Coal Mine Methane Project Protocol Scoping Meeting

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Denver, CO
February 10, 2009

California Climate Action Registry

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- Non-profit greenhouse gas registry created by state legislation in 2001
  - Encourage voluntary reporting and reductions
  - Develop protocols to track GHG emissions and reductions
- Members include leading businesses, government agencies, educational institutions, non-profits, and others across US
  - Over 370 members and 650 million metric tons CO_2e registered for years 2000 - 2007

Climate Action Reserve

- New CCAR program to register and track carbon offset projects throughout the US
- Develop standardized protocols through stakeholder-driven process
- Intended to be the premier place to register carbon offset projects for North America
  - Currently accepting US-based projects only
  - Expanding to Mexico and Canada for some project types

Why is CCAR doing this?

- Public concerns about the voluntary carbon market
  - Projects aren't real or additional
  - Projects create other social or environmental problems
  - Credits are being double counted or sold
- CCAR reputation for high-quality accounting standards can address these concerns
- CCAR goal: Be the recognized "seal of approval"

Today's Agenda

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Morning

- Reserve protocol development process
- What is a standardized project protocol?
- CMM project typology
- Existing resources

break for lunch

Afternoon

- Discussion
  - Key issues for each project type
  - Cross-cutting issues
  - Related project types

Scoping Meeting Purpose

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- Engage stakeholders in process
- Help shape direction and scope of protocol
- Gather information and input on key issues
- Assess project types for future development

Protocol Development Process

- Internal protocol scoping
- Form multi-stakeholder workgroup
- Discussion paper and/or draft protocol:
  - Maintain consistency with other high quality emission reduction standards
- Send draft through workgroup process
  - Workgroup provides feedback, consensus is built
  - Can be iterative process
- Draft protocol released for public review
- Public comments incorporated
- Protocol submitted to CCAR board for adoption

Timeline

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Scoping meeting	February 10, 2009
Drafting of protocol	February - April 2009
Workgroup process	March - June 2009
Public review period and public workshop	July - August 2009
Adoption by CCAR Board	October 2009

Principles of Reserve Project Accounting

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- **Real:** Reductions have actually occurred, and are quantified using complete, accurate, transparent, and conservative methodologies
- **Additional:** Reductions result from activities that would not happen in the absence of a GHG market
- **Permanent:** Reductions verified ex-post, risk of reversals mitigated
- **Verified:** Emission reports must be verifiably free of material misstatements
- **Owned unambiguously:** Ownership of GHG reductions must be clear
- **Not harmful:** Negative externalities must be avoided
- **Practicality:** Project implementation barriers should be minimized

Project Accounting Frameworks

- Top-down (standardized) approach
  - Criteria developed by GHG program (CCAR)
  - Applicable to multiple projects within sector

- Bottom-up (project-specific) approach
  - Developed on case-by-case basis by project developer
  - Represent conditions for a single project
  - CDM style approach to project accounting

The Standardized Approach

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Benefits to a top-down approach:

- Low up-front costs to project developers
- Efficient review and approval of projects
- Transparency and consistency
- Same approach applies across projects
- Prescriptive guidance to eliminate judgment calls

But...high initial resource investment to program

Project Protocol Components

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- Define the GHG reduction project
- Define eligibility (incl. “additionality”)
- Establish assessment boundary
- Calculate GHG reductions
  - Baseline emissions
  - Project emissions
- Verify project performance

Define GHG Reduction Project

- GHG project is a specific activity or set of activities intended to:
  - Reduce GHG emissions
  - Increase carbon storage or
  - Enhance GHG removals from atmosphere
- Project definition will delineate what activities are “creditable” under protocol
  - i.e., what baseline and project scenarios are accepted

Define Eligibility

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Additionality criteria

- Regulatory test
  - Is it required by law?
- Project start date
  - As early as Jan 1, 2001 for 12 month period after protocol is adopted
  - Only new projects after initial 12 months
- Performance threshold, technology standard and/or other conditions
  - Standard of performance applicable to all CMM projects, as defined in the protocol

Define Eligibility (cont.)

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Other eligibility criteria

- Project location
  - Must be based in the United States
- Regulatory compliance
  - Project activity must comply with all air & water quality regulations

Establish Assessment Boundary

- Delineates the sources and gases required to be assessed to determine net change in emissions from project activity
  - Primary effects
    - For CMM, reduction in fugitive emissions
  - Secondary effects
    - Must be identified and assessed
    - Large, negative secondary effects can render project activity unviable

Calculate GHG Reductions

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- Develop standardized measurement and monitoring to:
  - Estimate baseline emissions and
  - Calculate project emissions
- Procedures for collecting necessary data
- Frequency of monitoring
- Standardized calculation methodologies and default emission factors, where necessary

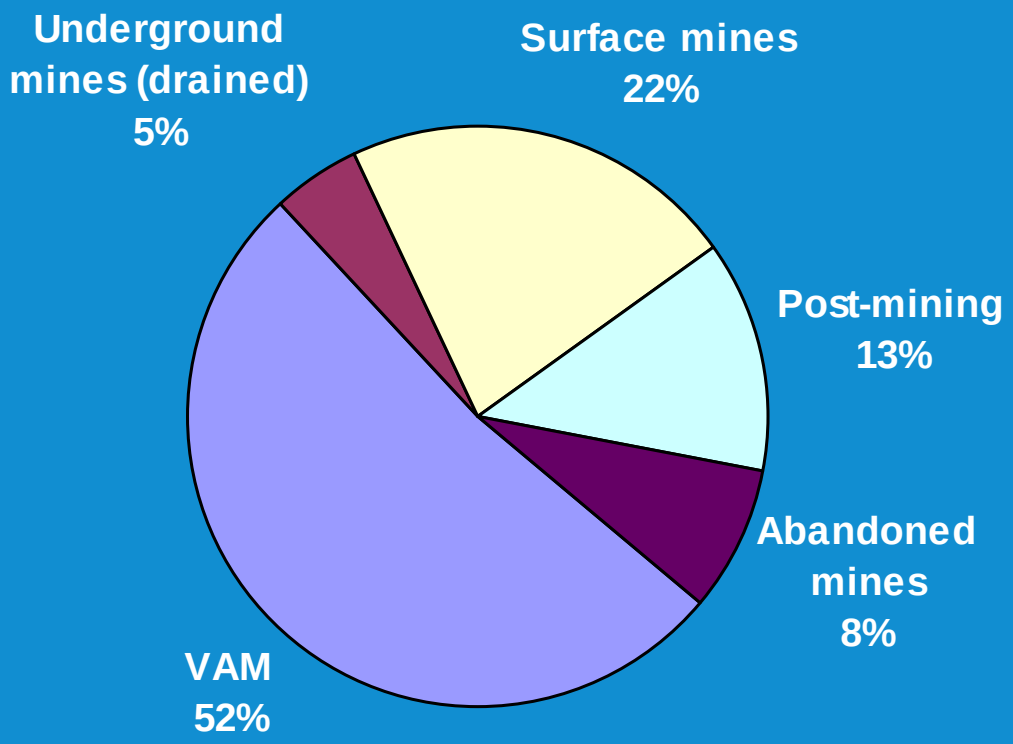
Verify Project Performance

- Reserve requires annual third-party verification by an accredited verification body
- Develop companion verification project protocol to guide verifiers
- Risk assessment and data sampling exercise
  - Site visits and desktop review of data to ensure no material misstatements (+/- 5%)

US CMM Sector[1]

- 2006 US coal production: 1.2 billion tons
- 2006 US CMM methane emissions: 158 bcf
  - 612 underground = 359 million tons coal; liberated 123 bcf methane
  - 812 surface = 803 million tons coal; liberated 35 bcf methane
- CMM is emitted from 5 sources:
  1. Drainage systems at underground coal mines (also commonly referred to as drainage systems)
  2. Ventilation air from underground mines
  3. Abandoned or closed mines
  4. Surface mines
  5. Fugitive emissions from post-mining operations

2006 US CMM Emissions[2]



- CMM is 12% of country's methane emissions

CMM Project Typology

1. Drainage system projects
   - Pre-mining (vertical, horizontal boreholes)
   - In-mine boreholes
   - Post-mining (vertical gob boreholes)
2. Ventilation air methane (VAM) projects
3. Abandoned mine methane (AMM) projects

** For all projects, methane must be used or destroyed to create GHG benefit (methane → carbon dioxide)*

*** No extra credit for displacement of grid electricity (per Reserve policy)*

Drainage System Projects

- Emissions from drainage systems are 40% of emissions from underground coal mining
- Systems developed primarily for safety reasons; can also recover methane for destruction/use
  - Pre-mining: produces medium to high quality gas
    - Vertical wells - drilled from surface into coal seam
  - In-mine: produces gas ranging from ~30% to 90% methane
    - Boreholes - drilled from inside mine into coal seam/surrounding strata prior to mining
  - Post-mining: produces low to medium quality gas
    - Gob wells - drilled from surface into coal seam just prior to mining

Drainage System Projects (cont.)

- Many uses for recovered methane; end use depends on quality

<u>High quality gas</u>

- Pipeline injection
- Vehicle fuel

<u>Low quality gas</u>

- Oxidation
- Combustion

<u>Medium quality gas</u>

- Power generation
- Coal drying
- Boiler fuel
- Industrial applications
- Upgrade for pipeline use
- Fuel cells

Drainage System Projects[1] (cont.)

- 23 mines with drainage systems in place
  - Majority in East and South; 25% in the West
- 14 are recovering and using CMM
  - 12 are injecting into pipeline
  - 1 is producing electricity
  - 1 is heating mine ventilation air

Drainage System Projects[1] (cont.)

- Drainage systems w/out recovery (9 mines):
  - 100% use vertical gob boreholes
  - 11% use horizontal pre-mine boreholes (1 mine)
- Drainage systems w/ recovery (14 mines):
  - 100% use vertical gob boreholes
  - 50% use horizontal pre-mine boreholes
  - 43% use vertical pre-mine boreholes
- "Gassiness"
  - All mines with drainage systems in top 40, but gassiest are not all recovering

VAM Projects[1]

- Ventilation systems required at all underground coal mines for safety
- VAM typically contains <1% methane, *but*
- VAM is largest source of CMM emissions in US
  - 52% of all CMM emissions
  - 60% of CMM emissions from active underground mines
- Estimated VAM emissions from 50 gassiest underground mines = 196 mmcf/day
  - 29 million metric tons/year

VAM Projects (cont.)

- Opportunities to use VAM as primary or ancillary fuel
- End use technologies
  - Thermal flow-reversal reactors
  - Catalytic flow-reversal reactors
  - Use as combustion air in engines and turbines
- Other potential end use technologies
  - Concentrators
  - Lean fuel gas turbines

VAM Projects (cont.)

- One commercial-scale oxidation project operational in Australia
  - VAM-to-power project using TFRR (6 MW)
- One demonstration project operational in US at closed mine (TFRR)
- One demonstration project at active mine approved by MSHA - in development (TFRR)

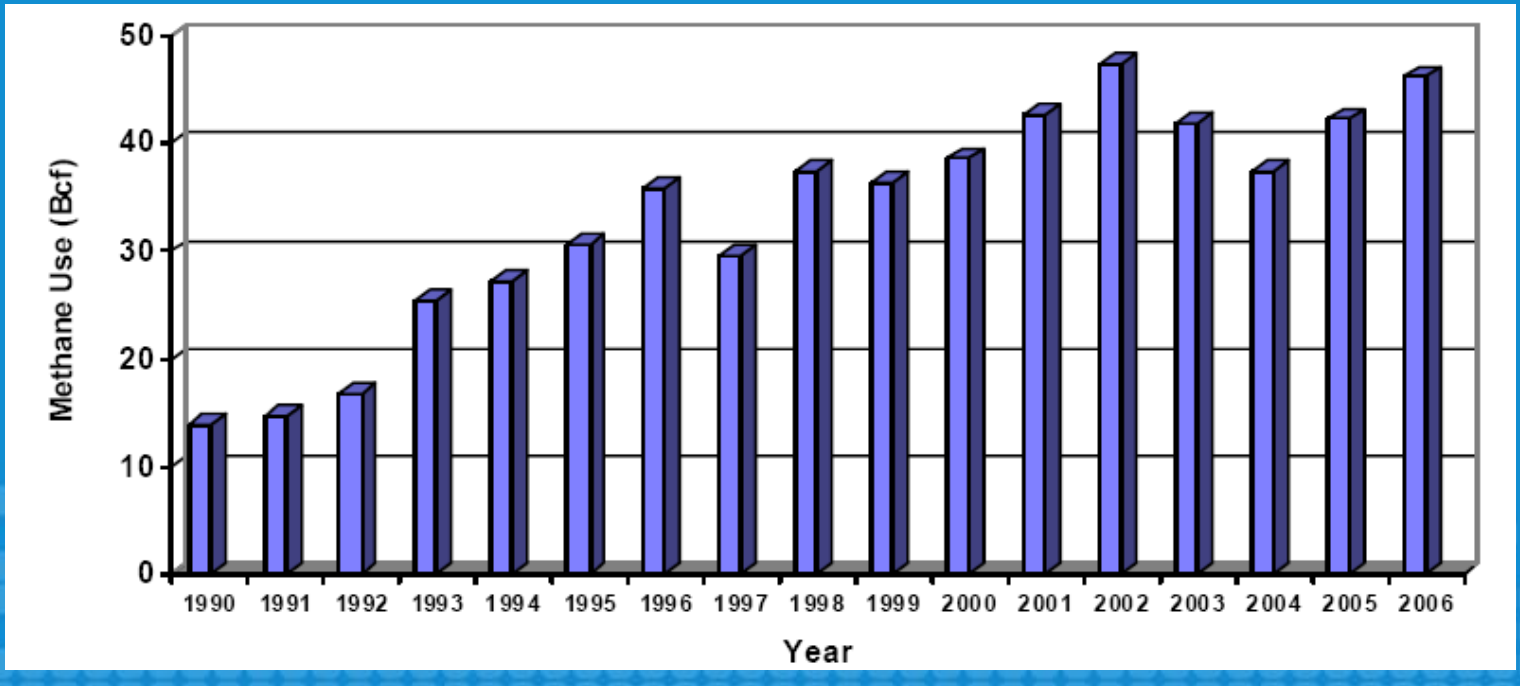
AMM Projects[3]

- AMM = 8% of total CMM emissions
  - Active mines = 144.5 bcf methane
  - Abandoned mines = 13.4 bcf methane
- Mines continue to release methane after closure
  - Unknown number of abandoned mines (thousands)
  - Some sealed, some flooded, some vented for safety
- US AMM emissions generally declining since 1996
- 44 AMM recovery projects
  - 42 pipeline injections
  - 2 direct sales

Summary of Existing CMM Projects[1]

50 bcf of CMM recovered and utilized - 32% (2006)

- 14 active underground mines = 46.2 bcf recovered; 18.7 MMT CO_2e reduced
- 33 abandoned underground mines = 3.4 bcf recovered; 1.4 MMT CO_2e reduced



Existing Resources

- CDM ACM0008
- Chicago Climate Exchange
- Greenhouse Gas Services (GE/AES)

Existing Resources

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	CDM	CCX	GGS
New and existing?	✓	✓	✓
Closed or abandoned?		✓	✓
Pre-mine	✓	✓	✓
In-mine	✓	✓	✓
Post-mine	✓	✓	✓
VAM	✓		
Project Location	International only	International and US	US only
# of projects	63 in the pipeline ▪ 14 registered ▪ 40 at validation ▪ 638,000 CERS issued	30% of CCX offsets sold (2003-2007)	Not available

Session 2

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CMM Project Types
and
Related Project Types

Additionality

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Drainage System Projects

- 23 mines have installed drainage systems for safety and/or methane recovery and use
- Appears drainage system and recovery is “business as usual” and cost effective for gassiest mines
- With existing market penetration, setting a standardized performance threshold may be difficult

2006 rank	Mine Name	Drainage system?	Recovered & Used?
1	Mc Elroy Mine	✓	
2	Enlow Fork Mine		
3	West Elk Mine	✓	✓
4	Blue Creek No. 7	✓	✓
5	Galatia		
6	Buchanan Mine	✓	✓
7	Bailey Mine	✓	
8	Blacksville No. 2	✓	✓
9	Oak Grove Mine	✓	✓
10	Cumberland	✓	✓
11	Blue Creek No. 4	✓	✓
12	Federal No. 2	✓	✓
13	Elk Creek Mine	✓	
14	Loveridge No. 22	✓	✓
15	Pinnacle	✓	✓
16	Emerald	✓	✓
17	Aberdeen	✓	
18	Eighty-Four Mine		
19	North River Mine		
20	Shoal Creek	✓	✓

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20 Gassiest Mines[1]

- 85% have drainage systems
- 60% recover and use the CMM

Additionality

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VAM Projects

- Technologies do exist for utilizing VAM
  - Use as combustion air in engines and turbines
  - Thermal flow-reversal reactors
  - Catalytic flow-reversal reactors
  - Concentrators? Lean fuel gas turbines? Ancillary fuel?
- No market penetration
- VAM recovery appears to *not* be “business as usual”

Additionality

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AMM Projects

- Recovery projects occurring at 30-40 mines out of thousands
- Little market penetration, thus appears to not be “business as usual”
- High correlation between recovery and certain site-specific factors

Mine Name	Active mine emissions over 1 mmcf/day?	Abandoned after 1990?	Sealed?
Arkwright No 1	✓	✓	✓
Blacksville No 1	✓	✓	✓
Bonny	✓	✓	✓
Cambria Slope No 33	✓	✓	✓
Golden Eagle	✓	✓	✓
Ireland	✓	✓	✓
Maple Meadow Mine	✓	✓	✓
Old Ben No 21	✓	✓	✓
Old Ben No 24	✓	✓	✓
Old Ben No 26	✓	✓	✓
Osage No. 3	✓	✓	✓
Virginia Pocahontas 4	✓	✓	✓
Virginia Pocahontas No 2	✓	✓	✓
VP 1	✓	✓	✓
VP No 3	✓	✓	✓
VP No 6	✓	✓	✓
Blue Creek No. 3	✓	✓	
Consol No 9	✓		
Consol No. 20	✓		
GATEWAY MINE	✓	✓	
Nelms #1	✓		
Kings			✓

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22 Gassy Mines[4]

- 95% produced over 1 mmcf/day when active
- 81% abandoned after 1990
- 77% sealed

Measurement

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Drainage System Projects

- Methodologies to quantify baseline and project emissions seem well developed

VAM Projects

- Need to measure methane recovered, methane concentration and destruction efficiency

AMM Projects

- Data limited to mines closed after 1972
- Challenge establishing baseline emissions

Cost - Drainage System Projects

- Drainage and recovery systems appear cost-effective at gassiest mines
- Mines highly variable in:
  - Amount of methane they liberate (0.8 - over 70 mmcf/day)
  - Methane liberated/ton of coal (71 - 7,000 cf/ton)
  - Coal production (200,000 - 10 million tons/year)
  - Distance from mine to pipeline or other potential end use
  - Projected remaining life of mine

Conclusion:

- Many site-specific factors determine actual cost of reductions
- $ per tonne of CO_2: <$10?

Cost - VAM Projects[5]

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- Cost information is limited
- For use as combustion air, costs seem negligible
- For TFFR, ROI is a function of the methane content of the oxidizer inflow
  - MEGTEC estimates ROI of 3-6 years if:
    - VAM concentrations are > 0.6 %
    - carbon sale price of $10.00/tonne CO_2e

Conclusion:

- $ per tonne CO_2: $10+?

Cost - AMM Projects

- 400 abandoned mines were considered “gassy” at time of closure (post-1972)
- Projects at gassy mines to date appear cost effective
- Many factors influence AMM emissions:
  - Time since abandonment
  - Gas content/adsorption characteristics of coal
  - Mine methane flow capacity
  - Mine flooding
  - Presence of vent holes
  - Mine seals

Conclusion:

- Many site-specific factors determine cost of project/offset tonne
- $ per tonne of CO_2: <$10?

Prioritizing Project Types

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	Additionality	Measurement	$/tonne
Drainage System Projects	Low	High	Low/variable?
VAM Projects	High	High	Medium to high?
AMM Projects	High	Moderate/low	Low/variable?

For Additionality and Measurement:

- Low = low perceived level of ease
- High = high perceived level of ease

For $/tonne:

- Low = low cost/tonne
- High = high cost/tonne

Questions/Issues

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VAM Projects

- Is technology developed enough for widespread deployment?
- How expensive will VAM projects be?
- Adequate space for equipment footprint?
- With VAM technologies, what sort of monitoring systems are necessary to calculate project emissions?
- Regulatory hurdles?
  - e.g., deployment of VAM oxidizers at active underground coal mines requires approval of MSHA

Questions/Issues

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AMM Projects

- Do drainage systems recover more gas than what would have happened in absence of project?

Drainage System Projects

- For those “gassy” mines with drainage systems, is recovery not cost-effective?
  - If not currently cost-effective, are carbon credits enough to incentivize?
- Do drainage systems recover more gas than what would have happened in absence of project?
- What are biggest factors in cost of:
  - Drainage system?
  - Recovery system?

Cross-Cutting Issues

Flaring

- Cost effective way to destroy CMM
  - Emission reductions do need to be net of CO_2 emissions from combustion
- No flaring to date at active mines in US for safety reasons
  - Successful flaring at active underground mines in UK
- CMOP is working to promote flare designs that may meet safety needs

Questions/Issues:

- Is flaring technologically a viable option?
- Regulatory challenges?
- Site specific challenges?

Federal Lands

- On private lands, case law has established precedent for CMM ownership
- BLM manages 700 acres of subsurface mineral estate
  - CBM and CMM utilization require an oil & gas lease separate from coal lease
- On federal lands, no gas leases have been granted to parties with mineral leases
  - Venting is their only option
  - Appears to be a procedure for securing CMM lease (same as for conventional natural gas)

Questions/Issues:

- Why have gas leases not been granted?
- Where does BLM stand on this issue?

Related Project Types

Surface Mines

- 67% of US coal production, but only 16% of CMM emissions
- Three potential sources:
  1. Methane emitted by coal during mining activities
  2. Methane emitted by surfaces exposed by mining activities
  3. Methane emitted by overburden coal waste piles

<u>Challenges:</u>

- Limited info on current activities
- Distinguishing between CBM and CMM may be unclear
- Measurement

Methane Recovery at Non-Coal Mines

- Can be large releases of methane at non-coal mines
  - US mines report methane emissions associated with oil shales, salt, trona, potash, limestone, copper, and uranium ores
- Unlike coal mines, methane emission rates in metal/nonmetal mines are not consistent

Questions:

- Enough opportunity to explore protocol development?
- Could CMM protocol be used to quantify reductions for methane recovery at non-coal mines?

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