National Air Quality Training Center

Training Request Checklist Attachments

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ATTACHMENT A

Description of National Air Quality Training Program Curricula

Curriculum	Description
Air Pollution Basics	These courses help federal, state, local, and tribal air professionals, as well as communities, build their knowledge base and capacity to conduct various duties in compliance with the applicable Clean Air Act (CAA) requirements.
Air Quality Modeling	These courses help state, local, and tribal air professionals build their knowledge base and capacity to conduct air quality modeling in compliance with the applicable Clean Air Act requirements.
Air Quality Planning	These courses help state, local, and tribal air professionals build their knowledge base and capacity to conduct air quality planning in compliance with the Clean Air Act (CAA) requirements. The curriculum focuses on implementation of National Ambient Air Quality Standards (NAAQS) via State/Tribal Implementation Plans (SIPs/TIPs) as well as Regional Haze requirements.
Air Toxics Rule Development and Implementation	These courses help state, local, and tribal air professionals build their knowledge base and capacity to conduct air toxic risk assessments, communicate air toxics risks appropriately, and/or develop rules in compliance with the applicable Clean Air Act requirements.
Ambient Air Monitoring	These courses help state, local, and tribal air professionals build their knowledge base and capacity to conduct ambient air monitoring in compliance with the applicable Clean Air Act requirements and associated monitoring regulations.
Emissions Inventories	These courses help state, local, and tribal air professionals build their knowledge base and capacity to develop emission inventories in compliance with the applicable Clean Air Act requirements.
Permitting	These courses help EPA, state, local, and tribal air pollution professionals build their knowledge base and capacity to conduct permitting activities and write permits in compliance with the applicable Clean Air Act requirements.
Source Emissions Testing and Source Emissions Monitoring	These courses help federal, state, local, and tribal air professionals build their knowledge base and capacity to observe and review reports from source emissions testing and source emissions monitoring in compliance with the applicable Clean Air Act and state/local/tribal emission measurement requirements.

ATTACHMENT B

Air Pollution Basics Curriculum (4/16/20)

Goal: To help federal, state, local, and tribal air professionals, as well as communities, build their knowledge base and capacity to conduct various duties in compliance with the applicable Clean Air Act (CAA) requirements.

Audience: This curriculum is intended for newly hired federal, state, local, and tribal air professionals, as well as communities. The audience for this curriculum is considered broad and includes any person who needs a basic knowledge of key concepts before taking courses under the job-specific curricula (e.g., permitting or air quality planning).

Learning Objectives: The learning objectives are intended to provide a broad foundational knowledge of air pollution and regulatory concepts required for success in job-specific curricula and duties.

- Identify key historic episodes and events that led to the passage of air pollution control legislation
    - Major influences that affected the development of air quality management programs in state, local and tribal air agencies across the US

- Highlight air pollution control successes since the 1970 passage of the CAA
    - The trends and factors that have caused large reductions in air pollutants

- List and describe the types of air pollutants regulated under the CAA
    - Criteria pollutants
        - Ozone
        - Particulate matter (coarse and fine)
        - Nitrogen dioxide
        - Sulfur dioxide
        - Lead
        - Carbon monoxide
    - Criteria pollutant precursors
    - Greenhouse gases
    - Hazardous air pollutants (HAPs)
        - List of air toxics

- Generally describe typical sources of anthropogenic air pollution, including but not limited to:
    - Point sources
    - Nonpoint sources
    - Onroad/nonroad sources

- Events (wildfires, prescribed fires, agricultural sources)

- Generally describe biogenic and geogenic sources of air pollution

- Explain the health and environmental effects of air pollutants for:
  - Each of the 6 criteria air pollutants
  - HAPs
  - Greenhouse gases
  - Trends in levels of these pollutants

- Explain basic concepts in environmental sciences related to air pollution
  - Basic concepts of pollutant emissions
    - Pollutants emitted directly
    - Precursor emissions that transform in the atmosphere
  - Atmospheric science
    - Overview of basic meteorology and atmospheric chemistry
      - Inert and chemically reactive pollutants
      - Influence of weather and climate, including inversions
      - Pressure (including altitude) and temperature effects
    - Dispersion (fate and transport) of primarily emitted pollutants (SO2, CO, Pb, PM10, direct PM2.5, NO2)
    - Differences between ground-level and stratospheric ozone
      - Basics of ground-level ozone formation chemistry (precursors, etc.)
      - Basics of stratospheric ozone formation
    - Secondary $PM_{2.5}$ formation
      - Chemical species
      - Spatial and temporal nature of formation
    - Visibility impairment (Regional haze)
  - Overview of air pollution across the US
    - Monitoring data—spatial patterns, seasonal, diurnal patterns
    - Modeled data—spatial patterns, seasonal, diurnal patterns
    - Spatially fused air quality information—spatial patterns, seasonal, diurnal patterns
  - Basics of interactions between meteorology and air pollution
  - Gas law, light properties
  - Pollutant source measurements and associated techniques
    - Continuous vs. episodic (e.g., CEMS vs. Stack test)
  - Scientific evaluation of health and environmental impacts of air pollution
    - Dose/response
    - Epidemiological data versus controlled studies
    - Acute versus chronic effects

    - Pathway from emissions to air quality to health impacts
        - How this pathway informs the air quality management cycle

- Describe common engineering practices and technologies used to control or minimize air pollutant impacts
    - Control of stationary source emissions
        - Process changes
        - Control technologies for particulate matter and gaseous emissions
    - Control of mobile source emissions
    - Prescribed burning practices

- Outline relevant information in the CAA on the following:
    - The CAA's structure
    - Major concepts, to include:
        - Criteria pollutants and National Ambient Air Quality Standards (NAAQS)
        - Designation of areas as attainment or nonattainment
        - State and tribal implementation plans
        - General and transportation conformity
        - Interstate transport
        - Regional haze
        - Air toxics
        - Acid rain program
        - Permitting
        - Stationary source standards for HAPs
        - New Source Performance Standards
        - Waste incinerator rules

- Outline the steps in the National Ambient Air Quality Standards (NAAQS)-setting process
    - Evaluation of scientific evidence
    - Evaluation of air quality data
    - Risk and exposure assessment
    - Policy assessment
    - The form and level of a standard
    - Rulemaking process, including opportunities for public comment
        - Timing
    - Regulatory impact analyses
    - Risk communication

- Explain implementation of the NAAQS
    - Basic CAA timeline for implementation requirements
    - Design value process

- Initial designation of areas as attainment, nonattainment, and attainment/unclassifiable
    - Area classifications for applicable NAAQS
    - Designation of areas of Indian country
- Exceptional Events program
    - Treatment of:
        - Wildfire
        - Prescribed fire
        - Wind-blown dust
        - Agricultural burning
- Redesignation process
- Roles of state, local and tribal air agencies
- State and Tribal Implementation Plans (SIPs and TIPs)
- The Tribal Air Rule and Treatment-As-State for tribes
- Use of monitoring and modelling data
- Overview of the Advance Program

- Define air pollution transport and Regional Haze
    - Broad history of interstate transport program to address regional ozone and $PM_{2.5}$ problems
    - Visibility and the CAA
    - Regional Haze Program and what processes and pollutants cause it
        - Regional Haze Rule overview

- Define operating permit and New Source Review programs
    - Title V
    - NSR (PSD vs. Non-attainment)
        - New vs. Existing Sources
        - Differences between major, minor, and synthetic minor sources
        - Actions taken for sources within attainment vs. nonattainment areas

- Describe the roles/responsibilities of air agencies under the CAA
    - State/Local
        - Approved
        - Delegated
    - Federal (EPA and other Federal agencies)
    - Tribal

- Explain the requirements for Federal coordination on air quality issues

- Describe how the EPA estimates the economic value of health benefits from reducing pollution
    - Use of the CO-Benefits Risk Assessment (COBRA) health impacts screening and mapping tool
    - Use of the Environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE) tool
    - Multipollutant considerations in air pollution strategies

- Explain the difference between ambient air monitoring and source testing, including regulatory requirements and constraints concerning data use

- Describe the basic principles for ambient air monitoring
    - Objectives for use of monitoring data
    - What is measured in the ambient air
        - Particles
        - Gases
        - Meteorology
    - Location for EPA monitoring requirements
    - Meteorological impacts on ambient air measurements
    - How the CAA defines ambient air and what must be measured
        - Criteria pollutants
        - HAPs
    - Measurement Methods
        - Federal Reference Methods
        - Federal Equivalent Methods
        - Non-regulatory methods
    - Quality assurance in using ambient air monitoring data
    - State annual air monitoring plan
    - The role of citizen science

- Define the Air Quality Index (AQI) and its regulatory basis

- Describe the basic principles for emission inventories
    - Overview of differences between types of emissions inventories, such as NEI and TRI, and greenhouse gas inventory
    - Overview of the types of emissions inventories and their purposes (more details on this provided in the EI Foundational curriculum)
    - Goals, purpose, and uses of the National Emissions Inventory (NEI)
    - Sources covered under emission inventory data categories

- Describe the basic principles for air quality modelling and its applications
    - Why conduct air quality modeling?

- Types of air quality models
- How air quality models are used for different purposes
  - Attainment planning
  - Emissions inventories
  - PSD/NSR compliance demonstrations
  - Conformity
  - Research
- The main types of inputs into air quality models
  - Source characterization and emissions inputs
  - Meteorological data
  - Terrain data
- Model performance evaluations
- Supporting analysis techniques for modeling assessments
  - Trajectories
  - Wind/pollution roses

- Describe the health assessment components of the air toxics program
  - Assessment of risk
  - Regulatory framework
  - Risk communication
  - Use of monitoring and modelling data
  - Estimates of air toxics public health risks
    - Cancer
    - Non-cancer

- Define the air toxics control program
  - Maximum Achievable Control Technology (MACT)
  - Generally Available Control Technology (GACT)
  - Residual Risk

- Explain the process of compliance and enforcement
  - Source testing
  - Emissions standards compliance demonstration
  - Inspections and audits
  - Enforcement mechanisms

- Define quality assurance and quality control
  - Developing Data Quality Objectives
  - Organizational Responsibility
  - Documentation
  - Audits
  - Reports

- Describe tools and resources available for public health messaging
    - AirNow
    - Air Trends
    - Air Data
    - Air Quality Flag Program
    - Sensors
    - Wildfire guide
    - Smoke Sense
    - NATA
    - EJ Screen

- List ways the public can participate in the regulatory process
    - Opportunities for public comment at the federal, state and local levels
    - Tribal outreach and consultation
    - Public hearings
    - Petitions (e.g., Title V)

- Identify basic issues related to environmental justice

ATTACHMENT C

Air Quality Modeling Curriculum (4/24/20)

Goal: To help state, local, and tribal air professionals build their knowledge base and capacity to conduct air quality modeling in compliance with the applicable Clean Air Act (CAA) requirements.

Audience: The primary audience is state, local, and tribal air professionals. This curriculum will also be helpful to EPA staff. The curriculum presumes these students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under Modeling.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[1] Learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts. The "intermediate" level is intended to help students apply and analyze concepts, and the "advanced" level is intended to help students create and evaluate key concepts as well as master the curriculum.

Foundational

- Explain why air quality modeling is conducted
    - Predict pollutant concentrations where monitors don't exist and assess pollutant emissions changes (i.e., simulate policy/controls programs, project to future years)
    - Overview of needs for modeling under the CAA

- Describe underlying atmospheric processes
    - Atmospheric stability
    - Atmospheric boundary layer
    - Atmospheric chemical processes and mechanisms

- Describe the different types of air quality models
    - Gaussian Dispersion Modeling
    - Lagrangian Modeling
    - Eulerian Modeling

- Outline a modeling protocol that defines a modeling platform (e.g., model inputs, model selection, output post-processing)
    - Emissions inputs
    - Meteorology inputs
    - Terrain/Surface inputs
    - Air quality model selection
    - Modeling domain and episode/time period
    - Modeling results and post-processing
    - Computing System Requirements (i.e., Windows vs. Linux Systems)

[1] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

- Explain a model performance evaluation
    - Evaluation approach, methods, and metrics (e.g., operational, diagnostic, dynamic, and probabilistic)
    - Potential bias and other sources of variability/uncertainty

Intermediate

- Describe the uses of air quality models to inform CAA programs
    - Federal rulemakings and administrative requirements
        - Legal basis of EPA rulemaking action
        - Executive Order 12866: Cost-Benefit Analysis
    - NAAQS Implementation
        - Area designations
        - State implementation plans (SIPs) and Tribal implementation plans (TIPs)—attainment demonstrations
        - Other CAA demonstrations (e.g., CAA section 179b, Exceptional Events, etc.)
    - New source permitting
        - Compliance demonstrations for National Ambient Air Quality Standards (NAAQS) and prevention of significant deterioration (PSD) increment
    - Regional Haze Program: Reasonable progress goals for visibility
        - SIP and four factor analysis
    - Health Assessments (i.e., Benefits, Risk and Exposure)
        - Risk assessments for NAAQS Reviews and Air toxics

- Outline EPA's *Guideline on Air Quality Models* (published as Appendix W to 40 CFR Part 51)
    - Purpose and applicability of the *Guideline*
    - Background and history of the *Guideline*
    - EPA preferred air quality models (definition, criteria, regulatory process)
    - EPA alternative air quality models (definition, criteria, process for approval)
        - OAQPS Model Clearinghouse
    - Air quality models/techniques and program applicability under the *Guideline*
        - Screening models
        - Refined models
            - Gaussian dispersion models
                - Spatial scale: local, near-source
                - Pollutant applicability: those directly emitted into the atmosphere: lead, CO, PM_{10}, direct $PM_{2.5}$, NO_2, and SO_2
                - Program applicability: screening approaches and preferred/alternative models for use under specific CAA programs
            - Lagrangian models
                - Spatial scale: local, near-source to regional
                - Pollutant applicability: directly emitted and chemically reactive pollutants.
                - Program applicability: screening approach for long-range transport assessments and limited refined use for secondary pollutants.
            - Eulerian models
                - Spatial scale: local, regional, global

        - Pollutant applicability: those formed through chemical reactions in the atmosphere: ozone, secondary PM2.5, and visibility
        - Program applicability: screening approaches and preferred/alternative models for use under specific CAA programs

- Locate information on Modeling Guidance and Support
    - EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website
    - EPA modeling and related technical guidance
        - Permit Modeling Guidance documents
        - State Implementation Plans (SIPs) and Tribal Implementation Plans (TIPs): Attainment Demonstration Guidance and related technical implementation guidance (e.g., PM2.5 Precursor Demonstration, 179B Demonstrations, various Exceptional Events guidance documents, etc)
        - Modeling Clearinghouse and Clarification Memos
    - Guidance issued by Federal partners, states/locals or state organizations

- Define Gaussian dispersion modeling: Model Platform for CAA applications
    - Air quality model selection
        - Screening (AERSCREEN)
        - Refined (AERMOD)
    - Modeling domain and receptors
    - Source Characterization and Emissions Inputs
        - Stack/building parameters (BPIPPRIME)
            - Building dimensions
            - Stack location
            - GEP Stack Height
            - Downwash
        - Seasonal/diurnal profile of emissions
        - Speciation of emissions
        - Typical sources of emissions inputs
    - Meteorological Inputs
        - Screening met (MAKEMET)
        - Refined met (AERMET)
            - Upper air observations
                - NWS met
                - Prognostic met
            - Surface observations
                - Site-specific met
                - NWS met
                    - Hourly observations
                    - 1- or 5-minute ASOS (AERMINUTE)
                - Prognostic met
            - Surface characteristics (AERSURFACE)
                - Land use/ land classification
    - Terrain inputs (AERMAP)
        - Terrain heights

- Background concentrations
  - Ambient monitoring data
  - Nearby sources
  - Other sources
- Modeling results
  - Design concentration calculation

- Define Photochemical models: Model Platform for CAA applications
  - Choice of photochemical model: CMAQ, CAMx, WRF-Chem, other
    - Model domain, episode selection, and horizontal grid resolution
    - Model science options
      - Gas-phase chemical mechanism
      - Aerosol sectional vs modal treatment
      - Inorganic aerosol partitioning model: ISORROPIA, ISORROPIA II
      - Organic aerosol treatment: VBS vs traditional
      - Deposition scheme
      - Chemical solver
  - Emissions inputs
    - Anthropogenic emissions sectors
      - Onroad mobile
      - Offroad mobile
      - Electric generating unit (EGU)
      - Non-EGU point
      - Area sources
      - Agriculture
      - Residential wood combustion
      - Commercial Marine Vessels
    - Biogenic/Geogenic emissions sectors
      - Fires
      - Biogenic volatile organic carbons (VOC)
      - Soil NO
      - Lightning
      - Dust
      - Sea Salt
    - Developing model-ready inputs
      - Spatial and temporal allocation for each source sector
      - Speciation for each source sector
    - Future year projections
  - Meteorology inputs from prognostic meteorological model
    - Model choice (i.e. WRF, MPAS) and model version
      - Physics options (Land surface model, PBL scheme)
      - Land use options
    - Nudging options and observational datasets
      - Temperature, wind, relative humidity
      - Sea Surface Temperature (SST)

        - Soil moisture
    - Meteorological performance evaluation
- Initial/ and boundary conditions from regional, hemispheric, or global model simulation
    - Model choice, resolution and science options
        - Coarser resolution regional model such as CMAQ/CAMx
        - Hemispheric CMAQ
        - GEOS-Chem
        - MOZART
        - Other global models
    - Global emissions datasets: HTAP, EDGAR, MIX-ASIA, others
    - Mapping from coarser scale model to regional model
        - Grid layer mapping from coarser scale model simulation to regional model
        - Species mapping between global model and regional model
- Model performance evaluation
    - Ambient data and data sources
        - monitoring data: AQS (SLAMS), PAMS, CSN, IMPROVE, CASTNET etc
        - Satellite data
    - Evaluation approach, methods and metrics
        - operational w/ statistics, plots, graphs
        - diagnostic evaluation
        - dynamic evaluation
- Utilizing modeling results for regulatory applications
    - Future-year model projections
        - Relative Response Factors (RRFs) for ozone, $PM_{2.5}$, and Regional haze SIP demonstrations
    - Model-observation fused surfaces
        - Model inputs to data fusion methods for risk and health benefits assessments
    - Single source impacts
        - Brute force simulations and use of instrumented techniques for new source permitting

Advanced

- New source permit modeling: Case Studies—Design and conduct air quality modeling, as part of the required air quality analysis, for permitting compliance demonstration for stationary sources [cover the various aspects of such modeling as part of a permit action]
    - Overview of Air Quality Analysis Checklist (https://www3.epa.gov/ttn/scram/guidance/guide/Air_Quality_Analysis_Checklist-Revised_20161220.pdf)
    - Process of Engagement
    - Pre-construction Ambient Air Monitoring
    - Development of a modeling protocol
        - Project Description
        - Source Characterization
        - Meteorological input data

        - Screening met
        - Site-specific met
        - National Weather Service (NWS) met
        - Prognostic met
        - Representativeness and surface characteristics
      - Air quality model selection
      - Model domain and receptors
      - Background concentrations
      - Analysis of Class I area impacts
      - Additional impact analyses
      - General considerations
    - Conduct NAAQS and PSD Increment Compliance Demonstration
      - Source Impact Analysis
        - Comparison to the SIL
      - Cumulative Impact Analysis
        - Determining modeled NAAQS and/or PSD increment violations
        - Comparison to the significant impact level (SIL)
    - Document Compliance Demonstration Results
      - Detail the comprehensive set of statistics, tables, plots, and other modeling results to be provided for each applicable NAAQS and PSD increment

- SIP and related Implementation Modeling: Case Studies—Design and conduct air quality modeling to inform implementation needs under CAA for criteria pollutants and Regional Haze with examples and references to appropriate guidance documents [conceptual model, modeling inputs and process, details of the attainment demos, post-processing software, weight of evidence, model performance evaluation].
    - Developing a modeling protocol
    - State Implementation Plans
      - NAAQS Attainment demonstrations
        - Primary pollutants (CO, NO2, Pb, SO_2, PM_{10})
        - Secondary pollutants (ozone, $PM_{2.5}$)
      - Regional Haze Reasonable Progress
    - CAA Implementation-related Demonstrations
      - Precursor Demonstrations for $PM_{2.5}$
      - 179B Demonstrations
      - Exceptional Events Demonstrations

- Conduct AERMOD modeling for various CAA programs

ATTACHMENT D

Air Quality Planning Curriculum (4/7/20)

Goal: To help state, local, and tribal air professionals build their knowledge base and capacity to conduct air quality planning in compliance with Clean Air Act (CAA) requirements. The curriculum focuses on implementation of National Ambient Air Quality Standards (NAAQS) via State/Tribal Implementation Plans (SIPs/TIPs) as well as Regional Haze requirements.

Audience: The primary audience is state, local, and tribal air professionals. This curriculum is also helpful to EPA staff. The curriculum presumes that students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under the Air Quality Planning curriculum.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[2] Learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts. The "intermediate" level is intended to help students apply and analyze concepts, and the "advanced" level is aimed at helping students create and evaluate key concepts as well as master the curriculum.

Foundational

- Describe NAAQS implementation (in general)
    - Timeline for implementation requirements
    - Roles of states, tribes, local air agencies and EPA
    - Area designations
    - State/tribal implementation plans (SIPs/TIPs)
    - Redesignation

- Describe the requirements and process to designate areas as attainment, nonattainment, or attainment/unclassifiable following promulgation of a new or revised NAAQS
    - CAA requirements
    - Summary of factors considered to determine area boundaries
    - Use of monitoring data for determining area designations (modeling can also be used for SO_2 only)
        - Weight of evidence including air quality modeling for defining area boundaries
    - Federal/state/tribal relationship in area designations
        - Tribal policy for designation as a separate area
        - EPA guidance for state and tribal area designation recommendations
    - Design values and the role they play in designations
    - Classifications
    - Exceptional events
    - Steps and timeframes leading to final designation decision

[2] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

        - Initial state recommendations, 120-day letter process, Federal Register publication, notice and comment, final designations (promulgation and effective date)
    - Review the current designations via the electronic Code of Federal Regulations (CFR) or Greenbook website

- Describe the role of each state to develop a state implementation plan (SIP)
    - SIP requirements under CAA section 110
        - Infrastructure SIPs (sections 110(a)(2)(A)-(M))
        - Interstate transport (section 110(a)(2)(D))
    - SIP requirements in EPA regulations (40 CFR part 51)
        - SIP submissions and public notice, opportunity for comment and hearing
        - Completeness criteria for SIPs
    - Nonattainment SIPs for certain states
    - Source-specific SIPs and other SIPs not related to nonattainment
    - Regional Haze SIPs (all states)
        - Basis in CAA sections 169A and 169B; to remedy visibility impairment in Class I national parks and wilderness areas
        - Reasonable progress goals
            - IMPROVE monitoring network for Class I areas
            - Metrics: visual range, deciview, inverse megameters
        - In general, SIP update every 10 years and progress reports every 5 years

- Describe the role of the EPA to take actions related to SIPs (required by CAA section 110(k), (l), (m))
    - Federal Register proposal, comment, response, finalization
    - Deadlines for action on SIP submissions (section 110(k))
        - Completeness determination
            - Generally made within 6 months of state submission
            - EPA final action required within 18 months of state submission
        - Generally identify types of actions (full and partial approval, conditional approval, disapproval, etc.)
            - Notice and comment rulemaking (APA and Federal Register)
            - Makes state law federally enforceable (CFR)
        - Federal Implementation Plans (FIPs), SIP calls, and corrections
    - Anti-backsliding and savings clauses (sections 110(l) and (n))
    - Sanctions (section (m))
        - Role of court decisions on EPA approval/disapproval actions

- Provide contextual information as it relates to Tribal Implementation Plans
    - Elective process

- Provide contextual information regarding the Tribal Authority Rule
    - Treatment as a State (TAS)

- Locate information about SIPs/TIPs (such as the current SIP-approved regulations, source-specific requirements and plans for a state)

- Regulations.gov - how to find a docket and read EPA's technical support documents for previous actions in order to inform future submittals
- Govinfo.gov - how to find FR notices by number, search for FR notices by content, and refer to the latest eCFR
- EPA website resources related to SIPs
- EPA State Plan Electronic Collaboration System (SPeCS) and Regional Office SIP compilations

- Identify sources of ambient air quality data
  - Overview of state, tribal, and national monitoring networks
    - Pollutants monitored
    - State development of monitoring plans; EPA review
    - General process for state certification of data each year
  - Where you can get data on the EPA website
    - AirData
    - AirTrends
    - AQS
    - AirNOW

- Outline the nonattainment area SIP/TIP development process
  - Overview of SIP/TIP submittal by state/tribe (including due dates)
    - SIP/TIP development timelines
    - Tribal Treatment as a State (TAS) status
    - State plan submissions made through electronic data system (SPeCS)
    - Public dashboard
  - EPA review process
    - Timelines and consequences for late/incomplete action (finding of failure to submit, finding of failure to act, sanctions and FIPs)

- Describe the contents of nonattainment area SIPs/TIPs
  - General SIP/TIP components
    - State develops enforceable rules or permit conditions as needed, following state requirements
  - Nonattainment area emission inventories for SIPs/TIPs
    - CAA requirements for nonattainment area emission inventory
    - Description of pollutants covered
    - Definition of point, area, mobile sources
  - Attainment demonstration modelling
    - Applicability to nonattainment areas for each of the NAAQS pollutants
  - Control measures for nonattainment SIPs (RACT/RACM)
    - CAA requirements for nonattainment area control measures
      - Attain by applicable attainment date/as expeditiously as practicable
      - SIP credit (permanent, surplus, Federally enforceable, etc.)
    - Process for evaluating technological and economic feasibility of control measure
    - What is control techniques guidance (CTG) for ozone, and for which source sectors have CTGs been developed?
  - Reasonable Further Progress (RFP)/Rate of Progress (ROP) Plans

        - CAA requirements
        - Annual incremental reductions
        - Baseline year
    - General conformity and transportation conformity
        - CAA basis
        - Determine how to implement state transportation plans after promulgation of a new or revised NAAQS
    - Contingency measures
        - CAA basis
        - Applying contingency measures
    - Use of electronic data systems for state plan submissions
    - Importance of early engagement

- Review completeness requirements for plans

- Describe redesignation from nonattainment to attainment, and maintenance plan requirements
    - Basis in CAA (section 175A)
    - Clean data determinations (CDD)
        - Difference between making a CDD and a full redesignation
        - Regulatory result of CDD compared to regulatory result of full redesignation
        - Some requirements are suspended as the result of a CDD (vary by NAAQS) and others are not (e.g., emissions inventory, nonattainment NSR elements)
    - Requirements to be met for an area to be re-designated from nonattainment to attainment
    - Requirements for an approvable maintenance plan, including contingency measures
    - Differences in process for tribes (e.g., TAS approval, etc.)

- Define Prevention of Significant Deterioration (PSD) permitting program
    - CAA and regulatory requirements
    - Major source and major modification
    - Classifications and area reclassification
    - Increments and ceilings
    - Definition of regulated NSR pollutant
    - Greenhouse gases and how they are treated in PSD
    - Best Available Control Technology (BACT)
    - Air quality modeling to ensure source is not exceeding PSD increment
    - Air quality modeling to ensure source is not causing or contributing to a NAAQS violation
    - Visibility and PSD

- Summarize nonattainment NSR (NNSR) CAA requirements and when they are triggered
    - Identify NNSR requirements in EPA regulations
    - Describe major source, major modification, minor source
    - Discuss basic principles of lowest achievable emission rates (LAER) and emission offsets
    - Overview of tribal NSR

- Define minor NSR program/tribal minor NSR
    - Basis in CAA (section 110(a)(2)(C)) and EPA regulations (40 CFR 51.160 through 164)

- Understand public participation requirements
- Understand requirement that new and modified stationary sources must not interfere with attainment and maintenance of the NAAQS

Intermediate

- Define technical factors, tools, and resources used in the designation process
  - Technical factors considered by EPA and states in process
    - Role of design values in designations
    - Evaluation of monitor representativeness in an airshed
    - Air quality data, emissions, meteorology, geography/topography, jurisdictional boundaries
    - Tools and resources for evaluating factors
  - Consideration of exceptional events
    - What types of events qualify?
    - Flagging and concurrence process
    - Exceptional events rule and guidance documents

- Explain the purpose of routine SIP rule revisions and updates
  - Submit for purposes of SIP strengthening
  - Submit to keep state and SIP-approved rules consistent and up to date with Federal requirements

- Evaluate completeness of plan submissions
  - Review of purpose and minimum criteria for determining completeness by EPA for SIP submissions (Appendix V to 40 CFR Part 51)
  - EPA completeness determination/complete by operation of law

- Outline infrastructure SIP requirements
  - Overview of individual subsections— e.g. A, B, C (except interstate transport subsection (D), which is covered separately)
  - Overview of multi-pollutant infrastructure SIP guidance

- Define attainment demonstrations
  - Overview of modeling guidance and air quality modeling typically used for attainment demonstrations for different NAAQS
    - Dispersion models for CO, lead, NO2, and SO2
    - Regional photochemical models for ozone and PM2.5
    - Developing modeling protocols
    - Emission rates/control measures within the SIP and used in final attainment modeling must reflect enforceable rules and/or permit conditions
  - Analyze emission inventories (especially for nonattainment areas)
    - Ways that nonattainment area inventory can improve upon state-level inventory data
    - Describe how EPA emission factors are developed
    - Methods for projecting emissions into the future (as needed for redesignations and/or ozone, PM2.5 and Regional Haze SIPs)

        - Relationship of emission inventory base year and reasonable further progress baseline year for ozone, PM2.5, and regional haze
    - Evaluate air quality planning issues specific to multijurisdictional nonattainment areas

- Evaluate control measures and their cost effectiveness
    - Resources for identifying control measures and evaluating cost effectiveness
        - Menu of Control Measures
        - RACT/BACT/LAER Clearinghouse
        - Other sources of information
    - Role of RACM in attainment demonstrations
    - Enforceability of and enforceable mechanisms for control measures
    - For ozone, describe:
        - Control measures required for each classification
        - Ozone Transport Region (OTR) requirements

- Describe requirements that relate to emissions during periods of startup, shutdown and malfunction
    - Director's discretion
    - Excess emissions

- Define conformity requirements
    - General conformity
        - What qualifies as an applicable Federal project?
        - What are 'de minimis' levels by precursor and NAAQS?
        - What is the process for a typical project?
    - Transportation conformity
        - Conformity budget
        - Regional emissions analysis
        - Conformity lapse
        - Conformity freeze

- Describe requirements for ROP/RFP plans
    - Specific requirements for ozone ROP and RFP for other NAAQS
    - Quantitative milestones for PM10 and PM2.5
    - Milestone compliance demonstration requirements for ozone and consequences for failing to achieve RFP

- Define contingency measure requirements
    - Defined as measures that can be implemented expeditiously but that are not included in the measures relied on to demonstrate attainment by the attainment date
    - Examples of past practice: what types of "triggers" have states included in SIPs
    - When can states rely on measures that are already being implemented ("early triggered") as contingency measures (e.g., each year mobile emissions reductions are realized due to fleet turnover)
    - Jurisdictional differences in treatment of early-triggered contingency measures (i.e., not allowed in 9th Circuit due to *Bahr* decision)

- Define the requirements for redesignation to attainment and maintenance plans
    - Analyses and policies for demonstrating maintenance: based either on air quality modeling or projected emissions
    - Initial maintenance plan covers 10 years after date of redesignation
    - Available guidance
    - Limited maintenance plan policies
    - Second maintenance plans are due 8 years after initial maintenance plans are approved

- Describe the use of Clean Data Determinations (CDDs) to suspend requirements before an eventual action to formally redesignate

- Analyze possible scenarios that might lead to a Federal Implementation Plan

- Describe the technical aspects of interstate transport analysis
    - EPA's four step interstate transport framework
    - NOx SIP call, CAIR, CSAPR, CSAPR Update, CSAPR Closeout
        - Note that CSAPR Closeout was remanded to EPA Sept. 2019 and Closeout vacated
    - Overview of technical (modeling and cost) analyses of EPA transport rules
    - NSR and visibility interstate transport requirements
    - Ozone Transport Region (OTR) and requirements
    - Implications of international transport

- Explain how Regional Haze SIPs are evaluated
    - Elements of a Regional Haze SIP (BART, long term strategy, reasonable progress)
    - Differences between first and second planning periods after rule revision

Advanced

- Prepare (states/tribes) and evaluate (EPA) state/tribal recommendations for area designations

- Prepare Infrastructure SIP submittal

- Describe special topics related to interstate transport
    - Overview of most recent guidance, most recent court decisions framing policy
    - Most recent technical analyses showing interstate contributions for ozone (examples from technical analyses)
    - Section 176A and Section 126 petitions for interstate transport
    - Transport regions and international border areas (Section 179B)

- Use different sources of air quality data to conduct analyses
    - Analyses to understand sources of pollution (PM2.5 speciation, VOC speciation, semi-volatiles)
    - Special purpose monitoring
    - Use of satellite data and other emerging sources
    - Supplemental data from low cost air sensors

- Analyze exceptional events; overview of rule and current guidance
    - Eligibility of the event
    - Required elements of an exceptional events demonstration
    - Exceptional events basic process
    - Implementation tools and resources

- Conduct nonattainment NSR (NNSR) analyses: LAER and emission offsets
    - Focus on LAER analysis and identifying the most stringent emission limitation in practice for a type of source
    - Case study on state "bank" for offsets

- Prepare an attainment demonstration for a nonattainment SIP
    - Prepare a modeling protocol for an attainment demonstration (e.g., lead, SO2, ozone, PM2.5)
    - Description of air quality modeling attainment tests and guidance (modeling process, details of attainment tests, post-processing software, weight of evidence)
    - Resources available for assistance
        - Guidance and advice – SCRAM/Model Clearinghouse
        - Assistance with preparing demonstration – multijurisdictional organizations, state guidance, EPA Regional Office modelers, etc.

- Research and develop information to ensure a SIP revision does not interfere with any applicable requirement concerning attainment, RFP, or other CAA requirements
    - Addressing CAA section 110(l)
    - Submitting a demonstration to support a SIP revision

- Compile emission inventories (especially for nonattainment areas)
    - Overview of nonattainment area emission inventory vs. statewide emission inventory
    - Overview of control measures and emission reduction assumptions; need to understand level of control before control measures are applied
    - PM condensable emissions
    - VOCs and semi volatile organic emissions
    - Use models for mobile source emissions and power sector

- Analyze and plan control measures for SIPs (i.e. RACT/RACM)
    - Compare RACT/RACM, BACT/BACM, MSM
    - RACT analysis approvability issues (sector- and source-specific)
    - Case studies, including different state examples, some of which may have requirements that are more stringent than EPA's

- Interpret and apply special CAA provisions
    - Consideration of international transport of air criteria pollutants (CAA section 179B) – prospective and retrospective
    - PM precursor demonstrations, i.e., showing that a PM10/PM2.5 precursor has insignificant contribution in an area
    - Rural transport (CAA section 182(h))

    - Economic incentive programs
    - Ozone transport region

- Interpret and apply general and transportation conformity requirements
    - General conformity case studies
    - Transportation conformity:
        - Hot spots
        - Isolated rural areas
        - Topics related to MOVES model for estimating future transportation emissions

- Formulate redesignation and maintenance plans
    - Limited maintenance plan policies
    - Requirements for first and second 10-year maintenance plans
    - Redesignation under revoked standards

- Prepare a Clean Data Determination (CDD) request

- Interpret and apply Regional Haze requirements
    - Specific elements and issues in plans for second planning period
        - Details on each step in the Regional Haze SIP process (e.g., ambient data analysis, source selection, four factor analysis, etc.)

ATTACHMENT E

Air Toxics Rule Development and Implementation Curriculum (3/3/20)

Goal: To help state, local, and tribal air professionals build their knowledge base and capacity to conduct air toxic risk assessments, communicate air toxics risks appropriately, and/or develop rules in compliance with the applicable Clean Air Act requirements.

Audience: The primary audience is state, local, and tribal air professionals; however, we recognize that this curriculum will also help serve to build capacity and knowledge of EPA staff. The curriculum presumes these students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under Air Toxics.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[3] Learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts. The "intermediate" level is intended to help students apply and analyze concepts, and the "advanced" level is intended to help students create and evaluate key concepts as well as master the curriculum.

Foundational

- Describe how and why air toxics are regulated by the EPA
    - Define air toxics
        - Toxicological endpoints of air toxics
        - Air toxics v. criteria pollutants
        - What are HAPs and where are they listed?
        - Process for adding or removing HAPs from the HAPs list
    - Cancer and non-cancer health effects associated with air toxics
        - Inhalation vs. other routes of exposure
        - chronic vs. acute exposures
    - Overview of changes in federal regulatory involvement from the 1970 Clean Air Act (CAA) to the 1990 CAA
        - The creation of Title III of the 1990 CAA
    - How the National Emission Standards for Hazardous Air Pollutants (NESHAPs) are used to regulate sources
        - NESHAP overview, history, and regulatory background
        - Major vs. area source categorization
            - Difference between a 3-part test for criteria pollutants and the 2- part test for HAPs
        - Listed source categories: what each entails for those sources, and how are changes made to the list of source categories.

[3] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

        - When do HAP-emitting sources require a federal operating permit?
        - What are the criteria for major versus area sources?

    - Introduction to the NESHAP process -- how HAPs are regulated under the CAA
        - CAA Section 112's role in establishing NESHAPs
            - Ambient standards for criteria pollutants vs. technology-based standards for HAP
            - How maximum achievable control technology (MACT) standards are established
            - How generally available control technology (GACT) standards are established
            - Residual Risk Standards
            - Risk and technology review (RTR) overview
                - When RTRs are done
                    - Ongoing technology review
                - Components of a residual risk program

    - Other national rules for HAPs
        - Rules under CAA Section 129 and other 112 Sections (e.g., 112(b))
        - Mobile source air toxics

- Summarize how toxicity values are selected and applied for air toxics risk assessments
    - Sources of toxicity values
        - EPA's Integrated Risk Information System (IRIS)
        - Health benchmarks from other agencies, such as CalEPA and Agency for Toxic Substances and Disease Registry (ATSDR)
    - Chronic versus acute health toxicity values
    - Carcinogenic versus non-carcinogenic toxicity values
    - Example methods used by state air toxics programs to evaluate toxicity
        - Basic principles of air toxics risk assessment and communication

- Describe the air toxics ambient air monitoring networks
    - NATTS
    - UATMP
    - Additional S/L operated AT
    - Community Scale Grant Project

- Describe available emissions data sources
    - National Emissions Inventory (NEI)
    - Toxics Release Inventory (TRI)

Intermediate

- Identify potential air toxics risk in an area
    - Data
        - NEI reporting, data flows, and access (Specific focus on HAPs)

        - Combined Air Emissions Reporting (CAER)
        - Ambient measurements of air toxics including discussion about NATTS/UATMP, caveats – or point to training for this
        - Ambient measurements near sources
        - TRI
    - Tools
        - Air quality modeling of HAPs
            - Purpose of air quality modeling
            - Model types:
                - Photochemical
                - Dispersion
            - Caveats about AQ Modeling
        - Risk assessment modeling of HAPs
            - Purpose of risk assessment modeling
            - Model types [by scale (community, facility, etc) and/or pathway))
            - Caveats about risk assessment modeling
        - National Air Toxics Assessment (NATA)
            - Background and purpose
            - Application of NATA (including NATA risk mapping GIS application)
            - Most recent NATA results

- Locate facility-specific data
    - TRI
    - NEI
    - ECHO
    - NATA Map application
    - Permits
    - ECatt (ECHO Clean Air Tracking Tool)
    - EJ SCREEN
    - RSEI (TRI)

- Review EPA's process for establishing MACT and GACT Standards
    - How are MACT floors set
    - What is a beyond-the-floor MACT evaluation
    - Establishing work practice standards
    - The difference between GACT and MACT
    - How is GACT established

- Explain residual risk standards
    - Section 112(f)
    - Identify residual risk requirements
    - Acceptability criteria and Ample Margin of Safety (AMOS)

- Explain how regulated sources demonstrate compliance
    - Parametric monitoring of control devices

- Monitoring of operations for process equipment
- Recordkeeping
- Reporting, including information about CEDRI
- Testing – annual or periodic
- Fenceline monitoring, continuous emissions monitoring systems
- Other sources of emission factors
- Emission calculations

- Explain the process for conducting RTRs
  - Evaluation of health factors, control options, environmental justice, and economic considerations
  - Use of AERMOD for RTR purposes
    - What are the inputs for AERMOD?
      - Source characterization
      - Meteorological data
      - Receptor placement—looking at potential areas for high concentrations or risk

- Define the key elements of performing a risk analysis
  - Developing emissions data (National Emissions Inventory)
  - Air quality modelling
    - Receptors, met data
  - Health benchmarks
  - Model scenarios (actual, allowable, whole facility, inhalation, multipathway, chronic, acute)

- Describe ways of utilizing available ambient data
  - Evaluation of air quality model outputs
  - Direct inputs to source-receptor models
  - Special studies
  - Network assessment
  - Trends

- Identify air toxics program implementation authority
  - State-only vs. federal HAP
  - Describe the regulatory process for delegation of authority to states and tribes

- Summarize the technologies used to control air toxics
  - Oxidation processes (incineration, afterburners, flares)
  - Scrubbers (aqueous alkaline or acid, dry sorbent injection)
  - Fabric Filter control (baghouses)
  - Electrostatic Precipitators
  - Activated Carbon Injection
  - Condensers
  - Carbon absorption and adsorption

- Identify source-specific performance considerations related to control technologies, for example:

    - Utilities
    - Petroleum refineries
    - Oil and gas
    - Chemical production
    - Mineral processing
    - Others

- Describe how emission factors are developed and where they can be found
    - Sources of emission factors
    - Uncertainty related to emission factors

Advanced

- Establish case-by-case standards for sources under CAA sections 112(g) and 112(j)

- Differentiate between setting a numeric emissions limit or setting a work practice

- Design and conduct a risk assessment
    - Apply health benchmarks
    - Special studies (e.g., monitoring)
    - Use methods for identifying at-risk populations (e.g., NATA and HEM/AERMOD model)
    - Compare ambient air monitoring data to risk assessment results ("ground truthing")

- Differentiate between advanced methods for utilizing ambient data to determine sources
    - Source apportionment—modelling for specific contributions
    - Wind roses/pollution roses
    - Back trajectories

- Apply ambient monitoring methods – operational and quality control focus
    - Method description, calibration, precision and bias statistics, network usage

- Execute effective risk communication
    - Best practices for effective risk communication
    - Interpretation of risk data
    - Memos
    - Presentations
    - Involving the public in risk communication, especially affected communities

ATTACHMENT F

Ambient Air Monitoring Curriculum (3/3/20)

Goal: To help state, local, and tribal air professionals build their knowledge base and capacity to conduct ambient air monitoring in compliance with the applicable Clean Air Act requirements and associated monitoring regulations.

Audience: The primary audience is states, local, and tribal air professionals. This curriculum is also useful for EPA staff. The curriculum presumes these students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under ambient air monitoring.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[4] The learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts; the "intermediate" level is intended to help students apply and analyze concepts; and the "advanced" level is intended to help students create and evaluate key concepts, as well as master the curriculum. After taking courses through this curriculum, students will be able to conduct planning, apply methods, and analyze and validate data.

Foundational

- Describe how atmospheric processes affect air pollutants (including the difference between primary and secondarily-formed pollutants)
    - Dispersion
    - Transport
    - Photochemistry
    - Meteorology

- Describe how the Clean Air Act (CAA) determines what is measured in the ambient air
    - Criteria pollutants (e.g., CAA section 110(a)(2)(A)(i))
    - Hazardous air pollutants (HAPs)

- Explain Federal-state-local-tribal partnership
    - Communication between states, locals, and tribes
    - Tribal sovereignty
    - Memorandums of understanding (MOUs) or memorandums of agreement (MOAs)
    - Primary Quality Assurance Organization (PQAO) agreements
    - EPA structure and function
        - HQ offices

[4] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

        - Office of Air Quality Planning and Standards
        - Office of Research and Development
    - Regional offices

- Explain the objectives for using monitoring data
    - NAAQS - Why we monitor and collect data
        - Primary and secondary standards
            - Describe what a design value is
        - State implementation--attainment and nonattainment
        - Difference between individual exceedances of NAAQS vs. non-attainment
    - Air toxics – Why we address air toxics
        - Authority to address air toxics
        - Types of air toxics sources we regulate
        - Urban air toxics
    - Air Quality Index/Public awareness
    - Support air programs and research, e.g.:
        - Accountability for emission control programs,
        - Health studies,
        - Air quality trends,
        - Local objectives

- Describe the key components of an ambient air monitoring program
    - Data Review / Data Management
    - Field Operations
    - Laboratory Operations
    - Basic network/monitor maintenance responsibilities
    - Example programs and associated considerations
        - Small tribal program
        - Large state program

- Define Federal Reference Method (RM) versus Federal Equivalent Method (FEM)
    - Samplers versus automated

- Describe monitoring specifications/ requirements
    - 40 CFR Parts 50, 53 and 58
    - Data requirements rule
    - Changed by notice and comment rulemaking (example)
    - AMTIC web site – source for additional information
    - Locate available guidance documents

- Describe the basic QA systems for data collection and the EPA QA system
    - Why the program is important

- List the monitoring networks in place to support NAAQS and other non-NAAQS pollutants
    - Monitoring Network Type / Classification
        - SLAMS
        - Tribal
        - SPM
        - EPA
        - Industrial
        - Non-EPA Federal
    - Network Affiliations
        - Criteria and Supporting Criteria Affiliations
            - NCore
            - PAMS (Photochemical Assessment Monitoring Stations) and EMPs (Enhanced Monitoring Plans)
            - CSN (Chemical Speciation Network)
            - Near-Road
            - IMPROVE (Inter-Agency Monitoring of Protected Visual Environments)
            - CASTNet
            - PSD
        - Air Toxics Affiliations
            - NATTS
            - UATMP
            - Additional S/L operated AT
            - Community Scale Grant Project
        - Other monitoring networks
            - Sensors
            - Industrial and PSD

- Explain where the monitoring data goes
    - AQS website
    - AIRNow website

Intermediate

- Distinguish between types of ambient monitoring methods
    - Monitors versus Samplers
    - FRM versus FEM—Manual versus automated

- Continuous gases
- Reactive and non-reactive (scavenging and residence time)
- Pb
- Other (PAMS – automated gas chromatographs) and/or evacuated canisters
- $PM_{2.5}$ speciation
- Introduction of potential bias when switching from FRM to FEM
- Sensors/Advanced Techniques

- Integrate network design considerations (based on 40 CFR 58, Appendix D)
  - Monitoring objective of a particular monitor/site
  - Site types (e.g., max concentration, population exposure)
  - Spatial scale of representation
  - Minimum network requirements
  - Sampling frequency requirements
  - Annual network plans and assessments

- Evaluate a site for probe siting (based on 40 CFR Part 58, Appendix E)
  - Permissible height above the ground for monitor/sampler inlet
  - Vertical and horizontal spacing from supports and other monitors/sampler inlets/probes
  - Spacing from minor sources, obstructions, and trees
  - Spacing from roadways
  - Requirements for probe material and sampling residence time
  - Collocation
  - Waiver provisions

- Apply quality assurance and data validation
  - Compare and contrast a PQAO to a Monitoring Organization Relationship
    - key elements of a QA program,
    - roles/responsibilities of key QA staff/manager contrasted with the monitoring staff/manager,
    - independence of QA organizations
  - Importance of data certification, defensibility of the data, and ensuring scientific integrity
  - Quality Assurance References
    - EPA Quality Policy
    - CFR Part 58
    - Quality Assurance Guidance Resources
    - Technical Memoranda
    - QA-EYE Newsletter
    - Tools
  - Data quality objectives and indicators

- Writing and reviewing/approving quality systems
  - Quality management plans (QMPs),
  - Quality assurance project plans (QAPPs),
  - Standard operating Procedures (SOPs),
  - MQOs and Appendix D Validation templates
- Contrasting Precision versus Bias
  - Error
- Data validity and qualification
  - Importance of documentation
- Traceability and certification
- Calibration and verifications
- Sample handling and custody
- Documentation/Record-keeping
- Data management
- Requirements and guidance
  - Example criteria for validation
  - Weight of evidence
- Audits
  - Regulatory requirements for audits
  - Audit types
  - Technical systems audits
  - Federal programs (NPAP, PEP)
  - State performance evaluations, flow audits
  - Network Support Programs (NATTS, PAMS, CSN Mega PE)
  - Troubleshooting and corrective action

- Apply best practices for acquiring, storing, and reporting data
  - Data acquisition systems
  - Telemetry
  - Data reporting requirements
  - Data handling appendices in CFR for each criteria pollutant (with the exception of carbon monoxide)
  - Statistical techniques and design values
  - How to access AQS
  - Data Certification
    - AQS data submission process
  - Training links

- Describe emerging monitoring options
  - Explain emerging monitoring options
  - Overview of sensors (applications, issues vs regulatory monitoring, resources)
  - Data fusion examples (model vs measurement)

- Satellite based measurements
- Emergency/Wildfire monitoring and forecasting

Advanced

- Apply ambient monitoring methods – operational and quality control focus
  - Continuous gases (CO, O_3, NO_2, SO_2)
    - Method description, calibration, precision and bias statistics, network usage
  - FRM PM monitors (PM_{10}, $PM_{2.5}$, Pb)
    - Method description, calibration, precision and bias statistics, network usage
  - FEM PM monitors (PM_{10}, $PM_{2.5}$)
    - Method description, calibration, precision and bias statistics, network usage
  - Supporting measurements (CSN, PAMS, Toxics)
    - Method description, calibration, precision and bias statistics, network usage

- Conduct Quality Assurance
  - Exploratory data analysis
  - QA statistical calculations and related tools
    - 40 CFR Part 58 Appendix A calculations
    - Data assessment statistical calculator
  - QA reporting tools
    - AQS reports
      - AMP251/256: QA Raw Assessment Report
      - AMP256: QA Data Quality Indicator Report
      - AMP504: QA Data Assessment Tool
      - AMP600: Certification Evaluation and Concurrence
    - Data Assessment Statistical Calculator (DASC)
    - Visualization tools

- Conduct network planning
  - Create annual monitoring network plan
  - Conduct 5-year network assessments

- Certify data annually
  - Timeline
  - Process

- Analyze data for various purposes
    - Trends
    - State Implementation Plans and Attainment Demonstrations
    - Exceptional Events
        - Exceptional event rule
        - Process for assigning an exceptional event in AQS

- Access comprehensive list of web tools (AQS Reporting/Training, AIRData, AIRNowTech, Air-trends, Fire resources)

ATTACHMENT G

Emissions Inventories Curriculum (4/7/20)

Goal: To help state, local, and tribal air professionals build their knowledge base and capacity to develop emission inventories in compliance with the applicable Clean Air Act requirements.

Audience: The primary audience is states, local, and tribal air professionals. This curriculum is also useful for EPA staff. The curriculum presumes students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under Emissions Inventories.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[1] The learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts; the "intermediate" level is intended to help students apply and analyze concepts; and the "advanced" level is intended to help students create and evaluate key concepts, as well as master the curriculum.

Foundational

- Define an emissions inventory
    - Explain differences between different emissions inventories, such as NEI and TRI, and greenhouse gas inventory
- Describe the goals, purpose, and uses of the National Emissions Inventory (NEI)
- Explain the types of emissions inventories and their purposes, including:
    - Air quality modeling for SIPs
        - Future-year emissions projections basics
        - The use of emission inventories for EPA rulemakings (transport analysis and cost/benefit analysis)
        - Modeled attainment demonstrations (for SIPs)
        - Source-based dispersion modeling
    - NAAQS and Regional Haze planning
        - Pollutant-specific inventories
        - Seasonal versus annual emissions inventories
    - Emissions trends for state, local, and tribal planning
        - Variability
    - Air toxics
        - Toxic release inventory (use of TRI in developing the NEI)
        - NATA (risk)
        - Risk and Technology Review (RTR) Modelling and files used to enhance NEI/TRI data
    - Greenhouse gases
        - Greenhouse Gas National Inventory
        - Greenhouse Gas reporting program

- Compliance Inspections
- NEPA analysis

- List sources covered under inventory data categories
  - Onroad/nonroad (developed using the MOVES and/or EMFAC models)
  - Point/Facility
  - Nonpoint
  - Events (wildfires, prescribed fires, ag burning)
  - Biogenic and Geogenic

- Describe sources of data for building emissions inventories
  - Stationary source emission factors
    - WebFIRE (emission factors from stack tests, Electronic Report Tool (ERT), WebFIRE Template)
    - Other sources (e.g., literature reviews, GHG program, ISIS Air)
  - Continuous Emissions Monitors (CEMs)
  - SPECIATE database overview
  - Overview of emissions data tools for nonpoint, mobile, and fire sources
  - EPA's emissions inventories webpage

- Describe the greenhouse gas (GHG) reporting program

- Describe streamlining efforts under E-Enterprise:
  - CAER (combined air emissions reporting)

Intermediate

- Apply the Air Emissions Reporting Requirement (AERR) Rule (purpose of the EI)
  - Who is covered by the AERR
    - State/Local air programs
    - Tribal air programs
  - Requirements under the AERR for each data category versus optional data
  - Schedule of data submissions under the AERR
  - Confidential business information (CBI)

- Select Emissions Inventory Reporting Tiers and Codes
  - Overview
  - How to select a Source Classification Code
  - How to request a new Code
  - Best practices

- Employ emissions data available on EPA's inventory homepage

- Locate facility specific emissions data
- Retrieve data for particular sectors
- Customize emission retrievals by specific geographic areas

- Employ the Emissions Inventory System (EIS)
  - EIS basics for SLT and MJOs
  - Accessing and downloading code tables
  - EIS summary reports: Focus on SLT's and MJO's needs
  - EIS summary reports: Focus on EPA needs (Regional Offices and HQ)

- Develop an inventory plan
  - Identify inventory type
  - Identify important sources for planning purposes
  - Create an Inventory Preparation Plan (IPP) and/or Quality Assurance Project Plan (QAPP)

- Use emission modelling framework (EMF)
  - To manage inventories
  - Use the CoST tool for control strategy development
  - To run emissions models

- Describe how EPA develops Emissions Factors using the Emissions Factors Procedure document

- Explain the requirements for SIP emissions inventories for NAAQS and Regional Haze attainment plans

- List and define the parts of EPA's emissions modeling platforms

- Identify priority source categories for inventory review and development

- Describe how to develop scientific research that meets the requirements needed to support the National Emissions Inventory, SPECIATE, and Emissions Factors development

- Develop an emissions fees program

Advanced

- Create an emissions inventory database and collection programs that comply with EPA requirements

- Develop data for nonpoint sources
  - EPA Wagon Wheel tool for selected Nonpoint categories

    - Tool specific trainings:
        - Development of emissions inventory for oil and gas (this will probably need to be several modules)
        - 1 training per sub-category. (note: this would be dozens of trainings, and could be used for tribal emissions calculations)

- Develop data for point sources
    - Facility inventory development
    - Estimating point source emissions and quality assurance
        - The importance of the quality of data (e.g., stack and fugitive release parameters and Lat/lon of the releases can have a significant impact on point source health risk modeling like NATA and OAQPS RTR program.)
    - EPA process for NEI point: EPA augmentation, completeness, EPA feedback, and providing comments
    - Integrate with the CAER Common Emissions Form System and its web services
    - Best practices for handling confidential business information (CBI)

- Develop data for mobile sources
    - Developing vehicle miles traveled (VMT) and vehicle population data
    - Developing other MOVES inputs for submission to the NEI Program via EIS
    - MOVES (note: using MOVES is a 2-day training for which OTAQ already has an ongoing program)

- Develop data for events sources
    - SMARTFIRE/Bluesky Framework for wildfires and prescribed burning
    - Agricultural fires methods
    - EPA process for NEI fires: providing inputs, review, and comments

- Create Biogenics emissions data
    - Running and evaluating results from the BEIS model
    - Running and evaluating results from the MEGAN model

- Create future-year emissions projections
    - Integrated Planning Model (IPM) – (note: need to coordinate with CAMD on this)
    - ERTAC EGU model
    - Onroad and nonroad sources using MOVES
    - Non-EGU stationary sources (both point and nonpoint in general)

- Conduct emissions modeling
    - Spatial allocation surrogates development
    - Running the Spatial Surrogates Tool and Spatial Allocator
    - Running the Speciation Tool

    - Temporal allocation factor development
    - Running SMOKE
    - Emissions modeling QA
    - EPA's emissions modeling platforms: understanding SMOKE run scripts and input files

- Develop inventory for SIP
    - Advanced inventory development for SIP, such as:
        - PM condensable emissions
        - VOCs and semi volatile organic emissions
        - Develop Emissions inventories at the sub-county scale

- Evaluate sources of uncertainty in emissions inventories
    - Point sources
    - Stationary nonpoint sources
    - Onroad mobile sources
    - Nonroad mobile sources
    - Events
    - Biogenic sources
    - Geogenic sources

- Submit data for NEI through EIS Gateway
    - QA versus Production environment
    - Required fields and how to edit them
    - Staging tables
    - Bridge tools
    - Web client
    - Node to node
    - How to review errors and warnings in feedback file
    - How to interpret and complete the nonpoint survey
    - Using the Gateway to make emissions inventory edits

- Analyze EIS outputs
    - Using comparison reports for inventory QA
    - Advanced emissions inventory reports

- Use the CAER Common Emissions Form

ATTACHMENT H

Permitting Curriculum (4/7/20)

Goal: To help EPA, state, local, and tribal air pollution professionals build their knowledge base and capacity to conduct permitting activities and write permits in compliance with the applicable Clean Air Act requirements.

Audience: The primary audience are professionals assigned to air quality permitting roles at EPA, state, local and tribal air agencies. The curriculum presumes these students will have taken some, or all, of the courses in the Air Pollution Basics curriculum before taking the courses under permitting.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[5] The learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts; the "intermediate" level is intended to help students apply and analyze concepts; and the "advanced" level is intended to help students create and evaluate key concepts, as well as master the curriculum.

Foundational materials

Preconstruction Permitting – New Source Review (NSR)

- Identify the role of the NSR permitting program

- Describe the major aspects of NSR Program history
    - Statutory requirements
    - Regulatory requirements
    - Sources and pollutants (including precursors) covered
    - Key guidance documents and policy memos developed by EPA and where to find them
    - The importance of permitting in protecting air quality—success stories, trends

- Outline the types of NSR permits and basic requirements for each
    - Major NSR permits
        - Attainment/unclassifiable (PSD)
        - Non-attainment NSR (NNSR)
    - Minor NSR permits
        - Synthetic minor sources
        - True minor sources
        - Tribal NSR
    - Other permitting options
        - General Permits
        - Permit by rule
        - Plant wide applicability limitations (PALs)

[5] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

- Outline the NSR permitting processes
    - Pre-application meetings/protocols/consultations
    - Determining Permitting Applicability
    - Permit Application Submittal
    - Permitting Authority Review
        - Include overview of BACT, LAER, use of emission reduction credits (ERCs) as emission offsets, modeling, emission limits to assure compliance with NAAQS
    - Public Participation
        - Opportunities for public comment (e.g., notice and hearing)
    - Permit Issuance
    - Appeals of Permit Decisions

- Describe provisions governing actions occurring after NSR permit issuance
    - Commence Construction
    - Begin Actual Construction
    - Permit rescission
    - Permit revision
    - Permit extension

- Describe regulatory authorities for issuing permits
    - EPA authority: issued by EPA regional office
        - EPA authority on Tribal lands
        - Outer Continental Shelf (OCS) jurisdiction
        - Areas without delegation or SIP approval
    - Authority delegated by EPA to state or local air agency: issued by air agency on behalf of EPA under EPA's rules
    - Authority under an approved SIP: issued by a state or local agency under its rules

- Navigate EPA website to access NSR websites, guidance documents, and other tools, (including EPS and RACT/BACT/LAER Clearinghouse)

Operating Permits – Title V Program

- Describe the statutory history of the operating permits program, from its inception

- Examine the purpose of the Title V Permitting Program
    - Role of compliance demonstration and recordkeeping
    - How Title V drives transparency,
    - Citizens' access to monitoring reports and records

- Identify pollutants covered by the Title V permit program

- Describe conditions requiring a source to obtain an operating permit

- Describe regulatory authorities for issuing permits
    - State authority under 40 CFR Part 70

- Federally enforceable state operating permits (FESOP)
- EPA authority under 40 CFR Part 71
  - Circumstances for permitting on Tribal lands
  - Outer Continental Shelf (OCS)
  - Areas where there is no EPA-approved state program (expired/withdrawn)
  - When EPA objects to state-issued permit and state does not fix

- Outline the Title V permitting processes
  - Determining permitting applicability
  - Preparing and submitting permit application
  - General practices for writing a permit
  - Statement of basis
  - Public Participation (include discussion of e-notice / e-access), Comment Period
  - EPA review (under Part 70)
    - EPA objection
    - Petition for EPA objection (under Part 70)
  - Permit issuance
  - Appeal of permit decision
  - EPA Reopens permit for cause (under Part 70)

- Describe types of permit actions
  - Initial application
  - Renewal
  - Modification
  - Administrative amendments

- Provide examples that help students discern what type of Title V permit action is required

- Navigate EPA website to be able to easily access Title V websites, guidance documents, and other tools

Intermediate materials

Preconstruction Permitting – New Source Review (NSR)

- Determine what types of sources are subject to federal NSR permitting
  - Definition of Stationary Source
  - Single source determinations – 3-part test and support facilities
  - Temporary emission sources
  - Vessels emissions
  - Outer Continental Shelf (OCS) sources
  - Deepwater ports
  - Portable sources (e.g., support vehicles or vessels)

- Identify NSR Pollutants and calculate emissions to determine major or minor NSR
  - Regulated NSR Pollutants
  - Secondary Emissions

- Potential to Emit and Enforceability
- Quantifying Emissions – estimating techniques, validity/accuracy
- Emission factors & reliability

- Define major NSR permit applicability requirements
  - Major Source applicability
    - NNSR applicability procedures
      - 100 TPY Major Source Threshold
      - Less than 100 TPY in certain NA areas
    - PSD applicability procedures
      - 250 TPY, unless a 100 TPY source category
      - If major for one pollutant, SER is trigger for other pollutants to be subject to PSD
      - Counting fugitive emissions
    - Reactivation of a permanently shutdown facility
    - Excess Emissions During Periods of Startup, Shutdown, or Malfunction
    - Relaxing Limits to Avoid Major NSR (e.g., 40 CFR 52.21(r)(4); 40 CFR §51.165(a)(5)(ii))
  - Major Modification applicability
    - Significant Emission Rates (SERs)
    - Exclusions from Modification – RMRR, hours of operation, etc.
    - Applicability procedures for modifying existing emission units, adding new emission units, and "Replacement Units"
    - Step 1: Significant Emissions Increase Calculation (Project Emissions Accounting)
      - Baseline Actual Emissions
      - Actual to Projected Actual (ATPA) applicability test
      - Project Aggregation
      - Debottlenecked Emission Units
    - Step 2: Significant Net Emissions Increase (Contemporaneous Netting)
  - Plant-wide Applicability Limitation (PAL) permits
    - Establishing an Actuals PAL – setting the limit; contents of the PAL permit; effective period
    - Other PAL actions: renewing, expiring, reopening, adjusting, increasing, terminating, etc.
    - Monitoring, recordkeeping, reporting

- Define major NSR permit requirements
  - PSD permit requirements
    - Top Down BACT
    - NAAQS and PSD Increment compliance demonstration
      - Ambient air
      - Significant Impact Level (SIL)
      - EPA's *Guideline on Air Quality Models*
        - Source Impact Analyses
        - Cumulative Impact Analyses
    - Class I area impacts analysis and Air Quality Related Values (AQRVs)
      - Federal Land Manager coordination
    - Additional impacts analysis (secondary impacts)

        - Preconstruction or postconstruction monitoring
    - NNSR permit requirements
        - Lowest achievable emission rate (LAER) analysis
        - Emissions offsets
        - Emission reduction credits (ERCs) , generation, banking and use as offsets
        -
        - CAA compliance certification
        - Alternatives Analysis

- Define minor NSR permit requirements
    - True and synthetic minor sources
    - Regulatory requirements for minor NSR
    - Tribal minor NSR program
    - State and local agency minor NSR programs

- Define procedures and best practices for preparing NSR permits
    - Pre-application meetings with applicant
    - Determining permit applications to be complete
    - Writing clear, unambiguous permit conditions
    - Setting enforceable PTE limits
    - Noticing the draft permit and public participation
    - Preparing a Statement of Basis for the draft permit
    - Responding to public comments on the draft permit
    - Issuing the final permit
    - Appeals of permit decisions

Operating Permits – Title V Program

- Evaluate a source for major source applicability
    - Single source determination

- Determine applicable requirements, e.g.,
    - MACT/NESHAP
    - NSPS
    - SIP limits
    - Limits from NSR permits
    - Synthetic minor limits
        - Why a source might take a synthetic minor limit
        - How to ensure limits are enforceable

- Implement the operating permit issuance process
    - Initial application
    - Renewal
    - Modification
        - Significant, Minor
    - Operational Flexibility - 502(b)(10) Changes

- Define best practices for writing title V permits
  - Writing clear, unambiguous permit conditions
  - Enforceability
  - Statement of Basis preparation
  - Public participation
  - Response to comments (RTC) preparation
  - Record keeping and reporting
- Incorporate by reference (IBR) (level of detail needed for incorporating applicable requirements)
  - Federal and state requirements

Advanced Materials

Preconstruction Permitting – New Source Review (NSR)

- Determine Actual-to-projected-actual (ATPA) values for an example scenario
- Determine Best Available Control Technology (BACT) for an example scenario
- Determine Lowest Achievable Emissions Rate (LAER) for an example scenario
- Perform air quality impact analysis
  - Explain how a NAAQS assessment is performed
  - Explain how a PSD Increment analysis is performed
- Perform contemporaneous netting analysis for an example scenario for both PSD and NNSR Perform Inter-pollutant trading (IPT) scenarios
- Write effective NSR permits
  - Required permit content
  - Enforceable permit conditions, including applicable
    - Emission limits/standards
    - Operating limits/standards
    - Testing requirements
    - Compliance Demonstration Methods
    - Emissions monitoring methods
    - Recordkeeping and reporting
  - State or local specific general conditions reporting
  - Public notice and Statement of basis
  - Response to Comments (RTC)

Operating Permits – Title V Program

- Write effective title V permits, per example scenarios
  - Writing clear, unambiguous permit conditions
    - Enforceable permit conditions, including applicable:
      - Conditions from consent decrees
      - Federal and state regulations
        - Emission limits/standards
        - Operating limits/standards
        - Testing requirements
    - Monitoring (including CAM to assure compliance)

        - Record keeping and reporting
            - Incorporate by reference (IBR) (level of detail needed for incorporating applicable requirements)
        - General conditions
        - Insignificant emission units
        - State-only (or local-only) permit conditions
        - Compliance schedule
        - Permit shield (optional)
    - Statement of Basis preparation
    - Public participation
    - Response to comments (RTC) preparation

- Apply advanced permitting concepts
    - Permit streamlining
    - Evaluating monitoring adequacy
        - Sufficiency Monitoring
        - Compliance assurance monitoring—applicability and reviewing plans
        - Parametric monitoring
        - Surrogates
        - 3 steps under part 70
            - Gap-filling monitoring

ATTACHMENT I

Source Emissions Testing and Source Emissions Monitoring Curriculum (3/3/20)

Goal: To help federal, state, local, and tribal air professionals build their knowledge base and capacity to observe and review reports from source emissions testing and source emissions monitoring in compliance with the applicable Clean Air Act and state/local/tribal emission measurement requirements.

Audience: The primary audience is state, local, and tribal air professionals. This curriculum is also helpful for EPA staff. The curriculum presumes these students will have taken some, or all, of the courses in the Air Basics curriculum before taking the courses under source emissions testing and source emissions monitoring. This curriculum also presumes that students have a basic understanding of math and science concepts and principles, commensurate with an undergraduate degree.

Learning Objectives: Learning objectives in this curriculum follow Bloom's Taxonomy.[6] The learning objectives for the "foundational" level courses are focused on helping students remember and understand key concepts; the "intermediate" level is intended to help students apply and analyze concepts; and the "advanced" level is intended to help students create and evaluate key concepts, as well as master the curriculum.

Foundational

- Describe the sections of the Clean Air Act and the Code of Federal Regulations that include emission test methods and monitoring requirements for stationary sources
    - CAA Section 110: State Implementation Plans (SIPs) and Tribal Implementation Plans (TIPs)
        - 40 CFR Parts 51 and 52
    - CAA Section 111: Standards of Performance for New Stationary Sources
        - 40 CFR Part 60 and 62
    - CAA Section 112: Hazardous Air Pollutants
        - 40 CFR Parts 61 and 63
    - CAA Section 129: Solid Waste Combustion
        - 40 CFR Part 60 and 62
    - CAA Section 301: General Provisions – Administration (delegations of powers and duties, including Tribal authority)
    - CAA Section 401: Acid Deposition Control (also called the Acid Rain Program)
        - 40 CFR Parts 72 and 75

[6] Bloom, B. M., Englehart, E., Furst, E. H., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals.* New York: McKay.

- Locate specific source test methods in the CFR
    - Introduction to EPA's Air Emission Measurements Center website (https://www.epa.gov/emc)

- Explain key concepts related to emission test methods
    - How measurement methods work
        - How one arrives at an emission concentration or rate (e.g., PM collected on a filter, concentrating mass on filter. At end of test, weigh mass, use volume of air to correlate…)
    - Detection limits—can compliance be determined without a "real" number?
    - How methods interface with the rules, particularly those located in the CFR Subparts
        - Introduction to alternative test methods and their use
            - Major vs. minor vs. intermediate
            - Who can approve modifications?
            - Define and provide examples of alternative, conditional, and other test methods, including ASTM
            - Discuss strategies for evaluating the implementation of these methods

    - Recognize different types of stack testing equipment (e.g., sampling train)
    - Where to find general performance testing requirements (e.g., 40 CFR 60.8)
    - Explain the difference between source testing, source monitoring, and test methods (isokinetic, non-isokinetic and instrumental)
    - Explain the difference between types of testing: engineering testing, performance testing and performance evaluations (also known as relative accuracy test audits (RATAs)
    - Explain accreditation

- Describe Pre-test Planning
    - Reviewing a test plan/protocol
        - Basic requirements
        - Explain the importance of the test plan/protocol
        - Dealing with major versus minor modifications to the source testing methods used. Example changes that can be allowed vs. those that are more significant
    - Responding to a test plan/protocol submittal (questions, process data, operating conditions, modifications)
    - Audit sample program – why audit samples are important and when are they required
    - What safety training/devices is required for observers? (basic HAZWOPER, personal protective equipment, body harness)

- Source responsibilities during test (final test report includes facility operating conditions/process parameters)
  - Correct unit operation
  - Process parameters
  - Review of test contractor report and certification
- Tester expectations during test
  - Field notes & data
  - Lab data & reports
  - Example calculations
  - QA/QC
  - Explanations of all deviations, data outliers, modifications and omissions

- Apply the basic principles for observing stack tests/conducting audits
  - Basics of observing a stack test
  - Check lists for source test observations
  - How to conduct audits of continuous emission monitoring systems (CEMS) and for a stack test, based on the particular test method or procedure
  - Identifying key parameters to watch on the source side during the test to ensure the operating conditions of the source are representative during testing runs and ensure emissions as tested by the reference method can be translated into proper emission factors or operating limits.

- Review completed source test reports
  - Deviations, modifications, omissions (what went wrong and why)
  - How to use consistency to identify testing problems
  - Example equations and verifying calculations
  - Lab data
  - Using EPA's electronic reporting tool (ERT) to review and enter data
    - Calculational errors generally avoided by using the ERT
  - Identify common errors
  - Discuss SLT/EPA/IG identified deficiencies/enforcement cases
    - Tester assumed "gr/ton" was grams/ton instead of grains/ton – facility failed source test and decided to shut down instead of install controls.
  - When are results "good enough" for compliance?

- Identify the primary procedures for Test Methods 1-5 and Method 19 (these are core methods for most tests) and describe why they are important and their limitations
  - Sampling location specifications (Method 1 and 1a)
  - Flow rate in a stack (Method 2 series)
  - Molecular weight for a stack test (Method 3 series)
  - Moisture in a stack (Method 4)
  - Particulate matter measurement (Method 5 series, Method 17)

- Calculation of emission rates using F-Factors (Method 19)

- Identify the primary procedures for Methods 9 and 22
  - Introduce digital camera opacity technique (DCOT)

- Identify the primary procedures for the Instrumental Test Methods and describe why they are important
  - Instrumental method concepts and basic principles
    - Calibration Gas Certifications
    - Sample transport and conditioning
      - Importance in methods
      - How does poor sample transport affect RMs and CEMS
        - Heating,
        - Wet vs. dry,
        - Extractive vs. dilution
    - Required QA/QC
  - Method 3A (O_2 and CO_2)
  - Method 6C (SO_2)
  - Method 7E (NOx)
  - Method 10 (CO)
  - Method 20 (NOx, SO_2, O_2, and CO_2 from turbines)
  - Method 25A
    - Destruction efficiency and capture efficiency testing

- Define the CEMS regulatory framework
  - Regulatory provisions regarding CEMS
  - General discussion of how performance specifications work
  - O&M versus compliance CEMS
  - CEMS for 40 CFR Part 75 versus CEMS required by 40 CFR Part 60 or 63

Intermediate

- Identify primary procedures for the following Test Methods, describe their relationship to the core methods and why the procedures are important
  - Method 30B (Mercury)
  - Methods 26/26A (Hydrogen Halides & Halogens)
  - Methods 12, 29, 101, 101A, 102, and 104 (Metals)
  - Methods 201A/202 (PM Fine including Condensibles)
  - Method 18 (VOC)
  - Method 25 (VOC)

- Identify the primary procedures for continuous monitoring systems (CMS) Performance Specifications (Part 60 Appendix B) and QA procedures (Part 60 Appendix F), and describe why they are important
    - Performance Specification 1 (Opacity)
        - Procedure 3
    - Performance Specification 2 (SO_2 & NOx)
    - Performance Specification 3 (O_2 & CO_2)
    - Performance Specification 4 (CO)
    - Performance Specification 6 (CERMS – continuous emission rate monitoring systems)
        - Procedure 1 (for PS 2, 3, 4, and 6)

- Method 205 Gas Dilution Systems for CEMS and Instrumental Methods

Advanced

- Identify the primary procedures for the following Test Methods, describe their relationship to the core methods (where relevant) and why the procedures are important and their limitations
    - Methods 106 (VOC)
    - Methods 11, 15, 15A, 16, 16A, 16B, and 16C (Sulfur Compounds)
    - Method 23 (Dioxins/Furans)
    - CTM 027 (Ammonia)
    - Method 21

- Identify the primary procedures for Instrumental Test Methods 320 and 321 (FTIR) and describe why they are important
    - Quality assurance/quality control of the FTIR

- Describe how different VOC methods are used in rulemakings, e.g.,:
    - Methods 18 and 106
    - Methods 25 and 25A
    - Method 320

- Identify the primary procedures for continuous monitoring systems (CMS) Performance Specifications and QA procedures (where relevant), and describe why they are important
    - Performance Specification 5 & 7 (TRS and H_2S)
    - Performance Specifications 8 and 8A (Total VOC and THC)
    - Performance Specification 9 (GC CEMS for Speciated VOC)
    - Performance Specification 11 (PM)
        - Procedure 2

    - Performance Specifications 12A and 12B (Hg)
        - Procedure 5
    - Performance Specification 15 (FTIR CEMS for gaseous compounds)
    - Performance Specification 16 (PEMS - Predictive Emissions Monitoring Systems)
    - Performance Specification 18 (HCl)
        - Procedure 6

- Data quality needed for compliance versus emission factor development
    - Detection limits—can compliance be determined without a "real" number?
    - How "good" does a measurement need to be to use it for an emission factor?

- Identify the primary procedures for capture and efficiency
    - Examples of applications
    - Method 204 series
    - Flow and ventilation for capture systems

- Identify the primary procedures for using CARB Method 431, the method prescribed for ethylene oxide sampling in 40 CFR 63 Subpart O – NESHAP for Commercial Sterilizers. (This method is used to determine sterilization chamber efficiency).

ATTACHMENT J

Learning Objective Guidelines: How to Draft Course-Level Learning Objectives

LEARNING OBJECTIVE GUIDELINES

Why We Use Learning Objectives to Guide Training

- Cognitive and learning research tells us that when learning objectives are used to guide and structure training, outcomes are significantly improved.
- Defining where you intend to go increases the likelihood that the learner ends up in the intended destination
- Sets the stage for what the “mastered” skill looks like
- Implied contract between instructor and learner: what is to be taught and what is to be learned

Components (“ABCDs”) of Effective Learning Objectives

- **Audience:** Who the training is intended for. Be as specific as possible.
- **Behavior**: One measurable verb that describes the behavior you want learners to be able to exhibit upon completion of the training.
- **Condition:** The conditions under which the learner will perform the desired behavior
- **Degree:** Indicates the desired level or degree of acceptable performance

Examples of Well-Structured and Effective Learning Objectives

- Given a standard sentence, the English 101 student should be able to identify the noun and verb without error.
- After completing the course, the participant should be able to articulate the effects of the six criteria pollutants on the human body and environment.
- After completing Module 1, the trainee should be able to define the five primary roles of an inspector

EPA Training Delivery Format Evaluation

Developed for: U.S. Environmental Protection Agency

Submitted by: ICF

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1 INTRODUCTION

ICF, in collaboration with the U.S. Environmental Protection Agency (EPA), conducted an evaluation of training delivery formats using criteria and training delivery formats provided by EPA (refer to the Criteria section of this report). ICF reviewed and analyzed past and current research on instructional design and training delivery formats and consulted with instructional design and multimedia design experts.

2 BACKGROUND

2.1 Criteria

EPA provided the following criteria to guide the evaluation of the training delivery formats:

- Description
- Features/Components
- Portability (i.e., ability to view on different devices)
- Audience
- Accessibility (i.e., Section 508 compliance)
- Scalability (i.e., number of learners it could accommodate)
- Ease of Updating
- Resource Requirements (i.e., staffing/people)
- Development Costs (e.g., actual cost, Adobe Connect license, level of effort [LOE])
- Provider Computer and Other System and Equipment Requirements (e.g., development requirements)
- User System Requirements
- Timing and Recommended Length (i.e., does the class need to be taken all at once, or can you start/stop over a period?)
- Learning Management System (LMS) Platform Requirements
- Effectiveness as Adult Learning Tool (i.e., effectiveness at information retention/learner engagement, where it lands on the active-passive learning spectrum)

**Please note: This list is not comprehensive and factors such as complexity/stability of content/subject matter, timing, and other factors should be taken into consideration when selecting the optimal training delivery format.

2.2 Training Delivery Formats

EPA provided the following training delivery formats for evaluation:

- On-the-Job Training (OJT)
- Microlearning
- Packaged Training Video

- Online Web Conference (Webinars and Webcasts)
    - Recorded Webinar
- Live-Streamed Training (Synchronous Virtual Instructor-Led Training [vILT])
- Basic eLearning (Level 1)
- Enhanced eLearning (Levels 2 and 3)
- Classroom Training (Instructor-Led Training [ILT])
- Performance Aids and Tools
- Blended Learning

Using the provided criteria, we expanded each format to provide more detailed descriptions and comparisons between each type in the Training Delivery Format Descriptions and Features/Components section of this report.

2.3 Instructional Design Models and Terminology

In this section, widely used models and methods that guide instructional design processes are described briefly, along with common terminology used in this report. These instructional design models and methods are crucial for the success of any training project provided in any format.

2.3.1 ADDIE (Analysis, Design, Development, Implementation, Evaluation) Model

When beginning a training project, the traditional process includes use of the ADDIE instructional design model and framework. The ADDIE model has five phases: A–Analysis, D–Design, D–Development, I–Implementation, and E–Evaluation (see Exhibit 1: ADDIE Model). In the analysis phase, the instructional goals and learning objectives are determined, as are information about the audience, the learner's existing knowledge and skills, and the behavioral outcomes.

Exhibit 1: ADDIE Model

During the design phase, the instructional delivery format is selected, which is the format used to deliver the instruction. The method of delivery can range from basic eLearning to classroom training, which ICF has outlined in this report.

A training project should not begin with a preconceived notion of what training delivery format to use, but rather the instructional designer(s) should select the most appropriate format based on a variety of factors, including learning objectives, corresponding content/subject matter, complexity/stability of the content/subject matter, timing, and budget.

2.3.2 Levels of Interactivity

When designing and developing eLearning training, three levels of interactivity and media richness can be used that increase in complexity. Each level is defined in Exhibit 2 below.

**Please note that there is a Level 4, which is not used as often as Levels 1–3, in which learners have full control over pace and content through use of high-level 3D simulations, avatars, virtual reality, gamification, etc.

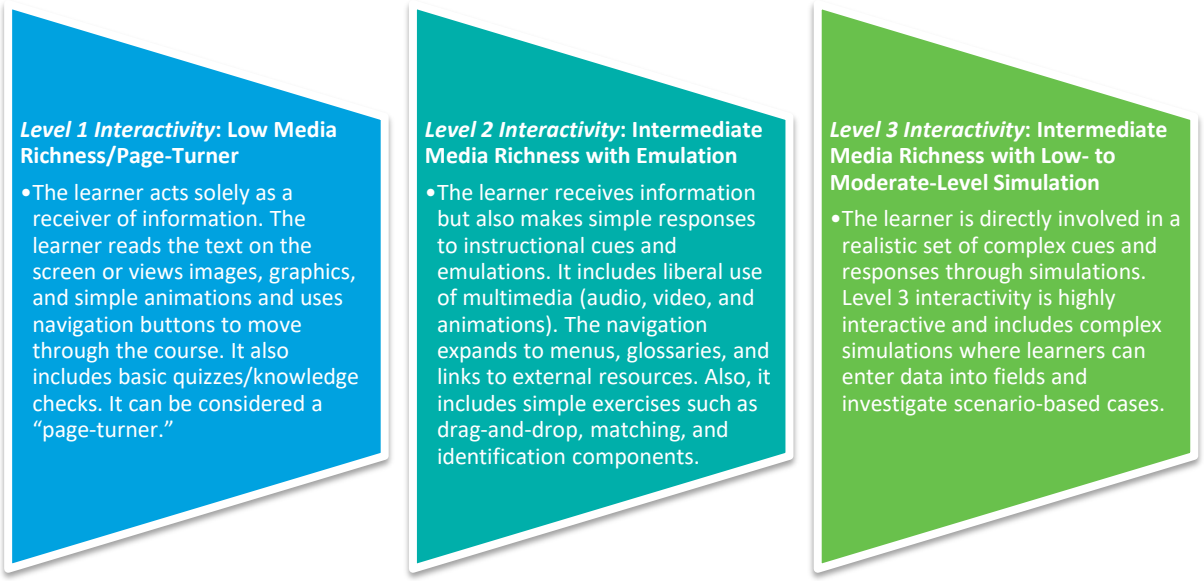


Exhibit 2: eLearning Levels of Interactivity

2.3.3 Active and Passive Learning

Passive learning involves content that is transmitted to learners who "absorb" the information, such as through a lecture or reading assignment, whereas ***active learning*** engages learners in activities in which they are exploring, communicating, creating, or practicing their new skills to gain experiences. *Active learning* can include hands-on exercises/activities, role playing, simulations, mentoring/job shadowing, and group discussions, to name a few.

**Please note that the "Learning Retention Pyramid" or "Cone of Learning," referenced in an article here, puts active and passive learning on a spectrum that has been heavily disputed and is not based on research. Therefore, ICF did not assign the various formats to a position within a "active-passive learning spectrum." It is important to note that active learning provides a more engaging experience for learners, but a mix of both active and passive learning in a blended learning solution can be very engaging and can increase knowledge retention.

2.3.4 Asynchronous vs. Synchronous Learning

**Please note that in this report, the term "synchronous" describes live-streamed training or vILT.

Synchronous learning refers to a type of training (primarily delivered online) that happens on a set schedule in which learners and instructor(s) meet at the same time. ***Asynchronous learning*** allows learners to complete the training on their own time, in a self-directed manner; typically, learners are provided a timeframe to complete the training.

These terms can also be used to describe components of a training. For instance, a live-streamed web conference or chat that happens during a web conference can be considered synchronous, whereas a discussion board or the materials provided to support a course, such as job aids, videos, etc., can be considered asynchronous.

2.3.5 Determining the Optimal Training Delivery Format

The optimal training delivery format can be determined through use of *ICF's Media Selection Methodology/Blended Learning Analysis Model* (see Exhibit 3), developed by Alice G. Hirzel. Determining the best training delivery format to use can depend on many factors but using this model can help to determine the format that is best aligned with the learning objectives and corresponding content. The model is based on research that shows that blended learning solutions can maximize learner retention and real-world application.

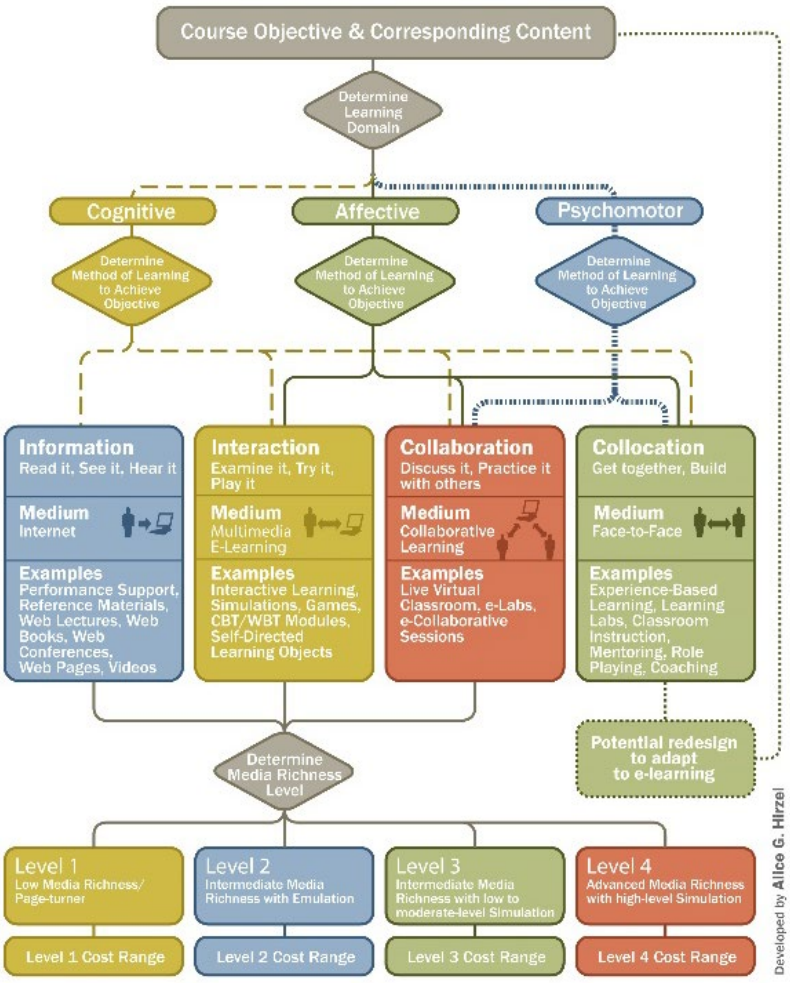


Exhibit 3: ICF's Media Selection Methodology/Blended Learning Analysis Model

For instance, if developing an ILT course, each course and lesson objective (along with its associated content) would be examined, and the following five-step process would be applied:

Step 1: Determine the type of learning (learning domain) required to achieve the course/lesson objectives.

The domains listed in Table 1 below specify a focal area of a training. This taxonomy is well known among the instructional design and training communities and is widely used in training development and delivery considerations.

Table 1: Learning Domains

Learning Domain	Example
Cognitive Domain (mental skills/knowledge). The cognitive domain involves knowledge and the development of intellectual skills.	This includes the ability to recall, recognize, understand, apply in new situations, analyze, synthesize or evaluate specific facts, procedures, and concepts.
Affective Domain (feelings or emotional areas/attitude). The affective domain encompasses how people relate emotionally to their environment and to other people.	This includes the ability to selectively apply attention, willingness to hear, participate actively in the learning environment, ability to compare and understand different values and apply a value system to specific situations.
Psychomotor Domain (manual or physical skills). The psychomotor domain requires that the learner master technical, tactile and tactical skills, such as using a fire extinguisher, which require the learning to engage knowledge, judgment, movement and skill. Development of these skills typically requires practice in performing them.	This includes physical movement and the coordinated use of motor-skills.

Step 2: Identify the learning environment, as listed in Table 2 below, appropriate for achieving the course/lesson objectives.

Table 2: Learning Environment

Learning Environment
Information. The learner interacts with the material at only a basic or very simple level (e.g., solitary reading, watching a video). No human interaction is necessary. The interaction is one-way between the learner and the learning environment.
Interaction. Some level of participation of the learner with the material occurs (e.g., demonstrations and simple exercises that can be completed by a single person). No human interaction is necessary. The interaction is two-way between the learner and the learning environment.
Collaboration. Learners interact not only with the material but with other learners (e.g., delivery that centers on case studies and scenarios with discussion with other learners). Human interaction is necessary, and the interaction is among students and between students and instructors is two-way through a learning environment.
Collocation. Learners move into another arena to re-enact certain circumstances as they would exist in the real world (e.g., simulation drills either in sophisticated computer programs or outdoor activities). Human interaction is necessary, and the interaction is face-to-face among students and instructors.

Step 3: Within each learning environment, identify the corresponding delivery medium.

Within each learning environment identified in Step 2, identify the corresponding delivery medium that will enable learners to meet the learning objective. Please note that the categories below are

generalized, and the specific types of training delivery formats listed in this report could fit under one or more of these categories:

- Synchronous (instructor and learner interact in real time) or asynchronous (instructor and learner interactions are separated in time) delivery. In asynchronous delivery, the course developer may be the "instructor."
- Internet/web-based, CD, or DVD delivery medium.
- Multimedia eLearning. Blending of multiple media that can be delivered over the internet/web and/or CD/DVD (e.g., streaming video/audio, simulations, gaming).
- Collaborative learning. Asynchronous (e.g., email feedback from fellow learners or the instructor) or synchronous interactions with other learners (e.g., study group, online discussion boards, conference calls).
- Face-to-face. In-person experiential/hands-on learning/classroom.

Step 4: Determine the media richness (level of interactivity) necessary to achieve the course/lesson objectives.

Step 5: Identify course and lesson objectives that are and are not adaptable to eLearning. Based on the results of previous steps in the analysis, identify the degree to which the course and lesson objectives can be adapted to an eLearning environment.

3 TRAINING DELIVERY FORMAT DESCRIPTIONS AND FEATURES/COMPONENTS

3.1 On-the-Job Training

OJT provides an opportunity for learners to practice actual required behaviors needed to complete a task on an immediate basis and is provided in the same environment in which they will be working. OJT can include:

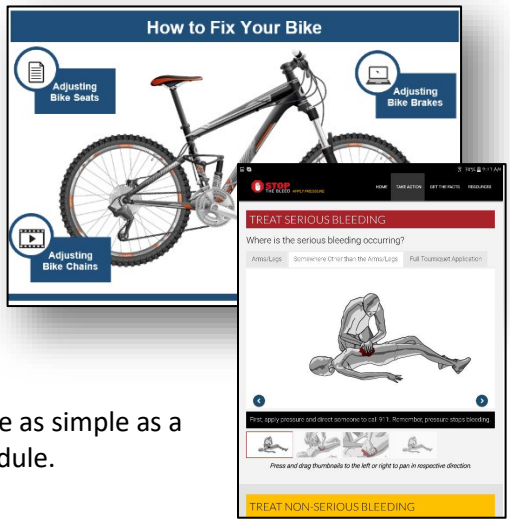
- Mentoring
- Coaching
- Observation
- Job rotation
- Job instruction
- Committee assignments
- Internships

Typically, OJT is divided into two types: structured (formal) and unstructured (informal). Unstructured OJT does not have any planning involved, such as assigning a new employee to observe an experienced employee. Structured OJT is planned and usually led by experienced employee(s).

Refer to the following website(s) for example(s) of OJT materials:

- https://www1.maine.gov/mdot/civilrights/docs/ojt/OJTManual2016.pdf

3.2 Microlearning



Microlearning provides training that delivers content in short, focused bites that fit naturally into a learner's workflow.

Microlearning is short in duration and focuses on a single learning objective. Also, it is usually accessed more than once when learners need it, so that it can serve as refresher training.

It can be delivered in a variety of formats, including infographics (static and interactive), videos (animated, interactive live action, instructive, webinars), webcasts and podcasts, educational games, and software applications. It can be as simple as a PowerPoint (PPT) presentation or a shorter eLearning (WBT) module.

Refer to the following website(s) for example(s) of microlearning:

- https://www.youtube.com/watch?v=YprN025suBY
- https://www.youtube.com/watch?v=y81aJ81ln5Q#action=share

3.3 Packaged Training Video

A packaged training video provides one-way communication and instruction through use of video. Videos can include:

- Live actors
- Presentations or vignettes
- Simple 2D or 3D animations/graphics
- Static images
- Demonstrations/role-plays
- Screencasts (e.g., showing how to use a new software)

Refer to the following website(s) for example(s) of packaged training videos:

- Simple 2D animation video: https://vimeo.com/229322628
- Live actor video: https://www.youtube.com/watch?v=xkpftmVL7MA&index=3&list=PLvrp9iOILTQYPA_9rg3DFsG56BjUzOWFi

3.4 Online Web Conference (Webinars and Webcasts)

An online web conference is a live event or broadcast in which all learners attend online, and audio, video, and visuals are streamed. It can either be a webinar or a webcast. A webinar facilitates two-way

communication with interactivity, whereas a webcast facilitates one-way communication with little to no interactivity.

Typically, a webinar provides a live, instructor-led presentation or seminar (through a PPT) at a single point in time that can be coupled with:

- Discussions
- Polling/surveys
- Exercises/activities
- Breakout sessions
- Video

In contrast, a webcast broadcasts a live or pre-recorded presentation in which learners can view but not interact. Both bring large groups together for consistent messaging.

Both webinars and webcasts can be recorded and posted to a server or LMS for learners to access anytime.

Additional Characteristics	
Setting	Online
Instruction Type	Live, Instructor-Led Training
Optimal Number of Trainees/Learners	Limited to number of spaces on the web conferencing license or the server or LMS, if previously recorded and posted to a server or LMS.
Optimal Course Timing	Two hours or less

Refer to the following website(s) for example(s) of online web conferences:

- https://www.youtube.com/watch?v=-J3akt3SmGY&list=PLw9VVPnm_6xePWilXKKRTiSo_TNKakD1Q

3.5 Live-Streamed Training (Synchronous Virtual Instructor-Led Training)

Live-streamed training or synchronous virtual instructor-led training (vILT) provides training where learners are accessing the instruction (provided by an instructor) over the web/phone in real time. It is a live, in-person classroom event broadcasted online to include remote trainees/learners that are not located in the same place.

vILT offers training sessions online, to replicate a classroom course, across a certain period of time (e.g., a week or month). vILT is also supplemented with various components, such as:

- Online discussions
- Polling/surveys
- Exercises/activities
- Breakout sessions
- Readings

Additional Characteristics	
Setting	Virtual classroom that uses web conferencing or other synchronous eLearning media to provide access to trainees/learners at remote locations
Instruction Type	Live/Virtual, Instructor-Led Training
Optimal Number of Trainees/Learners	Variable but limited to 30 people or fewer
Optimal Course Timing	Hours to days

Refer to the following website(s) for example(s) of vILT:

- https://ppls-portfolio.learning-transformation.com/ (navigate to "Virtual Instructor-Led Training for Emergency Response Personnel"). Chrome works best to view this website.

3.6 Basic eLearning (Level 1)

Basic eLearning (Level 1) provides training via the internet or digital device that is typically asynchronous. Level 1 is passive and has little to no interactivity (refer to the Levels of Interactivity section of this report).

Typically, the term eLearning is synonymous with web-based training (WBT).

Additional Characteristics	
Setting	Online through an LMS or other learning content server
Instruction Type	Self-directed
Optimal Number of Trainees/Learners	Unlimited
Optimal Course Timing	Hours to days

Refer to the following website(s) for example(s) of basic eLearning (Level 1):

- https://modsim01.icfconsulting.com/PUBLIC/HHI/proto/story_html5.html

3.7 Enhanced eLearning (Levels 2 and 3)

Enhanced eLearning (Levels 2 and 3) provides training via the internet or digital device that is typically asynchronous. Levels 2 and 3 interactivities include more complex animations and graphics than does Level 1.

Most basic eLearning at Level 2 includes liberal use of multimedia (e.g., audio, video, and animations) and a more expansive navigation including menus, glossaries, and links to external resources. It also includes quizzes and knowledge checks that are more extensive than multiple choice questions (e.g., matching). An eLearning course can also include elements of adaptive learning in which the learning adapts to the learner's needs and responses. For instance, a quiz will select questions based on the learner's previous responses or topics are selected based on the learner's input to a survey.

Level 3 interactivity is more complex, and the learner has more control. It usually includes sophisticated scenarios, animated videos, and custom animations. It is highly interactive, and participants are immersed in scenario-based cases in which they can enter data into fields.

Level 4 interactivity, which is employed less often, encompasses high-level 3D simulations, avatars, virtual reality, gamification, etc.

Refer to the following website(s) for example(s) of basic eLearning (Levels 2 and 3):

- Level 2 eLearning: https://www3.epa.gov/swerrims/re-powering-training-module/story_html5.html?lms=1
- Level 3 eLearning: https://ppls-portfolio.learning-transformation.com/ (navigate to "Solar Geometry Online Training"). Chrome works best to view this website.
- Level 3 eLearning: http://cdc-infection-control.s3-website-us-east-1.amazonaws.com/Index/story_html5.html

3.8 Classroom Training (Instructor-Led Training)

Classroom training or instructor-led training (ILT) provides training that is face-to-face and delivered in a live format. It is an in-person event at which learners and instructor(s) are collocated. ILT can include a combination of one or more:

- Lectures
- Exercises/activities
- Role playing exercises
- Group discussions
- Guided practice
- Pre- and post-work (planned reading)
- Case studies

Additional Characteristics	
Setting	Classroom, laboratory, auditorium, or other physical training facility
Instruction Type	Live, instructor-led training
Optimal Number of Trainees/Learners	Variable, but it is best to limit to 30 people or fewer
Optimal Course Timing	Hours to days

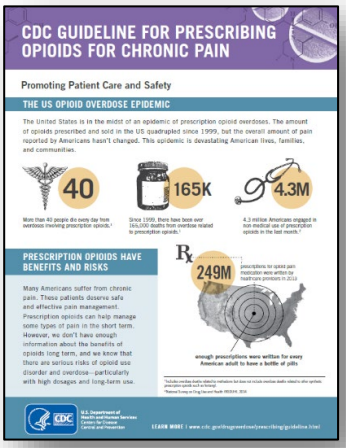
Refer to the following websites for example(s) of ILT materials:

- https://ppls-portfolio.learning-transformation.com/ (navigate to “Exercise-Based Instructor-Led Training for U.S. Marshals Service”). Chrome works best to view this website.

3.9 Performance Aids and Tools

Performance aids or tools provide a repository for information, processes, or perspectives that are external to the individual and that support work and activity by directing, guiding, and enlightening performance (Rossett, Gautier-Downes, 1991).

Performance aids are sometimes referred to as "Job Aids.” Performance aids can be technical manuals, flowcharts, or other documents that aid or list steps of a task that can easily be integrated into a learner's workflow.



Additional Characteristics	
Setting	Office, library, online
Instruction Type	Passive, self-directed
Optimal Number of Trainees/Learners	Unlimited
Optimal Course Timing	Unlimited

Refer to the following website(s) for example(s) of performance aids and tools:

- https://www.cdc.gov/drugoverdose/pdf/prescribing/Guidelines_Factsheet-a.pdf
- https://www.hud.gov/sites/documents/DOC_11609.PDF

3.10 Blended Learning

Blended learning provides a mix of different training delivery formats (i.e., classroom, instructor-led training supplemented with eLearning, and/or self-paced asynchronous formats). Typically, it is a formal

learning experience such as an ILT course combined and enhanced with self-paced asynchronous formats such as eLearning, webinars, videos, etc.

Blended learning can include a mix of components across all the training delivery formats listed in this report. It could be an eLearning course enhanced with interaction with an instructor or other learners (through discussion boards, email, webinars, video, etc.).

Additional Characteristics	
Setting	Dependent on the format used because it is a mix of different training delivery formats
Instruction Type	A mix of different training delivery formats, such as both active, instructor-led training and passive, self-directed learning
Optimal Number of Trainees/Learners	Depends on the training delivery format; would be constrained by the classroom sections of the course; online sections could serve multiple classroom sections
Optimal Course Timing	Depends on the training delivery format

Refer to the following website(s) for example(s) of blended learning:

- https://ppls-portfolio.learning-transformation.com/ (navigate to "Management Development Program for Fortune 500 Casual Dining Company"). Chrome works best to view this website.

4 COMPARISON OF TRAINING DELIVERY FORMATS

In this section, the training delivery formats are compared based on portability, audience types, accessibility (e.g., Section 508 compliance), scalability (i.e., number of learners it could accommodate), ease of updating, resource requirements, average development costs, provider and user system requirements, timing, LMS platform requirements, and effectiveness as an adult learning tool.

4.1 Portability

Portability is the ability for users to access training materials and/or courses on modern devices and browsers. Refer to Exhibit 4 for list of various training formats categorized on a scale from low to high portability.

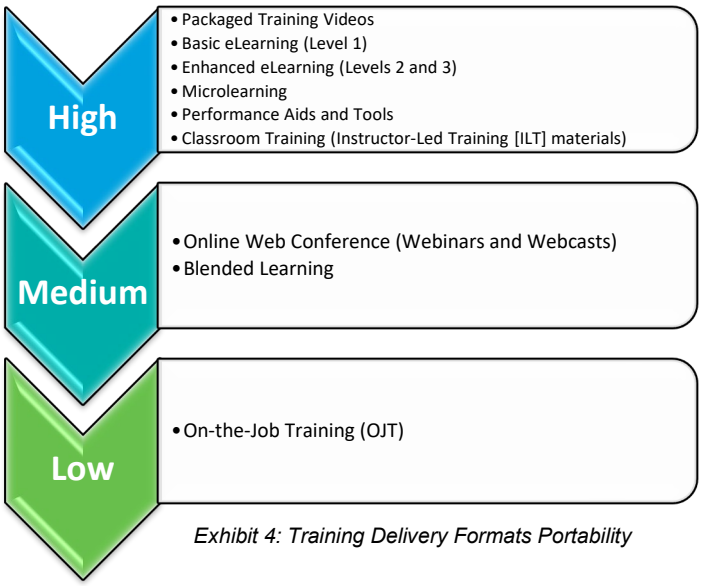


Exhibit 4: Training Delivery Formats Portability

High portability: Can be accessed and developed to work on all modern devices (e.g., computer, phone, iPad) and browsers, depending on the requirements and multimedia and/or software used.

Medium portability: Can be accessed and developed to work on some modern devices and browsers, depending on the requirements and multimedia and/or software used.

Low or no portability: Cannot be accessed or developed to work on most modern devices and browsers.

In terms of portability for OJT, it is considered low because the job site may have physical constraints (for instance, a field office with no computer) to access OJT materials or there may not be sufficient equipment available for learners to practice on. In addition, you need experienced coworkers/employees, managers, or human resource (HR) staff to be available and it can be depend on their schedules and availability, which makes portability lower.

For medium portability, online web conferences and blended learning, depending on the components used, may not be able to be accessed or developed to work on some modern devices and browsers, due to any constraints accessing the webinar software. For instance, Adobe Connect requires a flash player and a certain connection speed for learners to access a web conference.

Packaged training videos, basic and enhanced eLearning, microlearning, performance aids and tools, and ILT materials can be customized and developed to work on all modern devices, which makes them highly portable.

4.2 Audience

As a best practice, an informal audience analysis should be conducted to determine the most effective training delivery format, by asking the following questions:

- Who is the audience? What are their current levels/roles and backgrounds? What are their skills?
- How many participants/learners will attend?
- What motivates them?
- What are their expectations for the training?
- What type of learning do they prefer?
- Where are they located?
- How well do the participants know each other?
- What successes or difficulties have this audience encountered with this training topic?
- Are there any other audiences that need to be considered?

The answers to these questions can help guide you in determining the optimal training delivery format for your audience.

Typically, the audience for OJT is new hired employees, interns, or someone new to a position. For microlearning, packaged training videos, online web conferences, vILT/ILT, and basic and enhanced eLearning, the audience can be any but depends on factors such as:

- Learner level/background/seniority/skill set
- Type of learning preferred
- Learner expectations
- Learner availability to take the training
- Size of the audience

For instance, according to the 2019 Training Industry *What Learners Want: Strategies for Training Delivery* report, learners preferred ILT over all other types of training delivery formats. The next

preferred type of training delivery format was OJT, followed by eLearning and vILT. Also, learners whose jobs may be considered more complex prefer informal training that can be online/virtual. Learners with more direct reports prefer self-paced methods of learning such as basic and enhanced eLearning, performance aids and tools, microlearning, packaged training videos, or online web conferences (that are recorded).

In addition, microlearning can cater to learners who might have competing demands in the workplace and reduced attention spans. ILT can be an effective training delivery format for learners who may be averse to technology and change. For blended learning, the audience would depend on the answers to the questions listed above and what components would be used.

4.3 Accessibility (i.e., Section 508 compliance)

All training products must be developed to be Section 508 compliant, but it can depend on the complexity of interactions and media used especially for vILT and eLearning products. Section 508 is part of the Rehabilitation Act of 1973 to require all Federal agencies to make their technology and electronic products accessible to individuals with disabilities.

For videos to be Section 508 compliant, they must include the following:

- Synchronized closed captioning that is overlaid on top of the video frame and encoded within the video
- Audio descriptions and audio track that describes the video
- Section 508-compliant player that displays the closed captioning below the video file

For online web conferences, the webinar and webcast tools used would need to meet the accessibility requirements of the audience. In addition, any handouts or resources provided would need to be Section 508 compliant.

It is also important to note that for eLearning with Level 3 interactivity, Section 508 compliance may not be possible with highly complex interactions; therefore, a product that is instructionally equivalent would need to be created.

All performance aids and tools can be developed to be Section 508 compliant. Most performance aids and tools use Microsoft Word, but PPT, Excel, and/or PDF may be used, which also have specific rules (e.g., adding alternative text, adding column headers to tables) about Section 508 compliance.

For more information, refer to: https://section508.gov/create.

4.4 Scalability (i.e., number of learners it could accommodate)

Scalability refers to the number of learners a training delivery format could potentially accommodate. Refer to Table 3 below.

Table 3: Scalability for Each Training Delivery Format

Training Delivery Format	Scalability
On-the-Job Training	Dependent on EPA division/office/organization capabilities and staffing resources
Microlearning	Unlimited, but dependent on LMS and other server space where hosted

Training Delivery Format	Scalability
Packaged Video Training	Unlimited, but dependent on LMS and other server space where hosted
Online Web Conference (Webinars and Webcasts)	Typically, up to 1,500 people but dependent on the license; for breakout sessions, five or fewer
Live-Streamed Training (Synchronous Virtual Instructor-Led Training)	25 to 30 or fewer; for breakout sessions and/or activities, five or fewer
Basic eLearning (Level 1)	Unlimited, but dependent on LMS and other server space where hosted
Enhanced eLearning (Levels 2 and 3)	Unlimited, but dependent on LMS and other server space where hosted
Classroom Training (Instructor-Led Training)	Dependent on training requirements, cost, and facilities used, but ideal to limit size to 25 to 30 or fewer; for breakout sessions/activities, five or fewer
Performance Aids and Tools	Unlimited
Blended Learning	Dependent on components used

For OJT, scalability is dependent on EPA's division/office/organization capabilities and staffing resources.

For microlearning and packaged training videos, scalability can be unlimited in theory, but depends on the LMS or other server space where the microlearning is hosted.

Webinar and webcast software (such as Adobe Connect) can accommodate up to approximately 1,500 people. If a webinar is used and it includes interactivity such as breakout sessions to conduct exercises/activities, it is recommended that the class size be limited in size. Specifically, it is ideal to keep a breakout session limited to groups of five or fewer. In general, if using a webcast, more people can attend without affecting the experience. A webinar or a vILT (as explained below) tends toward more interactivity (e.g., breakout sessions, chats) so fewer participants are ideal unless you have co-facilitators who can handle a larger class size.

vILT sessions can be challenging if there are many participants, so it is ideal to keep the size limited to 25 or fewer. If conducting a breakout session and/or activity as part of a vILT, it is ideal to keep it limited to groups of five or fewer.

For Levels 1–3 eLearning, scalability can be unlimited, in theory, but it depends on the LMS or other server space where the eLearning is hosted.

For ILT, small class sizes are ideal to increase engagement, pace, and the interaction between the instructor(s) and learners. Class size can also depend on the training requirements, cost, and facilities used, but it is ideal to keep size limited to 25 or fewer.

For performance aids and tools, scalability is also unlimited; for blended learning, it depends on the training requirements and components used.

4.5 Ease of Updating

For all formats, the ease of updating (the ability to easily revise and maintain training courses and/or materials) can be dependent on the complexity and/or stability of the material/content and interactions, if used. Refer to Exhibit 5.

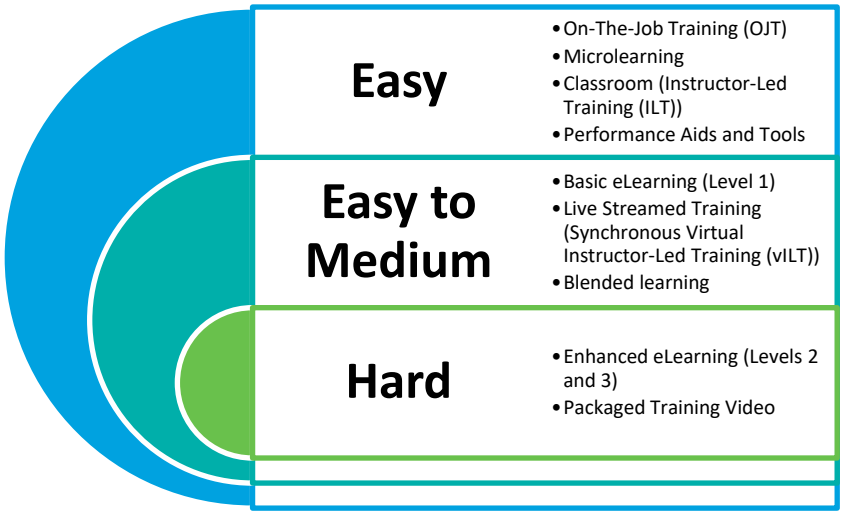


Exhibit 5: Training Delivery Formats Ease of Updating

Microlearning is typically easier and quicker to update than eLearning and videos. In general, videos are harder to update than microlearning or eLearning because they are more complex. If using live actors, it can be harder to update than if animations, images, or graphics (depending on the complexity) were used. Typically, webinars and webcasts use a PPT presentation to deliver instruction, which can easily be updated, along with the script. The ease of updating an eLearning course depends on the amount of interactivity, narration, and animation used. The more these are integrated in the course, the harder the content is to update.

Many vILT programs offer their content (through Microsoft PPT and Word) in shorter, incremental modules that are intended to be completed in combination with other curricula, so they can be easily updated. Typically, OJT materials, ILT materials, and performance aids and tools are the easiest to update because they usually include handouts, instructor/participant guides, job aids, etc. that are static and originally created using Microsoft Word and PPT.

4.6 Resource Requirements

Resource requirements can vary widely among the different training delivery formats. Table 4 below provides information on the recommended staffing resources needed to manage, design, and develop the training delivery formats outlined in this report.

Table 4: Recommended Resources/Staffing for Each Training Delivery Format

Training Delivery Format	Recommended Resources/Staffing
On-the-Job Training	• Peers (experienced coworkers/employees) • Managers • Sometimes human resource team members
Microlearning	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • Voiceover artist(s) • Subject matter experts (SMEs)

Training Delivery Format	Recommended Resources/Staffing
	If using video, refer to the column below.
Packaged Video Training	• Media producer/director and/or project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • 2D artist(s) • 3D modeler(s) and 3D animator(s) • 2D animator(s) (for motion graphics) • Voiceover artist(s) • Sound engineer(s) • Camera operator (for live action video) • Music director/composer (optional) • Production assistant(s) (for live action video) • SMEs Note that 1–2 people can take on multiple roles, depending on the budget and need. Also, these roles are dependent on the type of video developed (for instance, if using 3D animation, a 3D modeler and/or animator would be needed).
Online Web Conference (Webinars and Webcasts)	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • Facilitator(s)/Instructor(s) • Webinar/webcast moderator(s) • Webinar/webcast technical support • SMEs
Live-Streamed Training (Synchronous Virtual Instructor-Led Training)	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • Facilitator(s)/Instructor(s) • Webinar/webcast moderator(s) • Webinar/webcast technical support • SMEs
Basic eLearning (Level 1)	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • Voiceover artist(s) • SMEs

Training Delivery Format	Recommended Resources/Staffing
Enhanced eLearning (Levels 2 and 3)	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • 2D artists, 3D modeler(s), and 3D animator(s) for Level 3 • Voiceover artist(s) • SMEs
Classroom Training (Instructor-Led Training)	• Project manager/training lead • Instructional designer(s) • Multimedia programmer(s) • Graphic designer(s) • Facilitator(s)/Instructor(s) • SMEs
Performance Aids and Tools	• Project Manager/Training Lead • Instructional designer(s) • Graphic designer(s) • SMEs
Blended Learning	Depends on the type of components that will be part of the blended learning solution. Refer to the other rows for recommended resources/staffing, per delivery format.

4.7 Average Development Costs and Level of Effort

Cost and development hours (or LOE) can vary greatly depending on the training delivery format that is chosen. In addition, costs can be dependent on a multitude of factors, as listed below.

4.7.1.1 On-the-Job Training

For OJT, costs can vary and be dependent on EPA's capabilities, staffing resources, employee skill sets, and the type of OJT component used.

4.7.1.2 Microlearning

Costs and development hours can vary greatly depending on the length and format of the microlearning, interactivity, complexity/stability of content, and LMS administration (if hosted on an LMS). Typically, microlearning can be a quarter of the cost and development hours of a Level 1 eLearning course.

4.7.1.3 Packaged Training Videos

For training videos, cost and development hours can vary greatly depending on the training need, budget, special effects, complexity/stability of the content/material, LMS administration (if hosed on an LMS), and the length and complexity of the script. Costs can include:

- Pre-production tasks (e.g., scriptwriting, concept development, casting talent if live action)
- Production tasks
- Post-production tasks (e.g., video editing, motion graphics, captioning for Section 508 compliance)
- Deliverables (e.g., uploading to YouTube, hosting)

4.7.1.4 Online Web Conferences

For online web conferences, costs and development hours can vary greatly depending on the training need, budget, complexity/stability of the content/material, LMS administration, and size of the audience.

In addition, webinar/webcast software/licenses would be needed, and prices would vary depending on EPA's need. Multiple platforms can be used, including Adobe Connect, GoToMeeting, and Zoom:

- Costs for Adobe Connect can be found here: http://buyconnect.adobe.com/
- Costs for GoToMeeting can be found here: https://www.gotomeeting.com/meeting/pricing
- Costs for Zoom can be found here: https://zoom.us/pricing

4.7.1.5 Live-Streamed Training (Synchronous Virtual Instructor-Led Training)

The cost of vILT can be less than ILT because travel and lodging costs are not involved for the learners and facilitator(s)/instructor(s).

The cost and development hours are similar to ILT without the travel or lodging costs; refer to the ILT section for more information.

4.7.1.6 Basic and Enhanced eLearning

For eLearning, costs and development hours can vary based on the level of interactivity, as outlined in Table 5 below. Please note that these costs and LOE estimates do not include the costs/hours for reviews, revisions, LMS administration (backend database communication), consulting fees, graphic user interface (GUI) development, meetings, and consultation with SMEs. Refer to Table 5 below for estimated development hours and average costs depending on the level of interactivity.

Table 5: Estimated Development Hours and Cost for eLearning Courseware

Level of Interactivity	Estimated Development Hours	Estimated Average Cost
Level 1	Development hours can range from 49 to 125 (not including reviews and revisions), depending on the amount of interactivity. On average, it can take 79 development hours per 1 hour of Level 1 WBT.	On average, 1 finished hour of WBT (Level 1) can cost approximately $10,054 but can be cost-effective for large scale deployments.
Level 2	Development hours can range from 127 to 267 (not including reviews and revisions), depending on the amount of interactivity. On average, it can take 184 development hours per 1 hour of Level 2 WBT.	On average, 1 finished hour of WBT (Level 2) can cost approximately $18,583 but can be cost-effective for large scale deployments.

Level of Interactivity	Estimated Development Hours	Estimated Average Cost
Level 3	Development hours can range from 317 to 716, depending on the amount of interactivity. On average, it can take 490 development hours per 1 hour of Level 3 WBT.	On average, 1 finished hour of WBT (Level 3) can cost approximately $50,371 but can be cost-effective for large scale deployments.

4.7.1.7 Classroom Training (Instructor-Led Training)

For ILT, development hours can range from 22 to 82 —not including reviews, revisions, LMS administration (backend database communication), consulting fees, meetings, and consultation with SMEs—depending on the complexity of the subject matter and amount of classroom materials. On average, it can take 43 development hours per 1 hour of ILT. Refer to Exhibit 6 to review how average development hours differ between ILT and eLearning courses.

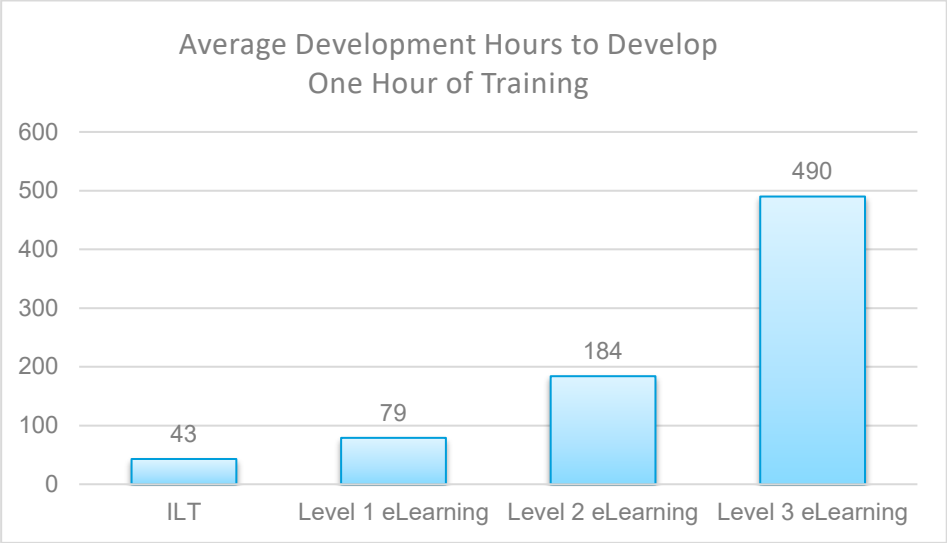


Exhibit 6: Average Development Hours to Develop One Hour of Training

. As previously mentioned in the Scalability section, ILT and vILT should ideally be constrained to 25-30 learners or fewer since its challenging facilitating activities and exercises if there are many participants. So, microlearning, packaged training videos, basic and enhanced eLearning could be more cost effective if you have a lot of participants since scalability is unlimited.

4.7.1.8 Blended Learning

Cost and development hours depend on the type of components that will be part of the blended-learning solution.

4.8 Provider Computer and Other System and Equipment Requirements

The provider and other system requirements and equipment can vary depending on the type of training delivery format. Refer to Exhibit 7 for a list of software that could be used to design and develop each type of training delivery format. Refer to Table 6 for a list of suggested equipment for each type of training delivery format.

For OJT, the materials developed would be similar to what might be included in an ILT but with a structured approach as to when the learner participates. Thus, Microsoft Work and PPT could be used to create any supporting materials to accompany OJT coaching, mentoring, etc.

For microlearning and eLearning, the requirements depend on the format and level of interactivity. Development software, such as Articulate Storyline 360, Trivantis Lectora, Adobe Captivate, Custom Code, and Adobe Creative Cloud (Illustrator, Photoshop, Audition, and Premier Pro) can be used. If creating static microlearning, Microsoft Word and PPT could be used.

For video development, development software can include, but is not limited to: Adobe Creative Cloud (Illustrator, Photoshop, Audition, Premier Pro, After Effects, and Character Animator), 3D Studio Max, or whiteboard animation software such as Videoscribe or PowToon.

For facilitation of webinars and vILTs, webinar/webcast software such as Adobe Connect, GoToMeeting, and Zoom can be used. It also requires use of a video camera, microphones, and speakers, as well as a high-speed processor and internet connection with high bandwidth to stream live video. To create presentations used in webinars and vILTs, Microsoft PPT and Word typically are used. If providing a live or virtual course, it may be necessary to have a video camera, microphones, and speakers situated throughout the room, among other equipment listed in Table 6. For a live, in-person course, it may require a high-speed processor to stream the live video and a high-speed internet connection with high bandwidth.

For ILT materials and performance aids and tools development, Microsoft Office products such as Word, PPT, and Visio can be used.

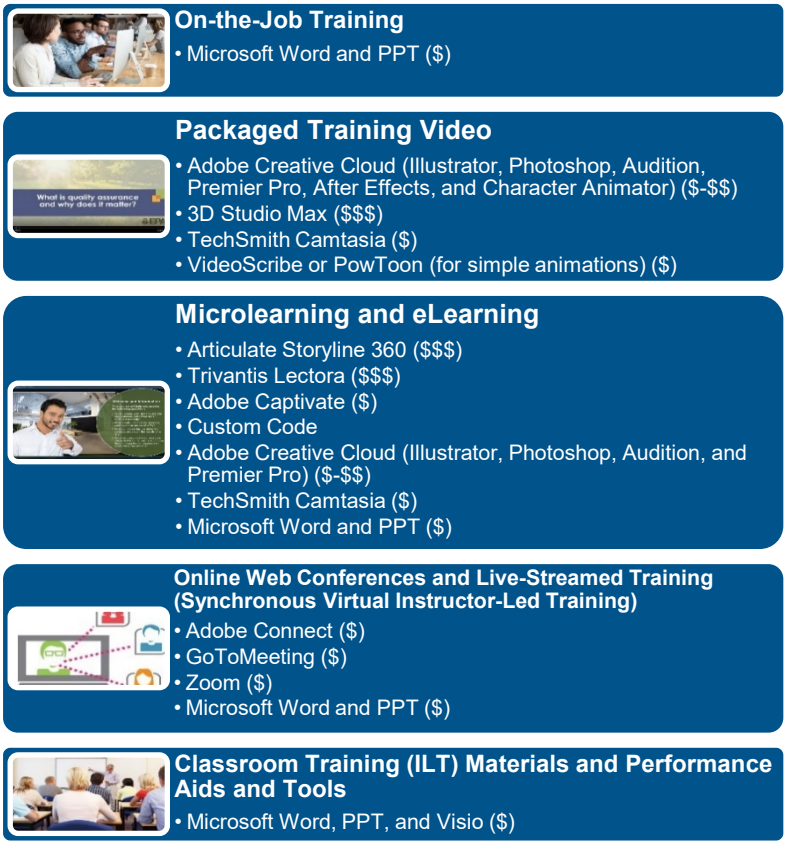


Exhibit 7: Provider Computer and Other System Requirements for Each Training Delivery Format

Low Cost - $ Moderate Cost - $$ High Cost - $$$

Table 6: Suggested Equipment Needed for Each Training Delivery Format

Training Delivery Format	Equipment Needed
On-the-Job Training	No special equipment needed other than what is used on the job such as a computer, unless it's a technical type of job and certain equipment is needed to show someone how to use it.
Microlearning	Computer and software listed above Exhibit 7

Training Delivery Format	Equipment Needed	
Packaged Video Training	Computer and software listed above Exhibit 7 for 2D/3D animations and live action. Below lists additional equipment needed in order to produce a live action video, from basic to professional.	
	Basic	Live action: • Camera such as a high quality cell phone • LED 3 point kit (lighting cord, stand, and lighting instrument) • Cardioid condenser microphone • 2-channel field recorder (what you plug your microphone into) • 15' microphone cable • Microphone stand
	Advanced	Live action: • Mirrorless digital single-lens reflex (DSLR) camera • LED lighting instrument • 4-channel field recorder (what you plug your microphone into) • LED 3-point kit (lighting cord, stand, and lighting instrument); multiple as needed • 1 hypercardioid condenser and 1 supercardioid condenser • 1 wireless lav microphone • Microphone wind protection • Medium-grade quality microphone cables
	Professional	Live action: • Professional digital cinema camera • LED lighting instrument • 8-channel field recorder (what you plug your microphone into) • LED 3-point kit (lighting cord, stand, and lighting instrument); multiple as needed • 4 hypercardioid condenser and 4 supercardioid condenser • 6 wireless lav microphone • Microphone wind protection • Microphone blimp and cover • Microphone boom • Medium to high-grade quality microphone cables

Training Delivery Format	Equipment Needed	
Online Web Conference (Webinars and Webcasts)	Computer and software listed above Exhibit 7. Additional equipment that would be needed is listed below from basic to professional.	
	Basic	• Webcam or video camera on facilitator/instructor's computer with an internet connection • Headset (headphones with microphone)
	Advanced	• A good quality microphone • Mirrorless digital single-lens reflex (DSLR) camera • LED lighting instrument • 4-Channel Field Recorder (what you plug your microphone into) • LED 3-point kit (lighting cord, stand, and lighting instrument); multiple as needed • 1 hypercardioid condenser and 1 supercardioid condenser • 1 wireless lav microphone • Microphone wind protection • Medium-grade quality microphone cables
	Professional	• High quality microphone/broadcast microphone • Microphone boom arm so facilitator(s) do not have to hold a microphone and ensure all sound is recorded • Professional digital cinema camera • LED lighting instrument • 8-channel field recorder (what you plug your microphone into) • LED 3-point kit (lighting cord, stand, and lighting instrument); multiple as needed • 4 hypercardioid condenser and 4 supercardioid condenser • 6 wireless lav microphone • Microphone wind protection • Microphone blimp and cover • Microphone boom • Medium to high-grade quality microphone cables • Optional green screen backdrop • Optional video editing software such as Adobe Premier Pro or iMovie if using video in your presentation

Training Delivery Format	Equipment Needed
	• Optional image editing tool such as Photoshop to insert high quality images and graphics into your PPT deck
Live-Streamed Training (Synchronous Virtual Instructor-Led Training)	Equipment needed would be the same as Online Web Conference. Refer to row above.
Basic eLearning (Level 1)	Computer and software listed above Exhibit 7
Enhanced eLearning (Levels 2 and 3)	Computer and software listed above Exhibit 7
Classroom Training (Instructor-Led Training)	• Large conference room to accommodate the number of learners with tables/chairs in a U- or V-shape arrangement for interaction with facilitator(s)/instructor(s) • Internet connection and computer • Facilitator/instructor guide, participant guide, handouts, and PPT deck • Overhead projector or computer projection system and cables for proper connection • Optional electronic remote device to advance slides in PPT presentation, if available • Projection screen (at least 6’ x 6’) • Optional pointer (preferably laser type), if available • Flip charts with easel and/or whiteboard with dry erase pens and eraser • Large markers (in assorted colors) • Participant tent cards (to list names and be placed on tables)
Performance Aids and Tools	Computer and software listed above Exhibit 7
Blended Learning	Depends on the components that will be part of the blended learning solution.

4.9 User System Requirements

Most of the training delivery formats, including microlearning, videos, webinars, vILT, and eLearning, would be developed to work on modern devices, including the latest browsers (Internet Explorer version 11, Edge, Apple Safari, and Google Chrome).

If computers are used in an ILT session, an internet connection would be needed. For the development of performance aids and tools, an internet connection may be needed and as would access to Microsoft Office products. For blended learning, system requirements would depend on the components used.

4.10 Timing and Recommended Length

Timing refers to how often the training needs to happen over a course of year. In addition, the timing and recommended length of each training delivery format is discussed and listed below in Table 6.

Table 7: Timing and Recommended Length of Each Training Delivery Format

Training Delivery Format	Timing	Recommended Length
On-the-Job Training	Depends on when the need to learn a new skill (or set of skills) is high; for example, directly following new employee onboarding, or over a period of time when an employee is transitioning into a new role, possibly because of promotion or succession planning.	Depends on the employer and/or human resources (HR) to align with a probationary period, transitioning to a new role, completing an apprenticeship program, completing a certification, etc.
Microlearning	Anytime, on-demand.	Typically, 1–5 minutes in length depending on the format used.
Packaged Video Training	Anytime, on-demand.	Research shows that videos should be shorter in length (on average about 2–3 minutes) to increase engagement and knowledge retention.
Online Web Conference (Webinars and Webcasts)	Depends on the subject matter, audience availability, and the time needed to cover the content.	Typically, learners lose interest after two hours, so it is recommended webinars/webcasts be less than two hours in length.
Live-Streamed Training (Synchronous Virtual Instructor-Led Training)	Depends on the subject matter, audience availability, budget, and the time needed to cover the content. Typically, a vILT course offers multiple sessions spread out over a certain period of time.	Each session should be less than two hours in length to ensure optimal engagement and knowledge retention.
Basic eLearning (Level 1)	Anytime, on-demand.	Depends on many factors including subject matter and budget but should be short in length or broken up into multiple modules to ensure optimal engagement and knowledge retention. Typically, eLearning modules can be 30 minutes to 1 hour in length.
Enhanced eLearning (Levels 2 and 3)	Anytime, on-demand.	Depends on many factors, including subject matter and budget, but should be short in length or broken up into multiple

Training Delivery Format	Timing	Recommended Length
		modules to ensure optimal engagement and knowledge retention. Typically, eLearning modules can be 30 minutes to 1 hour in length.
Classroom Training (Instructor-Led Training)	Can vary greatly and depend on the subject matter, audience availability, and the time needed to cover the content. Typically, ILT is broken up over a series of days or even weeks/months.	Can vary greatly and depend on the subject matter, audience availability, and the time needed to cover the content.
Performance Aids and Tools	Anytime, on-demand.	Depends on many factors including subject matter, complexity, and budget.
Blended Learning	Depends on the components that will be part of the blended learning solution.	Depends on the components that will be part of the blended learning solution.

4.11 Learning Management System Platform Requirements

The Learning Management System (LMS) requirements are dependent on what training delivery format is used and its capabilities. All products can be developed to work on an LMS, given its requirements and the LMS ability to accept the product.

Videos, online web conferences, and vILTs can also be standalone (i.e., provided via a website) but can be developed/packaged to work on an LMS. For ILT, courses can be listed in an LMS depending on the type of LMS and its capabilities. The LMS could be used for ILT coordination and enrollment/tracking. For blended learning, platform requirements depend on the components used and the LMS ability to accept its capabilities.

4.12 Effectiveness of an Adult Learning Tool

In this section, the effectiveness of information retention and learner engagement is discussed for each training delivery format, as is whether it assists with active or passive learning, or both. In addition, each training delivery format is also discussed in terms of where it falls within each of the learning domains as referenced in the Determining the Optimal Training Delivery Format/Method section of this report, as shown in Table 7.

Table 8: Learning Domain Alignment and Active/Passive Learning

Training Delivery Format	Active, Passive, or Both?	Cognitive	Affective	Psychomotor
On-the-Job Training	Active	X	X	X
Microlearning	Both	X	X	

Training Delivery Format	Active, Passive, or Both?	Cognitive	Affective	Psychomotor
Packaged Video Training	Passive	X	X	
Online Web Conference (Webinars and Webcasts)	Passive	X	X	
Live-Streamed Training (Synchronous Virtual Instructor-Led Training)	Both	X	X	
Basic eLearning (Level 1)	Passive	X	X	
Enhanced eLearning (Levels 2 and 3)	Both	X	X	X (Level 3)
Classroom Training (Instructor-Led Training)	Active	X	X	X
Performance Aids and Tools	Passive	X		
Blended Learning	Depends upon components used	Depends upon components used		

4.12.1.1 On-the-Job Training

OJT can be immediately applied on the job. It can target cognitive, affective, and psychomotor development, so it provides one of the highest forms of learner knowledge retention and engagement. OJT is considered active learning because it provides a comprehensive hands-on experience. OJT should be selected for certain types of learning, such as those that: (1) require a high level of case-by-case and individual judgment; (2) involve processes that are unpredictable and inconsistent; and/or (3) necessitate the development of detailed technical skills.

4.12.1.2 Microlearning

Because microlearning can utilize a variety of formats that connect to a wider variety of learning styles, learner engagement is high. Content is shorter, and knowledge retention is higher, especially if spaced repetition (practicing new topics repeatedly over time) and retrieval practice (using questions to recall information and strengthen memory) is incorporated. In addition, with growing evidence of increasingly reduced attention spans, microlearning can meet the needs of learners in the workplace. Microlearning can target cognitive and affective development. Microlearning is mostly passive learning, but active learning elements can be included.

4.12.1.3 Packaged Training Videos

Videos are ideal for showing learners how to perform a task or demonstrate a soft-skill training action that cannot be adequately represented in writing. They can also be used to model correct/incorrect behaviors or performance. Videos can target cognitive and affective development and are considered passive learning.

4.12.1.4 Online Web Conferences

Webinars and webcasts can target cognitive and affective development. Webinars are mostly passive learning, but active learning elements can be included (e.g., exercises, discussions), whereas webcasts are considered passive learning.

4.12.1.5 Live-Streamed Training (Synchronous Virtual Instructor-Led Training)

vILT retention can be higher than that of WBT alone because it can include ILT discussions and exercises/activities to help reinforce material. vILT can target cognitive and affective development and is mostly passive learning, but active learning elements can be included.

4.12.1.6 Basic and Enhanced eLearning

Basic eLearning (Level 1) can target cognitive and affective development and is considered passive learning. Basic eLearning (Level 1) should not be used to teach psychomotor skills; rather, it is ideal for subjects that are short in duration (e.g., compliance training) and easy to assimilate.

Enhanced eLearning can increase retention more than Level 1 basic eLearning because it can provide more complex scenario-based learning and real-world application. It is considered passive learning, but active learning elements can be included. Enhanced eLearning can target cognitive and affective development, and sometimes psychomotor in complex scenarios and simulations (Levels 3 and 4).

4.12.1.7 Classroom Training (Instructor-Led Training)

ILT encourages collaborative learning techniques and opportunities and is considered active learning. It also works well for learners adverse to technology and change. In addition, it exposes learners to multiple learning modalities that can target cognitive, affective, and psychomotor development. ILT can be very effective when focused on problem-solving and exchanging and sharing new ideas and solutions.

Similar to OJT and blended learning, ILT provides one of the most engaging forms of learning, with a higher rate of knowledge retention than asynchronous formats, eLearning, videos, webinars, and microlearning. It provides the maximum opportunity for learning, engagement, and retention.

4.12.1.8 Performance Aids and Tools

Performance aids and tools can target cognitive development and should not be used for psychomotor skills or if the learner does not have prerequisite skills. They are considered passive learning.

4.12.1.9 Blended Learning

Blended learning can target cognitive, affective, and psychomotor development, depending on the mix of formats. Because of the use of multiple learning modalities and formats, it provides one of the highest forms of learner knowledge retention and engagement. It can provide a mix of active and passive learning. The key to success with blended learning is choosing the right tool for each portion of the content. Blended learning can be the most powerful tool in the arsenal because it can be customized based on the learner and content. Learners and trainers alike benefit from the flexibility this format offers. It works very well with a large curriculum that is broken into pieces/sections and provided in a given order.

5 REFERENCES

Anderson, L.W., & Krathwohl, D.R. (eds.). (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives*. New York: Longman.

Why microlearning is huge. (2014, July). Retrieved from https://elearningindustry.com/why-microlearning-is-huge

Sink, L. Darryl (2014). Design models and theories for adults. American Society for Training & Development (ASTD). *ASTD Handbook*. Retrieved from https://dsink.com/downloads/10SinkASTDhandbook.pdf

Training budget benchmarks and optimizations for 2017. (2016, December). Published by Brandon Hall Group. Retrieved from https://www.litmos.com/lp/training-budget-benchmarks-optimizations-2017

Chapman, B. (2010). *How long does it take to create learning?* [Research Study]. Published by Chapman Alliance LLC. Retrieved from http://www.chapmanalliance.com/howlong/

Rossett, A. & Gautier-Downes, J. H. (1991). *A handbook of job aids.* San Diego: Pfeiffer & Company.

Virtual instructor-led training. (2013, February). Retrieved from https://trainingindustry.com/wiki/content-development/virtual-instructor-led-training-vilt/

L. Medsker, K & M. Holdsworth, K & Brethower, Dale. (2002). *Models and strategies for training design*. International Society for Performance Improvement.

What learners want: strategies for training delivery report. (2018, September). Published by Training Industry. Retrieved from https://www2.trainingindustry.com/what-learners-want-strategies-for-training-delivery

Piskurich, George M. Rapid Instructional Design. (2006). San Francisco: Pfeiffer, An Imprint of Wiley

What really is the cone of experience? (2017, August). Retrieved from https://elearningindustry.com/cone-of-experience-what-really-is

Laird D. (1985). *Approaches to Training and Development.* Reading, Massachusetts: Addison-Wesley.

Hrastinski, Stefan. (2008). Asynchronous and synchronous e-learning. Educause Quarterly. 4.

DeSimone, R. L., Werner, J. M. (2012). *Human Resource Development*. Mason, OH.: South-Western College Pub.

Hofmann, Jennifer (2018). *What Works in Talent Development: Blended Learning*. Alexandria, VA: Association for Talent Development (ATD) Press.