HALON & CFC DESTRUCTION, RECOVERY, RECYCLING, AND RECLAMATION TECHNOLOGIES

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ABSTRACT

The presentation outlines the latest issues associated with halon and chlorofluorocarbon (CFC) and recovery, recycling, reclamation, and destruction technologies. The results of a recently completed market survey of available equipment are also presented. The survey was conducted, under United States Air Force sponsorship, to identify commercially available equipment and services for recovery of chlorofluorocarbons (CFCs), halons, and related alternative materials. The results have been documented in a report which included (1) name, address, and telephone number for vendors; (2) price and a description of the systems; (3) performance data such as discharge and recharge rates, weight, dimensions, and compatible halocarbons; (4) description of the halocarbon purification systems, what contaminants can be removed, and how purity can be verified; (5) training availability and adequacy of operation and maintenance documentation; and (6) data indicating system maturity and reliability including historical data on number of systems in use. The report also included an evaluation of the available manufacturers, equipment, and the issues related to halocarbon recovery, recycling, and reclaiming with recommendations. Thirty four companies offering 54 different pieces of equipment and/or services were documented.
LAWS AFFECTING CFCs and HALONS

- Montreal Protocol
  - Then
  - Now
- Clean Air Act 1990 - Title VI
- OMNIBUS Budget Reconciliation Act of 1989
- DoD Action
  - Defense Authorization Act for FYs 90/91 Sec 356
  - DoD Directive 6050.9
    - AFR 19-15
- SARA Title III

MONTREAL PROTOCOL

- Negotiated by United Nations in Sep 87
  - Senate ratified Dec 88
  - Entered into Effect Jan 89
- Controls Production/Consumption of Ozone Depleting Compounds (ODCs)
- Periodic Reassessments
  - Based on scientific, environmental, technical and economic information.
  - Committees formed and reports published
    - 1989 Complete
    - 1991 In process
- Renegotiated June 1990 in London
CONTROLLED SUBSTANCES

- CFCs-11, -12, -113, -114, & -115
- Halons 1211, 1301, 2402
- Carbon tetrachloride (CC-10)
- Methyl chloroform (HCFC-140a)
- All fully halogenated fluorocarbons
- HCFCs - (several alternatives to current CFCs)

CLEAN AIR ACT 1990
Title VI

- CHEMICALS AND PHASEOUT SCHEDULES MATCH OR EXCEED CURRENT PROTOCOL
- MAKES EXEMPT
  - Safety & Medical Devices, National Security, Developing Countries, Fire  & Explosion
  - Generally regarded as "essential uses."
- REQUIRE LABELING
- ELIMINATES NONESSENTIAL USES
- CONTROLS EMISSIONS (RECOVERY/RECYLE)
CAA 1990 • TITLE VI
NATIONAL RECYCLING AND EMISSION REDUCTION PROGRAM

- **Jan 1992** - Requires Certified MAC service techs to use "approved" R/R equipment for Class I & II Sub.
- **July 1992** - Regulations restricting service and disposal of Class I Substances to "Lowest Achievable Emissions Level" also requires R/R
- **July 1992** - Venting Class I & II Substances used as refrigerant during appliance service, repair, or disposal prohibited.
- **Jan 1995** - Regulations for use and disposal of Class II Substances.
- **Jan 1995** - Venting Class I & II Substances and their substitutes prohibited; mandatory R/R/R or destruction.

OMNIBUS BUDGET RECONCILIATION ACT OF 1989

- New Taxes on CFCs and Halons (gov. not exempt)

  - **CFCs:**
    - 1990/91 - $1.37/lb X ODP
    - 1992 - $1.67/lb X ODP
    - 1993/94 - $2.65/lb X ODP
    - 1995 and beyond add $0.45/lb X ODP/yr

  - **Halon:**
    - 1991-93 - $0.25/lb X ODP
    - 1991 add $2.65/lb x ODP
      - H 1211 - $8.00/lb
      - H 1301 - $26.50/lb
    - 1995 and beyond add $0.45/lb x ODP:
      - H 1211 - $1.35/lb/yr
      - H 1301 - $4.50/lb/yr
STATE AND LOCAL LEGISLATION
Taking Aim At Ozone Depleting Chemicals (ODCs)

STATE LEGISLATION SUMMARY

<table>
<thead>
<tr>
<th>State</th>
<th>Foam</th>
<th>CFC R/R Mobile</th>
<th>CFC R/R Fixed</th>
<th>AC Ban</th>
<th>Container Ban</th>
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</table>
SEARCH FOR ALTERNATIVES

- UNEP (United Nations Environment Program, technical reports, reassessment in process)
- PAFTT (Program for Alternative Fluorocarbon Toxicity Testing - I, II, III, & IV)
- AFEAS (Alternative Fluorocarbon Environmental Studies - 14 Companies)
- ICOLP (Industry Cooperative for Ozone Layer Protection - 11 companies 7 cleaning projects)
- DOD, EPA, INDUSTRY (Reviewing MILSPECS and MILSTDS. Numerous alternative chemicals research programs)
- ASHRAE, ARI, EPA, SAE, and DOE (Reviewing existing systems, guidelines, and impacts.)

MILSPECS and MILSTDS

20 - Halons
118 - Refrigerants
178 - Solvents
1 - Foams
7 - Propellants
1 - Medical
RESEARCH OBJECTIVES

- Identify Commercially Available Equipment and Services
- Document Existing Information
- Discuss Applicable Issues
- Summarize Technologies and Provide Recommendations

ODC USES EVALUATED

- Refrigeration and Air Conditioning
  - CFCs 11, 12, 113, 114, 115, 500, and 502
  - HCFCs (new alternatives)
  - Mobile and Fixed Systems
- Halon Fire Extinguishants
  - Halons 1011, 1211, 1301, and 2402
  - Portable Extinguishers and Total Flood Systems
- Solvents
  - CFCs 113, 10, 140a
  - HCFCs (new alternatives)
  - Batch and Continuous Systems
ESTIMATED GLOBAL ODCs CONTRIBUTION TO OZONE DEPLETION BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Usage, %</th>
<th>Usage Adjusted for ODP, %</th>
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<tbody>
<tr>
<td>Refrigeration</td>
<td>34</td>
<td>21</td>
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<tr>
<td>Auto AC</td>
<td>13</td>
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<tr>
<td>Foam Products</td>
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<tr>
<td>Solvent</td>
<td>16</td>
<td>19</td>
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<tr>
<td>Polymer</td>
<td>11</td>
<td>2</td>
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<tr>
<td>Medical</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Aerosol</td>
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<td>3</td>
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<tr>
<td>Fire Extinguishants</td>
<td>4</td>
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</table>

DEFINITIONS

Recovery:

Recycle:

Remove Oils, Acids, Moisture, and Particles On Site or At Local Shop

System

Recover

System

Recover

R
dankery
DEFINITIONS (Continued)

Remanufacture:

System or Recovery Tank

Chemical Transformation Process

New Compound With New Use e.g., Alcohols, HCFCs
DEFINITIONS (Concluded)

Destruction:

System or Recovery Tank

Chemical Destruction Process
- incineration, steam reforming
- pyrolysis, hydrolysis

Convert Compounds to
- \( \text{CO}_2 \), \( \text{CO}_2 \), \( \text{H}_2 \text{O} \), and Halogen Acids

REGULATIONS, STANDARDS, SPECIFICATIONS, AND GUIDELINES FOR RIRARI

- ARI
  - K-1990 - Container standard for recovered CFCs
  - 700-88 - Specifications for fluorocarbon refrigerants

- ASHRAE
  - Guideline 3-1990 for reducing CFC emissions

- SAE
  - 1989 - Recommended service procedures for MACS
  - 1990 - R/R Equipment for mobile air conditioners
  - 1991 - Purity standards for mobile air conditioner systems

- UL
  - 1963 - Refrigerant recovery, recycle, and reclaiming equipment for MACS
  - 2066 - Halon 121 recovery, recycle, and reclaiming equipment

118
R/R/R MARKET SURVEY

- Contaminants Include
  - Particles
  - Moisture
  - Oils
  - Acids
  - Non-Condensible Gases

- Types of R/R/R Equipment and Services
  - Fixed - Usually Reclaim Technology
  - Portable - Recovery and Recycle Technology

<table>
<thead>
<tr>
<th>Category</th>
<th>Equipment</th>
<th>UL Listed</th>
<th>In Process</th>
<th>Services</th>
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<tr>
<td>CFCs</td>
<td>51 (32 Co)</td>
<td>24</td>
<td>4</td>
<td>5</td>
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<tr>
<td>Halons</td>
<td>3 (5 Co)</td>
<td>-</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Solvents</td>
<td>&gt;10 (10 Co)</td>
<td>-</td>
<td>-</td>
<td>5</td>
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</table>

CONCERNS

- General
  - Cross Contamination of Chemicals
  - Reliability of Equipment
  - Purity Requirements
  - Specification Attainment
- Industry
  - Refrigeration and Air Conditioning
  - Foam
  - Aerosol and Sterilants
  - Solvents
  - Fire Protection
- Safety Issues
- Residue Issues
- QA/QC Issues
DESTRUCTION TECHNOLOGIES

ESTABLISHED

- **Incineration** - High fuel consumption, costs, and emissions.
- **Biodegradation** - Slow.

EMERGING

- **Steam Reforming** - Low emissions and cost; commercial unit available for testing.
- **Plasma Pyrolysis** - Low emissions; prototype commercial unit available for testing.
- **Ozonolysis** - Prototype commercial unit available for testing.

DESTRUCTION TECHNOLOGIES (Cont.)

POTENTIAL

- Supercritical Water Oxidation • LANL
- Hydrolysis
- Catalytic Dehydrohalogenation
- Electron Beams and Water • LANL
- Microwave
- Destruction using Quicklime (?)
CONCLUSIONS

R/R/R

- Comercial Equipment & Services Are Available
- Many Factors Influence Purchase Decisions
- Traditional Methods Require Significant Change
- Determine Purity Requirements
- Assess Impact on Organization (Budget Requirements)

DESTRUCTION

- High Costs
- Loss of Valuable Resource
- Emerging Technologies Require Additional Research

DEVELOP WORLDWIDE, NATIONAL, & COMPANY BANK MANAGEMENT PROGRAMS