

## STATEMENT OF CONSIDERATIONS

REQUEST BY LUMMUS TECHNOLOGY INC. (LUMMUS) FOR AN ADVANCE WAIVER OF DOMESTIC AND FOREIGN PATENT RIGHTS UNDER DOE GRANT NO. DE-EE0003457; W(A) 2010-045

Lummus has requested a waiver of domestic and foreign patent rights of the United States of America for all subject inventions arising from its participation under the above referenced grant entitled "Autothermal Styrene Manufacturing Process with Net Export of Energy."

The project funded by the grant is focused on developing an economically competitive processing technology for styrene monomer (SM) synthesis that will reduce process energy requirements by a minimum 25% relative to those of conventional technology while achieving a minimum 10% return on investment and advance the technology towards commercial readiness. The general approach to achieve these goals is to develop and optimize novel catalysts for SM production that can selectively convert chemical grade toluene and natural gas feedstocks in the presence of oxygen with minimal CO<sub>x</sub> byproduct formation at economically competitive reaction conditions.

The period of performance for this grant is twelve months. The originally intended start date was September 1, 2010. However, the start of the grant has been delayed in order to resolve this patent waiver.

The anticipated total cost of the project under the grant is \$589,454, with Lummus providing 49.1% cost share, totaling \$289,454. This waiver is contingent upon Lummus maintaining, in aggregate, at least a 49.1% cost share over the course of the grant. In addition to the forgoing cost share, Lummus has invested approximately \$311,000 in equipment and labor cost at its U.S. Technology Development Center necessary to perform the research under this grant.

As stated in the enclosed petition from Lummus, Lummus has a history of developing and commercializing catalytic processes. Specifically, Lummus has extensive experience in SM production. It, along with its partner, has offered a SM production process since 1970 that is considered "the world's most reliable and efficient technology for styrene manufacture from ethylbenzene." This process has been selected in more than seventy-four major plants, has more than three hundred plant-years of successful operations, and is still used in forty-one plants. Lummus's experience also includes serving as the engineering contractor for implementing new process technologies in commercial plants.

Lummus has a Technology Development Center and Technical Center staffed for more than 60 years with process technology specialists having expertise in all aspects of R&D, front-end and detailed engineering. The Technology Development Center, along with partners, has been successful in developing three innovative and novel catalyst synthesis platforms. It is believed that these platforms will help lead to catalyst formulations targeted by this project.

Lummus also has more than 1000 active patents and more in patent applications, including patents directed to the catalyst synthesis platforms.

Lummus has agreed that this waiver shall be subject to the march-in and preference for U.S. industry provisions, as well as the U.S. Government license, comparable to those set out in 35 U.S.C. 202-204.

Lummus has not agreed to the standard U.S. competitiveness provision that requires products embodying any waived invention or produced through the use of any waived invention be substantially manufactured in the United States. According to Lummus, it cannot agree to such a provision due to its business model and the geographical distribution of styrene manufacturers. The likely outcome of the funded project is a new or modified process. The new process would likely include the use of a new feedstock that could be implemented in styrene manufacturing facilities. Lummus does not own or control any styrene manufacturing facilities. Lummus's business model is to develop technology and license it to others. Therefore, consistent with its business model, Lummus wants to license any resulting technology from this grant to any interested styrene manufacturing facility, including any facility in the U.S. or outside the U.S. Lummus can only recover its investment in this technology, including its cost share, if it is successful in licensing the technology to others.

According to information provided by Lummus, the U.S. is the world's third largest consumer of styrene with a 20% share of the 2008 world consumption of 20.8 million metric tons. The world's nameplate capacity is about 23.3 million metric tons of which 24% is manufactured in the U.S. by 12 styrene manufacturing facilities. About 85% of U.S. production is consumed in the U.S. and the remaining 15% is exported for use outside the U.S. However, due to increasingly competitive export markets, it is likely the U.S. exports may decrease in the near term.

Based on the information provided by Lummus, it is evident that there is significant opportunities to license any resulting technology to U.S. manufacturers. However, with 76% of the world styrene manufactured outside the U.S., it is also evident why Lummus can not limit its licensing to just U.S. manufacturers. The desire or need by Lummus to license the technology to non-U.S. manufacturers will not interfere with the ability to license or otherwise commercialize the technology in the U.S. If anything, the more wide-spread the technology becomes, the more likely the cost associated with it would come down making it even more viable for U.S. manufacturers, which would help create U.S. jobs through the implementation of the technology in the U.S. facilities and lower the energy consumption of the U.S. facilities.

In regards to U.S. manufacturers, Lummus is optimistic that the resulting technology should be especially attractive to them. The resulting technology, *i.e.*, the new SM production process, is likely to replace the ethylene feedstock used in the conventional process for SM production with domestic natural gas. Although historically there has been sufficient ethylene capacity in the U.S. to meet U.S. demand, lack of any new U.S. ethylene plant capacity will likely result in the need to import more ethylene to support SM production in the U.S. However, the adoption of Lummus's new SM production will likely allow the U.S. manufacturers to rely more on domestic sources of natural gas than on imported ethylene. Lummus is also optimistic

that if the new SM production process is able to achieve the targeted performance goals, then styrene may become more cost competitive with polypropylene (the main competitor to styrene) allowing for an increase of styrene demand and the encouragement of more U.S. styrene productions.

Although Lummus cannot agree to the standard U.S. competitiveness provision, Lummus is willing to demonstrate its commitment to make the new proposed SM process available to U.S. manufacturers and to otherwise benefit the U.S. economy. Specifically, in lieu of the standard U.S. competitiveness provision, Lummus agrees to the following legal commitments in exchange for this waiver:

- (i) All research and development activities under the grant will occur in the United States;
- (ii) Lummus shall license any waived invention to any manufacturer in the United States, under commercially reasonable and customary terms and at a royalty rate or licensee fee no greater than any royalty rate or licensee fee offered to a manufacturer outsider of the United States;
- (iii) When the resulting technology under this grant has advanced to commercial readiness, Lummus shall also actively engage manufacturers in the United States to inform the manufacturers of any waived invention under the grant and the opportunity to license it from Lummus; and
- (iv) When the resulting technology under this grant is ready for pilot testing or demonstration, Lummus will first engage manufacturers in the U.S. to provide an opportunity for a U.S. manufacturer to pilot the technology.

Referring to item 10 of the waiver petition, granting this waiver is not anticipated to have any adverse impact on competition. The funded project is only part of a multi-stage research program. It is anticipated that the first commercial license will not occur until about 2019-2020. Based on the uncertainty regarding market demands and pricing of commodity, it is hard to predict how successful the proposed new SM process will be compared to the existing technologies or other developments in this field between the time of this grant and when the proposed new SM process is ready for commercialization. However, Lummus is required to license any waived invention to any interested manufacturer in the U.S. under commercial and customary terms. Therefore, no one manufacturer in the U.S. will have exclusive access to any waived invention. Similarly, Lummus intends to license the waived invention to any interested manufacturer regardless of location. Therefore, no one manufacturer outside the U.S. is likely to have exclusive access to any waived invention.

Considering the foregoing, it is believed that granting this waiver will provide Lummus with the necessary incentive to invest its resources in commercializing the results of the grant in a manner that will make the above technology available to the public in the shortest time. Therefore, upon evaluation of the waiver petition and in view of the objectives and considerations set forth in 10 CFR 784, all of which have been considered, it is recommended that the requested waiver be granted.



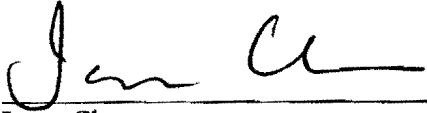
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Glen R. Drysdale  
Patent Attorney  
Golden Field Office

Date: 9/26/10

Based upon the foregoing Statement of Considerations and representations in the attached waiver petition, it is determined that the interests of the United States and the general public will best be served by a waiver of patent rights of the scope determined above, and therefore the waiver is granted. This waiver shall not apply to any modification or extension of the grant, where through such modification or extension, the purpose, scope, or cost of the grant has been substantially altered.

CONCURRENCE:

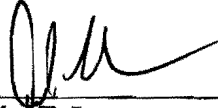


Isaac Chan  
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Date:

11/18/10

APPROVAL:



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11/19/2010