



EDGE CASE RESEARCH

We Deliver the Promise of Autonomy



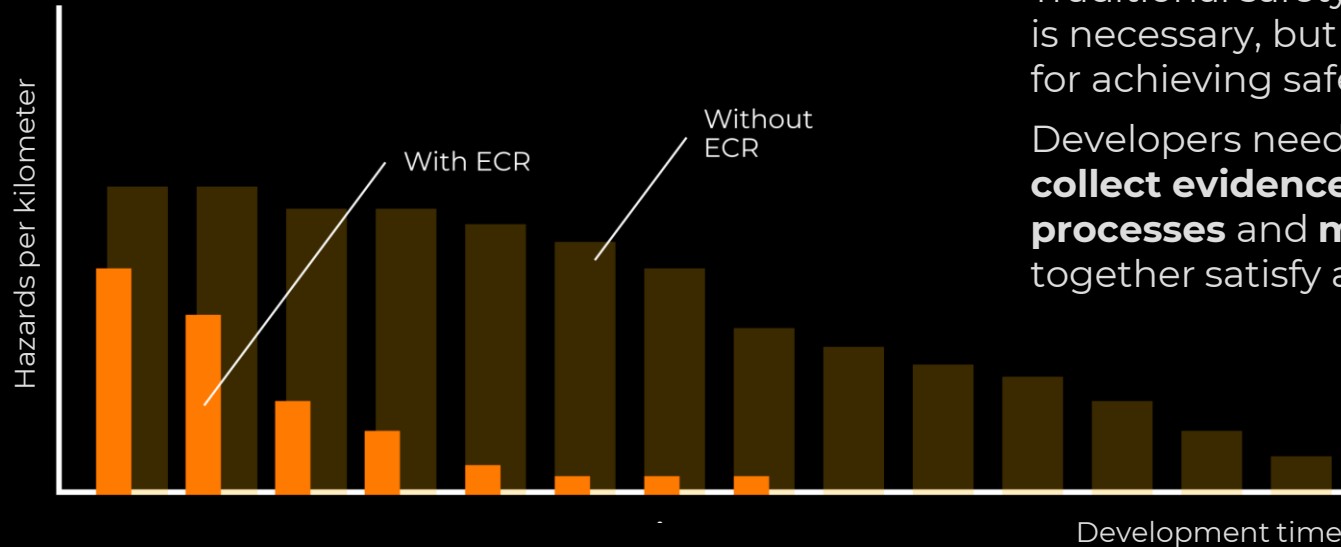
NIOSH Mine Automation and Emerging Technologies Health and Safety Partnership
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Presented by: Frank Fratrik & Dr. Victoria Chibuogu Nneji

With contributions from Prof. Philip Koopman

edge-case-research.com | [@EdgeCaseRes](https://twitter.com/EdgeCaseRes)

Edge Case Risk Management



Traditional safety engineering is necessary, but not sufficient, for achieving safe autonomy.

Developers need products to **collect evidence** of **engineering processes** and **metrics** that together satisfy a **safety case**.



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- ✔ UL 4600 addresses safety principles and processes for evaluating fully autonomous products requiring no human driver supervision.
- ✔ UL Standards developed this standard in partnership with Edge Case Research, a recognized leader in development of autonomous systems.
- ✔ In addition to autonomous vehicles, the standard can be applied to products used in mining, agriculture and maintenance as well as other products including unmanned aerial vehicles (UAVs).

ANSI/UL 4600 Basics

Self Driving Vehicle safety case assessment Underwriters Laboratories

Non-profit Standards Development Organization
Standards Technical Panel:

Developers, suppliers, academia, government,
insurance, assessors, international reps., ...

UL 4600 issued April 2020 for light vehicles

UL 4600-2 for heavy trucks intended for public roads kickoff fall 2020

UL 4601 for unmanned aerial vehicles kickoff fall 2020

Goal based approach:

Works with other standards to avoid gaps in safety approaches

ANSI/UL 4600 Basics

Safety claims

“What does safe mean?”

Arguments

“Why do we think it’s safe?”

Evidence

“Where’s the data?”

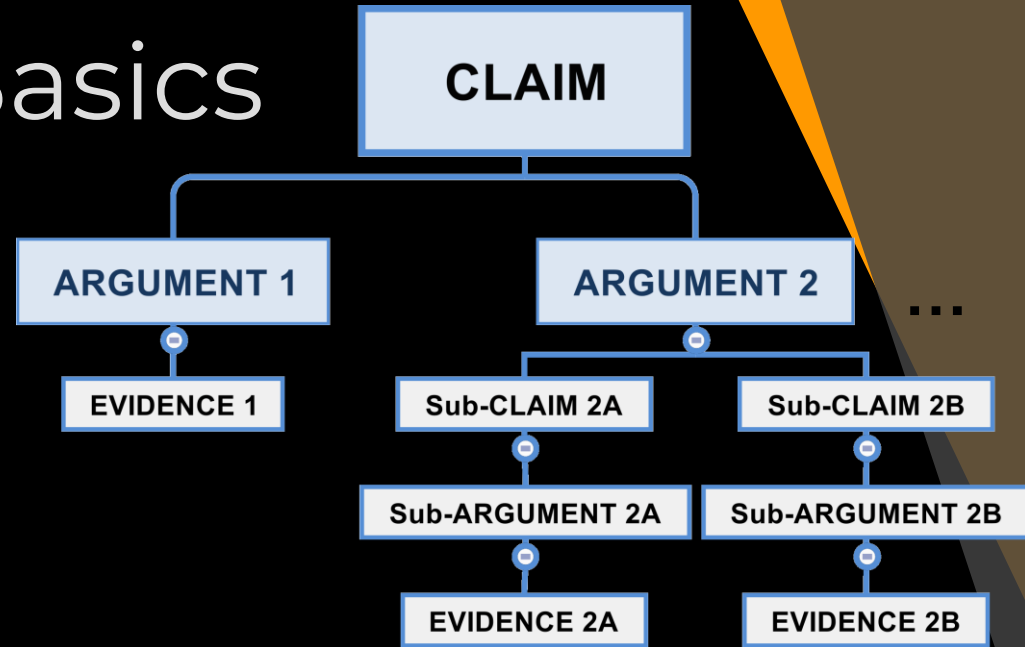
UL 4600 helps ensure:

Evidence → Arguments → Claims

Seeded hazard lists: #DidYouThinkofThat?

System level approach to safety

Consistency in safety assessment



ANSI/UL 4600 Basics

Safety risk assessment insights inform deployment decisions

Holistic Safety Case Scope

Safety of Autonomy Functions and Support System, Software, and Safety Processes
Lifecycle Safety Considerations and Measurement

Response to Off-Nominal Conditions

Lifecycle: deployment, operation, incidents, maintenance, ...

Infrastructure: vehicle, roads, data networks, cloud computing, ...

Road users: pedestrians, light mobility, emergency responders, ...

Environment: Operational Design Domain (ODD) violations ... and more ...



ANSI/UL 4600 Basics

Post-deployment feedback is essential

Safety Performance Indicators (SPIs)

Is the system's behavior safe?

Are assumptions in the safety case true?

Does field data look like we expect it to?

Feedback loops

Diagnose and fix root cause of SPI alerts:

- Testing, operational, procedural, training data, ...

Field feedback continually improves:

vehicle design // safety case // risk evaluation



Industry Support for UL 4600

Automotive

Argo AI
Aurora
Baidu
Intel
Infineon
Nissan
NXP
Uber ATG
ZTWO (Zenuity)

Insurance

Liberty Mutual
AXA/XL
Munich Re

Freight / Logistics

Locomotion



Underwriters Laboratories and SAE International Sign Agreement to Collaborate on Autonomous Vehicles

2020-06-02 NORTHBROOK, ILL. AND WARRENDALE, PA.

Partnership to include knowledge sharing and joint standards development

NORTHBROOK, Ill. and WARRENDALE, Pa. (June 2, 2020) – Underwriters Laboratories and SAE International have signed a memorandum of understanding (MOU) to formalize a cooperative relationship between the two standards development organizations centered on autonomous vehicles and other automotive applications.

Under the terms of the MOU, the two organizations agree to several goals for their partnership, including the following:

- Promote communication between the two organizations;
- Avoid duplication of work efforts where possible;
- Increase knowledge of each other's standards development activities;
- Facilitate the participation of stakeholders in each other's standards development efforts;
- Identify and undertake joint standards development initiatives
- Improve existing co-development / co-publication efforts
- Exploring opportunities for collaborative agreements with other standards development organizations

On April 1, 2020, Underwriters Laboratories published ANSI/UL 4600, the Standard for Safety for the Evaluation of Autonomous Products—which encompasses autonomous vehicles. SAE International is a recognized leader in the development of standards for the automotive field and other mobility industries. The agreement outlines how the two organizations will partner to advance the development of standards.



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More on UL 4600 at:

edge-case-research.com/ul4600