

Rail Event Recorder Crashworthiness

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Crashworthiness - Fire

Condition	IEEE Requirement	RSAC Discussions
Fire	<ul style="list-style-type: none">- 650°C (1200°F) for 30 minutes,- followed by 300°C (570°F) for 60 minutes,- followed by 100°C (212°F) for five (5) hours.	<ul style="list-style-type: none">- thermal flux of 158 kw/m² (50,000 Btu/ft²/ hour) for a continuous period of 60 minutes at a nominal 1000°C (1832°F)- 260°C (500°F) for 10 hours duration

Crashworthiness – Impact Shock

Condition	IEEE Requirement	RSAC Discussions
Impact Shock	55g peak, 100 ms duration, 1/2 sine crash pulse, 2.85 g-sec. energy area under curve, separately in the direction of each of the three principal axis.	23 g's magnitude for 250 ms duration, same amount of "energy under the curve" with a minimum of force of 23 g's is acceptable

Crashworthiness - Penetration

Condition	IEEE Requirement	RSAC Discussions
Penetration	23 kg (50 lb) weight with a protruding 0.25-inch (6.4 mm) diameter steel pin dropped from a height of 5.0 ft. (1.5 m)	Not required

Crashworthiness – Static Crush

Condition	IEEE Requirement	RSAC Discussions
Static Crush	110 kN (25,000 lbf) for 5 minutes.	111.2 kN (25,000 lbf) applied continuously for a period of 5 minutes 44.5 kN (10,000 lbf) applied continuously, using a loading surface equal to 25 percent of the surface area of the largest face

Crashworthiness – Fluid Immersion

Condition	IEEE Requirement	RSAC Discussions
Fluid Immersion	<p>Immersion in <i>all</i> of the following individually for 48 hours: grade 1 and 2 diesel fuel, regular and salt water, and lubricating oil; and</p> <p>Immersion in fire-extinguishing fluids for 10 minutes, followed by 48 hours in a dry location without being otherwise disturbed.</p>	<p>Sequentially, in grade 1 diesel fuel, grade 2 diesel fuel, regular (non-saline) water, salt water, and then lubricating oil for 48 hours each</p> <p>48 hours in a type of fire extinguishing agent likely to cause damage</p>

Crashworthiness – Hydrostatic Pressure

Condition	IEEE Requirement	RSAC Discussions
Hydrostatic Pressure	Immersion in salt water at a depth of 15 m (50 ft) for two days.	46.62 psig (equivalent to a depth of 30.5 meters (100 feet)) and at a nominal temperature of 25°C (77°F) for a period of 48 hours

What about the real world?

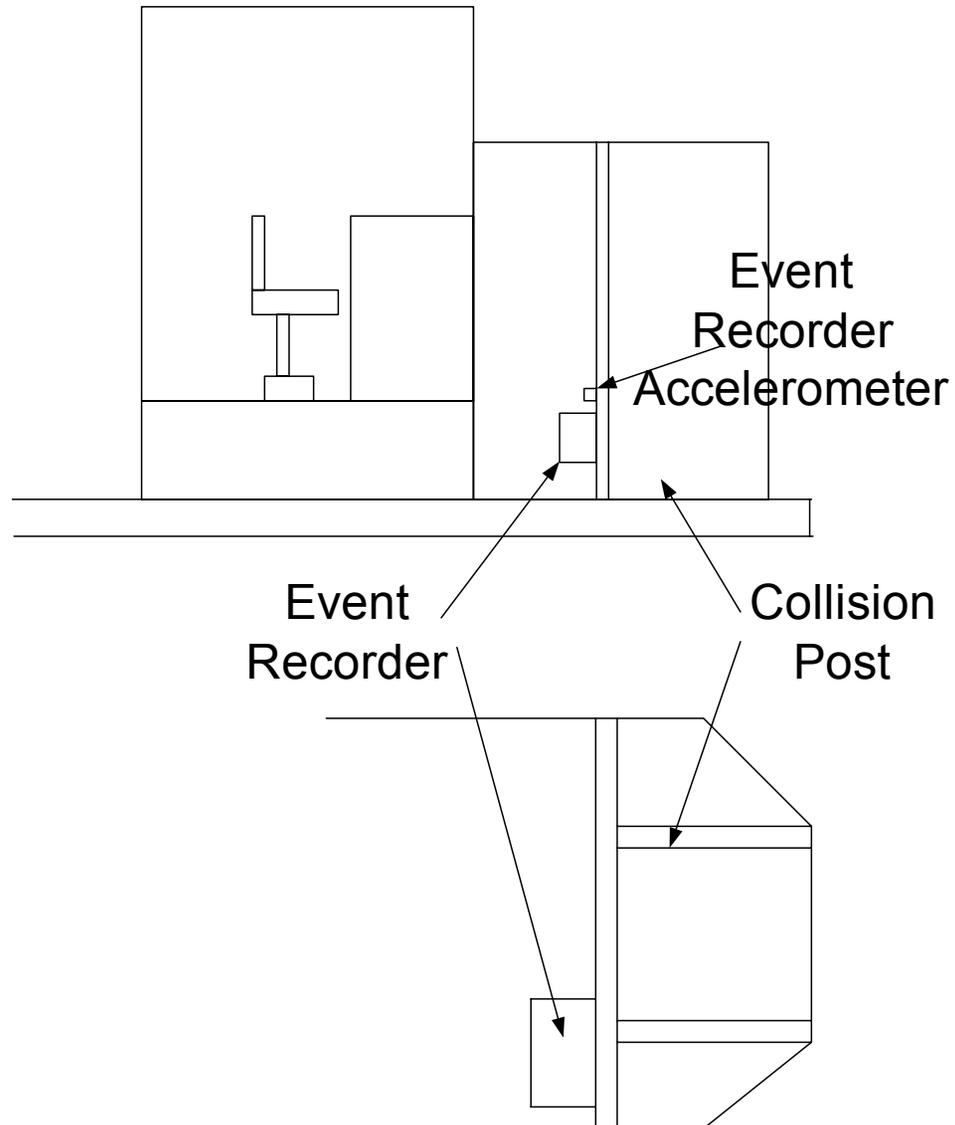
In the fall of 2002 and spring of 2003, the US Federal Railroad Administration (FRA) conducted the first ever crash-testing of a fully instrumented railway locomotive.

TTCI Crash Testing

An instrumented, AAR Specification S-580 compliant (SD-70 MAC) locomotive pulling three loaded hopper cars was subjected to three crash scenarios;

- 30 MPH into 35 loaded Hopper Cars
- 50 MPH into a Logging Truck
- 50 MPH into a roll of Coiled Steel

ERS Location Drawing



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ERS Location Picture



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Hopper Test – Oct 2022



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Logging Truck Test



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Steel Coil Test - Setup



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Steel Coil Test - Overhead



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Steel Coil – Post Crash External View



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Steel Coil – Post Crash Internal View



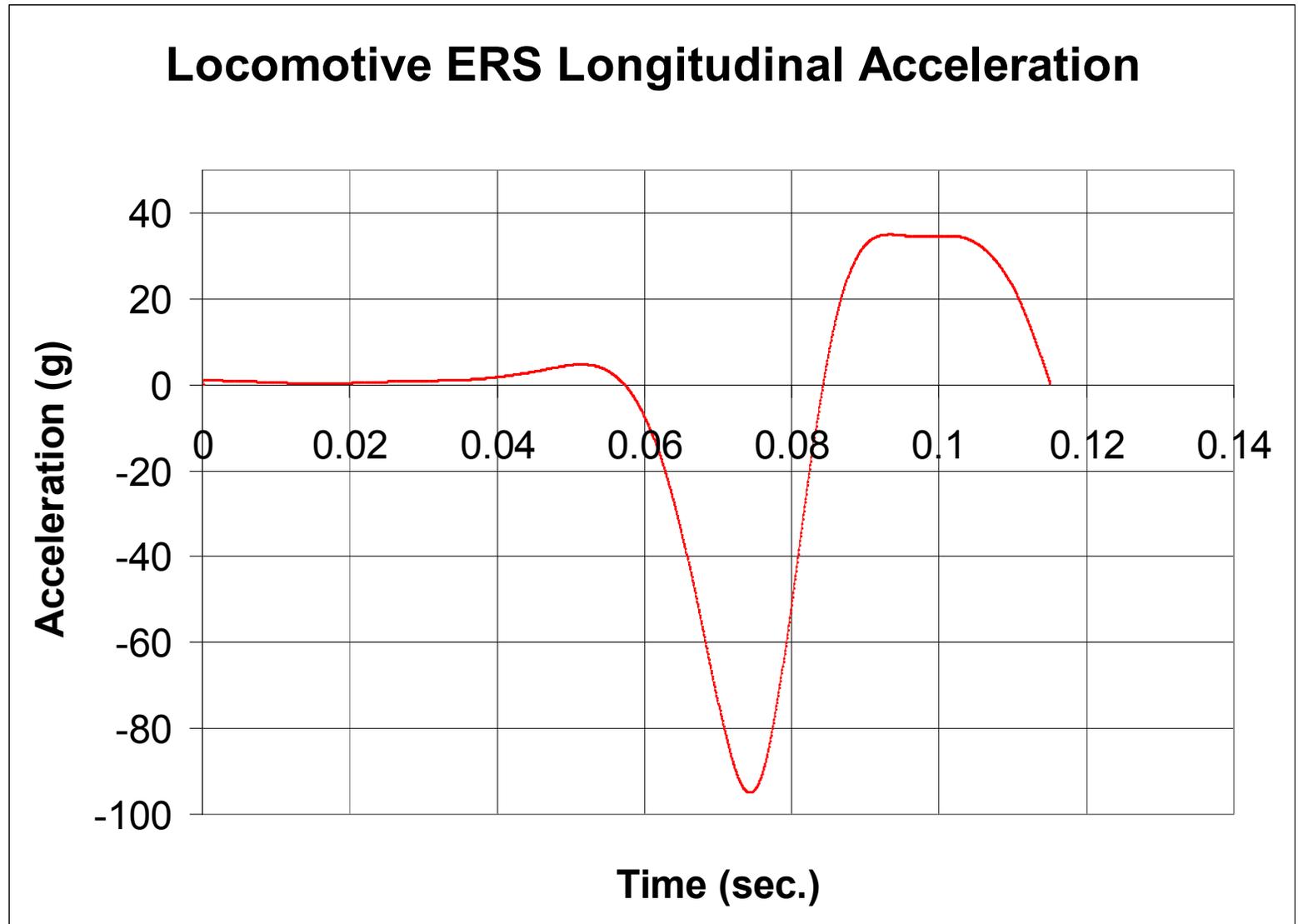
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Steel Coil – Recovered Event Recorder



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Steel Coil – Shock Pulse



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Steel Coil – Shock Calculations

Negative Shock Pulse

- Duration = 27 ms
- Amplitude = 94 g
- Impact Shock = $2A * D / \pi = 1.61$ g-sec

Positive Shock Pulse

- Duration = 31 ms
- Amplitude = 34 g
- Impact Shock = $2A * D / \pi = 0.67$ g-sec