Petition Body — Sections 1.0 through 11.3

SECTION 1.0 — INTRODUCTION & PURPOSE

This petition requests a Defect Investigation, Recall Action, and Rulemaking concerning a systemic safety condition affecting heavy-duty commercial-vehicle wheel-fastening systems. The condition arises from the progressive loss of clamp load (**preload decay**) inherent in torque-dependent wheel-end joints, which under normal service conditions can lead to nut rotation and wheel separations ("wheel-off" events), resulting in fatalities, serious injuries, and substantial property damage.

Between February and October 2025, at least nineteen (19) documented wheel-off incidents resulted in ten (10) confirmed fatalities, averaging approximately one fatality per month. When considered alongside historical federal investigations and FMCSA enforcement data spanning 1992–2025, national estimates indicate approximately 395–595 fatalities and more than 10,000 injuries associated with wheel-separation events over the past thirty-three years.

Wheel-separation hazards are not captured within a single federal dataset. Fatal crash outcomes are tracked by NHTSA through the Fatality Analysis Reporting System (FARS) and the Crash Report Sampling System (CRSS), while in-service wheel-fastener conditions involving loose or missing fasteners are documented separately by FMCSA and the Commercial Vehicle Safety Alliance (CVSA) during roadside inspections. Because these data streams are maintained independently and are not integrated at the defect-mechanism level, the full safety risk associated with post-installation wheel-fastener preload decay is not readily visible through any single reporting system.

This structural data fragmentation makes defect-level investigation by the Office of Defects Investigation (ODI) essential to determine whether a common design-related condition underlies both recurring enforcement findings and documented crash outcomes across the national heavy-duty commercial-vehicle fleet.

SECTION 2.0 — BACKGROUND & INDUSTRY CONTEXT

For more than three decades, the North American commercial-vehicle industry has relied on a single wheel-fastening architecture for nearly all Class 7–8 trucks, trailers, and buses: the **10-stud, 285.75 mm hub-piloted, torque-dependent wheel-end system**. This joint relies exclusively on **friction-based clamp load** and contains **no redundant mechanical locking mechanism** to prevent nut rotation once preload decays.

In this context, **preload decay** refers to the progressive and unavoidable reduction in clamp load that occurs after installation, even when fasteners are torqued correctly. Following initial torque application, clamp load is reduced by normal service mechanisms, including embedment and surface settlement at mating interfaces, thermal expansion and contraction during braking and ambient temperature cycles, dynamic load transfer, and elastic recovery of joint components. **These effects are inherent to torque-dependent bolted joints** and are widely recognized within heavy-vehicle maintenance practices, as evidenced by industry requirements for post-installation retorque and periodic verification procedures.

While braking capability, vehicle mass, duty cycles, and thermal loading have increased substantially over time, the **fundamental wheel-fastening architecture has remained largely unchanged** and was **not engineered to sustain clamp load under modern heavy-duty operating conditions**.

2.1 Universal Industry Adoption of a Torque-Dependent Architecture

Every major North American truck manufacturer—including Freightliner, Peterbilt, Kenworth, Volvo, Mack, International/Navistar, and Western Star—along with major trailer manufacturers and wheel-end, hub, and axle suppliers, employs this same torque-dependent wheel-fastening design.

As a result, the industry is exposed to a common-mode condition: if the architecture cannot reliably maintain preload under normal service conditions, the condition can manifest across all vehicle platforms using the system, regardless of manufacturer, fleet, or duty cycle.

2.2 Known Operating Conditions That Degrade Clamp Load

Heavy-duty commercial vehicles routinely operate in environments known to degrade preload in friction-based joints, including:

- Brake-generated temperatures that can exceed approximately 560–800 °F during sustained downhill braking;
- Repeated loading at or near maximum gross vehicle weight;
- Continuous vibration, lateral shear forces, and road-induced shock;
- Embedment and surface settling during early service life; and
- Corrosion and friction variability affecting stud-nut interfaces.

These conditions progressively reduce clamp load. Once preload falls below the joint's functional slip threshold, nut rotation becomes mechanically possible, initiating the failure sequence that can lead to wheel separation.

2.3 Reliance on Procedural Controls in Place of Engineering Safeguards

In response to wheel-off incidents in the early 1990s, the Tire Industry Association (TIA) developed the R.I.S.T. procedure (Remove debris, Inspect components, Snug fitment, Torque to specification). While intended to improve installation consistency, R.I.S.T.:

- Is not a retention or locking technology;
- Has not been validated under sustained brake-heat conditions; and
- Provides no redundancy once preload decays in service.

Despite these limitations, R.I.S.T. became the de facto industry standard, permitting continued reliance on procedural compliance rather than implementation of engineering-based safety controls, such as mechanical wheel-fastener locking mechanisms.

2.4 Resulting Systemic Safety Condition

Because the underlying wheel-fastening architecture has not been redesigned, wheel-separation incidents have persisted at levels that have not meaningfully declined since federal safety findings issued in the early 1990s. FMCSA enforcement data, state crash records, and publicly reported incidents consistently document catastrophic wheel-off events—many resulting in fatalities—linked to lug-nut loosening following preload loss.

The continued use of a torque-dependent joint in a high-temperature, high-vibration environment therefore presents a design-level safety concern, rather than a maintenance deficiency. This condition affects the entire heavy-duty commercial-vehicle fleet and every platform that relies on this fastening architecture.

SECTION 3.0 — TECHNICAL BASIS OF THE CONDITION AND SYSTEMIC EXPOSURE

Heavy-duty commercial vehicles are engineered around common axle, brake, and wheel-end architectures driven by axle-load capacity, braking-torque demands, and durability requirements under sustained service conditions. As a result, a high degree of wheel-end design standardization exists across vehicle manufacturers, axle suppliers, and fleets operating in freight and passenger service. In practice, the heavy-duty commercial-vehicle fleet is predominantly composed of standardized 10-stud, 285.75-mm hub-piloted wheel systems, while alternative hub patterns are generally confined to lighter-duty applications and are not widely approved for sustained heavy-duty service.

Based on official U.S. Department of Transportation vehicle inventory data, approximately 3.99 million Class 7–8 vehicles—representing the lower-bound operating population relevant to this petition—are currently in service nationwide. This petition's quantitative exposure analysis is therefore anchored to the Class 7–8 operating fleet, which reflects vehicles subjected to the highest axle loads, braking energies, and sustained duty cycles associated with wheel-end failure risk.

Although this petition's quantitative exposure analysis focuses on the Class 7–8 fleet, similar torque-dependent wheel-end architectures are also present in other GVWR applications, indicating that the underlying design limitations are not confined to a single vehicle class. The condition at issue therefore reflects a systemic architectural limitation, rather than a model-specific, manufacturer-specific, or operator-specific anomaly.

The condition underlying this petition arises from two inseparable engineering realities inherent to torque-dependent heavy-duty wheel-fastening systems:

- **Preload decay** is inevitable in torque-only joints under real-world service conditions; and

- **Mechanically required wheel-to-stud clearance** enables micro-slip and nut rotation once preload drops below a critical threshold.

Together, these conditions establish a predictable failure pathway that can culminate in wheel separation despite proper installation, procedural compliance, and routine inspection.

3.1 Core Engineering Logic — Unavoidable Design Condition

Heavy-duty wheel-end joints are intentionally designed with a **mechanically required wheel-to-stud diametral clearance**. In standard hub-piloted wheel systems, the **effective stud diameter at the wheel interface (≈22.0–22.6 mm)** is smaller than the **wheel bolt-hole diameter (26.0 mm)** specified by major wheel manufacturers. This dimensional difference creates an intentional clearance that is necessary for assembly, accommodation of manufacturing tolerances, thermal expansion during braking, and serviceability, and cannot be eliminated without preventing proper installation and normal operation.

Because this wheel-to-stud clearance is required, joint stability in the prevailing wheel-end architecture depends **entirely on sustained clamp load**, rather than on geometric interference or positive mechanical engagement. Once a vehicle enters service, dynamic forces—including acceleration, braking, torque reversals, vibration, and thermal cycling—act continuously on the joint, independent of installation quality or procedural compliance.

Under normal service conditions, as clamp load predictably decays following installation, the presence of clearance permits micro-slip at the wheel–fastener interface. This micro-slip is unavoidable in a clearance-dependent, torque-only joint and progressively accelerates post-installation preload loss even when specified torque values are initially achieved.

As preload continues to decay, the same clearance required for assembly allows incremental nut rotation, initiating a predictable loosening sequence that can culminate in wheel separation. Because required clearance, dynamic loading, micro-slip, and preload loss are inherent features of heavy-duty vehicle operation, a torque-dependent wheel-fastening system **cannot reliably maintain wheel integrity in service without a redundant mechanical locking mechanism**.

3.2 Thermal-Cycle Preload Decay — Primary Failure Mechanism

Heavy-duty commercial-vehicle braking can generate sustained temperatures approaching **560–800 °F**, particularly during long downhill grades or repeated high-energy braking events. These brake-heat cycles produce repeated thermal expansion and contraction of studs, nuts, hubs, and wheels. Because these components exhibit different thermal responses, repeated thermal cycling results in:

- Progressive loss of preload following braking events;
- Permanent joint relaxation; and

- Reduced friction at the nut–stud interface.

Even when installed in full compliance with specified torque values, effective clamp load diminishes over successive thermal cycles. Once preload falls below the joint's effective slip threshold, nut rotation becomes mechanically possible and increasingly likely. This behavior is intrinsic to torque-dependent wheel-fastening systems and occurs independently of operator skill or routine maintenance practices.

3.3 Embedment and Surface Settling During Early Service

During early service life, wheel-end joints undergo seating changes due to surface flattening, coating displacement, micro-yielding, and structural embedment at mating interfaces. These effects commonly reduce initial clamp load by an estimated **5–15 percent** before significant thermal cycling occurs.

In the absence of a redundant mechanical locking feature, this early preload loss increases the joint's susceptibility to micro-slip and incremental nut rotation under normal vibration and service loading, accelerating the onset of progressive loosening.

3.4 Vibration-Induced Rotation Following Preload Loss

Once preload falls below functional thresholds, vibration arising from road irregularities, engine harmonics, suspension dynamics, and trailer interaction can induce incremental nut rotation in multi-stud wheel-end joints. These micro-rotations initiate a loosening sequence that may progress toward wheel separation.

Industries facing comparable safety-critical fastening risks—such as aerospace and rail—commonly employ redundant mechanical locking systems to arrest rotation following preload loss. In contrast, prevailing heavy-duty wheel-fastening systems continue to rely primarily on torque-dependent retention without secondary locking to prevent rotation once preload decays in service.

3.5 Combined Brake-Heat and Dynamic Load Effects Under Heavy GVWR

In vehicles operating at or near **80,000 pounds GVWR**, multiple service-related factors compound preload decay in torque-dependent wheel-fastening systems:

- Braking forces increase proportionally with vehicle mass;
- Stud loading becomes uneven across the wheel circle due to torque transfer and deflection; and
- Thermal distortion of the wheel and hub amplifies localized stresses at the joint interface.

Together, these effects accelerate clamp-load degradation, increase the likelihood of nut rotation following preload loss, and raise shear demands on remaining fasteners. In a wheel-end joint lacking redundant mechanical retention, these predictable service conditions cannot be reliably accommodated over time.

3.6 Inspection Coverage, Enforcement Thresholds, and Residual Safety Exposure

FMCSA Motor Carrier Management Information System (MCMIS) data indicate that **194,760** Federal and State roadside inspections were conducted nationwide during November 2025, representing approximately **4–5 percent** of the estimated U.S. Class 7–8 operating fleet. Within this inspection volume, enforcement activity under **49 CFR § 393.205(c)** resulted in **598** wheel-fastener violation findings, including **107 Out-of-Service (OOS)** determinations.

Out-of-Service determinations are issued only when inspectors identify conditions posing an immediate safety hazard. Accordingly, these findings represent late-stage manifestations of a progressive wheel-end degradation process rather than early or intermediate preload-loss conditions. Vehicles experiencing developing preload decay or incipient nut rotation may not meet OOS criteria at the time of inspection and may continue operating and further degrade between enforcement contacts.

3.7 Failure Progression and Engineering Detectability Gap

Wheel-fastener loosening in heavy-duty commercial vehicles is a progressive loss-of-preload failure mode inherent to torque-dependent, multi-stud wheel-end joints. Clamp load degrades due to embedment relaxation, thermal cycling, vibration-induced micro-slip, and service loading during braking and cornering.

As preload diminishes, the joint transitions from a clamp-load-dominated state to one increasingly reliant on stud shear and frictional resistance. This transition permits incremental nut rotation prior to visible looseness or fastener departure. Roadside inspections cannot measure residual clamp load, joint stiffness, or micro-rotation and therefore may not identify joints undergoing active preload decay until degradation has progressed to an advanced or hazardous stage.

3.8 Procedural Controls Do Not Address the Failure Mechanism

The Tire Industry Association's R.I.S.T. procedure (Remove debris, Inspect components, Snug fitment, Torque to specification) is widely used to promote installation consistency but does not function as a retention or locking technology. Specifically, R.I.S.T.:

- Does not prevent thermal-cycle-induced preload decay;
- Has not been validated under sustained brake-heat or full-load service conditions;
- Provides no protection once preload decays during operation; and
- Assumes installation torque equates to sustained clamp load.

Accordingly, procedural compliance cannot compensate for the absence of a mechanically adequate retention mechanism capable of maintaining joint stability after installation.

3.9 Manufacturer Statements Confirm Known Limitations

Manufacturer technical communications acknowledge that wheel-fastener joints relax following installation and that long-term torque retention cannot be guaranteed under real-world operating conditions. These statements reflect widely recognized behavior of torque-dependent bolted joints subjected to vibration, thermal cycling, and sustained service loading.

3.10 Summary of Technical Findings

The governing mechanics establish that:

1. Installation torque alone cannot reliably sustain clamp load through repeated brake-heat cycles, thermal expansion, and service loading encountered in heavy-duty commercial-vehicle operation.
2. Preload decay is inevitable in torque-only wheel-fastening joints under real-world service conditions, independent of installation quality or procedural compliance.
3. Mechanically required wheel-to-stud clearance permits micro-slip and nut rotation once preload drops below a critical threshold, accelerating joint degradation and loosening.
4. Standard heavy-duty wheel systems do not incorporate a redundant mechanical locking mechanism capable of arresting nut rotation following preload loss.
5. Inspection- and procedure-based controls detect failures only after progression to a late-stage or immediate-hazard condition, rather than preventing the underlying failure mechanism.

Accordingly, heavy-duty wheel separations represent a **design-level safety concern inherent to the prevailing wheel-end architecture**, rather than a procedural or maintenance failure.

SECTION 4.0 — FIELD DATA AND CRASH EVIDENCE

This section summarizes observed field outcomes associated with wheel-fastener performance in heavy-duty commercial-vehicle service. Federal enforcement records, documented crash events, and long-term incident history demonstrate that wheel separations continue to occur during normal vehicle operation, resulting in fatalities, serious injuries, and Out-of-Service (OOS) enforcement actions. These observed outcomes provide empirical context for evaluating whether existing wheel-fastening practices and controls adequately mitigate the operating conditions described in Section 3.

4.1 FMCSA Roadside Inspection Findings — Field Evidence of Ongoing Conditions

Federal roadside-inspection records provide direct, contemporaneous observations of wheel-fastener conditions encountered during active service. Between June 6 and November 28, 2025, Federal Motor Carrier Safety Administration (FMCSA) and Commercial Vehicle Safety Alliance (CVSA) inspectors recorded:

- 3,422 violations of 49 CFR § 393.205(c) ("wheel fastener loose and/or missing"); and
- 546 Out-of-Service (OOS) determinations, issued only when inspectors identified conditions posing an immediate safety hazard.

These findings were recorded across multiple Motor Carrier Management Information System (MCMIS) snapshot dates, jurisdictions, and vehicle types, indicating recurring detection of the same condition rather than isolated or anomalous events. The continued appearance of § 393.205(c) violations during routine enforcement activity indicates that wheel-fastener loosening remains present in the operating fleet despite existing installation procedures, inspection protocols, and retorque guidance.

Supporting enforcement data are summarized in Appendix C — Attachment A, which reproduces official FMCSA MCMIS snapshot records for Calendar Year 2025.

4.2 Documented Wheel-Off Crashes — Observed Safety Outcomes (2025)

Crash reports and contemporaneous media documentation indicate that wheel-separation events continued to occur during 2025. Between February 1 and October 3, 2025, at least nineteen (19) documented wheel-off incidents were identified in the United States and Canada, resulting in:

- Ten (10) confirmed fatalities; and
- Multiple serious injuries, including injuries resulting in long-term or permanent impairment.

These incidents occurred across multiple vehicle configurations, manufacturers, service applications, and geographic regions. Despite this diversity, the reported events consistently involved loss of wheel retention during vehicle operation, followed by separation and secondary impact with motorists, pedestrians, or roadside infrastructure.

A consolidated summary of these incidents, including dates, locations, and source citations, is provided in Appendix B — Wheel-Off Accident Summary (2025 Cases).

4.3 Long-Term Context — Persistent Harm Associated with Wheel Separations (1992–2025)

Historical information compiled from federal enforcement records, state crash databases, and publicly documented incidents indicates that wheel-separation events have been associated with substantial harm over multiple decades. Available data suggest that, since 1992:

- Approximately 395–595 fatalities; and
- An estimated 10,000–13,000 injuries, including many resulting in permanent disability,

have been associated with wheel-off or runaway-wheel incidents involving heavy-duty commercial vehicles.

The recurrence of similar fatal and injury outcomes in 2025 is consistent with patterns observed in earlier periods and indicates that the underlying hazard has persisted over time, notwithstanding ongoing enforcement activity, inspection programs, and procedural guidance.

4.4 Consistent Failure Sequence Identified Across Field Cases

Crash investigations, enforcement records, engineering analyses, and fleet experience reports consistently describe a common and repeatable failure sequence preceding wheel-separation events:

1. Wheel fasteners are installed to specified torque;
2. Thermal cycling and service loading contribute to **progressive preload reduction**;
3. Preload falls below the joint's slip threshold;
4. Nut rotation initiates;
5. Clamp-load degradation accelerates;
6. Fastener fracture and/or nut departure occurs;
7. The wheel separates from the vehicle; and
8. The detached wheel becomes an uncontrolled, high-energy object.

The repeatability of this sequence across independent incidents, manufacturers, and operating environments supports the conclusion that wheel separations arise from a predictable progression of mechanical degradation, rather than from random, isolated, or operator-specific anomalies. The observed crash outcomes are mechanically consistent with the failure mechanisms and detectability limitations described in Section 3.

SECTION 5.0 — DEFECT DETERMINATION AND UNREASONABLE RISK TO SAFETY

This section evaluates whether the condition described in Sections 3 and 4 supports a determination that it constitutes a defect posing an unreasonable risk to motor vehicle safety under the Vehicle Safety Act. The analysis considers the nature of the condition, the effectiveness of existing industry controls, historical and current field outcomes, and whether the risk persists despite longstanding awareness and procedural mitigation efforts.

5.1 Nature of the Condition — Torque-Dependent Wheel-Fastener Retention (Design Limitation)

The wheel-end condition at issue arises from a design reliance on torque-dependent wheel-fastening systems used on heavy-duty commercial vehicles that lack any secondary mechanical locking or positive retention mechanism. These systems rely exclusively on frictional clamp load generated during installation to maintain wheel retention throughout service.

As described in Section 3, engineering analysis establishes that such joints are subject to progressive preload loss due to thermal cycling, embedment, vibration, and service loading. Once preload decays below critical thresholds, nut rotation becomes mechanically possible and increasingly likely. This behavior is inherent to the joint architecture and occurs independently of installation quality or maintenance intent.

5.2 Limitations of Industry Procedural Controls

Following federal safety recommendations issued in the early 1990s, industry response focused primarily on procedural controls, most notably torque-based installation guidance and the Tire Industry Association's (TIA) R.I.S.T. procedure (Remove debris, Inspect components, Snug fitment, Torque to specification).

While such procedures may improve installation consistency, they do not constitute an engineering control capable of maintaining clamp load during in-service operation. Specifically, procedural measures:

- Do not prevent thermal-cycle-induced preload loss;
- Do not arrest vibration-induced nut rotation once preload decays;
- Do not provide continuous retention between inspections; and
- Assume torque equates to sustained clamp load throughout service.

Accordingly, procedural compliance alone cannot address the failure mechanisms governing wheel-fastener retention under real-world operating conditions.

5.3 Absence of Validated Engineering Safeguards

Publicly available records do not demonstrate that truck OEMs, trailer OEMs, wheel manufacturers, axle suppliers, hub manufacturers, or brake-system suppliers have implemented or validated engineering safeguards addressing:

- Long-term clamp-load retention under thermal cycling;
- Dynamic preload degradation during service;
- Torque decay and joint-relaxation behavior; or
- Redundant mechanical locking of wheel fasteners.

Despite the absence of published validation or performance standards addressing these mechanisms, torque-dependent wheel-fastening systems remain in widespread use across the heavy-duty fleet.

5.4 Manufacturer Acknowledgment of Known Joint Behavior

Manufacturer communications included in the record acknowledge the expected behavior of torque-dependent wheel joints under service conditions. For example:

- Alcoa Wheel Products (2013) acknowledged that wheel-fastener joints relax after installation and that long-term torque retention cannot be guaranteed.
- Accuride Corporation (2025) identified vibration, compression, corrosion, and debris as contributors to lug-nut loosening and emphasized reliance on repeated torque verification.

These statements confirm industry awareness that preload loss and nut rotation are anticipated behaviors, rather than rare or anomalous events.

5.5 Persistent Field Outcomes Demonstrate Ongoing Risk

As documented in Section 4, federal enforcement records, crash data, and historical incident reports from 1992 through 2025 consistently document:

- Ongoing § 393.205(c) wheel-fastener violations;
- Out-of-Service determinations for immediate wheel-end hazards;
- Recurrent wheel-separation crashes; and
- Associated fatalities and serious injuries.

If procedural controls alone were sufficient to mitigate the underlying failure mechanisms, a sustained reduction in these indicators would reasonably be expected. Available data do not reflect such a reduction, indicating that the risk has persisted over multiple decades.

5.6 Maintenance-Based Explanations Do Not Fully Account for Observed Events

Wheel-separation incidents are frequently attributed to improper torque, failure to retorque, debris, or operator error. However, engineering analysis, enforcement observations, and manufacturer statements collectively indicate that:

- Preload loss occurs under normal service conditions;
- Thermal cycling acts independently of installation quality;
- Nut rotation becomes likely once preload decays; and
- Wheel separations have occurred even where installation procedures were reportedly followed.

These observations demonstrate that maintenance-based explanations alone do not adequately explain the frequency or persistence of wheel-separation events.

5.7 Determination — Unreasonable Risk to Safety

Taken together, the evidence demonstrates that:

- The wheel-end condition arises from an inherent design limitation of torque-dependent wheel-fastening systems;
- The failure mechanism is predictable, progressive, and not continuously detectable through inspection;
- Industry responses have relied primarily on procedural controls that do not address in-service preload loss;
- Manufacturers acknowledge expected joint-relaxation behavior; and
- Fatal and injury-producing wheel-separation events have persisted for decades.

Accordingly, the evidence supports a determination that the condition described herein constitutes a defect that poses an unreasonable risk to motor vehicle safety, warranting further evaluation under NHTSA's defect-investigation authority.

SECTION 6.0(A) — DESIGN-LEVEL CONDITION IN TORQUE-DEPENDENT WHEEL-FASTENING SYSTEMS

Wheel separations addressed in this petition arise from a design-level characteristic common to the predominant heavy-duty commercial-vehicle wheel-fastening systems used in North America. The prevailing architecture relies exclusively on friction-dependent clamp load established at installation and does not incorporate a redundant mechanical retention mechanism to maintain joint stability once preload decays under normal service conditions.

As documented in Sections 3 and 5, heavy-duty wheel-end joints are intentionally designed with necessary clearances to permit assembly, accommodate thermal expansion, allow for manufacturing tolerance stack-up, and enable serviceability. These clearances are a required functional design condition and cannot be eliminated without preventing proper wheel installation and normal operation. Because clearance cannot be eliminated, joint stability in the existing design depends entirely on sustained clamp load rather than geometric constraint or mechanical engagement.

This section explains why torque-dependent wheel-fastening systems cannot be reasonably relied upon to maintain clamp load under foreseeable heavy-duty operating conditions, and why the resulting wheel-separation risk originates from the wheel-end design architecture itself rather than from installation error or maintenance noncompliance.

6.1 Architecture of the Heavy-Duty Wheel-Fastening System

The dominant wheel-end configuration used on Class 7–8 trucks, trailers, buses, and vocational vehicles consists of:

- Threaded wheel studs;
- Flanged or cap nuts relying on frictional resistance for retention;
- Hub-piloted wheel centering with necessary assembly clearance; and
- Torque-based installation procedures.

In this configuration, installation torque serves only to establish initial clamp load. It does not provide geometric interference, positive mechanical engagement, or secondary locking. Once the vehicle enters service, no physical feature exists to arrest joint movement or nut rotation if preload decays.

6.2 Clamp Load Is the Sole Retention Mechanism — and It Is Not Stable in Service

In the prevailing wheel-fastening architecture, sustained clamp load functions as the sole retention mechanism for maintaining wheel-end joint integrity in service. Installation torque is an indirect proxy for clamp load and does not ensure long-term retention under operating conditions.

Under foreseeable heavy-duty service conditions, wheel-fastener joints are routinely exposed to sustained brake-heat cycles, repeated acceleration and braking events, torque reversals, vibration, differential thermal expansion among joint components, and embedment and surface settling during early service life. These conditions act on the joint after installation and are inherent to normal vehicle operation.

Engineering analysis and field experience demonstrate that, under such conditions, effective clamp load predictably decays over time, even when specified torque values are correctly applied and installation procedures are followed. Because the joint contains necessary clearances and lacks geometric locking, any reduction in clamp load directly reduces joint stability.

Accordingly, torque-dependent retention cannot be reasonably relied upon to maintain sustained clamp load throughout the service life of the joint under foreseeable heavy-duty operating conditions.

6.3 Clearance-Enabled Micro-Slip Following Preload Loss

Once clamp load decays below the joint’s effective slip threshold, the intentional clearances designed into the wheel-end assembly permit limited relative motion at the wheel-fastener interface during normal vehicle operation.

This relative motion—commonly referred to as micro-slip—occurs under routine dynamic service loads, including braking, acceleration, vibration, and torque transfer. Micro-slip is not visually detectable, cannot be measured through point-in-time inspection methods, and cannot be prevented through procedural torque verification alone once preload loss has occurred.

The presence of micro-slip contributes to additional frictional degradation and accelerated preload loss, increasing the likelihood of further joint relaxation. In a clearance-dependent, torque-only joint, micro-slip is therefore a foreseeable in-service behavior once clamp load begins to decay rather than an anomalous or misuse-related condition.

For visual reference only, Appendix D provides representative photographs illustrating the intentional clearance inherent in standard hub-piloted wheel assemblies, consistent with the dimensional specifications and engineering analysis discussed in this section.

6.4 Progressive Nut Rotation and Single-Point Failure Mode

As preload continues to diminish, the same necessary clearances that permit micro-slip also allow incremental nut rotation under normal vibration, braking forces, and torque reversals encountered during heavy-duty operation.

Because the prevailing system lacks redundancy, no secondary mechanical feature exists to arrest rotation once it begins, preserve joint integrity following preload loss, or interrupt progression toward wheel separation. The wheel-fastening system therefore exhibits a single-point failure mode, in which loss of sustained clamp load initiates a mechanical sequence that can continue unchecked.

Once initiated, this failure progression is mechanically predictable and self-reinforcing, particularly in high-load, high-heat service environments. In the absence of a redundant mechanical retention mechanism, torque-dependent wheel-fastening systems cannot be reasonably relied upon to arrest this progression following preload decay.

6.5 Predictable Failure Sequence Across Platforms

Field investigations, roadside-enforcement findings, and engineering analysis consistently describe the same failure progression:

1. Wheel fasteners are installed to specified torque;
2. Normal service conditions reduce clamp load over time;
3. Preload falls below the joint's effective slip threshold;
4. Clearance permits micro-slip under dynamic loading;
5. Incremental nut rotation initiates;
6. Clamp load degrades further;
7. Fastener loss or stud failure occurs; and
8. The wheel separates from the vehicle.

This sequence has been observed across vehicle types, manufacturers, duty cycles, and operating environments, indicating a common underlying mechanism associated with the torque-dependent wheel-fastening architecture.

6.6 Distinction from Installation or Maintenance Practices

Procedural standards such as torque specifications and the Tire Industry Association's R.I.S.T. protocol govern how a wheel is installed. They do not govern how clamp load is retained once the vehicle enters service.

Because preload loss occurs after installation and under foreseeable operating conditions, the resulting hazard cannot be fully mitigated through procedural compliance, inspection frequency, or retorque guidance alone. The risk arises from the absence of a design-level retention mechanism capable of maintaining joint stability after preload decay.

6.7 Design-Level Origin of Wheel-Separation Risk

Taken together, the evidence establishes that:

- Heavy-duty wheel joints require clearance as a functional design condition;
- Joint stability depends entirely on sustained clamp load, not geometric constraint;
- Clamp load predictably decays under normal service conditions;
- Clearance enables micro-slip and nut rotation once preload is reduced; and
- No redundant mechanical locking mechanism exists to arrest this progression.

Accordingly, wheel-separation risk associated with lug-nut loosening originates from the inherent characteristics of the torque-dependent wheel-fastening architecture itself rather than from isolated installation errors or maintenance omissions.

The design-level condition described above provides the engineering basis for the defect investigation, recall evaluation, and remedy request presented in **Section 6.0(B)**.

SECTION 6(B) — DEFECT INVESTIGATION, RECALL, AND REMEDY REQUEST

(49 U.S.C. §§ 30118–30120; 49 CFR § 552.4(d))

Pursuant to 49 U.S.C. §§ 30118–30120 and 49 CFR § 552.4(d), the Petitioner respectfully requests that the Office of Defects Investigation (ODI) initiate a formal defect investigation into torque-dependent wheel-fastening systems used on heavy-duty commercial vehicles and, upon confirmation of the defect condition described herein, require appropriate recall and remedy actions.

As demonstrated in Sections 3.0 through 6(A) of this petition, the wheel-separation hazard arises from a **design-level limitation inherent to the prevailing torque-dependent wheel-fastening architecture**, rather than from isolated manufacturing defects, improper installation, or maintenance noncompliance. The condition involves the inability of friction-dependent wheel joints to **be reasonably relied upon to maintain clamp load under foreseeable heavy-duty operating conditions**, resulting in progressive preload loss, incremental nut rotation, fastener degradation, and potential wheel separation during normal service.

The Petitioner does not assert that all torque-dependent wheel-fastening systems will fail in all cases, but that the architecture **cannot be reasonably relied upon to prevent progressive loosening under foreseeable service conditions across the operating fleet**. This distinction reflects a reliability-based defect concern consistent with the Vehicle Safety Act, rather than an allegation of universal or immediate failure.

The hazard persists despite compliance with existing installation procedures, torque specifications, and industry-recommended maintenance practices, including periodic retorque protocols. Because the failure mechanism develops **after installation and during normal vehicle operation**, procedural controls and episodic inspections cannot reliably prevent the condition or detect it prior to the onset of an immediate safety hazard. As such, the condition presents an **unreasonable risk to motor-vehicle safety** within the meaning of the Vehicle Safety Act.

The affected population includes a large, nationally distributed Class 7–8 operating fleet utilizing standardized 10-stud, hub-piloted wheel-end systems across manufacturers, axle suppliers, and fleets. The scope of exposure reflects **architectural standardization**, not anomalous behavior by particular operators or service providers. The continued occurrence of wheel-separation crashes, fatalities, injuries, and roadside Out-of-Service determinations under 49 CFR § 393.205(c) confirms that the condition remains present in active service and has not been mitigated through existing regulatory or procedural frameworks.

Accordingly, the Petitioner respectfully requests that ODI:

1. **Open a formal defect investigation** to evaluate whether torque-dependent wheel-fastening systems used on heavy-duty commercial vehicles present a safety-related defect due to the absence of a redundant mechanical retention mechanism capable of maintaining wheel integrity following preload loss;
2. **Assess manufacturer knowledge, design decisions, and historical risk recognition**, including awareness of preload decay, nut rotation, and wheel-separation mechanisms associated with torque-dependent retention systems;
3. **Evaluate feasible remedial measures**, including but not limited to:
   • Design modifications incorporating secondary mechanical locking or retention features;
   • Alternative wheel-fastening architectures that do not rely exclusively on friction-dependent preload;
   • Retrofit or containment solutions capable of arresting wheel separation following fastener loosening; and
   • Performance-based requirements addressing clamp-load retention under thermal, vibratory, and service-load conditions; and
4. **Require appropriate recall and remedy actions**, where necessary, consistent with NHTSA's authority under 49 U.S.C. §§ 30118–30120, including remedies that extend beyond procedural instructions or inspection guidance alone.

The Petitioner further requests that ODI consider whether existing safety standards and enforcement approaches adequately address **design-level retention failure modes** in heavy-duty wheel-end systems, and whether further investigation, corrective action, or regulatory review is warranted to prevent recurrence of this hazard across the affected vehicle population.

SECTION 6(C) — REMEDY CONSIDERATIONS AND DESIGN-LEVEL CORRECTIVE FRAMEWORK

If the defect condition described in Sections 3.0 through 6(B) is confirmed, effective remediation must address the **underlying design-level retention failure**, rather than relying solely on procedural or inspection-based controls.

As established herein, heavy-duty wheel-end joints require **necessary clearances** for assembly, thermal expansion, tolerance accommodation, and serviceability. These clearances cannot be eliminated without preventing the wheel system from functioning as designed. As a result, joint stability in the prevailing architecture depends entirely on sustained clamp load rather than geometric constraint. Under normal heavy-duty operating conditions, clamp load predictably decays, enabling micro-slip, nut rotation, and progressive loosening.

Because these mechanisms occur **after installation and during normal service**, remedies limited to revised torque procedures, retorque intervals, inspection frequency, or operator training **cannot eliminate the hazard**. Effective corrective action must therefore address the **absence of a design-level retention or locking mechanism capable of maintaining wheel integrity following preload loss**.

Accordingly, appropriate remedies may include, but are not limited to:

1. **Incorporation of a redundant mechanical locking or retention feature** that does not rely exclusively on friction-dependent preload to resist nut rotation and wheel separation under dynamic service conditions;
2. **Alternative wheel-fastening architectures** that provide positive mechanical engagement, containment, or locking independent of sustained clamp load;
3. **Retrofit or containment solutions** capable of arresting wheel separation or preventing fastener departure following preload loss in vehicles already in service; and
4. **Performance-based requirements or design criteria** addressing wheel-fastener retention under foreseeable thermal cycling, vibration, braking loads, torque reversals, and service-life conditions, rather than reliance on installation torque alone.

Any effective remedy should be evaluated based on its ability to **maintain wheel integrity throughout the vehicle's service life**, including during conditions where clamp load degradation is known to occur, and not solely at the point of initial installation.

The Petitioner respectfully submits that remediation strategies which do not address the **clearance-dependent, torque-only nature of the prevailing wheel-fastening system** are unlikely to prevent recurrence of wheel-separation events. Remedies that directly address the design-level retention gap identified in this petition are therefore necessary to reduce the unreasonable risk to motor-vehicle safety posed by this condition.

SECTION 7.0 — SYSTEMIC MISDIAGNOSIS OF THE FAILURE MECHANISM

For several decades, wheel-separation incidents involving heavy-duty commercial vehicles have commonly been attributed to maintenance practices, installation error, or operating environments.

These explanations appear in manufacturer service guidance, fleet maintenance programs, training materials, and industry commentary.

However, engineering analysis, field observations, federal roadside-inspection findings, and manufacturer technical communications indicate that these explanations do not fully account for the persistence, consistency, and repeatability of wheel-separation events across fleets, duty cycles, and operating conditions. The information presented in this petition indicates that the principal contributing mechanism is more closely associated with the inherent behavior of torque-dependent wheel-fastening systems—specifically, **post-installation clamp-load loss under real-world service conditions**—than with isolated errors in maintenance or operation.

This distinction is relevant to understanding why wheel separations have continued to occur despite decades of procedural controls, standardized torque specifications, retorque guidance, and technician training.

7.1 Persistence of the Maintenance-Error Attribution

Manufacturers and industry organizations have historically identified the following factors as primary contributors to wheel separations:

- Improper torque application;
- Failure to retorque after installation;
- Debris or contamination at mating surfaces;
- Technician error or insufficient training; and
- Environmental or roadway conditions.

These explanations have remained largely unchanged since the early 1990s. During the same period, industry practices expanded to include standardized torque specifications, improved torque tools, formalized installation procedures such as R.I.S.T., and broader technician training and certification programs. Despite these measures, wheel-separation incidents and wheel-fastener violations have continued to be observed, indicating that **maintenance-related factors alone do not fully explain the outcomes**.

7.2 Federal Inspection and Crash Data Provide Additional Context

Federal roadside-inspection data collected by FMCSA and CVSA document recurring findings of loose or missing wheel fasteners, including Out-of-Service determinations issued when inspectors identify conditions assessed as posing an immediate safety risk. These findings have been observed across multiple inspection periods, fleets, and operating environments.

If maintenance practices were the dominant causal factor, a sustained reduction in violation rates would reasonably be expected following decades of enforcement activity, training initiatives, and procedural guidance. Instead, inspection findings continue to reflect persistent wheel-fastener conditions associated with loss of retention, providing field-level context inconsistent with isolated or sporadic human error.

7.3 Manufacturer Technical Statements Provide Insight into Joint Behavior

Manufacturer technical communications further inform the evaluation of wheel-fastening performance. For example:

- Alcoa Wheel Products (2013) acknowledged that the joint relaxes after installation and expressed uncertainty regarding the ability to guarantee long-term torque retention; and
- Accuride Corporation (2025) noted that vibration, compression, corrosion, and environmental exposure can contribute to lug-nut loosening and advised frequent torque checks as a mitigation measure.

These statements reflect industry recognition that **preload loss can occur after installation** and that installation torque alone does not ensure durable retention during service.

7.4 Limitations of Retorque-Based Controls

Retorque guidance is commonly provided as a risk-mitigation measure, typically recommending inspection and retorque at early mileage intervals or following service. These procedures generally occur before the wheel assembly experiences:

- Sustained brake-heat exposure;
- Operation at full gross vehicle weight; and
- Repeated thermal cycling.

As a result, retorque checks conducted under partial-load or ambient conditions may not detect preload loss that develops later during service. Available information does not indicate that retorque procedures provide long-term protection against the failure sequence observed in wheel-separation cases.

7.5 Environmental and Maintenance Factors in Design Context

Environmental conditions such as vibration, dust, corrosion, temperature variation, and roadway irregularities are inherent to heavy-duty vehicle operation. Engineering practice generally requires that safety-critical systems be designed to accommodate foreseeable operating environments without catastrophic failure.

While proper installation and maintenance are essential, procedural controls cannot fully compensate for a wheel-fastening system that is **inherently susceptible to post-installation preload loss**. Once preload is reduced, nut rotation becomes mechanically possible regardless of maintenance intent.

7.6 Occurrence Under Proper Installation and Maintenance Conditions

Wheel-separation incidents have been reported under conditions including:

- Newly manufactured vehicles;
- Dealer-installed wheels;
- Recently serviced vehicles;
- Fleets employing certified technicians; and
- A wide range of duty cycles and climates.

The occurrence of similar outcomes across these conditions indicates that installer skill or maintenance diligence alone does not determine whether a failure will occur.

7.7 Contextual Summary

The information summarized in this section indicates that:

- Wheel separations have occurred despite adherence to maintenance procedures;
- The observed failure sequence is repeatable and predictable;
- **Torque-dependent wheel-fastening systems lack a redundant mechanism to arrest rotation following preload loss**; and
- Procedural controls alone have not eliminated the observed outcomes.

These observations provide context relevant to evaluating whether current wheel-fastening system designs adequately address known service conditions and support consideration of further federal evaluation.

SECTION 8.0 — INDUSTRY-WIDE SCOPE OF THE CONDITION

The condition described in this petition is not limited to a single manufacturer, supplier, or vehicle platform. It arises from a shared design architecture—the torque-dependent 10-stud, 285.75-mm hub-piloted wheel-fastening system—used on the vast majority of heavy-duty commercial vehicles operating in North America.

Because this architecture is widely adopted across the industry, the same underlying mechanism—**post-installation preload decay followed by nut rotation and progressive loss of wheel retention**—may occur across a broad, nationally distributed population of vehicles in service.

8.1 Truck OEMs Utilizing the Same Wheel-Fastening Architecture

Major North American Class 7–8 truck manufacturers employ the same torque-dependent wheel-fastening architecture, including:

- **Freightliner** (Daimler Truck North America)
- **Western Star** (Daimler Truck North America)
- **Peterbilt** (PACCAR)
- **Kenworth** (PACCAR)
- **Volvo Trucks North America**
- **Mack Trucks**
- **International / Navistar** (TRATON Group)

This architecture is used across line-haul tractors, vocational and construction trucks, utility and municipal fleets, and buses utilizing the same wheel geometry. Publicly available specifications generally indicate continued reliance on friction-based retention, without identification of a universal redundant mechanical locking feature designed to arrest nut rotation following preload loss.

8.2 Trailer Manufacturers Employing the Same Architecture

Major North American trailer manufacturers likewise rely on the same 10-stud, 285.75-mm hub-piloted wheel system, including:

- **Wabash**
- **Great Dane**
- **Hyundai Translead**
- **Utility Trailer Manufacturing**
- **Vanguard National**
- **Stoughton**
- **Fruehauf**
- **Trailmobile**
- **Strick**
- **Manac**

These platforms employ friction-dependent wheel joints and do not incorporate secondary mechanical locking features intended to preserve wheel retention once preload decays during service.

8.3 Wheel-End, Hub, Axle, and Component Suppliers

Major wheel-end, hub, axle, and component suppliers produce systems that rely on torque-generated friction for wheel retention, including:

- **Meritor** (Cummins–Meritor)
- **Dana / Spicer**
- **ConMet**
- **Webb Wheel Products**
- **Hendrickson**
- **SAF-Holland**

- **Gunite** (Accuride)
- **Bendix / Knorr-Bremse**
- **Eaton**
- **Dexter Axle**

These suppliers manufacture hubs, drums, rotors, axles, suspensions, studs, nuts, and integrated wheel-end systems that rely on frictional preload and do not incorporate positive mechanical locking mechanisms designed to maintain retention following preload loss.

8.4 Relevance to Industry-Wide Evaluation Under Federal Safety Law

Under 49 U.S.C. § 30118, NHTSA evaluates whether a safety-related condition arises from a common design or engineering practice used by multiple manufacturers. The recurrence of similar failure outcomes across manufacturers and platforms provides context relevant to evaluating whether the condition described herein is systemic rather than isolated.

8.5 Common Failure Mechanism Across Platforms

Wheel-separation incidents reported across different brands, vehicle types, and operating environments commonly follow the same sequence:

Post-installation preload decay → nut rotation → progressive loss of clamp load → wheel separation

This mechanism does not depend on fleet-specific practices or manufacturer identity and is not eliminated through installation or maintenance procedures alone.

8.6 Implications for Federal Review

Because the same wheel-fastening architecture is widely used across the heavy-duty fleet, evaluation on a manufacturer-by-manufacturer basis may not fully address the scope of the condition. The information presented supports consideration of a coordinated federal review examining whether the common design architecture adequately mitigates known service-related preload-loss mechanisms.

SECTION 9.0 — LIMITATIONS OF EXISTING INDUSTRY STANDARDS AND GUIDANCE

Despite recurring wheel-separation incidents over multiple decades, industry standards and guidance applicable to heavy-duty wheel-fastening systems have focused primarily on component geometry, materials, and installation procedures rather than on **in-service retention**

performance. Existing standards do not establish widely adopted, performance-based requirements addressing clamp-load retention, thermal-cycle durability, or resistance to nut rotation under representative heavy-duty operating conditions.

As a result, heavy-duty wheel systems continue to rely on torque-dependent architectures that are not subject to standardized validation for the service conditions known to influence preload stability.

9.1 SAE Standards Address Geometry and Installation Inputs

Standards published by the **Society of Automotive Engineers** applicable to heavy-duty wheel systems address parameters such as:

- Stud materials and geometry;
- Nut flange and thread characteristics;
- Wheel and hub dimensional tolerances; and
- Installation torque specifications.

Publicly available SAE standards do not establish requirements for:

- Preload-retention testing under brake-heat or thermal-cycle conditions;
- Measurement of clamp-load decay over service life;
- Nut-rotation resistance following preload loss;
- Evaluation of redundant mechanical locking mechanisms; or
- Durability certification of wheel-fastening systems under representative heavy-duty service conditions.

Accordingly, SAE standards emphasize dimensional compliance and installation inputs rather than validation of long-term retention performance.

9.2 TMC Recommended Practices Emphasize Procedural Compliance

Recommended Practices issued by the **Technology & Maintenance Council** primarily address:

- Torque sequences and tightening order;
- Inspection and retorque intervals;
- Maintenance documentation; and
- Technician training and qualification.

TMC guidance does not establish:

- Performance-based retention testing requirements;
- Thermal-cycle durability benchmarks;
- Vibration-induced loosening criteria; or
- Requirements for redundant mechanical locking systems.

As a result, TMC practices generally assume that correct installation torque and periodic inspection are sufficient to ensure wheel retention during service.

9.3 TIA's R.I.S.T. Procedure Is Procedural in Scope

The **Tire Industry Association** R.I.S.T. procedure (Remove debris, Inspect components, Snug fitment, Torque to specification) is widely promoted to improve wheel-installation consistency. However, R.I.S.T.:

- Is an installation checklist, not a retention or locking system;
- Does not require performance validation or durability testing;
- Provides no data regarding clamp-load retention under thermal cycling or sustained service conditions; and
- Does not address nut rotation following post-installation preload loss.

Accordingly, R.I.S.T. functions as a procedural control, not an engineering-based performance standard capable of ensuring long-term wheel-fastener retention under heavy-duty operating conditions.

9.4 OEM Specifications Focus on Installation, Not Retention Validation

Truck and trailer manufacturers publish specifications addressing:

- Installation torque values;
- Tightening sequences;
- Retorque intervals; and
- Inspection guidance.

Publicly available OEM documentation generally does not include:

- Preload-retention performance data;
- Thermal-cycle clamp-load decay analysis;
- Vibration-induced loosening studies; or
- Long-term durability validation of wheel-fastening systems under representative service conditions.

OEM specifications commonly assume that correct torque application equates to continued retention during service.

9.5 Absence of Performance-Based Retention Standards Over Time

From the early 1990s through the present, industry standards bodies have not established:

- Mandatory performance benchmarks for clamp-load retention;
- Thermal-cycle durability requirements;
- Nut-rotation resistance criteria; or
- Requirements for redundant mechanical locking mechanisms in heavy-duty wheel-fastening systems.

In the absence of such standards, validation of in-service retention behavior has not been systematically required across manufacturers or platforms.

9.6 Relevance of the Standards Gap to Defect Evaluation

Because existing standards emphasize procedural compliance rather than **retention performance**, wheel-fastening system designs have not been uniformly evaluated against the operating conditions known to influence preload stability. This standards gap limits the ability of industry practices alone to address observed wheel-separation outcomes and is relevant to evaluating whether current wheel-fastening architectures adequately mitigate foreseeable service-related risks.

9.7 Summary — Implications for Federal Safety Review

In summary:

1. Existing industry standards emphasize installation inputs, not in-service retention performance;
2. Procedural guidance does not substitute for engineering validation of preload stability;
3. No widely adopted standard requires testing for thermal-cycle-induced preload loss or nut-rotation resistance; and
4. Field outcomes indicate that these unaddressed mechanisms remain relevant.

These considerations provide context relevant to evaluating whether further federal review is warranted under NHTSA's defect-investigation framework.

SECTION 10.0 — REGULATORY REPORTING CONSIDERATIONS (49 CFR PART 573)

Federal law requires manufacturers to notify **National Highway Traffic Safety Administration** when a motor vehicle or item of motor-vehicle equipment contains a safety-related defect that poses an unreasonable risk of death or serious injury. These obligations are established under 49 U.S.C. §§ 30118–30120 and implemented through 49 CFR Part 573.

This section summarizes information relevant to evaluating whether manufacturers' defect-reporting obligations have been met with respect to wheel-separation events associated with post-installation preload loss in torque-dependent wheel-fastening systems.

10.1 Defect Reporting Requirements Under Federal Law

Under 49 CFR § 573.6, manufacturers are required to notify NHTSA when they determine that:

- A defect exists in a motor vehicle or item of motor-vehicle equipment; and
- The defect presents an unreasonable risk to motor-vehicle safety.

A reportable condition may include performance failures, deviations from intended design behavior, or conditions associated with an increased risk of crash, injury, or fatality. Wheel-separation events involving loss of wheel retention are relevant to these criteria.

10.2 Information Relevant to Manufacturer Awareness of the Condition

Available information indicates that manufacturers and industry participants have long recognized that:

- Heavy-duty wheel joints experience preload loss during service;
- Thermal cycling contributes to embedment, relaxation, and potential nut rotation;
- Torque-based installation does not ensure sustained clamp-load retention;
- Federal roadside inspections repeatedly identify loose or missing wheel fasteners; and
- Wheel-separation events have been associated with fatalities and serious injuries over multiple decades.

Manufacturer technical communications included in Appendix A provide examples of acknowledgments related to wheel-fastener behavior under representative service conditions.

10.3 Federal Enforcement Data as Context for Risk Awareness

Roadside-inspection data collected by the **Federal Motor Carrier Safety Administration** and the **Commercial Vehicle Safety Alliance** document recurring findings of loose or missing wheel fasteners nationwide, including Out-of-Service determinations issued when inspectors identify conditions posing immediate safety risks.

For example, between June and November 2025, inspectors recorded thousands of violations of 49 CFR § 393.205(c). Similar observations have been documented over extended periods. These enforcement trends provide relevant context for evaluating industry awareness of wheel-fastener retention issues.

10.4 Historical Federal Safety Investigations

Federal safety investigations conducted in the early 1990s examined wheel-separation incidents and resulted in safety recommendations addressing inspection practices and maintenance procedures. These investigations identified wheel-fastening system performance as an area of concern but did not result in enforceable, performance-based standards addressing post-installation preload retention or resistance to nut rotation.

10.5 Absence of Publicly Available Retention-Performance Testing

Publicly available documentation does not identify published manufacturer data addressing:

- Preload-retention performance over service life;
- Thermal-cycle clamp-load degradation;
- Nut-rotation resistance testing; or
- Long-term durability validation of torque-dependent wheel-fastening systems.

The absence of such disclosures is relevant to understanding how retention performance has been evaluated for safety assessment and reporting purposes.

10.6 Procedural Explanations and Reporting Obligations

Wheel-separation events have frequently been attributed to maintenance practices, environmental exposure, or installation variability. However, engineering analysis and field observations indicate that preload loss can occur under foreseeable service conditions even when installation procedures are followed.

Federal defect-reporting obligations are not limited to conditions arising from misuse or abnormal operation and may extend to design-related performance characteristics relevant to motor-vehicle safety.

10.7 Public Record Review of Part 573 Reporting

A review of publicly available NHTSA records does not identify Part 573 defect reports submitted by truck OEMs, trailer manufacturers, wheel manufacturers, hub suppliers, or axle manufacturers specifically addressing wheel-separation events arising from post-installation preload loss in torque-dependent wheel-fastening systems.

This absence of reporting is relevant to evaluating compliance with Part 573 requirements.

10.8 Relevance to ODI Review

Under the Vehicle Safety Act, NHTSA has authority to evaluate whether manufacturers have met their reporting obligations and to determine appropriate corrective actions where warranted.

The information summarized in this petition provides a factual basis for ODI to assess:

- Whether wheel-separation events associated with preload loss constitute a reportable condition;
- Whether manufacturers appropriately evaluated wheel-retention performance; and
- Whether additional investigation or regulatory action is necessary.

10.9 Summary — Relevance to Defect and Compliance Evaluation

In summary:

1. Wheel-separation events involving preload loss present safety concerns relevant to federal defect-reporting criteria;
2. Manufacturer communications and enforcement data reflect long-standing awareness of wheel-fastener retention behavior;
3. Public records do not identify Part 573 reports specifically addressing this condition;
4. Field data indicate continued occurrence of wheel-separation events; and
5. These factors support further ODI evaluation under NHTSA's defect-investigation framework.

Accordingly, the Petitioner respectfully requests that ODI review the information presented and determine whether a formal Defect Investigation, including evaluation of reporting compliance under 49 CFR Part 573, is warranted.

SECTION 11.0 — SUPPLEMENTAL REQUESTS FOR AGENCY ACTION AND WHISTLEBLOWER CONSIDERATION

In addition to the defect investigation, recall, and remedy request set forth in Section 6.0(B), the Petitioner submits this section to preserve and request consideration of additional agency actions available under NHTSA's statutory and regulatory authorities, including 49 CFR Part 552 and 49 U.S.C. §§ 30118–30120 and 30172.

This section is intended to **supplement**, not replace, the defect-based request. It is provided to ensure the submitted evidence is evaluated under the Agency's full range of authorities—investigative, corrective, reporting-compliance, rulemaking, and whistleblower—appropriate to a systemic, safety-critical condition affecting a nationally distributed heavy-duty vehicle population.

11.1 Requested NHTSA Actions

Pursuant to 49 CFR Part 552 and 49 U.S.C. §§ 30118–30120 and 30172, the Petitioner respectfully requests that NHTSA consider the following actions, as appropriate:

A. Initiate a Defect Investigation or Engineering Analysis
Open a Defect Investigation and/or Engineering Analysis to evaluate wheel-separation events associated with post-installation clamp-load loss (preload decay) in torque-dependent wheel-fastening systems used on Class 7–8 trucks, trailers, buses, and heavy vocational vehicles, consistent with the defect condition described in Sections 3.0 through 6.7.

B. Evaluate the Industry-Wide Scope of the Condition
Assess whether the observed failure mechanism—progressive preload decay followed by clearance-enabled micro-slip, nut rotation, and progressive loss of retention—is associated with the standardized 10-stud, 285.75-mm hub-piloted wheel-end architecture used across multiple manufacturers, platforms, and operating environments.

C. Review Manufacturer Defect-Reporting and Safety-Notification Compliance (49 CFR Part 573)
Evaluate whether manufacturers and/or equipment suppliers appropriately assessed, documented, and reported wheel-separation risks under 49 CFR Part 573, and require corrective, supplemental, or late reporting where warranted based on the evidence of recurring fatalities, injuries, and enforcement findings.

D. Consider Recall, Remedy, or Other Corrective Action Within Statutory Authority
If a safety-related defect is identified, consider appropriate corrective action within NHTSA's authority under 49 U.S.C. §§ 30118–30120, including remedies that address design-level retention limitations and are not limited to procedural instructions, inspection intervals, or retorque guidance.

E. Consider the Need for Rulemaking or Performance-Based Retention Requirements
Evaluate whether existing federal safety standards and enforcement frameworks adequately address wheel-fastener retention performance under foreseeable heavy-duty service conditions—including thermal cycling, brake-heat exposure, vibration, torque reversals, and sustained high-GVWR duty—and consider whether performance-based requirements for retention after installation are warranted.

F. Acknowledge and Process Whistleblower Filing Status (Non-Public Handling)
Process this submission as a protected whistleblower disclosure under 49 U.S.C. § 30172, applying all applicable confidentiality protections and routing procedures, including coordinated handling by the Office of Defects Investigation (ODI), the Office of Chief Counsel, and the appropriate whistleblower officials.

11.2 Final Statement

Wheel-separation incidents involving heavy-duty commercial vehicles have resulted in fatalities, serious injuries, and property damage over multiple decades, as reflected in crash documentation, federal enforcement records, and engineering analysis. These events have occurred across manufacturers, fleets, duty cycles, and operating environments, indicating a recurring condition rather than isolated or anomalous occurrences.

As documented in Sections 3.0 through 7.0, torque-dependent wheel-fastening systems are subject to post-installation clamp-load loss under normal service conditions, including thermal cycling, brake-heat exposure, vibration, dynamic loading, and sustained operation near maximum GVWR. Because standard heavy-duty wheel assemblies require mechanically necessary clearance for assembly and serviceability, loss of preload permits micro-slip and nut rotation once critical thresholds are crossed. This degradation develops during service and is not reliably detectable through point-in-time inspection methods.

As discussed in Section 3.6, inspection- and procedure-based controls generally identify wheel-fastener conditions only at an advanced or immediate-hazard stage and do not reliably intercept progressive preload-loss mechanisms earlier in service. Field data indicate that these limitations persist despite established torque specifications, retorque guidance, and technician training.

Based on the information presented, the Petitioner respectfully requests that NHTSA review the submitted record and determine whether further investigation, corrective action, reporting-compliance review, and/or regulatory consideration is warranted under applicable law.

11.3 Whistleblower Award Eligibility (Non-Public Request)

The Petitioner respectfully requests that NHTSA and the U.S. Department of Transportation consider whether this submission satisfies the statutory criteria for whistleblower award eligibility under 49 U.S.C. § 30172, including:

- Voluntary submission of original, non-public information;
- Information relating to a motor-vehicle safety condition likely to cause death or serious physical injury; and
- Substantial assistance in identifying issues relevant to federal motor-vehicle safety oversight.

This request is submitted in good faith and without prejudice to the Petitioner's rights to confidentiality, protection, and award consideration under applicable federal law.

Respectfully submitted,

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[redacted]