DEVELOPMENT OF A COMPOSITE POLYETHYLENE - FIBERGLASS REINFORCED PLASTIC HIGH INTEGRITY CONTAINER FOR DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

Bondico, Inc. has received numerous industry requests for a high integrity container (HIC) for the disposal of low-level radioactive wastes (LLW) that has excellent chemical resistance as well as structural stability. As a result Bondico has initiated a design and development program to utilize its unique technology used for making hazardous waste containers, to provide a HIC of composite construction with an inner layer of polyethylene (PE) and an outer casing of fiberglass reinforced plastic (FRP) that has improved volumetric efficiency and integrity. Two sizes of HIC are planned initially for containing 7 ft^3 and 10 ft^3 of waste. Future development of larger size units to about 200 ft^3 capacity is planned. Each HIC has a full opened lid which is sealed remotely after filling by means of a high integrity polyethylene weld. To date handmade prototype units have been fabricated, loaded, sealed and tested to the most demanding NRC and state requirements. In many cases the HIC prototypes have exceeded key requirements by about 100%. A comprehensive materials testing program to cover physical strength properties, creep characteristics, performance under thermal cycle conditions, performance after gamma and ultraviolet radiation, resistance to biodegradation, and resistance to interior and exterior chemical exposures is in progress. Concurrently production methods and equipment are being finalized. Production units will be produced and subjected to full-scale testing conditions. Based upon this development program, a topical report will be submitted to NRC for review and approval later this year.

INTRODUCTION

Nuclear Regulatory Commission (NRC) Regulations 10 CFR Part 61 provide the Licensing Requirements for Land Disposal of Radioactive Waste, specifically low level waste. Subpart D of this regulation provides the technical requirements for land disposal facilities. Paragraph 61.55 of this subpart covers the classification of the three types of waste that are the subject of this regulation. The characteristics of acceptable wastes of these types are included in paragraph 61.56. This paragraph, inter alia, provides that the waste form must provide stability and integrity either by immobilization in a solidified inactive matrix or by means of a container or structure that will provide stability and integrity after disposal.

The use of such a container, called a HIC, can provide both convenient and economical means for the handling, transportation, and disposal of such wastes. As a result, numerous radioactive waste management vendors have developed a variety of HIC's for such applications.

To provide further information for potential HIC vendors and users for the development and review of HIC's, NRC has provided guidance in the form of a Branch Technical Position (BTP) on waste characteristics.

In addition, since HIC's may be used by a variety of waste generators and may be disposed of in several different land disposal sites, NRC has provided a means for submittal of generic HIC information for review and approval by the NRC staff. The process requires the development of a topical report which describes the HIC and how it meets the requirements and guidance of the NRC and the states that have LLW land disposal facilities.

To date NRC has reviewed numerous HIC topical reports, but has approved only two HIC's for land disposal of LLW. They are as follows:

(1) Pacific Nuclear Systems FL-40/EA-50 HIC made of a special alloy (Ferralium-255) that will hold 50 ft^3 of LLW.

(2) Chichibu Cement Co. Ltd, 200 l and 400 l HIC's made of a special steel fiber reinforced, polymer impregnated concrete (SFPIC), that will contain either 200 or 400 liters of LLW.

Bondico, Inc. has been manufacturing special composite containers for hazardous chemical wastes. These containers are made with an inner layer of polyethylene (PE) encased in an outer layer of fiberglass reinforced plastic (FRP). The two layers are intimately joined, by a patented process, so that they perform together as a single composite unit which enhances the performance of the inner PE layer.

Their use has been approved by the Environmental Protection Agency for containing leaking or damaged packages of hazardous materials, i.e., PCB's, dioxins, corrosives, etc. In addition, these containers qualify under Department of Transportation regulations as 7A type A packaging for LLW and are

being used for specialty packaging by the nuclear industry.

PRELIMINARY PROTOTYPE HIC DEVELOPMENT AND TESTING

In response to requests from several nuclear waste generators, Bondico embarked a program to initially design and develop two sizes of HIC's. One HIC will be essentially equivalent in size to a 55-gal. drum and contain 7.4 ft^3 of LLW. It is shown in the photograph below and will be called HIC-7.

The second unit, HIC-10, will contain a 55-gal. drum and have an internal volume of 10.8 ft^3.

Preliminary handmade prototypes of these HIC's have been fabricated, loaded, sealed, and tested to meet the most demanding aspects of the NRC and state requirements and guidance with very adequate margins of safety in the range of 100% or more. The preliminary prototype testing has included:

- External hydrostatic pressure - 100-120 psig.
- Internal hydrostatic pressure - 25 psig.
- Free drop test on unyielding surface - 4 ft.
- Free drop test on compacted sand - 25 ft.

The pressure test conditions are essentially 100% over the NRC requirements that result from either:

(1) maximum burial conditions or
(2) reduced external pressure conditions.

The former requires resistance to a pressure equivalent to a burial depth of 55 ft, or an external pressure of 46 psig. The latter requires resistance to an external pressure of 3.5 psia or an internal pressure of 11.2 psig. In both pressure tests, the prototype HIC's withstood the pressure conditions with outstanding results and showed no significant effect.

The free drop tests were performed in several orientations to simulate the maximum potential damage conditions on the top lid corner or the bottom HIC knuckle. In all tests the HIC's were loaded with wet sand and free water to simulate a full load of resin wastes and were then sealed. Following the drop tests, the impacted areas were inspected for damage. The tested HIC's showed little or no effects from the drop tests. As proof of this undamaged condition, the HIC's were tested for internal pressure integrity and were checked for any water leakage. No loss of integrity was detected as a result of any drop tests.

PRODUCTION MATERIAL AND HIC PROTOTYPE TESTING PROGRAMS

A comprehensive production material testing program has been initiated with a large national testing laboratory. Production material in large plate form has been fabricated by Bondico. From numerous batches of this material, the testing laboratory has machined actual test specimens for the following tests:

1. Physical Properties
   - Tensile Strength
   - Compressive Strength
   - Shear Strength
2. Creep Characteristics
3. Performance after Thermal Cycling Exposure
4. Performance after Gamma Ray and Ultra Violet Exposure including Gas Generation Analysis
5. Resistance to Biodegradation by Fungi and Bacteria
6. Resistance to Internal and External Chemical Exposures

Following exposure to test conditions in 3, 4, 5, and 6 above, the test specimens will be tested for physical strength properties and the results will be compared to the results obtained from the tests performed in 1 above.

After production processes have been finalized and production equipment procured and installed, production prototype HIC's of each size will be manufactured. These prototype units will be loaded with simulated wastes, sealed and will be tested to demonstrate performance under the following test conditions:

- Compression
- External Hydraulic Pressure
- Internal Pressure (Leak tightness)
- Penetration (Bar Drop)
- Free Drop test
  - Unyielding Surface
  - Compacted Sand
  - Five Orientations
- Dewatering Performance
- Passive Venting
- Lifting Deceleration
- Transportation Vibration

HIC TOPICAL REPORT

In addition to reporting the results of the above extensive materials and prototype testing programs, a topical report will be prepared that will include the following items:

- HIC Engineering Design,
- Fabrication Methods
- Handling and Loading Procedures, and
- User Requirements.

It is planned that this topical report will be submitted to the NRC for review and approval about mid year 1987.