

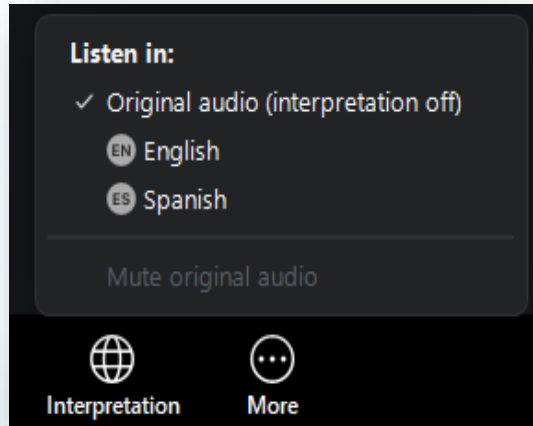


Transport Refrigeration Units (TRU) Part 2 Regulation Concepts Workshop #1

July 14, 2026

Listening to Language Interpretation

- In your meeting/webinar controls, click **Interpretation**. (located at bottom of screen)
- Click the language that you would like to hear.
 - English, Spanish (español)
- To only hear the interpreted language, click **Mute Original Audio**.



- En los controles de su reunión/seminario web, haga clic en **Interpretación**. (ubicado en la parte inferior de la pantalla)
- Haga clic en el idioma que le gustaría escuchar.
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Before We Get Started

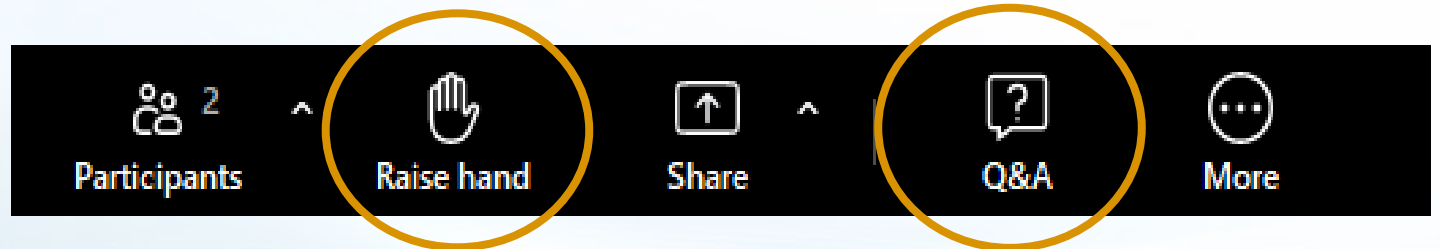
- Please **mute** and **rename** yourself.

First Name, Last Name - Affiliation

- Affiliations: Community Organization / Agency / Air District / Company / Resident / etc.



- To raise your hand
 - Press raise hand
 - Callers press *9
 - Press *6 to mute/unmute



- **Need help? - let us know in the Q&A.**

Agenda

1. Background
2. Foundational Information and Assumptions
3. Zero-Emission TRU Approval Criteria



Background

What is a Transport Refrigeration Unit (TRU)?

Why Are They Important?

- TRUs are refrigeration systems that provide temperature control and air flow for temperature-sensitive goods in trucks, trailers, railcars, and shipping containers.
- A TRU generator set is a generator that provides electricity for a refrigeration system.
- Most TRUs and TRU generator sets run on diesel, which create pollutants like diesel particulate matter (PM) and oxides of nitrogen (NO_x).
- Exposure to PM and NO_x can have significant health impacts.



Types of TRUs

- There are five types of TRUs
- TRU operations are highly variable



Truck TRU



Trailer TRU



**Domestic Shipping
Container (DSC) TRU**



Railcar TRU



TRU Generator Set

TRU Operations

	Truck TRUs	Trailers TRUs	Domestic Shipping Container TRUs	Railcar TRUs	TRU Generator Sets
Route Type and Mode of Transport	Local / On-road	Local, Regional, Long-Haul / On-road	Long-Haul / On-road & Rail	Long-haul / Rail	Local, Regional, Long-Haul / On-road & Rail
Energy Usage	~6 gallons / day	~12 gallons / day	~12 gallons / day	~12 gallons / day	8-12 gallons / day: clip-on / underslung
Route Time	~9 hours / day	10-14 hours	2-15 days	2-15 days	1-15 days: clip-on 10-16 hours / day: underslung
Shifts/Day	1-2	1-2	1	1	1-2
Dwell Time	~1 Hour	.5 hours up to 3 days to leave facility	Up to 24 hours at railyard	Up to 2 days	3-4 days

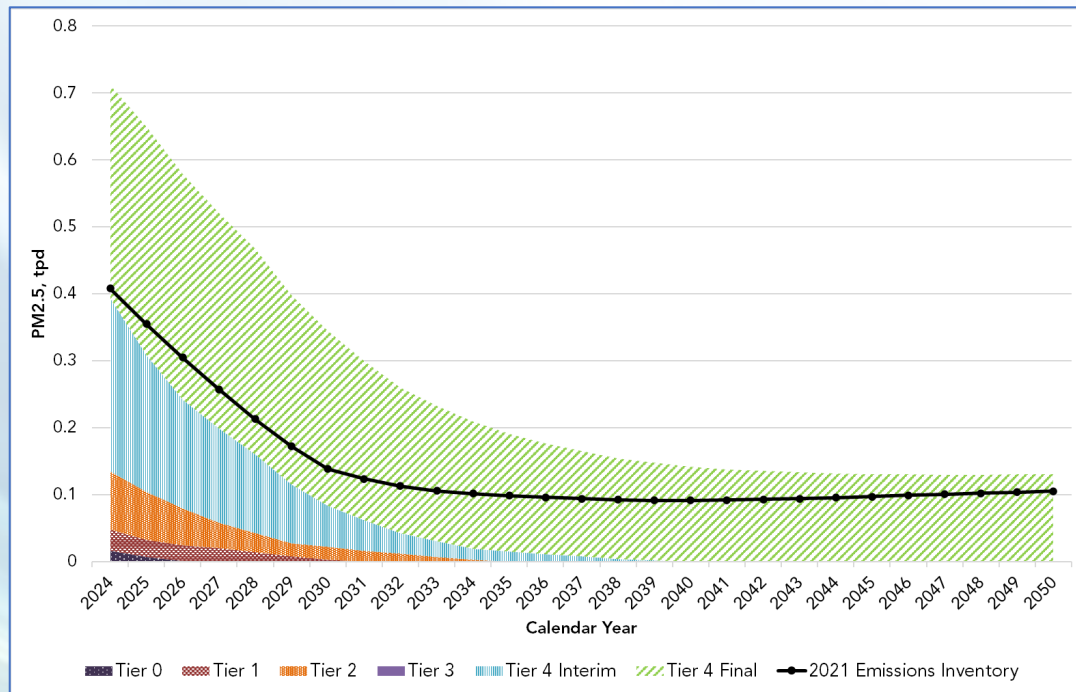
TRU Regulatory History

- Adopted in 2004
 - TRU Airborne Toxic Control Measure (TRU ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets and Facilities Where TRUs Operate
- Amended in 2010, 2011
- Amended in 2022
 - Adopted by CARB's Board
 - July 18, 2022
 - Approved by the Office of Administrative Law
 - October 1, 2022
 - Effective Date
 - January 3, 2025
 - U.S. EPA waived federal preemption for portions of CARB's TRU Regulation, but did not act on the zero-emission truck TRU requirements.

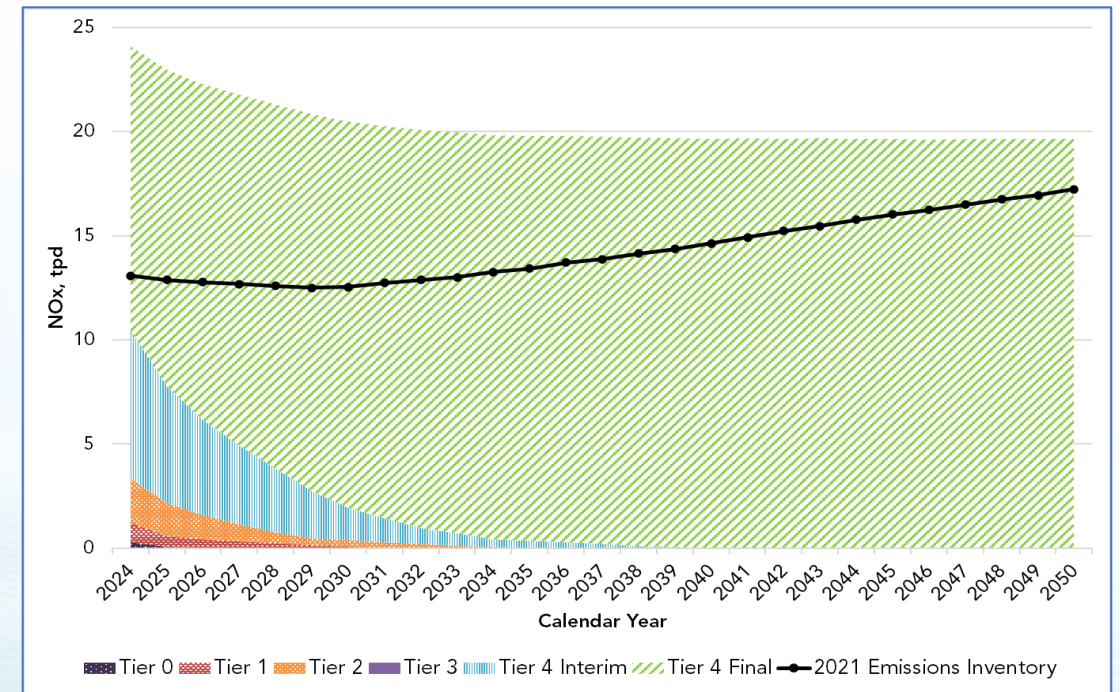


California TRU Emissions Inventory 2024-2050

Diesel Particulate Matter (PM2.5)



Oxides of Nitrogen (NOx)



TRU Population (2025)

TRU Type	California-Based Population	Out-of-State-Based Population	Percent of Total Population
Trailer TRU	48,002	141,336	77.3%
TRU Generator Set	6,292	22,128	11.6%
Truck TRU*	10,598	0	4.3%
Railcar TRU*	0	5,841	2.4%
DSC TRU*	0	10,862	4.4%

*The TRU Emissions Inventory considers all truck TRUs to be California-based and all Railcar and DSC TRUs to be out-of-state-based

Planning Coordination

Support ongoing planning efforts

- Executive Order N-79-20 and N-27-25
- State Implementation Planning (SIP)
- CARB's AB 617 Community Air Protection Program (CAPP)
- South Coast Air Quality Management Districts (SCAQMD) Warehouse Actions and Investments to Reduce Emissions (WAIRE) Program
- Bay Area Air Quality Management District (BAAQMD) Indirect Source Rule Planning Efforts



CAPP Communities

Rulemaking Goals

- Develop a comprehensive regulation that:
 - Reduces health risks to communities
 - Reduces emissions from all TRU types in the near and long term
 - Support statewide emission reduction planning efforts
 - Explores pathways to cleaner technologies





Foundational Information and Assumptions

Data Sources

- 150+ discussions with equipment manufacturers, fleets, and facilities
- 2022 Non-Truck TRU Fleet Survey
- 2 workshops
- Site visits
- 2025 Emissions Inventory
- Literature



Cleaner TRU Technologies

Types of cleaner TRU technologies available or in development:

- Hybrid
- E-TRU w/E-Axle
- Solar Assist with Back-Up Engine
- Power Take-Off (PTO)*



*This technology is still under development to fully meet TRU power needs

Cleaner TRU Technologies (Continued)

Technology Type	Estimated Emission Reduction (%)	Estimated Battery Size (kWh)	Estimated Add. Weight (lbs.)	Estimated Capital Costs*
Hybrid TRU	~50 to 80%	20 to 50	0 to 800	\$40,000 to \$60,000
eTRU w/ e-Axle	93% to 99%	30 to 50	200 to 500	\$70,000 to \$100,000**
TRU w/ Solar Assist and Back-Up Engine	~95%	15 to 60	1,000 to 2,000	\$50,000 to \$95,000***

*Excludes the cost of trailer/container/boxcar/truck body; includes battery pack costs; in 2024\$

**Assumes the e-axle component alone costs \$5,000 to \$10,000

***Assumes the solar assist component alone costs \$5,000 to \$20,000

Zero-Emission TRU Technologies

- Types of zero-emission TRU technologies available or in development:
 - Battery-electric
 - Truck TRU
 - Trailer TRU
 - TRU generator set
 - Solar assisted battery-electric
 - Trailer TRU
 - Hydrogen fuel cell (under development)
 - Trailer TRU



Zero-Emission TRU Technologies

Battery Size, Power Draw, and Cost

TRU Type	Battery Sizes (kWh)	Typical Power Draw* (kW)	Estimated Capital Costs**
Truck TRU	10 to 40+	2 to 5	\$50,000+
Trailer TRU	100 to 140+	4 to 8	\$100,000 to \$120,000+
DSC TRU	140+	4 to 8	\$120,000+
Railcar TRU	140+	4 to 8	\$120,000+
TRU generator set	Clip-on: 70+ Underslung: 60+	4 to 8	Clip-on: \$86,000+ Underslung: \$82,000+

*Excludes power draw during initial temperature pull-down. Power draws are specific to zero-emission TRUs, which staff assume are more efficient than their diesel counterparts.

**Battery pack system estimated to cost between ~\$550/kWh to \$850/kWh. Cost excludes the trailer/container/boxcar/truck body; in 2024\$

Zero-Emission TRU Technologies

Weight

TRU Type	Battery Sizes (kWh)	Estimated Add. Weight (lbs.)	% Reduction in Payload Capacity
Truck TRU	10 to 40+	~0	0
Trailer TRU	100 to 140+	1,150 to 1,750+	2.5 to 4
DSC TRU*	140+	1,600+	2.5
Railcar TRU	140+	1,750+	0
TRU generator set**	Clip-on: 70+ Underslung: 60+	Clip-on: 170+ Underslung: 550+	Clip-on: 0.5 Underslung: 2

*Assumes 80-gal diesel fuel tank

**Assumes 120-gal and 50-gal diesel fuel tank for clip-on and underslung TRU generator sets, respectively

Note on weight sensitivity: assumption that 10% of refrigerated trailer and container trips weigh out

Infrastructure: Charger to TRU Ratio

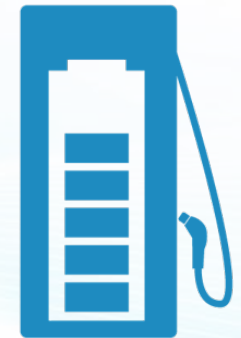
- Assumption:
 - One dedicated charger (level 2 or DC) is needed per zero-emission trailer TRU, regardless of application
- Based on feedback, the charger to trailer TRU need ranges from 3:1 to 1:2
- Individual fleet need will vary



Infrastructure: Charger to TRU Ratio (Continued)

Assumption Considerations:

- Level 2 charger to truck TRU ratio of 1:1
- In-state truck and trailer TRUs generally leave in the morning and return at the end of the day
- The portion of the population needing DC fast chargers
- The portion of the population that will use reefer plugs to assist with charging
- The reduced need for chargers if TRUs can be powered with auxiliary power sources



Staff is seeking additional input on charger ratios

Discussion

Topics and additional input requests

- TRU operations
 - *Additional information on TRU operations and energy usage?*
- Cleaner and zero-emission technologies
 - *Additional data on cleaner and zero-emission technologies?*
 - *Input on challenges or changes to operations from using zero-emission?*
- Infrastructure
 - *Additional input on the charger to TRU ratio?*



Please raise your hand to speak or submit your question to the Q&A.



Please state your *name* and *affiliation*.



Regulatory Concept Development

Initial Regulatory Concepts

Cleaner TRU Technologies

Manufacturing

Applicable Facilities

TRU Labels

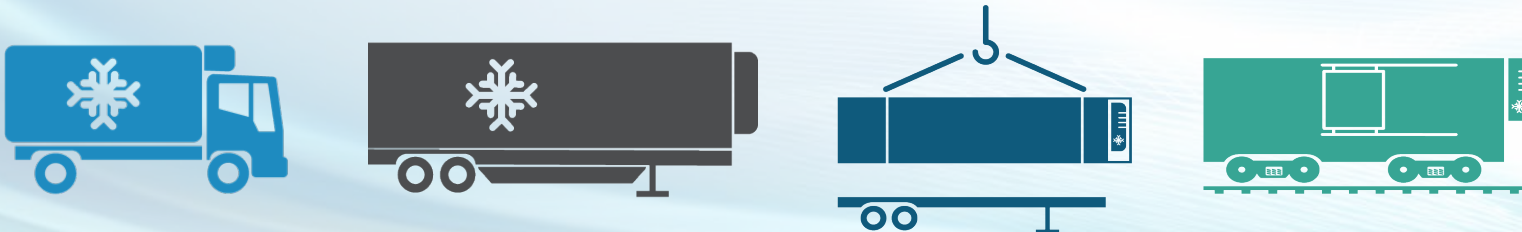
TRU Emission Reduction Pathways

- Potential concepts to reduce TRU emissions may include pathways that:
 - Reduce emissions from all TRUs while accounting for operational differences across fleets and applications
 - Phase-out diesel use while incentivizing the use of technologies that achieve significant emission reductions
 - *Ideas to encourage early adoption?*
 - Support the transition to cleaner TRUs
 - Fleet or unit-based turnover
 - *Challenges with unit-based requirements?*
 - Manufacturing or sales



TRU Emission Reduction Pathways (Continued)

- Technologies staff are evaluating:
 - Hybrid systems and range-extending technologies
 - Battery-electric systems
 - Infrastructure solutions
 - Other lower-emission technologies and operational strategies
 - *Other technologies to consider?*



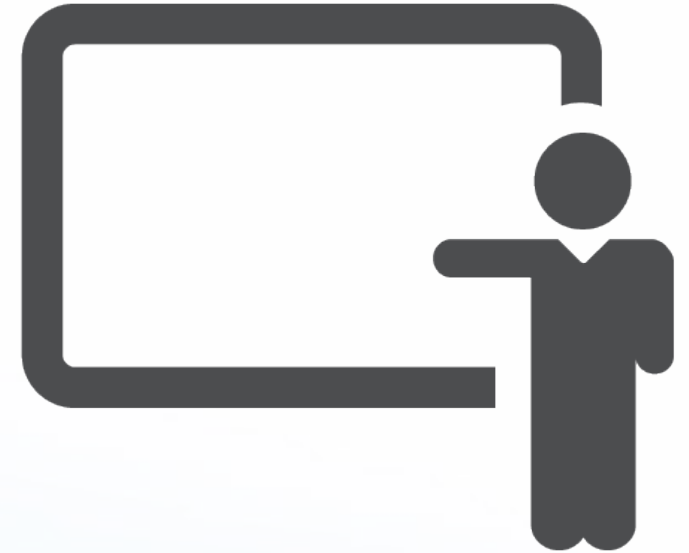
Other Potential Concepts

- Applicable facility requirements
 - Refrigerated warehouses or distribution centers ($\geq 20,000$ sq ft)
 - Grocery stores ($\geq 15,000$ sq ft)
 - Seaport facilities with TRU activity, and
 - Intermodal railyards with TRU activity
- 2024 workshop included idea to add dry/inland ports and proposed definition
- *Other facility types to consider?*
- TRU labels
 - Potential updates to the existing labels requirements based on feedback from fleets
 - *How do facilities currently verify TRU compliance, and do owner-affixed ARB labels provide the same level of usability and confidence as CARB-issued compliance labels?*



Next Steps

- Continue outreach and discussions
- Refine assumptions and develop concepts
- Modeling:
 - Health risk, health benefits, and scenarios
- Next workshop:
 - Late 2026/early 2027 (tentative)
 - Potential topics:
 - Regulatory concepts
 - Initial analysis (emissions, costs, alternatives)
 - Post CEQA notice of preparation



Contact Info: TRU Part 2 and Resources

Submit any additional questions,
comments, or information to
freight@arb.ca.gov

TRU Incentives Webpage

<https://ww2.arb.ca.gov/our-work/programs/transport-refrigeration-unit/tru-funding-assistance>

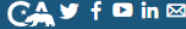
TRU Program Webpage

<https://ww2.arb.ca.gov/our-work/programs/transport-refrigeration-unit>

The TruckStop

<https://ww2.arb.ca.gov/our-work/programs/truckstop-resources/truckstop>



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Transport Refrigeration Units (TRU) are refrigeration systems powered by diesel internal combustion engines designed to refrigerate or heat perishable products that are transported in various containers, including truck vans, semi-truck trailers, shipping containers, and railcars.

[MORE ABOUT THIS PROGRAM >](#)

2022 Amendments to the TRU ATCM

On February 24, 2022, CARB approved amendments (2022 Amendments) to the Transport Refrigeration Unit Air Toxic Control Measure (TRU ATCM) for In-Use Diesel-Fueled TRUs (Title 13 CCR §§ 2477-2477.24), effective October 1, 2022. The 2022 Amendments require TRU and facility owners or owner/operators to pay operating and registration fees, respectively. On September 17, 2025 Governor Newsom signed *Senate Bill (SB) 153* granting CARB authority to impose fees on entities regulated under the 2022 Amendments to the TRU ATCM.

Guidance documents and answers to frequently asked questions are now available to assist stakeholders with TRU operating and applicable facility registration fee requirements.

[LEARN MORE](#)



TRU Rulemaking Activity



Check TRU Compliance



Register Your TRU Online

POPULAR RESOURCES

PRIMARY CONTACT

TRU Help Line
Email arber@arb.ca.gov
Phone (888) 878-2626

CATEGORIES

Topics Airborne Toxics, Air Pollution, Freight & Goods Movement, On-Road Heavy-Duty Vehicles
Division Transportation and Toxics Division

Discussion

Topics and additional input requests

- Potential pathways and technologies to reduce TRU emissions
 - *Defining a hybrid?*
- Potential updates for OEMs, applicable facilities, and labels
 - *Challenges with a unit-based rule?*
 - *Experience implementing labels?*
- Other ideas to achieve TRU Part 2 goals
 - *Other considerations (i.e., health impacts, costs, technology etc.) for evaluating emission reduction pathways?*
 - *Feedback on emission reduction pathways?*
 - *Additional ideas for pathways or other concepts?*



Please raise your hand to speak or submit your question to the Q&A.

Please state your *name* and *affiliation*.



Zero-Emission Transport Refrigeration Unit (ZE TRU) Approval Criteria

July 14, 2026

Freight Approvals Section (FAS) Overview

- FAS develops and implements approval processes to ensure technologies meet regulatory or funding program requirements
 - This technical evaluation work supports consistent, transparent implementation
- Our current approval programs include:
 - Emission control devices (e.g., diesel particulate filters) for stationary diesel engines and freight equipment (including TRUs)
 - Tier 4 and ZE locomotives
- FAS is developing approval criteria for ZE TRUs
 - Seeking feedback from workshop participants

Purpose of ZE TRU Approval Criteria

- Provide a clear and consistent framework for evaluating ZE TRUs
- Ensure transparency for ZE TRU owners and operators
- Assess design, basic performance, reliability, durability, warranty, and other criteria
- Support potential TRU emission reduction strategies and funding program eligibility

Development of Approval Criteria

- Criteria being developed by CARB staff with support from UC Riverside's CE-CERT research center and input from ZE TRU manufacturers
- Modeled after existing CARB technical approval programs
- Format and timeline of approval process to be determined based on program needs
- Application details treated as confidential business information

ZE TRU Approval Criteria - Proposed Outline

- Information to be provided to CARB by ZE TRU manufacturer applicants
- Technical specifications
 - System schematics and dimensions
 - ZE technology information (e.g. battery details)
 - Refrigerant information
 - Charging, fueling, and infrastructure requirements
 - Estimated runtime
- TRU applications (e.g., trucks, trailers, railcars), container requirements, and temperature range
- System demonstration and commercial operation history

ZE TRU Approval Criteria – Proposed Outline (Continued)

- Operating conditions, safety standards, limitations, and failure modes
- Information available to the operator
 - Battery status information (i.e. state of charge, health)
 - Monitoring and diagnostics, including conditions that will trigger an alert
- Performance testing
 - Performance rating standards for TRUs (i.e. AHRI 1110 or equivalent)
 - Durability demonstration

ZE TRU Approval Criteria – Proposed Outline (Continued)

- Service and repair information
 - Planned maintenance intervals
 - How to access service and repair
 - Battery end-of-life information
- Warranty requirements
 - Whole system and battery-specific
 - Intended to align with industry norms and other program requirements
 - Potential reporting requirement

ZE TRU Approval Criteria

- CARB is seeking stakeholder feedback
- Approval criteria draft and contact information can be accessed at <https://ww2.arb.ca.gov/proposed-approval-criteria-zero-emission-transport-refrigeration-units>
- Contact us:
 - zeapprovals@arb.ca.gov

Questions ?



Please raise your hand to speak or submit your question to the Q&A.
Please state your *name* and *affiliation*.

Recap of Requested Input

- Additional information on TRU operations and energy usage
- Additional data on cleaner and zero-emission technologies a
- Input on challenges or changes from using zero-emission
- Additional input on the charger to TRU ratio
- Ideas for regulatory pathways to encourage early adoption of cleaner technologies
- Feedback or additional ideas on emission reduction strategies
- Challenges with a unit-based rule
- How to define a hybrid TRU
- Experiences with implementing labels
- Feedback on the Zero-Emission TRU Approval Criteria

Input preferred by August 28



Thank You!

Contact us at freight@arb.ca.gov