USCAR Annual Report

2024

USCAR
UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH

TABLE OF CONTENTS

By TLC or Technical Area

**All TLC/section names link directly to their corresponding page/section*

USCAR OPERATIONS & OVERVIEW

WHAT IS USCAR?

"The collaborative automotive technology of Ford, GM and Stellantis"

Current Mission

The mission of USCAR is to create value for our three members by accelerating the development of enabling automotive technologies that address the personal transportation needs of our customers and society, while contributing to national economic security and safeguarding the environment. This value proposition is achieved principally by identifying common areas of interest and organizing teams who engage in activities that leverage the resources of the members and others to generate knowledge and results which can be independently applied by each member.

- Founded in 1992 – 33 years old
- Projects funded by Ford, GM and Stellantis as well as the US government and suppliers
- Focus on global industry issues but primarily US projects

USCAR BY THE NUMBERS

3	Member Companies
>7	Primary Technical Research Areas
~50	Teams and Working Groups
550+	Active Participants
~10	USCAR Staff Members
>100	Projects

KEY 2024 DATES/ACTIVITIES

Government Funding

- USABC awarded full $60M grant through DOE funding opportunity announcement, DE-FOA-0002965
  - Current USABC/DOE agreement ended in Oct. 2024
- Partnered with Oak Ridge National Lab and MIT for application to DOE Smart Manufacturing AMMTO (Advanced Materials and Manufacturing Technologies Office) funding opportunity announcement for $2.5M – application withdrawn when 1 of 3 members didn't agree to cost-share commitment
  - Investigating additional opportunities with AMMTO in manufacturing and/or materials
- Pursuing new funding for USAMP 2.0. Seeking a $25M mark from Congress to DOE for an automotive materials consortium

Government Influence

- Hosted Smart Manufacturing Event with keynote speakers, former US Rep. Brenda Lawrence and DOE AMMTO director Chris Saldana
- Co-Hosted first in-person joint US DRIVE and 21st Century Truck Partnership All Tech Team Meeting with DOE in October 2024. Previous in-person meeting was US DRIVE only and in 2018

Public Influence

- Published two USCAR Whitepapers
  - *Necessity for Mobile H2 Fueling Stations for MD Fuel Cell EVs in the US* and *Need for Low-Carbon Fuels*
- Released USCAR-53 standard on Industrial Data Communications for Automotive Manufacturing

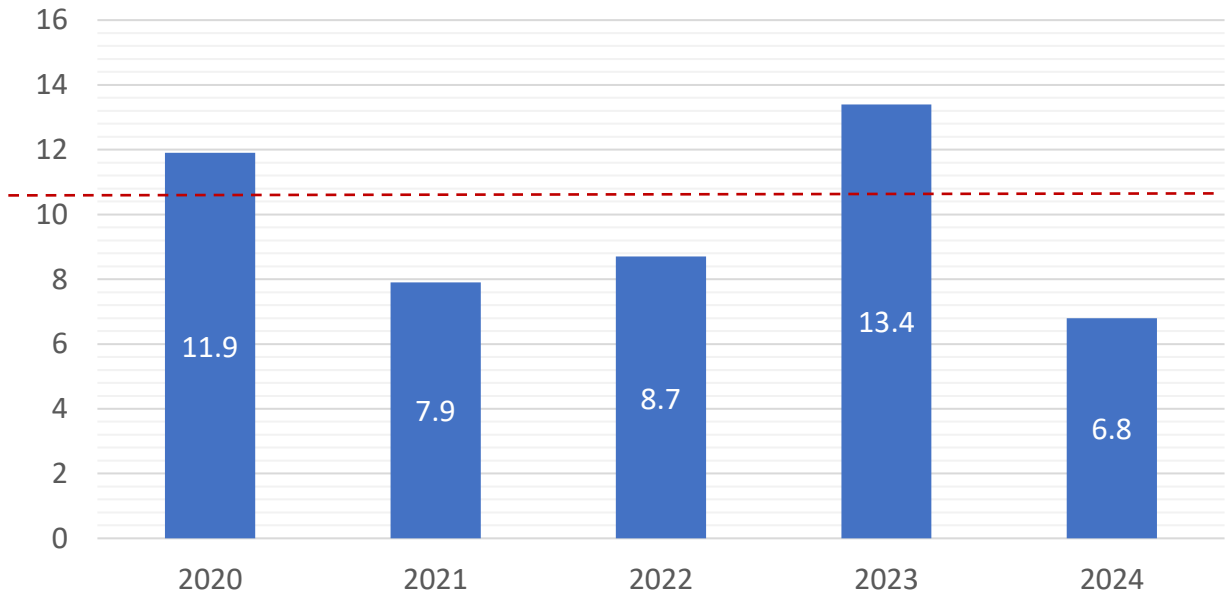
Operations

- Officially moved two working groups to task forces; sunset one team and archived five
- Restructured team oversight to move AIGER (Automobile Industry and Government Emissions Research) and ISATT (US DRIVE Integrated Systems Analysis Tech Team) under Adv. Propulsion TLC
- Hired two full-time staff, three part-time employees separated

FINANCIAL LEVERAGE – 9.74x

Multiplied for Each $1 of Spend (Average Member Cash Investments by Year)* Over the Past 5 Years

5-Year Average: 9.74x



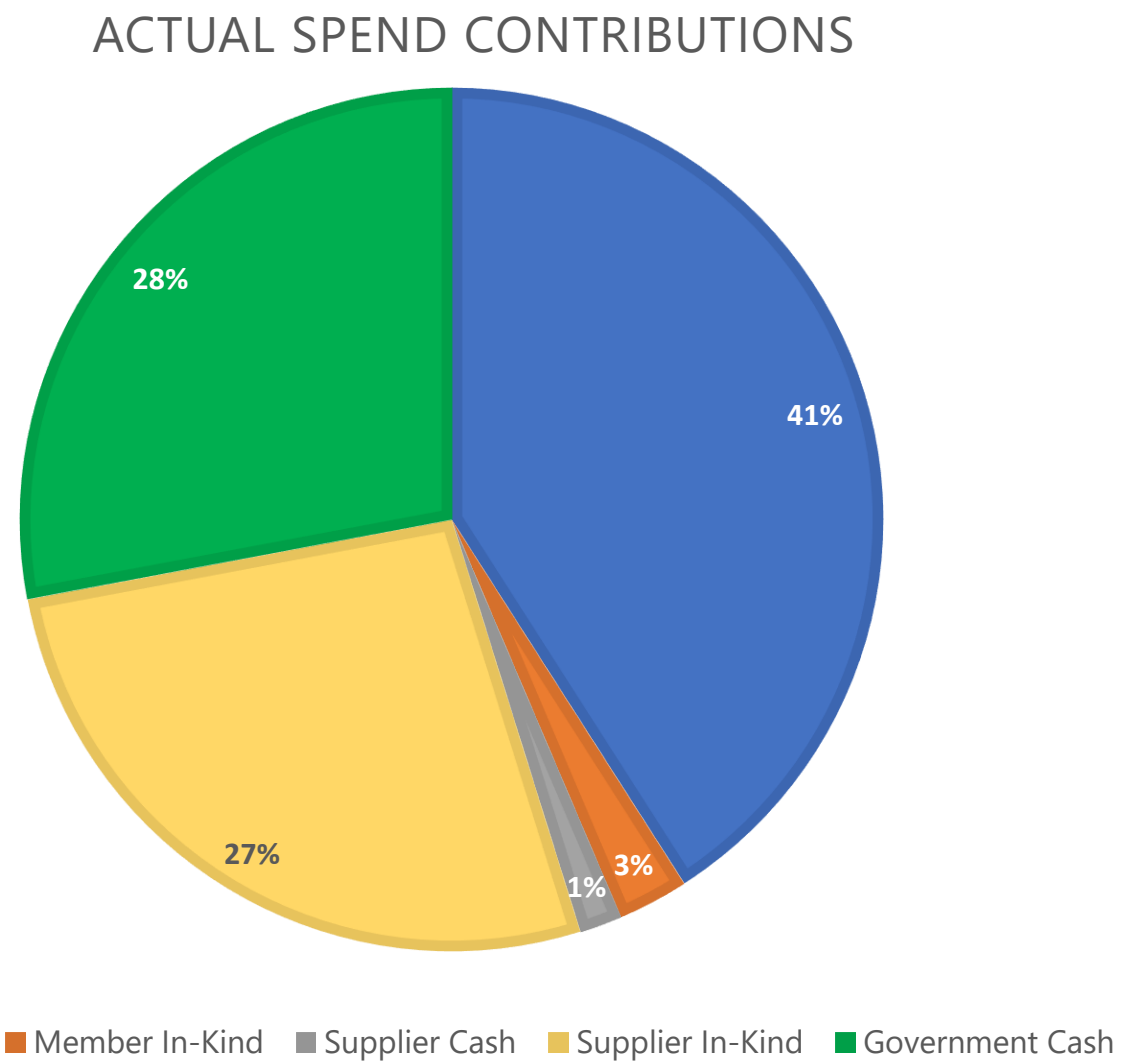
	2020	2021	2022	2023	2024
Average Cash Investments ($M)	1.36	2.3	2.27	1.8	2.7
USCAR total spend ($M)	16.14	18.15	19.7	24.1	18.4

Influences >$100M DOE and National Lab research

Influences and shapes U.S. government energy and transportation policy

* Total spend including USCAR OEM members, government (DOE/National Labs) and suppliers (inc. startups) divided by Average Member Cash spend

2024 USCAR ACTIVITIES WITH DIRECT INVOLVEMENT



USCAR TEAMS

December 2024

Leadership Group (ULG): Cynthia Flanigan, Paul Krajewski, John Borowski, Steve Przesmitzki

Council: Matt Jones, Dan Nicholson, Steve Rober

U.S. DRIVE/21CTP Tech Team

Operating under a cooperative agreement or CRADA

Technical Leadership Councils (TLCs)

AS	SS	BR	SS	AS	AB	SS	SS
Advanced Propulsion T. McCarthy S. Naik H. Santoso	**Electrical + Electronics** TBD J. D'Ambrosio TBD	**Energy Storage** K. Snyder G. Cintra O. Gross	**Hydrogen + Fuel Cell** M. Veenstra C. Freese J. Daley	**Manufacturing** M. Bastian J. Abell McKenzie/Weber	**Materials** M. Nichols H. Doty B. Macek	**Safety** S. Barbat N. Nagappala K. Chitoor	**ULG** C. Flanigan P. Krajewski J. Borowski
Aftertreatment Data Exchange	Advanced Compute TT	Batteries TT	Fuel Cell JTT	Body Structures/ Stamping WG	Decorative Trim Corrosion WG	Crash safety WG	Aero WG
Engine Benchmarking WG	Electrical Power Systems WG	U.S. Advanced Battery Consortium (USABC)	Fuel Cell Benchmarking WG	Ergonomics WG	Engineering Materials WG	Occupant Safety Research Partnership (OSRP)	Auto Industry Govt Emissions Research (AIGER)
Auto Industry Govt Emissions Research (AIGER)	EVAP WG		Hydrogen JTT	Manufacturing Safety WG	Glazing WG		Integrated Systems Analysis JTT
Electric Drive TT	Fuels WG		Hydrogen Fuel System Component WG	Smart Manufacturing WG	Materials TT		Oil Pumps WG
Electrified Propulsion WG	Grid Integration JTT				Substances of Concern & Vehicle Interior Air Quality WG (SOC-VIAQ)		Process Definition & Approval WG
Integrated Systems Analysis JTT	Electrical Wiring Component Partnership (EWCAP)				Sustainable Materials WG		Vehicle & Mobility Systems Analysis JTT
	Light Duty OBD WG				U.S. Auto Materials Partnership (USAMP)		Vehicle Arch. Data Exchange WG
	Lighting WG						Vehicle Structure NVH Bench WG
	Net Zero Carbon Liquid Fuels JTT						

Org Changes

- Realigned Team
- Archived Team
- Sunset Team

Sunset: *Work completed; do not anticipate further activity*

Archived: *Team currently inactive; may restart activity as deemed necessary*

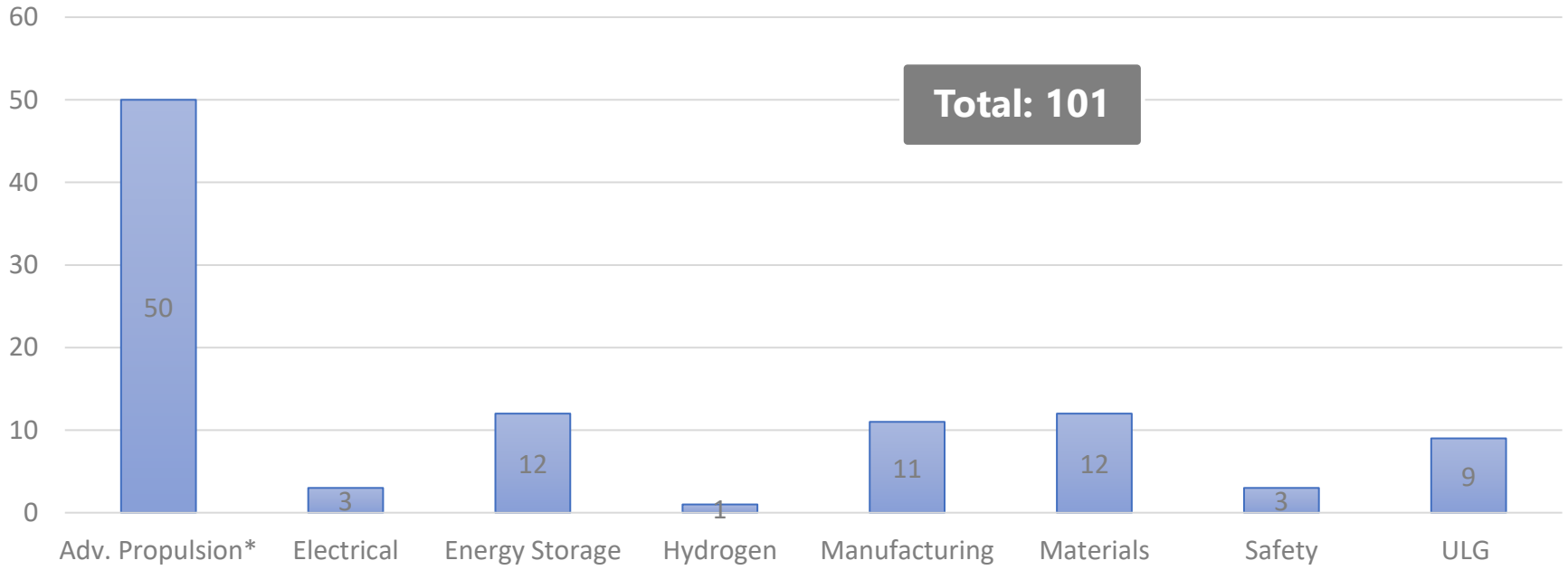
USCAR Operations

- TT/JTT – Tech Team, Joint Tech Team
- WG – Working Group

SS Staff Support Rep Initials | Business & Technical Support (BTS) | Finance (FiSh) | Industry Gov't Relations (IGR) | Communications | Other – Legal, IT, Real Estate

PROJECTS BY TLC

2024 Project and Initiative Count by Technical Area (estimate)

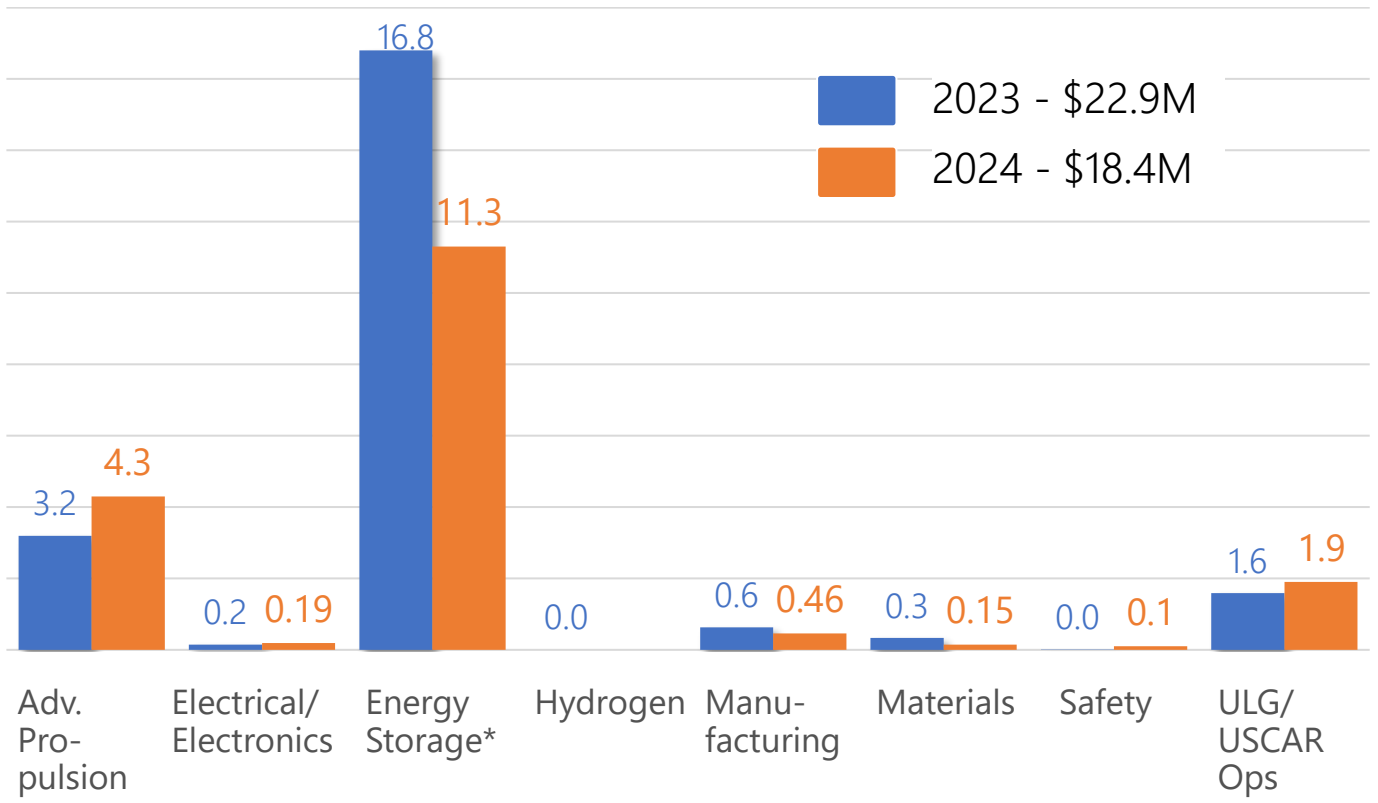


* Advanced Propulsion includes vehicle and propulsion benchmarking projects

SPEND BY TLC

2023 and 2024 Project and Initiative Spend By Technical Area (estimate)

US$ Millions.



* Energy Storage (USABC) primarily funded by Dept of Energy grant and suppliers

US DRIVE PARTNERSHIP

Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability

US DRIVE is a non-binding and voluntary government-industry partnership focused on advanced automotive and related energy infrastructure technology research and development (R&D). The Partnership is a forum for pre-competitive technical information exchange among partners to discuss R&D needs, develop joint goals and technology roadmaps, and evaluate R&D progress for a broad range of technical areas.

By providing a framework for frequent and regular interaction among technical experts in a common area of expertise, the Partnership accelerates technical progress and helps avoid duplication of efforts.

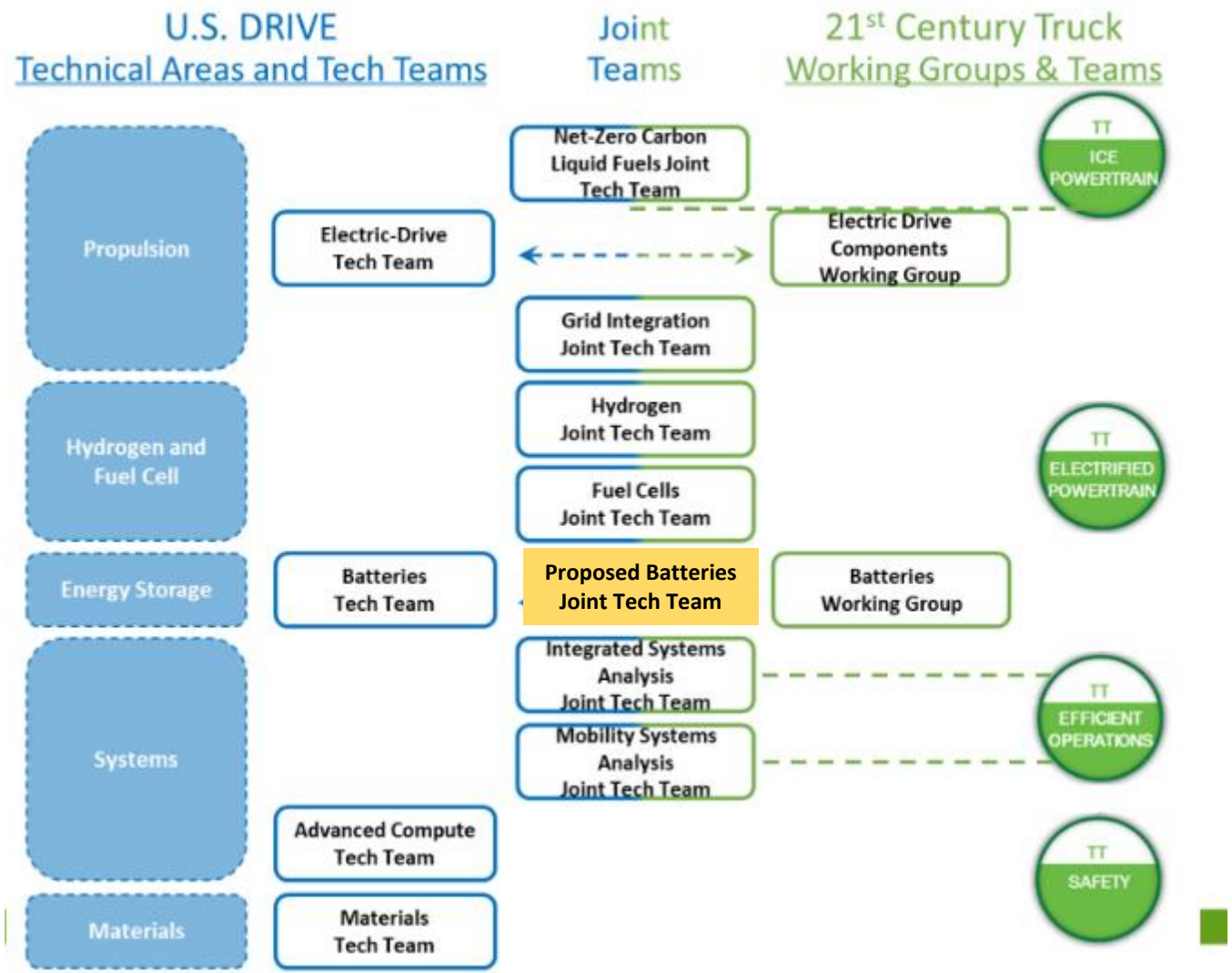
	Automotive	Electric Utility	Energy/Oil	Federal Government
Partners	USCAR	American Electric Power, DTE Energy Duke Energy, Electric Power Research Institute and Southern California Edison	BP America, Chevron, ExxonMobil, Phillips 66 and Shell Oil Products US	U.S. Department of Energy

2024 US DRIVE Operational Accomplishments

- Hosted Grid Integration workshop in conjunction with SAE GIM to align with DOE and partners on direction and scope
- Co-Hosted first in-person joint US DRIVE and 21st Century Truck Partnership All Tech Team Meeting with DOE in October 2024
- Progressed towards establishing Joint Battery Tech Team

US DRIVE Page: https://www.energy.gov/eere/vehicles/us-drive
Partnership Plan: https://www.energy.gov/sites/default/files/2022-06/USDRIVE%20Partnership%20Plan_072022.pdf

US DRIVE & 21ST CENTURY TRUCK PARTNERSHIP TECH TEAMS



ADVANCED PROPULSION TLC SUMMARY

2024 Annual Report

TLC SCOPE

To lead and drive all collaborative advanced propulsion activities to achieve leadership in technical knowledge and capability for the USCAR members.

TLC MEMBERS

- Tom McCarthy (Ford)
- Sanjeev Naik (GM)
- Halim Santoso (Stellantis)

TLC TEAMS

- Aftertreatment Data Exchange Working Group
- Auto Industry Government Emissions Research (AIGER)
- Electric Drive Tech Team
- Electrified Propulsion Working Group
- Engine Benchmarking Working Group
- Evaporative Emissions Working Group
- Fuels Working Group
- Grid Integration Tech Team
- Integrated Systems Analysis Tech Team
- On Board Diagnostics (OBD) Working Group
- Net Zero Carbon Liquid Fuels Tech Team

VALUE STATEMENT

As one of the largest and most diverse TLCs within USCAR, the APTLC derives values in several ways:

- Influence US DOE investments to accelerate electrification technologies and explore sustainable pathways for propulsion
- Influence future regulations through collaborative actions for both the OBD & Evaporative Emissions working groups
- Influence future emissions & energy management certification procedures through collaboration between AIGER and the regulatory agencies
- Realize cost savings on vehicle benchmarking with a better than 3:1 leverage on cash investment (split 3+ ways, plus volume discounts) and data sharing

KEY 2024 ACCOMPLISHMENTS

1. Published Low Carbon Liquid Fuels Whitepaper to highlight the need for drop-in, on-road fuels to decarbonize the legacy fleet - directly impacts U.S. National Blueprint for Transportation Decarbonization
2. Developed, incorporated feedback from national laboratories, and submitted Statement of Work for High EV Adoption Impacts on the U.S. Power Grid - 2024 Study to US DOE
3. Propulsion Benchmarking completed and ongoing work encompasses 23 vehicles split across BEVS, PHEVS, HEVS, and ICE vehicles. 2024 approximately $6M benchmarking value, for ~$1.6M cash contribution per member
4. Moved AIGER, ISATT under APTLC oversight for better integration, reduced number of working groups by consolidating SCR Working Group into OBD

ADVANCED PROPULSION TLC

2024 Annual Report

Advanced Propulsion Technical Leadership Council

T. McCarthy (Ford) / S. Naik (GM) / H. Santoso (Stellantis)

Aftertreatment Data Exchange
Aasari Srinivasan / Rahul Mittal / Vence Easterling

Engine Benchmarking WG
Brad Boyer/ Azadeh Narimissa / Jean Baptiste Martin

Fuels WG
Jim Anderson / Elana Chapman / Asim Iqbal

Noise, Vibration & Harshness
Bert Bradley & Walt Ortman/ Thomas Archer & John Miller/Jeffrey Orzechowski

Electrified Propulsion WG
Hong Jiang / Azadeh Narimissa / Mark Levine

EVAP WG
Scott Bohr / Steven Horetski / Michael Grote

Light Duty OBD WG
Suzie Stuber / Janean Potter / Yichao Guo

Auto Industry Govt Emissions Research (AIGER)
Darius Harrison / Steve DeCarteret / Mahmoud Yassine

Electric Drive TT
Krishna Bhat / Avoki Omekanda / Pradeep Attibele

Grid Integration JTT
Sunil Goyal / Orgun Guralp / Richard Scholer

Integrated Systems Analysis JTT
Hyung Chul Kim / Ian Sutherland / Marcela Arrambide

Net Zero Carbon Liquid Fuels JTT
Jim Anderson / Elana Chapman / Michael Moore

Working Group Name
Ford/GM/Stellantis Lead

Operating under a cooperative agreement

U.S. DRIVE/21CTP Tech Team

Concentration area, not a separate WG

Auto Industry Government Emissions Research (AIGER) CRADA

KEY 2024 ACCOMPLISHMENTS

1. Investigated xEV measurement correlation between power analyzers and on-board current sensors. Supporting potential use of on-board energy data for future In-Use/Cert testing
2. Identified key factors influencing PM tunnel background contamination at -7 °C. The survey was updated with new best practice information from different labs for cold temperature testing
3. Shared PM measurement best practices for filter handling including: static charge, gloves, anti-static cleaning materials for weigh room and filter holder, and filter transportation containers
4. Worked with CRC to analyze and complete the E-140 project defining a model for low-level NOx & NMOG emission measurement uncertainty
5. CRADA Conversion to MOU in progress (completed March 2025)

Electric Drive Tech Team

KEY 2024 ACCOMPLISHMENTS

1. Developed a 100 kW and 200 kW segmented inverter designs and prototypes that meet the 100 kW/L goal
2. Developed a HfO2 gate dielectric on GaN fabricated using atomic layer deposition has enabled a trench MOSFET with 10x the linear current density of the best previously reported GaN MOSFET
    - This exceeds the linear current density of typical SiC power MOSFETs by approximately the same factor
    - Scaling a fully manufacturable process would enable a significant reduction in specific on-resistance and conduction loss as well
3. The American Axle Manufacturing high-speed induction motor project moved the needle in bringing a Rare Earth Elements free electric motor closer to production
    - Influences DOE to bring more Tier 1 suppliers into the projects

Grid Integration Tech Team

KEY 2024 ACCOMPLISHMENTS

1. Developed and refined, cooperatively w/DOE, renewed EVs@Scale Study to quantify Grid readiness for growing electric LD/HD fleets
2. Agreement to add partners from EVSE suppliers, Charger Service Operator industries and increasing cooperation with 21st Century Truck; In process of inviting members agreed on by GITT membership
3. Mapped out DOE and Industry supported offices and consortia focused in GITT areas; This activity supports adding definition and specificity to GITT responsibilities and ensure all work is non-redundant and filling a need
4. Continued monitoring and guiding project portfolio in EVs@Scale Consortium (Collection of National Labs working to solve challenges associated with expansion of an affordable, convenient, and reliable national charging infrastructure)

Integrated Systems Analysis Tech Team

KEY 2024 ACCOMPLISHMENTS

- Continued work on cradle-to-grave analysis for medium and heavy-duty trucks
  - Class 6 Box Truck and Class 8 Day Cab and Sleeper Cab
  - Bottom-up material composition completed
  - Current and future efficiencies under range of technology progress rates quantified
  - Both per-mile and per-ton-mile metrics included
  - Report writing in progress
    (GHG emissions only – no cost comparisons across fuel/vehicle pathways per DOE leadership direction)
- ISATT-GITT EVs at Scale Grid Impact Study – SOW draft reflecting USCAR and 21CTP member input and priorities

Propulsion Benchmarking

KEY 2024 ACCOMPLISHMENTS

BEVS

MY21 VW ID.4, completed
MY22 Lucid Air DE, final report in,
component testing in progress
MY23 Rivian R1T, completed incl. EDU NVH
MY23 BYD Seal BEV, final report
MY22 BMW iX xDrive50, in progress
MY22 Mercedes EQS580, in progress
MY23 Tesla Model S Plaid, in progress
MY23 Nissan Ariya, in progress
MY23 Toyota bZ4x, in progress
MY23 Geely Zeeker 001, in progress
MY24 Cybertruck (2), in progress
2nd truck was to expedite data collection,
3rd truck in discussion to expedite teardown
MY24 Mercedes eSprinter, in progress
MY24 Xpeng G9, in progress
MY25 NIO ET7, kicking off
MY25 Porsche Macan, kicking off

HEVs & PHEVs

MY22 Volvo XC60, completed
MY24 BMW x5 xDrive50e, in progress
MY24 Changan SL03, in progress
MY25 BYD Shark, kicking off
MY25 Prius Prime, kicking off
MY25 Mercedes GLE, kicking off
MY25 LiXiang L9, kicking off

ICEVs

MY24 BMW X1, kicking off
MY25 Mazda CX90, kicking off

Color Key
Black = completed testing
Blue = testing in progress
Green – 2024 project, just started

Evaporative Emissions Working Group

KEY 2024 ACCOMPLISHMENTS

1. Support of new emissions regulations (Euro 8, China 7, Brazil PL9, ACC3/LEV5, Clean Truck Program 2)

2. Collaboratively worked to positively influence China VECC to set rational globally aligned EVAP emission standards and test procedures

3. Published testing methodology for non-fuel-based emissions as a hedge to future emissions setting on EVs

Fuels Working Group/Net Zero Tech Team

KEY 2024 ACCOMPLISHMENTS

1. Published Low Carbon Liquid Fuels Whitepaper to highlight the need for drop-in, on-road fuels to decarbonize the legacy fleet - directly impacts U.S. National Blueprint for Transportation Decarbonization
2. Have verbal agreement from DOE (Austin Brown) to invite the BioEnergy Technologies Office (BETO) back into the Net Zero Tech Team

On Board Diagnostics Working Group

KEY 2024 ACCOMPLISHMENTS

1. Subcommittee on DPF Efficiency, met with CARB OBD staff to propose regulation relief due to unavailability of PM sensing technology that has been identified to meet OBD requirements
2. Collaborated with EMA to present Engine Aging Harmonization proposal to CARB OBD staff as part of the Clean Trucks Partnership (CTP) Low NOx Omnibus rulemaking
3. Collaborated with EMA to present a regulation revision proposal for Diesel Particulate Filter Non-Methane Hydrocarbon requirements to CARB OBD staff as part of the Clean Trucks Partnership (CTP) Low NOx Omnibus rulemaking
4. Collaborated with EMA to petition EPA to align SCR inducement requirements across vehicle weight classes. Currently, EPA's regulation defines requirements for Heavy-Duty engine/vehicles, USCAR and EMA asked EPA to write a guidance for light-duty and medium-duty that allows 50 state harmonization
5. Renewable/Green fuels workgroup has started a project that is being executed through the Coordinating Research Council (CRC)

ELECTRICAL/ELECTRONICS TLC SUMMARY

2024 Annual Report

TLC SCOPE

To work collaboratively to create common, foundational electrical/electronic technologies, electronic controls, software, and standards that enable the members to focus efficiently and effectively within their own companies on competitive strategies for automotive electronics.

TLC MEMBERS

- TBD, *Ford*
- Joe D'Ambrosio, *GM*
- TBD, *Stellantis*

TLC TEAMS

- Electrical Wiring Component Applications Partnership (EWCAP)
- Lighting Workgroup
- Advanced Compute Workgroup*
- AI/ML V&V Workgroup**
- Electrical Power Systems Workgroup*

* Not currently active ** Done/Sunset

VALUE STATEMENT

Use of shared connector technology by the OEM member companies brings a three-times cost reduction multiplier. This advantage applies to both shared designs and test methods.

Common specifications and validation tests for lighting lowers development costs for OEMs and suppliers.

KEY 2024 ACCOMPLISHMENTS

1. Updated test spec. USCAR-49 for high frequency connectors. Methods added for more efficient testing. Completed 4Q2024
2. Developed and published a USB Type C connector design interface with automotive capability. Completed 2Q2024
3. Published design guidelines specific to High Voltage connector systems. Completed 3Q2024
4. Published AI/ML verification and validation guidelines
5. Developed consensus on lighting regulatory proposals and SAE updates such that the USCAR members had a unified voice for these updates
6. Continued merging each companies' requirements for LED light sources for USCAR-50

Electrical Wiring Component Applications Partnership (EWCAP)

TEAM SCOPE

Develop optimized designs of electrical connectors for common use. Develop test and design specifications for electrical connectors/ wiring, and match specific connector designs to specific common devices.

TEAM LEADS

- Joel Pittenger, *Ford*
- Khara Pratt, *GM*
- David Kwang, *Stellantis*

VALUE STATEMENT

Drive competitive design and development within the supplier network by using shared connector technology by the OEM member companies. This has brought a three-times cost reduction multiplier and increased quality and innovation within the supply base by fostering a competitive environment. This advantage is guided by sharing common design interfaces, design requirements, and test methodologies.

KEY 2024 ACCOMPLISHMENTS

1. Updated test spec USCAR-49 for high frequency connectors. Methods added for more efficient testing. Completed 4Q2024
2. Developed and published a USB Type C connector design interface with automotive capability. Completed 2Q2024
3. Published design guidelines specific to High Voltage connector systems. Completed 3Q2024
4. Developed and published a common terminal cavity for Ethernet connectors. Completed 3Q2024
5. Updated USCAR-2, the test spec. for low voltage connectors. Completed 4Q2024

Lighting Working Group

TEAM SCOPE

Enable and encourage cooperative research and development of common test specifications for automotive lighting sources, lamp sockets, and lighting assemblies.

TEAM LEADS

- Ketan Desai, *Ford*
- Michael Larsen, *GM*
- Dennis Novack, *Stellantis*

VALUE STATEMENT

The USCAR Lighting Working Group benefits from creating common specifications. This allows the common Tier 2&3 suppliers to validate their products once to a common specification and that validation is essentially accepted by the USCAR members.

USCAR also enables the members to discuss common issues with the tiered suppliers and regulatory items where the USCAR members can come to a consensus voice to suppliers on common issues, issues with the Alliance for Automotive Innovation (AfAI), and other such organizations.

KEY 2024 ACCOMPLISHMENTS

1. Developed consensus on regulatory proposals and SAE updates such that the USCAR members had a unified voice for these updates
2. Continued merging each companies' requirements for LED light sources for USCAR-50

ENERGY STORAGE TLC SUMMARY

2024 Annual Report

TLC SCOPE

The USABC seeks to direct pre-competitive domestic electrochemical energy storage (EES) R&D relevant to the automotive industry through a consortium that engages automobile manufacturers, EES manufacturers, the Department of Energy, national laboratories, universities, and other stakeholders.

The USABC engages with developers who demonstrate the potential to develop a commercially viable product, that can produce sufficient volumes to meet automotive requirements and provide engineering and testing support to meet automotive implementation requirements.

TLC MEMBERS

- Kent Snyder, *Ford*
- Meng Jiang, *GM* (interim rep and 2024 chairperson)
- Oliver Gross, *Stellantis*

TLC TEAMS

- Technical Advisory Committee
  - Matt Denlinger, Ford
  - Meng Jiang, *GM* (2024 chairperson)
  - Lamuel David, *Stellantis*

- US DRIVE Batteries Tech Team
  - Kent Snyder, *Ford*
  - Vijay Saharan, *GM*
  - Trey Weaver, *Stellantis*

VALUE STATEMENT

Creates the pathway to more efficient and effective project outcomes by leveraging the unique strengths and capabilities of each stakeholder. In addition to the efficient and timely usage of resources, the consortia members recognize that successful commercialization of these technologies will only be achieved when the supplier base has been established for the selected components and subsystems.

KEY 2024 ACCOMPLISHMENTS

1. Developers of low-cost, fast-charge technology developed the high energy density , low-cost Li-ion cell capable of achieving the project goals and, successfully develop a prototype cell able to reach the fast charge DST cycles
2. Developer of beyond lithium technology demonstrated the manufacturing capability of Li metal pouch cells and developed Li metal cell technologies with consistent performance
3. In September 2024, the final 12 projects under federal award number DE-EE0006250 were completed. This milestone brought the eleven-year cooperative agreement with the DOE to a close. It ensured all closeout reports were timely submitted, thereby maintaining it's reputation as a trusted DOE partner
4. USABC concluded its final negotiations for a $60M, five-year Department of Energy (DOE) Vehicle Technology Office (VTO) cooperative agreement aimed at addressing the needs of electric vehicle manufacturers to manage pre-competitive, vehicle-related research and development in advanced battery technology, including domestic supply chain development

ENERGY STORAGE TLC DETAIL

2024 Key Accomplishments by Technology Area

Technology Area	Accomplishments	Value
Low-Cost/Fast-Charge (LC/FC) EV Applications	• Developed high energy density , low-cost Li-ion cells capable of achieving the project goals of $75/kWh and 15 min fast charge for 80% of capacity • Successfully developed a prototype cell able to reach the fast charge Dynamic Stress Test (DST) cycles	• Fast charging is a crucial enabler of the mainstream adoption of electric vehicles (EVs) to make them competitive with the internal combustion engine cars • The high energy cell chemistry is a good foundation for further development of high-performance fast charging cells for the electric vehicle market
Manufacturing/ Pre-Lithiation	• Successfully validated a prelithiation process for high-volume manufacturing, particularly for electric vehicle batteries • Prelithiation increased the specific energy density of the cells while reducing costs at GWh-scale production	• High-volume battery manufacturing is important to ensure a reliable battery supply is ready to meet increased EV demand and an important component towards reducing costs
Beyond Lithium-Ion (BLI)	• Demonstrated the manufacturing capability of Li metal pouch cells and developed Li metal cell technologies with consistent performance • Developed Li metal cell technology targeted to provide Beginning-of-Life (BOL) energy density, End-of-Life (EOL) energy density after 500 cycles at cost target	• With the emergence of post-Li-ion batteries, safe and efficient operation of Li metal anodes has become an enabling technology which could impact the success of several promising candidates for the next generation energy storage systems, including rechargeable Li–air batteries, Li–S/Se batteries, and Li metal batteries which utilize intercalation compounds as cathodes

ENERGY STORAGE TLC DETAIL

2024 Key Accomplishments by Technology Area

Technology Area	Accomplishments	Value
Recycling	• Demonstrated a sustainable, fully domestic supply chain partnering a battery recycler, a cathode material producer and cell manufacturer. The recycling process was scaled and produced several hundred kilograms of battery materials (nickel, cobalt and manganese sulfates and lithium hydroxide) which were then used to synthesize precursor and then cathode material in various recycled/virgin ratios. Materials were then built into ~ 3 Ah cells for comparative evaluation. A cost model based on the subject recycling process predicts an ~$11/kWh savings of recycled battery metals vs primary sourced equivalents • Developed a sustainable novel front-end lithium (Li) recovery process that demonstrated an overall Li recycling efficiency of >95%, and generating a lithium carbonate of 99.95% purity in the small-scale experiments. The process also promises economic benefits, offering lower reagent and byproduct disposal costs • Developed an integrated process for recycling large format lithium-ion batteries able to 'up-scale' from a lower Ni black mass feedstock to a target high nickel NMC chemistry. The proprietary process bypasses the classical solvent extraction steps used by most hydrometallurgy based processes and thus offers improved sustainability (confirmed by LCA), lower CO2 footprint and fewer unwanted byproducts	• Creating a circular economy for battery materials through recycling generates a domestic source for battery metals, aka the Urban Mine. Benefits are both environmental (offsetting and ultimately replacing the need for mining of battery metals) and supply chain security • The programs demonstrated various technical approaches for battery recycling, each providing valuable learnings and showing the powerful promise of recycled materials • Stakeholders learned how to manage unique aspects of recycled materials that in some cases differed from those typically entering pCAM and CAM production. Once the technical differences (impurities, morphology, pH etc.) were identified, recyclers developed countermeasures / process adaptations to address them, so that the recycled materials could compete directly with virgin equivalents

HYDROGEN & FUEL CELL TLC SUMMARY

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TLC SCOPE

To facilitate technological developments based upon roadmaps and targets that enable the USCAR Members to successfully deploy medium-duty and heavy-duty fuel cell electric vehicles, in support of environmental and energy diversity objectives, for the benefit of society.

TLC MEMBERS

- Mike Veenstra, Ford
- Charles Freese, GM
- TBD, Stellantis

TLC TEAMS

- Fuel Cell Benchmarking Working Group
- Fuel Cell Joint Tech Team (FCJTT)
- Hydrogen Fuel System Component Working Group
- Hydrogen Joint Tech Team (HJTT)

VALUE STATEMENT

The Hydrogen & Fuel Cell TLC provides significant value as a powerful, single voice to communicate USCAR's position and priorities to DOE & other entities regarding hydrogen infrastructure, on-board hydrogen storage, and fuel cell systems.

We have utilized whitepapers in mutual areas of collaboration to drive funding and targets.

KEY 2024 ACCOMPLISHMENTS

1. Published Whitepaper: MOBILE H2 FUELING STATIONS FOR MEDIUM-DUTY FCEV (4/15/24)
    - The Whitepaper – Mobile H2 Fueling Stations for Medium-Duty Fuel Cell Electric Vehicles was reviewed was approved by the USCAR ULG on April 10th and then uploaded to the USCAR site on April 15th
2. Supported DOE H2 Infrastructure Strategy (1/17/24) and H2 Priority Deployment Workshop (2/28/24)
    - HFC TLC members were invited to a DOE H2 Infrastructure Strategy Workshop on an OEM panel for providing guidance to the DOE and industry
3. Enabled progress with the Million Mile Fuel Cell Truck consortium and SuperTruck 3 project milestones
    - Million Mile Fuel Cell Truck (M2FCT) consortium has facilitated collaboration on fuel cell durability evaluation and testing protocols, which is benefiting the industry
    - DOE SuperTruck 3 MD Demonstration Projects (including Ford and General Motors) are progressing the technology through durability evaluation testing and concept vehicle integration strategies

MANUFACTURING TLC SUMMARY

2024 Annual Report

MTLC SCOPE

To champion and drive collaboration among USCAR members and leveraged partners in advanced manufacturing development, that results in high value, cost effective benefits.

MTLC has been changing the landscape of projects from tactical to strategic, raising the bar for the entire industry.

TLC Members

- Mike Bastian, *Ford*
- Jeff Abell, *GM*
- Joe Weber, *Stellantis (2024 MTLC Chair)*

TLC Teams

- Body Structures /Stamping Working Group
- Ergonomics Working Group
- Smart Manufacturing Working Group
- ***New!*** Manufacturing Safety Working Group

VALUE STATEMENT

In 2024 the MTLC has advanced the U.S. automotive industry with research projects in stamping technologies, ergonomic analysis, smart manufacturing, and collaboration on occupational safety.

A 2024 highlight was the presentation of The Automotive Smart Manufacturing Roadmap to automotive manufacturers and suppliers at a public event on April 15, 2024. The roadmap outlines the need for standards-based openness and interoperability, providing a foundation for collaborative initiatives, such as a potential multi-year development of a Smart Manufacturing Center.

KEY 2024 ACCOMPLISHMENTS

- In a CRADA with Oak Ridge National Lab, developed AI software for real-time process monitoring of lightweight metal stamping
- Completed dynamic library of motion files for digital human modeling software
- Completed benchmark evaluation of ring-laser additive manufacturing technology
- Evaluated requirements for virtual commissioning with digital twins
- Published global standard components for assembly and stamping operations
- Determined galling thresholds for stamping structural aluminum with varying coatings

2024-Apr-15 USCAR Smart Manufacturing Roadmap Public Launch Event

MANUFACTURING TLC

Organization, Goals, Projects and Partners

Goals:
To champion and drive collaboration among USCAR members and leveraged partners in advanced manufacturing development, that results in high value, cost effective benefits.

Strategy: 2019 – present
To advance transformative trends in manufacturing
- Smart Manufacturing
  - Additive
  - Data comm. standards
- High Performance Computing

Partnering with:
- Universities
- National Labs
- Engineering companies

WORKING GROUPS

Manufacturing TLC

Safety
- EV Manufacturing Safety – providing a forum for information exchange of incident details, PPE, hazard prevention, etc.
- Conveyor Crossing Safety – developing standards for conveyor crossing based on speed, hazards, population, etc.

Body Structures /Stamping
- Assembly tool & Stamping Standards
- Light Material Stamping Modeling Leveraging Artificial Intelligence

OAK RIDGE National Laboratory

Ergonomics
- Digital human modeling
- Standards development
- Wire harness assembly and installation modeling

University of Windsor

Smart Manufacturing
- Additive manufacturing productivity
- Virtual commissioning with digital twins
- Data Standards (templates, protocols, authentication)
- Strategic roadmap development

CESMII THE SMART MANUFACTURING INSTITUTE

MANUFACTURING TLC

Accomplishments

SMART MFG.

Name	Description	Value	Status
Smart Mfg. Roadmap	Smart Manufacturing Roadmap with Dept. of Energy / Clean Energy Smart Manufacturing Innovation Institute	• Strategic initiative to enable sustainable Smart Manufacturing for USCAR OEMs and their suppliers by developing a framework of standards and demonstrable technologies	2024 Workshop
Industrial Machine Comm. Standards	Mfg. systems have evolved over decades in a highly proprietary, closed manner. Standards are being developed for interoperability and extensibility of these machines	• Standards to drive open machine communication are imperative to insure cost efficient operation and competitive viability	Completed

Virtual Commis-sioning with Digital Twins	Study of feasibility of computer-based environment to validate operational conditions and performance of integrated and automated or semi-automated manufacturing process (Ford and GM)	• Virtual commissioning enables verification of
		  • System-level control logic
		  • Machine-level kinematics and controls
		  • Network communications
		  • Safety systems
			Completed

Metal Additive Mfg. Multi-Mode Laser Benchmark	Benchmarking ring-shaped laser performance in metal powder bed fusion for increased speed. (with Ohio State University Center for Design & Mfg. Excellence)	• Addresses need for higher throughput for at-scale production **as outlined in USCAR Automotive AM Roadmap**	Completed

2024 USCAR Smart Manufacturing Workshop

STANDARD PUBLISHED

USCAR AM Roadmap

The industry is listening!

MANUFACTURING TLC

Accomplishments

ERGONOMICS

Name	Description	Value	Status		
Ergonomics Standards Updating	Four published ergo standards were reviewed for gaps and required updates based on new technology & plant experience.	• Recognized common challenges for all OEMs (project included participation by Rivian) • Led to project proposal for Electrical Harness Modeling	Completed	SAE INTERNATIONAL	***COMPLETED***
Electrical Harness Modeling	There are gaps in modeling wire harnesses to reflect critical ergonomic elements such as bending behavior for hand clearance and bending force prediction.	• Production cost reduction by early identification of ergonomic build issues	Phase 1 (of 3) Completed	Sandalwood Engineering & Ergonomics Work Smarter. Work Safer.	***PROJECT In-Progress***

Dynamic Motions Library	Dynamic human posturing takes 4-8 hours to create a full dynamic simulation. A library of motion files is developed to streamline the process.	• Siemens software leverages human motion library to streamline creation of simulations
		  • Task 1: data collection in lab completed 2022
		  • Task 2: data collection in plant completed 2023
		  • Task 3: data analysis and final report
			Completed	Sandalwood Engineering & Ergonomics Work Smarter. Work Safer.	***COMPLETED***

MANUFACTURING TLC

Accomplishments

	Name	Description	Value	Status
BODY & STAMPING	**CRADA for Stamping Variation Reduction**	Dept. of Energy / Oak Ridge National Lab - Cooperative Research and Development Agreement - Stamping Variation Reduction Leveraging Artificial Intelligence for Image Analysis	• Enables wider adoption of lighter and stronger sheet materials in stamped panels by developing machine learning tools which leverage expanded sensor & control technologies to improve formability and surface quality	**CRADA conversion to MOU**
	Aluminum Galling & Die Wear Reduction	Study detrimental adhesion of aluminum to bare and coated curved surfaces. Compare performance of 3D-printed stamping tools to conventional cast or wrought alloys.	• Improves prediction of when galling will occur on stamping dies, particularly curved surfaces • Reduces press downtime for removing build-up • Optimizes stamping die costs	Completed
	North American Automotive Metric Standards (NAAMS)	Since 1992, NAAMS has produced and maintained global standard components for assembly and stamping (linked here)	• Tooling Standardization reduces the time and cost of designing and building body assembly machine tooling and stamping die tooling through the use and growth of common components and standardization	• Ongoing activity
MFG. SAFETY	**EV Mfg. Safety**	EV Manufacturing Safety Informational Exchange (held quarterly)	Workplace safety through subject matter experts exchange of EV occupational safety topics • Regulatory Information • Storage and Incident Response • Dangerous Goods Transport	New!

MATERIALS TLC SUMMARY

2024 Annual Report

TLC SCOPE

To collaboratively develop materials technology and associated manufacturing processes that are relevant to the needs of the United States Council for Automotive Research (USCAR) LLC, member companies.

TLC MEMBERS

- Mark Nichols, *Ford*
- Herbert Doty, *GM*
- Bryan Macek, *Stellantis*

TLC TEAMS

- Glazing Working Group
- Engineering Materials – Strain-Rate Dependent Fracture & Fatigue Testing
- Materials Technical Team
- Substances of Concern – Vehicle Interior Air Quality (SOC-VIAQ) & its 7 subgroups
- Sustainable Materials Working Group

VALUE STATEMENT

Materials TLC and its projects aid OEMs to develop and implement new Materials for lightweighting and sustainability. Collaboration between the Detroit three (3) OEMs help to identify materials goals/metrics that aid in scoping and assessing projects. They identify R&D pathways to address challenges and create more robust materials supply chains, low-carbon high throughput manufacturing, and sustainable recycling and recovery strategies.

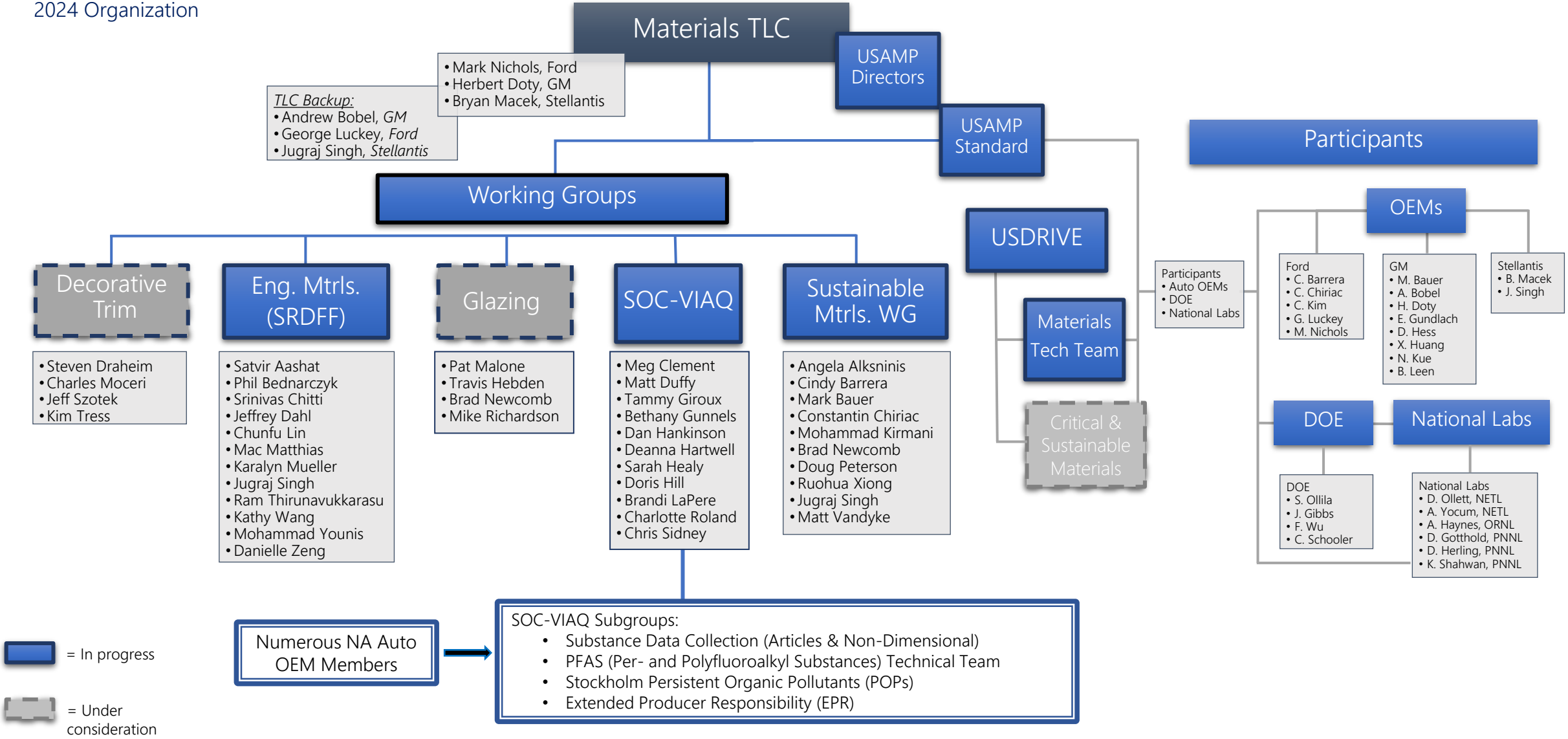
Resources and funding are needed to collect and generate data for modeling. Working together sharing resources saves money, resources, time, energy, and provides the Detroit 3 with a 3:1 value.

KEY 2024 ACCOMPLISHMENTS

1. Materials Workshop was held, and slides were created to discuss and share with Acting Materials Program Manager, Jerry Gibbs and Program Manager Materials Technology, Sarah Ollila at the Department of Energy (DOE). TLC requested DOE to issue a competitive solicitation to form & fund an industry consortium led by vehicle OEMs to accelerate the development of advanced, structural and functional automotive materials
2. Strain-Rate Dependent Fracture Fatigue Test Data of Engineering Materials (SRDFF) completed Phase 5 materials list and test matrix on 12 materials. They drafted a Request for Quote (RFQ) and sent it out to labs. Three labs were chosen, and testing will begin by start of 1Q2025
3. SOC-VIAQ – On-going efforts heavily focused on the global PFAS (per- and polyfluoroalkyl substances) reporting and prohibition obligations. This included a comprehensive study to analyze the total PFAS content in varying vehicles and powertrains. The study was extremely successful, aggregating data on 9 OEMs, across 46 vehicles of varying powertrains (EV, ICE, PHEV), on over 2200+ unique PFAS substance identifiers. The data collection results were leveraged to assess OEM technical reporting strategies (Federal & State). The USCAR SOC-VIAQ data collection achievements were featured in the Automotive Industry Action Group (AIAG) "IMDS, Product Compliance & Sustainability Conference (2024)"

MATERIALS TLC

2024 Organization



MATERIALS TLC

2024 Accomplishments

Team/Project Name	2024 Project Initiatives	Progress, status, challenges, or results	Status
Decorative Trim Transform global electroplating industry to fully sustainable technologies	• Proposal did not meet the USCAR scope of work; may be revised for future work • Project required extended OEM work group and pre-competitive strategy • Technological and commercial limitations • Efforts in 2023 by the Decorative Trim Corrosion Workgroup was to set up a new critical project within USCAR. This proposal was determined to be outside of the mission/scope of USCAR	• The project was moved to AIAG (Automotive Industry Action Group) • The WG's focus has been on this new activity and there has been no USCAR activity since early 2023 where the only focus was setting up the new project • The WG remains committed to moving forward within USCAR, but the new project is demanding all available resources. The USCAR WG is on hold	On hiatus
Engineering Materials Strain-Rate Dependent Fracture & Fatigue Test Data for Engineering Materials	• Developed Phase 4 Materials List • Developed test matrices for Phase 4 materials • Complete testing of all 8 materials and collect feedback from all OEM's and laboratories • Draft, approve, and pay POs for 2 labs ($416,267) • Phase 4 completed; drafting final report	• Project continuation from 2022 • Drafting materials List for Phase 5 • Drafting test matrices for Phase 5 materials • Prepare drafting of RFQ for Phase 5 • Barriers – Can only test about 3 different materials for Phase 5 due to lack of funds	On-going
Glazing WG Mine existing data sources to establish a complete NA data set on plastic glazing apps.	• Continued 2 key supplier relationships • Existing supplier agreed to re-sign MOU for an additional year • Continue twice monthly meetings and data collection	• The SAE Glazing Committee is progressing on a new J83097 standard update but not certain timetable for publication. It is expected sometime in early 2025 • Glazing will resume 2025	On hiatus

ORNL – Oak Ridge National Lab; NREL – National Renewable Energy Lab; SNL – Sandia National Lab

MATERIALS TLC

2024 Accomplishments

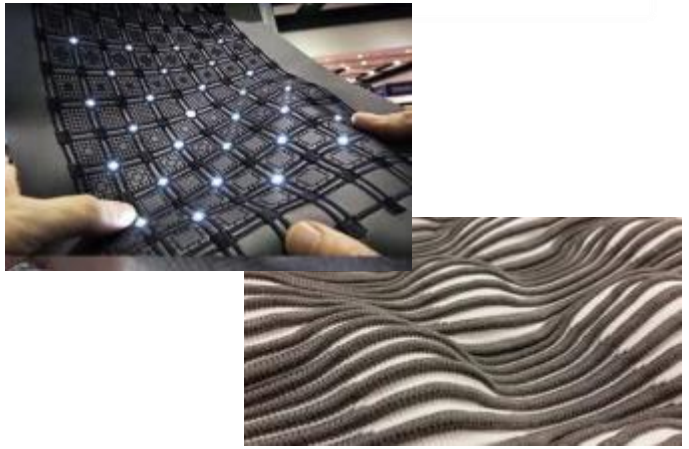
Team/Project Name	2024 Project Initiatives	Progress, status, challenges, or results	Status
Materials Tech Team US DRIVE Materials Tech Team	• Alignment and revisioning of MTT to include critical, lightweight, and sustainable materials • Establishing meaningful metrics and targets for sustainable and critical materials • Engage Energetics to facilitate and update US DRIVE Materials Roadmap	• Materials technical forum between OEM's, DOE and National Labs & Energetics • Benchmarking and technical forecasting of needs / gaps with DOE and national labs • Identify enabling technologies to support US auto industry and manufacturing in US • Review leveraged projects for the DOE Vehicle Transportation Office	On-going
SOC-VIAQ Regulation WG Substances of Concern – Vehicle Interior Air Quality *(Numerous NA Auto OEM Members)*	Exchange technical information on global SOC and VIAQ policies including: • Perform data collection and analyze OEM impact on chemical restrictions • Examine PFAS obligations (restriction and notification) to define and address automotive industry technical challenges • Investigate the regional impact on international initiatives (e.g., Stockholm POP substances) and exchange any disparities with the global OEM network • Study the EPR OEM obligations, implement regulatory requirements matrix, and strategize data collection solutions	• Data collection completed to determine total PFAS content in vehicles (PFAS substances= 2200+, OEM participants = 9, Vehicles = 46) • Facilitated global OEM exchanges between ACEA, JAMA, KAMA, and USCAR on international SOC-VIAQ topics (quarterly) • Launched PFAS Supplier workshops – initially focusing on seat textile applications • Defined EPR workgroups focus areas and facilitated Producer Responsible Organization (PRO) engagement meetings • Selected data summaries were sent to trade associations for advocacy purposes, enabling streamlined reporting for US TSCA, Maine, and Canada, resulting in cost savings for auto industry members	On-going
Sustainable Materials planning to move beyond inaugural ASR project	• Fostered collaboration through USCAR presentation to Suppliers Partnership for the Environment • Due to lack of project and participation WG took a hiatus in May 2024 • 2024 Meetings started again in September • Participating in All-Tech Team Meeting (ATTM)	• Challenge is to find a non-competitive project and the correct SMEs to participate • Looking for more progress after ATTM	On-going

ORNL – Oak Ridge National Lab; NREL – National Renewable Energy Lab; SNL – Sandia National Lab

MATERIALS TLC

Project Highlights

Materials Discussion with DOE-VTO



Materials TLC respectfully requested the Vehicle Technologies Office (VTO) to issue a competitive solicitation to form & fund an industry consortium led by vehicle OEMs to accelerate the development of advanced, structural and functional automotive materials.

Project Goal: The USAMP consortium would lead collaborations with automotive suppliers, government laboratories, and universities on DOE-funded projects to accelerate the development and implementation of next generation materials and processes that will enhance the competitiveness of the US automotive industry.

Ideally the consortium would:

- Solicit and select a variety of new projects at various TRLs that target key gaps in the current automotive materials and manufacturing landscape especially those related to sustainability and lightweighting
- Provide technical direction and resources to ensure the projects are aligned and progress sufficiently, such that at the end of the projects the deliverables are ready for targeted implementation at the automotive OEMs
- The specific areas of highest interest are Sustainable Materials, Lightweighting, Performance Materials/Functional Materials, Critical Materials, Materials Benchmarking/Materials Property Data Collection

SAFETY TLC SUMMARY

2024 Annual Report

TLC SCOPE

To identify challenges, technical issues and vehicle accident safety research needs, and to conduct or direct pre-competitive leveraged research in automotive safety.

TLC MEMBERS

- Saeed Barbat, *Ford*
- Naveen Nagappala, *GM*
- Karthik Chitoor, *Stellantis*

TLC TEAMS

- Crash Safety Working Group (CSWG)
- Occupant Safety Research Partnership (OSRP)

VALUE STATEMENT

In 2024, the Safety TLC continued its focus on understanding the effects on vehicle design and safety of environmental regulations and the technologies developed to address them; and on understanding the response characteristics of Anthropomorphic Test Devices (ATD) as they relate to potential regulations and vehicle design.

KEY 2024 ACCOMPLISHMENTS

CSWG

- Utilized Human Body Model (HBM)-midsize male and a generic vehicle buck to simulate frontal crashes. DOE conducted to evaluate the occupant response and investigate injury mechanisms for non-conventional seating configurations (seat rotation and seat back inclination) in autonomous & semi-autonomous vehicles
- Developed multi-physics modeling capability for performance of Lithium-Ion batteries under mechanical and thermal loads with NREL
- Developed CAE methodology for modeling Lithium-Ion cylindrical cells and battery packs to better understand Intrusion effect on High Voltage (HV) packs. Battery pack test fixture and Sled testing of battery pack planned to complete, post model build/analysis (Ongoing)

OSRP

- Completed calibration tests of WorldSID-50M – RibEye™ ATD. Initial pendulum tests using ISO shoulder pad 67% completed and analyzed against ISO and NHTSA Standards
- RFQ for THOR-50M repeatability, reproducibility, and durability testing sent to CALSPAN and MGA. Testing planned on a Gold Standard Buck to compare THOR-50M and H3-50M (ongoing)
- Draft test plan for THOR-5F repeatability, reproducibility, and durability created

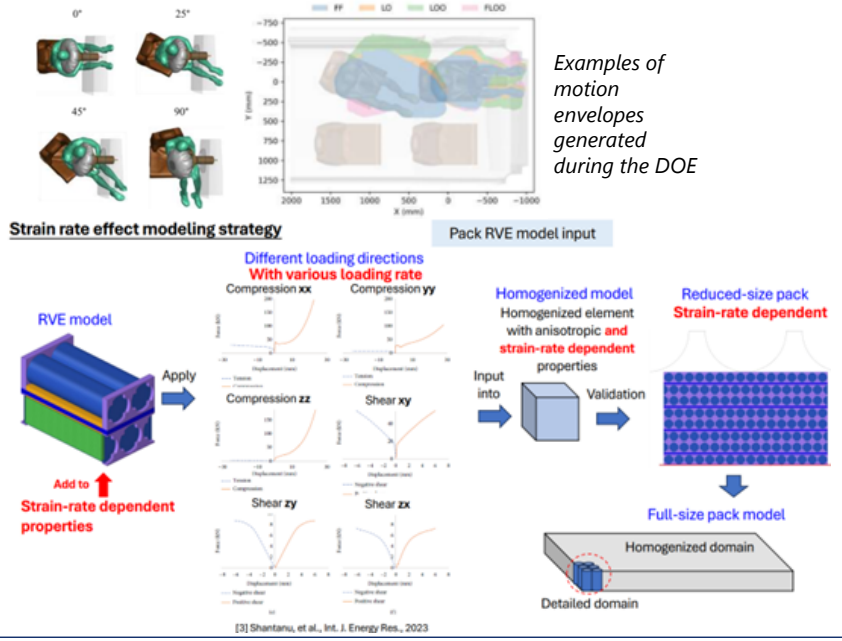
Crash Safety Working Group (CSWG)

RESEARCH SCOPE

Conduct research on the safety related effects of new and emerging vehicle technology, related to environmental and safety requirements and regulations and how that will affect vehicle design.

2024 KEY PEOPLE

- Lisa Furton & Allison Lenhoff - GM
- Saeed Barbat & Min Zhu - Ford
- Sudhir Maddireddy - Stellantis



Examples of motion envelopes generated during the DOE

2024 NOTABLE CHANGES

The CSWG continues to focus on understanding the effects to vehicle design and safety of different environmental regulations and the technologies developed to address them; and has expanded the focus to investigate deformation effects on high voltage battery packs.

VALUE STATEMENT

There is significant cost avoidance and time savings for each OEM by combining financial resources and contracting 3rd party entities to carry out the prescribed research projects. Additionally, each member benefits from the collective technical discussions and insights compared to working independently. Finally, the learnings as a group should lead to more harmonized approaches to the technologies under study in the future. This collective learning supports greater input into the direction of future regulations.

MOST IMPACTFUL PROJECTS OR WORK STREAMS

1. Unconventional seating configuration safety analysis for Autonomous Vehicle/Personal Autonomous Vehicle (AV/PAV) scenarios
2. Develop recommendations and design specifications on battery pack crash induced intrusion
3. Multi-physics modeling for Li-Ion batteries

2024 KEY ACCOMPLISHMENTS

1. Completed Phase 3 of the Unconventional Seating Safety Analysis. The study showed how an increase in seatback angle, seat rotation, and impact speed influences various injury metrics and injury risks which will help develop countermeasures for the AVs
2. Framed CAE methodology for modeling Lithium-Ion cylindrical cells and battery packs to understand Intrusion effect on HV packs. Initiated sled test methodology
3. Formally wrapped up the multi-physics modeling capability discussions with NREL. Scope of application in automotive safety will be limited to special case scenarios

Occupant Safety Research Partnership (OSRP)

RESEARCH SCOPE

Evaluate new Anthropomorphic Test Devices (ATDs), proposed ATD modifications, and new instrumentation technologies to provide member companies with data useful in responding to Notices of Proposed Rulemaking (NPRM), Requests for Comment (RFC) and fundamental knowledge of repeatability, reproducibility, ease of use, durability and ATD artifacts and biofidelity.

2024 KEY MEMBERS

- Jessica Mack, *Ford*
- Greg Crawford, *GM*
- Gaurav Sharma, *Stellantis*

OSRP TEAMS

- Alternate Chest Deflection Technologies
- THOR-5F
- THOR-50M
- WorldSID-50M

VALUE STATEMENT

The primary value is to the driving public in terms of reduced risk of injury and fatality. The value to the companies is in terms of research and development costs. By running tests as a partnership, we have a greater impact and louder voice in terms of influencing the directions of the regulations, and that voice can have long-reaching effects in terms of lives saved, reduced vehicle development costs, etc. In terms of OEM value, each company gains an understanding of repeatability, reproducibility, usability, durability, and dummy artifacts that would take longer to gain on an individual company level. For cost savings, there is significant cost avoidance (~10K) in sharing parts for WorldSID-50M and running THOR-50M sled testing as a consortium (~ 120K per company).

KEY 2024 ACCOMPLISHMENTS

1. The THOR-50M, WorldSID-50M, THOR-5F ATDs, and alternate ATD chest deflection measurement technologies are new and in a constant state of change. The designs and performance criteria have not been finalized or incorporated in 49 CFR PART 572. In many instances the ATD criteria are not globally harmonized. The teams have monitored information from NHTSA, consumer metric organizations, and research publications related to these ATDs to ensure our evaluations will provide data relevant to upcoming regulatory NPRMs, RFCs and consumer metrics. Test plan revisions or updates have been made
2. WorldSID-50M & Alternate Chest Deflection Technologies Repeatability and Reproducibility Testing. The group completed initial certification tests with the RibEye™ ATDs and have successfully passed certification. 67% of the ISO 15830 shoulder pad pendulum tests have been completed. Testing is ongoing
3. THOR-50M Repeatability and Reproducibility testing. Test fixture (Gold Standard 2 buck) and test plan involving three different THOR-50Ms and one H3-50M ATD were finalized. Six potential external labs were contacted resulting in quotes from three of the labs. CALSPAN and MGA were the main labs considered. Both labs submitted initial RFQs by the end of 2024
4. THOR-5F Repeatability and Reproducibility testing. Draft project plan created with test fixture (Gold Standard 2 buck) and three different THOR-5Fs and one H3-5F ATD. Current plan is to conduct testing in-house at the OEM labs. Ford received one THOR-5F in Q4 2024

USCAR LEADERSHIP GROUP (ULG) SUB-TEAMS SUMMARY

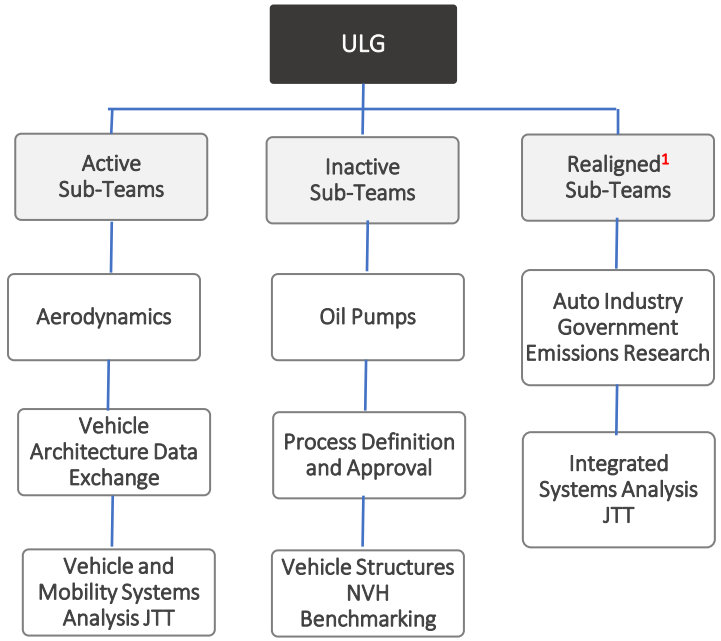
2024 Annual Report

SCOPE

The ULG maintains oversight for groups whose activities either do not fall within the scope of Technical Leadership Councils (TLCs) or crosscuts multiple TLCs.

KEY PEOPLE

- Each sub-team has different member company representatives



[1] Realigned under the Advanced Propulsion TLC

SYNOPSIS

In 2024 the technical diversity of the ULG sub-teams continued across a broad range of technical disciplines facilitated by a US DRIVE/21CTP Joint Tech Team (JTT) and Working Groups (WGs) including; the Vehicle Mobility Systems Analysis JTT, and the Aerodynamics and Vehicle Architecture Data Exchange (VADE) WGs. The Auto Industry Government Emissions Research (AIGER) CRADA and Integrated Systems Analysis JTT were realigned under the USCAR Advanced Propulsion TLC (APTLC).

VALUE STATEMENT

Collectively the ULG Sub-teams' total cost savings and avoidance is estimated exceeding $20M.

MOST IMPACTFUL PROJECTS OR WORK STREAMS

1. Aerodynamics WG continued to bolster the Aero Data Exchange increasing the focus on self-submissions because of the complexities of evaluating EVs and HEVs
2. Vehicle Architecture Data Exchange continued to share vehicle architecture data including with SAE and the Global Car Geometrical Information Exchange (GCIE)
3. VMSAJTT executed studies to evaluated roadmap technology options to identify potential synergies across Light-/Medium-/Heavy-Duty (LD/MD/HD) vehicles

2024 KEY ACCOMPLISHMENTS

1. Aerodynamics WG agreed to adjust the Aero Data Exchange to a rolling 4-year (2022-2025) data collection versus annually as member company transitions to rolling road wind tunnels with focus on EVs and HEVs
2. VADE exchanged data of 12 vehicles
3. VMSAJTT completed Cooperative Adaptive Cruise Control (CACC) study incorporating Medium-/Heavy-Duty (MD/HD) vehicles equipped with CACC

ULG SUB-TEAMS

Aerodynamics Working Group

TEAM SCOPE

Through the Aero Data Exchange, member OEMs measure wind tunnel data on competitive vehicles to minimize duplication of effort and maximize value of the testing. The Aero Working Group also collaborates on best practices and standards for aero testing as well as safety practices.

TEAM LEADS

- Alex Nastov, *GM*
- Greg Fadler, *Stellantis*
- Kevin Howard, *Ford*

VALUE STATEMENT

In 2024, 22 vehicles have been added to the Aero Data Exchange, resulting in 67% savings to members, note each vehicle received is ~$10k per OEM per vehicle.

Continuous exchange of safety best practices to ensure people, vehicle and facility safety.

KEY 2024 ACCOMPLISHMENTS

1. Agreement to adjust the Aero Data Exchange to a rolling 4-year data collection (2022-2025) versus annually as OEM transition to rolling road tunnels, with focus on EVs, HEVs
2. Focused technical discussions on new test processes, new facilities, and competitive vehicle aerodynamics (Aero of the Month)

ULG SUB-TEAMS

Vehicle Architecture Data Exchange (VADE) Working Group

TEAM SCOPE

To exchange vehicle architecture designs and surface data to support internal vehicle development. CAD nominal math data exchange is especially important. We also exchange scans from competitors which saves resources in scanning and procuring vehicles. It's worth noting that we help each other understand complex industry regulations that deal with government reporting.

TEAM LEADS

- Gary Sodhi – *Ford*
- Dave Bratkowski – *GM*
- Ted Sawdon – *Stellantis*

VALUE STATEMENT

- Total Savings (Per Rented Vehicle) VS. Internal Scanning $20,200.00 (Most costly case)
- We had two OEM rental that were avoided due to adjustable pedal position math
- The amount of money each OEM saves by getting data months ahead of time is almost incalculable are very hard to monetize. This is especially true when CAD nominal occupants and groundlines are exchanged

KEY 2024 ACCOMPLISHMENTS

1. We continued to share vehicle architecture data throughout the year. A total 12 requests were exchanged (4 more than last year)
2. We also continued to exchange technical expertise in several areas which include GCIE and SAE measurement standards. An example was the topic of approach, departure and breakover angles
3. OEM Expertise sharing -- Homologation for China and EU for vehicle mass and dimensions. This includes four plane drawings which is part of the certification process

ULG SUB-TEAMS

Vehicle & Mobile Systems Analysis Joint Tech Team (VMSAJTT)

RESEARCH SCOPE

Identify, analyze, and accelerate the development of pre-competitive, innovative energy-efficient mobility system technologies that affect the future of light-duty vehicles and associated infrastructure (communications, fueling, and built environment).

KEY PEOPLE

- Norman Bucknor (GM, Lead)
- Robb De Kleine (Ford)
- Shashank Rai (Stellantis)
- Melissa Rossi(DOE VTO, USDRIVE Lead)
- Michael Potter (Energetics, 21CTP Lead)

VALUE STATEMENT

VMSAJTT assesses long-term potential impacts of vehicle technologies (e.g. V2X) on the transportation system. A typical example is transport system energy consumption impact of ADAS tech. The Tech Team also monitors current technical developments in V2X, including ADAS Technology benchmarking. OEMs gain access to tools, expertise and benchmarking studies not typically found in-house at minimal cost. Cost to VTO to execute the 2024 MD/HD CACC study was around $250K for the study design, run, analysis, and reporting.

MOST IMPACTFUL PROJECTS OR WORK STREAMS

1. Execute studies on the roadmap technology options. Identify technology synergies across LD/MD/HD segments
2. Tracking V2X technology progress via demonstration projects and ADAS system benchmarking
3. Develop new collaboration opportunities across USDRIVE and 21CTP (e.g. working group with ISATT/GITT)

2024 KEY ACCOMPLISHMENTS

1. Completed Cooperative Adaptive Cruise Control (CACC) Study incorporating MD/HD vehicles equipped with CACC
2. Tech Reviews-ANL 'On-Road Data Collection of State-of-the Art LD CAVs': analysis of OEM ADAS (FSD); NREL: Truck Platooning Intrusion Detection; Ford 'Blue Cruise'; DOT's V2X National Deployment Plan
3. Joint meetings (August & ATTM) with ISATT, FOETT to devise potential cross-cutting projects

Finalized May 14, 2025