# V.A.3 Materials Solutions for Hydrogen Delivery in Pipelines

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*Subcontractors:*
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*ASME, New York, NY*
*C3 International, LLC, Canton, OH*
*Columbia Gas of Kentucky, Lexington, KY*
*Oregon Steel Mills, Portland, OR*
*Schott North America, Duryea, PA*

*National Laboratory Partner:*
*Oak Ridge National Laboratory, Oak Ridge, TN*

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## Objectives

- To identify steel compositions and associated welding filler wires and processes that would be suitable for construction of new pipeline infrastructure
- To develop barrier coatings for minimizing hydrogen permeation in pipelines and to develop in-situ deposition processes suitable for these coatings
- To understand the cost factors related to the construction of new pipelines and modification of existing pipelines and to identify the path to cost reduction

## Technical Barriers

This project addresses the following technical barriers from the Hydrogen Delivery section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- D. High Capital Cost and Hydrogen Embrittlement of Pipelines

## Technical Targets

This project will evaluate the embrittlement of commercial pipeline steels under high hydrogen pressures, identify steels that will perform the best, and develop new steel compositions if necessary. In addition, the

project will develop and assess the role of barrier coatings in minimizing the dissolution and penetration of hydrogen. Use of new materials and coatings identified will increase the reliability of pipelines relative to $H_2$ embrittlement concerns and integrity. This project will also assess the current costs of construction and maintenance of pipelines, evaluate the change in costs that could be expected with the introduction of new materials, and identify potential avenues for cost savings so that the target of $0.8 million/mile for pipeline construction and the target cost for delivery of hydrogen of less than $ 1/gge can be achieved by 2015.

## Approach

The proposed approach consists of five major tasks: Task 1. Evaluate hydrogen embrittlement characteristics of existing commercial pipeline steels under high-pressure hydrogen. The primary focus of this task is the evaluation of the hydrogen embrittlement characteristics of existing commercial pipeline steels under high pressure hydrogen (up to 5000 psi). Results from this task will be used to understand the relationship between the alloy composition, microstructure, and embrittlement characteristics of steels. Task 2. Develop and/or identify alternate alloys and evaluate hydrogen embrittlement. Using the understanding developed in Task 1, we will identify alternate existing steels or develop new compositions and study their hydrogen embrittlement characteristics with high pressure hydrogen. Both bulk materials and weld joints will be part of both studies.

In addition to identifying/developing bulk materials that would have better resistance to hydrogen embrittlement, this project will also evaluate the use of barrier coatings. As part of Task 3, certain existing coatings will be studied for their ability to act as a barrier to the dissolution and penetration of hydrogen into steels. Promising coatings will be identified and the embrittlement of steels coated with these compositions will be evaluated as part of Task 4.

Task 5 will focus on developing cost models for current pipeline construction, and evaluate potential avenues of savings. The costs associated with the introduction of new materials will be assessed and the new cost models will be further evaluated. These models will be used to identify potential path towards reaching the target costs for pipeline construction.

Figure 1 shows a diagram illustrating the overall project approach.

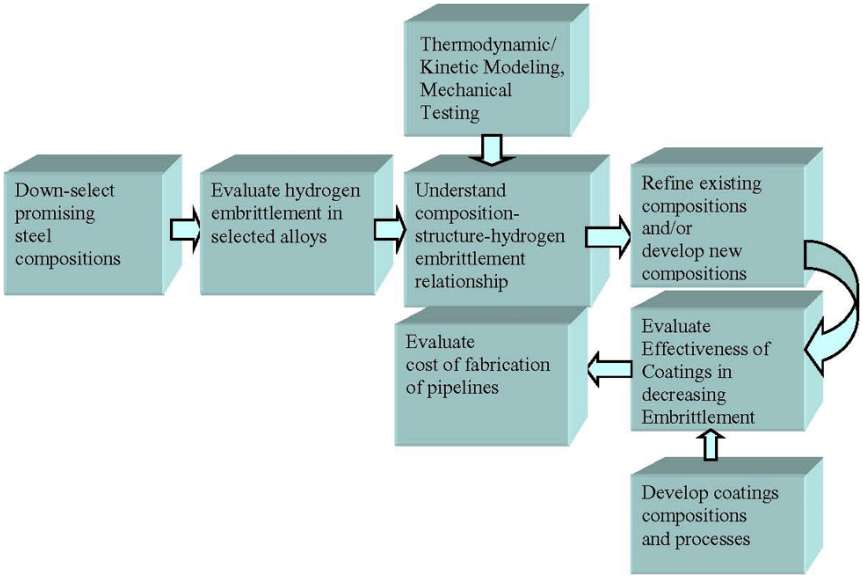


**Figure 1.** Schematic of Overall Approach