SECTION 2

SAFETY, TOOLS AND EQUIPMENT, SHOP PRACTICES

UNIT 9

REFRIGERANT AND OIL CHEMISTRY AND MANAGEMENT – RECOVERY, RECYCLYING, RECLAIMING, AND RETROFITTING

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- describe ozone depletion and global warming.
- discuss how CFCs deplete the earth's ozone layer.
- differentiate between CFCs, HCFCs, HFCs, and HCs.
- discuss popular refrigerants (including R-410A) and their applications.
- discuss refrigerant blends.

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- discuss temperature glide and fractionation as it applies to refrigerant blends.
- discuss refrigerant oils and their applications.
- discuss EPA regulations as they relate to refrigerants.
- define the terms recover, recycle, and reclaim.
- describe methods of recovering refrigerants, including active and passive methods.
- identify a DOT-approved recovery cylinder.

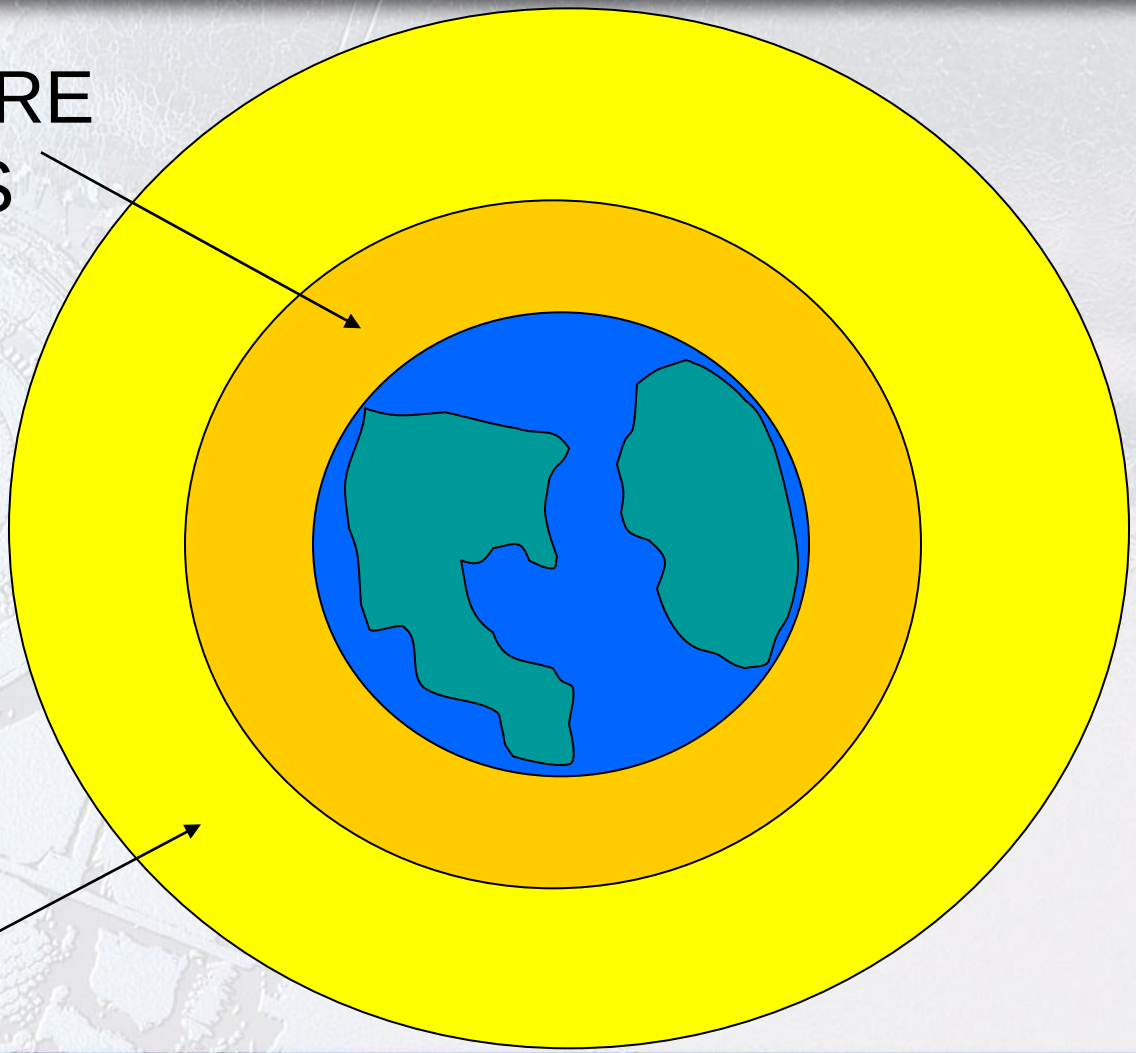
REFRIGERANTS AND THE ENVIRONMENT

- Chemicals are reaching the earth's atmosphere
- Some of these chemicals are refrigerants
- Refrigerants are stable if contained within systems
- Refrigerants are pollutants when released to the atmosphere

OZONE DEPLETION

- Ozone is found in both the stratosphere and troposphere
- Stratosphere is located 7 to 30 miles above the earth
- Troposphere is located ground level to about 7 miles
- Stratospheric ozone is considered good ozone, and acts as a shield by preventing excessive amounts of the sun's ultraviolet rays from reaching the earth
- Tropospheric ozone is considered a pollutant (smog)

TROPOSPHERE
0 – 7 MILES



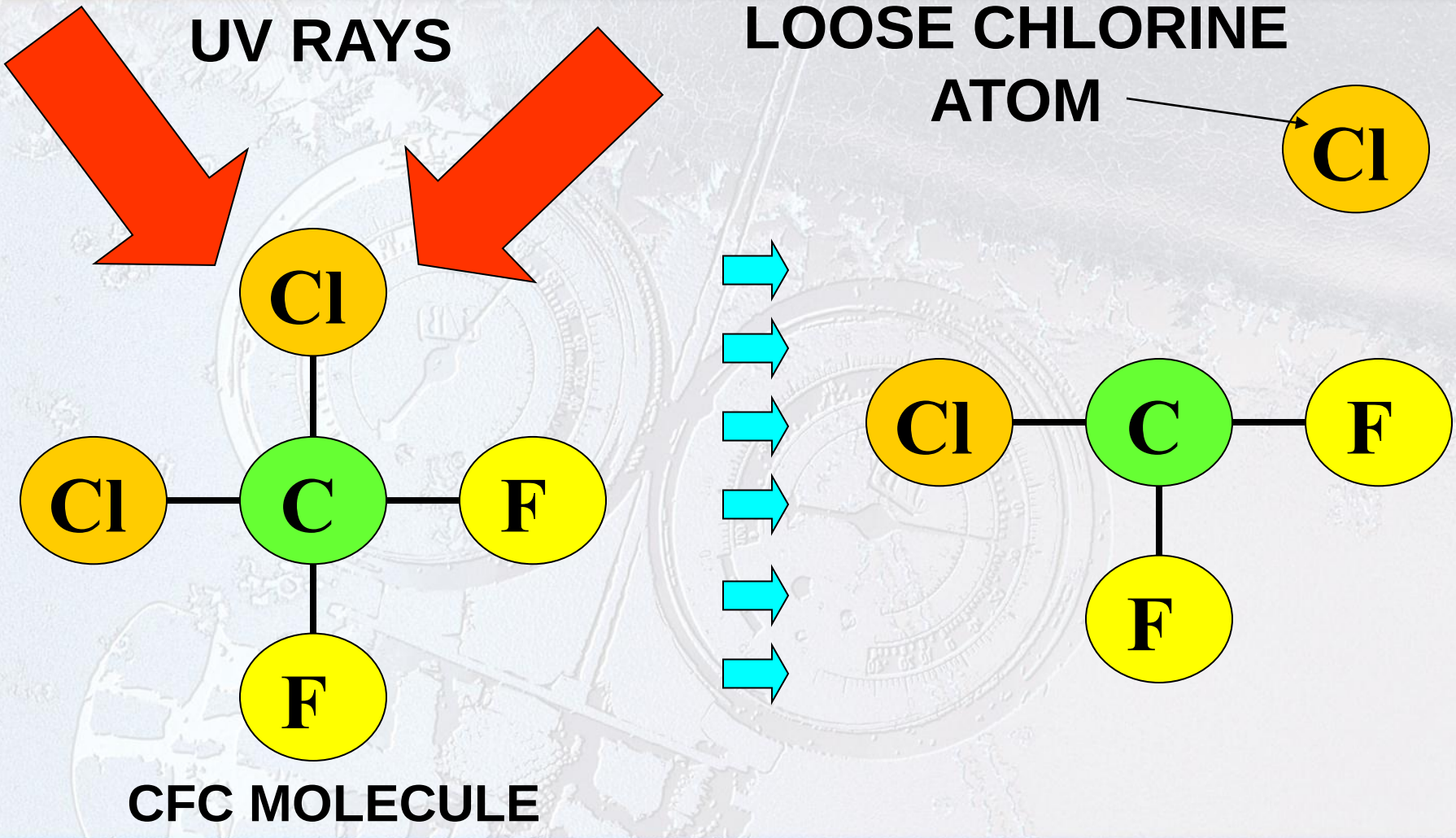
STRATOSPHERE
7 – 30 MILES

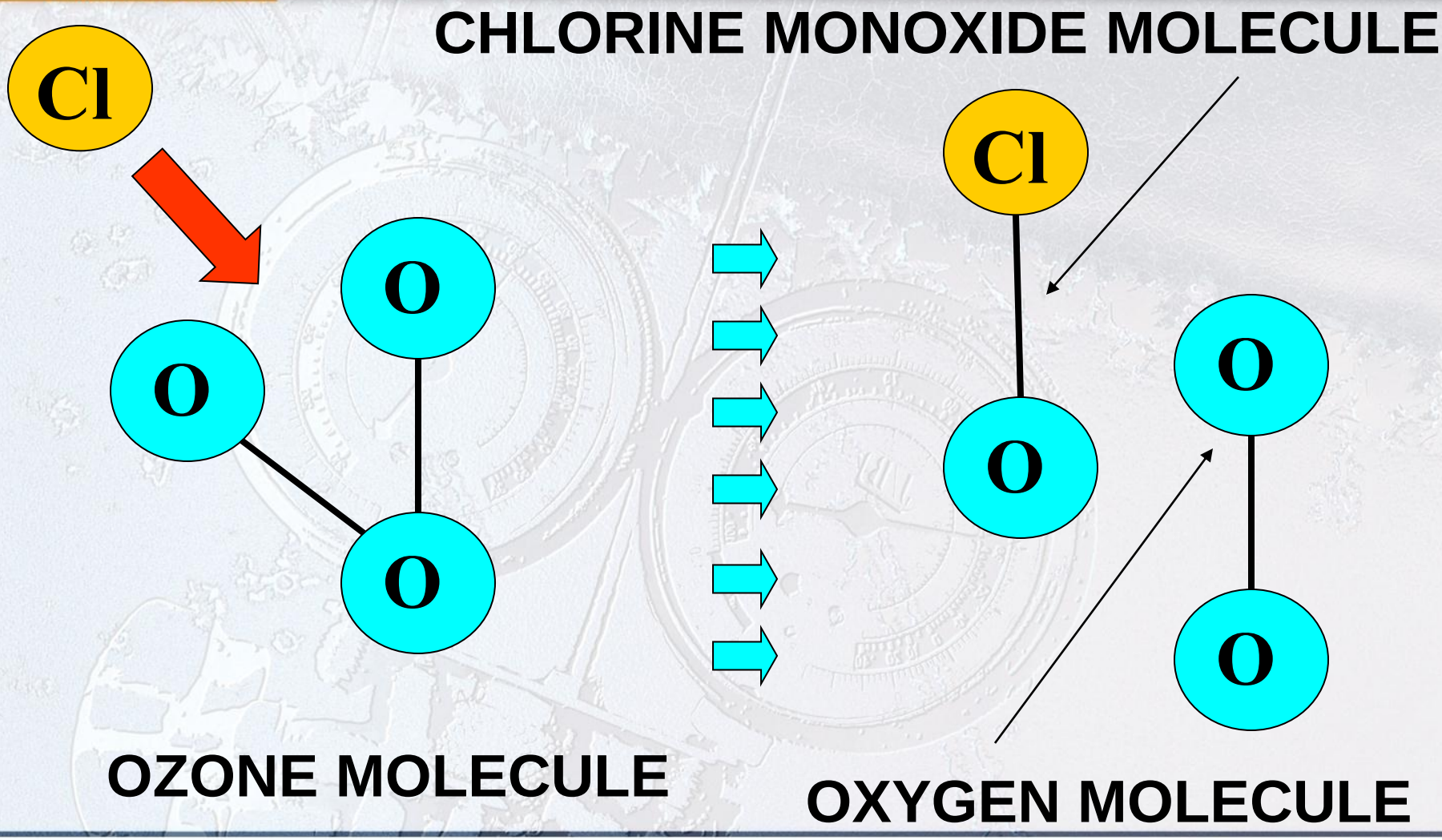
OZONE DEPLETION

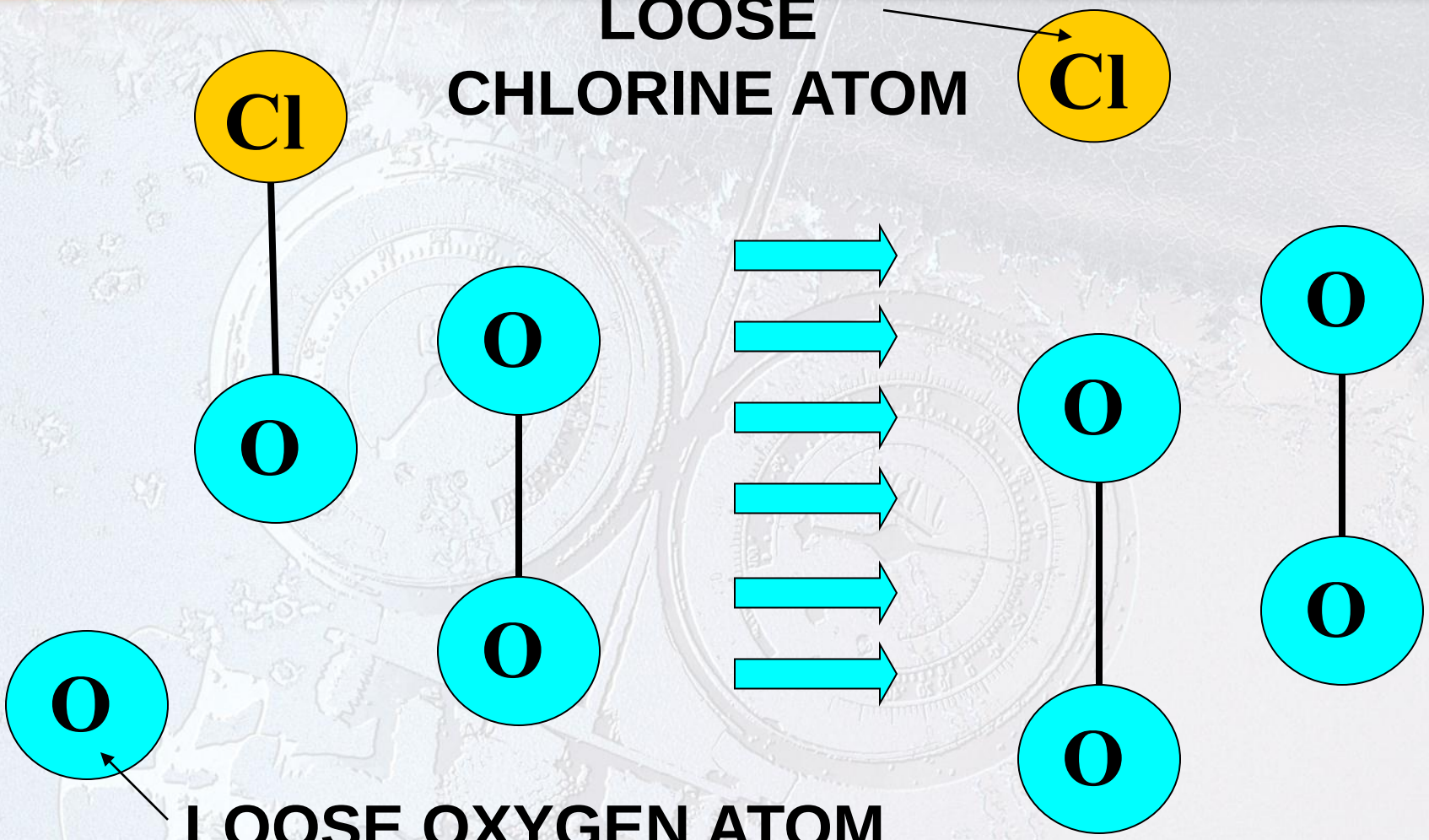
- Depletion of the ozone shield
  - Can cause an increase in skin cancer
  - Can have adverse effects on crops and other plant life
- An ozone molecule is made up of three oxygen atoms
- Chlorine destroys ozone molecules
- One chlorine atom can destroy up to 1 million ozone molecules

OZONE DEPLETION

- Ozone depletion potential (ODP)
- The higher the ODP, the more damaging the chemical
- Used for regulatory purposes by the United Nations Environment Programme (UNEP)
- Ultraviolet rays break off the chlorine atom of a CFC molecule
- The chlorine atom attaches itself to ozone and forms a chlorine monoxide molecule and an oxygen molecule







GLOBAL WARMING

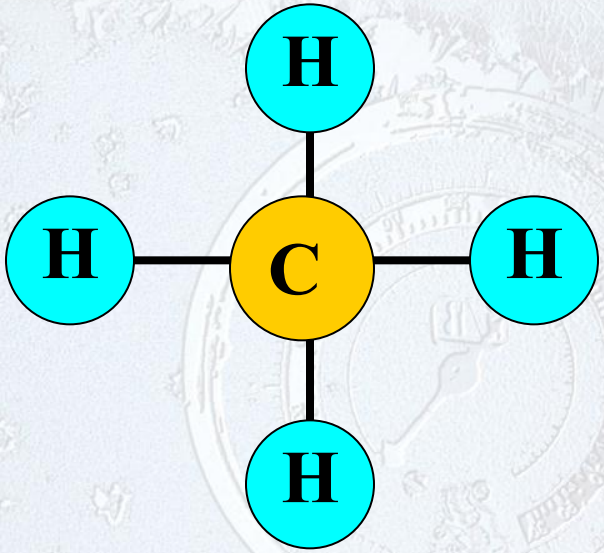
- Refrigerant gases prevent the earth's infrared radiation from escaping from the lower atmosphere
- Also called the greenhouse effect
- The GWP of various substances is measured by comparing them to carbon dioxide, which has a GWP of 1.0
- Total equivalent warming impact (TEWI), measures the global warming effects of refrigerants
- R-134a has a zero ODP but contributes to global warming

REFRIGERANTS

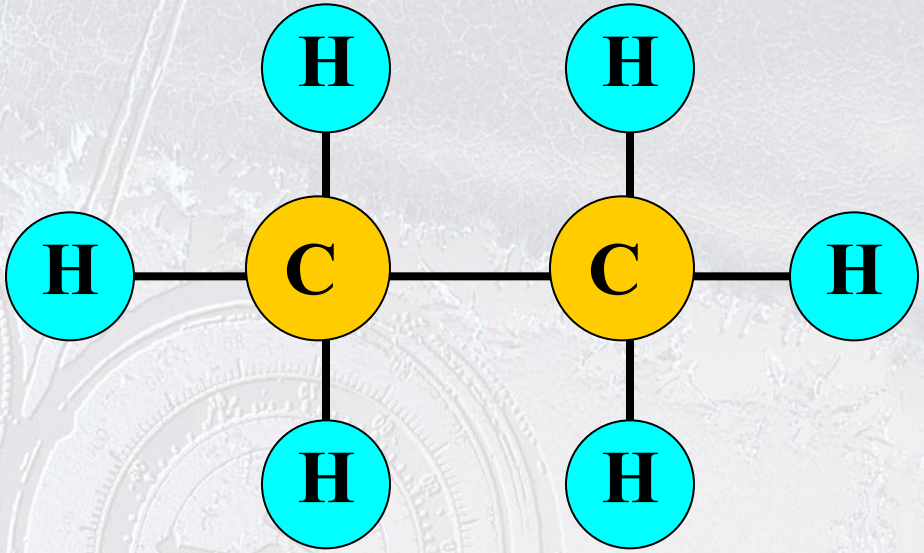
- Most refrigerants are made of methane and ethane molecules
- Removing hydrogen atoms and adding chlorine or fluorine creates a chlorinated or fluorinated refrigerant including CFC's, HCFCs, and HFCs
  - CFC – Chlorofluorocarbons
  - HCFC – Hydrochlorofluorocarbons
  - HFC – Hydrofluorocarbons

HC REFRIGERANTS

- Contain no fluorine or chlorine
- Contain only hydrogen and carbon
- Zero ODP rating
- Still contribute to global warming
- Not used as standalone refrigerants in USA because they are highly flammable
- Common HC refrigerants include methane, ethane, propane and butane



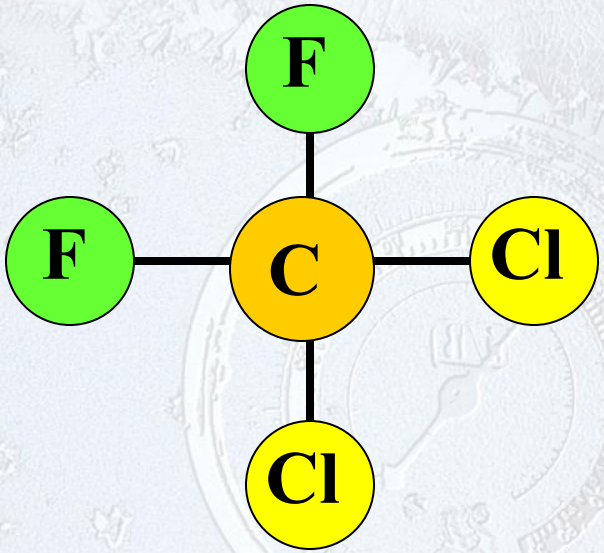
METHANE



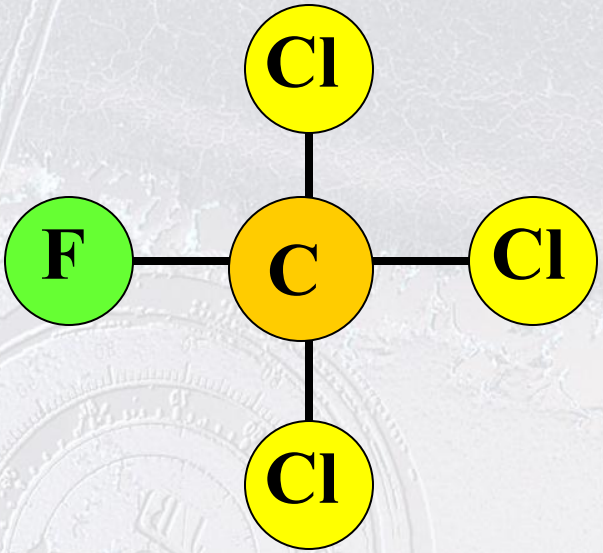
ETHANE

CFC REFRIGERANTS

- Contain only chlorine, fluorine and carbon
- CFCs are the most damaging to the stratosphere ozone
- On July 1, 1992, it became illegal to intentionally vent CFC refrigerants
- CFCs were phased out of production at the end of 1995



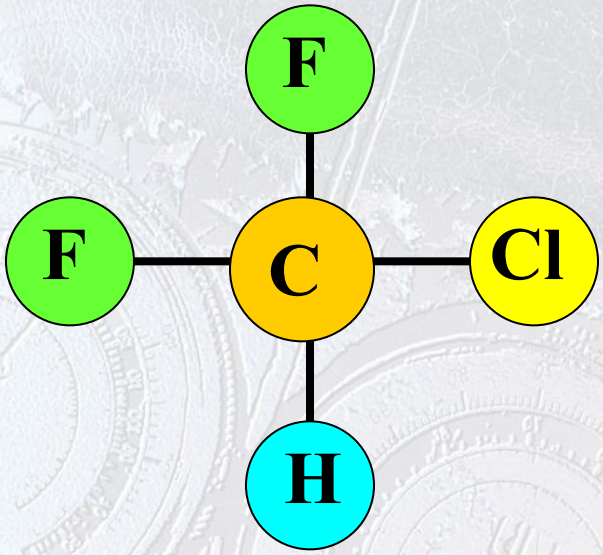
R-12



R-11

HCFC REFRIGERANTS

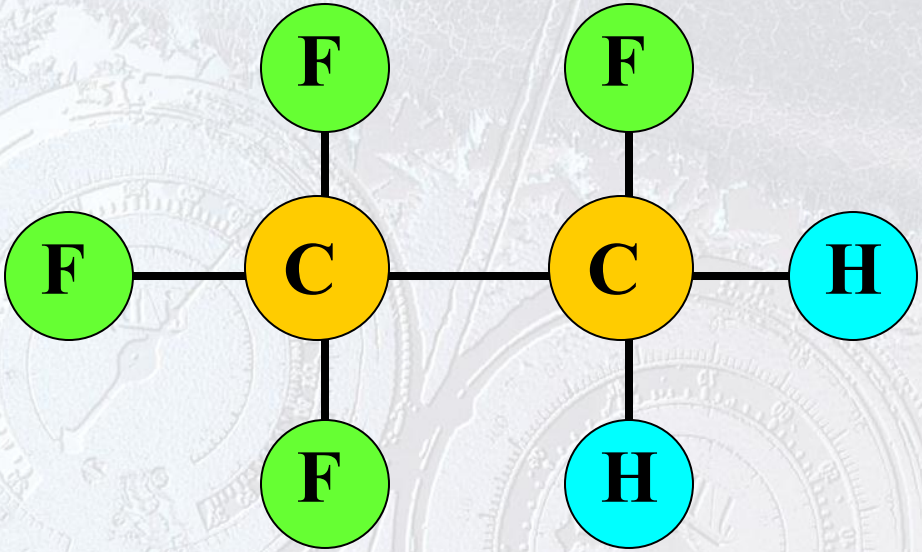
- Contain hydrogen, chlorine, fluorine, and carbon
- Have a less damaging effect on ozone depletion than CFCs
- The HCFC group is scheduled for a total phase-out by the year 2030
- R-22 will not be used in new equipment after 2010. Total production phase-out of R-22 in 2030
- On July 1, 1992, it became illegal to intentionally vent HCFC refrigerants



R-22

HFC REFRIGERANTS

- Contain hydrogen, fluorine, and carbon
- Do not contain chlorine
- Have no damaging effect on ozone depletion (have a zero ODP)
- On November 15, 1995, it became illegal to intentionally vent HFCs
- R-134a is an example of an HFC refrigerant



R-134a

REFRIGERANT BLENDS

- Refrigerants that are made from existing refrigerants
- Azeotropic mixtures are blended refrigerants of two or more liquids
- Near-azeotropic mixtures are blends that can separate
- Blends of two or more refrigerants may separate into different mixtures
- When leaking from a system they will leak out at different rates (fractionation)
- Zeotropic blends have greater temperature glide and fractionation than azeotropic blends

OIL GROUPS - SYNTHETIC

- Alkylbenzenes – work well with HCFC refrigerants
- Glycols – PAGs (automotive systems)
- Esters – used with HFC refrigerants
- Polyol esters (POE)

REGULATIONS

- Montreal Protocol Act
  - A treaty that was signed by thirty or more countries
  - Limits the use and production of CFC refrigerants
  - Set dates for phase-out of refrigerants that damage the ozone layer
- The United States Clean Air Act of 1990 regulates the use and disposal of CFCs and HCFCs
- EPA is charged with enforcing Clean Air Act

RECOVER, RECYCLE, OR RECLAIM

- Recovery – to remove refrigerant in any condition from a system and store it in an external container without necessarily testing or processing it in any way
- Recycling – to clean the refrigerant by oil separation and single or multiple passes through devices such as replaceable core filter driers, which reduce moisture, acidity, and particulate matter
- Reclaiming – to process refrigerant to new product specifications by means which may include distillation

METHODS OF RECOVERY

- Refrigerant can be recovered in the vapor or liquid state
- Active method of recovery – the process of using a self-contained recovery unit to remove refrigerant from a sealed system
- Passive method of recovery – uses the system's compressor to pump refrigerant
- System dependent method of recovery
  - Uses a non-pressurized cylinder or recovery apparatus
  - The refrigerant will flow from the system naturally

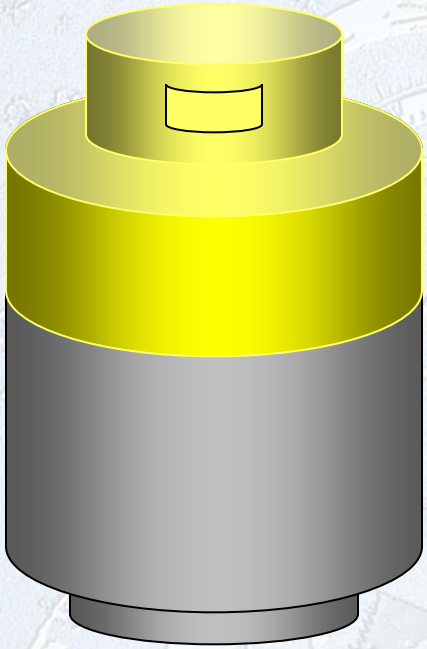
TECHNICIAN CERTIFICATION PROGRAM

- November 14, 1995 – Technicians required to be certified
- Type I Certification: Small Appliance packaged units containing 5 lbs or less of refrigerant
- Type II Certification: High-Pressure Appliances uses refrigerant with a boiling point between -58˚ F and 50˚ F at atmospheric pressure
- Type III Certification: Low-Pressure Appliances uses refrigerant with a boiling point above 50˚ F at atmospheric pressure
- Universal Certification: Certified in I, II and III

MECHANICAL RECOVERY SYSTEMS

- The fastest method to recover refrigerant from a system is to take it out in the liquid state
- The slowest method of removing refrigerant is to remove it in the vapor phase
- Recovery cylinders are approved by the Department of Transportation (DOT)
- Recovery cylinders should not be filled to more than 80% of their liquid capacity
- Recovery cylinder color code: Gray body, yellow top and shoulder

DOT-APPROVED RECOVERY TANKS



Tanks are stamped with:

- Tank weight (kg and lbs)
- Date of manufacture
- DOT number
- Tank serial number

DOT – APPROVED RECOVERY TANKS HAVE VAPOR AND LIQUID VALVES

TECHNICIAN OPTIONS FOR RECOVERED REFRIGERANT

- Charge recovered refrigerant back into the sealed system
- Recycle refrigerant using a certified recycling unit
- Return refrigerant to a reclamation center

MECHANICAL RECOVERY SYSTEMS

- All refrigerants to be recharged into a system should be tested for acids
- Cross contamination should be avoided
- Recovery cylinders should be evacuated to at least 1,000 microns before recovering refrigerant
- EPA requires the recovery of refrigerant when repairing or replacing the evaporator, condenser, compressor or metering device

LEAK CHECKING SEALED SYSTEMS

- R-22 is the only refrigerant used as a trace gas for leak checking any sealed system
- Mixtures of R-22, backed up by nitrogen, are the best method for pressurized a system for leak checking
- Mixtures of R-22 and nitrogen used for leak checking a system may be vented
- Nitrogen only is recommended for leak checking sealed systems that operate with HFC refrigerants

UNIT SUMMARY - 1

- Stratospheric ozone protects the earth from harmful UV radiation
- Tropospheric ozone is considered bad ozone (smog)
- Chlorine is broken free from refrigerant molecules when they come in contact with ultraviolet rays
- Chlorine depletes ozone by forming chlorine monoxide
- ODP rates a substance's effect on the ozone layer
- Global warming is commonly known as the greenhouse effect
- TEWI is the total warming effect of a substance

UNIT SUMMARY - 2

- Most modern refrigerants are ethane or methane based
- HC refrigerants contain only hydrogen and carbon
- CFC refrigerants contain chlorine, fluorine and carbon
- HCFC refrigerants contain hydrogen, chlorine, fluorine and carbon
- Blended refrigerants can be azeotropic blends, near azeotropic blends or zeotropic blends
- The Montreal Protocol limits the use, production and phase-out of CFC refrigerants

UNIT SUMMARY - 3

- The Clean Air Act regulates the use and disposal of CFC and HCFC refrigerants
- Refrigerant can be recovered, recycled or reclaimed
- Recovery is the most common and popular field option
- Active recovery uses a self-contained recovery unit
- Passive recovery uses the system compressor
- As of November 14, 1995, all technicians must be certified
- Refrigerant must be recovered into DOT-approved recovery tanks