United States
Environmental Protection
Agency

EPA-600/R-01-030
April 2001

Research and Development

Coating Alternatives GuidE

(CAGE)

User's Guide

Prepared for

Office of Air Quality Planning and Standards

Prepared by

National Risk Management
Research Laboratory
Research Triangle Park, NC 27711

FOREWORD

The U. S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources, protection of water quality in public water systems; remediation of contaminated sites and-groundwater; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

EPA REVIEW NOTICE

This report has been peer and administratively reviewed by the U.S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/R-01-030
April 2001

Coating Alternatives GuidE (CAGE)

User's Guide

Prepared by:

Dean R. Cornstubble
Research Triangle Institute
P. O. Box 12194
Research Triangle Park, NC 27709

EPA Cooperative Agreement CR824257-01-0

EPA Project Officer: Michael Kosusko
Office of Research and Development
National Risk Management Research Laboratory
Air Pollution Prevention and Control Division
Research Triangle Park, NC 27711

Prepared for:
U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

DISCLAIMER

Neither the U.S. Environmental Protection Agency (EPA) nor Research Triangle Institute (RTI) makes any representations or warranties with respect to the contents or recommendations provided by this program. This program is provided as an information dissemination service only. The information this program contains is provided solely as a preliminary source of information on low-emitting coating alternatives for metal parts and products painting only. The U.S. EPA and RTI do not recommend the use of any particular generic coating technology. Any mention of trade names or commercial products, if any, does not constitute recommendation for use or endorsement.

Final selection of any coating alternative must be conducted by individual users in consultation with a coating vendor.

ABSTRACT

This guide provides instructions for using the Coating Alternatives GuidE (CAGE) software program, Version 1.0. The guide assumes that the user is familiar with the fundamentals of operating an IBM-compatible personal computer (PC) under the Microsoft disk operating system (MS-DOS).

CAGE is designed to provide alternative coating chemistry recommendations for paint and coating operations. The initial focus of the program is on coatings for metal substrates. Additional modules will be developed for plastic, wood, and other substrates. The CAGE program leads the user through a question-and-answer session. Based on the user's response to each question, a list of relatively ranked low-emitting coating technologies is generated. The user may then review brief descriptions of the alternatives on the computer screen. If any of the alternatives are of interest, the user may request a detailed report. The report includes sections on general information, substrate and surface preparation, application techniques, curing methods, performance properties, safety/environmental concerns, industrial case studies for the selected alternative, and information references. The program also provides information on contacts for state technical assistance for the user's geographical location.

This guide was submitted in partial fulfillment of Cooperative Agreement No. CR824257 under the sponsorship of the U.S. EPA.

This guide covers work performed from April to July 1996, which was based on the beta version 1.0b, released in March of 1996. CAGE version 1.0 was completed as of July 3, 1996.

TABLE OF CONTENTS

Section		Page
DISCLAIMER		ii
ABSTRACT		ii
ACKNOWLEDGMENTS		iv
1.0	BETA VERSION UPDATES	1
2.0	ABOUT CAGE	1
3.0	COATING ALTERNATIVES	2
4.0	APPLICATION EQUIPMENT ALTERNATIVES	2
5.0	INSTALLATION	3
6.0	STARTING CAGE	4
7.0	GETTING HELP	5
8.0	MENU SELECTION	5
9.0	EXPLANATIONS	5
10.0	RETURNING TO PREVIOUS SCREENS	5
11.0	GENERATING THE REPORT	5
12.0	REVIEWING YOUR SELECTIONS	6
13.0	ASSISTANCE	6

ACKNOWLEDGMENTS

The software development was principally the work of Dean Cornstubble of RTI, based on an original concept by Michael Kosusko, the EPA Project Officer. The information provided by CAGE was acquired by Jenni Elion and Liz Hill of RTI's Center for Engineering and Environmental Technology and Jesse Baskir, Alton Peters, Coleen Northeim, and Subba Nishtala of RTI's Center for Environmental Analysis. The Internet Web version of CAGE was designed by Dean Cornstubble and Greg Bray, of RTI's Center for Engineering and Environmental Technology, and is maintained by Greg Bray. This version of CAGE incorporates ideas and suggestions for the improvement of the beta version 1.0b from four coatings experts in the coatings industry and many National Pollution Prevention Roundtable members.

1.0 BETA VERSION UPDATES

Version 1.0 adds some minor bug fixes to the beta version 1.0b. It also improves the logic used for the analysis of coating alternatives. Some general information on equipment costs has been added. The amount of information in each alternative and the number of case studies have been increased. Also, the portion of the report for generating the questions asked and the user's answers has been improved.

2.0 ABOUT CAGE

The CAGE program is designed to provide suggestions for alternative low-emitting coating technologies that will accommodate the user's current coating process. Coatings for miscellaneous metal parts painting are the initial focus. Only higher-solids (>50 percent) solvent-borne, water-reducible, 100 percent solid, radiation-curable, and powder coating technologies are considered as viable solutions.

The program is designed to be used by state regulatory personnel, process engineers, shop supervisors, or anyone looking for information on alternative coating technologies.

The goal of the program is to provide general information on viable coating alternatives. The intent is that the program should provide enough information to the user to reduce the number of alternatives that must be considered. Specific trade names for coatings or application equipment are not currently provided. However, this information will, in time, be provided under the Related Web Links page on the CAGE Internet Web site (http://cage.rti.org).

CAGE works by asking a series of questions about the user's specific coating process. Based on the answers to those questions, the program provides a list of alternative coating technologies. More detailed information can then be requested on the alternatives of interest. The questions may be bypassed at the beginning of the program to allow the user to directly select information on coating alternatives and their application equipment.

Note that the coatings and application equipment are not recommended as paired sets. This is because many different coating chemistries can be used with the various application equipment. It will be up to the user to select and evaluate the various components that will make up the total coating process. However, upcoming versions of the CAGE Internet Web site will contain an optimal selection of application equipment paired with each of the recommended coating alternatives and a generic economic analysis of each paired selection.

At the end of any CAGE session, a detailed report can be prepared and written to a hard disk file, reviewed on the screen, or simultaneously written to hard disk and reviewed on the screen. A glossary of terms common in the coatings industry is also available for the report.

We do not recommend reviewing the detailed report on the screen due to the length of most reports. The report generation process may take several minutes so please be patient. We have attempted to accelerate the process, but it may take 5 minutes or more to generate a report.

3.0 COATING ALTERNATIVES

The possible coating alternatives in CAGE are:

Autophoretic
Electrocoat
100 percent Solids (Plastisols)
Powder:
- *Acrylic*
- *Epoxy*
- *Epoxy-polyester Hybrid*
- *Fluorocarbon*
- *Polyester*
- *Polyurethane*

Radiation-cured
Solvent-borne, Air/force-dried:
- *Alkyd*
- *Epoxy Ester*
- *One-component Urethane*
- *Silicone*
- *Two-component Epoxy*
- *Two-component Urethane*

Solvent-borne, Baked Alkyd
Water-reducible, Air/force-dried:
- *Acrylic Epoxy*
- *Acrylic Latex*
- *Alkyd*
- *Two-component Epoxy*
- *Urethane Dispersions*

Water-reducible, Baked Alkyd, Modified Alkyd, and Acrylic.

4.0 APPLICATION EQUIPMENT ALTERNATIVES

The possible application equipment alternatives in CAGE are:

Air-assisted Airless Atomization
Airless Atomization Spray
Conventional Air Atomization
Dip Coating
Dip-spin Coating
Electrostatic Spray
Flame Spray Coating
Flow Coating
Fluidized Bed
High-volume, Low-pressure (HVLP) Air Atomizing Spray
Roll Coating (Direct and Reverse)
Rotary Atomization.

Please feel free to call the program developers or the U.S. EPA Project Officer (see Section 13.0 of this guide or the README.TXT file) with any suggestions for future improvement. In addition, if you have a well-documented case study that you are willing to share, we would welcome the information.

5.0 INSTALLATION

The minimum system requirements for the DOS version of CAGE are:

PC-AT (286) or compatible personal computer with hard disk,
MS-DOS 3.3 or higher,
an EGA/VGA Monitor, and
5 megabytes (MB) of free hard disk space.

The CAGE directory size is approximately 2.5 MB. All of the necessary files are contained in a compressed, self-extracting file called "CAGE.EXE." You will want to copy the version of the *readme* file most suitable to your word-processing and the CAGE.EXE files to a separate directory for CAGE on your computer's hard drive. The *readme* file is this user's guide describing how to load the program onto your computer, how to decompress the self-extracting CAGE.EXE file, and how to navigate the CAGE program. All of the files contained in the CAGE.EXE file will require approximately 3 MB of hard disk space.

After decompressing CAGE.EXE, enter <cage> at your computer's screen prompt. Follow the instructions on the screen to maneuver through the program. Since CAGE is a DOS-based program, it is best to execute the program outside of any Windows-based environment.

The following command sequences will create a directory named "CAGE," place the appropriate files in the directory, and decompress the files. If you are downloading CAGE from the CAGE Internet web page (see Section 13), then do the following from your hard drive prompt, which is typically C:

1) MD C:\CAGE,
2) MOVE C:\CAGE.EXE C:\CAGE, and
3) CD C:\CAGE.

If you obtained CAGE on a floppy disk, then perform the following:

1) MD C:\CAGE,
2) Insert disk into the floppy drive (typically A:),
3) MOVE A:\CAGE.EXE C:\CAGE, and
4) CD C:\CAGE.

The files in the CAGE directory must include the following:

cage.bat
ltr.exe
ltrhelp.msg
lterrs.msg
fdcmst.dcl
fdctre.dcl
fdcstr.dcl
fdcxid.dcl
ltgraph.pre
*.tpf (115 files with the extension “tpf”)
*.frg (116 files with the extension “frg”)
*.tp (56 files with the extension “tp”).

You will have a total of 296 files after the files are decompressed, excluding the appropriate *readme* file.

Your "CONFIG.SYS" file needs to have the files and buffers set to at least 20:

files = 20
buffers = 20.

These are minimum values. If your settings are already at higher values, do not change them. Use a standard text editor or word processor to modify your "CONFIG.SYS" file as required before running CAGE.

6.0 STARTING CAGE

If you are operating in a DOS environment, switch to the CAGE directory on your hard drive. Type the command "CAGE". This will bring up the first CAGE screen, a graphics screen. Depress the "ENTER" key twice. This will place you at the first function screen for CAGE.

If you are using any of the Windows environments, it is best if you exit to DOS and run CAGE from there. In most cases, it is best to run CAGE in DOS mainly due to the limitations of its programming shell.

7.0 GETTING HELP

Limited on-line help is available from any menu, window, or warning message. Type "ALT H" (depress the ALT key together with the "H" key) to activate the help screen.

The help screen will have an index on the left. On the right will be a message for the selected (highlighted) topic. Use the arrow keys or a mouse to move through the help topics.

You may exit the help window at any time by depressing the "ESC" key.

8.0 MENU SELECTION

Most CAGE questions are answered by selecting items from a menu. You may use a mouse or the arrow keys to move through the various items. The current item is always highlighted and may be selected by depressing the "ENTER" key.

Some menus will allow you to select more than one item. Other menus will allow only one selection to be made. The option(s) that you select will be marked with an arrow head to the left of the selection. If you want to change a selection, place the highlight bar on the selection and use the "+" key to select (or deselect) that item. This also will allow the selection of multiple items; use the "+" key on each desired item in the menu. The item that the highlighted bar is on when you leave a screen will always be selected.

9.0 EXPLANATIONS

Most questions will have explanations available. If there is an explanation for a screen, you will see the word "EXPLANATION" on the menu bar at the top of the screen. Type "ALT E" to activate the explanation. The explanation may hide the original question screen. When you are through reading the explanation, use the "ENTER" key to return to the original question screen.

10.0 RETURNING TO PREVIOUS SCREENS

You can back up for a maximum of six screens during a CAGE session. Type "ALT B" to back up to the previous screen. This will allow you the immediate opportunity to change some previous selections or correct mistakes.

11.0 GENERATING THE REPORT

After answering questions, CAGE will then ask you to select a destination for the detailed report. The possible choices are 1) Screen Review Only, 2) Disk File Only, 3) Screen Review and Disk File, or 4) No Report. You will also be asked if you would like to have a glossary of

common coating terms provided. If you select the "NO REPORT" option, the program will advance to the next screen.

If you request that the report be sent to a disk file, the report will be stored in a file called "REPORT.DOC" in the same directory that contains the CAGE program. ***Be aware that, if you run CAGE more than once, it will overwrite the "REPORT.DOC" file every time that you specify that the report be written to disk.***

The REPORT.DOC file is an ASCII text file. You can print it out on any printer that is attached to your computer. It can also be imported, edited, and formatted in almost any word processing software package.

Depending on the type of computer machine, the report may take up to 5 minutes to generate. Please be patient.

Any report generated will have, at a minimum, generic information on each coating technology desired, if selected by the user as part of the report. This information will contain several subheadings divided into: General Information, Substrate, Surface Preparation, Application Methods, Process Considerations, Curing, Performance, Environmental, Safety, Economics, Case Studies, and References.

12.0 REVIEWING YOUR SELECTIONS

After the report selection has been made, CAGE will give you the opportunity to review your answers to permit inclusion of additional coating parameters in the report, if you so desire. If you do not want to review your answers, you may exit the program.

You may exit from CAGE at any point during a session by using the "ESCAPE" key. You may need to depress the "ESCAPE" key a number of times, depending on where you are in the program.

13.0 ASSISTANCE

Any suggestions or problems with the DOS version of the CAGE program should be directed to:

Dean Cornstubble
Research Chemical Engineer
Research Triangle Institute
Phone: (919) 541-6813
Fax: (919) 541-7155
E-mail: dean@rti.org

or

Michael Kosusko
Senior Project Engineer
U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory
Phone: (919) 541-2734
Fax: (919) 541-0359
E-mail: kosusko.mike@epa.gov.

For those who have Internet access, Internet Web site version of CAGE can be accessed at the following URL:

http://cage.rti.org.

Any suggestions or problems with the Internet Web site version of CAGE should be directed to the cagemaster@clean.rti.org. In addition, you can download the DOS version of CAGE, the self-extracting and *readme* files, from this location as well.

In the near future, CAGE will be available from the National Technical Information Service:

5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

RTI and EPA are always looking for well-documented case studies of successful coating substitution projects. We are especially interested in projects with good economic data and projects that have used a "drop-in replacement" option. If you have this type of information, please contact the EPA Project Officer, Michael Kosusko, at (919) 541-2734, or the CAGE developer, Dean Cornstubble, at (919) 541-6813, for inclusion in revised versions of the DOS program and updates to CAGE's Internet Web site.