# *PipeTaz*: Automated Pipe Asbestos Insulation Removal System Development for DoE Site Remediation

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**Abstract** - *The asbestos remediation for wrap-and-cut piping in D&D applications for DoE is conservatively estimated at $300 million complex-wide. The development of an automated system to separate the insulation from the pipe, allowing for waste-volume reduction and waste-segregation is offered as a solution capable of saving DoE between 20% and 40% of the total job cost in years to come. The application to the industrial market segment is even larger and is expected to drive the commercial viability of the system. This paper presentes the system design for the development of* ***PipeTaz****, a system under development with DoE SBIR Phase II funding.*

## I. Introduction

Airborne asbestos-fiber is an important health-hazard. Asbestos abatement is a significant component of the overall cleanup costs associated with building demolition and renovation. For example, asbestos abatement efforts associated with the DoE's national weapons' complex clean-up efforts may amount to $300 million. Abatement costs are primarily driven by the issues related to environmental and worker safety regulated by EPA and OSHA, which for asbestos are primarily spelled out in 40 CFR Part 61 (fiber emissions levels to 0.01 f/cc) and 29 CFR 1926.1101 (work procedures and safety processes). Studies of the asbestos abatement market carried out for DoE [1,2] and the industrial market-sector [3], suggest that DoE has a total of about 2 million linear feet of asbestos-clad piping (in the 4 to 8-inch diameter range) across its major facilities (Savannah River, Hanford, INEEL, Oak Ridge, Rocky Flats, Fernald, etc.), both indoors (75%) and outdoors (25%). The residential and industrial abatement market is estimated to approach about 15 million linear feet per year abated (over the next 5 to 10 years) in all pipe-sizes.

The per-foot abatement costs for commercial and industrial jobs [4] are around $15.- to $35 per linear foot. DoE pipe abatement costs are between $75 to $150.- per linear foot [5]. This represents overall asbestos abatement costs of about $150M to $300M total for the DoE, and costs to industrial sectors of $200M to $500M annually. The cost of abatement for DoE may be even higher, if as surveyed, about 25% of DoE pipe insulation is also radiologically contaminated. Radiologically contaminated asbestos insulation will drastically increase the abatement costs - potentially doubling the cost of the overall abatement for that segment to as much as $500M.

## II. Objectives

Lowering the costs associated with the removal and disposal of contaminated asbestos and asbestos insulation would greatly reduce abatement costs. Disposal costs can represent as much as 40% of contaminated insulation abatement job-costs, and as much as 20% of uncontaminated asbestos abatement costs. For DoE, these disposal costs alone represent as much as $165M. Disposal costs are mostly due to the cost of long-term storage of the contaminated material and are typically based on waste volume (although sometimes on weight). Hence, any waste-segregation system that could reduce overall waste-volume, and for DoE also reduce the level of contaminated waste (such as radionucleides) contained within the overall waste, could dramatically reduce disposal costs.

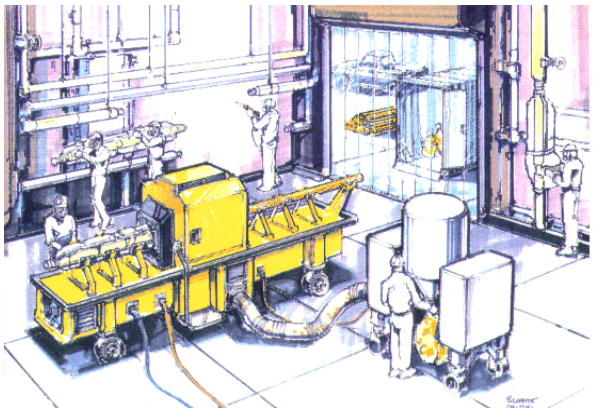

***Figure 1 : Schematic of PipeTaz demonstrating all stages of operation from wrap-and cut pipe removal to bagging of asbestos waste***

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We aim to develop a fully self-contained asbestos pipe-insulation removal, segregation and handling, and waste reduction system for thermal asbestos-containing insulation and associated by-products - ***PipeTaz***. An easily movable unit capable of *in-situ* 'stripping' of insulation from wrap-and-cut pipes would provide for the ability to separate the insulation from its heavy pipe-core, enabling (i) high degrees of waste-volume/-weight reduction, (ii) cost-effective post-processing of contaminated insulation into more benign forms, (iii) recycling of non-contaminated scrap metal and (iv) overall reduction of disposal costs due to reduced volumes and potentially reduced contamination levels. The method would also facilitate the use of post-removal contamination reduction methods. For example, the DoE through FETC has developed several chemical and thermal processes to break down asbestos into harmless compounds and 'extract/bind' radionucleids so as to reduce the regulated level of radiological contamination.

Such an abatement system could reduce waste-volumes by 25% to 75% and reduce weight by 95% or more, which could represent a savings to DoE of $40M to $120M. This does not count the potential savings of being able to alter the waste-form chemically/radiologically, providing for additional savings. Impact on the commercial sector is similar in scale, as although their per unit disposal costs are lower, their annual volume is far larger.

## III. Approach

*PipeTaz,* will provide high-speed asbestos pipe-insulation abatement and waste-separation for wrap-and-cut abatement contractors, in order to reduce disposal costs and abatement project durations while allowing for pipe-recycling and asbestos-waste re-processing. The *PipeTaz* system is depicted here in an operational setting typical in the industry. The automated abatement system consists of an overall framework to support the basic pipe-feed and removal chamber mechanisms. Pipe of almost any size (1 to 12 inch) can be placed on the support frames and automatically advanced into the removal chamber, where the insulation is removed. The removal chamber is under vacuum and contains the cutting, spraying and encapsulation systems to remove the insulation off the pipe while sealing the pipe. The pipe can then be recycled or further processed.

*PipeTaz* is a direct offshoot of *BOA*$^{TM}$, a novel remote-control high-speed asbestos abatement system developed at Carnegie Mellon University (CMU) [6]. *BOA* is a self-locating mini enclosure, which moves along piping dicing up lagging and removing the material to an off-board bagging system. *PipeTaz* differs from *BOA* in that it is a stand-alone unit through which cut piping is passed and asbestos lagging removed. *PipeTaz* is implicitly a low-risk implementation since all of its main components are based on the tried and tested subsystems inherent to the *BOA* on-pipe system. Maintenance should be simple, due to the inherent simplicity and modularity of the system. The off-board logistics systems are OEM components and have been tested, the control and computing enclosure will be a simplified industrial version of the *BOA* system. *PipeTaz* is expected to be far cheaper to manufacture and operate than *BOA*. We also expect to only require two operators, with additional crew wrap-and-cut working the pipe network using glovebags and either no or simple asbestos-protective clothing (Figure 1 shows all stages of operation but does not imply that 6 or more operators are required).

## IV. Project Description

We engaged in a Phase I SBIR program under DoE funding in FY 2000, and are currently funded to proceed into a Phase II development effort through DoE. As art of this Phase II prototype and field-trial program we will explore the potential for *Pipetaz* to achieve cost-effective, automated asbestos pipe-insulation removal and waste-separation/-minimization/-reprocessing/-disposal in a safe and cost-effective manner. This will allow DoE, and the abatement industry at large, to separate asbestos covered pipe waste-streams - reducing disposal costs and enabling application of other waste-recycling processes.

## V. Phase I SBIR Program Results

As part of our Phase I activities, we focused on two main areas:

***(1) Investigation of the design-feasibility of a commercial system.***

***(2) Testing of the functionality of a pre-prototype cutting system utilizing asbestos-simulants.***

The goal was to generate valuable design and test-data to feed into the design-phase of the final prototype that we are now funded to develop as part of the Phase II SBIR effort. The design-feasibility effort resulted in the development of an overall assembly design for the removal unit, as shown in Figure 2.

As part of the assembly design, a process-flow and control diagram was generated and utilized the specify major components seen in Figure 3.

The cutting and abatement system design was based on experiments run with a wide selection of cutters and media. The most notable discovery was that a simple

right-angle grinder with a slotted diamond-coated saw running at 10,000 RPM+ was perfectly suited to cut through all anticipated materials, including canvas and metallic lagging and chalky insulation materials (see Figure 4).

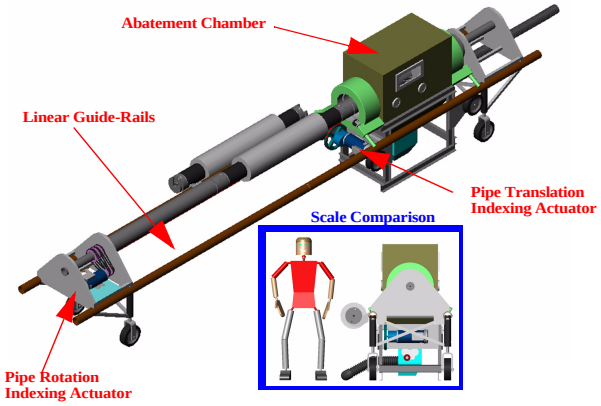


***Figure 2 : PipeTaz Assembly Preliminary Design Overview***

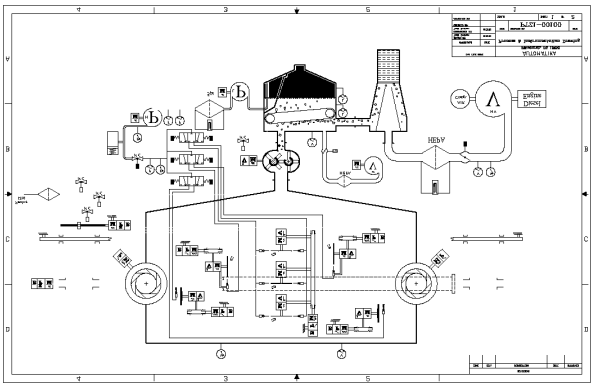

***Figure 3 : PipeTaz Process Diagram***


***Figure 4 : Prototype cutting systems testers***

In addition, the project team re-designed a hand-held water-jet cutting and ablation unit designed for manual use on boilers and concrete decking (see Figure 5), and delivered it as a prototype saleable product to a local asbestos remediation company for extensive on-the-job trials.

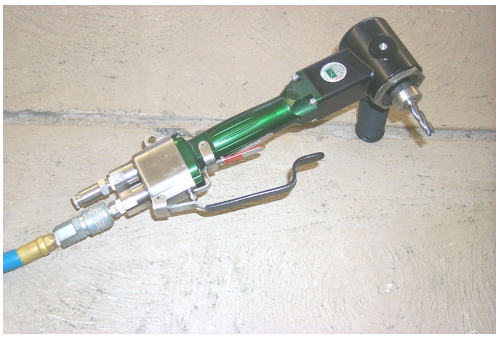

***Figure 5 : Pre-prototype manual abatement cutter***

## VI. Anticipated Benefits and Impacts of *PipeTaz*

The *PipeTaz* system is based on proven DoE-funded technology developed at Carnegie Mellon University. The system allows for waste-separation, either on- or off-site, thereby speeding the disposal of waste-material by virtue of easing the handling of bagged insulation. The handling of the insulation is also easier, as the insulation is contained in lighter double-bagged poly-bags, rather than handling and disposing of large sections of insulated and bagged pipe-sections. The disposal cost savings will rapidly mount, especially for larger abatement contractors, as the available disposal volume has been increased dramatically (a shipping container packed with wrap-and-cut pipe-sections will reach its weight-limit when 30% of it is filled - this implies that 70% of the paid-for disposal-volume represents wasted money). Ease of use will allow the system to be operated by people with minimal training. Handling of the material is safer than with manual methods, as the piping is fully cleaned, blasted and sealed, while the waste is handled inside double poly-bag units. The human laborer is never directly exposed to any fiber-emitting materials. Unlike *BOA*, which is designed for *PipeTaz* is usable in almost any demolition job (which by far dominates the types of large-scale abatement jobs). This implies that the system could be used for asbestos abatement tasks by most of the abatement companies across the country.

The funded program to develop and commercialize *PipeTaz* will yield substantial economic benefits to both government and private-sector abatement markets in several areas:

***Waste-Separation***: *PipeTaz* is able to separate lagging and insulation (including radioactively-contaminated lagging) from steel piping, allowing for

reduced disposal costs and optional recycling or further processing of these waste-streams.

***Waste-Volume Reduction***: Because *PipeTaz* separate waste-streams into asbestos-containing waste and cleaned piping, the total waste-volume is drastically reduced. Removing the steel (or other metallic) pipe from the waste-stream, reduces the hazardous waste-volume by 35% to 65%, prior to further processing (compaction, chemical treatment, etc.), with a weight-reduction of upwards of 99%.

***Disposal Cost Reduction***: The ability of *PipeTaz* to greatly reduce disposal costs is based on its ability to separate wastes requiring costlier disposal (asbestos, low level nuclear waste, etc.) from those that could theoretically be simply landfilled or possibly even recycled. At the commercial level, reducing the weight and volume of the waste to be landfilled will result in cost-savings for commercial abatement contractors.

***Waste-Stream Recycling***: In the case of pipe-insulation, the value of recycling is the scrap-metal value of the pipe itself (carbon steel, stainless, etc.) for both DoE and commercial abatement efforts, and the cost savings associated with reduced waste disposal costs. Additionally, in the case of contaminated asbestos, DoE will garner the benefit of having a separated waste-stream of asbestos-containing insulation that can potentially be treated further either chemically or through heating to reduce its classification from harmful to harmless.

***Waste Packaging and -Handling***: The waste materials are segregated as a part of the *PipeTaz* abatement process. The lagging and insulation materials are packaged in double 6-mil polybags and the piping is separated into cleaned portable sections. The handling of the waste is such that it can be done without any further protection or additional costly procedures, since it has been rendered into an 'amenable' state by the process.

The ability to reduce waste-volumes by 25% to 75% (weight-reduction by 95% and more), could represent a savings to DoE of $40M to $120M. This does not count the potential savings of being able to alter the waste-form chemically/radiologically, providing for additional savings if enacted by DoE. The annual cost savings potential in the commercial sector is similar in scale, as although their disposal costs are lower, their volume is far larger.

The current system design anticipates that human workers will perform the industry-standard wrap-and-cut process, and thus will tend the machine. This method is appropriate for non-radiologically contaminated scenarios, but not for situations or waste material with substantial radiological contamination. It is envisioned that if remote operations are used for performing the removal of the insulated piping in the facility, that the same equipment could be utilized to feed the machine, as long as certain key functions are remoted, which would certainly be possible in a future revised model of the ***PipeTaz*** system.

# VII. Future Activities

We will utilize the design and test data generated in the Phase I SBIR effort to build a final prototype under the most recent Phase II SBIR funding from DoE. A complete system design is expected by May 2003, and a prototype completed by late 2002. The prototype will be tested in partnership with a large asbestos remediation company under realistic working environments sometime in early 2003. Following testing we aim to commercialize the system for use in both public and private sector asbestos remediation projects.

The potential market is significant, encompassing not only the DoE but also the industrial abatement sector (both residential/professional spaces and industrial settings). Wrap-and-cut pipe-sections can be brought from any remote site and processed at a central site by any abatement contractor or other post-processing entities. Alternatively, the system can be set up on site. Once the system is proven and accepted by regulatory agencies as an acceptable treatment process, we expect to provide these systems on a for-sale or -lease arrangement, for medium- to large-scale abatement contractors both nationally and internationally.

# VIII. Acknowledgements

We acknowledge funding from the US DOE for the Phase I and II SBIR and the development and testing of *PipeTaz* under grant DE-FG02-00ER82955.

# IX. References

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