

- **Boiler Technology and Installation Basics:** Modern boilers use premix gas burners, electronic controls, and various venting and piping arrangements. Proper installation requires checking venting, condensate systems, gas and system piping, and water quality to ensure safe and efficient operation.
- **Venting Systems and Clearances:** Venting includes near appliance venting with CPVC or PVC, concentric sidewall and roof vents, and two-pipe systems. Clearances for exhaust and air-inlet pipes must meet minimum distances above grade, snow level, and roof to prevent flue gas recirculation and ensure safety.
- **Gas Piping and Pressure Testing:** Gas piping must follow national codes with proper sizing based on length, fittings, gas type, and appliance input. Gas line pressure checks involve static and max firing rate tests, ensuring no leaks and proper regulator placement at least 10 feet from the gas valve.
- **Combustion Testing and Boiler Settings:** Combustion analysis is mandatory for LP conversions and recommended at startup. Boiler settings include minimum and maximum firing rates, pump postpurge times, and emergency setpoints. Flame failure detection and burner modulation control are key for safe operation.
- **Piping Arrangements and Circulation:** Primary-secondary piping arrangements optimize flow and pressure. Combi boilers require no primary-secondary loop if flow is under 5 GPM at 9 ft head. Proper circulator sizing and flow rates prevent cavitation, noise, and system damage.
- **Water Quality and System Maintenance:** Water quality critically affects boiler longevity and efficiency. Parameters like pH (7-8.5), conductivity (<100-300 $\mu\text{S}/\text{cm}$), hardness, TDS, iron, chloride, and copper levels must be controlled. Poor water causes scaling, corrosion, sludge, and heat exchanger failures.
- **Water Treatment and Filtration:** Regular water testing, flushing, and treatment with inhibitors and glycol are essential. Magnetic dirt separators, side stream filters, and Y strainers remove debris and prevent damage. Proper air elimination and leak repair maintain system integrity.