Wisconsin Municipal Solid Waste Combustor Operator

TRAINING MANUAL

This manual was written and prepared by Dr. Lauren Wentz, University of Wisconsin-Eau Claire—Barron County.

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Wisconsin Municipal Solid Waste Combustor Operator Training

Course Outline

I. **Introduction to training requirements**
   a. Wisconsin NR 499.07—Overview of minimum training course content for operators of solid waste combustors with energy recovery
   b. Requirements for Shift Operators
      i. 24 hours of initial training
      ii. Topic coverage (see II.a., below)
      iii. Duties and responsibilities of Shift Operators
   c. Requirements for Chief Facility Operators
      i. 32 hours of initial training
      ii. Topic coverage, in addition to requirements for Shift Operators (see II.b., below)
      iii. Duties and responsibilities of Chief Facility Operators
   d. Solid waste treatment facility operator examination and certification procedures
   e. Refresher training, certification renewal, certification expiration; fees; suspension and revocation of certifications

II. **NR 499.07--Topics to be covered in Shift Operator and Chief Facility Operator initial training**
   a. Shift Operators and Chief Facility Operators
      i. Environmental concerns
         1. Air contaminants
         2. Pathogen destruction
         3. Ash handling
      ii. Applicable federal, state, and local environmental regulations
      iii. Facility design and waste combustion theory and principles
      iv. Different types of solid waste treatment facilities and equipment that burn waste
      v. Identification of waste types acceptable for treatment
      vi. Proper waste handling procedures
      vii. Proper facility startup, operation, shutdown, and maintenance procedures
      viii. Ash handling procedures
      ix. Work safety procedures
      x. Monitoring and automatic control systems
      xi. Recordkeeping procedures
      xii. An introduction to air pollution control equipment
      xiii. Malfunction prevention and abatement procedures
   b. Chief Facility Operator training also includes:
      i. Air pollution control systems
      ii. Solid waste input issues including prohibitions in Wisconsin statute 287.07 (and exceptions)
      iii. Risk management

COURSE TOPICS with NR 499 references to training subject matter

I. **Short History of Solid Waste Management in the U.S.**
   a. Pre-1990
   b. Solid waste characterization – post-1990 facts and figures
      i. Types of solid waste managed by communities
      ii. Role of curbside recycling and composting
      iii. Landfill characteristics
      iv. Combustion facilities facts and figures
   c. Special concerns over medical waste
   d. Hierarchy of solid waste management choices
      i. Source reduction
      ii. Recycling
      iii. Incineration (with and without energy recovery)
      iv. Landfilling
   e. History of the Barron County facility

II. **NR 499.07(2)(a)1. Environmental Concerns in Solid Waste Management**
   a. Air contaminants
   b. Water contaminants
   c. Pathogen presence and destruction
   d. Ash handling
   e. New Source Performance Standards (NSPS)
      i. Air contaminants—detail
         1. Emissions standards
         2. Continuous monitoring requirements
      ii. Water contaminants
      iii. Pathogens
      iv. Ash handling requirements

III. **NR 499.07(2)(a)2. Introduction to federal and state environmental regulations for solid waste combustion facilities**

   a. **Federal regulations**
      i. Code of Federal Regulations (CFR), Title 40, Protection of the Environment (electronic version; lists all chapters of Title 40: https://www.ecfr.gov/cgi-bin/text-idx?SID=9550136fc7509592c85cfb73c4f68f73&mc=true&tpl=/ecfrbrowse/Title40/40tab_02.tpl
      ii. 40 CFR Part 60, Subpart E – Standards of Performance for Incinerators
         1. Link to text of 40 CFR 60, Subpart E: https://www.law.cornell.edu/cfr/text/40/part-60/subpart-Ea
      iii. 40 CFR Part 60, Subpart AAAA -- Standards of Performance for Small Municipal Waste Combustion Units for Which Construction is Commenced After August 30, 1999 or for Which Modification or Reconstruction is Commenced After June 6, 2001
      iv. 40 CFR Part 60, Subpart BBBB -- Emission Guidelines and Compliance Times for Small Municipal Waste Combustion Units Constructed on or Before August 30, 1999

v. Clean Air Act – 42 U.S.C. 129, Part A, Section 7429 – Air quality and emission limitations for solid waste combustion facilities
    1. Link to 42 U.S.C. 129, Part A, Section 7429: https://www.gpo.gov/fdsys/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partA-sec7429.htm
vi. Clean Water Act
    1. Summary at EPA.gov: https://www.epa.gov/laws-regulations/summary-clean-water-act
vii. Resource Conservation and Recovery Act
    1. RCRA Overview at EPA.gov: https://www.epa.gov/rcra
viii. Toxic Substances Control Act
    1. TSCA summary at EPA.gov: https://www.epa.gov/laws-regulations/summary-toxic-substances-control-act
ix. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; Superfund)
    1. Link to CERCLA provisions at EPA.gov: https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act

b. **State of Wisconsin regulations**
    i. State statute 283.31 – Water pollutant discharge elimination system; permits, terms and conditions
        1. Link to 283.31: https://docs.legis.wisconsin.gov/statutes/statutes/283/IV/31
    ii. State statute 285.60 – Air pollution control permits
        1. Link to 285.60: https://docs.legis.wisconsin.gov/statutes/statutes/285/VII/60
    iii. State statute 289 – Solid waste facilities
        1. Link to 289: https://docs.legis.wisconsin.gov/statutes/statutes/289/I/01/39
    iv. NR 335 – Incinerator bans and recycling act

    v. NR 445 – Control of Hazardous Pollutants
        1. http://docs.legis.wisconsin.gov/code/admin_code/nr/400/445.pdf
    vi. NR 502.13 – Rules for Solid Waste Combustor Operation:
        1. https://docs.legis.wisconsin.gov/code/admin_code/nr/500/502/13
    vii. Additional provisions of the State of Wisconsin Natural Resources (NR) regulations concerning air quality, water quality, recycling, etc. NR 300-399, NR 400-499, NR 500-599, and NR 600-699: https://docs.legis.wisconsin.gov/code/admin_code/nr

IV. NR 499.07(2)(a)4. Types of Solid Waste Treatment Facilities

a. Thermal treatment facilities
    i. Combustors/incinerators
    ii. Pyrolysis/gasification
    iii. Open burning (banned)
b. Land-based disposal
    i. Landfill structure and operation
    ii. Monofills
c. Waste-to-energy facilities

d. Composting operations
e. Anaerobic digesters
f. Wastewater treatment facilities
g. Hazardous waste management
h. Medical waste management

V. NR 499.07(2)(a)5. Identification of Waste Types Acceptable for Treatment by Incineration

a. What is waste, and what are the types of waste generated by human activity?
    i. Municipal solid waste (MSW)
    ii. Commercial/industrial waste
    iii. Wastewater treatment sludge
    iv. Construction and demolition debris
    v. Medical waste
    vi. Pathological/animal waste
b. Characterization of MSW
    i. Source
    ii. Type
    iii. Material constituents
    iv. Proximate analysis
    v. Ultimate analysis
    vi. Fuel variability
c. Acceptable waste types
d. Unacceptable waste types in MSW
    i. White goods
    ii. Electronics
    iii. Hazardous waste—see section VIII.
    iv. Yard waste
    v. Waste oil
    vi. Lead-acid batteries
    vii. Recyclables
    viii. Waste tires

VI. NR 499.07(2)(a)5. Hazardous and Special Wastes

a. Classes of waste—EPA non-hazardous vs. hazardous
b. Hazardous wastes
    i. Listed waste—F and K lists, P and U lists
    ii. Characteristic waste--definition
        1. Ignitability
        2. Corrosivity
        3. Reactivity
        4. Chemical toxicity
    iii. Mixed waste
c. Special wastes – cement kiln dust, waste from fossil fuel operations, mining waste
d. Other types of special waste – e.g., ash, asbestos, white goods, automotive waste, etc.

VII. NR 499.07(2)(b)2. Solid Waste Input Issues, Including Prohibitions in s.287.07 Stats.

a. Prohibitions on land disposal and incineration
    i. Batteries, major appliances, oil

ii. Yard waste
iii. Waste tires
iv. Materials that can be recycled
1. Aluminum containers
2. Corrugated cardboard
3. Foam polystyrene packaging
4. Glass containers
5. Magazine or other material printed on similar paper
6. Newspaper/newsprint
7. Office paper
8. Plastic containers
9. Steel containers
10. Steel/aluminum containers
v. Used oil filters, oil absorbent material
vi. Electronic devices

b. Exceptions to 287.07
i. Waste generated in regions that have effective recycling programs
c. Medical waste disposal and incineration issues (as described in 287.07)

VIII. NR 499.07(2)(a)3. Combustion Facility Types and Design

a. Goals of incineration
i. Volume reduction
ii. Energy recovery
iii. Control of emissions

b. Types of MSW combustors
i. Mass burn
ii. Modular
iii. Refuse-derived fuel (RDF)

IX. NR 499.07(2)(a)3. Combustion Facility Design Details

a. Solid waste flow path
i. Scales
ii. Tipping floor or storage pit
iii. Front end processing equipment for RDF facilities
iv. Charging hopper or feeder
v. Combustion chamber grate or transfer ram
vi. Bottom ash and fly ash collection system
vii. Ash removal system
viii. Ash disposal location

b. Solid waste incinerator design options
1. Fuel processing
2. Charging method
3. Stoichiometric design
4. Chamber wall construction
5. Energy recovery design

c. Mass burn units vs. refuse derived fuel (RDF) facilities (equipment)
d. Types of combustion equipment

1. Excess-air units (mass burn)
2. Controlled air units (2-stage combustion)
3. Others

e. Types of medical waste incinerators
   1. Multiple chamber excess air
   2. Controlled air modular
   3. Rotary kiln

X. NR 499.07(2)(a)3. Waste Combustion Theory and Principles

a. Combustion basics and theory
   i. Definition of combustion
   ii. General principles of combustion
      1. Commonly used chemical symbols
      2. Composition of air
      3. Complete vs. incomplete combustion
      4. Air/fuel ratios and stoichiometric levels
   iii. Combustion operating factors—the Three T's
      1. Combustion air
      2. Incinerator design elements
      3. Fuel heating values
      4. Incinerator heat input
      5. Ignition temperature
   iv. Thermo-chemical concepts
      1. Fuel heating values and load
      2. Ignition temperatures
      3. Combustion temperatures
      4. Temperature control methods
      5. Incombustible materials

b. Combustion chemistry (combustion basics, part II)
   i. Combustion chemical equations
   ii. Combustion quality indicators
      1. Opacity
      2. Stack gas oxygen concentration
      3. Stack gas CO concentration
      4. Combustion temperature
      5. Ash combustibles
   iii. Control of temperatures in incinerators
      1. Factors that affect combustion temperatures
         a. Fuel variability and modulation
         b. Heat transfer to surroundings
         c. Heat sink materials
         d. Water in fuel
         e. Excess air
         f. Water sprays

XI. NR 499.07(2)(a)6. Proper Waste Handling Procedures

a. Materials handling components
   i. Site access

ii. Truck scale/weigh scale
iii. Storage area
iv. Front-end loaders/cranes
v. Rams/grates
vi. Ash handling equipment and ash storage

XII. NR 499.07(2)(a)8. Ash Handling Procedures

a. Types of ash produced in incinerators
    i. Bottom ash
    ii. Fly ash
b. Is incinerator ash a hazardous waste? Review RCRA
c. Metallic constituents of ash and metals of greatest concern
d. TCLP testing and federal/state limits on heavy metals in ash
e. Ash treatment before disposal
    i. Ferrous metals separation
    ii. Chemical extraction
    iii. Chemical additives
    iv. Compaction
    v. Vitrification
    vi. Creation of useful end products
f. Ash management and disposal
    i. On-site
    ii. Transport
    iii. Landfill/monofill disposal
g. Regulatory requirements for ash (Wisconsin regs)—testing procedures, intervals, and reporting requirements

XIII. Types of Air Emissions

a. Air pollutants—definition and types
b. Sources of emissions
c. Particulates
d. Gaseous pollutants of concern
e. Health and environmental effects of air pollutants
    i. Health effects
    ii. Acid precipitation
    iii. Greenhouse effect and climate change
    iv. Smog
f. Fuel, combustion quality, and APCD-dependent air pollutants
g. Brief intro to APCD types

XIV. NR 499.07(2)(a)12. Introduction to Air Pollution Control Equipment

a. Equipment types overview
    i. Wet scrubbers
    ii. Dry scrubbers
    iii. Fabric filter (baghouse)
    iv. Electrostatic precipitators (ESPs)
b. Catalytic oxidation for dioxin/furan removal
c. Non-catalytic and catalytic oxidation/reduction for NOx removal

XV. NR 499.07(2)(b)1. Air Pollution Control Systems (CFO training)

a. Equipment types overview
   i. Wet scrubbers
   ii. Dry scrubbers
   iii. Fabric filter (baghouse)
   iv. Electrostatic precipitators (ESPs)
b. Catalytic oxidation for dioxin/furan removal
c. Catalytic and non-catalytic methods for NOx removal
d. CO monitors
e. Emissions monitoring devices

XVI. Energy Recovery from Waste – The Basics

a. General design of a waste-to-energy plant
b. Types of boilers
   i. fire-tube boilers (generally not used at MWCs)
   ii. integral boilers
   iii. waste-heat boilers
c. Features of the Barron County WTE Facility
   i. condensing steam turbine
   ii. cooling towers
d. output from WTE facilities
   i. direct provision of steam for heat (e.g., at the facility or nearby manufacturing facilities, etc.)
   ii. conversion to electricity and distribution through local/regional electrical grids

XVII. Ash Residue Management and Testing—Review of Ash Handling Procedures and Requirements for Ash Testing

XVIII. Water and Wastewater Management at a Combustion Facility

a. Sources of wastewater at MSW combustion facilities
   i. Leakage of fluids from MSW itself
   ii. Sludge from bottom and fly ash removal
   iii. Condensates from APCDs
b. Regulations governing handling of MWC wastewater
   i. Wisconsin NR 290, NR 205, and NR 220
   ii. Clean Water Act (WI regs based on CWA)
c. Effluent limitations for wastewater
d. Handling procedures—treatment, storage, disposal

XIX.NR 499.07(2)(a)7. Proper Facility Startup, Operation, Shutdown, and Maintenance

a. Operator responsibilities
b. Operator job functions—automatic control systems manager, equipment operator
c. Typical walk-down checklist
d. Potential major hazards
   i. Loss of water
   ii. Explosive fuel/air mixtures

iii. High pressure steam pipe rupture

e. Standard operating procedures
f. Pollutants influenced by operations
g. Combustion control
h. Boiler water treatment
i. Combustion system start-up
j. Combustion system shutdown

XX. NR 499.07(2)(a)13. Malfunction Prevention and Abatement Procedures (Troubleshooting)

a. Typical combustion upsets
b. Indicators of combustion quality
c. Personal combustion observations
    i. Combustion conditions
    ii. Bottom ash
d. Fuel preparation and handling
e. Upsets associated with fuel problems and remedies
    i. Improper feed rate
    ii. Improper fuel bed thickness
    iii. Sudden change in fuel properties
f. Combustion air upsets and remedies
g. Combustion temperature upsets and remedies
h. Furnace draft condition upsets and remedies

XXI.NR 499.07(2)(a)10. Monitoring and Automatic Control Systems

a. Levels of control systems
    i. Manual
    ii. Automatic timer sequence
    iii. Automatic
b. Measurements and systems monitoring
    i. Temperature
    ii. Pressure
    iii. Gas flow rate
    iv. Weight
c. Other monitoring
    i. Carbon monoxide
    ii. Opacity
    iii. Charging rate
d. Incineration facility systems requiring control
    i. Cranes, loaders
    ii. Combustion control system
    iii. Ash handling system
    iv. Flue gas cleaning system
    v. Turbine/generator
    vi. Feedwater/demineralizer/condensate
    vii. Motor controllers
    viii. Cooling water
    ix. Draft

XXII. NR 499.07(2)(a)11. **Recordkeeping Procedures**

a. Overview of NR 502.13(7)—Recordkeeping requirements for solid waste combustors
b. Daily and annual reports
c. Waste screening plan
d. Plan of operation
e. air permit
f. Testing records
g. Other important records

XXIII. NR 499.07(2)(a)9. **Work Safety Procedures**

a. General health and safety
    i. Recognition of hazards
    ii. Consequences of exposures
    iii. Standard safety procedures
    iv. Personal protective equipment
b. Major hazards of operational systems
    i. Water side explosions
    ii. Gas side explosions
c. Other incinerator system safety hazards
    i. Exposure to MSW
    ii. Pit fires and explosions
    iii. Combustion and boiler systems
    iv. Removal of blockages
    v. Observation hatches/hopper doors
    vi. Operations in confined spaces
d. Standard safety considerations
    i. Electrical shock
    ii. Exposure to corrosives
    iii. Noise and vibration
    iv. Exposure to rotary equipment
    v. Awkward access
    vi. Movement of heavy objects
    vii. Welding and metal forming
    viii. Fire hazards
e. Personal protective equipment
f. Public safety—warning signs, restrictions on public access
g. Symptoms of illness

XXIV. NR 499.07(2)(b)3. **Risk Management**

a. Goals of risk management
b. Aspects of risk management
    i. Insurance against production and casualty losses
    ii. Evaluation of current conditions and probability of loss
    iii. Economics and intangibles
c. Operator responsibilities
    i. Safety
    ii. Operations
    iii. Maintenance (preventive and corrective)

iv. Recordkeeping and communications

d. Goals of preventive maintenance
e. Features of a maintenance program
f. In-service and outage maintenance

Wisconsin Solid Waste Combustor Operator Training

Course Schedule

DAY 1

8:00 a.m. Registration/Check-in; Introduction to Training Requirements
8:30 a.m. WDNR Learning Objectives/Topic Coverage
9:00 a.m. History of Solid Waste Management
9:30 a.m. History of Solid Waste Management
10:00 a.m. Environmental Concerns
10:30 a.m. Environmental Concerns
11:00 a.m. Federal and State Environmental Regulations
11:30 a.m. Federal and State Environmental Regulations + Quiz
Noon: Lunch Break
12:30 p.m. Types of Solid Waste Treatment Facilities
1:00 p.m. Types of Solid Waste Treatment Facilities
1:30 p.m. Identification of Waste Types/Characterization of Solid Waste
2:00 p.m. Identification of Waste Types/Characterization of Solid Waste
2:30 p.m. Hazardous Waste
3:00 p.m. Solid Waste Input Issues, incl. WI s.287.07 Stats.
3:30 p.m. Solid Waste Input Issues, incl. WI s.287.07 Stats.
4:00 p.m. Introduction to Combustion Facility Design
4:30 p.m. Introduction to Combustion Facility Design + Quiz
5:00 p.m. Adjourn

DAY 2

8:00 a.m. Review + Day's Learning Objectives
8:30 a.m. Combustion Theory
9:00 a.m. Combustion Theory
9:30 a.m. Combustion Theory: Chemical Equations
10:00 a.m. Combustion Quality Indicators
10:30 a.m. Proper Waste Handling Procedures
11:00 a.m. Proper Waste Handling Procedures
11:30 a.m. Ash Handling + Quiz
Noon: Lunch Break
12:30 p.m. Types of Air Emissions
1:00 p.m. Types of Air Emissions
1:30 p.m. Principles of Air Pollution Control
2:00 p.m. Principles of Air Pollution Control
2:30 p.m. Principles of Air Pollution Control
3:00 p.m. Air Pollution Control Systems/Equipment

3:30 p.m. Air Pollution Control Systems/Equipment
4:00 p.m. Air Pollution Control Systems/Equipment
4:30 p.m. Summary + Quiz
5:00 p.m. Adjourn

DAY 3

8:00 a.m. Review + Day's Learning Objectives
8:30 a.m. Continuous Emission Monitors
9:00 a.m. Energy Recovery from Waste
9:30 a.m. Energy Recovery from Waste
10:00 a.m. Energy Recovery from Waste
10:30 a.m. Ash Residue Management
11:00 a.m. Ash Residue Management
11:30 a.m. Water and Wastewater Management + Quiz
Noon: Lunch Break – Travel to Barron County WTE Facility in Almena
12:30 p.m. TOUR of Barron County WTE Facility
1:00 p.m. TOUR of Barron County WTE Facility
1:30 p.m. Proper Startup, Operation, Shutdown, and Maintenance
2:00 p.m. Proper Startup, Operation, Shutdown, and Maintenance
2:30 p.m. Malfunction Prevention and Abatement Procedures (Troubleshooting)
3:00 p.m. Troubleshooting, continued
3:30 p.m. Monitoring and Automatic Control Systems
4:00 p.m. Monitoring and Automatic Control Systems
4:30 p.m. Recordkeeping and Environmental Reporting + Quiz
5:00 p.m. Adjourn

DAY 4

8:00 a.m. Review + Day's Learning Objectives
8:30 a.m. Public Relations—Role of the Operator
9:00 a.m. Health and Safety Considerations
9:30 a.m. Health and Safety Considerations
10:00 a.m. Risk Management
10:30 a.m. Risk Management
11:00 a.m. Learning Objectives Review
11:30 a.m. WDNR Exam Prep and Review
Noon: Lunch Break
12:30 p.m. WDNR Examination
1:00 p.m. WDNR Examination
1:30 p.m. WDNR Examination
2:00 p.m. Adjourn

INDEX TO POWERPOINT SLIDE SETS CORRESPONDING TO EACH LESSON

DAY 1

MSW Training 1—Introduction to Training Reqs
MSW Training 2 – History of Solid Waste Management
MSW Training 3 – Environmental Concerns
MSW Training 4 – Regulations
MSW Training 5 – Types of Treatment Facilities
MSW Training 6 – What is Solid Waste
MSW Training 7 – Hazardous and Special Waste
MSW Training 8 – Solid Waste Input Issues
MSW Training 9 – Combustion Facility Design

DAY 2

MSW Training 9 – Combustion Facility Design
MSW Training 10 – Combustion Theory, Part I
MSW Training 11 – Combustion Theory, Part II
MSW Training 12 – Waste Handling Methods
MSW Training 13 – Ash Handling
MSW Training 14 – Types of Air Emissions
MSW Training 15 – Principles of Air Pollution Control
MSW Training 16 – Air Pollution Control Equipment and Monitors

DAY 3

MSW Training 16 – Air Pollution Control Equipment and Monitors
MSW Training 17 – Energy Recovery from Waste
MSW Training 18 – Ash Residue Management-Water-Wastewater Management
MSW Training 19 – Startup Operation Shutdown Maintenance
MSW Training 20 – Troubleshooting Combustion Upsets
MSW Training 21 – Monitoring and Automatic Control Systems
MSW Training 22 – Recordkeeping

DAY 4

MSW Training 23 – Safety Considerations
MSW Training 24 – Risk Management