

**INHERENTLY SAFER CHEMICAL PROCESSES:  
THE USE OF METHYL ISOCYANATE (MIC) AT BAYER CROP SCIENCE**

**REVISED PROPOSAL 10-DELS-178-01(REVISED)**

**PROJECT CONTEXT**

Public Law 111-88 (the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010) directs the Chemical Safety and Hazard Investigation Board (CSB) to conduct “a study by the National Academy of Sciences to examine the use and storage of methyl isocyanate including the feasibility of implementing alternative chemicals or processes and an examination of the cost of alternatives at the Bayer CropScience facility in Institute, West Virginia.”<sup>1</sup>

For a number of years, the Bayer facility in Institute<sup>2</sup> has stored approximately 200,000 pounds of methyl isocyanate (MIC), which has been used as an intermediate to produce carbamate pesticides, including carbofuran, carbaryl, aldicarb, methomyl, and thiodicarb (Larvin). It is the only remaining site in the U.S. which manufactures and stores large quantities of MIC, the chemical released in the Bhopal disaster of 1984. In August 2009, one year after a serious explosion and fire near an aboveground MIC storage tank, Bayer announced a plan to reduce the maximum inventory of MIC at the Institute site by 80% and to eliminate aboveground storage of the chemical. This plan, which is currently being implemented, would leave approximately 40,000 pounds of MIC stored underground at the site on an ongoing basis. To achieve the inventory reduction, Bayer plans to use its existing carbamate manufacturing technology but to discontinue the production of two MIC-derived carbamate pesticides, methomyl and carbofuran.<sup>3</sup> This study will focus on further risk-reduction opportunities, above and beyond the envisioned 80% reduction in MIC inventory.

**STATEMENT OF TASK**

The National Research Council will produce a detailed written report, conclusions, and recommendations where appropriate on the following subjects:

1. Review the current industry practice for the use and storage of MIC in manufacturing processes, including a summary of key lessons and conclusions arising from the 1984 Bhopal accident and resulting changes adopted by industrial users of MIC.
2. Review current and emerging technologies for producing carbamate pesticides, including carbaryl, aldicarb, and related compounds.

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<sup>1</sup> Congress appropriated \$600,000 for conducting the study.

<sup>2</sup> The facility was constructed in the 1940's and was developed as a carbamate pesticide manufacturing complex by Union Carbide, which owned the facility from 1947-1986. Bayer CropScience acquired the facility in 2002.

<sup>3</sup> On December 31, 2009, the U.S. Environmental Protection Agency revoked all tolerances for the pesticide, having determined that “dietary, worker, and ecological risks are unacceptable for all uses of carbofuran.”

The review should include:

- a. Synthetic methods and patent literature
  - b. Manufacturing approaches used worldwide for these materials
  - c. Manufacturing costs for different synthetic routes
  - d. Environmental and energy costs and tradeoffs for alternative approaches
  - e. Any specific fixed-facility accident or transportation risks associated with alternative approaches
  - f. Regulatory outlook for the pesticides including their expected lifetime on the market
3. Examine the use and storage of MIC at the Bayer Crop Science facility in Institute, West Virginia:
- a. Identify possible approaches for eliminating or reducing the use of MIC in the Bayer carbamate pesticide manufacturing processes, through, for example, substitution of less hazardous intermediates, intensifying existing manufacturing processes, or consuming MIC simultaneously with its production.
  - b. Estimate the projected costs of alternative approaches identified above.
  - c. Evaluate the projected benefits of alternative approaches identified above, including any cost savings, reduced compliance costs, liability reductions, reduced emergency preparedness costs, and reduced likelihood or severity of a worst-case MIC release or other release affecting the surrounding community.
  - d. Compare this analysis to the inherently safer process assessments conducted by Bayer and previous owners of the Institute site.
  - e. Comment, if possible, on whether and how inherently safer process assessments can be utilized during post-accident investigations.

## **PLAN OF WORK**

### **Committee Composition**

The committee will include experts with diverse backgrounds, including:

- Process industries
- Chemistry and chemical engineering (including carbamate pesticide manufacturing)
- Process safety
- Economics
- Community organizations (including the interests of Kanawha Valley residents)
- Environmental organizations (including environmental justice issues)
- Community emergency preparedness and response
- Labor organizations representing the process industries

Committee expertise will be required in chemical process engineering, chemical process safety, chemical process management, industrial hygiene, risk management, and economic evaluation. Committee members will be screened for possible conflict of interest, and the committee as a whole examined for overall balance of perspective on the issue at hand, following standard National Research Council procedures. Committee members may be drawn from outside the US as necessary to secure the required expertise.

The committee will carry out its data-gathering through a series of meetings and one site visit as detailed in the preliminary work schedule below. A consultant will be utilized to assist with a detailed literature survey of carbamate pesticide synthesis and manufacturing processes, and a technical writer may be engaged to assist in final drafting and editing of the committee's report.

#### Preliminary work schedule

Month 0: Receipt of funding

Month 1-2: Committee members identified, nominated, and appointed. Initial discussion of committee balance and composition. Committee teleconference to discuss task, data needs, and work plan. Committee establishes working groups responsible for the items in the Statement of Task.

Month 3: First face-to-face committee meeting. Committee discusses statement of task with Chemical Safety Board representatives, revisits committee balance and composition as necessary, and holds initial briefings and data gathering. Working groups refine plans for data-gathering and workplans, agree to outline of final report, and make writing assignments.

Month 5: Second face-to-face committee meeting. Committee participates in a site visit to Bayer facility in Institute, WV. Committee continues data gathering efforts, reviews report draft to date, and deliberates on findings and recommendations. Public hearing held to receive public concerns.

Month 6: Committee teleconferences as necessary.

Month 7: Third face-to-face committee meeting. Data gathering completed. Committee reviews report draft and finalizes findings and recommendations.

Month 8-9: Committee teleconferences.

Month 9: Final report enters NRC report review process.

Month 10: Preparation of response to review.

Month 11: Fourth committee meeting to finalize response to review.

Month 12: Report approved for release. Prepublication version released.

Month 12-15: Report publication and dissemination. Briefings to sponsor and other parties as appropriate. Public briefing in Institute, WV.

#### Dissemination Plan

The dissemination plan targets relevant federal agencies, congressional stakeholders, industrial and trade groups, and non-governmental advocacy groups. Elements may include:

--Briefings to federal agencies. Briefings to the sponsoring agency, U.S. Chemical Safety

and Hazard Investigation Board, as well as the Environmental Protection Agency and the Department of Homeland Security. Briefings of Congressional staff will be planned.

--Outreach to trade press. Coverage in trade and professional press will be sought, with outreach to outlets such as Chemical and Engineering News (American Chemical Society), Chemical Engineering Progress (American Institute of Chemical Engineers), and others.

--Outreach to non-governmental organizations and advocacy groups, especially local community groups.

--A website with project updates and project developments.

#### **DELIVERABLES**

The NAS shall provide a quarterly progress report to the CSB from inception to completion. The NAS should promptly notify the CSB of any problems encountered or other matters that require CSB attention.

The principal deliverable item is a detailed written report of the expert panel addressing each point in Tasks 1-3 above. The report should be produced within 12 months of the initiation of the project.

#### **FEDERAL ADVISORY COMMITTEE ACT (FACA)**

The committee and staff may require access to proprietary information which is exempt from public disclosure as described in title 5 U.S.C. §552(b)(4) i.e. exemption (b)(4) in the Freedom of Information Act (FOIA) and for which a non-disclosure agreement may need to be established between the National Academy of Sciences (NAS) and Bayer CropScience, and other companies as appropriate. The NRC staff will identify the need for and nature of such information as early as possible from the sponsor, the U.S. Chemical Safety and Hazard Investigation Board, and make appropriate arrangements for such access in accordance with NRC procedures in consultation with the NRC's Office of General Counsel (OGC).

#### **PUBLIC INFORMATION ABOUT THE PROJECT**

In order to afford the public greater knowledge of Academy activities and an opportunity to provide comments on those activities, the Academy may post on its website (<http://www.national-academies.org>) the following information as appropriate under its procedures: (1) notices of meetings open to the public; (2) brief descriptions of projects; (3) committee appointments, if any (including biographies of committee members); (4) report information; and (5) any other pertinent information.

#### **PROJECT FUNDING**

The total revised cost to the Chemical Safety and Hazard Investigation Board for this 15-month activity is \$574,925; a revised budget is enclosed.