

# *Radon In Private Well Water Mitigation*

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# Mitigation Techniques

- Storage Tanks
- Blending
- Reverse Osmosis
- Activated Charcoal
- Aeration Units



# What's In The Water?

- Radon
- Radionuclides
- Microorganisms
- Hardness
- Corrosivity
- Total Dissolved Solids/Conductivity
- pH
- O<sub>2</sub>
- Metals
- Turbidity

# What is the Radon Level?

- Minimum of Two Samples
- Best Practice Would Be To Have Samples From Different Times During The Year
- Radon Levels Will Vary
- Treat The Highest Level

# Hardness Problems

- Clogging
- Scale build up on system components



# Metals

- Aeration yields insoluble gelatinous compound
- Iron bacteria clog pipes, impart bad taste and odor

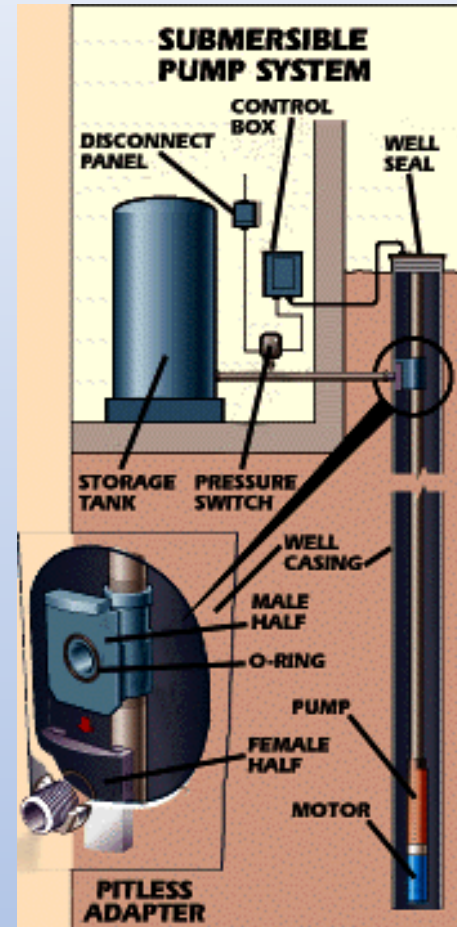
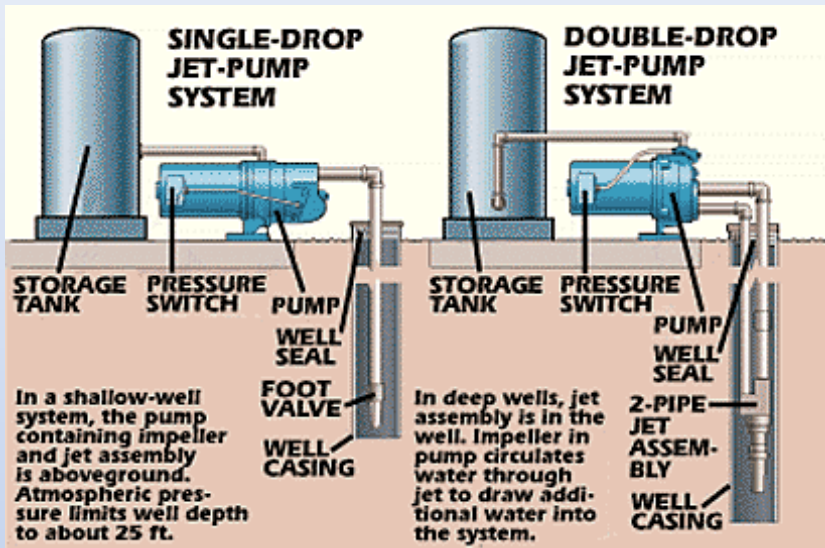


# Relevant Contaminant Levels

Parameter	Recommended Levels
pH	6.5 – 8.5
Iron	< 0.3 mg/L
Manganese	< 0.05 mg/L
Turbidity	< 1 ntu
Corrosion Index	± 0.5
Conductivity or TDS (Canadian*)	<1,500 (RO1-100 micromhos/cm)

Pre-treat Any Contaminant That Can Foul The Radon  
In Water System

# Well Characteristics



- **Shallow well:** single drop jet pump
- **Medium well:** double drop jet pump
- **Deep well:** submersible pump



# Flow Rate

## Recommended Flow Rates for Home Water System (Gallons/Minute)

No of Bedrooms	Number of Bathrooms in Home			
	1	1.5	2	3
2	6	8	10	12
3	8	10	12	14
4	10	12	14	16
5	12	13	15	17
6	13	15	16	18
Flow rate in Gallons per Minute				

(Modified from Private Water Systems Handbook)

# Determining Gallons/Minute

- Ensure no one is using water
- Tank should be at full pressure with pump off
- Shut off pump
- Drain water into bucket of known volume
- Calculate gallons drained
- Turn off water and close drain valve
- Turn on well pump and time until shutoff
- Convert seconds to minutes = gallons/minute

# Water Pressure Requirements

## Water Pressure/Pipe Size/GPM

Size of:		Water Pressure (PSI)							
Water Meter	Service Line	30	35	40	45	50	55	60	65
		Gallons Per Minute (GPM)							
5/8"	1/2"	2	3.5	5	6	6.5	7	7.5	8
5/8"	3/4"	3.5	5	7	8.5	9.5	10	11	11.5
3/4"	3/4"	5	7	8	9	11	12	14	15
3/4"	1"	7.5	10	11.5	13.5	15	16	17.5	18.5
1"	3/4"	6	7.5	9	10	12	13	15	16
1"	1"	9	12	13.5	17	19	20	21	21

# Checking Pressure

- Turn on water near system
- Note when pumps turns on and goes off
- Low pressure is when pump goes on (20-35 psi)
- High pressure when pump goes off (40-60 psi)
- On/Off pump cycle should take about 45 seconds

# Well Room Characteristics



# Codes

- Check local codes
- Follow local codes, e.g.
  - ***No placement within 3 feet of electrical panel***
  - ***No placement that blocks other systems***
- Use licensed plumber and or electrician if required by code

# Radon System Placement

- Locate equipment:
  - After other treatment systems
  - Before final pressure tank
  - By-pass outdoor spigots and sprinklers

# Mitigation Systems

- Storage Tanks
- Blending
- Reverse Osmosis
- Activated Charcoal
- Aeration Units



**BEST  
AVAILABLE  
TECHNOLOGY**



# Granular Activated Carbon (GAC)

- The GAC system adsorbs radon from the water without the use of mechanical components
- GAC systems, when properly sized and installed, can yield 90+% reduction of radon when initially installed. Other contaminants in the water can adversely affect the radon removal efficiency of the GAC system over time



# Carbon Fouling

Iron & Manganese

Sediment

Microorganisms

Carbonates

**Reduce radon removal**

Uranium

Radium

**Increase radioactivity**

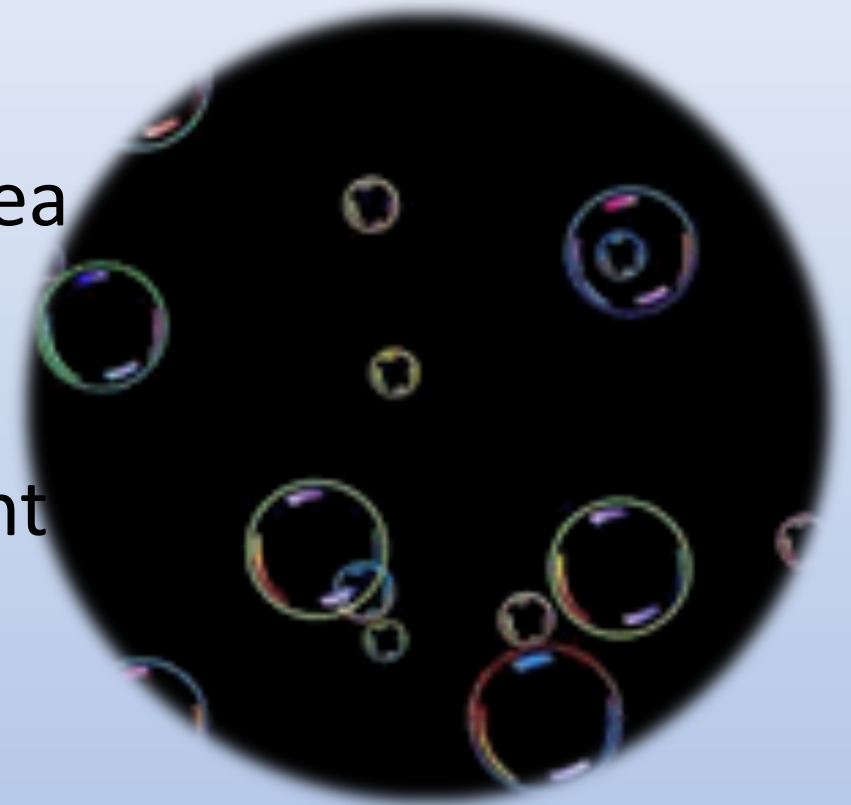
# Carbon Cautions

- Fouling maintenance
- Gamma emanations
- Carbon disposal
- Collection of radioactivity on pre-filters



# Aeration Principles

- Radon has high Henry's Constant (easily released from water)
- "Air-stripping": Increases surface area of air:water contact
- Allows radon to off-gas
- Lots of small bubbles in small amount of water releases more radon



# Aeration Units

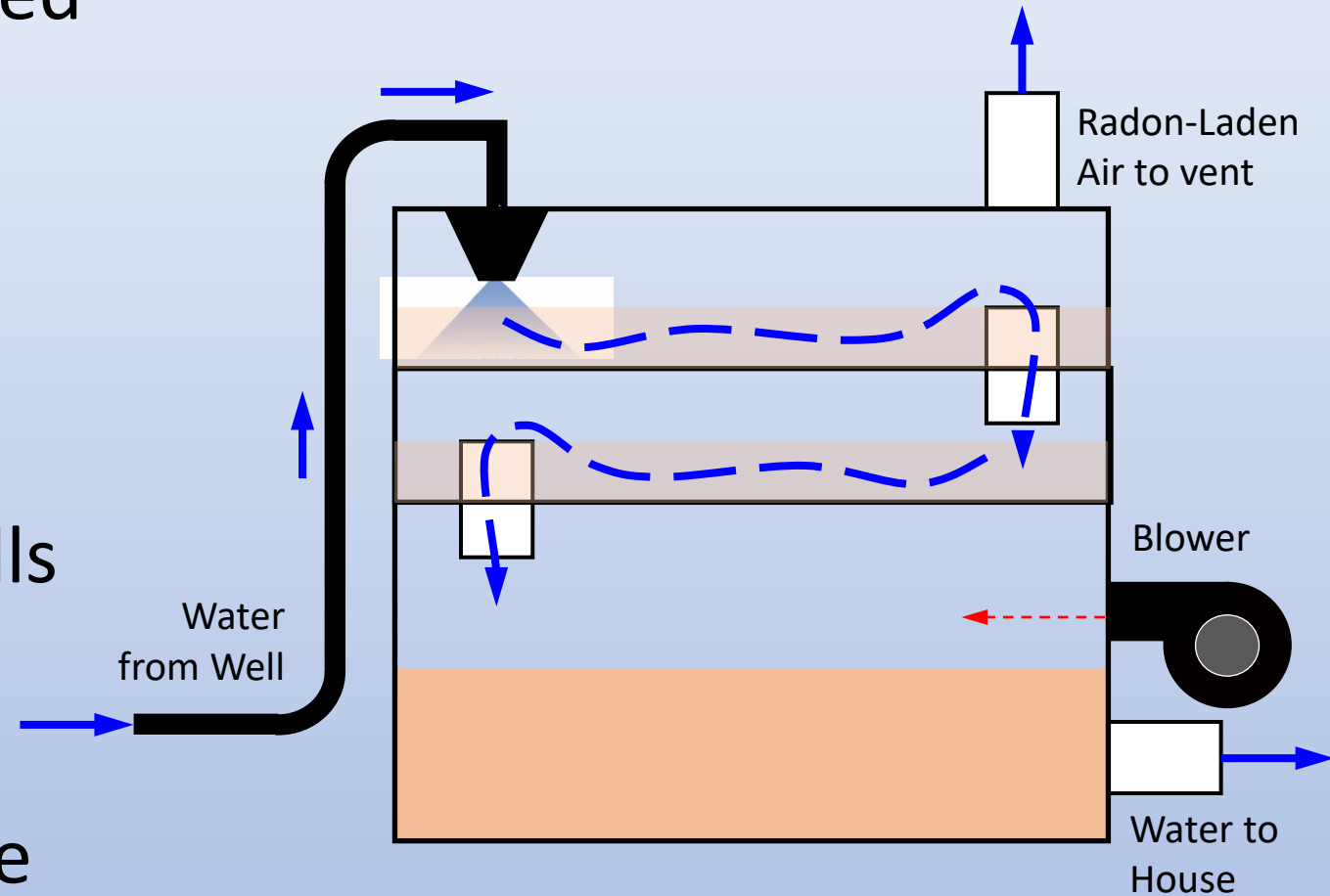
- Spray Aeration
- Jet Aeration
- Cascade Aeration
- Packed Tower
- Tray Aeration
- Pressure Aeration
- Diffused-bubble

# BAT

- Best Available Technology based on:
  - Large removal efficiencies (over 99.9%)
  - Compatibility with other treatment processes
  - Availability of treatment technologies

# Shallow Tray Aeration

- Well water sprayed into shallow tray
- Air pumped through water in tray
- Treated water falls to reservoir on bottom and is pumped to house



# Shallow Tray Cautions

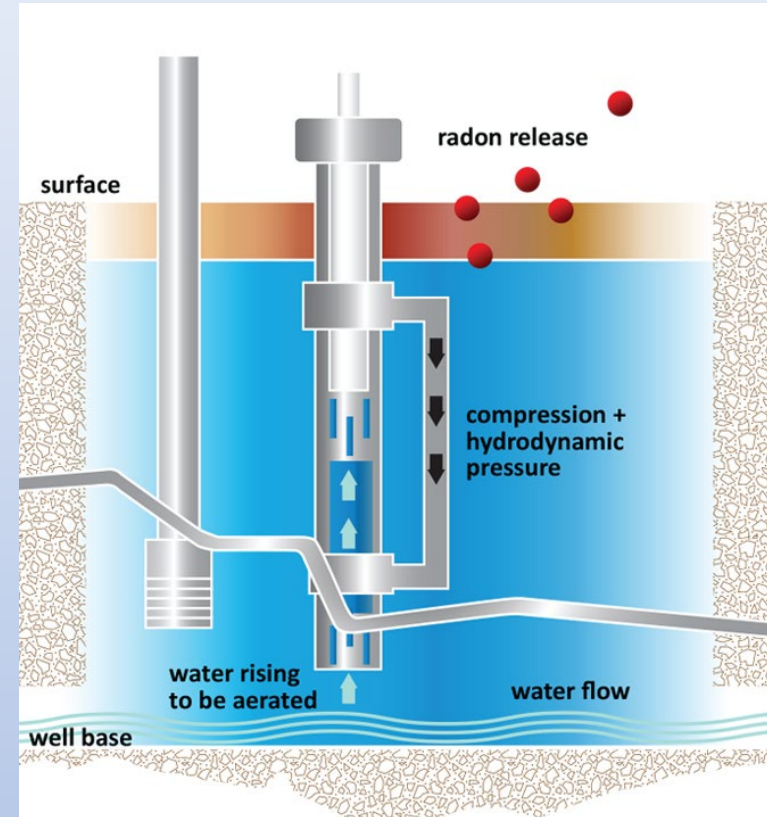
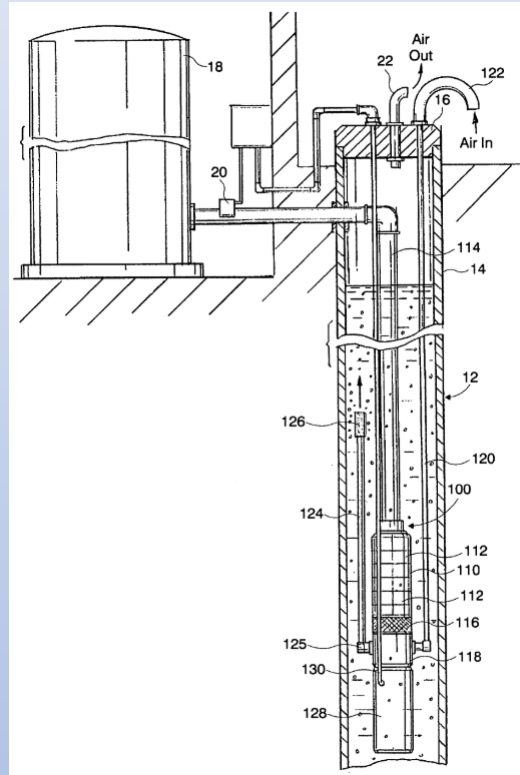
- Uses 100 ft<sup>3</sup>/minute of air
- Can depressurize basement and/or back draft appliances
- Vent Line requires an inline fan





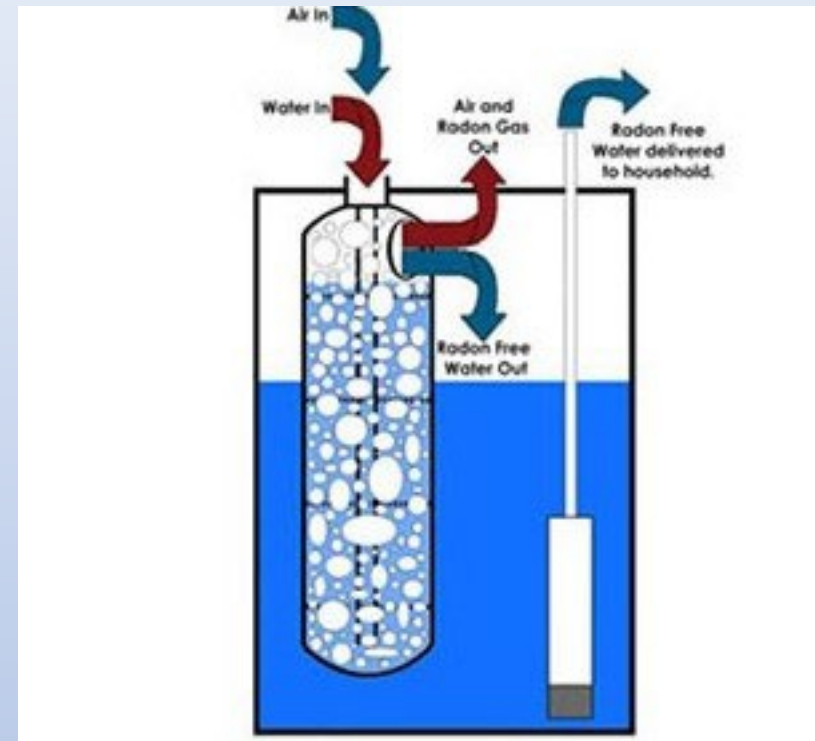
# In Well Aeration

- Air pumped down pipe into well
- Air pump located outside
- Radon vented at well head



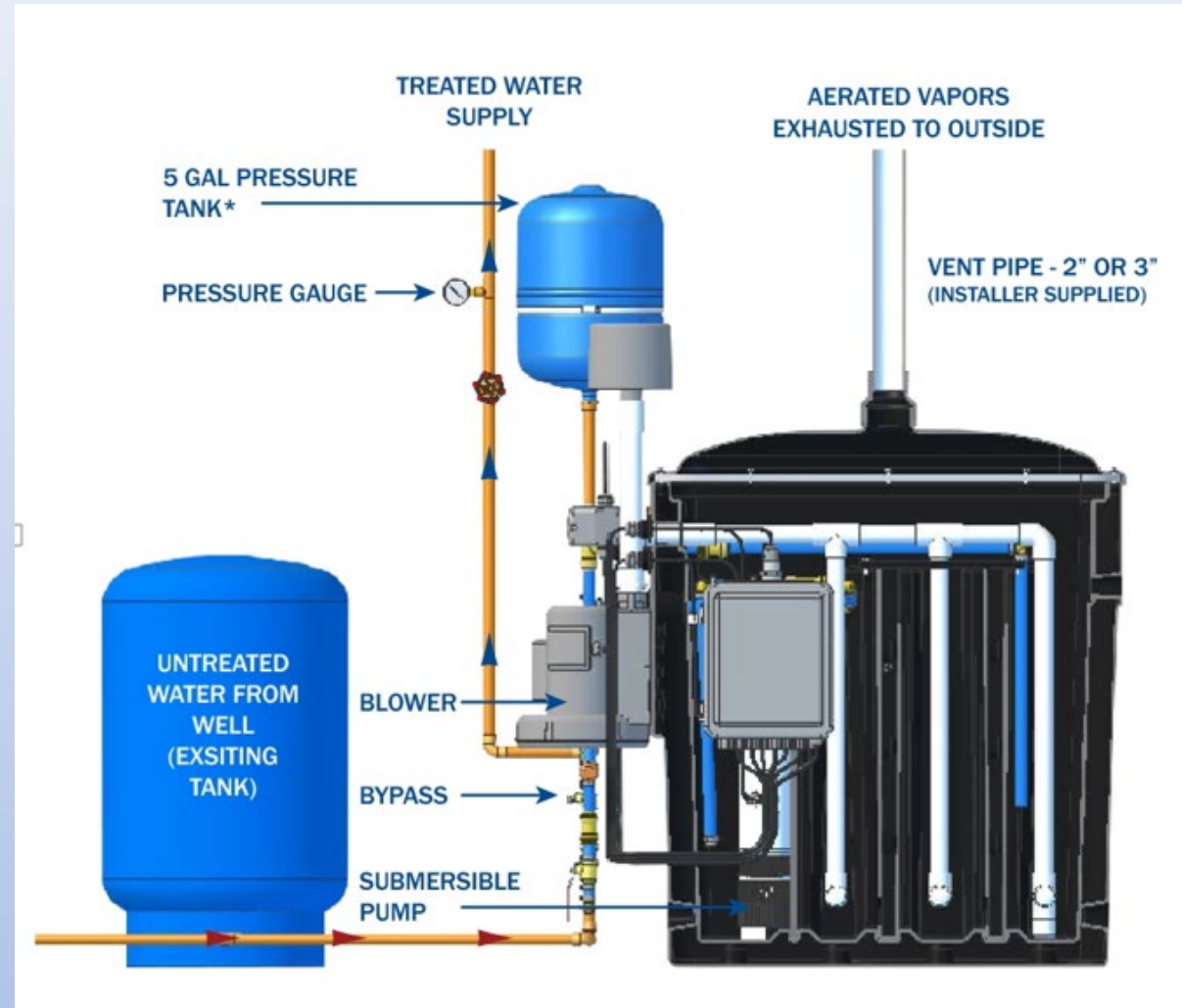
# Bubble Aeration

- Water sprayed into chamber with air
- Radon vented to outside



# Diffused-Bubble Aeration

- Water sprayed into chamber
- Flows from aerated chamber to aerated chamber
- Radon vented to outside



# Diffused-Bubble Aeration



# Aeration Comparison

Treatment Method	Removal Efficiency, %	Flow Range, m <sup>3</sup> d <sup>-1</sup>	Unit Construction Cost, \$ m <sup>-3</sup> d <sup>-1</sup>
I. Aeration Methods			
1. Packed tower	79 to >99%	49 to 102,740	18 to 481
2. Diffused bubble			
a. Single-stage	93	431	312
b. Multi-stage	71 to >99	65 to 6,540	11 to 433
3. Spray Aeration	~88 <sup>a</sup> (est)	1,025	5.3
4. Slat tray	86 to 94	1,989 to 2,453	5.3 to 124
5. Cascade aeration	~88 <sup>a</sup> (est)	5,450	7.9
II. Granular Activated Carbon	20 to >99	11 to 981	77 to 365
<sup>a</sup> Estimated.		Source: Drago (1998), Pontius (1998).	

# Aeration Installation Challenges

- No Standards For Radon In Water Mitigation
- System Must Be Sealed
- Mechanical Components Can Fail
- Venting High Levels of Radon
  - Follow Venting Standards For Air
- Electrical Connection Should Be A Dedicated Circuit
- Multiple Professional Skills/Licenses Needed
  - Radon
  - Electrical
  - Plumbing
  - Water Treatment

# Venting Challenges



# Point of Entry Systems Must Be Sealed





# OM&M

- Retesting Is a Must
- Label All Components For Future Servicing
- Annual Service Is a Requirement

**ANNUAL SERVICE AND TESTING IS A  
REQUIREMENT!**