UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

BEFORE THE ADMINISTRATOR

In the Matter of:	)	
	)	
Carbon Injection Systems LLC,	)	**Docket No. RCRA-05-2011-0009**
Scott Forster,	)	
and Eric Lofquist,	)	
	)	
Respondents.	)	

DECLARATION OF FREDERICK CHARLES RORICK

I, Frederick Charles Rorick, declare and state as follows:

INTRODUCTION

I have been retained on behalf of Respondents Carbon Injection Systems LLC, Eric Lofquist and Scott Forster.

QUALIFICATIONS

My qualifications have already been presented in my initial report entitled "Blast Furnace Issues in the Matter of Carbon Injection Systems LLC, et al. Docket No. RCRA-05-2011-0009. Some key points are listed below.

1. I am an internationally recognized expert, of now 45 years experience on the blast furnace process and blast furnace operations, whose opinion is routinely sought for the most difficult and unexplainable of blast furnace events. I have published and/or presented more than 50 papers over that time
2. For the first 36 years of my career I was employed by the former Bethlehem Steel Corporation, in a variety of increasingly responsible positions, including for nearly 20 years as Bethlehem's corporate blast furnace expert.
3. I was loaned by the former Bethlehem Steel to other steel companies experiencing unique blast furnace experiences, including the former Stelco in Canada, and US Steel in the U.S.A.
4. Since 2002 I have been President of Rorick, Inc. an international consulting firm specializing in blast furnace matters, including both direct service to individual steel companies on six continents, and service and analysis in support of legal matters for both the steel companies and their insurers.

Attachment C

5. I have been accepted as an expert in testimony for the Health and Safety Executive of the United Kingdom, and by the Supreme Court of Sweden, among others.
6. Over my career I have received numerous awards and recognitions from my peers, including the internationally prestigious Thomas L. Joseph Award for lifetime achievement in ironmaking. Only 26 persons in history have received this award.

STATEMENT OF OPINIONS AND DISCUSSION

1. The Use of the Terms "Fuel" and "Fuel Injection Are Misnomers.

Ironmaking is an ancient process, with the first relics of manufactured tools coming from ancient Egypt nearly 3000 years B.C., which brings us to the first misnomer, the word "ironmaking." Iron is the 4th most common chemical element on Earth, so we cannot at all say that anyone makes it; it already exists. The only thing that we can say is that humankind have refined and processed iron, usually in combination with one or more other chemical elements, into useful items. Another thing we know is that, over the centuries, as technical developments, or observations, were made, people at the time created terms to explain what they thought they knew, and in their own language. That knowledge was transmitted to other people, in other cultures, and they either adopted the terms from the originating language, or created their own new term in their own language. As new developments, or observations, occurred, sometimes the old term was continued but with a new meaning, and, on other occasions, totally new terms were created.

An example of this is the term "pig iron". Centuries ago the liquid iron from a production furnace, a predecessor of what we today call a blast furnace, was directed to hand-made sand molds which some ancient identified as looking like a sow suckling a brood of piglets, and the term "pig iron" was created for that solidified iron. Eventually the term was expanded to relate additionally to the liquid metal produced by a blast furnace, even though it was not solidified, and the term is still in limited use today, although the proper term is internationally established as "hot metal". Incidentally we can find the term "pig iron" in the title of Chapter 15, "The Manufacture of Pig Iron in the Blast Furnace", of the book "The Making, Shaping and Treating of Steel" which the EPA's expert, Dr. Fruehan, states in his Declaration that he edited. There are many more examples that could be cited, such as slag volume which really should be termed slag rate, and other terms such as bosh and tuyere which were anglicized in this case from French with only some resemblance to the original meanings. Blast furnace technicians, operators, and experts have all recognized this evolution of terminology and have become comfortable

with it despite the confusion which sometimes occurred, particularly with those not working directly with the process.

The terms "fuel" and "fuel injection" fit into the category of old terms with multiple meanings. From the earliest times until the mid 1960's it was accepted that the blast furnace was a combustion process, complete with a belief that it utilized a "fuel", in early times charcoal and gradually evolving through coal to coke. From the 1960's forward, as injection technology was expanded, and to higher and higher levels, it became totally clear that the "combustion" theory was not valid. Basic premises derived from the "combustion" theory were disproved over and over again, until by the 1980's it was clearly understood that the blast furnace was a thermodynamic process and that both the coke and injectants were chemical reductants and not "fuel." In 1998 Jeschar and Dombrowski published their analysis, and that is still considered to be the definitive work on this subject. The old terms of "fuel" and "fuel rate" have never entirely disappeared and the blast furnace operators, experts, and technicians for a variety of reasons continue to occasionally use the old terms, sometimes because they are just simpler. For example the ancient term "salamander" is, after all, much easier to say than "the solidified remains of a blast furnace hearth after it is taken out of service and cooled."

2. Injectants are not Burned for Energy Recovery in a Blast Furnace
On page 38 of the U.S. EPA's "Memorandum in Support of its Motion for Partial Accelerated Decision as to Liability" we find the following statement "...Fruehan Decl. at ¶ 13; Burning of Waste Fuel and Used Oil Fuel in Boilers and Industrial Furnaces, 50 Fed. Reg. 49,164, 49,171 (Nov. 29, 1985)..." This is just one of many indicators of the reliance of the EPA and their expert Dr. Fruehan on the combustion theory to explain blast furnace operation and technology. In my initial report, "Technical Report on Blast Furnace Issues in the Matter of Carbon Injection Systems LLC, et al, Docket No. RCRA-05-2011-0009," it was explained the blast furnace is nowadays considered to be a chemical and thermodynamic process wherein coke and various injectants are utilized as chemical raw materials. Dr. Fruehan and the EPA in trying to explain the blast furnace process using the combustion theory have generated several scientifically incorrect conclusions in their report and subsequent comments, among which are the following:

a. On page 38 of the U.S. EPA's Memorandum , and with continuing similar references on other pages, it is concluded that the primary purpose of the injectants is for energy recovery. If this were to be so, and in consideration of the First Law of Thermodynamics, it should be then possible to substitute another form of energy for the energy of the injectants with identical

process results. So for a typical electrical power generation process driven by a heat from a combustion boiler, one could rationally substitute a plasma, results of nuclear fission, solar energy, or even the kinetic energy from the wind for the boiler and still achieve the power generation equivalently as before. However, for the blast furnace no substitution of any form of other energy for the injectant is possible that would allow the process to chemically succeed because no reducing gases would be generated. This is a fundamental difference between the blast furnace process and various combustion processes.

b. The next point for discussion relates to the relative efficiencies of various reductants. If we considered that the combustion theory was correct, the blast furnace should act similar to a boiler in that it would have some fundamental efficiency based upon the engineering design, and then some relative efficiency for each reacted material based upon its heating value. However, that is absolutely not the case for the blast furnace. It is true that each potential injectable reductant for the blast furnace has a different replacement ratio, i.e. 1 kg of coal would replace 0.9 kg of coke, on a dry basis, while for natural gas the ratio is 1.3:1 to 1.5:1, while for oil it is 1.1:1. These ratios are all different, and certainly not in any way related to their calculated heating values. As a further point it has been found that different oils have fundamentally the same replacement ratio when injected into the same blast furnace, and this also should not be possible. Again we have a fundamental conflict with the combustion theory.

c. The EPA's discussion entirely omits the very substantial role of hydrogen as a reductant, focusing instead on carbon. The crucial developments with regard to hydrogen were published by J.C. Agarwal et al of Charles River Associates in both theory and test results using the blast furnace at the former Acme Steel, near Chicago. The results are widely distributed and formed the basis for elevated levels of natural gas injection still in use, and influenced other hydrocarbon injection practices as well, including not only coal injection, but also specifically co-injection of natural gas with another injectant as was the case at WCI in this matter. The role of hydrogen both as a powerful reductant and as an enhancer of shaft permeability was very prominent in their conclusions. One very interesting point, in the context of this case, is that the use of injected hydrocarbons, with a high percentage of hydrogen, is actually environmentally advantageous as it results directly in a reduction of the so-called "greenhouse gas" CO_2.

Given these scientific conflicts, and more, it is apparent that there must be something more fundamental at work, much greater than "energy recovery", and we find the answers clarified in the work of Jeschar and Dombrowski entitled "Summary Evaluation and Assessment of Carbon and Hydrocarbon Raw Materials for Iron Ore Reduction", which I have cited in my earlier Technical Report. Jeschar and Dombrowski were able to specify that, of all the possibilities, the coke and hydrocarbon carriers are classed as "chemical raw materials" because their components are involved in the chemical reactions of iron ore reduction." More importantly, and specifically regarding the various "energy" arguments, Jeschar and Dombrowski proved by calculation and comparison with actual blast furnace results that 70% of the total input energy to the blast furnace is chemically bonded to the hot metal, 13% to the enthalpy of the top gas, 14% to the enthalpy of the hot metal and slag, and only 3% is lost. Thus we can see that the chemical activity is not incidental to the blast furnace process, but rather is fundamental and essential. It is now clear that blast furnace injectants are not utilized for energy recovery, but as critical chemical raw materials.

3. Injectants are a Source of Carbon in Hot Metal Produced in a Blast Furnace.

It is stated on page 41 of the U.S. EPA's Memorandum, and other pages as well, that all of the injectants are reacted in the blast furnace raceway and none enters the final product. This deserves comment from two different standpoints. The first is that, if this is true, a process limit would be established for the blast furnace such that the maximum injectant which can be efficiently and economically utilized should be the maximum that can be reacted in the raceway. In fact, in the 1960's this was widely believed to be true, and thus injection facilities were designed and constructed such that the system capacity matched that limitation. Considering that the velocity of the blast entering the blast furnace through the tuyere is approximately 200 m/sec and that the raceway is always approximately 1 meter in depth, the reaction time is thereby limited to 0.005 seconds. With varying content of oxygen in the blast entering the blast furnace this theoretical limit was established at 50 – 60 kg/ton of hot metal. However actual blast furnace results since that time have established that operation with more than 150 kg/tHM is routinely achieved world-wide, with sustained maximums to date of 250 kg/tHM. This means that substantial quantities of injectants must actually react elsewhere inside the blast furnace, and that the theoretical limit imposed by combustion calculations is incorrect.

Following upon the development of the preceding point, we come to the disposition of the chemical elements Carbon and Hydrogen from the injectants. There is no evidence to date that the hydrogen moves

downward into the blast furnace hearth, reacting with the liquid iron there, since no hydrogen has yet been measured or detected in the final pig iron product. Carbon is an entirely different story altogether. Pig iron contains 4 – 5% carbon by weight, with the carbon going into solution with the liquid iron after melting, this occurring as liquid iron droplets descend in the lower part of the blast furnace and contact carbon molecules. Since there are no direct measurements available from inside the furnace proper in this region it is impossible to exclude any carbon molecule in that region from potentially entering solution as the iron has no idea, nor does it care, where the carbon molecule originated. It only matters that it is there, and we know from the earlier discussion point that un-reacted carbon, in substantial quantities is available. Further, tracer studies have verified the movement of the un-reacted carbon molecules into the hearth, in support of our position. So, the carbon in the final hot metal product originates both in the coke and also in the injectants.

4. Other Points

There are some additional points deserving of comment in the U.S. EPA's Memorandum.

In the center of page 42 of the Memorandum we find the following statement:

> *"The regulations would also apply when an industrial furnace burns the same secondary material for both energy and material recovery. Examples are blast furnaces that burn organic wastes to recover both energy and carbon values... These activities are not so integrally tied to the production nature of the furnace as to raise questions about the Agency's jurisdiction. In addition, EPA believes that both the existing statute and the new legislation express a strong mandate to take a broad view of what constitutes hazardous waste when hazardous secondary materials are burned for energy recovery, and to regulate as necessary to protect human health and the environment."*

The specific comment regarding an integral tie to the production nature of the blast furnace as noted is not correct as indicated in the previous section of this Declaration, point 3 above, and that is that these chemical raw materials, coke and injectants, are fundamental and essential for the blast furnace process to function.

Then on page 42 of the Memorandum, and continuing on pages 43 and 44 are statements indicating to me that, even if the scientific and technical

arguments provided by CIS et al are accepted by the Court, the ultimate decision in this case should turn on prior incorrect statements, mis-statements, and communications made by individuals from both WCI and CIS stating that the materials provided were "fuels." Dr. Fruehan in his statements even refers to many existing technical manuals, etc., which use the same terminology. It is an unfortunate fact of life that, as technology advances, many individuals, for a variety of reasons, continue to use the old technological terms with which they were trained. It sometimes takes two or three generations before the old technological terms can be fully and totally replaced by proper terms. Adding to the difficulty old publications using the old technology still remain available, even though now accepted as incorrect, and they can serve to either reinforce the uninformed, or to prolong confusion, regarding which are the proper terms. The fact that such conditions exist in no way alters the scientific and technological facts, and those are overwhelmingly clear. It seems a cruel joke that the resolution of a technical problem and technical analysis might rest upon inaccurate statements made by persons who would not normally be in a position to fully understand and comprehend modern and evolving technical developments.

Finally, as a 'seemingly when all else fails scenario' we find on page 45 of the Memorandum an incomplete and for the most part technically inaccurate discussion on the Cadence Product as definitive, again without regard to actual technical developments, simply as a precedent. It is clear that precedents change as facts dictate them to change. Scientifically speaking decisions are always to be taken upon data and facts, even when centuries of precedent are thus overthrown. For example, we know from our history that for thousands of years the world was considered to be flat, until it was proven that it was not flat, but rather round. In all future study the precedent now disproven had no value, and the newly established facts became the standard.

5. Suitability of Unitene LE, Unitene AGR, and JLM Column Bottoms for Use As Injectants in a Blast Furnace.

I have received some detailed data on the chemical and physical composition of Unitene LE, Unitene AGR, and JLM Column Bottoms. These are three materials at the heart of this particular dispute. It is fundamental that any hydrocarbon or other carbon form is a potential candidate for injection into a blast furnace if is easily transportable to and into the blast furnace via a pipe. These three materials qualify in that regard. Ultimately the blast furnace operators make judgments regarding which of the potential injection candidates to consume, of those materials available at their particular location, by analyzing the degree of difficulty of pipeline transport, e.g. some materials require higher pressure and

others higher temperature, the relative efficiency of the specific material in the blast furnace process versus the reductant it would replace, and whether or not there are any process limitations for their particular plant and ultimate steel product mix concerning trace elements, e.g. chrome, chlorine, zinc, etc., and the relative cost of any process adjustments necessary to comply with those process limitations, e.g. reducing consumption of another material in order not to exceed a maximum individual chemical element input. These considerations are usually managed by a standard heat and mass balance analysis, a normal routine in the day-to-day operation of a blast furnace. There were no obvious process alarms to me for the chemical suitability of any of the three noted materials. The moisture standard, and the test results identified in the WCI responses are also well within process norms.

6. Documents Reviewed for this Declaration

   a. U.S. EPA's "Memorandum in Support of its Motion for Partial Accelerated Decision as to Liability", including the Declaration of Richard J. Fruehan
   b. "Technical Report on Blast Furnace Matters in the Matter of Carbon Injection Systems LLC, et al., Docket No. RCRA-05-2011-0009
   c. "Summary Evaluation and Assessment of Carbon and Hydrocarbon Raw Materials for Iron Ore reduction', by Jeschar and Dombrowski, 1998 International Congress on the Science and technology of Ironmaking, Toronto, Canada, 1998
   d. CD containing JLM Material Specs, WCI Responses CX23, CX24, CX25, CX26, CX27, CX28, Unitene Material Specs

7. Opinion and Bases

   The conclusions and opinions I have reached as a result of my investigations are based, upon a reasonable degree of engineering certainty, my education, background and experience in the operation of blast furnaces and their associated equipment. I reserve the right to alter, amend, supplement, or modify my opinions should other new information become available.

8. Pursuant to 28 U.S.C. Section 1746, I declare, under penalty of perjury, that the foregoing is a true and accurate statement of my opinions in this matter.

Frederick C Rorick

Dated: April 2, 2012

Frederick C. Rorick