Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.1: Cement Production

California Environmental Protection Agency
Air Resources Board

Welcome and Introductions

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- The Climate Registry Team
  - William (Bill) Master - Direct Path Strategies, Inc.
  - John Kline – Cement expert

MRR Verifier Accreditation: Course Content and Exams

Course 1: General Verification for Mandatory GHG Reporting

Course 2: Transactions Specialty

Course 3: Oil and Gas Systems Specialty

Course 4: Process Emissions Specialty

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production
4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

Process Emissions Specialist

Provides verification services to operators of facilities engaged in

§95110 - Cement production (9)
§95116 - Glass production (10)
§95117 - Lime manufacturing (<3)
§95118 - Nitric acid production (<3)
§95119 - Pulp and paper manufacturing
(7 recycled paper plants - no pulp plants in CA)
§95120 - Iron and steel production (<3)
§ 95124 - Lead production (<3)

Disclaimer

This accreditation training is intended to provide administrative detail and recommended practices for compliance with the verification provisions of the California Air Resources Board's (ARB) Regulation for the Mandatory Reporting of Greenhouse Gas (GHG) Emissions (Regulation) (Title 17, California Code of Regulations, sections 95100- 95158).

Unlike the Regulation itself, this training and associated materials do not have the force of law. The training and associated materials are not intended to and cannot establish new mandatory requirements beyond those that are already in the regulation, and they do not supplant, replace or amend any of the legal requirements of the regulation. Conversely, any omission or truncation of regulatory requirements does not relieve verification bodies, lead verifiers, verifiers of emissions data reports, or reporting entities of their legal obligation to fully comply with all requirements of the regulation.

Note: ARB verification accreditation exams are not limited to this verification accreditation training or associated materials. The exams may test on anything contained in the regulation, this accreditation training, and associated materials.

Course 4.1 Handouts

4.1.1 Cement and Lime Mass Balance Calculation Workbook

4.1.2 Cement Case Study Handout

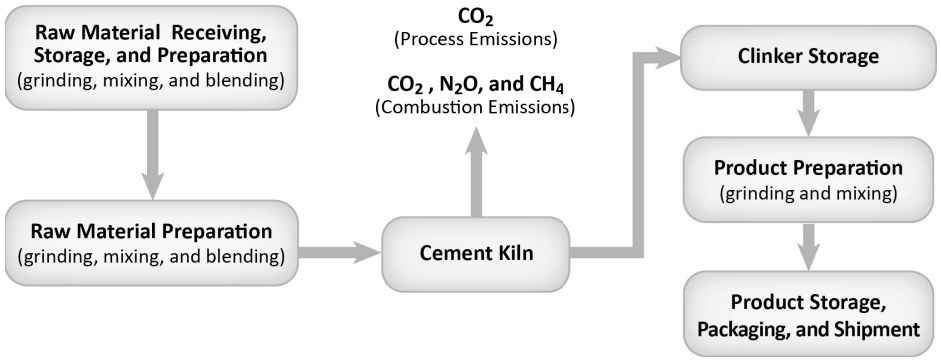
Course 4.1 Cement Production

1. **Overview**
2. **Emissions Data**
3. **Calculation Methods**
4. **Verifying Emissions**
5. Product Data
6. Case Study

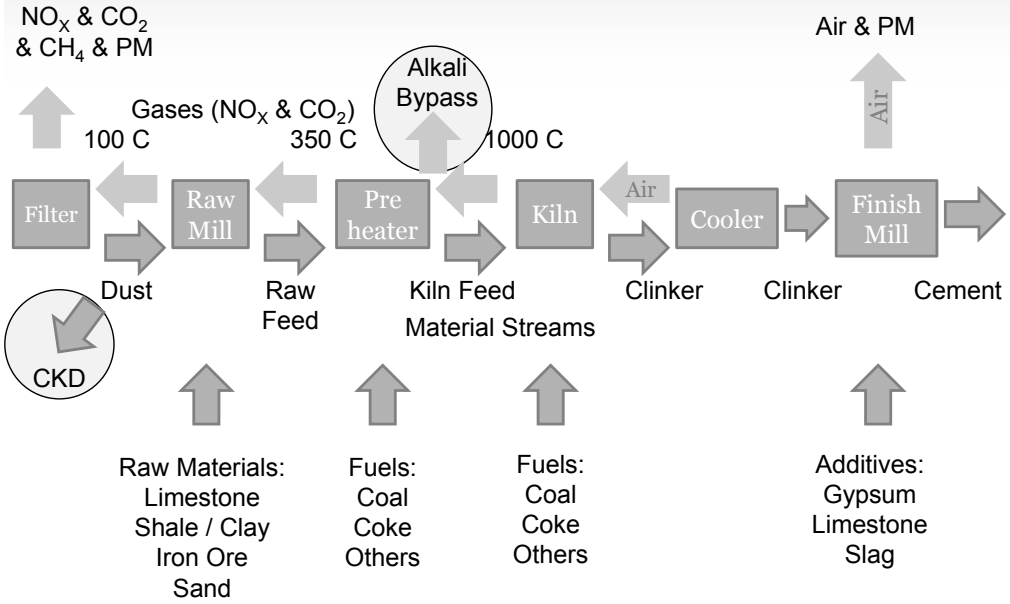
§ 95110 Cement Production

- Portland cement production facilities
  - Kilns and in-line kiln/ raw mills
  - Alkali bypasses
- No reporting threshold
- ≥ 25,000 $MTCO_2e$ triggers
  - Verification
  - Cap-and-Trade covered entity

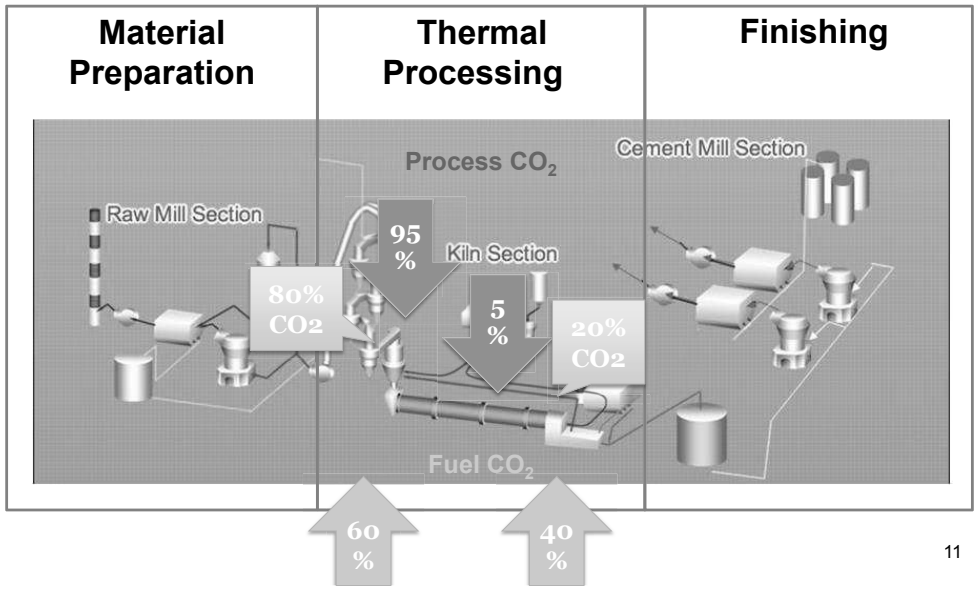
Material Flow at a Cement Plant



Cement Manufacturing Process



Cement Manufacture - Precalciner



Rules of Thumb

Production Ratios (Approximate)

- 1.55 tons of dry raw material per ton of clinker
- 1.1 tons of cement per ton of clinker
- 1 ton of fuel per 10 tons of clinker produced
- 0.75 tons of CO_2 per ton of clinker produced

Emissions Data Reported for Cement Production Facilities (1 of 2)

These emissions must be reported:

- CO_2 process emissions from cement kilns and in-line kiln/raw mills (§ 95110)
- CO_2, CH_4, and N_2O emissions from stationary combustion of fuels in cement kilns and in-line kiln/raw mills (§ 95115)
- CO_2, CH_4, and N_2O emissions from all other stationary combustion sources (e.g., dryers, process heaters, electricity generation, cogeneration supplemental firing) (§ 95112, 95115)

Emissions Data Reported for Cement Production Facilities (2 of 2)

- All process emissions assumed to occur in precalciner and kiln
- No process emissions are assumed for the following:
  - Quarrying, material extraction and transport
  - Raw material handling and grinding
  - Clinker coolers and associated equipment
  - Product blending/grinding
  - Load out and transportation of finished goods

§ 95110 Relation to Subpart H

- Section 95110 refers to Subpart H for all reporting requirements, including CO_2 CEMS data, except
  - Follow § 95115 (c) on allowable Tiers (1-3) for non-CEMS stationary fuel combustion emissions
- Missing data substitution
  - § 95110 missing data only includes provisions for mass-balance calculation
  - § 95110 refers to § 95129 missing data for SFC sources
  - Subpart H refers to Subpart C or Part 75 for missing CEMS data
- Covered product data reporting requirements contained in § 95110

Calculation Methods for CO_2 Process Emissions from Cement Kilns

Reporters must use one of the two methods specified in Subpart H for estimating emissions:

- CEMS
  - Report CO_2 from both combustion and process <u>combined</u>
- Mass balance calculation based on production data and composition analysis of clinker, CKD, and raw materials
  - Report CO_2 from combustion and process <u>separately</u>

Note: All cement kilns reporting in California use CEMS to monitor CO_2 emissions

Common Issues with CEMS Reporting

- Gas flow meter accuracy
- CEMS CO_2 concentration - % accuracy
- H_2O corrections
- CEMS software focused on generating quarterly compliance reports, but may not be transparent for verification

Verifying CO_2 Emissions from Cement Kilns that use CEMS

- Review records of dates and results of CEMS certifications and quality assurance procedures performed during each reporting year
  - Linearity checks
  - Cylinder gas audits
  - Relative accuracy test audits (RATA)
- Determine whether the CEMS certifications and quality assurance procedures conform with the relevant requirements
  - 40 CFR Part 60 or Part 75
  - Air District Monitoring Program using CEMS

Verifying Missing Data Substitution for CO_2 Emissions Measured with CEMS (1 of 2)

Evidence to request

- Operator of a unit monitoring and reporting emissions and heat input data under §95115 using Tier 4 (40 CFR 98.33(a)(4)) must follow the missing data procedures in 40 CFR 75.31 to 75.37
- CEMS certified under 40 CFR Part 60 uses quality-assured data defined according to QA/QC procedures in Part 60
- Operators with an unforeseen CEMS breakdown resulting in >10% loss of emissions data may request ARB approval of an interim procedure (§95129(i))

Verifying Missing Data Substitution for CO_2 Emissions Measured with CEMS (2 of 2)

How to evaluate the evidence

- Verify that missing data substitution procedures conform with the applicable procedures in 40 CFR Part 75
- If there was a CEMS breakdown, verify that
  - The reporter followed applicable procedures during the breakdown period, or
  - The reporter requested and received ARB approval to use interim data procedures during the breakdown period

Reporting CO_2 Combustion Emissions from Mixed Fuels Using CEMS (1 of 2)

Total CO_2 = Covered CO_2 + Exempt CO_2

or

Exempt CO_2 = Total CO_2 – Covered CO_2

[Note: "Covered" CO_2 *equals Non-exempt* CO_2 *+ Process* CO_2*]*

Three options

Option 1 - Directly measure quantities of biomass fuels combusted to determine biogenic CO_2

- Subtract only fuel quantities that are accurate

Reporting CO_2 Emissions from Mixed Fuels Using CEMS (2 of 2)

Option 2 - Sample flue gas to determine biogenic CO_2

- Conduct accurate and representative quarterly stack sampling (ASTM D6866-08) to determine biogenic fraction (as a percentage of total flow)
- Added expense, and might not detect low biogenic fraction
- Relieves requirement for biomass fuel measurement accuracy

Option 3 - Report all CO_2 from CEMS as covered emissions

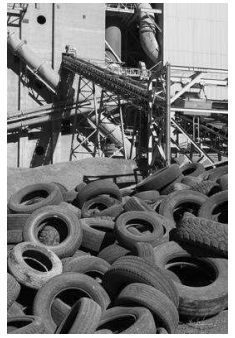
- If quarterly biogenic sampling is not representative and amount of exempt fuel is not accurately known, all emissions are assumed to be fossil /covered emissions

Fuels for Cement Manufacture

- Cement companies pay for most fuels
  - The exception is waste fuels provided at no cost or where there may be a tipping fee paid to the cement plant
  - Therefore, fuel accounting is typically auditable and meets financial transaction criteria for accuracy
- Fuel inventory levels are generally low in plants, especially for waste fuels, so inventory adjustments may be small
- Moisture content of the fuel can be an issue
  - Accurate moisture values need to be established

Emissions from Waste Tires

- Waste tires are burned at 5 out of 9 cement plants
  - Very high energy, low-cost fuel
- Similar reporting requirements to other fuels
  - Regulation allows a default of 20% biogenic
  - Monthly fuel sampling is allowed if a default is not used, but sampling is difficult and may not be representative
  - Tire purchases might not match amount of tires combusted, unless transaction occurs at the point of delivering fuel into kiln



Course 4.1 Cement Production

1. Overview
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4. Verifying Emissions
5. **Product Data**
6. **Case Study**

Covered Product Data §95110(d)

Requires conformance with +/- 5% accuracy on each measurement and material misstatement evaluation on sum of the following (short tons):

- Annual clinker produced
- Annual clinker consumed
- Annual limestone consumed for blending
- Annual gypsum (natural and synthetic) consumed for blending

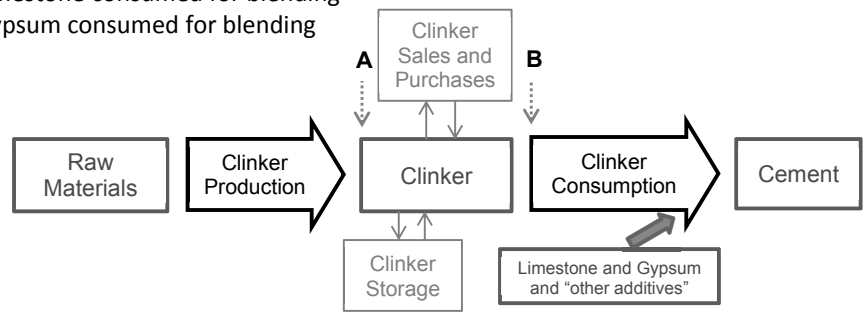
CEMENT IS NOT A COVERED PRODUCT!

Annual cement substitute is reported but not "covered"

Note: covered product data for cement plants may not be excluded

Covered Product Data from Cement Plants: Illustrative Example (Part 1)

Clinker produced
Clinker consumed
Limestone consumed for blending
Gypsum consumed for blending



- Measurement point A - Clinker produced
- Measurement point B - Clinker consumed

Verifying Covered Product Data: Evidence to Request

- Documentation describing how operator determined production quantities (GHG Monitoring Plan)
- Maintenance and calibration records for weighing scales
- Original records, weighing measurement records, sales receipts, and invoices
- Beginning and end of year inventory records
  - Cement, clinker, gypsum for blending, limestone for blending
- If clinker production is based on raw material feed measurements and a feed-to-clinker ratio, then request
  - Records of raw material consumption (direct measurement records/delivery receipts, etc.)
  - Clinker production/raw material consumption data used to determine monthly feed-to-clinker ratio

Material Misstatement vs. Conformance for Covered Product Data for Cement Plants

- Material misstatement based on the sum of Clinker Produced + Clinker Consumed + Limestone and Gypsum Consumed for Blending
  - Material misstatement is only triggered if overall sum is not within +/- 5%
  - Note that Cement Substitutes consumed are not included in the material misstatement evaluation
- Any single covered product that is not measured accurately within +/-5% is a non-conformance (§ 95103(k), (k)(2)and(6))
  - Results in a qualified positive verification statement if discrepancy is not a material misstatement (and no correctable error is present)

Cement Covered Product Data Reporting Examples

- Annual data must be accurate
  - Monthly data can provide additional support on accuracy, but only annual data must be accurate
  - Verifiers will scrutinize entire process to determine conformance with regulation
  - During site visit, ensure all staff necessary to explain process are in attendance
  - Review whether methods have changed
- Following are two examples for reporting covered product data
  - See *Cement Producers Covered Product Data Reporting Guidance* on ARB website.

Cement Covered Product Data Reporting Example 1

- Operator directly measures products using accurate and calibrated truck scales, weigh feeders, and belt scales or other meters
  - Other inventory measurements using tank drop and pile surveys must still be accurate (+/-5%)
- Good option for cement plants if measurement equipment is robust and appropriate

Cement Covered Product Data Reporting Example 2

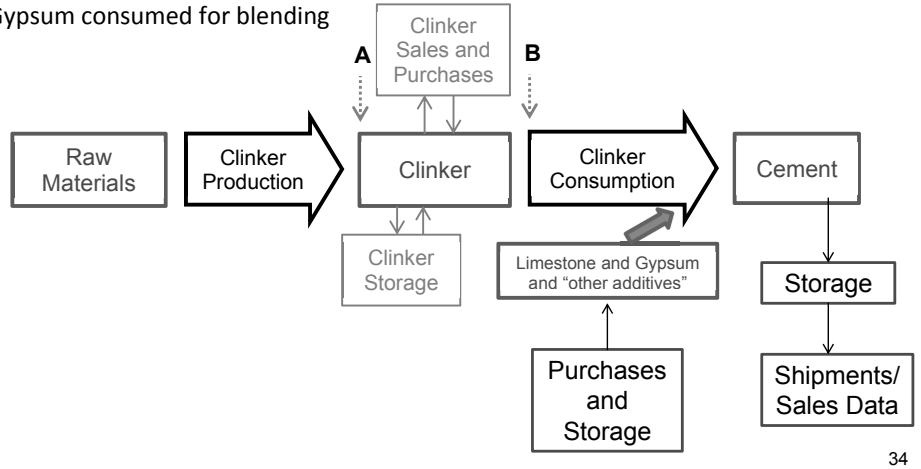
- Use cement sales and analysis data to back-calculate covered product data
- Adjust for beginning and ending cement inventory to ensure only covered products that are *produced during data year* are reported
- Review the accuracy of total cement produced

Inventory Adjustments for Covered Product Data at Cement Plants

- Operators may calculate production using a backwards calculation from cement sold
  - Cement sold is typically weighed on regulated truck scales
- Accurate inventory adjustments are necessary as large quantities of cement and clinker storage are common
  - Cement is usually stored in silos, clinker can be stored in silos, domes, and / or storage buildings and outside piles
  - The larger the ratio of sales-to-storage volumes, the relatively smaller the estimated inventory adjustment will be to the reported data; however, accurate measurement is still required for conformance

Covered Product Data from Cement Plants: Illustrative Example (Part 2)

A-Clinker produced
B-Clinker consumed
Limestone consumed for blending
Gypsum consumed for blending



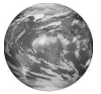
Production Check (Backwards Calculated) [1]

Cement Sold	1,200,000	Tons	Plant Data
Inventory Period Beginning	75,000	Tons	Plant Data
Inventory Period End	50,000	Tons	Plant Data
Cement Produced	1,175,000	Tons	Sold + End - Beginning
Cement Additives Purchased	100,000	Tons	Plant Data
Inventory Period Beginning	15,000	Tons	Plant Data
Inventory Period End	10,000	Tons	Plant Data
Cement Additives Consumed	105,000	Tons	Purchased + Beginning - End
Average Moisture Level	5.0%		Plant Data
Dry Additives Consumed	99,750	Tons	Consumed * (1 - H2O%)
Clinker Consumed	1,075,250	Tons	Cement Produced - Dry Additives
Clinker Consumed	1,075,250	Tons	Plant Data
Inventory Period Beginning	60,000	Tons	Plant Data
Inventory Period End	40,000	Tons	Plant Data
Clinker Produced	1,055,250	Tons	Consumed + End - Beginning

[1]See the cement – lime mass balance calculation handout 4.1.1.

Verifying Other Data for Cement Plants

- "Production-related" data
  - 40 CFR 98 subpart H requires other production-related data to be reported to U.S. EPA: cement production
  - Production-related data ≠ Covered product data
- *Other production-related data are not subject to the same requirements as covered product data required under MRR and listed in Table 9-1 of the Cap-and-Trade Regulation. However, the 40 CFR 98 production-related data elements must be verified for conformance.*
- If production-related data are used to calculate emissions (no CEMS), then they must be reviewed for accuracy and missing data and could influence the evaluation of material misstatement for emissions data.



Case Study, Course 4.1 Cement Handout 4.1.2

See Handout

Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production

Next:

4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production
4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.2: Lime Manufacturing

California Environmental Protection Agency
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Course 4: Process Emissions Specialty

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California Environmental Protection Agency
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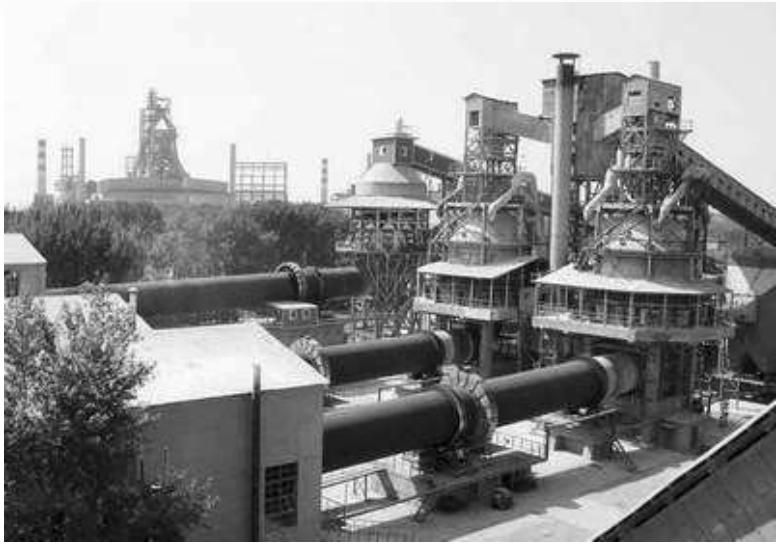
Course 4.2 Handouts

See 4.1.1 Cement and Lime Mass Balance Calculation Workbook from Course 4.1

Course 4.2 Lime Manufacturing

1. Overview
2. Emissions Data and Calculation Methods
3. Verifying Emissions
4. Missing Emissions Data Substitutions
5. Product Data
6. Group Participation Exercise

Lime Production Plant



§95117 Lime Manufacturing (1 of 2)

- Refers to Subpart S for reporting process emissions
- Applies to lime manufacturing plants (LMPs) that manufacture lime products by calcination of limestone*, dolomite**, shells, or other calcareous substances (aragonite, chalk, coral, marble)
  - Calcium oxide
  - High-calcium quicklime
  - Calcium hydroxide
  - Hydrated lime
  - Dolomitic quicklime
  - Dolomitic hydrate

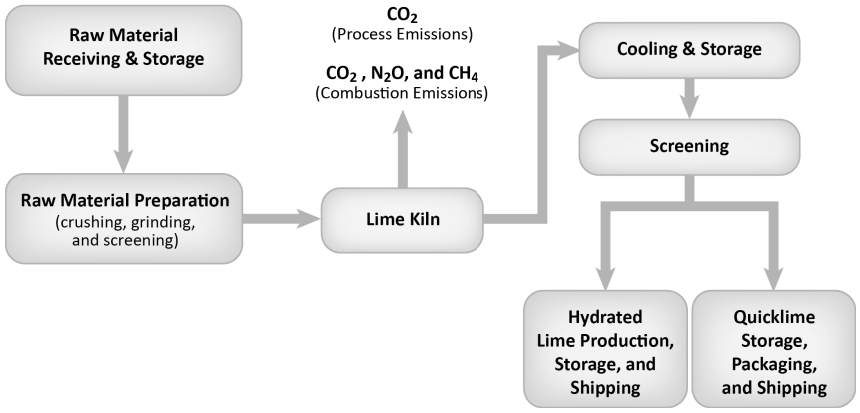
**Rock must contain at least 50% calcium carbonate to be classified as limestone*

***Rock that contains 30 to 45% magnesium carbonate is referred to as dolomite or dolomitic limestone*

§95117 Lime Manufacturing (2 of 2)

- Includes marketed and non-marketed lime manufacturing facilities
- Lime production facilities are “all in”
- Excluded from § 95117 (but none in California)
  - LMPs located at a Kraft pulp mill, soda pulp mill, and sulfite pulp mill (report under 40 CFR Part 98, Subpart AA)
  - LMPs that process only sludge containing calcium carbonate from water softening processes

Processes and Emissions Generation in a Lime Plant



Rule of Thumb Values

Production Ratios (Approximate)

- 0.5 Ton Lime / Ton Limestone (wet)
- 0.44 Ton CO_2 / Ton Limestone (dry)
- 0.1 - 0.15 Ton Fuel / Ton Lime
- 0.1 Ton Lime Kiln Dust (LKD) / Ton Lime

Basic Reactions (Process Emissions)

- Limestone $CaCO_3$ is heated to release CO_2 giving lime product (CaO)
  - $CaCO_3$ + Heat => CaO + CO_2
  - 1 metric ton of pure, dry limestone gives 440 kg of CO_2
- Dolime (calcined dolomite) $CaMg(CO_3)_2$ is heated to release CO_2 giving lime product (CaO) and MgO
  - $CaMg(CO_3)_2$ + Heat => CaO + MgO + $2CO_2$
  - 1 metric ton of pure, dry dolomite gives 477 kg of CO_2

Loss on Ignition (LOI)

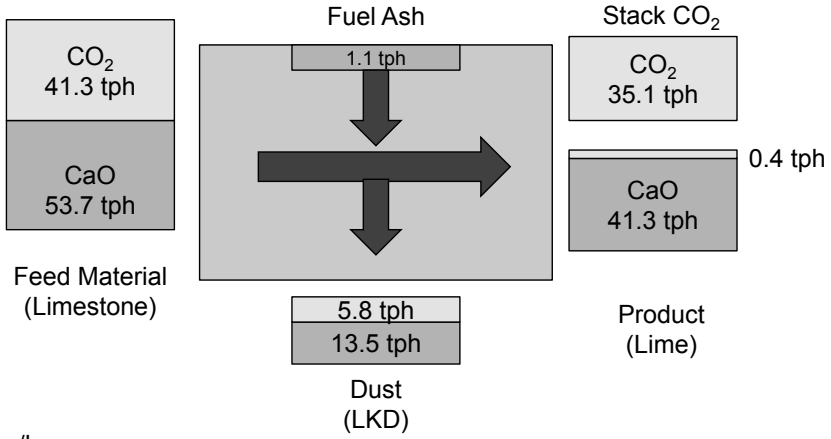
- The purity of limestone is measured by the lime (CaO) and/or magnesium oxide (MgO) content
- One common measure used in the industry is the Loss on Ignition (LOI) or Ignition Loss
- This is the loss of weight of a dried sample of limestone or dolomite when heated above the calcination temperature and generally represents the amount of CO_2 in the sample
- LOI is important for mass balances

Example Mass Balance (LOI Basis)

Limestone Feed Rate	100	TPH	Plant Data
H2O %	5%	Percent	Plant Data
Dry Limestone	95	TPH	Limestone * (1 - H2O%)
Limestone LOI %	43.5%	Percent	Plant Data Lab Test
Inerts in Limestone	53.68	TPH	Dry Limestone * (1 - LOI%)
CO2 in Limestone	41.33	TPH	Dry Limestone - Lime in
Fuel Feed Rate	10.00	TPH	Plant Data
Fuel H2O %	10%	Percent	Plant Data
Fuel Ash %	12%	Percent	Plant Data
Fuel Ash	1.08	TPH	Fuel Rate * (1 - H20%) * Ash%
Daily Lime Production Rate	1000	TPD	Plant Data
Hourly Product Out	41.67	TPH	Daily Production / 24 Hours
Product LOI %	1.0%	Percent	Plant Data Lab Test
Lime Out (excl. CO2)	41.25	TPH	Product * (1 - LOI%)
CO2 in Product	0.42	TPH	Product Out - Lime Out
LKD excluding CO2	13.51	TPH	Lime in + ash in - Lime Out
LKD LOI %	30%	Percent	Plant Data Lab Test
LKD Out (incl CO2)	19.29	TPH	LKD Lime / (1 - LOI%)
CO2 in LKD	5.79	TPH	LKD Out - LKD excluding CO2
Process CO2 Emitted	35.12	TPH	CO2 LS - CO2 Prod - CO2 LKD
Hours of Operation	7500	Hours	Plant Data
Total CO2 Tons per Year	263404	Tons	CO2 TPH * Hours
*Loss on Ignition (LOI) - lab test determined loss upon combustion (in % as CO2)			

Process Emissions Lime Kiln

CO_2 in stack = CO_2 in Raw Material – CO_2 in Product – CO_2 in Dust



tph = tons/hr

Emissions Data Reported for Lime Manufacturing Facilities (1 of 2)

These emissions must be reported:

- CO_2 process emissions from lime kilns (§95117)
- CO_2, CH_4, and N_2O emissions from stationary combustion of fuels (§95115)
- CO_2 captured for use on-site (40 CFR 98.196(b)(17))

Emissions Data Reported for Lime Manufacturing Facilities (2 of 2)

All process emissions assumed to occur in kiln; no process emissions are assumed to occur from

- Raw material handling
  - Receiving, crushing, grinding, and screening, & transportation
- LKD handling
  - Treatment, transportation, and disposal / disposition
- Lime screening and grinding
- Lime storage and shipping
- Hydrated lime production (when sole LMP process)

§95117 Relation to Subpart S

§95117 refers to subpart S for all requirements except

- Stationary fuel combustion emissions - Tiers 1 through 4 methodologies as specified by fuel type in § 95115
- More conservative missing emissions data substitution procedures
- Additional product data reported
  - Dolime produced (covered product data)
  - Lime produced (not a covered product)

Calculation Methods for CO_2 Process Emissions from Lime Kilns

- Reporters must use either of the methods specified in Subpart S:
  - **Mass balance calculation** based on quantity and composition analysis of lime product, LKD, and calcined byproducts/wastes
    - Report CO_2 from combustion and process separately
  - **CEMS (California facilities do not have CEMS)**
    - Report CO_2 from both combustion and process combined
- When verifying produced CO_2 used onsite
  - New requirement – discuss with ARB during verification
  - No covered product data reported

Verifying CO_2 Emissions from Lime Kilns (1 of 2)

For mass balance method

- Obtain and review documentation describing how facility derived its lime and calcined lime byproduct/waste production and sales numbers including measurement data
- Verify appropriate measurement methods were used to determine
  - Monthly lime/lime byproduct (40 CFR 98.194(b))
  - Total CaO and MgO weight fractions in each product/byproduct (40 CFR.194(c))

Verifying CO_2 Emissions from Lime Kilns (2 of 2)

Reproduce CO_2 emission calculations using Eq. S-1 through S-4 to calculate CO_2 emissions

S-1 - Calculate monthly emission factor for lime

S-2 - Calculate monthly emission factor for LKD sold

S-3 - Calculate CO_2 emissions from waste not sold

S-4 - Sum of emissions from lime, LKD sold, and waste not sold

$$E_{CO_2} = \sum_{i=1}^{t}\sum_{n=1}^{12}(EF_{LIME,i,n} * M_{LIME,i,n}) + \sum_{i=1}^{b}\sum_{n=1}^{12} EF_{LKD,i,n} * M_{LKD,i,n}) + \sum_{i=1}^{z} E_{waste,i}$$

Verifying Missing Emissions Data Substitution (1 of 2)

- § 95117 refers to § 95129 for missing SFC data
- For mass balance method
  - Missing CaO or MgO composition data § 95117(c)(2)
    - If ≤ 10% missing, use best available data for reporting year
    - If >10 and ≤20% missing, use highest quality assured value recorded for the missing parameter during the given year, as well as the two previous years
    - If >20% missing, use highest quality assured value recorded for the parameter in all records kept

Verifying Missing Emissions Data Substitution (2 of 2)

For emissions data reporting using mass balance method

- Missing monthly amounts of lime production and byproduct/waste produced and sold (and used to report emissions) § 95117(c)(3)
  - If ≤20% missing , use best available estimate based on all available process data or data used for accounting purposes
  - If >20% missing , use the maximum capacity of the lime kiln

Data Elements Reported for Lime Manufacturing Facilities under Subpart S

- Monthly quantities of each lime product
- Monthly quantities of calcined lime byproduct/waste sold
- Annual quantities of calcined lime byproduct/waste not sold
- Beginning and end of year inventories of each lime product
- Beginning and end of year inventories of each calcined byproduct/waste sold
- Annual quantity of CO_2 captured for onsite production process, if applicable (quantity that is used, not sold)

Product Data Reported for Lime Manufacturing Facilities under § 95117(d)

- Annual quantity of dolime produced (Covered, short tons)
- Annual quantity of lime produced (Not covered, short tons)
- Missing data procedures not allowed for product data reporting

Verifying Product Data for Lime Manufacturing Facilities

- Evidence to request
  - Documentation describing how the facility determined its production data (for emissions and covered product data)
  - Direct measurement records from product measurement
  - Product sales invoices/delivery receipts
  - Beginning and end of year product inventory records
- How to evaluate evidence
  - Confirm records are complete
  - Confirm that monthly data are summed correctly
  - Compare summed monthly data with reported production data

Verifying Other Production-Related Data for Lime Manufacturing Facilities

- "Other production-related" data
  - 40 CFR 98 subpart S requires other production-related data to be reported to U.S. EPA: annual quantity of lime sold, amount of calcined lime/byproduct waste sold/not sold, monthly weights and mass of each lime product sold, annual production capacity per facility
  - Production-related data ≠ Covered product data
- *Other production-related data are not subject to the same requirements as covered product data required under the MRR and listed in Table 9-1 of the Cap-and-Trade Regulation. However, the 40 CFR 98 production-related data elements must be verified for conformance.*
- If production-related data are used to estimate emissions, then they must be accurate and errors could influence the evaluation of material misstatement for emissions data.

Questions and ARB Comments

California Environmental Protection Agency
Air Resources Board

Group Participation Exercise 4.2.1 LMP Missing Data Substitution (1 of 2)

- A lime plant operates a single kiln that produces 1,000 tons of dolime per day. During the site visit, the plant manager indicated that some construction at the plant resulted in a plant shutdown beginning September 30, 2014. The plant started back up on October 21, 2014 and operated at its normal production level, but the data was not recorded and is "missing" for 11 days after the plant restarted. The plant provided the dolime production data shown in the next slide.
- What value should be substituted for the missing dolime production data (for the purposes of calculating emissions and for reporting covered product data) for October?
  - A. 7,100
  - B. 17,000
  - C. 20,000
  - D. 20,583

Group Participation Exercise 4.2.1 LMP Missing Data Substitution (2 of 2)

	Monthly Dolime Production (Based on Plant logs) (tons)	
	2013	**2014**
January	20,000	20,000
February	22,000	22,000
March	20,000	20,000
April	20,000	20,000
May	25,000	20,000
June	20,000	20,000
July	21,000	21,000
August	21,000	21,000
September	20,000	15,000
October	18,000	missing
November	20,000	20,000
December	20,000	20,000
Total Production for the year	247,000	
Annual Average (based on available data)	20,583	19,909

Group Participation Exercise 4.2.1
LMP Missing Data Substitution - Solution

- For emissions, as missing data is less than 20%, can use best estimate based on available data
- Answer **A** is the most reasonable (7,100 tons or 11/31*20,000 which is the average output for 11 days in October where there is missing data), but other answers are possible
- For covered product data, missing data substitution is <u>not</u> allowed; so October dolime production would have to be reported as excluded

Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production

4.2 Lime Manufacturing

Next:

4.3 Glass Manufacturing

4.4 Nitric Acid Production

4.5 Iron and Steel Production

4.6 Pulp and Paper Manufacturing

4.7 Lead Production

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.3: Glass Manufacturing

California Environmental Protection Agency
Air Resources Board

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Course 4: Process Emissions Specialty

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production
4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

California Environmental Protection Agency
Air Resources Board

Course 4.3 Handouts

No handouts are used for this course.

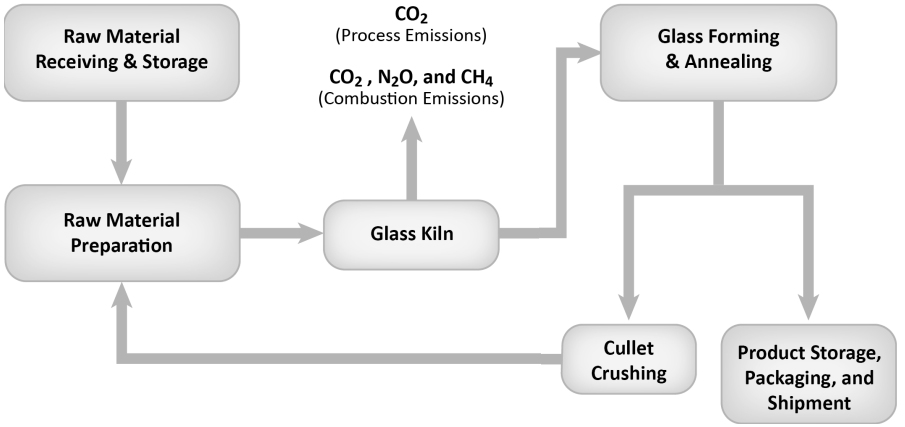
Course 4.3 Glass Manufacturing

1. Overview
2. Emissions Data
3. Verifying Emissions
4. Product Data
5. Verifying Product Data
6. Group Participation Exercise

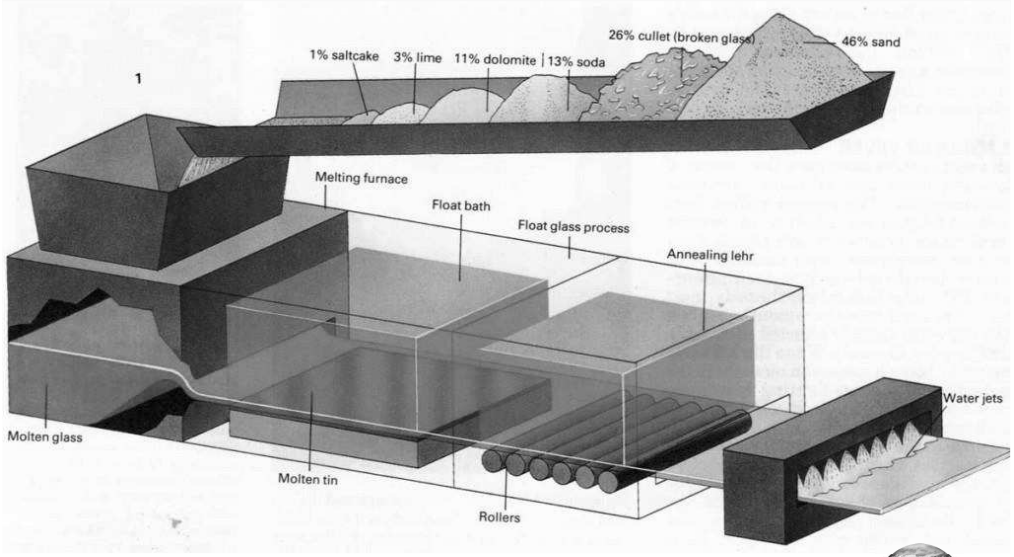
§95116 Glass Production

- Applies to glass manufacturing facilities that manufacture flat glass, container glass, or fiberglass by melting a mixture of raw materials to produce molten glass and form the molten glass into sheets, containers, or fibers
- Reporting is required only for continuous glass melting furnaces
  - Excludes batch and experimental furnaces
- 10 glass manufacturing facilities have been verified

Process Flow for a Glass Manufacturing Facility



Flat Glass Manufacturing Example



Emissions Data Reported for Glass Manufacturing Facilities

- These emissions must be reported:
  - CO_2 process emissions from glass kiln/furnace §95116
  - Stationary combustion emissions from all fuels § 95115
    - Includes kiln plus other ovens and heaters
- All process emissions assumed to occur in furnace
  - Process emissions are not separately reported for
    - Raw material handling - receiving, crushing, weighing, mixing
    - Glass forming - annealing, curing, molding, glass fiber forming

§95116 Relation to Subpart N

In addition to Subpart N, § 95116 requires

- Missing emissions data substitution for annual amount of raw materials
  - If ≤20% missing - use best available data
  - If >20% missing - use maximum capacity of glass kiln
- If mass fraction data from suppliers (or sampling data) is missing, a mass fraction of 1.0 (100%) must be used
- Covered product data defined as glass pulled § 95116(d)
  - No substitute data are allowed for missing covered product data

Verifying CO_2 Process Emissions (1 of 3)

Evidence to request

- Documentation describing how facility derived its carbonate-based raw material rates and mineral-based fractions
- Monthly measurements of raw material charged to each furnace
  - Calibration records for batch scales or weigh hoppers
  - Records of raw material purchases

Verifying CO_2 Process Emissions (2 of 3)

How to evaluate evidence

- Compare mass of raw material charged to each furnace with purchases 40 CFR 98.144(a)
  - Review inventory adjustment (Dec/Jan) if needed to validate reported raw material usage
  - If total quantities are accurate, a reasonable allocation of materials/emissions is acceptable between furnaces
- Reproduce CO_2 emission calculations using Eq. N-1
  - Verify equation inputs to Cal e-GGRT

Verifying CO_2 Process Emissions (3 of 3)

Carbonate-based mineral mass fraction

$$E_{CO2} = \sum_{i=1}^{n} MF_i \bullet (M_i \bullet \frac{2000}{2205}) \bullet EF_i \bullet F_i$$

Calcination fraction

- A default of 1 may be used for carbonate-based mineral mass fraction (40 CFR 98.144(c))
  - Otherwise, must use documentation from suppliers and at least annual sampling/chemical analysis to verify supplier data
- A default of 1 may be used for calcination fraction (40 CFR 98.144(d))
  - Otherwise, use records of annual sampling and chemical analysis of the calcination fraction for each carbonate consumed

Verifying Missing Emissions Data Substitution (§ 95116)

- Section 95116 refers to § 95129 for missing SFC data
- For monthly quantities of carbonate-based raw materials
  - If at least 80% data capture, use Subpart N
  - If <80% data capture, substitute each missing value with max. capacity of the system (§ 95116(c)(4))

"Glass Pulled" as Covered Product Data §95116(d)

- All facilities must report annual quantity of glass "pulled" from each melting furnace
- All **glass pulled** from a melting furnace is considered covered product data
  - Glass that is recycled back to the furnace is not subtracted from covered product data (cullet is included if it passes through the furnace again)
- Covered product data only includes glass pulled during that reporting period
  - Guidance
    - Inventory adjustment is not applicable
    - Glass that is off-spec is still covered product data

How Glass Pulled Is Measured

Actual measurement depends on the type of glass

- **Container glass** requires information on conveyor speed, average bottle mass (typically at 15-minute increments), bottle count, type of bottle, frequency of sheer cut, production hours for furnace and glass feed and cutter time vs. glass dumped to basement when mold shop is "down"
- **Flat glass** requires conveyor speed, dimensions of glass panels including thickness (which is QA'd several times per shift), and density measurements and calculations
- **Fiberglass** is measured by glass flow cameras that track fiber manufactured and curtailed (recycled) back to furnace; pull-rate measured by frequent weight validations

Verifying Glass Pulled (1 of 2)

Evidence to request

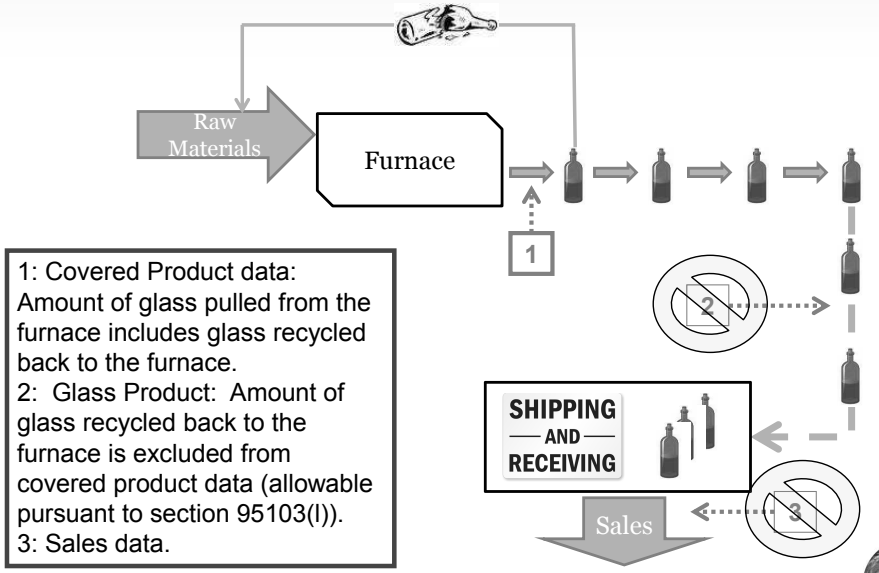
- Documentation describing how the operator determined its production data including
  - the location of the glass pulled measurement
  - query that compiles daily/monthly glass pulled data from a data management system
- Direct, original measurement records from product weighing (e.g., weighing measurement records, daily production data)
- Other records
  - Product sales invoices/delivery receipts for a cross-check
  - Maintenance and calibration records for weighing scales

Verifying Glass Pulled (2 of 2)

How to evaluate evidence

- Confirm record completeness
- Confirm glass pulled data collection location is appropriate
- Compare summed monthly data with reported annual production data
- Cross-check with raw material and cullet usage using a material mass-balance estimation

Location of Glass Pulled Measurement



1: Covered Product data: Amount of glass pulled from the furnace includes glass recycled back to the furnace.
2: Glass Product: Amount of glass recycled back to the furnace is excluded from covered product data (allowable pursuant to section 95103(l)).
3: Sales data.

Group Participation Exercise 4.3.1 Glass Kiln Process Emissions (1 of 2)

- A glass manufacturing facility with one kiln uses the following quantities of raw materials in its production of flat glass:
  - Silica (SiO_2) - 57,950 short tons
  - Soda ash (Na_2CO_3) - 21,500 short tons
  - Limestone ($CaCO_3$) - 21,450 short tons
  - Albite (feldspar) ($Na_2O{\cdot}Al_2O_3{\cdot}6SiO_2$) - 10,250 short tons
  - Borax ($Na_2B_4O_7{\cdot}10H_2O$) - 10,450 short tons
- According to the raw material vendors, the silica, albite, and borax have a purity of 98%, while the soda ash and limestone have purities of 99.8% and 99.5%, respectively
- The plant manager estimates that calcination of the carbonates in the furnace is about 98%

Group Participation Exercise 4.3.1 Glass Kiln Process Emissions (2 of 2)

What are the estimated CO_2 process emissions in MT CO_2/yr?

- A. 17,968
- B. 16,595
- C. 18,335
- D. 18,297

Group Participation Exercise 4.3.1
Glass Kiln Process Emissions Solution (1 of 2)

- Since the facility does not have CEMS, emissions must be calculated using mass balance Eq. N-1.

$$E_{CO2} = \sum_{i=1}^{n} MF_i \bullet (M_i \bullet \frac{2000}{2205}) \bullet EF_i \bullet F_i$$

- Although the facility uses silica, soda ash, limestone, albite and borax in their production process, only the soda ash and limestone are carbonate-containing materials
- The plant manager estimated the fraction of calcination for soda ash and limestone to be 98%. However, the operator must have completed tests to determine the fraction of calcination. Therefore, the verifier must assume calcination is 100%, not 98%.

Group Participation Exercise 4.3.1
Glass Kiln Process Emissions Solution (2 of 2)

Entering the values for soda ash and limestone into Eq. N-1

E_{CO2} = [0.998 x 21,500 short tons x (2000 MT / 2205 short ton) x 0.415 x 1]
+
[0.995 x 21,450 short tons x (2000 MT / 2205 short ton) x 0.440 x 1]

E_{CO2}= 16,595 MT CO_2/year
(Answer B)

Note: Emission factors for carbonate-based raw materials in Table N-1 are in units of MT CO_2 emitted per MT of carbonate-based raw material

Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing

Next:

4.4 Nitric Acid Production
4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.4: Nitric Acid Production

California Environmental Protection Agency
Air Resources Board

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

California Environmental Protection Agency
Air Resources Board

Course 4.4 Handouts

No handouts are used for this course.

Course 4.4 Nitric Acid Production

1. Overview
2. Emissions Data
3. Verifying Emissions
4. Product Data
5. Verifying Product Data
6. Group Participation Exercise

§ 95118 Nitric Acid Production

- Nitric acid production facilities that use 1 or more trains to produce weak nitric acid (30-70% in strength) using catalytic oxidation of ammonia
- Applies to all nitric acid production facilities regardless of GHG emission levels
- ≥25,000 MT CO_2e triggers
  - Verification
  - Cap-and-Trade covered entity

Emissions Data Reported

- N_2O process emissions from individual production trains - § 95118 refers to Subpart V
- CO_2, CH_4, and N_2O emissions from stationary fuel combustion - § 95115

§ 95118 Relation to Subpart V of 40 CFR 98

§ 95118 refers to subpart V for all requirements except

- Stationary fuel combustion - Any Tier (1-4) from 40 CFR 98.33(a) is permitted by fuel type in § 95115
- Missing emissions data more prescriptive in MRR
- § 95118(d) requires reporting of covered product data for nitric acid and calcium ammonium nitrate (CAN-17, a fertilizer solution)

Calculation of N_2O Process Emissions

Subpart V equations

- Calculation of train-specific emission factor (Eq. V-1)
- Calculation of abatement utilization factor (Eq. V-2)
- Calculation of train-level emissions
  - 1 technology after test point (Eq. V-3a) - at least one plant in CA
  - 2+ technologies (in series) after test point (Eq. V-3b)
  - 2+ technologies (in parallel) after test point (Eq. V-3c)
  - 0 technologies after test point (Eq. V-3d) - at least one plant in CA
- Calculation of facility-level emissions (Eq. V-4)

Verifying N_2O Process Emissions

Evidence to request

- GHG Monitoring Plan
- Detailed facility description and schematic – individual trains, abatement technologies, performance test locations
- Performance test results – N_2O concentration, volumetric flow rate of effluent gas, production rate during test run
  - Is annual test data representative of "normal" operations
- Abatement technology information - destruction efficiencies, utilization factors, fraction control factors
- Nitric acid production
- Missing emissions data procedures and records used

Verifying Equation V-1 - Train-Specific Emission Factor

- Evidence to request
  - Equation inputs (data from performance test runs - N_2O concentration, volumetric flow rate of effluent gas, production rate during test run)
- How to evaluate evidence
  - Confirm appropriate test methods used
  - Confirm methods properly followed
  - Confirm missing emissions data procedures were followed
    - Estimation of missing test data is <u>not</u> permitted; new performance test is required
  - Confirm correct calculation

$$EF_{N2Ot} = \frac{\sum_{1}^{n} \frac{C_{N2O} * 1.14 \times 10^{-7} * Q}{P}}{n} \qquad \text{(Eq. V-1)}$$

Verifying Equation V-2 - Abatement Utilization Factor (1 of 2)

Evidence to request

- Equation inputs (nitric acid production - total and with abatement)
- Direct measurement records (flow meters, weigh scales, etc.)
- Abatement records (operation log books)

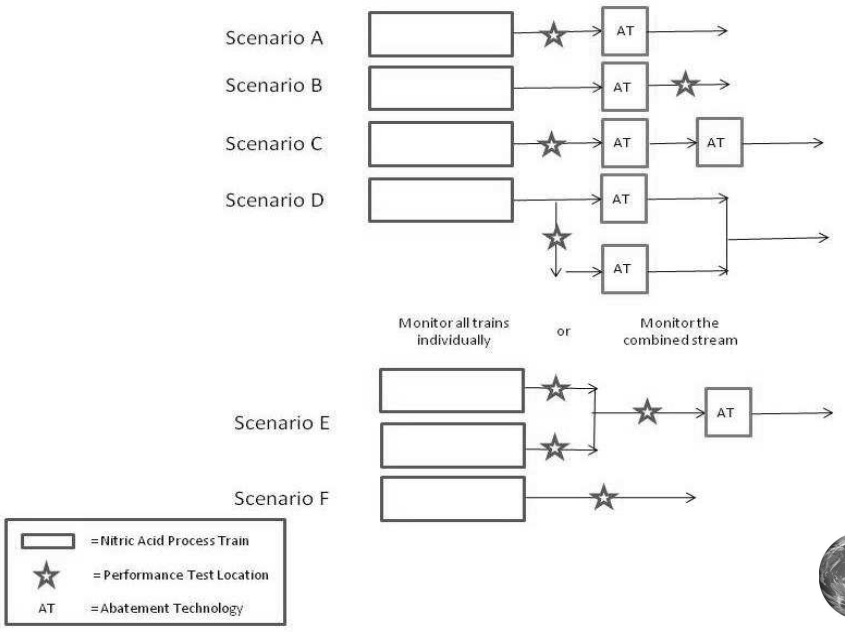
Verifying Equation V-2 - Abatement Utilization Factor (2 of 2)

How to evaluate evidence

- Confirm production record completeness
- Identify if operation periods are indicated as "abated" or "not abated" with respect to air pollution control device
- Confirm missing emissions data procedures were followed:
  - Best available (process/accounting) data (≤20% missing) or maximum production data (>20% missing)
  - Only permitted for calculation of emissions or emission factors; <u>not</u> permitted for covered product data reporting
- Confirm correct calculation

$$AR_{t,N} = \frac{P_{t,N}}{P_t} \qquad \text{(Eq. V-2)}$$

Various Nitric Acid Train Configurations



Process Emissions Equations (V-3a,b,c,d)

$$E_{N2Ot} = \frac{EF_{N2Ot} * P_t}{2205} * \left(1 - \left(DF * AF\right)\right) \qquad \text{(Eq. V-3a)}$$

$$E_{N2Ot} = \frac{EF_{N2Ot} * P_t}{2205} * \left(1 - \left(DF_1 * AF_1\right)\right) * \left(1 - \left(DF_2 * AF_2\right)\right) * \ldots * \left(1 - \left(DF_N * AF_N\right)\right) \qquad \text{(Eq. V-3b)}$$

$$E_{N2Ot} = \frac{EF_{N2Ot} * P_t}{2205} * \sum_{1}^{N}\left(\left(1 - \left(DF_N * AF_N\right)\right) * FC_N\right) \qquad \text{(Eq. V-3c)}$$

$$E_{N_2Ot} = \frac{EF_{N2Ot} * P_t}{2205} \qquad \text{(Eq. V-3d)}$$

Differences Between Equations V-3a, V-3b, V-3c, and V-3d

Equation	# of Technologies[a]	DF[b] Needed?	AF[c] Needed?	FC[d] Needed?	Configuration[e] ("Scenario" in Slide #3)
V-3a	1	Yes	Yes	No	A, E
V-3b	2+ (in series)	Yes	Yes	No	C
V-3c	2+ (in parallel)	Yes	Yes	Yes	D
V-3d	0	No	No	No	B, F

[a]Number of abatement technologies after test point
[b]Destruction efficiency
[c]Abatement utilization factor
[d]Fraction control factor
[e]Configuration identified in Checklist Table 1

Verifying Equations V-3a, V-3b, V-3c, and V-3d (1 of 2)

Specific evidence needed

- Equation inputs
  (nitric acid production, destruction efficiency, abatement utilization factor, fraction control factor)
- Basis for destruction efficiency
- Basis for fraction control factor
- Direct measurement records
  (flow meters, weigh scales, etc.)

Verifying Equations V-3a, V-3b, V-3c, and V-3d (2 of 2)

How to evaluate evidence

- Confirm production record completeness
- Confirm reasonableness of destruction efficiency
- Confirm missing emissions data procedures were followed
  - Best available (process/accounting) data (≤20% missing) or maximum production data (>20% missing)
  - Only permitted for calculation of emissions or emission factors; not permitted for product data reporting
- Confirm correct calculation

Verifying Equation V-4 - Facility-level emissions

- Evidence to request
  - Equation inputs (train level emissions)
- How to evaluate evidence
  - Confirm inclusion of all trains
  - Confirm correct calculation

Verifying Covered Product Data for Nitric Acid Production

- Evidence to request
  - Monthly nitric acid production data
  - Monthly calcium ammonium nitrate (CAN-17) solution production data
  - Direct measurement of production and concentration (e.g., flow meters, weigh scales, etc.)
  - Existing plant procedures used for accounting purposes (e.g., dedicated tank-level and acid concentration measurements, etc.)
- How to evaluate evidence
  - Confirm record completeness
  - Confirm that monthly data are summed correctly
  - Compare summed monthly data with reported production data
  - Missing data procedures only permitted for calculation of emissions or emission factors; not permitted for product data reporting

Questions and ARB Comments

1. Overview
2. Emissions Data
3. Verifying Emissions
4. Product Data
5. Verifying Product Data
6. **Group Participation Exercise**

Group Participation Exercise 4.4.1
Nitric Acid Process Emissions

- A single production train produces 40,050 tons/yr of nitric acid (100% concentration)
- Only one annual performance test was conducted using specified ASTM
- Production train "t" has one abatement technology downstream of the test location
  - Abatement Technology always operating, receives 100% of N_2O with 80% destruction efficiency
- Other Information:
  - 4.57 tons nitric acid (100% concentration) **produced during 1 hour source test**
  - [N_2O] is 500 ppm
  - Flow rate is 600,000 dscf/hr
- **How much Process N_2O is emitted?**
  - A. 11.29 MT N_2O
  - B. 27.17 MT N_2O
  - C. 100 MT N_2O
  - D. 3,955 MT N_2O

Group Participation Exercise 4.4.1 Solution

How much Process N_2O is emitted?

A. 11.29 MT N_2O
B. 27.17 MT N_2O
C. 100.0 MT N_2O
D. 3,955 MT N_2O

$$EF_{N2Ot} = \frac{\sum_{1}^{n} \frac{C_{N2O} * 1.14 \times 10^{-7} * Q}{P}}{n} \quad \text{(Eq. V-1)}$$

$C(N_2O)$ = 500 ppm
Q = 600,000 dscf/hr
P = 4.57 tons HNO_3/hr*
n = 1 test run
500 x 1.14E-7 x 600,000/4.57 =
7.48 lbs N_2O/ton HNO_3 produced

* Verifier should confirm production rate ("P") during performance test is representative of normal operations

$$AF_{tN} = \frac{P_{tN}}{P_t} \quad \text{(Eq. V-2)}$$

Abatement Utilization Factor
PtN = Pt = 40,050 tons
40,050/40,050 = **1**

$$E_{N2Ot} = \frac{EF_{N2Ot} * P_t}{2205} * \left(1 - \left(DF * AF\right)\right) \quad \text{(Eq. V-3a)}$$

EFN_2O = 7.48 lbs N_2O/ton HNO_3
Pt = 40,050 tons HNO_3
DF = 0.8
AF = 1
= **27.17 MT N_2O**

Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production

Next:

4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.5: Iron and Steel Production

California Environmental Protection Agency
Air Resources Board

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Course 4: Process Emissions Specialty

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production
4.5 Iron and Steel Production
4.6 Pulp and Paper Manufacturing
4.7 Lead Production

California Environmental Protection Agency
Air Resources Board

Course 4.5 Handouts

No handouts are used for this course.

Course 4.5 Iron and Steel Production

1. Overview
2. Emissions Data
3. Verifying Emissions
4. Verifying Product Data
5. Group Participation Exercise

§ 95120 Iron and Steel Production (1 of 2)

- Any facility with the following processes, emitting at least 10,000 MT CO_2e (reporting threshold)
  - Taconite iron ore processing
  - Integrated iron and steel manufacturing
  - Cokemaking (not co-located with an integrated iron and steel manufacturing process)
  - **Electric arc furnace (EAF) steelmaking (not co-located with an integrated iron and steel manufacturing process)**
- Integrated iron and steel manufacturing
  - Produces steel from iron ore or iron ore pellets
  - Operates a basic oxygen furnace (BOF) for refining molten iron into steel
  - May include cokemaking processes and electric arc furnace (EAF) processes

§ 95120 Iron and Steel Production (2 of 2)

- ≥ 25,000 $MTCO_2e$ triggers
  - Verification
  - Cap-and-Trade covered entity

Steel rolling and aluminum processing is not reported under § 95120. The product data for steel rolling is reported under § 95115 - **Subpart A** in Cal e-GGRT.

Emissions Data Reported for Iron and Steel Production Facilities

- CO_2 process emissions from the following sources are reported under Subpart Q (§95120)
  - Taconite indurating furnace
  - Basic oxygen furnace (BOF)
  - Non-recovery coke oven battery combustion stack
  - Coke pushing process
  - Sinter process
  - **Electric arc furnace (EAF)**
  - Argon-oxygen decarburization vessel
  - Direct reduction furnace
- Stationary combustion emissions reported under Subpart C (§95115)
- CO_2, CH_4, and N_2O emissions from flares (§95113)

§ 95120 Relation to Subpart Q

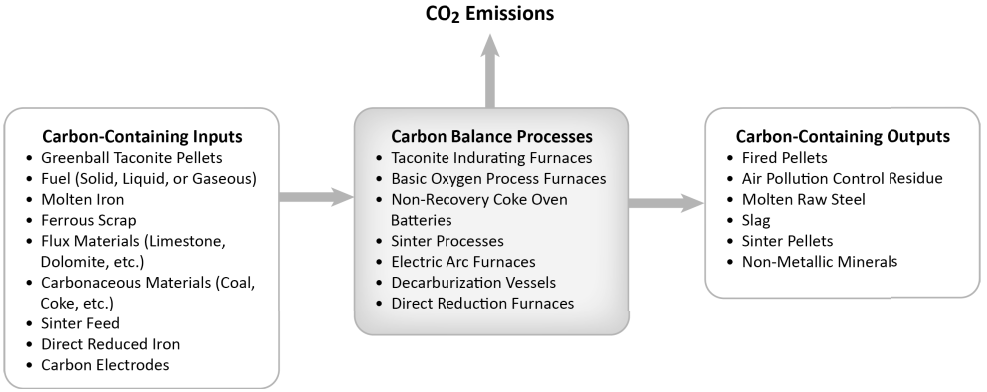
In addition to subpart Q, § 95120 also requires

- More stringent missing emissions data reporting procedures
- Covered product data
  - Annual production of primary iron and steel products
    - Facility forms steel billets which are subsequently pulled into reinforcing bar

Methods to Estimate CO_2 Process Emissions for Iron and Steel Facilities

- Subpart Q carbon balance equations for process emissions
  - Taconite indurating furnace emissions (Eq. Q-1)
  - Basic oxygen process furnace (BOF) emissions (Eq. Q-2)
  - Non-recovery coke oven battery emissions (Eq. Q-3)
  - Sinter process emissions (Eq. Q-4)
  - **Electric arc furnace (EAF) emissions (Eq. Q-5)**
  - Decarburization vessel emissions (Eq. Q-6)
  - Direct reduction furnace emissions (Eq. Q-7)
- Site-specific emission factor (alternative to carbon balance)
  - CO_2 mass emission rate (Eq. Q-8)
- Coke pushing emission factor

Iron and Steel Production – Carbon Balance Processes



Verifying CO_2 Process Emissions (1 of 2)

Evidence to request

- Annual mass quantities of all carbon-containing inputs and outputs
  - If any process input and output category (i.e. "Flux") contributes less than 1% of the total carbon mass, it can be excluded (§ 98.174(b)(4))
- Carbon content of each carbon-containing input and output
  - Analysis provided by supplier, or collecting and analyzing at least three samples per year, used as inputs into Cal e-GGRT
- Any other data that can validate reported data
  - Hours of operation, average outputs, financial data, and any other monitored/measured data

Verifying CO_2 Process Emissions (2 of 2)

How to evaluate evidence

- Confirm completeness of carbon-containing input and output quantities
- Confirm appropriate test methods used
- Confirm methods properly followed
- Confirm correct calculation
  - For Electric arc furnaces (EAF) emissions use carbon balance Eq. Q-5

$$CO_2 = \frac{44}{12} * \left[(Iron) * (C_{Iron}) + (Scrap) * (C_{Scrap}) + (Flux) * (C_f) + (Electrode) * (C_{Electrode}) + (Carbon) * (C_c) - (Steel) * (C_{Steel}) - (Slag) * (C_{Slag}) - (R) * (C_R) \right] \quad \text{(Eq. Q-5)}$$

Verifying Missing Emissions Data Substitution

- For carbon content confirm missing emissions data procedures were followed
  - Estimation of missing carbon content test data is not permitted
  - New test is required
- For mass of carbon-containing inputs and outputs, confirm missing emissions data procedures were followed
  - Best available (process/accounting) data (≤20% missing) or maximum production data (>20% missing)

Verifying Covered Product Data

- Evidence to request
  - Monthly production data of primary iron and steel products
  - Direct measurement of production (e.g., weigh hoppers, belt weigh feeders, weighed purchased quantities in shipments or containers, combination of bulk density and volume measurements, etc.)
  - Existing plant procedures used for accounting purposes
- How to evaluate evidence
  - Confirm record completeness
  - Confirm that monthly data are summed correctly
  - Compare summed monthly data with reported production data
  - Missing data procedures not permitted for covered product data

Verifying Other Data for an Iron and Steel Production Plant

- Other "non-emissions" data
  - Subpart Q requires other production-related data to be reported to U.S. EPA: e.g., annual production quantity (in metric tons) for taconite pellets, coke, sinter, iron, and raw steel
- Other production-related data are not subject to the same requirements as covered product data required under the MRR and listed in Table 9-1 of the Cap-and-Trade Regulation. However, the 40 CFR 98 production-related data elements must be verified for conformance.
- If production-related data are used to estimate covered emissions, then they could influence the evaluation of material misstatement for emissions data

Questions and ARB Comments

1. Overview
2. Emissions Data
3. Verifying Emissions
4. Verifying Product Data
5. **Group Participation Exercise**

Group Participation Exercise 4.5.1
Electric Arc Furnace

An electric arc furnace has the following inputs and outputs.

- Inputs
  - Scrap iron -1,500,000 MT (4% C)
  - Scrap ferrous metal - 50,000 MT (3% C)
  - Flux (limestone) - 300,000 MT (12% C)
  - Coal - 200,000 MT (67% C)
  - Coke - 40,000 MT (83% C)
- Outputs
  - Finished steel - 800,000 MT (0.8% C)
  - Slag - 1,000,000 MT (0.16% C)
  - Air pollution control residue - 5,000 MT (1.5% C)

What is the total MT CO_2 emitted by the furnace?

- A. 935,458 MT
- B. 935,733 MT
- C. 940,958 MT
- D. 941,233 MT

Group Participation Exercise 4.5.1
Electric Arc Furnace - Solution (1 of 2)

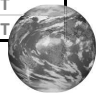
- Calculate using Eq. Q-5
- All four answers are correct
- Because ferrous scrap metal carbon is only 0.6% of the total C input, and air pollution control residue carbon is 0.9% of total C output, either or both may be excluded
- CO_2 = (Input Carbon - Output Carbon) × (44/12) = **metric tons**

If nothing was excluded, (264,700 - 8,075) x 44/12 = 940,958 MT
If both are excluded, (263,200 - 8,000) x 44/12 = 935,733 MT
If only input was excluded, (263,200 - 8,075) x 44/12 = 935,458 MT
If only output was excluded, (264,700 - 8,000) x 44/12 = 941,233 MT

Group Participation Exercise 4.5.1
Electric Arc Furnace - Solution (2 of 2)

Course 4-5; Iron and Steel Case Study						
Inputs	MT	% C	C, in MT			
scrap iron	1,500,000	0.04	60,000	22.67%		
scrap ferrous metal	50,000	0.03	1,500	0.57%	may be excluded	
flux (limestone)	300,000	0.12	36,000	13.60%		
coal	200,000	0.67	134,000	50.62%		
coke	40,000	0.83	33,200	12.54%		
			264,700	total inputs		
			263,200	total inputs minus exclusion		
Outputs						
finished steel	800,000	0.008	6,400	79.26%		
slag	1,000,000	0.0016	1,600	19.81%		
APC residue	5000	0.015	75	0.93%	may be excluded	
			8,075	total outputs		
			8,000	total outputs minus exclusion		

MT CO2 = (input C - output C) x 44/100			
If nothing was excluded:	(264,700 - 8,075) x 44/12 =	940,958	MT
If both are excluded:	(263,200 - 8,000) x 44/12 =	935,733	MT
Only input was excluded:	(263,200 - 8,075) x 44/12 =	935,458	MT
Only output was excluded:	(264,700 - 8,000) x 44/12 =	941,233	MT



Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production
4.2 Lime Manufacturing
4.3 Glass Manufacturing
4.4 Nitric Acid Production
4.5 Iron and Steel Production

Next:

4.6 Pulp and Paper Manufacturing
4.7 Lead Production

California Environmental Protection Agency
Air Resources Board

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Process Emissions Specialty
Course 4.6: Pulp and Paper Manufacturing

California Environmental Protection Agency
Air Resources Board

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Course 4: Process Emissions Specialty

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California Environmental Protection Agency
Air Resources Board

Course 4.6 Handouts

No handouts are used for this course.

Course 4.6 Pulp and Paper Manufacturing*

1. Verifying Covered Product Data
2. Example

* No process emissions for existing California facilities

Verifying Covered Product Data (1 of 2)

Covered products (air dried short tons) (§ 95119(d))

- Recycled boxboard
- Recycled linerboard
- Recycled medium
- Saleable tissue by type, along with a description of the process used to produce tissue
  - Bathroom tissue reported separately for each distinct water absorption capacity (WAC)
  - Facial tissue
  - Delicate task wipers
  - Paper towels

Verifying Covered Product Data (2 of 2)

- For bathroom tissue, water absorption capacity must be measured at least once in the data year (ISO standard with ARB-specific parameters for humidity and temperature)
- Sum product of each output x WAC to get total production

$$\sum_{i=1}^{n} O_i \; x \; WAC_i$$

Where:

O_i = annual product output in air dried saleable ton for each bathroom tissue product (*i)* with a distinct water absorption capacity; and

WAC_i = water absorption capacity for each bathroom tissue product (*i*) with a distinct water absorption capacity.

Covered Product Data Example Calculation

Category	Reported Air Dried Short Tons	Water Absorption Capacity (WAC)	Total Reported Quantity
Paper Towels	24,450 (50%)		24,450 (9%)
Bathroom Tissue Type A	17,222 (35%)	9.91	170,670 (65%)
Bathroom Tissue Type B	7,041 (15%)	9.78	68,861 (26%)
Total Covered Product Data			263,981

1. Mass quantities

2. Used for material misstatement (Tons x WAC for bathroom tissue)

Questions and ARB Comments

Course 4: Process Emissions Specialty

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4.1 Cement Production
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Next:

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Process Emissions Specialty
Course 4.7: Lead Production

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Course 4: Process Emissions Specialty

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Air Resources Board

Course 4.7 Handouts

No handouts are used for this course.

Course 4.7 Lead Production

1. Overview
2. Verifying Emissions
3. Verifying Product Data

§ 95124 Lead Production - Applicability

Any facility with a lead smelting furnace emitting ≥ 25,000 $MTCO_2e$ triggers

- Verification
- Cap-and-Trade covered entity

§ 95124 Relation to Subpart R

In addition to Subpart R, which provides the methods for calculating process emissions from lead smelting and missing emissions data substitution, § 95124 also includes

- Covered product data
  - Annual production of lead and lead alloy products
  - Any product that contains lead is a covered product, regardless of percent lead content

Methods to Estimate CO_2 Process Emissions for Lead Production Facilities (Subpart R)

- Assumes all carbon in recycled batteries is emitted as CO_2

$$E_{CO2} = \frac{44}{12} \times \frac{2000}{2205} \times \left[(Ore \times C_{Ore}) + (Scrap \times C_{Scrap}) + (Flux \times C_{Flux}) + (Carbon \times C_{Carbon}) + (Other \times C_{Other}) \right] \quad \text{(Eq.R-1)}$$

- If an input category (i.e. Scrap) contributes <1% of total carbon mass, can be excluded from emissions reporting (40 CFR 98.184(b))

Verifying Missing Emissions Data Substitution (§ 95124)

- Section 95124 refers to § 95129 for missing SFC data
- For missing <u>quantities</u> of carbon-containing inputs
  - If at least 80% data capture, use Subpart R
  - If <80% data capture, substitute each missing value with max. capacity of the system (§ 95116(c)(2)(B))

Verifying Emissions (1 of 2)

Evidence to request during verification

- Annual mass quantities of all inputs (sum of monthly mass values from plant instruments)
- Carbon content
  - Material supplier data, or collection and analysis, of three or more samples per year (§ 98.184(b)(2))
  - No missing data procedures provided, operator must retest carbon content for each input (§ 98.185(a))
- Cal e-GGRT inputs
- Any other data that can validate reported data
  - Hours of operation, average outputs, financial data, and any other monitored/measured data

Verifying Emissions (2 of 2)

How to evaluate evidence

- Evaluate material misstatement using data checks, then separately conduct data checks and measurement accuracy assessment to review conformance
- Confirm methods properly followed and no changes from previous year
- Confirm correct calculation

Verify Emissions from Carbon-Containing Materials

- Evidence to request
  - Monthly quantity of carbon containing materials charged to smelter
- How to evaluate evidence
  - Confirm completeness of material quantities
  - Confirm correct emission factor used
  - Confirm correct calculation

$$E_{CO2} = \frac{44}{12} \times \frac{2000}{2205} \times \left[(Ore \times C_{Ore}) + (Scrap \times C_{Scrap}) + (Flux \times C_{Flux}) + (Carbon \times C_{Carbon}) + (Other \times C_{Other}) \right] \quad \text{(Eq. R-1)}$$

$$CO_2 = \sum_{1}^{k} E_{CO2_k} \quad \text{(Eq. R-2)}$$

Verifying Other Emissions

- CO_2, CH_4, and N_2O from stationary fuel combustion
  - Methods include Tier 1, 2, 3, and 4 methodologies from 40 CFR 98.33(a) by fuel type specified in § 95115
  - Verify according to stationary fuel combustion (SFC) procedures for the correct Tier
- For conformance, confirm other data required by Subpart R is reported properly

Verifying Covered Product Data for Lead Production Plants

- Evidence to request
  - Monthly production data of lead and lead alloys
    - Compare with sales data as a cross-check
  - Direct measurement of production
  - Existing plant procedures used for accounting purposes
- How to evaluate evidence
  - Confirm measurement accuracy, and if covered data are excluded, confirm that an estimate is reported
  - Confirm that monthly data are summed correctly
  - Compare summed monthly data with reported production

Group Participation Exercise 4.7.1 - Lead Covered Product Data

- A battery recycling facility purchases used batteries and produces lead at a specified purity.
- Lead is sold to California customers and lead alloy is sold overseas.
- There was a power failure on December 30, 2013, and 30 hours of production data is missing from the data acquisition and handling system, but that material was separated and re-measured using the same measurement system and entered into the data handling system the following week.
- What does the verifier do on the site visit to verify covered product data?

Group Participation Exercise 4.7.1 - Lead Covered Product Data Solution (1 of 2)

- If production data during power failure is collected after the power failure and is verifiable, it is not considered "missing data"
- Mass of purchased batteries can be used to cross check reported mass of inputs and outputs
- Sales data can be used to cross check reported outputs and product data (in-state versus out-of-state sales not relevant)

Group Participation Exercise 4.7.1 - Lead Covered Product Data Solution (2 of 2)

- Requested data should include daily input and output data (mass and carbon content by type), several days of hourly production data, lab analysis data, battery purchase data and product sales data.
  - Cross check data and summations to get annual totals
- Review data management system; how data are tracked, controlled, quality assured; and who has read access and editing access
- How are the data queried and compiled into Cal e-GGRT?
- Review lab sample acquisition and lab analysis procedures
- Review procedures for measurement of input and output mass, as well as meter and measurement QC system

Questions and ARB Comments

Course 4: Process Emissions Specialty

Complete:

4.1 Cement Production

4.2 Lime Manufacturing

4.3 Glass Manufacturing

4.4 Nitric Acid Production

4.5 Iron and Steel Production

4.6 Pulp and Paper Manufacturing

4.7 Lead Production