

CONF-95/203--44

Hazardous Materials Transportation Expert System (HaMTES)

R. D. Michelhaugh<sup>1</sup>, R. B. Pope<sup>1</sup>, J. J. Ferrada<sup>1</sup>, R. R. Rawl<sup>1</sup>

<sup>1</sup>Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States of America

To be presented at Packaging and Transportation of Radioactive Materials PATRAM '95  
Conference, Las Vegas, NV, Dec. 3-8, 1995.

The submitted manuscript has been  
authored by a contractor of the U.S.  
Government under contract No. DE-  
AC05-84OR21400. Accordingly, the U.S.  
Government retains a nonexclusive,  
royalty-free license to publish or reproduce  
the published form of this contribution, or  
allow others to do so, for U.S. Government  
purposes.

Oak Ridge National Laboratory  
Oak Ridge, Tennessee 37831-6495

managed by  
MARTIN MARIEITA ENERGY SYSTEMS, INC.

for the  
U. S. DEPARTMENT OF ENERGY  
under contract  
DE-AC05-84OR21400

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED JR

MASTER

## INTRODUCTION

Under the sponsorship of the U.S. Department of Energy's (DOE's) Transportation Management Division (TMD), Oak Ridge National Laboratory (ORNL) has designed and developed an expert system application of the hazardous materials transportation regulations. The Hazardous Materials Transportation Expert System (HaMTES) was developed to provide straightforward and error-free application of hazardous materials transportation regulations. The interactive system is designed to give users access to knowledge and skills that previously could be obtained only from a highly trained and experienced expert in the hazardous materials shipping regulations.

The HaMTES, Version 1.0, was based on the 1995 regulations. It was not officially released by DOE for use by the governmental community. HaMTES, Version 2.0, includes the U.S. regulatory changes recently enacted to align the U.S. regulations with 1985 International Atomic Energy Agency (IAEA) Safety Series (SS) 6. Version 2.0 also includes several other enhancements suggested during the beta testing of Version 1.0.

The TMD has several different software applications under development. Joint Application Development (JAD) sessions are being held to analyze, improve, and discuss the integration of these transportation-related software packages. As DOE funding allows, it is anticipated that HaMTES will be the core of the hazardous materials module of the Automated Transportation Management System (ATMS), which was also developed under the sponsorship of the TMD to provide field offices and site contractors with the automated tools necessary for transacting the increasingly complex transportation management tasks. The ATMS provides the mechanism for using technological advances to reduce DOE's current reliance on labor-intensive, manual processes. Thus, through the application of this technology in operations, the potential for human error when applying the transportation regulations can be virtually eliminated, and the costs associated with the packaging and transportation of hazardous materials can be reduced significantly.

## DEVELOPMENT OF HaMTES

Version 1.0 of HaMTES was completed in May 1995. Although DOE did not officially release Version 1.0 for general use by the DOE community, the system was beta-tested by staff at several DOE and contractor sites. In addition, the HaMTES software was demonstrated for the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Transportation (DOT). These regulators were sufficiently supportive of the system's development to assist in the verification of the logic. The overall flow of the decision process used in HaMTES as well as the detailed logic of the supporting subroutines were reviewed in detail to ensure that the regulations were applied consistently in the manner that they should be applied as defined by the regulators. Some revisions to the logic were suggested and subsequently implemented. There were also examples of literal applications of the regulations, as they were written, not matching the desired outcome. The regulators are formulating clarifications and respective changes to the regulations. Overall, during demonstrations and beta testing of Version 1.0, significant confidence was gained that HaMTES applies the complex sets of requirements accurately.

## HaMTES OPERATING ENVIRONMENT AND ARCHITECTURE

The HaMTES software was developed in a Windows™ multimedia environment which gives designers the ability to organize, manage, and present information in a number of formats: text, graphics, sound, and full-motion video. Graphics and text are used to describe the requirements for transporting hazardous materials. Users will be able to obtain visual information from full-motion pictures of topics related to the transportation of hazardous materials as the full range of multimedia capabilities are implemented. As a major time-saving feature, users of the expert system can access the text of the regulations and navigate quickly and easily through a series of regulation references. This feature is provided by a link to a commercial software package (RegScan™) which supplies the textual source of the regulations.

HaMTES was designed as a modular system so that specific areas of expertise could be easily added or enhanced. Figure 1 illustrates the general architecture of HaMTES and the various interactions of the system with sources of information.

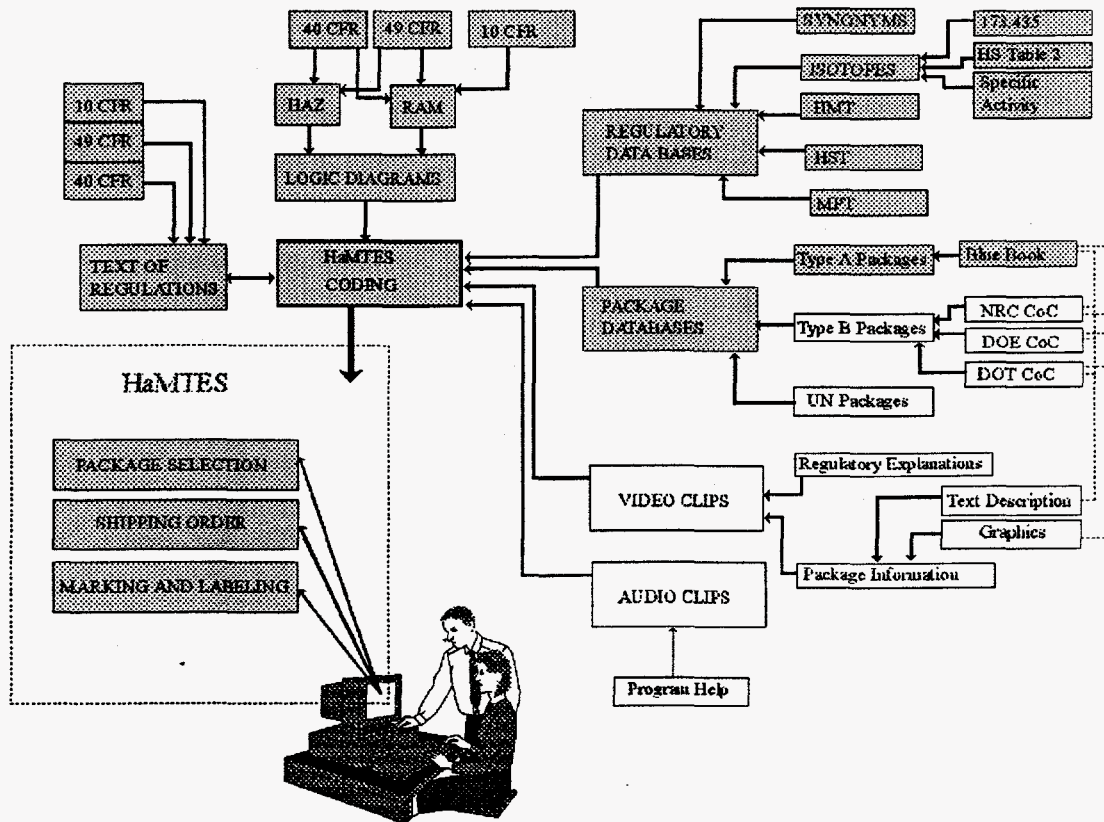


Figure 1. HaMTES architecture.

## ENHANCEMENTS TO HaMTES - DEVELOPMENT OF VERSION 2.0

The coding of HaMTES, Version 2.0, was completed in November 1995. The HaMTES software now includes the capability to print, in a generic form, the Straight Bill-of-Lading, Declaration of Dangerous Goods, and the Uniform Hazardous Waste Manifest. Continuation sheets are automatically included for each as necessary. In developing Version 2.0, the architecture has been modified to facilitate its

integration into the ATMS. Version 2.0 has been updated to include all of the applicable changes to the DOT regulations, including HM-215 and HM-169A.

Because these changes required major modifications to the system, HaMTES will be released as Version 2.0, beta. The operational release of Version 2.0 is expected to be ready in 1996. Upon authorization from DOE, Version 2.0 could be distributed to the DOE shipping community and other government agencies which request a copy.

## USE OF HaMTES

The use of HaMTES offers a consistent and an error-free methodology to prepare hazardous material shipments. During each HaMTES consultation session, the user is presented with a set of initial inquiries which is used by the system to obtain the final determinations. Figure 2 illustrates some of the initial questions asked of the user by the software. Some major problems which HaMTES solves are: (1) elimination of mathematical errors for radionuclide mixtures and  $A_1/A_2$  calculations, (2) proper classification of multiple hazard materials, and (3) automatic Reportable Quantity determination required for transport in the U.S.

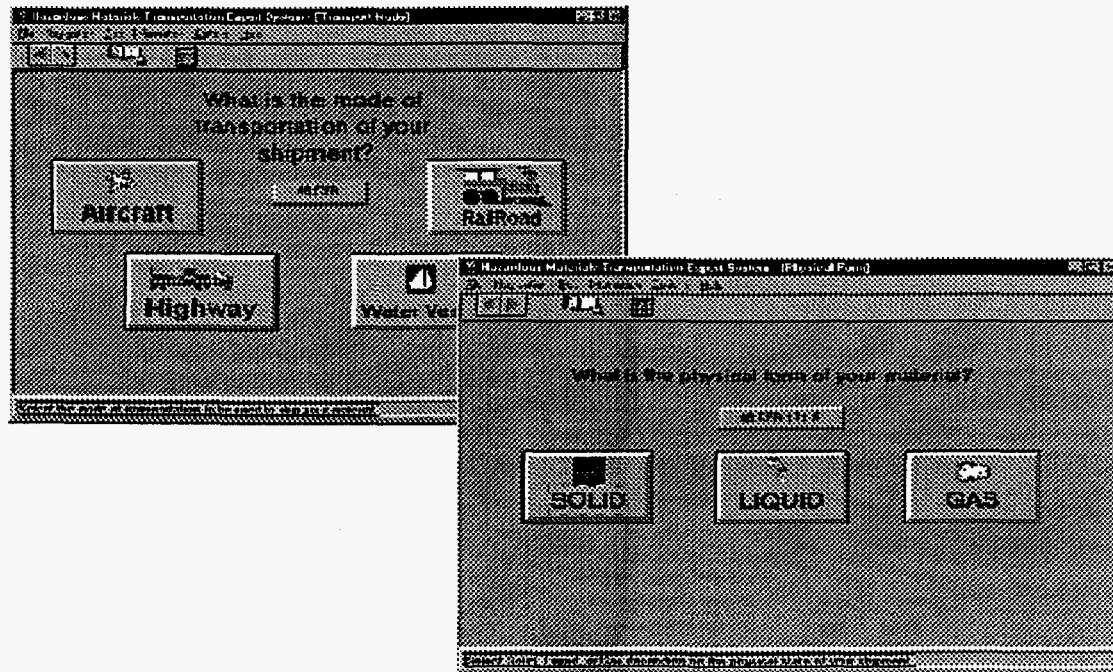


Figure 2. Sample input screens.

HaMTES provides the user access to large databases of radionuclides and hazardous chemicals so that the user can choose from the list rather than type in long and easily misspelled names. Figure 3 shows the HaMTES screen from which the radionuclides for a given package are to be selected.

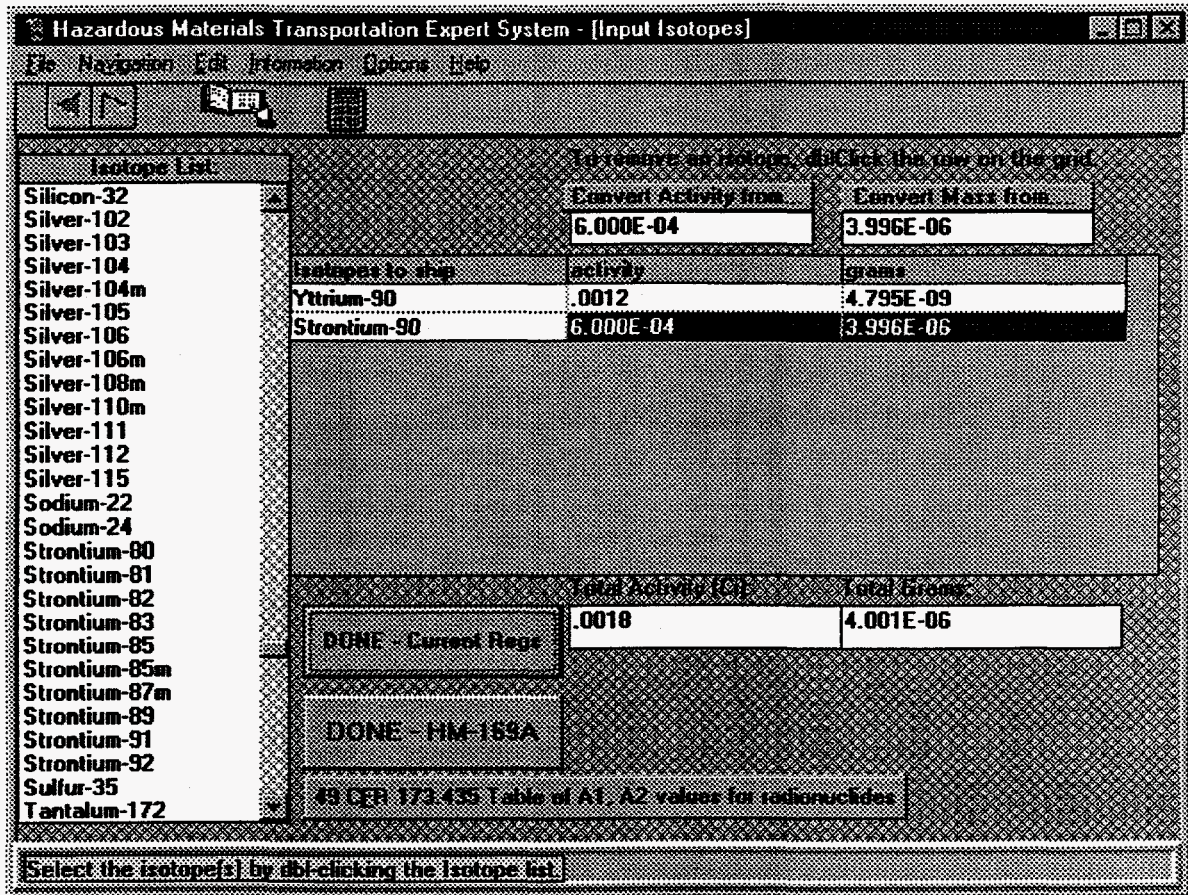


Figure 3. Isotopes input screen.

When the user has entered the basic information for the specific contents (e.g. radionuclides and their quantities), HaMTES processes the information through many logic paths and presents the following outputs to the user: the classification, the proper shipping name, the markings, the required placards, the package type, and the shipping papers. Figures 4 and 5 illustrate the format of the labeling and shipping papers delivered by HaMTES.

Figure 5. Bill of Lading screen.

Labels Required: RADIOACTIVE YELLOW-II TYPE A USA DOT 7A Transport Index: 0.45 Total Activity: 5,000E-04(Ci) Contents: Actinium-227 Physical and Chemical Form: Solid, OXIDE Normal Form Radioactive material, n.o.s., 7, UN2982		TYPE <input checked="" type="checkbox"/> X
No. Pkgs: HM Route: over hill over date	DESCRIPTION OF MATERIAL Vehicle or Car Initial and Number	WEIGHT CLASS RATE
Shipper Your Company Name P.O. Box 1010 Attn: John Smith 1234 Your Street Your City	Consignee Their Company Attn: John Doe Box 1000 MS-33 Anywhere TN: 12345-6789	Shipper hereby certifies that he is familiar with all the Bill of Lading terms and conditions in the governing classification and the said terms and conditions and accepts for himself and his assigns.
Bill of Lading		

Figure 4. Labeling screen.

Click on DONE when you are ready to see the placards required.	
Data RG, Toxic liquids, flammable, organic, n.o.s., [inhalation hazard, Packing Group I, Zone B], 6.1, UN2929	Description
Primary Hazard Label: POISON	Secondary Hazard Label: FLAMMABLE LIQUID
49 CFR 172.403	PRINT DONE
Hazardous Materials Transportation Expert System - [Labeling]	

Another feature of HaMTES Version 2.0 is the ability to save a consultation session and return to it quickly at a later date. This offers a timesaving advantage because the user does not have to answer the questions again for repeat shipments. The user is given the opportunity to change a few inputs such as radionuclide quantities and net mass of the shipment. The user selects the session to rerun, and HaMTES reevaluates the shipment according to the most current rules, which may have changed since the last shipment. Figure 6 shows the HaMTES screen from which a previous session can be chosen.

**CONCLUSION**

To Load a Saved Run, click on one and click 'OK'

OK CANCEL

Co-60/acid

AC-227  
acetone w/ cyanohydrin  
acid  
CAL-1

Co-60/acid  
Gd/ACID

lithium  
test  
lm117m

Is it Acidic?

Yes  
 No

Physical Form

Solid  
 Liquid  
 Gas

Shipping Range

Domestic  
 International

Transport Mode

Air  
 Highway  
 Railroad  
 Water

Is it Radioactive?

Yes  
 No

Form

Special  
 Normal

Figure 6. Previous session selection screen.

User inputs to the HaMTES system are simple, straightforward, and easy to use. The system evaluates the inputs and classifies the material, assigns the proper shipping name, assists in the selection of the proper packaging, determines the required markings and labels, selects the placards which must be offered to the carrier, and prepares the shipping papers with the shipping description, as required by the regulations.

The feedback from beta test sites indicates that the positive impacts on actual operations can be substantial. As with any new system, a learning curve is involved. Most users are able to see preparation times for a given consignment drop substantially after using the system for only one or two days. Shipment classification and preparation time was reduced in some cases from 45 to 10 minutes. The added benefit of having computerized checking of the shipment preparation, including the descriptions on the shipping papers, is invaluable. HaMTES virtually eliminates the potential for human error.