The GM Ignition Switch: When a Fish Scale Revealed What the Reliability Process Missed

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Abstract

The General Motors ignition-switch failure is an unusually well-documented example of how a simple electromechanical weakness can remain unresolved for years when fragmented investigations and assumptions about the hardware displace direct measurement, configuration control, and empirical comparison. The switch could rotate unexpectedly from RUN to ACC/ACCESSORY, shutting off engine power and disabling airbag deployment under certain crash conditions. A stronger detent spring and longer plunger were approved in 2006 to increase switch torque. Still, GM did not assign a new part number even though the change affected function, and the associated master work order did not document the mechanical change. Years later, investigators were hindered because old and redesigned switches appeared in GM records as the same part. Ultimately, direct physical comparison and simple torque measurements helped expose what the documentation and investigation process had missed. This case illustrates a central reliability principle: measure the hardware, understand its margins, control design changes, and preserve configuration traceability.

1. Why This Case Matters to Reliability Engineering

Serious field failures are rarely documented publicly in enough detail to allow reliability engineers to reconstruct the sequence of design decisions, investigations, missed clues, and corrective actions. The GM Cobalt ignition-switch case is an exception. The 2014 investigation led by former U.S. Attorney Anton Valukas, congressional hearings, GM and Delphi records, and subsequent litigation exposed an unusually detailed history of the switch and the organization's response to its failures.

The most important reliability lesson is not simply that the original switch had inadequate torque margin. It is that a weakness that could be characterized by direct physical measurement remained obscured for years, while a later design change that improved the switch was not properly identified in GM's configuration system.

2. The Failure Mechanism Was Measurable

The ignition switch depended on a spring-loaded detent mechanism to provide sufficient resistance to rotation. If the torque required to move the key from RUN was too low, disturbances such as key-chain loading, driver contact, vibration, or combinations of these effects could move the switch toward ACC/ACCESSORY. The safety consequence was much greater than an engine stall alone: loss of ignition power could prevent the airbags from deploying in a subsequent crash.

This was therefore a problem with a physical and measurable design parameter: rotational torque. Instead of treating the switch as a pass/fail component, an engineer could measure torque distribution across multiple samples and compare it with disturbances capable of rotating the switch.

3. A Design Change That Became Nearly Invisible

The documentation history makes the case especially significant. In April 2006, GM design release engineer Raymond DeGiorgio signed a Form 3660 authorizing Delphi to manufacture a redesigned switch. The form identified a new detent plunger using a different spring/plunger configuration to increase torque. GM policy required a new part number when a change affected fit, form, or function, yet the GM part number was not changed.

The documentation failure went deeper. Congressional investigators reported that each Form 3660 was required to link to a master work order. The work order associated with this redesign documented electrical changes but did not mention the mechanical spring-and-plunger change that increased torque. Delphi's records preserved the change, including Engineering Change 57128, but GM's configuration system continued to identify the old and improved switches with the same part number.

This is more than an administrative mistake. Failure analysis depends on knowing exactly what hardware configuration failed. When two physically different designs share the same identifier, engineers can unknowingly compare different hardware as though it were identical. The unchanged part number removed one of the most valuable clues available to later investigators: the failure behavior changed after the switch design changed.

4. The Improved Design Was Not a New Technological Breakthrough

Delphi documentation indicates that both shorter and longer detent spring/plunger configurations existed during the original development period in 2001. The stronger configuration later authorized in 2006 therefore did not require a new scientific discovery. The available evidence indicates that a more robust mechanical configuration was already known.

That fact sharpens the reliability lesson. The eventual improvement depended on recognizing that torque margin mattered, selecting the more robust physical configuration, and controlling the change. The problem was not a lack of sophisticated prediction mathematics. It was a failure to act effectively on a measurable physical design characteristic.

5. When Direct Observation Finally Became Decisive

One of the most memorable episodes in the investigation occurred when GM engineers examining Cobalt vehicles in a junkyard noticed how easily a key could rotate. They obtained a simple fish scale and used it to compare the force required to move switches from RUN toward ACC/ACCESSORY. The instrument was crude compared with laboratory torque equipment, but the engineering principle was sound: directly measure the characteristic associated with the suspected failure.

Later physical comparison of older and replacement switches also revealed that switches carrying the same identification were mechanically different. Once investigators looked directly at the hardware, the discrepancy that configuration records had concealed became much easier to understand.

6. What a Margin-Oriented Development Test Could Have Asked

It is impossible to prove retrospectively that a particular HALT or step-stress protocol would have prevented the Cobalt failures. However, a margin-oriented development program could have asked questions that conventional pass/fail testing apparently did not resolve:

- What is the distribution of detent torque across multiple production-intent switch samples?
- How far is the low-torque tail from the disturbance required to rotate a key out of RUN?
- How do vibration, key-chain mass, key orientation, driver contact, temperature, wear, and tolerance variation affect that margin?

- What physical feature of the switch controls the torque limit?
- Does the limit shift with supplier, lot, assembly process, or design revision?
- Can a simple production measurement detect switches with inadequate torque margin?

A progressively increased disturbance test using multiple samples, combined with direct torque measurement, would likely have exposed low torque margin and unit-to-unit variation. The objective would not have been to reproduce one exact field accident on a test track. It would have been to discover the switch's functional limit and understand what controlled that limit.

7. Reproducing the Exact Field Event Is Not the Only Way to Learn

GM attempted to reproduce the problem under rough-road conditions, but reproducing an intermittent field event with a small number of complete vehicles is difficult. The relevant combination of switch torque, key-chain load, vibration, driver contact, vehicle condition, and individual component variation may not occur during a limited test.

This is a recurring reliability problem. When engineers try only to reproduce the customer's exact event, they may spend considerable time searching for one particular combination of conditions. Stress-to-limit testing asks a different question: what parameter controls the failure, and where is its limit? Once the limiting parameter is identified, variation and margin can be measured directly.

8. Configuration Control Is a Reliability Tool

The ignition-switch history demonstrates why configuration management belongs inside reliability engineering rather than being treated merely as documentation. A robust engineering-change system should ensure that a performance-changing modification remains traceable years later, independent of any individual's memory.

The 2006 mechanical change increased torque and therefore changed the switch's functional performance. Yet the unchanged GM part number and incomplete linkage in the work-order documentation made the improved design difficult for later investigators to recognize. Congressional investigators specifically noted that GM policy required a new part number for changes affecting fit, form, or function.

The reliability consequence is straightforward: without configuration traceability, field-return data can combine different design populations. Failure rates, root-cause comparisons, warranty trends, and corrective-action effectiveness can then be misinterpreted because engineers may not know which physical design was actually installed.

9. The Fish Scale Is the Metaphor, Not the Method

The lesson is not that automotive engineers literally need fish scales in their reliability laboratories. The fish scale is a useful metaphor for something more important: direct observation and measurement of the actual hardware.

Sophisticated simulation, statistical analysis, reliability prediction, and system-level testing all have appropriate uses. But none should substitute for measuring a physical parameter that controls failure when that parameter can be measured. The GM switch case shows the danger of allowing organizational complexity, incomplete configuration records, and assumptions about supposedly identical hardware to obscure a simple empirical difference.

10. Reliability Lessons from the GM Ignition-Switch Case

- Measure functional margins, not merely compliance with specifications.
- Use multiple samples to expose the distribution of product strength and manufacturing variation.

- When a field event is difficult to reproduce, identify and stress the physical parameter that controls the failure.
- Treat every performance-changing design modification as a configuration-control event with complete traceability.
- Do not assume that identical part numbers guarantee identical hardware.
- Compare failed, nonfailed, old, new, and replacement hardware directly whenever possible.
- Preserve supplier engineering-change records and connect them unambiguously to internal design records.
- Use root-cause findings to create simple production measurements or screens when practical.

11. Conclusion

The GM ignition-switch failure is often discussed as a story of corporate culture, delayed recall, and organizational failure. It is all of those things. But it is also an important reliability-engineering case history.

A critical weakness existed in a simple electromechanical device. The relevant design parameter - switch torque - was directly measurable. A stronger mechanical configuration was available. When the design was eventually improved, the change was not properly identified in GM's part-number and work-order system, making later failure analysis more difficult. Years of investigation were ultimately clarified by examining, comparing, disassembling, and measuring the actual hardware.

The enduring lesson is simple: before trying to predict every way a product might fail, measure the product, discover its limits, understand the physical mechanism, preserve configuration traceability, and improve the margin.

References and Source Documents

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Author's Note

This article is based on the author's earlier commentary, 'Will GM Add a Fish Scale to Its Reliability Toolkit?' and has been substantially expanded using the public Valukas investigation, congressional records, and GM/Delphi engineering-change evidence. Statements about what a margin-oriented development test could have revealed are engineering interpretations, not findings of the Valukas investigation.