Rule 1109.1 – NOx Emission Reduction for Refinery Equipment and Related Operations

Working Group Meeting #17

February 4, 2021

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Agenda

- Progress of Rule Development
  - Comments from Working Group Meeting #16
    - Follow-up on Boilers <40 MMBtu/hour
    - Co-Pollutant Discussion
    - Rule Language Updates Released on 12/24/20
  - Clear Sign Presentation
- Next Steps

Progress of Rule Development

Summary of Working Group # 16 (12/10/20)

- Provided response to stakeholder's comments on CO limits and CEMS
- Consultants presented their findings and final report released
- Provided response to consultant's report
- Presented revised BARCT Compliance Alternative Plan (B-CAP)

Since Last Working Group Meeting

- Released second version of rule language based on stakeholder feedback
- Followed up with consultants regarding recommendations
- Meeting with facilities to discuss specific BARCT Compliance Alternative Plan (B-CAP)
- Continued meetings with control technology manufacturers

Key Comments From WGM #16

Comment #1: Installation of ultra-low NOx burners (ULNB)

- Not feasible for all units
- Based on Norton's Report, some ULNB applications may only achieve 50 ppmv; therefore, 2 ppmv may not be technically feasible even with 95% reduction from SCR

Comment #2: Superficial velocity of the flue gas must be evaluated when assessing the BARCT limits

Comment #3: Fuel NOx must be considered for the SRU/TG Incinerator

- Fuel NOx contributes to overall NOx emissions

Comment #1: Installation of ultra-low NOx burners (ULNB)

- For boilers and heaters >40 MMBtu/hr, staff proposed a 2 ppmv NOx limit based on a combination of ULNB and SCR
  - Typical ULNB achieve between 30 to 40 ppmv NOx
  - SCR can achieve 95% NOx reductions

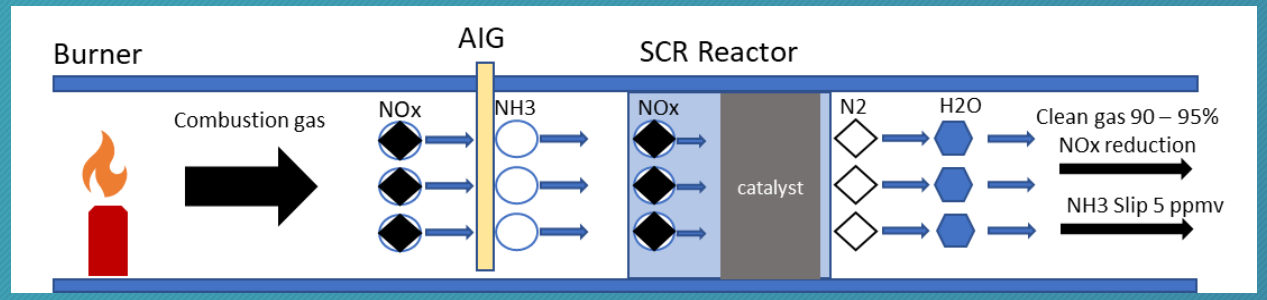
  } Combination can achieve 2 ppmv

- Stakeholders stated not all units can be retrofit with ULNB and therefore 2 ppmv is not technically feasible even with 95% reduction from SCR

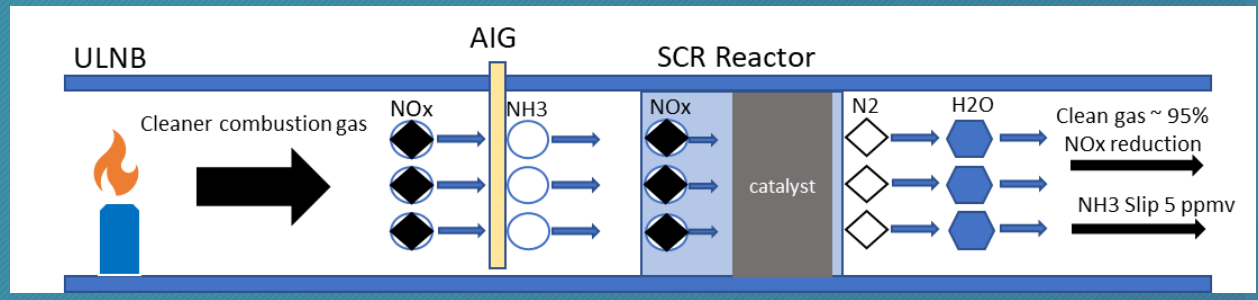
Comment #1: Installation of ultra-low NOx burners (ULNB) *(cont.)*

- Staff consulted with Norton, FERCo, and SCR catalyst vendors regarding the feasibility of installing ULNB and achieving 2 ppmv NOx for units with sub-optimal conditions
- Consultants stated that regardless of ULNB NOx performance, 2 ppmv is feasible by installing multiple catalyst reactors or a two-stage SCR reactor
  - Multiple ammonia injection grids (AIG) in between each reactor or a reactor designed to achieve proper distribution and mixing
  - Static mixer in between each bed or SCR reactor (two stage arrangement)
- According to SCR vendor, two-stage reactors are typically employed in nitric acid plants where NOx can be up to 4,000 ppmv

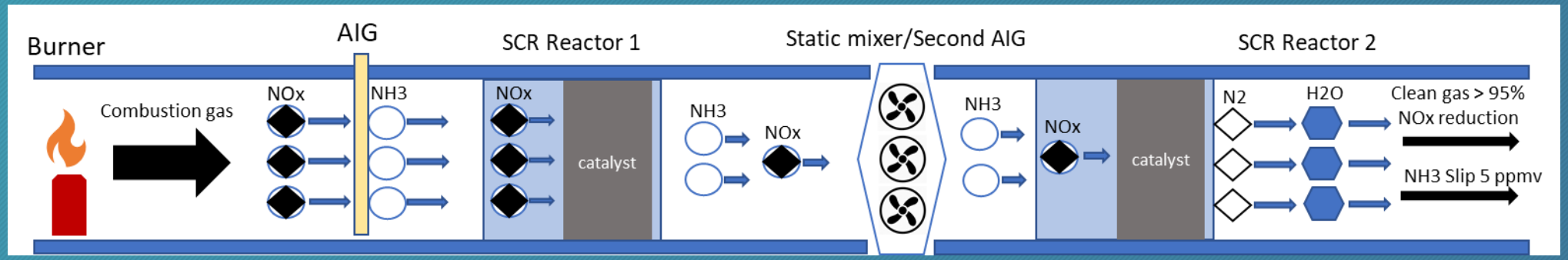
Options for Achieving Proposed NOx Limit



1) SCR Only (90-95% NOx reduction)



2) ULNB + SCR (>95% NOx reduction)



3) Two-Stage Reactor SCR without ULNB (>95% NOx reduction)

Cost Assessment for Multiple Reactor SCR

- Consultants and SCR vendor stated the additional reactor would contribute an additional ~25% to the cost of the SCR
  - Additional piping for the ammonia injections and catalyst (capital)
  - Additional cost for the catalyst replacement and ammonia (O&M)
- Staff re-assessed the cost-effectiveness of boilers and heaters greater than 40 MMBtu/hr
  - Increasing costs 25% for multiple reactors and removing the cost for the ULNBs
  - Adding $40,000/year for SCR tuning as recommended by FERCo
- Revised cost-effectiveness will follow the superficial velocity discussion

Comment #2: Superficial velocity of the flue gas must be evaluated when assessing the BARCT limits

- Superficial velocity is a design parameter that sets the size of the catalyst bed and plot area for the SCR
  - Superficial velocity is the volumetric rate of the flue gas divided by the front-face area of the catalyst
- Lower superficial velocity equals a greater NOx reduction but requires a bigger catalyst inventory, increasing cost and plot space
- Vendors recommended 10 ft/s or lower at the inlet to the SCR to achieve maximum NOx reductions
- Superficial velocity can be reduced by increasing the catalyst volume

Comment #2: Superficial velocity of the flue gas must be evaluated when assessing the BARCT limits *(cont.)*

- Staff consulted with Norton, FERCo, and SCR catalyst vendors regarding how to address superficial velocity concerns
  - Norton recommended increasing the catalyst volume by 30% to address units that may require additional catalyst volume to slow the flue gas velocity
  - 30% catalyst volume increase was confirmed by FERCo and SCR catalyst vendors to be effective for this purpose
- Staff accounted for a 30% increase in the catalyst costs to address the potential need for increased catalyst volume
  - Catalyst costs are a minor cost of the overall SCR (5% of the TIC)

Staff's Revised Cost Assumptions base

- Initial costs based on U.S. EPA spreadsheet staff altered costs as follows:
  - ✓ Amended U.S. EPA spreadsheet with costs refineries provided to reflect costs at California refinery costs
  - ✓ Used stakeholder costs when available, otherwise used amended U.S. EPA spreadsheet
  - ✓ Added cost of ULNB if percent reduction exceeded 92% - burner costs estimated using curve generated from costs refineries provided
    - ✓ Alternatively, conducted cost assessment for installation of dual reactors
      - ✓ 25% increase to TIC to address additional costs
  - ✓ Added $40,000 annual costs for SCR tuning – based on Ferco recommendation
  - ✓ Added 30% increased cost for the catalyst based on Norton recommendation to account for gas velocity
- Cost for SCR installation estimated ~ $10 to $80 million (present worth value)

Reassessment of Cost-Effectiveness for SCR Based on Consultant and Vendor Feedback

SCR Cost-Effectiveness Reassessment		
SCR Design Parameter	**Cost Increase**	**Comments**
Catalyst Increase	30% of Catalyst Cost	Addresses the potential need of additional catalyst
Multiple Stage Reactor with additional AIG or Static Mixer	25% of Total Installed Cost (TIC)	Addresses potential cost increase of additional catalyst, reactor, and installation
Increased O&M	25% of O&M	Addresses potential increase in ammonia consumption and electricity needed for larger fan associated with multiple beds of reactors
Annual Tuning	Additional $40K added to annual O&M Costs	Addresses the proper mixing and distribution

Revised Cost Effectiveness for 2 ppmv NOx Limits

- Original and Revised Cost-Effectiveness

Equipment Class	NOx Limit	ULNB/SCR	Dual Reactor
Heaters 40 – 110 MMBtu/hr	2 ppmv	$35,000	$39,000
Heaters >110 MMBtu/hr	2 ppmv	$35,000	$44,000
Boilers 40 – 110 MMBtu/hr	2 ppmv	$49,000	$48,000
Boilers >110 MMBtu/hr	2 ppmv	$12,000	$15,000

Staff's Recommendation:

- 2 ppmv NOx limit is technically achievable and cost-effective
- Several technologies are available to achieve 2 ppmv limit

Comment #3: Fuel NOx must be considered for the SRU/TG Incinerator

- Stakeholder commented the source of NOx for these units can be from fuel NOx in addition to thermal NOx
  - Most NOx formed in combustion equipment is thermal NOx or prompt NOx which are both controlled by the burner
  - Units that combust fuel that contains nitrogen containing components will also produce fuel NOx which cannot be controlled by the burner
- SRU/TG Incinerators combust nitrogen containing fuel which will generate fuel NOx
  - Retrofitting with ULNBs will not address fuel NOx
- Staff consulted with Norton who suggested longer averaging times (365-day rolling average) to address any NOx spikes formed by fuel NOx
- Staff seeking input from stakeholders

Follow-up on Boilers <40 MMBtu/hr

BARCT Assessment for Boilers <40 MMBtu/hr

- Stakeholder inquired about a low-use exemption for boilers <40 MMBtu/hr
  - Low-use exemptions can be included for units that have very high cost-effectiveness
- For these units, *first draft* of rule included a provision that the burners would have to be replaced *within 10 years of rule adoption* or *at the end of useful life*, whichever was sooner
- None of the boilers <40 MMBtu/hr were cost effective to replace burners until burner replacement
  - Requiring burner replacement within 10 years of rule adoption may precede routine burner replacement cycle

BARCT Assessment for Boilers <40 MMBtu/hr (cont.)

Original cost-effectiveness analysis assumed:

Burner replacement at the end of useful life	No or minimal additional costs since burner already being replaced

Staff revisited assumptions:

10 years deadline in first version of PR 1109.1 may not represent end of useful life	John Zink stated the 5 ppmv burners will cost 25 – 40% more than a traditional 9 ppmv burner

Staff reassessed the BARCT approach for this class/category

BARCT Assessment for Boilers <40 MMBtu/hr (cont.)

- Four boilers in this class/category
- All fueled with natural gas boilers and operate between 9 ppmv and 30 ppmv
- One boiler is low-use where cost-effectiveness would be > $1 million
- Staff re-evaluated cost-effectiveness based on 40% higher cost for 5 ppmv burner replacement (~$4 million/burner)

Boilers <40 MMBtu/hr	Prior to Burner Replacement	At Burner Replacement
Original Cost Effectiveness	$120,000	No Additional Cost
Revised Cost Effectiveness	$170,000	$36,000*

* Excludes Low-Use Unit

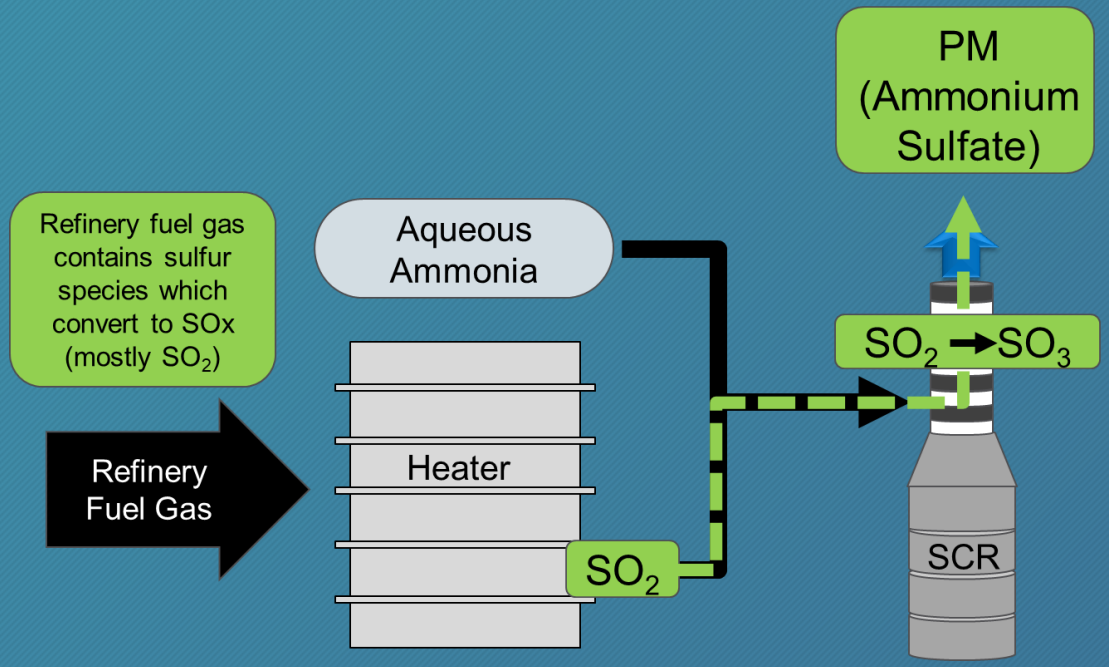
Staff's Recommendation:

- ULNB to achieve 5 ppmv at burner replacement
- Remove the 10-year replacement requirement in PR 1109.1
- Low-use exemption (200 hours/year) for boilers <40 MMBtu/hr with 9 ppmv permit limit

Co-Pollutant Discussion

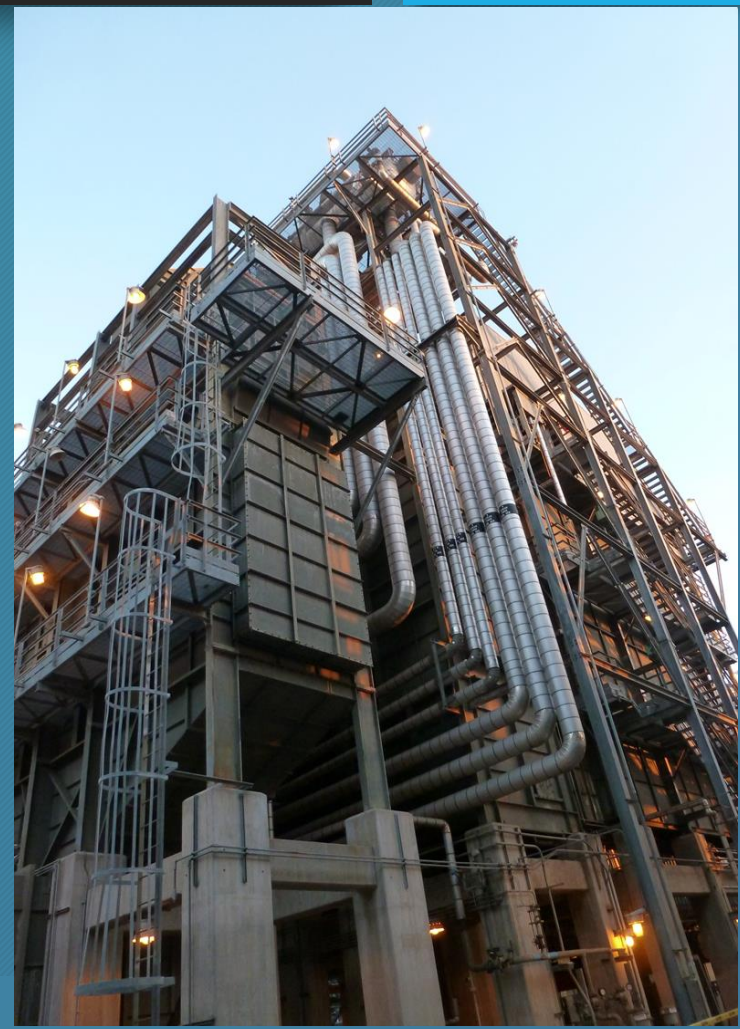
Co-Pollutant Background – BACT Applicability

- Rulemaking discussions for Proposed Rule 1109.1 have highlighted that installations of Selective Catalytic Reduction (SCR) to control NOx emissions from a refinery boiler or heater can result in secondary particulate matter (PM) emissions
- Under Regulation XIII, emission increases exceeding the NSR threshold would require BACT, modeling, and offsetting for PM10
  - Regulation XIII threshold for PM10 is one pound per day



Co-Pollutant Issue Significance

- Staff has been working with CARB and U.S. EPA on different strategies to address the co-pollutant issue
- PR 1109.1 will be the most significant command-and-control rule to address NOx emissions
  - NOx emission reduction potential is substantial (7 to 9 tons per day)
- NOx reductions from implementing PR 1109.1 is staff's priority in order to attain federal and state ozone standards
  - South Coast Air Basin is in extreme non-attainment for the federal ozone standard



Proposed Co-pollutants Strategy

- Other California air districts have provisions that exempt sources from BACT when complying with a BARCT requirement
- Staff is proposing a similar but narrower BACT exemption that:
  - Will be limited to projects needed to transition from RECLAIM to command-and-control
  - Will be limited to a rule that establishes BARCT emission limits for an ozone precursor where the project is "solely the addition" of air pollution control equipment
  - *Will not apply to additional improvements, upgrades, or capacity increases that are included as part of the installation of the air pollution control equipment*
  - Will be limited to non-ozone precursor emission increases that are below the federal NSR thresholds
  - Will not apply to ammonia emissions associated with installation of SCR

Further discussion in next Working Group Meeting

Co-Pollutant Strategy Summary

- Staff is proposing a BACT exemption for non-ozone precursor emission increases associated with air pollution control equipment installations to comply with NOx BARCT standards
- Staff worked with CARB and U.S. EPA to develop the proposed strategy
  - CARB is supportive of the co-pollutant strategy
  - U.S. EPA agrees that BACT is not triggered unless federal thresholds are exceeded
    - For major sources over 70 tons per year, the major modification thresholds are 15 ton per year for PM10 and 10 tons per year for PM2.5
- Proposed Amendment to Rule 1304 scheduled for June 2021
- Staff will address refinery fuel sulfur content during the transition of SOx RECLAIM
- More details provided in the RECLAIM/NSR presentation on January 21st, 2021 http://www4.aqmd.gov/enewsletterpro/uploadedimages/000001/Vo/RECLAIM%20-%20WGM%2001-21-2021%20_%20Final.pdf

Rule Language Updates Released on 12/24/20

Subdivision (d) – Emission Limits

- Averaging Time was increased from 8-hours to 24-hours for the following equipment based on consultant feedback:
  - Boilers (≥40 MMBtu/hr)
  - Gas Turbines
  - Process Heaters (≥40 MMBtu/hr)
  - SRU/TG Incinerators
  - SMR Heaters
  - SMR Heater with Gas Turbine
- Excluding emissions measurements during the start-up, shutdown, and malfunction events when calculating the applicable Table 1 rolling average NOx and CO emissions
- Removed CO CEMS requirement but must maintain if already installed

Subdivision (e) – Start-up, Shutdown and Malfunction (SSM)

- Added SSM limits for all units
- Removed requirement to submit planned start-up/shutdown schedule
- Revised to include recordkeeping requirements instead of reporting requirements
- Added requirements for the best engineering practices to minimize SSM

TABLE 2: START-UP, SHUTDOWN, MALFUNCTION ALLOWANCES

Unit	Not to Exceed per Start-up, Shutdown, or Malfunction Event (hours)
• Boilers and Process Heaters <40MMBtu/hour • Gas Turbines • Flares • Vapor Incinerators	2
• Sulfuric Acid Furnace	24
• Boilers and Process Heaters ≥40MMBtu/hour • Steam Methane Reformer Heaters	48
• Steam Methane Reformer with Gas Turbine	60
• FCCUs • Petroleum Coke Calciner • SRU/TG Incinerators	120

Subdivision (e) – Start-up, Shutdown and Malfunction (SSM)

- Staff considering addressing SSM in separate rule
  - Rule 429 - Start-up And Shutdown Exemption Provisions For Oxides Of Nitrogen (adopted 1989, last amended 1990)
  - PAR 429 would be considered at the same time as PR 1109.1
  - Would include SSM provisions for PR 1109.1 sources and other combustion sources
  - Streamline rule provisions
  - Similar approach to Rule 430 – Breakdown Provisions

Subdivision (f) – CEMS Requirements

- Included requirement for SRU/TG Incinerators to install and maintain CEMS (*inadvertently omitted in the initial draft*)
- Omitted the requirement for calculating missing data due to a non-operational CEMS
- Removed requirement to install CO CEMs
  - Included provision to require existing CO CEMS to be operated and maintained
- Revised new requirements for Sulfuric Acid Furnace:
  - NOx CEMS in operation at the time of rule adoption
  - Revised O_2 CEMS requirement to allow 12 months for installation

Subdivision (g) & (h) – Source Test Requirements & Diagnostic Emission Checks

- Updated Source Testing Schedule to remove SRU/TG Incinerators – included in CEMS requirements
- Updated source test schedule for a unit that has not conducted a source test within the schedule in Table 3:
  - 20 – <40 MMBtu/hr: 6 months from date of rule adoption
  - <20 MMBtu/hr: 12 months from date of rule adoption

TABLE 3: SOURCE TESTING SCHEDULE

Combustion Equipment	Rated Heat Input Capacity (MMBtu/hour)	Source Test Schedule
Boilers and Process Heaters	<40	Within 12 months from previous source test and every 12 months thereafter
Vapor Incinerators and Flares	All	Within 36 months from previous source test and every 36 months thereafter

- Revised requirements for Diagnostic Emission Checks from every 30 days to every 90 days

Subdivision (i) – Monitoring, Recordkeeping and Reporting (MRR) Requirements

- Added MRR provisions for the process heater, boiler or flare that is exempt from emission limits pursuant to section (l)
  - Install and operate a non-resettable totalizing time meter or a fuel meter for the exempt equipment in section (l) within 90 days of rule adoption date:
    - Must be equipped with a permanent supply of electric power that cannot be unplugged, switched off, or reset except by the main power supply circuit for the building and associated equipment or the safety shut-off switch, only for maintenance or safety
    - Must be calibrated, and recalibrated annually thereafter, based on the manufacturer's recommended procedures or an alternative calibration method approved in writing by the Executive Officer

Subdivision (j) – Compliance Schedule

- Removed the requirement to replace burners within 10 years for boilers less than 40 MMBtu/hour based on revised BARCT assessment
- Added a provision to require facilities that exceed the low-use exemptions (e.g., 200 hours for start-up heaters at FCCU and start-up or shutdown boilers or heaters used at sulfuric acid plants) to meet the emissions limits within 6 months of surpassing the low-use limits

Subdivision (k) – BARCT Compliance Alternative Plan

- Extended B-CAP Schedule as previously discussed in Working Group #16 Meeting

TABLE 4: B-CAP IMPLEMENTATION SCHEDULE

	Phase I	Phase II	Phase III
Permit Application Submittal Deadline	July 1, 2022	July 1, 2024	July 1, 2026
Implementation and Final Compliance Date	30 months after a Permit to Construct is issued	24 months after a Permit to Construct is issued	24 months after a Permit to Construct is issued

Subdivision (l) - Exemptions

- Removed exemption for heaters less than 40 MMBtu/hour from meeting the 30 ppmv interim NOx limit
  - 30 ppmv limit was removed based on Norton's feedback
- Included exemption for FCCU from meeting Table 1 emission limits during required boiler inspections
- Included a low-use exemption (less than 200 hours annual) for boilers less than 40 MMBtu/hour
- Included exemption for boiler or process heater operating only the pilot during start-up or shutdown

Clear Sign Presentation

Next Steps

- Continuing Meetings with Facilities on B-CAP
- Working Group Meeting #17 to Discuss Comment Letters - February 11th
- Provide Update to Stationary Source Committee - February 19th
- Continue Meetings with Stakeholders
- Release Preliminary Draft Staff Report and Rule Language
- Public Workshop
- Public Hearing

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