leaving it in a partially gelled state. Such a partially gelled mixture could not be formed into panels that could be tested under the ASTM C473-95 standards. One of ordinary skill would have no way of predicting what the resulting properties of a set gypsum matrix made from such a mixture might be in any form.

145. The Sucech and Summerfield references relate to conventional gypsum wallboard manufacturing and contain no disclosure relevant to using phosphoric acid or condensed phosphate compounds as enhancing materials to improve the characteristics of gypsum wallboard of other set gypsum products.

146. Therefore, the combination proposed by Mr. Harlos would leave one skilled in the art without any guidance regarding making acceptable gypsum board using STMP or the other enhancing materials claimed by the '914 patent, or that could satisfy the degree of sag resistance required by the claims of the '914 patent.

147. Also, one of ordinary skill would not find the references relied upon by Mr. Harlos to be directed to the same problems as those addressed by the '914 patent or to offer the same or even similar solutions. Graux concerns making a thickened gypsum paste, which was not suitable for gypsum panels. Hjelmeland is directed to holding a gypsum slurry in a partially gelled state and then causing it to set quickly by neutralizing its retarder so that the retarder cannot affect formation of the cured gypsum matrix. The ASTM C473-95 standards concern testing of gypsum panels, and none of the issues addressed by Graux and Hjelmeland. Sucech and Summerfield relate to gypsum wallboard manufacturing, but do not disclose or suggest the use of STMP or any other enhancing material to improve the sag resistance of gypsum panels, improve the strength properties of gypsum panels or improve the dimensional stability of gypsum panels.

B. The Identified Disclosures Of Graux, ASTM C473-95, Hjelmeland, Sucech And Summerfield Do Not Result In The Claimed Inventions

148. In the sections that follow, I explain why the specific combination of disclosures relied on by Mr. Harlos does not result in or suggest the particular gypsum wallboard products with improved sag resistance set forth in the challenged claims. I address the elements of the challenged claims 1–4, 6, 8 and 10 of the '914 patent separately below.

Claim 1a: A gypsum board comprising:

149. Graux discloses gypsum plaster compositions containing cationic starch compounds as thickening agents. Graux discloses that these pastes can be formed into finished articles. (Ex. 1006 at 1:24–30.) However, one of ordinary skill in the art would understand that comment in its full context to refer to finished articles made from the kind of manual plasters, coating plasters and adhesive plasters described in the immediately preceding paragraphs. (*Id.* at 1:4–23.) Graux does not state that the disclosed plaster compositions are suitable for the production of gypsum board. The assertion by Mr. Harlos that “finished articles” would necessarily include gypsum board (Ex. 1001 ¶ 103) ignores both the preceding context and Graux’s direct teaching that cationic amylaceous compounds should not be used to thicken gypsum slurries for producing “plaster bord [sic] or plaster tiles with a cardboard coating.” (Ex. 1006 at 1:43–61.) One of ordinary skill in the art would heed Graux’s warning against using his starch compounds in the production of gypsum board products and would not have had a reasonable expectation that Graux’s thickened pastes could be successfully used to make gypsum board.

150. Several other passages indicate that Graux is concerned primarily with thickening agents used in plaster compositions having a pH of more than 10.5. (*Id.* at 2:27–34; 2:50–54; 2:63–3:3.) This also teaches away from the use of such

compounds in gypsum panels, which are typically manufactured using gypsum slurries having a pH in the range of 6.5–8.5.

Claim 1b: a core of material sandwiched between cover sheets, wherein the core comprises an interlocking matrix of set gypsum,

151. Mr. Harlos relies on the '914 patent specification and the Summerfield reference to establish that gypsum board was conventionally made by sandwiching a set gypsum core between cover sheets. (Ex. 1001 ¶ 105.) However, Mr. Harlos has not shown that this claim would have been obvious based on his proposed combination of references. Mr. Harlos does not argue that the Summerfield reference somehow overcomes Graux's directive not to use starch thickening agents in gypsum board slurries.

Claim 1c: the board has been prepared by a method comprising:

152. In paragraph 107, Mr. Harlos essentially repeats the assertions of paragraph 103 that Graux discloses making gypsum board. He again ignores Graux's direct teaching against the use to the disclosed calcined gypsum and thickened starch compositions for the manufacture of gypsum board.

Claim 1d: forming or depositing a mixture between the cover sheets, wherein the mixture comprises a calcined gypsum, water, an accelerator, and one or more enhancing materials selected from the group consisting of: sodium trimetaphosphate, tetrapotassium pyrophosphate, tetrasodium pyrophosphate, aluminum trimetaphosphate, sodium acid pyrophosphate, ammonium polyphosphate having 1000-3000 repeating phosphate units, and acids, salts, or the anionic portions thereof, and,

153. In paragraph 110, Mr. Harlos asserts that Graux discloses this claim element by disclosing a mixture of calcined gypsum, water, accelerators and “cationic potato starch . . . , crosslinked with sodium trimetaphosphate.” (Ex. 1001.) Crosslinked starch is not STMP, does not contain STMP, and is not an enhancing material relevant to the challenged claim. Graux’s disclosure of gypsum paste compositions containing crosslinked starch does not disclose a composition containing STMP or any of the other recited enhancing materials.

154. Mr. Harlos relies mainly on Graux. His analysis of this claim limitation does not look to another reference for a disclosure of forming an aqueous calcined gypsum mixture containing STMP or any other recited enhancing material. (Ex. 1001 ¶¶ 110–11.) Mr. Harlos refers elsewhere to Hjelmeland for its disclosure of “polyphosphates” as retarders. However, as mentioned above, Hjelmeland states that the retarder would prevent the formation of set gypsum. This leads away from using polyphosphates to produce a set gypsum-containing product that can satisfy any of the claims of the ’914 patent.

Claim 1e: maintaining the mixture under conditions sufficient for the calcined gypsum to form the interlocking matrix of set gypsum,

155. The thickened gypsum paste in Graux will cure under the conditions disclosed in Graux to form an interlocking matrix of set gypsum. However, the mixture disclosed in Graux does not correspond to the mixture recited in this step because it does not contain STMP or any other claimed enhancing material.

Claim 1f: the enhancing material or materials having been included in the mixture in an amount such that the gypsum board has greater sag resistance than it would have if the enhancing material had not been included in the mixture, said board having a sag resistance as determined according to ASTM C473-95 of less than about 0.1 inch per two foot length of said board,

156. As explained, Graux does not relate to the production of set gypsum panels and cautions against the use of the disclosed compounds as thickening agents in the manufacture of set gypsum panels. (Ex. 1006 at 1:43–61.) Because Graux does not disclose a mixture containing any of the claimed enhancing materials, it necessarily does not disclose this limitation. In analyzing this limitation, Mr. Harlos continues to confuse STMP with starch that was crosslinked using STMP. (Ex. 1001 ¶ 113.) He asserts that the Graux gypsum composition contains STMP, but then immediately refers to the description in Graux of cationic potato starch crosslinked with STMP. (*Id.*) Crosslinked starch is not STMP, does not contain STMP, and is not an enhancing material relevant to the challenged claims.

157. In paragraph 115, Mr. Harlos contends that a person of ordinary skill in the art would have understood that STMP “was known in the art as improving the quality of set gypsum-containing products.” (Ex. 1001.) He then asserts that a person having ordinary skill would have known of the ASTM C473-95 test for measuring sag resistance. From this he deduces that this claim limitation “is simply stating an inherent property of a known composition.” (*Id.*) However, Mr. Harlos has not established that claim 1 recites a “known composition.” For this he relies on Graux, but Graux does not disclose the use of STMP or any of the other recited enhancing materials in gypsum slurries for any purpose.

158. Mr. Harlos also points to Figures 2 and 3 of the '914 patent for its disclosure of a prior art Gold Bond set gypsum panel having sag of less than 0.1 inches. (Ex. 1001 ¶ 116.) I fail to see the relevance of that information because there is no indication that the Gold Bond boards contain any of the recited enhancing materials. Also, the Gold Bond products were not tested using the ASTM C473-95 test method, and Mr. Harlos can only speculate that these products would satisfy the recited sag resistance standard. (*Id.*)

159. Furthermore, Mr. Harlos fails to appreciate the real significance of that reported sag resistance data. As the '914 patent specification explains, the ½ inch Gold Bond board sag resistance data in Figures 2 and 3 corresponds to the “average ½ inch interior ceiling” board shown in Figure 1. (Ex. 1038 at 15:13–15.) Figure 1

shows that board having a density of 1800 pounds per 1,000 sq. ft. compared to only 1600 pounds per 1,000 sq. ft. for the ½ inch board made per the invention. The ½ inch Gold Bond board showed good sag resistance, but this was achieved by adding mass to the board, which results in a heavier and more expensive product. The ½ inch board of the invention significantly outperformed the Gold Bond board in terms of sag resistance despite being about 11% lighter. Thus, the ½ inch Gold Bond board does not demonstrate that the invention was known or obvious, but instead shows an alternative undesirable approach of achieving sag resistance by making heavier and more expensive products.

160. Furthermore, Graux provides no information at all regarding improving the sag resistance gypsum board. The only product characteristic of interest to Graux is the gypsum paste thickness. There is no information in Graux from which to determine the impact of any such additives on the properties of gypsum board. Mr. Harlos has not provided any independent test results or other evidence to establish any such effect. A person of ordinary skill would conclude that there is insufficient evidence to demonstrate what impact, if any, whether enhancing or detrimental, the starch additives disclosed in Graux may have on the sag resistance of gypsum board.

Claim 1g: the accelerator having been included in an amount such that the gypsum board has greater strength than it would have if the accelerator had not been included in the mixture.

161. Graux discloses including an accelerator in compositions used to make set gypsum-containing products. However, Graux does not disclose the use of an accelerator in a gypsum composition containing STMP or any other recited enhancing material. Mr. Harlos also points to the Hjelmeland reference for its discussion of accelerators. (Ex. 1001 ¶ 118.) As explained above, the Hjelmeland accelerator composition was limited to neutralizing the retarder. By precipitating out the retarder, both the retarder and accelerator would be assumed to be removed from any effect on the gypsum crystallization.

Claim 2: The gypsum board of claim 1, wherein the concentration of the enhancing material in the mixture is from 0.004 to 2.0 percent by weight, based on the weight of the calcined gypsum.

162. Claim 2 includes all of the requirements of claim 1 and also requires a particular range of enhancing material concentration in the gypsum board mixture. Mr. Harlos states that the specific amount of set retardant disclosed in Hjelmeland would have informed one of ordinary skill to add the retardant to Graux's gypsum paste in an amount that satisfies the concentration range for the enhancing material set forth in claim 2. (Ex. 1001 ¶¶ 119–22.) That reasoning does not hold. The amount of phosphate compound used in Hjelmeland is dictated by Hjelmeland's objective of retarding crystal growth to keep the gypsum plaster paste in a fluid form so that

it can be mixed and pumped. The pot life and final set time for the application shown in Hjelmeland is much different than in gypsum board production and thus the usage rates of retarders and accelerators would be in a completely different range. Furthermore, Hjelmeland does not disclose an amount of polyphosphate set retarder included in a finished product, but instead describes using an accelerator to complex with and precipitate out the retarder and prevent it from having any effect on the hydration reaction between the water and calcined gypsum. (*Id.* at 4:4–10 and 4:17–28.)

163. Hjelmeland does not teach the use of phosphate compounds to improve sag resistance of set gypsum products and would not have led the person of ordinary skill to select a concentration in the range of claim 2 for achieving the degree of sag resistance required by the independent claim 1. Furthermore, Hjelmeland suggests that using the disclosed polyphosphates in a gypsum paste would only prevent gypsum crystallization. This would not provide a motivation to use these compounds to achieve a set gypsum product having the sag resistance claimed.

164. Also, as addressed above, Mr. Harlos does not explain why the person of ordinary skill in the art would look to Hjelmeland to improve Graux in the first place. Because Graux only uses STMP as a reactant to crosslink starch, the amount of phosphate compound disclosed in Hjelmeland for the different purpose of retarding the gypsum set reaction would have been considered irrelevant.

Claim 3: The gypsum board of claim 1, wherein the calcined gypsum comprises one or more of: calcium sulfate anhydrite; calcium sulfate hemihydrate; or ions of calcium and sulfate.

165. Graux discloses one or more of these forms of calcined gypsum. However, because claim 3 depends on claim 1 and includes all the limitations of claim 1, Mr. Harlos has also not shown that this claim would have been obvious based on his proposed combination of references.

Claim 4: The gypsum board of claim 1, wherein the enhancing material comprises one or more of the following salts, or the anionic portions thereof: sodium trimetaphosphate and ammonium polyphosphate having 1000-3000 repeating phosphate units.

166. Claim 4 includes all of the elements of claim 1 and is more specific regarding the identity of the enhancing material(s). Mr. Harlos again relies on Graux's disclosure of starch crosslinked with STMP (Ex. 1001 ¶¶ 125–26), which does not disclose gypsum board containing STMP.

Claim 6: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch.

167. Claim 6 includes all of the requirements of claim 1 as well as an additional requirement regarding the inclusion of pregelatinized starch in the gypsum mixture. Mr. Harlos also relies on Graux's disclosure of adding a pregelatinized form of cationic amylaceous starch compound to gypsum paste. (Ex. 1001 ¶¶ 127–29.) However, Graux contemplates pregelatinized starch only as a thickening agent for gypsum pastes, and indicates that amylaceous starch

compounds should not be used to thicken gypsum slurries for producing wallboard. (Ex. 1006 at 1:43–61.) As explained above, thickening the gypsum slurry is to be avoided in wallboard production because it prevents the gypsum slurry from spreading uniformly on the paper cover sheet, requiring the addition of more and resulting in higher energy cost to drive off the excess water in the final drying step. Contrary to Mr. Harlos’ assertions, Graux does not disclose and actually teaches away from forming a set gypsum composition containing pregelatinized starch for use in wallboard production.

Claim 8: The gypsum board of claim 1, wherein: the core has voids uniformly distributed therein; and the mixture further comprises an aqueous foam.

168. Mr. Harlos relies on the ’914 patent specification and the Sucech reference to establish that it was known to use foam to manufacture gypsum board having uniformly distributed voids. (Ex. 1001 ¶¶ 130–31.) However, because claim 8 depends on claim 1 and includes all the limitations of the base claim, Mr. Harlos has not shown that this claim would have been obvious based on his proposed combination of references. Mr. Harlos does not argue that the Sucech reference overcomes Graux’s directive not to use starch thickening agents in gypsum board slurries, or that Sucech discloses the use of trimetaphosphate compounds or other recited enhancing materials to achieve the gypsum board sag resistance performance claimed.

169. As explained above, Graux instructs that its starch compounds should not be added to gypsum slurries used to produce gypsum wallboard. (Ex. 1006 at 1:43–61.) One of ordinary skill would therefore not consider Graux’s gypsum compositions as a starting point for producing lower density foamed wallboard. Also, the other additives Graux identifies for potential use in its gypsum plaster compositions include “anti-foaming agents” instead of foaming agents. (*Id.* at 7:28–59.) This is consistent with the fact that Graux’s improved thickening gypsum paste is not suitable for making gypsum board, and therefore is not suitable for making lower density foamed gypsum board.

Claim 10: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch and an aqueous foam.

170. Claim 10 includes all of the requirements of claim 1 as well as an additional requirement regarding the inclusion of pregelatinized starch in the gypsum mixture. In paragraphs 132 to 134, Mr. Harlos makes the same arguments regarding pregelatinized starch that he asserts in paragraphs 127 to 129 for the corresponding requirement in claim 6. As explained above, Graux teaches away from forming a set gypsum composition containing pregelatinized starch for use in wallboard production.

171. Claim 10 also requires the mixture to contain an aqueous foam. In paragraphs 135 to 136, Mr. Harlos makes the same arguments regarding foaming

agents that he asserts in paragraphs 130 to 131 for the corresponding requirement in claim 8. Mr. Harlos' analysis is incorrect for essentially the same reasons explained above in relation to claim 8.

XI. THE CLAIMS ARE NOT OBVIOUS BASED ON THE COMBINATION OF SATTERTHWAITE, ASTM C473-95, HJELMELAND, SUCECH AND SUMMERFIELD

172. I disagree with Mr. Harlos' analysis and conclusion in paragraphs 137–199 that the subject matter of the challenged claims of the '914 patent would have been obvious to a person of ordinary skill in the art based on the disclosures of Satterthwaite, in view of ASTM C473-95, Hjelmeland, Sucech and Summerfield. I have concluded that Mr. Harlos has not shown that the challenged claims of the '914 patent cover subject matter that would have been obvious based on these references to a person skilled in the art at the time of the invention.

173. Mr. Harlos offers similar reasoning in this second theory of obviousness, but relies on the disclosure of Satterthwaite instead of Graux as his primary reference and starting point. In my opinion, Satterthwaite is also far afield from the specific methods of making set gypsum board products described in the challenged '914 patent claims.

174. In the discussion that follows, I first address why the asserted references, alone or in combination, would not have provided useful guidance to a person of ordinary skill in the art who was attempting to solve the problems

addressed by the '914 patent, and that such a person would not have been motivated to combine their disclosures. I then explain why the combination of their disclosures proposed by Mr. Harlos would not have led to the particular inventions claimed.

A. Mr. Harlos Has Not Established Any Motivation To Use Or Combine The Asserted References

175. In paragraphs 150–160, the Harlos Declaration asserts that a person of ordinary skill in the art would have been motivated to combine the disclosures of Satterthwaite, ASTM C473-95, Hjelmeland, Sucech and Summerfield and would have had a reasonable expectation of success in doing so. Mr. Harlos' reasoning appears to be as follows:

- i. Satterthwaite is directed to a “set gypsum-containing product,” in particular “acoustical ceiling tile and other tile products made from a mixture of water, gypsum, mineral wool and other ingredients.” (Ex. 1001 ¶ 151.) It supposedly discloses all ingredients in the claims of the '914 patent except an accelerator. (*Id.*)
- ii. Mr. Harlos acknowledges at the same time that the disclosure of Satterthwaite actually is directed to “the production of a starch binder comprising a thick-boiling starch and a polyhydric alcohol fatty acid ester.” (*Id.* ¶ 139 (quoting Satterthwaite at 1:11–12).)

- iii. This starch binder provides the “faster drying rate . . .[,] elimination of sub-standard tile . . .[,] increased wet strength, increased density and increased resistance to warp or sag” disclosed by Satterthwaite. (*Id.* ¶ 141 (quoting Satterthwaite at 1:58–62).)
- iv. One of ordinary skill supposedly would have been motivated by the ASTM C473-95 standards to use the Satterthwaite ceiling tile mixture to make gypsum panels that meet the requirements of those standards, including the sag resistance standard, which were supposedly predictable outcomes. (*Id.* ¶¶ 153–54.)
- v. One of ordinary skill supposedly would have incorporated the accelerators and STMP as disclosed in Hjelmeland “to accelerate the hardening process, “and STMP supposedly would have been known from Hjelmeland to increase the strength of the Satterthwaite ceiling tile mixture. (*Id.* ¶ 151.) One of ordinary skill would have found it obvious to use the amount of STMP specified by Hjelmeland in what Mr. Harlos characterizes as set gypsum tile products of Satterthwaite. (*Id.* ¶ 155.)
- vi. One of ordinary skill would have understood from Sucech that foaming agents are used to lower the weight and density of set gypsum containing products and would have found it obvious to add

such a foaming agent to the tile products disclosed by Satterthwaite.

(*Id.* ¶ 156.)

vii. One of ordinary skill would have also found it obvious to manufacture the set gypsum tile products supposedly disclosed by Satterthwaite with paper cover sheets because Summerfield and the '914 patent specification demonstrate that the basic process of manufacturing paper-faced gypsum wallboard was known. (*Id.* ¶ 157.)

viii. These references supposedly all address the same problems as the '914 patent, and the '914 patent acknowledges that gypsum wallboard manufacturing and the use of foam and accelerators was known. Therefore, one of ordinary skill would have had a reasonable expectation of success combining the teachings of the asserted references. Any required modifications would have been routine for the person skilled in the art because the products disclosed by the reference are all “compatible.” (*Id.* ¶¶ 158–60.)

176. Satterthwaite does not relate to the production of set gypsum board or to improving the sag characteristics of such products by adding STMP or any other enhancing material to a calcined gypsum slurry. Satterthwaite relates only to the production of tile products consisting of ingredients bound together by thick boiling

starch. It does not disclose forming mixtures of calcined gypsum, water and other ingredients or the production of set gypsum products by a controlled crystal growth setting operation. Therefore, a person of ordinary skill in the art would not look to Satterthwaite for guidance regarding making set gypsum board having improved sag resistance or strength.

177. Furthermore, Satterthwaite does not disclose the solution to the sag resistance problem discovered by the inventors of the '914 patent. It does not disclose adding STMP or any of the other claimed enhancing materials to a calcined gypsum composition for improving the strength, dimensional stability or sag resistance of set gypsum board. Satterthwaite uses compounds such as STMP only in a separate chemical reaction that produces crosslinked starch compounds. The crosslinked starch is then washed and dried before being used as a binder in wet tile mixtures. (Ex. 1007 at 2:29–31.)

178. Mr. Harlos does not state that STMP or any other phosphate material is actually present in the Satterthwaite ceiling tile compositions. He concedes that it is the starch binder, and not STMP or any other phosphate compound, that provides a faster drying rate, increased wet strength, increased density and increased resistance to sag in the tile mixes disclosed by Satterthwaite. (Ex. 1001 ¶ 141.) There is no STMP or other recited enhancing material in the tile mixtures disclosed in

Satterthwaite because those reactants are consumed or washed out during the crosslinking procedure used to form the starch binder.

179. Hjelmeland uses polyphosphate retardants to slow the setting of gypsum pastes. A person investigating how to use STMP to crosslink starch, as taught by Satterthwaite, or how to improve the drying characteristics of starch-based tile compositions, would gain nothing from the disclosures of Hjelmeland. It provides no information on that topic, and would have been ignored.

180. Without taking into account the distinct objectives of the two references, neither of which relates to improving strength or sag resistance of set gypsum products, Mr. Harlos asserts that a person of ordinary skill would take the amount of condensed phosphoric acid or ion of a condensed phosphate disclosed in Hjelmeland and use it in the set gypsum tiles of Satterthwaite. (Ex. 1001 ¶ 155.) But Hjelmeland only discloses these compounds for use as retarders of the rehydration of his calcined gypsum pastes. Because Satterthwaite is not directed to tiles made by the rehydration of calcined gypsum, there would have been no motivation to use Hjelmeland's retardants in Satterthwaite's starch-based tile mix composition, and Mr. Harlos does not establish what supposed motivation would have existed.

181. Furthermore, a person attempting to improve the sag resistance of a set-gypsum board products would not have benefited from either reference. Neither of them suggests that the phosphate compounds recited as enhancing materials in the

claims would be effective for that purpose. One of ordinary skill would only have consulted Satterthwaite if attempting to improve the drying characteristics or other properties of starch-based tile products, and not set gypsum boards. Hjelmeland would not have provided motivation to add the recited enhancing materials to such a set gypsum slurry. Hjelmeland's disclosure that certain phosphate compounds will retard gypsum crystal growth in his paste compositions would have led one of ordinary skill away from using those compounds in the manufacture of set gypsum boards.

182. The ASTM C473-95 standard test procedures do not disclose how to formulate calcined gypsum compositions to improve sag resistance in gypsum boards. This reference would not have assisted one of skill in the art in developing compositions and methods for enhancing the sag resistance of set gypsum boards.

183. The Sucech and Summerfield references (Exs. 1036 and 1017, respectively) relate to conventional gypsum board manufacturing and contain no disclosure relevant to using phosphoric acid or condensed phosphate compounds as enhancing materials to improve the characteristics of gypsum board or other set gypsum products.

184. Therefore, the person of ordinary skill in the art would not have even considered these references in relation to the problem of sag in set gypsum board. There would have been no motivation to combine their disclosures in a manner that

leads to the set gypsum compositions or gypsum board recited in the challenged '914 patent claims.

185. Also, one of ordinary skill would not find the references relied upon by Mr. Harlos to be directed to the same problems as those addressed by the '914 patent or to offer the same or even similar solutions. Satterthwaite concerns making a more evenly dried starch bound ceiling tile product, which does not involve forming a calcined gypsum and water slurry or making set gypsum board. Hjelmeland is directed to holding a gypsum slurry in a partially gelled state and then causing it to set quickly by neutralizing its retarder so that the retarder cannot affect formation of the cured gypsum matrix. The ASTM C473-95 standards concern testing of gypsum boards, but do not address the issues addressed by Satterthwaite and Hjelmeland. Sucech and Summerfield relate to gypsum board manufacturing, but do not disclose or suggest the use of STMP or any other enhancing material to improve the sag resistance of gypsum boards, improve the strength properties of gypsum panels or improve the dimensional stability of gypsum boards.

B. The Identified Disclosures Of The Asserted References Do Not Result In The Claimed Inventions

186. In the sections that follow, I explain why the specific combination of disclosures relied on by Mr. Harlos does not result in the particular gypsum board products with improved sag resistance set forth in the challenged claims. I address

the elements of the challenged claims 1–4, 6, 8 and 10 of the '914 patent separately below.

Claim 1a: A gypsum board comprising:

187. As discussed further below, Satterthwaite addresses the preparation of thick boiling starch compositions for use as binders in tile products. Although it discloses starch based tile products containing mineral gypsum as a filler, it does not disclose the type of set gypsum board described by this claim as a whole.

Claim 1b: a core of material sandwiched between cover sheets, wherein the core comprises an interlocking matrix of set gypsum,

188. Satterthwaite does not disclose this claim element. As explained above, Satterthwaite addresses the preparation of thick boiling starch compositions for use as binders in tile products. These products are not set gypsum board products. They are formed by drying wet compositions of starch and other ingredients in an oven. Satterthwaite is concerned with getting these starch-based tiles to dry evenly and completely in the oven stage of the manufacturing process.

189. Satterthwaite discloses gypsum may be included in the composition as a mineral filler. As explained above, one of ordinary skill in the art would understand that gypsum filler refers to mineral gypsum and not set gypsum.

190. Furthermore, Satterthwaite does not disclose or suggest forming tile products having cover sheets. Mr. Harlos relies on the '914 patent specification and

the Summerfield reference to establish that gypsum board was conventionally made by sandwiching a set gypsum core between cover sheets. (Ex. 1001 ¶¶ 163–64.) However, Mr. Harlos has not explained what would have supposedly motivated one of ordinary skill in the art to add cover sheets to Satterthwaite’s tile products. Summerfield relates only to the production of set gypsum boards. Neither reference discloses or suggests any benefit associated with the inclusion of cover sheets in starch based tile products, and neither reference provides any information from which one of ordinary skill could have reasonably concluded that Satterthwaite’s tiles could be modified in this way without detrimentally affecting their drying characteristics.

191. Satterthwaite is concerned with producing tiles that dry faster resulting in less wet tile produced. (Ex. 1007 at 1:54–60.) Satterthwaite addresses this problem by combining a thick boiling starch and a polyhydric alcohol fatty acid ester. (*Id.* at 1:9–12.) One of ordinary skill in the art would have understood that modifying Satterthwaite’s tile products to include cover sheets would slow down the drying process and cause other problems with uneven drying causing warping. Cover sheets would undermine the goal of improved drying that Satterthwaite attempts to achieve by use of the disclosed thick boiling starch binder.

192. Adding cover sheets would also require a completely different set of process equipment. To process a board having cover sheets, the core must set

quickly so that the boards can be cut, turned over and dried with the face liner facing up to protect the surface. Set gypsum board is made this way using equipment designed for this purpose. The type of tiles disclosed in Satterthwaite require the drying step to cause the starch binder to form ribbons that stick to each other and other components to give the tile strength. These compositions must be supported continuously until dry enough to be handled, requiring a completely different process and equipment compared to the equipment described in Summerfield for producing set gypsum board. The longer drying times compared to set gypsum board manufacturing would make the Satterthwaite process far too slow and inefficient for practical use to make starch based tile having a core sandwiched between cover sheets.

193. Therefore, Mr. Harlos has not established that the additional element of cover sheets would have been obvious based on his proposed combination of references.

Claim 1c: the board has been prepared by a method comprising:

194. In paragraph 161, Mr. Harlos essentially repeats the assertions of paragraph 103 that Satterthwaite discloses making set gypsum board. He again ignores Satterthwaite's tiles are based on starch and are not set gypsum boards.

Claim 1d: forming or depositing a mixture between the cover sheets, wherein the mixture comprises a calcined gypsum, water, an accelerator, and one or more enhancing materials selected from the group consisting of: sodium trimetaphosphate, tetrapotassium pyrophosphate, tetrasodium pyrophosphate, aluminum trimetaphosphate, sodium acid pyrophosphate, ammonium polyphosphate having 1000-3000 repeating phosphate units, and acids, salts, or the anionic portions thereof, and,

195. Satterthwaite does not disclose forming the composition required in this step. In paragraphs 168 to 169, Mr. Harlos appears to concede that Satterthwaite discloses a mixture in which starch is the binder and gypsum is an inert filler. As explained above, one of ordinary skill in the art would understand that gypsum filler refers to mineral gypsum, and not calcined gypsum. The Harlos Declaration only offers that “it would be a very small step for a person having ordinary skill in the art to replace gypsum as the binder and or use gypsum as a co-binder along with starch as disclosed in Satterthwaite.” (*Id.* ¶ 169.)

196. But Mr. Harlos does not explain why such a modification would have been made. He does not assert that replacing gypsum with calcined gypsum to serve as a co-binder would improve the drying characteristics or other properties of Satterthwaite’s tile products. The suggestion of replacing the starch entirely with calcined gypsum is incompatible with the fundamental disclosures of Satterthwaite, which relate only to starch-based tile products and not set gypsum-containing tiles.

Switching from one to the other represents a fundamental shift to an entirely different set of process technologies, ingredients and manufacturing equipment.

197. Satterthwaite also fails to disclose an accelerator. This is to be expected because accelerators are used to control the calcined gypsum growth reaction; they are not applicable to the starch solidification and drying phenomenon that is being addressed in Satterthwaite. Mr. Harlos does not contend that Satterthwaite discloses an accelerator. In paragraph 171, he asserts that one of ordinary skill would have been motivated by the disclosures of Hjelmeland to add an accelerator to the composition of Satterthwaite. (Ex. 1001.) But his logic assumes incorrectly that both references are directed to the production of set gypsum products, when Satterthwaite is not. Because Satterthwaite relates only to the production of tile products formed by drying wet compositions of starch binder and other ingredients, it leads directly away from the use of agents known to accelerate the formation of a set gypsum crystal matrix in calcined gypsum slurries.

198. Satterthwaite also fails to disclose a mixture containing any of the recited enhancing materials. Mr. Harlos states that “Satterthwaite discloses including STMP as it describes ‘treating the starch in aqueous alkali slurry with reagents such as . . . sodium trimetaphosphate . . . or others which form cross-links between the starch molecules.’” (Ex. 1001 ¶ 170 (quoting Satterthwaite at 2:9–13).) However, as explained above, in providing a method for preparing a binder composition made of

starch crosslinked with STMP, Satterthwaite does not disclose adding STMP to a mixture of water and a calcium sulfate material. The crosslinked starch compounds mixed with water and other ingredients such as gypsum filler and mineral wool do not contain STMP and do not correspond to any of the other recited enhancing material compounds.

Claim 1e: maintaining the mixture under conditions sufficient for the calcined gypsum to form the interlocking matrix of set gypsum,

199. Satterthwaite is not directed to forming set gypsum board, and it does not disclose this step. It discloses the unrelated process of forming a plastic mass of starch binder and other ingredients into a sheet, followed by scoring the sheet and drying it in an oven. (Ex. 1007 at 1:18–23.)

Claim 1f: the enhancing material or materials having been included in the mixture in an amount such that the gypsum board has greater sag resistance than it would have if the enhancing material had not been included in the mixture, said board having a sag resistance as determined according to ASTM C473-95 of less than about 0.1 inch per two foot length of said board.

200. Satterthwaite does not disclose a mixture containing any amount of the recited enhancing materials. In analyzing this limitation, Mr. Harlos asserts that the Satterthwaite “discloses STMP.” But he supports that assertion only by citation to Satterthwaite’s description of treating starch with STMP to produce crosslinked starch. (Ex. 1001 ¶ 175.) That disclosure of STMP as a starch crosslinking agent is not relevant to the use of STMP, or any other recited enhancing material, in gypsum

board having the ASTM C473-95 sag resistance performance required by this claim element.

201. Mr. Harlos points to Satterthwaite's disclosure that "the finished tile shows . . . increased resistance to warp or sag." (Ex. 1001 ¶ 175 (citing Satterthwaite at 1:60–62).) The full quote actually describes "increased wet strength, increased density and increased resistance to warp or sag." (Ex. 1007 at 1:60–62.) It thus appears that the sag resistance referred to is that of the wet tile before the oven drying operation is complete, and not sag of the final dried tiles. To the extent that one of ordinary skill would interpret Satterthwaite as disclosing improved warp/sag resistance in the finished starch-based tile products, the reference still offers no insights relevant to improving sag resistance of set gypsum board. As explained earlier, an incompletely dried starch-bound tile will deform in a completely different way than a humidified gypsum board. Satterthwaite's disclosure does not relate to the production of set gypsum board, and it does not teach or suggest that adding a sufficient amount of the recited enhancing materials to produce set gypsum board having the level of sag resistance recited in this claim step.

202. In paragraph 178, Mr. Harlos contends that one of ordinary skill in the art would have understood "that STMP was known in the art as improving the quality of set gypsum-containing products." (Ex. 1001.) He further asserts that such a person would have known of the ASTM C473-95 test for measuring sag resistance. From

this he deduces that this claim limitation recites an inherent property of an “already-known composition.” (*Id.*) However, Mr. Harlos has not established based on Satterthwaite or any other reference that claim 1 recites an “already-known composition.” The fact that none of the references relied on by Mr. Harlos actually disclose the claimed composition confirms my own belief that these compositions were not known in the industry before the invention of the ’914 patent.

203. Mr. Harlos also points to the disclosure in Figures 2 and 3 of the ’914 of a prior art Gold Bond set gypsum panel having sag of less than 0.1 inches. (Ex. 1001 ¶ 179.) As discussed above, there is no indication that the Gold Bond boards were made using any of the recited enhancing materials, that those products were tested using the ASTM C473-95 test method, or that they would satisfy the recited sag resistance standard. The ½ inch Gold Bond board results demonstrate the conventional wisdom that controlling sag resistance required increasing board density, and thus undesirably increasing board weight and expense. This would not have led one skilled in the art to the invention of the ’914 patent, which as demonstrated in Figures 1–3, permits producing less dense, lighter weight set gypsum panels having sag resistance characteristics superior to heavier, more expensive conventional products.

Claim 1g: the accelerator having been included in an amount such that the gypsum board has greater strength than it would have if the accelerator had not been included in the mixture.

204. Mr. Harlos asserts that the person of ordinary skill would have considered Hjelmeland and concluded that the starch-based tile mixture of Satterthwaite should be supplemented by addition of an accelerator. (Ex. 1001 ¶¶ 180–81.) As explained, that argument conflates two distinct technologies. Accelerators can be useful in the production of set gypsum products. Satterthwaite addresses only the production of starch-based products containing mineral gypsum as a filler. The process disclosed in Satterthwaite involves the solidification of wet starch polymers, not the growth of a gypsum crystal matrix. There would have been no motivation to add a calcined gypsum crystal growth accelerator to a mixture that lacks calcined gypsum and is not being formed into a set gypsum core.

Claim 2: The gypsum board of claim 1, wherein the concentration of the enhancing material in the mixture is from 0.004 to 2.0 percent by weight, based on the weight of the calcined gypsum.

205. Claim 2 includes all of the requirements of claim 1 and also requires a particular range of enhancing material concentration in the gypsum board mixture. Mr. Harlos states that the specific amount of set retardant disclosed in Hjelmeland would have informed one of ordinary skill to use an amount of retardant in Satterthwaite's tile composition that satisfies the concentration range for the enhancing material set forth in claim 11. (Ex. 1001 ¶¶ 182–86.) This reasoning again

ignores the fundamental differences between the starch-based products of Satterthwaite and set gypsum-containing products, such as the gypsum pastes of Hjelmeland. The manufacture of Satterthwaite's tiles does not involve converting calcined gypsum to a set gypsum crystal matrix. Thus, there is no setting process to retard. Satterthwaite's starch based tile compositions have no use for the set retardants disclosed in Hjelmeland.

206. Furthermore, the amount of phosphate compound used in Hjelmeland is driven by Hjelmeland's objective of retarding crystal growth and keeping the calcined gypsum paste in a fluid form so that it can be mixed and pumped. The pot life and final set time for the application shown in Hjelmeland is much different than in gypsum board production and thus, even if Satterthwaite was related to the production of set gypsum board (it is not) the usage rates of retarders and accelerators would be in a completely different range and would not have been taken from Hjelmeland. Furthermore, Hjelmeland does not disclose an amount of polyphosphate set retarder included in a finished product, but instead describes using an accelerator to complex with and precipitate out the retarder and prevent it from having any effect on the hydration reaction between the water and calcined gypsum. (*Id.* at 4:4–10 and 4:17–28.)

207. Hjelmeland does not teach the use of phosphate compounds to improve sag resistance of set gypsum products, and the reference as a whole discloses

subsequently reacting the retarding agent with an accelerator to neutralize the retarder and remove it from the solution. This would motivate one of ordinary skill to either not use, or to remove, any phosphate compounds from the gypsum slurry so as to avoid interfering with the setting reaction. The combination of references would not have led the person of ordinary skill to select the concentration of enhancing materials of dependent claim 2 for achieving the degree of sag resistance required by independent claim 1 in set gypsum board.

Claim 3: The gypsum board of claim 1, wherein the calcined gypsum comprises one or more of: calcium sulfate anhydrite; calcium sulfate hemihydrate; or ions of calcium and sulfate.

208. As discussed, Satterthwaite does not disclose gypsum board having a calcined gypsum core and therefore does not disclose any of the forms of calcined gypsum recited in this claim element.

Claim 4: The gypsum board of claim 1, wherein the enhancing material comprises one or more of the following salts, or the anionic portions thereof: sodium trimetaphosphate and ammonium polyphosphate having 1000-3000 repeating phosphate units.

209. Claim 4 includes all of the elements of claim 1 and is more specific regarding the identity of the enhancing material(s). Mr. Harlos again relies on Satterthwaite's disclosure of treating starch with STMP to form crosslinked starch (Ex. 1001 ¶ 189), which does not disclose gypsum board containing STMP.

Claim 6: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch.

210. Claim 6 includes all of the elements of claim 1 and also requires the presence of pregelatinized starch in the mixture. Mr. Harlos erroneously relies on Satterthwaite for the pregelatinized starch element as well. (Ex. 1001 ¶ 191.) According to Mr. Harlos, “Satterthwaite contemplates pregelatinized starch as it discloses that gelatinization of starch and crosslinking of starch.” (*Id.*) However, Satterthwaite teaches that his disclosed composition “is made by first treating a starch in a manner which is described hereinafter in an aqueous system at a temperature *below* its gelatinization temperature.” (Ex. 1007 at 1:48–51 (emphasis added).) In the disclosed example, the starch is treated at 60° F. (Ex. 1007 at 2:19–22.) Thereafter, the “starch composition . . . becomes a binder upon gelatinization of said starch.” (Ex. 1007 at 4:29–30, 4:35–36, 4:41–42.) The example described includes final heating of the mixture of starch and gypsum to 200° F. (*Id.* at 3:38.) Thus, Satterthwaite does not disclose, and in fact teaches away from, pregelatinization of the starch. In Satterthwaite’s composition, the starch is not pregelatinized and only converts to a gelatinized form upon heating of the water, calcium sulfate, and starch material.

211. Therefore, Satterthwaite fails to disclose forming a composition containing either the recited enhancing materials or the pregelatinized starch of

claim 6. Mr. Harlos does not contend that these elements are disclosed by any other prior art reference. He asserts that pregelatinized starch was a known alternative to other types of starches, but he provides no support for that assertion. (Ex. 1001 at ¶ 192.)

Claim 8: The gypsum board of claim 1, wherein: the core has voids uniformly distributed therein; and the mixture further comprises an aqueous foam.

212. Mr. Harlos relies on the '914 patent specification and the Sucech reference to establish that it was known to use foam to manufacture gypsum board having uniformly distribute voids. (Ex. 1001 ¶¶ 193–94.) However, because claim 8 depends on claim 1 and includes all the limitations of the base claim, Mr. Harlos has not shown that this claim would have been obvious based on his proposed combination of references.

213. Mr. Harlos contends that one of ordinary skill would have known and been motivated to add foam to the Satterthwaite composition to reduce the density and increase the strength of the Satterthwaite tile products. (Ex. 1001 at ¶ 194.) However, his rationale treats Satterthwaite as if it had disclosed set gypsum tile products, when in fact it does not. Sucech relates only to the use of foam to create air voids in set gypsum products, and does not disclose or suggest using foam in starch based tile products. Satterthwaite also does not suggest that foam could be successfully incorporated into its starch bound tile products to reduce density. Mr.

Harlos has not identified any reference establishing that it was known to use foam in starch based tile products, or that this could be done with reasonable expectation of making reduced density starch based tile product having acceptable properties.

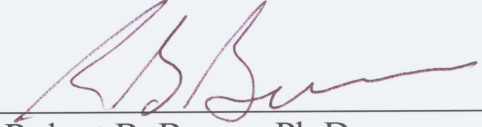
Claim 10: The gypsum board of claim 1, wherein the mixture further comprises a pregelatinized starch and an aqueous foam.

214. Claim 10 includes all of the requirements of claim 1 as well as an additional requirement regarding the inclusion of pregelatinized starch in the gypsum mixture. In paragraphs 195 to 197, Mr. Harlos makes the same arguments regarding pregelatinized starch that he asserts in paragraphs 190 to 192 for the corresponding requirement in claim 6. As explained above, Satterthwaite teaches away from forming a composition containing pregelatinized starch for use in its starch based tile products.

215. Claim 10 also requires the mixture to contain an aqueous foam. In paragraphs 198 to 199, Mr. Harlos makes the same arguments regarding foaming agents that he asserts in paragraphs 193 to 194 for the corresponding requirement in claim 8. Mr. Harlos' analysis is incorrect for essentially the same reasons explained above in relation to claim 8.

I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and

further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: Aug 18/17 By: 
Robert B. Bruce., Ph.D.

Work Experience

- GypsumInfo Inc.** (gypsum consulting services, Burlington, Canada) (2015-present)
 President and Owner – part time consulting services in gypsum technology, operations, markets and business strategy
- The NuGyp Corp.** (New technology firm – energy saving in gypsum processing)
 Inventor, Director, President, Shareholder - technology, IP, finance (2008-2017)
- Innogyps Inc.** (Internationally recognized gypsum consulting firm, Hamilton, Canada) (1997-2013)
 Founder, President and Owner – mine to market consulting services in gypsum
 Sold business assets in 2013. New business owner continues as Innogyps Ltd. today
- BPB plc** now **Saint-Gobain/CertainTeed** (Leading global gypsum manufacturer, Slough, UK)
 Director of Technical Services - operations, R&D, engineering, mineral resources, capital spending, benchmarking, IP and technology exchange, environment (1996-1997)
 Technical Manager (1994-1996)
- BPB Westroc** now **CertainTeed** (Canadian gypsum manufacturer, Mississauga, Canada)
 Vice President, Strategic and Technical Development (1993-1994)
 Vice President, Manufacturing (1990-1993)
 Operations Manager (Factories, Mines) (1986-1990)
 Technical Manager (R&D, Engineering, Logistics) (1984-1986)
 Development Manager (1982-1984)
 Process Development Manager (1981-1982)
- Ontario Research Foundation** now **Process Research Ortech** (Contract research, Canada)
 Manager Non-metallic Minerals Group (1979-1981)
 Research Scientist (1978-1979)
 Associate Research Scientist (1977-1978)
- UNISUL**, University of Calgary (Calgary, Alberta) (Interdisciplinary sulphur research group)
 Post Doctorate Fellow, Tutorial Leader (1996-1977)

Connections

Inventor of several patented technologies related to gypsum – international coverage
 Speaker/keynote speaker at several international gypsum conferences
 Recognized worldwide for gypsum expertise – “mine to market”
 Past member of ASTM, Burlington and Hamilton Chambers of Commerce, Board of Trade
 New business mentor – Hamilton Technology Centre
 Ph.D. in Chemistry 1997 McMaster University, Hamilton, Ontario, Canada
 Honours B.Sc. Chemistry 1972 McMaster University, Hamilton, Ontario, Canada

Presentations made by Robert B Bruce at Gypsum Industry Conferences during the past 14 years

1. The Gypsum Industry and Climate Change

Presented at Global Gypsum Conference 2015, New Orleans, October 2013

With the recent agreement in Paris on climate change, this paper presents a look at the gypsum industry's contribution to the problem ... and the solution.

2. Disruptive Innovation in Gypsum

Presented at the Global Gypsum Conference 2013, Toronto, October 2013

Disruptive innovation is happening all around us every day. How it might affect the gypsum industry?

3. Growth Does Not Equal Success

Presented at Global Gypsum Conference 2012, Istanbul, Turkey

How can you tell what projects or companies will be successful? What are the Critical Success Factors for growth in gypsum?

4. Global Gypsum Growth

Presented at MixBuild 2011 Conference, Moscow, Russia

The gypsum industry has been growing at a rate faster than GDP and population growth for decades, with this likely to continue for decades to come.

5. Global Gypsum Evolution – Where to now?

Presented Global Gypsum Conference 2011, Las Vegas, USA

Ideas are presented to help the North American companies survive the current market and take on a wider role in growing the gypsum business globally.

6. Megatrends in Gypsum: Can the past predict the future?

Presented at Global Gypsum Conference 2010, Paris, France

Manufacturing costs will drop and reasonable profits will be made, with the profitability being more stable as a result of growing market demand and larger companies with longer term perspectives.

7. When Will Gypsum Profits Return in North America?

Presented at Global Gypsum Conference 2009, Rio de Janeiro, May 2009

The business world has become a very difficult place over the past two years with the construction sector having been hit harder than most.

8. Gypsum Industry to 2025

Presented at Global Gypsum Conference 2008; Dubai, UAE May 2008

The gypsum industry in the USA has shown declining shipments and profits for 18 months now. The extended period of growth in construction driven by easily available mortgage funds was indeed unsustainable. Gypsum board shipments are now down over 30% and the near future prospects are not good with housing starts and permits down 50% from two years ago.

9. Survival Economics 2008

Presented at the Global Gypsum Conference 2007, Shanghai, China, May 2007

The gypsum board industry in North America has enjoyed an extended period of growth, resulting in record shipments and profits in 2005-2006. In the second half of 2006, however, the building industry entered a down cycle.

10. Market Dynamics Impacting FGD Gypsum Usage

Presented at World of Coal Ash Conference, Covington, Kentucky, May, 2007

Use of FGD Gypsum has begun to level off at a time when an unprecedented number of FGD scrubbers are coming online. The Clean Air Interstate Rule has encouraged a build-up in new gypsum wallboard capacity to use the FGD Gypsum that will be produced.

11. Impact of USA Flue Gas Desulfurization Programs on North American Gypsum Supply & Demand (2003, 2010, 2015)

Market analysis introduced November 2004

The production of FGD gypsum is a by-product of the generation of electricity and as a by-product is not subject to the normal supply/demand market forces that would tend to influence pricing and production volumes. The FGD gypsum will be made whether it is used or not. The gypsum industry has refitted many of their manufacturing facilities to allow the replacement of gypsum rock with this coal combustion product (CCP) such that several million tons are being used.

12. Gypsum - What's New and Why This Matters

Presented at Global Gypsum Conference, Barcelona, Spain, September, 2003

The gypsum industry continues through tumultuous times, continuing to grow in spite of a wide range of market and legal issues. This paper will update the progress the industry is taking towards providing a stable supply of value added building systems, with comments on which companies show the best evidence of making this necessary transition.

Title	Publication number	Publication date	Inventor(s)	Applicant(s)	Application number	Date of application	Priority number(s)
PROCESS FOR THE TREATING OF CALCIUM SULPHATE HEMIHYDRATE	UA99271 (C2)	2012-08-10	BRUCE ROBERT BYRON ,[CA]; FLUMIANI MARK RICHARD,[CA]; BLOW CHARLES E,[GB]	NUGYP CORP[CA]	UA20090007539	20071217	US20060871039P 20061220
CALCIUM SULPHATE-BASED COMPOSITIONS AND METHODS OF MAKING SAME	EA200501487 (A1); EA008810 (B1)	2006-04-28	COX DANNY, W, ; BRUCE ROBERT, B	G.B. TECHNOLOGIES, LLC	EA20050001487	20040318	US20030456207P 20030320; US20040800780 20040315; WO2004US08234 20040318
Fungus resistant gypsum-based substrate	US2004092190 (A1)	2004-05-13	BRUCE ROBERT B ,[CA]; HARRISS DAVID M,[US]	BRUCE ROBERT B, ; HARRISS DAVID M	US20030702901	20031106	US20030702901 20031106; US20000513097 20000225; US19990121697P 19990225; US19990121698P 19990225
Gypsum-based construction material	US6485821 (B1)	2002-11-26	BRUCE ROBERT B ,[CA]; HARRISS DAVID M,[US]	DU PONT, [US]; INNOGYPS INC,[CA]	US20000512921	20000225	US20000512921 20000225; US19990121698P 19990225
GYPSON BOARD HAVING IMPROVED FLEXIBILITY, TOUGHNESS, ABUSE RESISTANCE, WATER	US2003232182 (A1); US6800361 (B2)	2003-12-18	BRUCE ROBERT B ,[US]; SHAH ASHOK HARAKHLAL,[US]	E. I. DU PONT DE NEMOURS AND COMPANY	US20020172135	20020614	US20020172135 20020614

RESISTANCE AND FIRE RESISTANCE							
Sag-resistant gypsum board containing coal fly ash and method for making same	US4403006 (A)	1983-09-06	BRUCE ROBERT B ,[CA]; KUNTZE RICHARD ,[CA]	UNITED STATES GYPSUM COâ€,[US]	US1980012 9870	19800313	CA19800343439 19800110
CONVERSION OF FLUOROANHYDRITE TO PLASTER	WO8302266 (A1)	1983-07-07	BRUCE ROBERT BYRON ,[CA]; GAYNOR JOHN C,[US]; PALMER JAY W,[US]	UNITED STATES GYPSUM CO,[US]	WO1982US 01776	19821221	US19810332579 19811221
WALLBOARD MADE FROM GYPSUM AND PLASTIC FACING MATERIAL	CA1189434 (A)	1985-06-25	BRUCE ROBERT B ; HARTEL ALFRED; LEEMING PETER A	BPB INDUSTRIES PLC	CA1982039 6368	19820216	CA19820396368 19820216