NATIONAL TRANSPORTATION SAFETY BOARD
Office of Railroad, Pipeline, and Hazardous Materials Investigations
Washington, D.C. 20594

Survival Factors

Group Chairman's Factual Report of the Investigation[1]

– Crashworthiness and Fire Department Response[2] –

Report Date: August 24, 2022

A. **Accident Information**

NTSB Accident Number:	RRD22MR007
Location (accident reference):	San Bruno, CA (San Mateo County)
Date / Approx. Time of Accident:	March 10, 2022 / 10:34 a.m. PST[3]
Brief Synopsis:	commuter train collision with railroad construction project equipment
Railroad (Property Owner):	Caltrain
Accident Site (Location):	Caltrain Main Line, Track #2, at milepost 11.7 (approximately), which was about $^{8}/_{10}$ of a mile south of the San Bruno (commuter train) station

Note – photographs and videography imagery obtained by the Survival Factors investigation generally are not included in this report, due to the volume content and unwieldy format of the documentation media, or due to confidentiality considerations, in which the photographs and videography imagery is made available, to the extent possible, as separate report documentation (allowing for confidentiality / sensitivity considerations of the individual image contents).

[1] Generally described, NTSB investigations are conducted pursuant to the criteria cited under 49 CFR Part 831.

[2] This Survival Factors investigation exclusively addresses the elements and factors of [1] the railroad equipment crashworthiness (locomotive and passenger coach cars), and [2] the Fire Department Response to the accident.

[3] Pacific Standard Time

B. Synopsis of the Accident

See Synopsis narrative, as compiled by the Investigator-in-Charge, which is available in the NTSB public docket.

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Select abbreviations and acronym nomenclature used in this report

CA	California
CAD	Computer Aided Dispatch
CFR	Code of Federal Regulations (see https://www.ecfr.gov/)
ref	reference, or in referenced to
FRA	Federal Railroad Administration (see https://railroads.dot.gov)
PCJPB	Peninsula Corridor Joint Powers Board
ROW	right-of-way [in the context of railroad trackage]
SF	Survival Factors [NTSB investigation]
SBFD	San Bruno Fire Department
SBPD	San Bruno Police Department
USGS	United States Geological Survey (see [Internet] https://www.usgs.gov/)

C. Crashworthiness and Fire Department Response – Technical Working Group Participants[4]

Richard M. Downs, Jr., P.E.
Crashworthiness and Fire Department Response - Group Chairperson
NTSB / Washington, DC

Henry Flores
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Caltrain / San Jose, CA

Ari Delay
Fire Chief
Fire Department
City of San Bruno, CA

D. Details of the Investigation[5]

1.0 Relevant Background Factors / Information

1.1 Accident Scenario / General Description

[4] Participants of the Technical Working Group typically include [1] the Group Chairperson [NTSB investigative staff], [2] participants as designated by the Party to the Investigation, pursuant to the criteria of 49 CFR 831.11, and [3] potentially other individuals as designated by other organizations / entities that the Technical Working Group Chairperson deems necessary and appropriate to participate in the Group.

[5] Data and documentation of the investigation, as accrued from, or as made available to the investigation by the individual participants of the Crashworthiness and Fire Department Response Group, and/or data / documentation as made available to the investigation by other contributors (as individually noted), is described in this report section.

The accident involved the collision of a commuter train (in revenue service) with railroad construction project equipment (which was located in the path of the oncoming train), and fire that subsequently ignited as a result of the collision. The commuter train was comprised of one locomotive (at the lead-end of the train) and five passenger coach railcars (trailing the locomotive). The railroad construction project equipment, which was unoccupied at the time [i.e., moment] of the collision[6], consisted principally of a ‘pilot vehicle’, and two, road / rail [capable], ‘crane-type’ vehicles, positioned in sequence on the track. The railroad construction project equipment was operated by a technical contractor of Caltrain, by the name of Balfour Beatty, which was engaged in a railroad construction project in that area of the railroad. Balfour Beatty operations were supported by a subcontractor / subgroup coordinator by the name of Transit America Services, Inc (TASI). All of the railroad construction project equipment vehicles were fitted with ‘hi-rail wheelsets’, which allowed the construction project equipment vehicles to travel on railroad track (to perform the railroad construction project activities).

1.2 Locality of the Accident / Civil Jurisdiction, and Property Identification[7]

The accident occurred on the Caltrain Main Line, Track #2, at (approximately) railroad milepost[8] (MP) 11.7, which was about $^{8}/_{10}$ of a mile south of the current San Bruno (commuter train) passenger station, which is located in the City of San Bruno, California. The accident site is within the emergency services / public safety and security jurisdictions of the municipal services agencies of the City of San Bruno, and San Mateo County. The railroad track, as configured within the railroad right-of way (ROW) in this area, is property of, and is operated by, the railroad operating carrier, which was Caltrain (see further § 2.0 Railroad / Train – Owner / Operator, in this report). The City of San Bruno is a civil municipality of San Mateo County. The accident site is within the emergency services jurisdiction of the San Bruno Fire Department (SBFD) (see § 4.1 Jurisdictional Fire / Emergency Services - Rescue Agency – SBFD), and is within the law enforcement jurisdiction of the San Bruno Police Department (SBPD).

1.3 Site Characterization – Pre-Accident

1.3.1 Overall Physical Configuration of the Accident Site[9]

[6] Investigation note - a railroad construction project employee, who was located in one of the railroad construction project vehicles immediately prior to the collision, reportedly jumped-clear of that vehicle moments before the collision (ref [activity] statement of another railroad construction project employee [who witnessed the noted employee’s egress from the vehicle], as made available to the investigation), in which that employee (who ‘jumped clear’) sustained injury during / subsequent to the egress from the railroad construction project vehicle; see further § 5.1.3 Railroad Construction Project Employee Injury.

[7] ref, and for further information, see [Internet] https://sanbruno.ca.gov.

[8] A Milepost refers to point along the railroad line that identifies a dimensional distance, in miles, relative to the designated origin reference point.

[9] Description based upon pre-recovery site inspection imagery, and recorded aerial images of the accident site, as made available to, and as obtained by, the investigation, and imagery (recorded prior to the event) as shown in [Internet] https://www.google.com/maps/, and as further described.

Generally described, the accident occurred on railroad trackage that was owned / operated by Caltrain[10], in which the collision occurred on Main Track number 2, which is the western-most track of the double-track Caltrain mainline that is located in this area. The Caltrain Main Track in this area is configured generally in a north/south orientation, in which the Main Track number 2, which closely parallels the adjacently located Main Track number 1, is tangent (straight) and has a slight descending grade (to the south).

See the Railroad Operations Group Factual Report, and the Track and Engineering Group Factual Report, for additional information detail on the mainline track.

In the geographical area generally at the north-end of the accident site, a level ‘paved-surface area’ was observed to be situated along the immediate west edge of the Main Track number 2, which measured about 9.5 feet in width, and extended to the south, for a total length of about 500 feet.[11] In the geographical area generally at the south-end of the accident site, which is also to the south of the [above described] ‘paved-surface area’, a drainage ditch was observed to be situated along the immediate west edge of the Main Track number 2. The drainage ditch, which (during the on-scene investigation) wasn’t observed to contain a measurable amount of water, measured about 15 feet in width (at the top edges) and up to about six feet in depth, which also contained an abundance of foliage overgrowth (which was observed to somewhat impede passage, on foot, through the drainage ditch).

The ground-surface area to the west of the (above described) Main Track (i.e., the accident site), was an area comprised of two property lots, in which each lot measured about 50 feet in width (i.e., the east side, to the west side, dimension), which consisted of:

(a) a vacant lot (that was perimeter-bounded by an enclosure fence), which was situated generally to the north-end of the accident site, which served as an equipment and materials storage lot that was utilized by resources of Balfour Beatty, and/or TASI, supportive to the railroad construction project that was underway, and,

(b) an equipment and materials storage lot / yard (that was perimeter-bounded by an enclosure fence) that was a City of San Bruno property (which is locally referred to as the “San Bruno City Corp Yard”), which was situated generally to the south-end of the accident site, which was utilized as a storage yard by the City of San Bruno / Water Division.

A two-lane, paved, municipal street, labeled “Huntington Avenue”, which is oriented parallel to the Main Track in this area, was located to the immediate west of the above-described property lots.

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[10] As a technical characterization, the Caltrain railroad track and ROW, and railroad operating equipment, is actually owned by the Peninsula Corridor Joint Powers Board, as described in [Internet] https://www.caltrain.com/about-caltrain.

[11] A publication by [author] Mark Duncan, titled “The San Francisco Peninsular Railroad Passenger Service, Past Present and Future” (ref [Internet] http://www.askmar.com/Railroad/Book-SF-Peninsula-Railroad.pdf), describes a railroad “shelter”, which was referred to as the Lomita Park [station] that existed between 1911 and 1963, which was located on Huntington Avenue, at a location that is consistent with the identified ‘paved, ground-surface area’.

The ground-surface area to the immediate east of the (above described) Main Track area, consisted of a tall concrete wall, which served as an enclosure barrier to property / trackage that was utilized by the BART System[12]. Heavy, vertically oriented, steel ‘catenary pole’ structures were located in the area proximate to the accident site (but were not involved in the accident).

1.3.2 Map of Accident Site

An annotated segment of a USGS topographic (survey) map[13], describing the general area proximate to the accident site, is provided in Exhibit 1.

1.4 Railroad Construction Project Equipment – General Description[14]

The railroad construction project equipment was operated by a technical contractor of Caltrain, by the name of Balfour Beatty[15], which was engaged in a railroad construction project in that area of the railroad. The vehicles were positioned on the track in the sequence as follows (i.e., the first vehicle listed was the first vehicle that was located in the path of the southbound train).

[1] Pilot vehicle:

- year, make, model: undetermined, Ford, F-350 pickup truck
- weight [unladen], length: 7,000 lbs., 22.2 feet
- vehicle configuration:
  - this vehicle was essentially a commercially available highway vehicle that was fitted with ‘guide wheels’, which are flanged (similar in function to a railroad wheel), which keep the road-wheels of the vehicle aligned and centered on the top of the rail.

[2] Road / rail [capable], 30-Ton crane / flatbed truck – Maintenance Project Vehicle # 2:

- year, make, model: 2016, Western Star / Manitex, model 30112S
- weight [unladen], length: 39,460 lbs. / 34.5 feet
- vehicle configuration:
  - vehicle is referred to by the vehicle owner as the “swing cab” crane.
  - this vehicle, which was positioned a reported 50 feet to the south of the prior vehicle (located to the north), was oriented with the vehicle cab facing to the north, in which

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[12] i.e., the San Francisco Bay Area Rapid Transit District, which is locally referred to as BART, as further described in [Internet] https://www.bart.gov.

[13] Excerpt from United States Geological Survey (USGS) topographic survey map, [map ref] Montara Mountain, CA, Quadrangle, [dated] 2022 (7.5 Minute Series, original scale 1:24,000); ref, and for further information, see [Internet] https://ngmdb.usgs.gov.

[14] Source: documentation and correspondence from vehicle owner (Balfour Beatty).

[15] ref, and for further information, see [Internet] https://balfourbeattyus.com/our-work/project-portfolio/caltrain-design-build-electrification.

two IPS [material transport] carts were attached to the rear of the vehicle by drawbar connection rods.

- vehicle was a commercially manufactured flatbed highway truck, the flatbed deck of which was fitted with a commercially manufactured, 30-ton (rated) capacity, telescoping lifting crane and associated equipment.
- vehicle was fitted with 'guide wheels', which are flanged (similar in function to a railroad wheel), which keep the road-wheels of the vehicle aligned and centered on the top of the rail.

[3] Road / rail [capable], 19-Ton Boom / flatbed truck – Maintenance Project Vehicle # 3:

- year, make, model: 2018, Freightliner / Manitex, model 1970C
- weight [unladen] / length: 27,750 lbs. / 34.1 feet
- vehicle configuration:
  - this vehicle is referred to by the vehicle owner as the "boom truck".
  - vehicle was positioned an unknown distance to the south of the prior vehicle (located to the north) and was oriented with the vehicle cab facing to the south.
  - this vehicle was a commercially manufactured flatbed highway truck, the flatbed deck of which was fitted with a commercially manufactured, 19-ton (rated) capacity, telescoping lifting crane and associated equipment.
  - this vehicle was fitted with 'guide wheels', which are flanged (similar in function to a railroad wheel), which keep the road-wheels of the vehicle aligned and centered on the top of the rail.

See the Railroad Operations Group Factual Report for additional information detail regarding the railroad construction project and equipment.

2.0 Railroad / Train – Owner / Operator

The accident involved a Caltrain commuter train that was involved in a collision with railroad construction project equipment on property of Caltrain.

2.1 Brief Summary – Operational Background[16]

Caltrain is a standard gauge[17], Tier I [commuter rail service] Provider[18], which operates local commuter railroad service along the San Francisco Peninsula[19], in which the operation is governed by the Peninsula Corridor Joint Powers Board (PCJPB). The PCJPB operates as a

[16] ref, and for further information, see [Internet] https://www. caltrain.com/about-caltrain, and as further described.

[17] U.S. "standard gauge" track is 56.5 inches (143.5 cm) between the rails, as measured on straight track.

[18] ref, U.S.D.O.T, Federal Transit Administration, "Asset Type" Tier designation, and for further information, see [Internet] https://www.transit.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2020/90134.pdf.

[19] Caltrain does make limited freight service available to select industries that are situated along the railroad.

government entity, in which its business headquarters is located in San Carlos, CA. Caltrain owns the motive power [locomotives] and rolling stock [passenger railcars] of the railroad operation, consisting of 29 locomotives and 134 passenger railcars, and operates on approximately 154 directional route-miles of track, between San Francisco (at the northern end of the system) and Gilroy, CA[20] (at the southern end of the system).[21] Dispatching of Caltrain trains is provided by an operations facility, located in San Jose, CA.

See the Railroad Operations Group Factual Report for additional information detail.

2.2 Accident Train – Consist and Technical Specifications[22]

The accident involved a southbound, Caltrain commuter [passenger] train, having a Caltrain Timetable designation of Train Number 506, which was comprised of one locomotive (at the lead-end of the train) and five passenger coach railcars.

Generally described, the floorplan arrangement of the coach railcars consisted of a passenger compartment at both ends of the railcar, which was comprised of lower-level and upper-level seating (in which a stairway is provided to access the upper-level seating areas), and a vestibule area in the center of the railcar, containing the access doors of the railcar, as situated on both sides of the railcar.

Summarized technical specifications of the Caltrain commuter train equipment, as involved in the accident, is described in the tabulation cited in Exhibit 2.[23]

See the Railroad Operations Group Factual Report for additional information detail.

2.3 Brief Background – Crashworthiness of the Motive Power, and Fire Protection of the Rolling Stock[24]

Responsive to this data inquiry, the railroad made data / documentation available to the investigation that addressed the crashworthiness of the operating locomotive [road number] 919, and the fire risk assessment of Caltrain passenger railcar [road number] 3819, and an overall fire hazard assessment of Caltrain operations, which is summarized as follows.

2.3.1 Crashworthiness of Locomotive 919

[20] Note: Caltrain trains, operating between Tamien and Gilroy, operate under a 'trackage rights' arrangement / agreement, with the Union Pacific Railroad (which owns / operates that segment of track).

[21] ref, US DOT / National Transit Database, available at [Internet] https://www.transit.dot.gov/ntd/transit-agency-profiles/peninsula-corridor-joint-powers-board-dba-caltrain-pcjpb.

[22] Source: description of the accident train was sourced to observations by NTSB investigative staff (during, and subsequent to the on-scene phase of the investigation), and data as offered by Caltrain, and as further described.

[23] ref, and for further information, see [Internet] https://www.caltrain.com/about-caltrain/statistics-reports/commute-fleets, and as further described.

[24] The railroad was afforded an opportunity to make data / [original] documentation available to the investigation, which was accommodated during a technical review on 03/15/2022, at the railroad maintenance facility.

On-scene inspection of the train identified that the operating locomotive of the train consist sustained collision and fire damage to the front cowl structure of that locomotive unit; see further § 3.4.1 Railroad Equipment – Damage Description, in this report.

Pre-recovery examination of the locomotive indicated that the builder's identification information label (sometimes referred to as a 'builder's plate') was illegible, in which the railroad provided [original] manufacturing documentation of the locomotive [from the railroad records library] that indicated a manufacture date [year] of 1987, in which the locomotive was also overhauled (i.e., also referred to as 'remanufactured') in February 2000.

Review of FRA regulation [for railroad locomotives][25] indicated that there were no applicable [crashworthiness] regulations for this particular locomotive unit, as it was built / overhauled prior to the regulation effective ("Applicability") date.[26]

Alternately, in lieu of a regulatory requirement, a literature review located a voluntary industry standard that was applicable to railroad locomotives, which prescribed that locomotives manufactured after April 1, 1956, must be designed in accordance with the provisions of Association of American Railroads (AAR) Standard S-580, revision effective at the date of manufacture.[27] A report by the U.S. Department of Transportation identified that the model F-40PH-2 locomotive (i.e., the specific make / model unit that was involved in the accident) was manufactured to AAR Standard S-580, revision effective at the date of manufacture.[28]

2.3.2 Fire Risk Assessment of Caltrain Passenger Railcar 3819

a. Background / Fire Damage Condition

The investigation identified that Caltrain passenger coach [road number] 3819 was constructed [new] by Nippon Sharyo Seizo Kaisha, Ltd. (Nippon Sharyo), in 1985, in which the railcar was rebuilt (i.e., a process that is also referred to as having been "overhauled / remanufactured") by Alstom in 2001.

On-scene examination of the train identified that the first passenger railcar in the train consist [coach 3819], located directly behind the locomotive, sustained severe fire, smoke and soot deposit damage to the interior of the aft end passenger compartment of the railcar (i.e., immediately aft of the mid-car vestibule). The remaining railcars of the train consist, however,

[25] Ref, 49 CFR Part 229 Railroad Locomotive Safety Standards, Subpart D - Locomotive Crashworthiness Design Requirements; for further information, see [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-229/subpart-D.

[26] Ref, 49 CFR Part 229.203 Applicability, under paragraph (a), cites "… this subpart applies to all locomotives manufactured or remanufactured on or after January 1, 2009."; for further information, see above [Internet] ref.

[27] Ref, AAR [Standard] S-580 Locomotive Crashworthiness Requirements; for further information, see [Internet] https://aar.com/standards/MSRPs/MSRP-A1.pdf.

[28] Ref, [report by] Federal Railroad Administration. (2014). Development, Fabrication and Testing of Locomotive Crashworthy Components: Base Effort [DOT/FRA/ORD-14/38]. Washington, DC: U.S. Department of Transportation; for further information, see [Internet] https://railroads.dot.gov/elibrary/development-fabrication-and-testing-locomotive-crashworthy-components-base-effort.

were essentially undamaged (i.e., minor smoke / soot accumulation); see further § 3.4.1 Railroad Equipment – Damage Description, in this report.

b. Applicable Regulation

On May 12, 1999, the Federal Railroad Administration (FRA) issued regulations that addressed passenger rail equipment safety standards[29], as applicable to intercity passenger and commuter rail systems. The passenger equipment safety standards included regulation [prescribed requirements] on fire safety, as applicable to those intercity passenger and commuter rail systems (ref, 49 CFR 238.103 Fire safety).[30] The fire safety regulation addressed flammability and smoke emission / toxicity testing requirements of materials that were used in constructing a [new] passenger car (which cited an applicable [effective] date of September 8, 2000), and the regulation also addressed equipment that was placed in service for the first time (which cited an applicable [effective] date of September 9, 2002).

The fire safety regulation further stipulated, that materials introduced in a passenger car or a locomotive cab, as part of any kind of rebuild, refurbishment, or overhaul of the car or cab, shall meet the test performance criteria for flammability and smoke emission / toxicity characteristics as prescribed in the regulation, which cited an applicable [effective] date of May 12, 1999.

c. Fire Risk Assessment – Source Documentation

Given the above-described fire safety regulation (49 CFR 238.103 Fire safety), to which the regulation would apply specifically to overhauled passenger railcars, a review was conducted by the investigation, of supporting documentation that addressed the test performance characteristics for flammability and smoke emission / toxicity testing of materials, as contained within the Caltrain passenger railcars (which included Car 3819). Supportive to that, Caltrain made documentation available to the investigation[31], relative to demonstrating compliance with the applicable regulation (49 CFR 238.103 Fire safety), which consisted of the following correspondence / documentation.

Document 1.

Date:	11/24/2000
Correspondence from:	Alstom / Montreal, Quebec, Canada
To:	Caltrain / San Carlos, CA
Subject / Title:	TS 20.s – Fire Safety and Toxicity Matrix, Rev. 2; Contract Number C-60445JPB

[29] Ref, 49 CFR Part 238 Passenger Equipment Safety Standards; for further information, see [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238.

[30] Ref, 49 CFR 238.103 Fire safety; for further information, see [Internet] https://ww.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238/subpart-B/section-238.103.

[31] Source: email from Caltrain Party participant of the Crashworthiness Group, to Group Chairperson, [subject line] “RE: San Bruno, CA (RRD22MR007) / Crashworthiness Group >> RE: Fire Risk Assessment for Caltrain Nippon Sharyo Gallery cars”, dated 08/03/2022.

Content / context:	Transmittal [cover letter] of 'Matrix', Rev. 2 [which preceded the current Revision 5]; see further Document 2 (below)

Document 2.

Date:	06/25/2002
Subject / Title:	"Caltrain Overhaul - Matrix for Passenger Vehicle Material Fire Risk Assessment / Rev 5"
Content / context:	Tabulation / spreadsheet, summarizing the flammability and smoke emission / toxicity testing data of the 31 individual materials tested; see further Document 3 (below)

Document 3.

Date:	---
Subject / Title:	Car Overhaul – 'data compendium' of test performance documentation
Content / context:	This is a documentation package [comprehensive / loose-leaf binder] that was comprised of (a) individual 'Tabbed' sections, containing test performance documentation [sheets] for the specific flammability and smoke emission / toxicity testing, as conducted on the 31 individual materials contained within the subject passenger railcars, and (b) the Matrix document (described in Document 2, above, summarizing the testing data).

d. Test Performance Documentation Review

A review was conducted by the investigation, of the (above described) supporting documentation that addressed the test performance characteristics for flammability and smoke emission / toxicity testing of materials, as contained within the Caltrain passenger railcars (which included Car 3819). In the review, it was apparent that not all of the 31 individual materials [cited in the summary Matrix] had necessarily contributed to the fire in Caltrain passenger car 3819. As a measure of time-resource conservation[32], post-recovery examination of that railcar identified that six (6) of the 31 test-evaluated materials comprised the principal materials [components] that had ignited and were consumed in the fire [in car 3819], which consisted of the following materials and application (i.e., Area of the railcar).

Material	Area (application)	Report Tab
foam	seat cushion	A
foam	seat armrest	B
vinyl covering	seat components	C
FRP shroud material	seat components	D
floor carpeting	floor	I

[32] Review of the testing data of the materials that weren't located in the areas of fire damage wasn't necessary, as those materials didn't contribute to the fire ignition or propagation (e.g., HVAC, cab seat, rest room elements, etc.).

Fiberglas	pier panels (windows)	R

Review of the individual test performance results for the flammability and smoke emission / toxicity testing (i.e., the individual test result pages contained within individual 'Tabbed' sections of the documentation binder), identified that (a) all testing was performed as specified, in which (b) all six (6) test-evaluated materials met or exceeded the performance criteria of the individual tests as conducted (i.e., all materials passed the stipulated testing procedures).

A copy of the (above described) Fire Risk Assessment report - Document 1., and Document 2., as examined / addressed in the above review, is provided in Exhibit 3.

e. Fire Hazard Assessment – Documentation Review

Further supportive to demonstrating compliance with the applicable safety standard regulation (49 CFR 238.103 Fire safety), a review was conducted by the investigation, of supporting documentation that addressed the overall fire hazard assessment of Caltrain operations. Supportive to that, Caltrain made documentation available to the investigation, which consisted of the following correspondence / documentation.[33]

Document 4.

Date:	02/17/2004
Correspondence from:	Executive Director / Caltrain (Peninsula Corridor Joint Powers Board)
To:	Motive Power and Equipment Division / Office of Safety Assurance and Compliance / Federal Railroad Administration / Washington, DC
Content / context:	Transmittal [cover letter] of "Fire Hazard Assessment Prepared for Caltrain" report, describing the submittal was supportive to compliance with 49 CFR Part 238; see further Document 5 (below)

Document 5.

Date:	March 2001
Subject / Title:	"Fire Hazard Assessment Prepared for Caltrain"
Content / context:	A report, prepared as a joint publication by two transportation safety contractors[34], that comprehensively addressed topics of fire incident data, fire safety mitigation, fire scenarios, vehicle [fire hazard] evaluations, among other fire hazard assessment topics, relative to addressing an overall fire hazard assessment of Caltrain operations

[33] Source: email from Caltrain Party participant of the Crashworthiness Group, to Group Chairperson, [subject line] "RE: San Bruno, CA (RRD22MR007) / Crashworthiness Group >> RE: Fire Risk Assessment for Caltrain Nippon Sharyo Gallery cars", dated 08/03/2022.

[34] i.e., Parsons Transportation Systems [having globally located facilities], and Fire Cause Analysis [located in Port Richmond, CA].

Review of the fire hazard assessment report indicated that no significant fire safety hazards, as might be relevant to the circumstances / consequences of the accident, were described.

A copy of the (above described) Fire Hazard Assessment documentation (Document 4, and 5), as examined / addressed in the review, is provided in Exhibit 4.

2.3.3 Fire Risk Assessment of the Other Caltrain Passenger Railcars in the Train Consist

The investigation identified that, as the other passenger coaches in the train consist were overhauled in the same group of Caltrain passenger railcars as coach 3819, the fire safety compliance requirements, and corresponding test results, of the other Caltrain passenger railcars in the train consist, would be the same as coach 3819 (i.e., all materials passed the stipulated testing procedures).

2.4 Preparedness Training Made Available to Jurisdictional Emergency Services Agencies[35]

Caltrain documented to the investigation that, responsive to regulation[36], for the five years prior to the accident date, outreach activities, consisting of periodic (usually annual), in-person, training activity sessions (which may also be referred to as "emergency simulations"), had been made available to the jurisdictions of the various emergency services agencies through which the railroad operates (which includes the agencies of San Mateo County).

2.5 Safety Information Distribution[37], Prior to the Accident, to the Local Emergency Services Agencies[38]

Caltrain documented to the investigation that, supportive to the Emergency Preparedness Plan of the railroad (i.e., responsive to regulation[39]), a PowerPoint® presentation titled "Caltrain Emergency Preparedness – First Responders Guide", had been made available to the various emergency services agencies through which the railroad operates (which includes the agencies of San Mateo County). The presentation consisted of 73 slides, depicting railroad equipment familiarization, and corresponding safety procedures and best practices to be engaged, in which the presentation is / was also exhibited to the corresponding emergency services agencies during

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[35] Source: documentation of the railroad as made available to the Crashworthiness Group Chairperson during the on-scene phase of the investigation.

[36] Ref, 49 CFR 239.103 Passenger Train Emergency Simulations; for further information, see [Internet] https://www.ecfr.gov/current/title-49/part-239#239.103.

[37] Safety Information, in the context to this investigation, refers to documentation that describes equipment familiarization, and corresponding safety procedures and best practices that could be applied when responding to a railroad emergency or accident, which would include a collision incident (as occurred in this accident).

[38] Source: documentation of the railroad as made available to the Crashworthiness Group Chairperson during the on-scene phase of the investigation.

[39] Ref, 49 CFR 239.103 Emergency Preparedness Plan; for further information, see [Internet] https://www.ecfr.gov/current/title-49/part-239#239.101.

'live-session' preparedness training activity sessions (which are also referred to as "emergency simulations") that the railroad conducts (as described above).

3.0 Accident Site - Wreckage Distribution, Equipment Damage Characterization, and Relevant Factual Data

3.1 Time of the Event Occurrence[40]

The investigation identified the collision occurred at about 10:34:45 a.m. PST[41], on March 10, 2022.

3.2 Train Speed at the Time of Collision[42]

The train was traveling at a reported speed of 37.5 mph at the time of the accident (i.e., the moment of impact).

3.3 Approximate Point of Collision and Location Where Train Came to Rest[43]

The point of collision was identified to be proximate to [railroad] MP 11.69, in which it was observed that the front of the locomotive (at the lead end of the train) came to rest proximate to MP 11.76. Mathematical calculation by the investigation[44] identified that the train traveled about 370 feet, between the point of collision, and the point where the front of the locomotive came to rest.

See the Track and Engineering Group Factual Report for additional information detail.

3.4 Pre-recovery – Railroad Equipment, and Construction Project Equipment - Damage Description / Site Condition[45]

A pre-recovery examination of the railroad equipment, and the accident site, is conducted by the investigation, to accurately / appropriately document the accident-relevant information and site artifacts, prior to disturbance of the equipment at the site, as damage to the equipment, and disturbance of the site, can readily occur during the equipment recovery process.

3.4.1 Railroad Equipment – Damage Description

[40] Source: locomotive event recorder download data.

[41] Pacific Standard Time

[42] Source: locomotive event recorder download data.

[43] Location(s) based upon evidentiary artifact data identified, during the on-scene phase of the investigation, by the Track and Engineering Group, as described in the report documentation of that Group.

[44] Calculation by the SF Group Chairperson identified: MP 11. 76 - [minus] MP 11. 69 = 0.07 of a mile, which upon multiplying by 5280 feet/mile = 369.6 feet.

[45] Source: pre-recovery site / equipment examination conducted on 03/11, and 03/12/2022, by participants of the SF Group, with the data notations of that examination recorded in the Group Chairperson's Field Notes Logbook.

The observed condition of the railroad equipment, as a result of the collision and subsequent fire, is summarized as follows.

a. Locomotive 919

- visibly apparent fire damage was sustained to the lead end cowl structure (which is also referred to as the ‘short hood’), and overall pilot structure of the locomotive,
- the lead end cowl structure sustained inward deformation, which could not be accurately [visibly] estimated (see further § 3.5.1 Post-recovery – Railroad Equipment Damage Description),
- batter damage was sustained to the pilot plow and associated mounting elements,
- an open breach was sustained to the center / upper areas of the lead end cowl structure,
- left windshield panel was shattered,
- cab interior did not display visibly apparent damage, or any personal injury trauma indicator(s) (i.e., evidence of blood, or injury trauma),
- both axles of the lead truck assembly were derailed, and displaced by a few inches to the east.

b. Coach 3819

- moderate smoke and soot deposit damage was sustained to the interior of the lead end passenger compartment of the railcar,
- severe fire, smoke and soot deposit damage was sustained to the interior of the aft end passenger compartment of the railcar (i.e., immediately aft of the mid-car vestibule),
- heavy smoke and soot deposit damage was displayed to the interior area aft of the severely fire damaged area of the railcar (described above),
- the east side, exterior, aft end passenger compartment of the railcar (i.e., aft of the mid-car vestibule), displayed severe fire damage, and smoke and soot deposit damage,
- the remaining exterior areas of the railcar (i.e., on both sides of the railcar), displayed minor to moderate smoke and soot deposit damage,
- the railcar was not derailed, and remained coupled to the adjacent railroad equipment.

c. Remaining Coach Equipment of the Train Consist

- coach 3829 (which was coupled to the aft end of Coach 3819) sustained minor smoke and soot deposit damage, to both the interior and exterior areas of the railcar,
- in the remaining railcars of the train consist, a number of emergency exit windows were observed to have been ‘pulled’ (manually removed),

- the remaining railcars of the train consist did not display damage sustained in the accident, were not derailed, and all remained coupled to the adjacent railroad equipment.

3.4.2 Railroad Construction Project Equipment – Damage Description

The observed condition of the railroad construction project equipment, as a result of the collision and subsequent fire, is generally characterized as follows.

a. Pilot Vehicle:

- the wreckage of this vehicle came to rest lodged between the front of locomotive 919 and wreckage of the Road / Rail ‘Boom Truck’ Vehicle # 3,
- this vehicle sustained severe collision impact damage and severe fire damage, to which the identity of this vehicle (i.e., the make and model designation) was visibly indiscernible.

b. Road / rail [capable], 30-Ton crane / flatbed truck – Maintenance Project Vehicle # 2:

- the wreckage of this vehicle came to rest in a somewhat upright orientation, on the Number 1 track of the Main Line trackage, situated to the immediate east of where coach 3819 came to rest, in which it was located proximate to an area aft of the mid-point segment of that railcar,
- the cab of this vehicle sustained severe collision impact damage and severe fire damage, in which the cab of this vehicle came to rest immediately adjacent to the exterior sidewall of coach 3819,
- the cab of this vehicle wreckage came to rest approximately 229 feet to the south of the approximate point of collision.

c. Road / rail [capable], 19-Ton Boom / flatbed truck – Maintenance Project Vehicle # 3:

- the wreckage of this vehicle came to rest on its left side, at approximately a 45-degree orientation to the track centerline, and was essentially wedged against the front of locomotive 919,
- a segment of the wreckage of the Pilot vehicle came to rest lodged between the front of locomotive 919 and the wreckage of this vehicle,
- the cab of this vehicle sustained severe collision impact damage and severe fire damage.

3.4.3 Wreckage Distribution / Aerial Imagery [Map][46]

An annotated aerial imagery [map], describing a segment of the wreckage distribution at the accident site, is provided in Exhibit 5.

[46] Source: aerial imagery, as made available to the investigation, from responded UAV [unmanned aerial vehicle] resources (also referred to as aerial ‘drones’), to which annotated data (describing select attributes / physical elements of the site) is correspondingly inserted in the image.

3.5 Post-recovery – Railroad Equipment Damage Description[47]

A post-recovery examination of the railroad equipment is conducted by the investigation to accurately / appropriately document the accident-relevant information of the damaged equipment, upon relocation of the railroad equipment to a secure site, in which the time can be taken to more closely examine / document the informational details and artifacts, as might be contained within the subject railroad equipment.

3.5.1 Railroad Equipment – Damage Description

The observed condition of the railroad equipment, as a result of the collision and subsequent fire (i.e., in addition to the damage documented during the pre-recovery investigation activity, described in § 3.4.1 Railroad Equipment – Damage Description), is summarized as follows.

a. Locomotive 919

- visibly apparent fire damage was sustained to the exterior lead end cowl structure, and overall pilot structure of the locomotive,
- the lead end cowl structure sustained inward deformation, [visibly] estimated to be about four feet in depth,
- an open breach was sustained to the center / upper areas of the lead end cowl structure,
- anti-climber element intact, but displaced [pushed] aft, about 3 feet on the left side, and about 1 foot on the right side,
- end plate shear damage observed at the ‘coupler box’, with the coupler appearing intact,
- minor deformation visibly apparent on cab compartment front exterior surfaces,
- the operator’s cab compartment [interior] appeared to be essentially intact (i.e., the operator’s seat, control stand, cab walls, ceiling, floor, side windows), and cab compartment did not display visibly apparent fire, smoke or soot damage, or structural damage, or apparent evidence of personal injury trauma (i.e., blood / tissue, or other injury trauma artifact), in which the operator’s cab compartment side doors were fully operational,
- the locomotive ‘cowl compartment’[48] appeared to be essentially intact, except for the (as previously described) [1] inward deformation sustained to the lead end cowl structure, and [2] the open breach sustained to the center / upper areas of the lead end cowl structure,
- the left windshield panel was shattered, with apparent impact damage sustained to the “A-post” element on the left side of the left windshield panel, with minor separation of the

[47] Source: post-recovery equipment examination conducted on 03/13/2022, at a secure site to which the train had been relocated (after the locomotive was re-railed) as an evidence preservation measure, by participants of the SF Group, with the data notations of that examination recorded in the Group Chairperson’s Field Notes Logbook.

[48] i.e., a small compartment situated to the front of the locomotive cab, containing a commode and other operational equipment.

windshield mount framing structure, and minor windshield center mullion aft-ward deformation, with damage sustained by the [exterior] left side mirror.

- the locomotive engine compartment [interior] appeared to be essentially without damage, except for [a small degree of] fire damage displayed at the engine turbine intake hose,
- the locomotive fuel tank, which appeared (per the fuel-level indicator gauge) to contain about 700 gallons of [diesel] fuel, displayed no visible leakage or fire damage.

b. Coach 3819

- moderate smoke and soot deposit damage sustained to the interior of the lead end passenger compartment of the railcar,
- severe fire, smoke and soot deposit damage was sustained to the interior of the aft end passenger compartment of the railcar (i.e., immediately aft of the mid-car vestibule),
- heavy smoke and soot deposit damage was displayed to the interior area aft of the severely fire damaged area of the railcar (described above),
- the east side, exterior, aft end passenger compartment of the railcar (i.e., aft of the mid-car vestibule), displayed severe fire damage, and smoke and soot deposit damage,
- the remaining exterior areas of the railcar (i.e., on both sides of the railcar), displayed minor to moderate smoke and soot deposit damage,
- the railcar was not derailed, and remained coupled to the adjacent railroad equipment.

c. Remaining Coach Equipment of the Train Consist

- coach 3829 (which was coupled to the aft end of Coach 3819) sustained minor smoke and soot deposit damage, to both the interior and exterior areas of the railcar,
- in the remaining railcars of the train consist, a number of emergency exit windows were observed to have been ‘pulled’ (removed),
- the remaining railcars of the train consist, other than minor smoke and soot residue, did not display damage sustained in the accident, were not derailed, and all railcars remained coupled to the adjacent railroad equipment.

4.0 The Emergency Response

4.1 Jurisdictional Fire / Emergency Services - Rescue Agency – SBFD[49]

The accident occurred on private property within the response jurisdiction of the San Bruno Fire Department (SBFD), which also provided resources in response to the incident.

[49] Source: [1] informal debriefing interview(s) of the SBFD Party participant to the SF Group by NTSB staff (during the ‘on-scene phase’ of the investigation), and [2] response operations data of the SBFD as made available to the investigation, and [3] background information on the SBFD, as available at [Internet] https://www.sanbruno.ca.gov /295/Fire, and as further described.

4.1.1 Background / Overview

The SBFD is the principal emergency services agency responsible for responding to fire suppression, emergency rescue, and an initial response to hazardous materials incidents within the City of San Bruno that encompassed the accident site, and was the initial fire / rescue agency that responded to the scene in this incident.

As described by the agency, “The San Bruno Fire Department is an organization dedicated to the protection of health, life and property of all persons in the City of San Bruno. The Fire Department has a long-standing tradition of service and excellence. SBFD provides a full range of services delivered in a responsive and cost-effective manner. Our priority is to ensure the safety and emergency preparedness of our citizens through outreach programs in activities related to: Fire prevention, Public education, Advanced life support, Hazardous material safety, Fire suppression.” [50]

The Fire Chief is the senior Command Officer in charge of the operational management of the agency, in which, briefly summarized, the SBFD[51]:

- is a fully paid [wages] emergency services agency, which (at the time of the accident) maintained a total personnel roster count of 37 firefighters, and operates out of two fire stations (as strategically located in the City of San Bruno),
- maintains an apparatus roster count of five tactical response vehicles, and
- has formal “mutual aid” response agreements with fire department resources from neighboring municipal jurisdictions in San Mateo County, and correspondingly, is available to respond to emergency incidents in those jurisdictions.[52]

Dispatching of the resources of the SBFD is performed by San Mateo County – Public Safety Communications. Documentation, or other activity-data archive, which are routinely compiled by the Public Safety Communications agency, includes:

[1] what is informally referred to as ‘dispatch log sheets’, which uses an automated Computer Aided Dispatch System (referred to as a “CAD System” by some emergency services agencies) to automatically document communications and dispatch services activities, and

[2] automatically archives digital voice recordings of agency dispatch service radio communications.[53]

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[50] Ref, (as quoted from) [Internet] https://www.sanbruno.ca.gov/294/Fire.

[51] Ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/313/Emergency-Response.

[52] “Equipment and personnel from other cities may respond to aid in any emergency as part of the San Mateo County Joint Powers Agreement.”, as described in [Internet] https://www.sanbruno.ca.gov/313/Emergency-Response.

[53] The automatically applied, audio recording equipment ‘timestamp’ function was verified as accurate by the investigation, relative to an official, US Government-sourced, time standard (e.g., [Internet] http://www.time.gov/).

4.1.2 Mutual Aid Response Support in the Incident[54]

The SBFD had formal / documented "mutual aid" response agreements with fire department resources from neighboring jurisdictions in San Mateo County, which included the following agencies.

Central County Fire Department
South San Francisco Fire Department
North County Fire Authority
Colma Volunteer Fire Department
Menlo Park Fire Protection District

4.1.3 Training Activities – Emergency Response to Railroad Incidents

The agency identified to the investigation that [1] the agency has access to a number of on-line [Internet-sourced] training courses on the topic of railroad emergency response that are routinely utilized by the agency personnel, and [2] the agency typically, but not always, participates in an annual training drill activity, as conducted by the railroad (Caltrain). The most recent training activity attended by the agency occurred in May 2019, which was titled "Caltrain Awareness".

4.2 Execution of the Emergency Response

4.2.1 Event Chronology ("Timeline")

An event chronology ("Timeline") is typically constructed in an investigation, to identify the sequencing facts of the emergency response to the event, and to examine the execution of the emergency response effort (e.g., fire suppression / search and rescue). In support of this, the principal responding emergency services agencies (i.e., the local fire department, law enforcement, EMS) are afforded the opportunity to provide incident response data and communications information as relevant to this accident.

4.2.2 Timeline – Activities of Jurisdictional Fire Department and Responding Emergency Services Support Agencies[55]

An event chronology Timeline [tabulation], describing the execution of the emergency response to the accident, was compiled in the investigation, which is provided in Exhibit 6.

4.2.3 Principal Responding Jurisdictional Emergency Services Agencies / Organizations[56]

[54] Source: SBFD document [describing the SBFD response to the incident], ref email from the SBFD Chief, [subject line] "Responding Agencies List request", dated 3/11/2022.

[55] Source: data of the Timeline tabulation was obtained during incident debriefing interviews with principals (command officers) of the identified emergency services agencies, as conducted by the Technical Working Group Chairperson, and source documentation as made available by the identified emergency services agencies.

[56] Source: SBFD document [describing the SBFD response to the incident], ref emails from the SBFD Chief, to the Group Chairperson [subject line] "Responding Agencies List request", dated 3/11/2022.

A roster of the responding principal jurisdictional emergency services agencies / organizations was compiled in the investigation, which is provided in Exhibit 7.

4.2.4 Apparatus / Other Emergency Services Resources – Response List[57]

A roster of the apparatus (fire trucks), and other emergency services resources that responded to the incident, was compiled in the investigation, which is provided in Exhibit 8.

5.0 Medical and/or Pathology Data[58]

5.1 Injuries Sustained[59]

5.1.1 Train Passenger Injuries[60]

Age	Gender*	General nature of injury
63	F	Hand pain
24	M	Laceration over left eye
45	M	Back pain
36	M	Back and arm pain
34	F	Neck pain
24		Pain in right hip and left wrist
*M = male, F = female		

5.1.2 Railroad Employee Injury[61]

[57] Source: SBFD document [describing the SBFD response to the incident], ref emails from the SBFD Chief, to the Crashworthiness Group Chairperson [subject line] “Responding Agencies List request”, dated 3/11/2022.

[58] The information cited reflects injury data as might have occurred during the on-scene response of the local emergency services agencies / organizations. Note – the data (of this report section) does not reflect injuries as might have occurred during the damage mitigation [site clean-up / recovery] processes / activities, which may have occurred subsequent to the initial on-scene response of the local emergency services agencies / organizations.

[59] Source: informal debriefing interview of the identified agencies / organizations, and as further described.

[60] Source: informal debriefing interview of the EMS contracted services provider (AMR).

[61] Source: quoted statement of the Caltrain - Director of Safety, Training, and Compliance, generically describing the railroad employee injury sustained (ref, email from Caltrain Party participant to the Crashworthiness Group Chairperson, dated 8/02/2022).

"A train crewmember reported falling to the ground of the locomotive upon impact, causing a minor injury to the left rib. The employee was transported by ambulance to a local hospital and was treated and released with no restrictions shortly thereafter."

5.1.3 Railroad Construction Project Employee Injury[62]

One railroad construction project employee was transported by ambulance to a medical facility, for burn injury sustained in the accident. The employee reportedly was treated for his injury, to which, after a period of recuperation, the employee was able to return to work.

5.1.4 Emergency Responder Injuries

There were no injuries to firefighters, law enforcement, or EMS personnel reported to local law enforcement, or to the investigation.

5.1.5 Fatalities

There were none reported to local law enforcement, or to the investigation.

5.2 Medical Facilities Utilized in the Response to the Accident[63]

Facility	Location
Mills-Peninsula Medical Center[64]	Burlingame, CA
Saint Francis Memorial Hospital[65]	San Francisco, CA
Saint Francis Memorial Hospital - Bothin Burn Center[66]	San Francisco, CA

E. **Authorship**

Compiled by: // s // Date August 24, 2022
Richard M. Downs, Jr., P.E.
Mechanical Engineer (Crashworthiness)
Survival Factors – Technical Working Group Chairperson

[62] Source: informal debriefing interview of the EMS contracted services provider (AMR).

[63] Source: informal debriefing interview of the EMS contracted services provider (AMR), and as further described.

[64] Ref, and for further information, see [Internet] https://www.sutterhealth.org/find-location/facility/mills-peninsula-medical-center.

[65] Ref, and for further information, see [Internet] https://locations.dignityhealth.org/emergency-room-saint-francis-memorial-hospital.

[66] Ref, and for further information, see [Internet] https://dignityhealth.org/bayarea/locations/saintfrancis/services/bothin-burn-center.

System Safety Division (RPH-40)

Supervisory review: // s // Date August 24, 2022
Robert J. Beaton, Ph.D., CPE
Chief, System Safety Division (RPH-40)

List of Exhibits

1. Annotated Segment of USGS Topographic (Survey) Map

2. Accident Train – Summarized Technical Specifications

3. Fire Risk Assessment Report

4. Fire Hazard Assessment Report

5. Wreckage Distribution / Aerial Imagery Map - Annotated

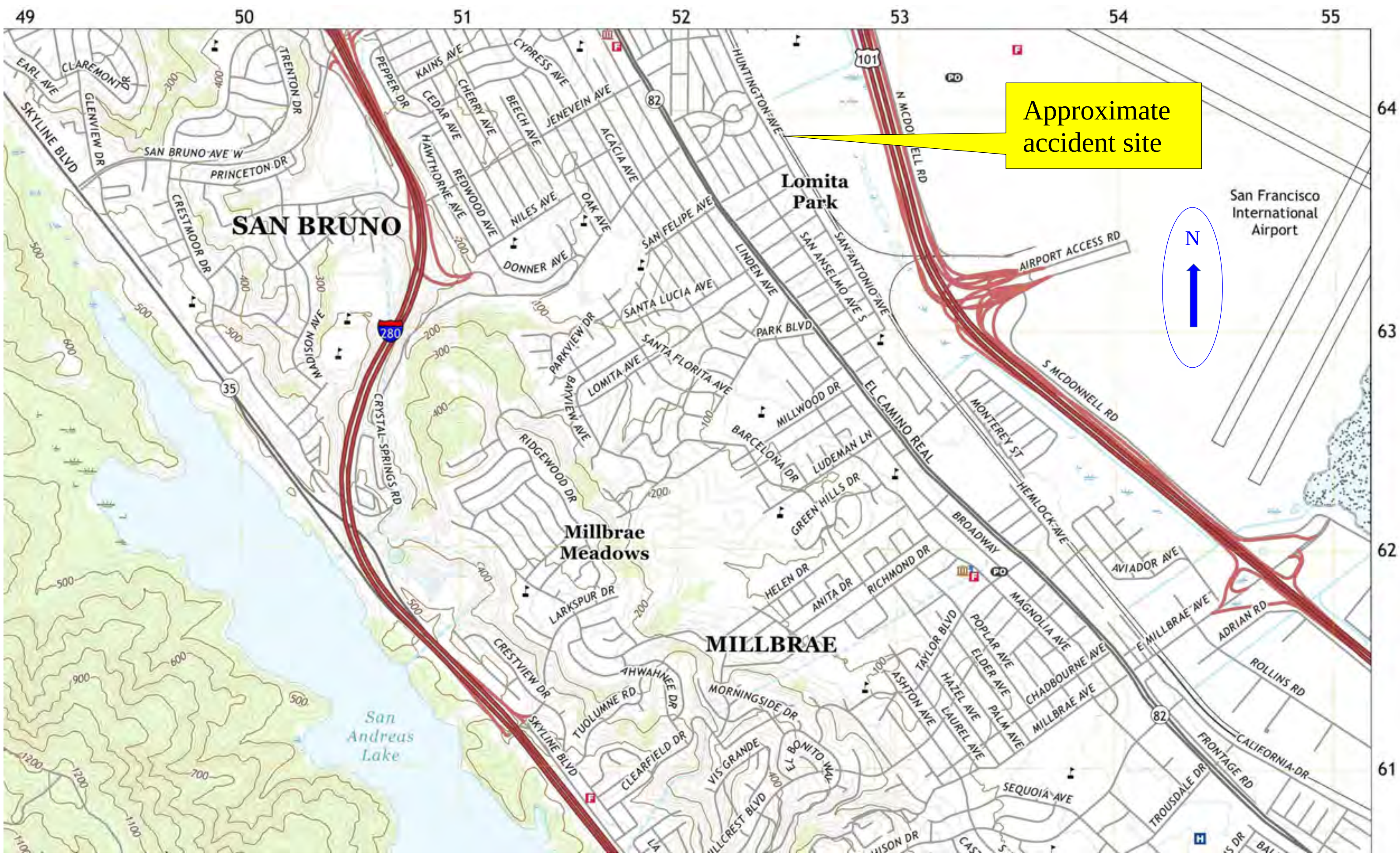
6. Execution of the Emergency Response Activities - Chronology (Timeline)

7. Roster of Principal Responding Jurisdictional Emergency Services Agencies / Organizations

8. Roster of Apparatus and Other Emergency Services Resources – Response List

– End of Exhibits List –

Exhibit 1. Annotated Segment of USGS Topographic (Survey) Map, Proximate to Accident Site[1, 2]



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[1] Excerpt from United States Geological Survey (USGS) topographic survey map, [map ref] Montara Mountain, CA, Quadrangle, [dated] 2022 (7.5 Minute Series, original scale 1:24,000); ref, and for further information, see [Internet] https://ngmdb.usgs.gov.

[2] Annotation by NTSB (SF Group Chairperson) to describe approximate accident site location, and compass (North) label.

Exhibit 2. Accident Train – Summarized Technical Specifications

Equipment type	Road number	Manufacturer (Model) / Year built	Operational Feature(s) / number of seats [of the described passenger cars]	Length	Weight (lbs)
Locomotive	919	EMD[1] (F-40PH-2) / 1987; Overhauled in Feb 2000 by Alstom	Train Operator's cab oriented at the lead ["F"] end	56 ft 2 inch	260,000
Coach	3819	Nippon Sharyo[2] / 1985; Overhauled in 2001 by Alstom	conventional coach seating, both levels / 142	85 ft 0 inch	121,880
Coach	3829	Nippon Sharyo / 1985	conventional coach seating, both levels / 108	85 ft 0 inch	121,880
Coach	3804	Nippon Sharyo / 1985	conventional coach seating, both levels / 142	85 ft 0 inch	121,880
Coach	3863	Nippon Sharyo / 2000	ADA[3] car, otherwise conventional coach seating, both levels / 120	85 ft 0 inch	121,880
Cab-car / Coach	4026	Nippon Sharyo / 2000	Train Operator's control compartment oriented at aft end. Conventional coach seating, lower level fitted with bicycle racks / 78	85 ft 0 inch	124,740

[1] i.e., Electro-Motive Division of General Motors, which is currently operating under the company name Progress Rail; ref, and further information, see [Internet] https://www.progressrail.com.

[2] All of the coach railcars were supplied by the same manufacturer (Nippon Sharyo); ref, and further information, see [Internet] https://www.n-sharyo.co.jp/business/tetsudo_e/pages/zjpb-caltrans.htm.

[3] ref, the Americans With Disabilities Act; the railcar is fitted with appliances to support use by passengers with disabilities (e.g., access ramp to facilitate boarding / egressing the railcar, spaces specifically for wheelchair use), in which, for further information, see [Internet] https://www.ada.gov.

Exhibit 3.

Fire Risk Assessment Report[1]

[1] note - PII [signature + telephone numbers] redacted in attached document

ALSTOM

CANADA
Transport
11/24/2000

Project Management
ACT/JPB-0434 PM

DOC. No.	LTR-1345
Response Due	/ /
COPY	
COPY	
COPY	
FILE	C9.5
FILE	FIRE/TOXIC
FILE	
Caltrain Program Mgmt.	
JPB-ACT-1462	

BOOK IS ON SHELF

Mr. Steve Coleman
CALTRAIN
1250 San Carlos Avenue
P.O. Box 3006
San Carlos, CA
USA 94070

Subject: TS 20.s – Fire Safety and Toxicity Matrix Rev.2
Contract Number: C-60445JPB

Dear Mr. Coleman:

Attached is Revision 2 of the Fire Safety & Toxicity Matrix with the corresponding laboratory test reports all gathered in a single binder.

As discussed at the October 4, 2000, Project Review, this binder is to be updated simultaneously with each update of the matrix. It was agreed that the receiver of a binder would be responsible to update it as need be.

Correspondence JPB-ACT-1163 is answered as follows:

1. Noted.

2. The fire safety criteria to be used by Alstom is the Federal Register Vol. 54, No. 10, dated January 17, 1989.

3. Noted. As agreed at the October 4, 2000, Project Review, agenda item II(C), Alstom is to include all information pertaining to waivers in the appropriate tabbed sections for each non-metallic component.

4. Noted.

5. Noted.

1830, rue Le Ber
Montréal (Québec)
H3K 2A4
Tél. : (514) 925-[redacted]
Fax : (514) 925-

RECEIVED
ALSTOM Canada inc.
Transport
NOV 27 2000

ALSTOM

6. Noted.

7. Items have been added to the matrix.

Sincerely,

[redacted]

Philippe Marée

Enc.

cc:	F. Banko	PB
	A. Rhéaume	AC
	J. Tremblay	Alstom

CALTRAIN OVERHAUL - MATRIX FOR PASSENGER VEHICLE MATERIAL FIRE RISK ASSESSMENT

		MATERIAL			SMOKE AND FLAME						TOXICITY							
Area	**Part Number**	**Item Description**	**Material Trade Name**	**Manufacturer Supplier**	**Testing Procedure**	**Performance Criteria**	**Results**	**Laboratory**	**Date of Testing**	**Reports**	**Testing Procedure**	**Performance Criteria**	**Results**	**Laboratory**	**Date of Testing**	**Reports**	**Tab**	**Comments**
Seat		Foam	CR SAFEGUARD FOAM Batch 0454	CHESTNUT RIDGE FOAM INC	ASTM D3675 ASTM E662 ASTM E662	Is ≤ 25 Ds (1.5) ≤ 100 Ds (4.0) ≤ 175	4 57 107	Bodycote Ortech Bodycote Ortech Bodycote Ortech	8/28/00 8/28/00 8/28/00	00-02-417 00-02-417 00-02-417	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HBr≤100 ppm HCN≤150 ppm	1223 <1 <1 29 <1 <1 7	Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech	8/28/00 8/28/00 8/28/00 8/28/00 8/28/00 8/28/00 8/15/94	00-02-417 00-02-417 00-02-417 00-02-417 00-02-417 00-02-417 00-02-417	A	PASS
		Foam	MT1 MAGNIFOAM	MAGNIFOAM TECHNOLOGY INC	ASTM D3675 ASTM E662 ASTM E662	Is ≤ 25 Ds (1.5) ≤ 100 Δσ (4.0) ≤ 175	22.6 43 70	Govmark Org. Inc Govmark Org. Inc Govmark Org. Inc	4/11/97 4/10/97 4/10/97	2-15361-0-RV 2-15361-1-RV 2-15361-1-RV	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	1496 11100 2 <1 <1 <1 <1 <1	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	11/4/96 11/4/96 11/4/96 11/4/96 11/4/96 11/4/96 11/4/96 11/4/96	96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3) 96-J52-95-5-172(B3)	B	PASS
		Vinyl cover	Ambassador LS	MORBERN	14 CFR 25 14 CFR 25 ASTM E662 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 250 Ds (4.0) ≤ 250	0s 3" 203 220	Diversified Diversified Commercial Testing Co. Govmark	12/3/97 12/3/97 12/8/95 11/2/00	8450 8450 105260 2-31607-0	Bombardier SMP801 . (1995).	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	500 N/A 6.5 1 120 0 N/A 9	Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing	12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95	105259 105259 105259 105259 105259 105259 105259 105259	C	PASS (SMP880 in 1995 was equivalent to BSS-7239, so CO2 and HBr were not tested at that time)
		FRP shroud	ZERCHO 5626 SMC (Mat. Z5625-25)	ZERCHO	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	17.6 6 107	Govmark Govmark Govmark	10/19/95 10/19/95 10/19/95	2-09683-0 2-09683-1 2-09683-1	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	50 <1.5 <3 <0.2 <0.2 <0.2	Govmark Govmark Govmark Govmark Govmark Govmark Govmark Govmark	12/10/96 12/10/96 12/10/96 12/10/96 12/10/96 12/10/96 12/10/96 12/10/96	2-14144-2 2-14144-2 2-14144-2 2-14144-2 2-14144-2 2-14144-2 2-14144-2 2-14144-2	D	PASS
		Fabric	FABRIC 3105-1462 Pattern 3071-1267, Shrunk Retrofitted fabric sample 01-02-S0111	KINGS PLUSH	14 CFR 25 14 CFR 25 ASTM E662 14 CFR 25 14 CFR 25 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 200 Ds(1.5) ≤ 100 FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 200	0,9s 2,7" 54 36 0S 2.1" 105	STI STI Govmark Bodycote Ortech Bodycote Ortech Bodycote Ortech	12/1/99 12/1/99 11/20/98 2/22/01 2/22/01 2/22/01	99C002 99C002 2-21899-0 01-02-111 01-02-111 01-02-111	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	100 20 30 14 <0.2 12	Govmark Govmark Govmark Govmark Govmark Govmark	12/23/97 12/23/97 12/23/97 12/23/97 12/23/97 12/23/97	2-18072-0 2-18072-0 2-18072-0 2-18072-0 2-18072-0 2-18072-0	E	PASS
		Cotton canvas	100% cotton canvas		14 CFR 25 14 CFR 25 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 200 Ds(1.5) ≤ 100	0 3.3 95 43	Ortech Ortech Ortech	1996 1996 1996	95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	245 9150 1 <1 <1 <1 <1 <1	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	1996 1996 1996 1996 1996 1996 1996 1996	95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138 95-J52-79-44-138	F	PASS
		Armcap	NEOPRENE 60 - 70 DURO	EASTWEST ELASTOMER	ASTM C542/C116(ASTM E662 ASTM E662	PASS Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	PASS 39.75 175	Borax Borax Borax	9/30/97 9/30/97 9/30/97	n/a n/a n/a	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	200 2 25 30 50 50	SGS Testing Co. SGS Testing Co. SGS Testing Co. SGS Testing Co. SGS Testing Co. SGS Testing Co.	8/12/99 8/12/99 8/12/99 8/12/99 8/12/99 8/12/99	133216 133216 133216 133216 133216 133216	G	PASS
		Vinyl	Cavalry red	Morbern	14 CFR 25 14 CFR 25 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 250	0 s 1" 418	PFG PFG TEC Inc.	10/10/00 10/10/00 10/2/00	- - -	Bombardier SMP801	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Item of less than 8oz each and less than 5 lbs per car			H	SPEC ITEM Approved with letter JPB-ACT-1291
Flooring	017130975	Floor carpet	Performer 28 PLB 712 Steel 5A	Mohawk	ASTM E648 ASTM E662 ASTM E662	C.R.F. > 5kW/m² Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	8.2kW/m² 2 57	Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing	8/9/96 8/9/96 8/9/96	965400 965400 965400	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm	180 50 10 <50 <1.5	Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing	11/25/98 11/25/98 11/25/98 11/25/98 11/25/98	n/a n/a n/a n/a n/a	I	SPEC ITEM PASS

CALTRAIN OVERHAUL - MATRIX FOR PASSENGER VEHICLE MATERIAL FIRE RISK ASSESSMENT

	MATERIAL				SMOKE AND FLAME						TOXICITY							
Area	Part Number	Item Description	Material Trade Name	Manufacturer Supplier	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Tab	Comments
												HCN≤150 ppm	7	Indpt Textile Testing	11/25/98	n/a		
	017130975	Floor carpet	Performer 28 UPS 712 Steel 5A	Mohawk	ASTM E648 ASTM E662 ASTM E662	C.R.F. > $5 kW/m^2$ Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	$6.6 kW/m^2$ 6 156	Mohawk Industries Indpt Textile Testing Indpt Textile Testing	9/29/00 11/9/01 11/9/01	797 219203 219203	Boeing BSS-7239	CO≤3500 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	<0.1 20 20 <1 5 <2	Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing Indpt Textile Testing	11/9/01 11/9/01 11/9/01 11/9/01 11/9/01 11/9/01	219203 219203 219203 219203 219203 219203	I	PASS
	614128725	Entry Mat	Foyer 9100 Sample tested 91450	Interface Flooring	ASTM E648 ASTM E662 ASTM E662	C.R.F. > $5 kW/m^2$ Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	$10.2 kW/m^2$ 13 254	Testing Services Inc. Testing Services Inc. Testing Services Inc.	7/26/99 7/26/99 7/26/99	14031 14031B 14031B	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Waiting for information from Interface			J	SPEC ITEM Approved with letter JPB-ACT-1290
	046130976 046130977	Rubber ribbed floor Rubber flat floor	TR 204	RCA Rubber	ASTM E648 ASTM E662 ASTM E662	C.R.F. > $5 kW/m^2$ Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	$10 kW/m^2$ 45 156	Hardwood Plywood Mfrs Govmark Govmark	7/22/85 5/13/94 5/13/94	FRP 260 2-04280-0 2-04280-0	Boeing BSS-7239	CO≤3500 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	400 10 23 <1 <1 1	Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc	11/24/97 11/24/97 11/24/97 11/24/97 11/24/97 11/24/97	74687 74687 74687 74687 74687 74687	K	SPEC ITEM PASS
		Glue	3M Super 77	3M	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Δσ (1.5) ≤ 100 Δσ (4.0) ≤ 200	0 0.1 1.1	Southwest Research Inst Southwest Research Inst Southwest Research Inst	1/7/94 1/7/94 1/7/94	01-5919-149c 01-5919-150a 01-5919-150a	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Waiting for information from 3M			M	PASS
	046129766	T-cap moulding	Rubber compound RC 94701	Central Sales & Service I	ASTM C1166 ASTM E662 ASTM E662	Pass Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	Pass 11 176	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	10/30/00 10/30/00 10/30/00	00-02-562 00-02-562 00-02-562	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	1695 15250 <1 24 186 <1 <1 5	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	10/30/00 10/30/00 10/30/00 10/30/00 10/30/00 10/30/00 10/30/00 10/30/00	00-02-562 00-02-562 00-02-562 00-02-562 00-02-562 00-02-562 00-02-562 00-02-562	Y	PASS
Wall	017139974	Wall Carpet - Mohawk 84130 Sample 274-38061-VB6030-54445	84130	Mohawk	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	18.22 32 150	Commercial Testing Commercial Testing Commercial Testing	7/16/98 3/17/98 3/17/98	2929-1286 2893-8917 2893-8917	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	1062 21902 26 38 <1 <1 <1 36	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	9/6/95 9/6/95 9/6/95 9/6/95 9/6/95 9/6/95 9/6/95 9/6/95	95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B) 95-J52-92-77-396(B)	P	SPEC ITEM PASS
	046130978	Wall vinyl - Schneller 11458	GT TRIM G 2002	Schneller	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	1 6 12	Ortech Ortech Ortech	7/3/97 7/3/97 7/3/97	97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C)	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	418 8100 <1 <1 53 6 2 <1	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	7/3/97 7/3/97 7/3/97 7/3/97 7/3/97 7/3/97 7/3/97 7/3/97	97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C) 97-J52-97-42-258(C)	Q	PASS
	615127877 61512881101 61512881102 612127877 61212787601 61212787602 61212787603 612127878 612127879 612127875	Window masks Window end mask Window end mask Window end mask Window end mask Window end mask Window end mask Joint for window mask Joint for window mask Pier panel	Fiber Glass DION FR® 7704	Stillman Northern	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	10 9.9 187.5	Southwest Research Inst Southwest Research Inst Southwest Research Inst	6/24/96 6/20/96 6/20/96	01-7520-295 01-7520-296 01-7520-296	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	3378 24850 <1 2 <1 <1 3	Ortech Ortech Ortech Ortech Ortech Ortech Ortech	10/9/96 10/9/96 10/9/96 10/9/96 10/9/96 10/9/96 10/9/96	96-J52-79-53-498(A) 96-J52-79-53-498(A) 96-J52-79-53-498(A) 96-J52-79-53-498(A) 96-J52-79-53-498(A) 96-J52-79-53-498(A) 96-J52-79-53-498(A)	R	PASS
	002131750	Glue	Fastbond 30NF	3M	ASTM E286 ASTM E286	Is ≤ 35 Ds (1.5) ≤ 100	0 0.3	Southwest Research Inst Southwest Research Inst	1/30/94 1/30/94	01-5919-149b1 01-5919-149b1	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm						Results obtained

CALTRAIN OVERHAUL - MATRIX FOR PASSENGER VEHICLE MATERIAL FIRE RISK ASSESSMENT

MATERIAL					SMOKE AND FLAME						TOXICITY							
Area	Part Number	Item Description	Material Trade Name	Manufacturer Supplier	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Tab	Comments
					ASTM E286	Ds (4.0) ≤ 200	3.7	Southwest Research Inst	1/30/94	01-5919-149b1		NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Item of less than 8oz each and less than 5 lbs per car			S	for Fastbond 50 NF PASS
		Toilet wall Toilet door	Plymetal	Railtech	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	0 1 2	Ortech Ortech Ortech	1/8/98 1/8/98 1/8/98	97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	898 35300 2 <1 4 3 <1 <1	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	1/8/98 1/8/98 1/8/98 1/8/98 1/8/98 1/8/98 1/8/98 1/8/98	97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630 97-J52-86-13-630	T	PASS
	002130004	Gallery edge protection Vinyl	Vinyl - Ambassador LS/PL M04 buff	Morbern	14 CFR 25 14 CFR 25 ASTM E662 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 250 Ds (4.0) ≤ 250	0s 3" 203 220	Diversified Diversified Commercial Testing Co. Govmark	12/3/97 12/3/97 12/8/95 11/2/00	8450 8450 105260 2-31607-0	Bombardier SMP801	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	500 N/A 6.5 1 120 0 N/A 9	Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing Commercial Testing	12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95 12/8/95	105259 105259 105259 105259 105259 105259 105259 105259	C	PASS (SMP880 in 1995 was equivalent to BSS-7239, so CO2 and HBr were not tested at that time)
	612129869 612129870	Foam protection Foam protection	CR Safeguard Batch No. 51380	CHESTNUT RIDGE FOAM INC	ASTM D3675 ASTM E662 ASTM E662	Is ≤ 15 Ds (1.5) ≤ 100 Ds (4.0) ≤ 175	4 57 107	Bodycote Ortech Bodycote Ortech Bodycote Ortech	8/28/00 8/28/00 8/28/00	00-02-417 00-02-417 00-02-417	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HBr≤100 ppm HCN≤150 ppm	1223 <1 <1 29 <1 <1 7	Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech Bodycote Ortech	8/28/00 8/28/00 8/28/00 8/28/00 8/28/00 8/28/00 8/15/94	00-02-417 00-02-417 00-02-417 00-02-417 00-02-417 00-02-417 00-02-417	A	PASS
	615128745 615128746 612130662 01713295	Tool cover Fire extinguisher cover Map schedule holder Form holder	LEXAN MRT	GE Plastics	ASTM E162 ASTM E662 ASTM E662	Is ≤ 100 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	13 2 112	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	1/25/99 1/25/99 1/25/99	99-J52-93-72-13(A1) 99-J52-93-72-13(A2) 99-J52-93-72-13(A2)	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	636 23200 3 <1 <1 <1 <1	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	1/25/99 1/25/99 1/25/99 1/25/99 1/25/99 1/25/99 1/25/99	99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3)	U	PASS
Lighting	027128054 027128062 027128060 027128053 027128061 025128323 027128056 027128055 027128058 027128059 027128057	Lense Lense Lense Lense Lense Lense Lense Lense Lense Lense Lense	LEXAN MRT	GE Platstics	ASTM E162 ASTM E662 ASTM E662	Is ≤ 100 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	13 2 112	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	1/25/99 1/25/99 1/25/99	99-J52-93-72-13(A1) 99-J52-93-72-13(A2) 99-J52-93-72-13(A2)	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	636 23200 3 <1 <1 <1 <1 1	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	1/25/99 1/25/99 1/25/99 1/25/99 1/25/99 1/25/99 1/25/99 1/25/99	99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3) 99-J52-93-72-13(A3)	U	PASS
	615128767 024128593 024128594 61512787101 024128591 024128590 61512876801 61512876802 61512876803	Side window glazing Emergency escape window Emergency escape window Windshield glazing Siding sash window Siding sash window Vest. Door window End door window Side door window	LEXAN MRT	GE PLASTICS	ASTM E162 ASTM E662 ASTM E662	Is ≤ 100 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	1 2 10	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	1/25/99 1/25/99 1/25/99	99-J52-93-72-13(B1|) 99-J52-93-72-13(B2|) 99-J52-93-72-13(B2|)	Boeing BSS-7239	CO≤3500 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	225 14.5 0 0 0 0	VTEC LAB. VTEC LAB. VTEC LAB. VTEC LAB. VTEC LAB. VTEC LAB.	2/14/94 2/14/94 2/14/94 2/14/94 2/14/94 2/14/94	N/A N/A N/A N/A N/A N/A	X	PASS
	61512881101 61512881102 61512787102 61512787103 61512985201 61512985202 61512985203 61512985204 61512985205 61512985206	Side window glazing rubber Side window glazing filler Windshield glazing rubber Windshield glazing filler Vest. Door glazing rubber End door glazing rubber Side door glazing rubber Vest. Door glazing filler End door glazing filler Side door glazing filler	Rubber Compound 24051	SAS Rubber Co.	ASTM C1166 ASTM E662 ASTM E662	Pass Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	Pass 9 164	SGS U.S. Testing Co. Bodycote Ortech Inc. Bodycote Ortech Inc.	6/16/98 7/28/97 7/28/97	109313-2 97-J52-91-39-342 97-J52-91-39-342	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm NO_2≤100 ppm SO_2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	1363 10850 1 13 171 <1 <1 2	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	7/28/97 7/28/97 7/28/97 7/28/97 7/28/97 7/28/97 7/28/97 7/28/97	97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342	Y	PASS
			Rubber compound RC 94701	Central Sales & Service I	ASTM C1166 ASTM E662	Pass Ds (1.5) ≤ 100	Pass 11	Bodycote Ortech Inc. Bodycote Ortech Inc.	10/30/00 10/30/00	00-02-562 00-02-562	Bombardier SMP800C	CO≤3500 ppm CO_2≤90000 ppm	1695 15250	Bodycote Ortech Inc. Bodycote Ortech Inc.	10/30/00 10/30/00	00-02-562 00-02-562		

CALTRAIN OVERHAUL - MATRIX FOR PASSENGER VEHICLE MATERIAL FIRE RISK ASSESSMENT

MATERIAL					SMOKE AND FLAME						TOXICITY							
Area	Part Number	Item Description	Material Trade Name	Manufacturer Supplier	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Tab	Comments
					ASTM E662	Ds (4.0) ≤ 200	176	Bodycote Ortech Inc.	10/30/00	00-02-562		NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	<1 24 294 <1 <1 5	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	10/30/00 10/30/00 10/30/00 10/30/00 10/30/00 10/30/00	00-02-562 00-02-562 00-02-562 00-02-562 00-02-562 00-02-562	Y	PASS
Weatherstrip	216129855 024128524 024128519 024128526	End door rubber edge Sensitive edge side door Sensitive edge vest. Door Air tube	24051 Rubber compound	SAS Rubber Co	ASTM C1166 ASTM E662 ASTM E662	Pass Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	Pass 9 164	SGS Ortech Ortech	16/06/98 28/07/97 28/07/97	109313-2 97-J52-91-39-342 97-J52-91-39-342	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	1363 10850 1 13 171 <1 <1 2	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	28/07/97 28/07/97 28/07/97 28/07/97 28/07/97 28/07/97 28/07/97 28/07/97	97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342 97-J52-91-39-342	Y	PASS
	616129861 616128781 512130687 616128760 616129887 046130920 002116181 002114949 046131625	End door weatherstrip Rubber door bumper Door trim Side door weatherstrip Side door weatherstrip Anti-squeak tape Anti-squeak tape Anti-squeak tape Gasket	NEOPRENE 35/AA	PRO-FLEX	ASTM C1166 ASTM E662 ASTM E662	Pass Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	Pass 17 183	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	9/23/99 9/23/99 9/23/99	99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm HCN□100 ppm	2833 26700 3 151 442 <1 <1 5	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	9/23/99 9/23/99 9/23/99 9/23/99 9/23/99 9/23/99 9/23/99 9/23/99	99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515 99-J52-91-19-515	Z	PASS
HVAC	515127870 515127869	Flexible duct Flexible duct	PORON HT101	ROGERS CORP.	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	2 11 21	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	7/6/99 7/6/99 7/6/99	99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B)	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	157 13650 1 <1 <1 <1 <1 <1	Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc. Bodycote Ortech Inc.	7/6/99 7/6/99 7/6/99 7/6/99 7/6/99 7/6/99 7/6/99 7/6/99	99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B) 99-J52-88-39-369(B)	AA	PASS
	027130965 027130777 027130778 027130776 027130840 027130779 027130784 027130783 027130781 027130780 027131552 027130807 027131554 027131505	Flexible conduit 12mm dia Flexible conduit 23mm dia Flexible conduit 29mm dia Flexible conduit 36mm dia Flexible conduit 17mm dia T connector Adapter Y connector End cap End cap T connector Push in connector End cap Straight connector	Nylon	PMA	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	0 6 36	Ortech Ortech Ortech	4/22/93 4/22/93 4/22/93	93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	270 N/A 5 <1 15 <2 N/A 27	Ortech Ortech Ortech Ortech Ortech Ortech Ortech Ortech	4/22/93 4/22/93 4/22/93 4/22/93 4/22/93 4/22/93 4/22/93 4/22/93	93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170 93-T52-91-90-170	AB	PASS (SMP880 in 1995 was equivalent to BSS-7239, so CO2 and HBr were not tested at that time)
		Insulation padding	ARMAFLEX AP	CHAMBERLIN RUBBER	ASTM D3675 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	1 13 25	Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc	3/3/00 3/3/00 3/3/00	00-02-111(A) 00-02-111(A) 00-02-111(A)	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	312 13850 16 2 51 <1 1 15	Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc	3/3/00 3/3/00 3/3/00 3/3/00 3/3/00 3/3/00 3/3/00 3/3/00	00-02-111(A) 00-02-111(A) 00-02-111(A) 00-02-111(A) 00-02-111(A) 00-02-111(A) 00-02-111(A) 00-02-111(A)	AC	PASS
Insulation	049129729	Glass Fiber Insulation	Spin-Glas 814 FSK	DISPRO	ASTM 162 ASTM E662 ASTM E662	Is ≤ 25 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	0 1 1	Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc	4/19/99 4/19/99 4/19/99	99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B)	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm	198 16200 2 2 <1 <1 <1 3	Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc Bodycote Ortech Inc	4/19/99 4/19/99 4/19/99 4/19/99 4/19/99 4/19/99 4/19/99 4/19/99	99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B) 99-J52-79-44-190(B)	AD	PASS
	047130028	Sound deadener	Coating 368	Daubert Chemicals	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	3 10.77 59.58	SGS US testing SGS US testing SGS US testing	10/19/99 10/19/99 10/19/99	131296-001 131296 131296	Boeing BSS-7239	CO≤3500 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤200 ppm	400 10 10 0 0	SGS US testing SGS US testing SGS US testing SGS US testing SGS US testing SGS US testing SGS US testing	10/19/99 10/19/99 10/19/99 10/19/99 10/19/99 10/19/99 10/19/99	131296 131296 131296 131296 131296 131296 131296	AE	PASS

CALTRAIN OVERHAUL - MATRIX FOR PASSENGER VEHICLE MATERIAL FIRE RISK ASSESSMENT

MATERIAL					SMOKE AND FLAME						TOXICITY							
Area	Part Number	Item Description	Material Trade Name	Manufacturer Supplier	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Testing Procedure	Performance Criteria	Results	Laboratory	Date of Testing	Reports	Tab	Comments
												HCN≤150 ppm	5	SGS US testing	10/19/99	131296		
Wire and cables		Wire and cable	110C Polyrad XT	BICC General	ANSI/EEE 383 ASTM E662	PASS Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	PASS 8.05 134.38	Bicc Brand Rex Co Intertek Testing Services Intertek Testing Services	12/2/92 5/18/00 5/18/00	41551-10-01 J99027061-R1-002 J99027061-R1-002	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Waiting for information from			AM	PASS
Cab seat	024130988	Vinyl covering	Phoenix 6474	Uniroyal	14 CFR 25 14 CFR 25 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 200	1.6 s 2.6" 162	United States Testing Co United States Testing Co United States Testing Co	9/6/90 9/6/90 9/6/90	008070-1 008070-1 008070-6	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Waiting for information from USSC			AN	PASS
		Backshell	Kydex 6200 52114 P-	Kleerdex Company	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	1.25 20 158.9	Southwest Research Inst Southwest Research Inst Southwest Research Inst	11/18/99 11/29/99 11/29/99	01.03048.01.044a 01.03051.01.018b 01.03051.01.018b	Boeing BSS-7239	CO≤3500 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	100 trace 3 1000 1400 ND	Southwest Research Southwest Research Southwest Research Southwest Research Southwest Research Southwest Research	1/4/00 1/4/00 1/4/00 1/4/00 1/4/00 1/4/00	01.03051.01.021 01.03051.01.021 01.03051.01.021 01.03051.01.021 01.03051.01.021 01.03051.01.021	AO	PASS
		Foam	CR SAFEGUARD FOAM	CHESTNUT RIDGE FOAM INC	ASTM D3675 ASTM E662 ASTM E662	Is ≤ 15 Ds (1.5) ≤ 100 Ds (4.0) ≤ 175	6.28 72 123	Commercial Testing Co. Hardwood Plywood Lab Hardwood Plywood Lab	4/30/97 5/2/96 5/2/96	110425 S-1212 S-1212	Boeing BSS-7239	CO≤3500 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤200 ppm HCN≤150 ppm	150 3 N.D. N.D. 28 2	Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc Herb Curry Inc	8/15/94 8/15/94 8/15/94 8/15/94 8/15/94 8/15/94	41432 41432 41432 41432 41432 41432	A	PASS
iscellaneous		Vinyl covering Observer seat	Phoenix 6474	Uniroyal	14 CFR 25 14 CFR 25 ASTM E662	FLAME TIME ≤ 10s BURN LENGTH ≤ 6" Ds (4.0) ≤ 200	1.6 s 2.6" 162	United States Testing Co United States Testing Co United States Testing Co	9/6/90 9/6/90 9/6/90	008070-1 008070-1 008070-6	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Waiting for information from USSC			AN	PASS
	024115853	Toilet seat	Noryl SE-100 Polypropylene	BENEKE	FAR 25.853 (vertical) Method 1 - 60 sec.	FLAME TIME ≤ 10s BURN LENGTH ≤ 6"	7.47 3.1	CAROL's Aircraft Interiors, Inc	4/13/94	Test # 917	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Item of less than 5 lbs per car			AX	-
	012114950 046130289	Reclosable fastener Reclosable fastener	SJ 3552 SJ 3551	3M	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	26.72 17.7 104	Southwest Research Inst Southwest Research Inst Southwest Research Inst	4/8/94 2/4/92 2/4/92	01-5919-293a 01-4510-213 01-4510-213	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Item of less than 8oz each and less than 5 lbs per car			BA	PASS
		Double Sided Tape	VHB 4936	3M	ASTM E162 ASTM E662 ASTM E662	Is ≤ 35 Ds (1.5) ≤ 100 Ds (4.0) ≤ 200	34 9 21	Southwest Research Inst Southwest Research Inst Southwest Research Inst	7/24/89 7/24/89 7/24/89	01-2601-303 01-2601-302 01-2601-302	Bombardier SMP800C	CO≤3500 ppm CO2≤90000 ppm NO2≤100 ppm SO2≤100 ppm HCl≤500 ppm HF≤100 ppm HBr≤100 ppm HCN≤100 ppm		Item of less than 8oz each and less than 5 lbs per car			BB	PASS

– End of Exhibit –

Exhibit 4.

Fire Hazard Assessment Report[1]

[1] note - PII [signature + telephone numbers] redacted in attached document

Caltrain®

TRANSIT OPERATIONS

FEB 18 11 34 AM '04

February 17, 2004

Mr. David Mao
Mechanical Engineer, Motive Power and Equipment Division
Office of Safety Assurance and Compliance
Federal Railroad Administration, Mail Stop 25
400 7th Street S. W., Washington D.C. 20590

Dear Mr. Mao:

This letter is in response to communications from Mr. George Gavalla, Associate Administrator for Safety, Federal Railroad Administration, concerning submissions related to 49 CFR, Part 238. Enclosed, you will find the following documents; Caltrain's Fire Hazard Assessment, completed January 1, 2001; Fire Hazard Assessment completed by Sound Transit and reviewed/approved by Caltrain staff for new Bombardier passenger cars purchased from Seattle in 2002; Fire Hazard Assessment for new Locomotives, completed January 10, 2003; The Caltrain Safety and Security Certification Plan; and the Caltrain Configuration Management Standard Operating Procedure.

The preliminary Caltrain's Fire Hazard Assessment, completed January 1, 2001, found no significant fire safety hazards. Every new addition of rolling stock following this initial analysis is required to not only have its own Fire Hazard Assessment, but must also undergo review of both a "System Modification Review Committee" and a "Safety and Security Certification Committee". These two additional processes ensure that nothing in the operating environment will introduce unacceptable risks when actual operations are integrated with the rolling stock. These processes also ensure an update to the Caltrain Fire Hazard Analysis if such configuration changes should adversely affect fire safety on our system.

As noted, the letter from Mr. Gavalla makes mention of compliance dates for this regulation having past. Each requirement for compliance was enthusiastically met on time by Caltrain. Our staff was the first to volunteer through APTA for a review of our efforts by both APTA and FRA. Unfortunately, APTA and FRA cancelled the scheduled review last year. We are prepared for further reviews and will welcome a new scheduling at your convenience. If your agency would like to establish a new schedule for a review of our programs or for any other questions related to Part 238 compliance, please contact our Safety Officer, Christopher Payne, 650.508.[redacted]

Sincerely,

[redacted]

3/15/04 Dist to
JK
S Coleman

Michael J. Scanlon
Executive Director

C: Chris Payne
Chuck Harvey
George Cameron

Fire Hazard Assessment

PREPARED FOR:

Caltrain™

JPB Project Manager: - Christopher Payne: Safety Officer, Rail

Work Conducted under subcontract to Parsons Transportation Systems

Program Manager: William Shafer

By

Fire Cause Analysis

213 West Cutting Blvd

Pt Richmond CA 94804-2015

Project Manager

Joseph B. Zicherman, Ph.D., SFPE

[redacted]@fcafire.com

March 2001

Executive Summary

Caltrain is a commuter rail system serving the San Francisco Peninsula. Along with other commuter systems it has developed a heightened awareness of fire safety issues. This fact, along with recent Federal Railway Administration (FRA) regulations has led to the preparation of this system-wide Fire Safety Analysis.

Parsons Transportation Systems and Fire Cause Analysis, a Division of IFT, Inc. in association with and under contract to Caltrain, conducted this project.

The Caltrain system has been evaluated according to conformance with specific fire safety performance goals, rather than individual prescriptive requirements and is thus performance-based. The primary method of analysis used in this study was the American Public Transportation Association (APTA) RP-PS-005-00, *Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment.* Additional methodologies were used and are described in the body of this report.

Figure 1: Caltrain Station, FCA photo

The specific steps followed in this analysis were:

- To compile, as accurately as possible, a historic record of equipment fire incidents.
- To inventory, from a fire safety point of view, of each type/design of equipment used in passenger service.
- To determine the number and characteristics of significantly different operating environments present on the railroad.
- To determine the number of categories of equipment and service in operation on the railroad and developed a fire safety analysis for each one.
- To develop a list of significant ignition sources for each category of equipment and service.
- To assess the hazard severity impact, considering existing fire safety design features and other countermeasures, for each category of equipment and service.
- To identify fire scenarios that could result in personal injury to passenger or crew were identified.
- To estimate the frequency of occurrence and the consequences of the fire scenarios/incidents resulting from ignition source hazards identified.
- To develop approaches to monitor, track and update the Caltrain System Safety Program Plan (SSPP) draft. Present and make recommendations for the implementation of a program to keep more complete and accurate fire incident records.

Figure 2: Typical Caltrain ROW through San Mateo County, FCA photo

Caltrain's right-of-way includes approximately 78 miles of track (San Francisco to Gilroy). There are 35 stations distributed over this right-of-way. Nine stations are staffed (4th and King, Millbrae, Burlingame, San Mateo, Hillsdale, Palo Alto, California Avenue, Sunnyvale, and San Jose Diridon). Seven stations (Millbrae, Burlingame, San Carlos, Menlo Park, Palo Alto, Santa Clara, San Jose) are listed on the National Register of Historic places. Approximately 28,000 commuters per day use the system.

Between San Francisco and San Jose, the right-of-way travels through an urban environment, with an average population density of approximately 8,000 persons per sq. mi. Between San Jose and Gilroy, the operating environment becomes significantly more rural, with an average population density of 100 persons per square mile.

The right-of-way consists of a minimum of two tracks, one for each direction except for one short single-track section 18.5 miles long on Union Pacific's ROW south of San Jose. Four railroads, in addition to Caltrain, operate on the "Joint Power Board" (JPB) right-of-way. A total of 80 trains operate on the right-of-way per day.

The primary Caltrain fleet of rolling stock includes 23 diesel locomotives operating in push-pull mode and 94 gallery style bi-level passenger cars. Of the latter 21 are cab cars and the balance (73) are trailers.

The set of 94 gallery cars were all designed and built by Nippon Sharyo Seizo Kaisha of Japan and were purchased by Caltrain in two generations. Initial purchases began in the early 1980's and a newer generation of similar vehicles is currently being delivered. The original gallery cars are currently undergoing completing rehabilitation. This situation assures that all Caltrain vehicles in routine day-to-day use include state of the art, fire-resistant materials.

A typical train (consist) in weekday service is made up of one locomotive and 4 passenger cars and weighs approximately 375 tons. Caltrain may run up to seven cars per train when service coincides with special events, such as San Francisco Giants baseball games.

In addition to the primary Caltrain gallery style car fleet, 14 "VRE" cars including both cab cars and trailers were purchased from the Virginia Railway Express in April 2000. These are single level cars originally purchased for commuter DMU service by the MBTA in greater Boston. Subsequent to their original construction their diesel engines were removed and they were reconfigured for cab or trailer use with diesel electric locomotives. At Caltrain they are used to supplement the primary car fleet and provide extra capacity for special events when needed.

Fire incident information reviewed from Caltrain data sources covered six of the last seven years. Sources included Caltrain's Daily Reports, the Amtrak Safety Information System (ASIS) database, and the California Fire Incident Reporting System (CFIRS) database. First responders stationed along the Caltrain ROW were interviewed to provide a separate source of information.

The only source of information that showed any fire related incidents or overheatings were the "daily reports" and none of these incidents were serious. During those 7 years an average of four incidents per year of fire/smoke or equipment parts "burned" or subjected to overheated conditions were noted. The daily reports also included fire incidents along the ROW, which are unrelated to train operations. The lack of significance of these incidents was corroborated by the data compiled from other reporting sources such as ASIS and CFIRS, which did not show *any (serious) fire incidents* having occurred which affected Caltrain passenger service.

Caltrain's schedule indicates that the system provides approximately 33 billion (3.26×10^{10}) passenger miles per year. This translates to one "fire" incident every 8 billion-passenger miles based on the raw data provided by the daily reports. ***None of the incidents identified resulted in injuries to passengers or crew.***

Only one incident in the last 7 years was serious enough to involve a local fire department and by the time they arrived the incident was over. None of the others resulted in significant damage to rolling stock or seriously affect train service. However they do warrant recording as "an incident" with an outcome. The fact that none of these incidents led to fire growth-endangering passengers or crew attests to the robust nature of Caltrain's equipment.

After reviewing Caltrain's operating environment it appears that the greatest potential fire safety problems are associated with grade crossings. By comparing information on grade crossing incidents with the total number of fire incidents (as well as the seriousness of the fire incidents), it can reasonably be argued that Caltrain's fire safety record is so high that the best mitigation strategy to protect the public would be to expend disproportionate resources from those used at present to reduce the number of crossing accidents. As such, resources used to maintain the current, high level of fire safety appear appropriate and effective.

Caltrain's System Safety Plan draft is consistent with the recommendations of the APTA working group, which developed the recommended practice on which it is based. However the draft plan does not contain sections specifically related to fire safety or training to address potential fire situations. This should be reviewed.

In conclusion, review and analysis of Caltrain's fire incident data shows that the system does not have a significant - or even an insignificant - fire safety problem. Perhaps the most important observation that can be made is the fact that the fire safety system in place at Caltrain functions quite well. In *all* cases serious fire incidents threatening passengers or crew have been avoided. The challenge of the situation is to provide enhanced record keeping capabilities to answer questions as to how the system wide high level of fire safety has been accomplished

Foreword

This report is the product of work on behalf of Caltrain undertaken in response to recent Federal requirements requiring all passenger railroads in the US to conduct a detailed Fire Hazard Assessment.

The work was undertaken with leadership for the program for Caltrain being provided by Christopher Payne, Safety Officer – Rail.

Parsons Transportation Systems acted as subcontract manager with Bill Shafer, PE as project manager.

The work was assisted by Caltrain personnel Steve Coleman, Walt Stringer, Betty Ann Buckley, Mark Hennessy, Manager of Maintenance of Way, David Olmeda, Kathleen Holt, Rail Analyst, and Steven Frew, Security Manager.

Amtrak personnel Fred Jackson, Director of Safety Amtrak West, John Fallowfield, Tom Pollard, Ed Rielgel, Kathy Virdure, Material Control Clerk, Lisa Figueroa, Manager Material Control, Dave Mottershead and Dave Dozier, Amtrak Maintenance – San Francisco.

Conducting the analysis for Fire Cause Analysis were Joseph B. Zicherman Ph.D. project leader and engineers Scott D. Alber, PE (Mechanical and Fire Protection), Jim Gourley, PE (Fire Protection) and Frank Hsu, Ph.D. and PE (Mechanical). Assisting them were Ariane Hurley and Gloria Haskins, research associates at FCA.

Table of Contents

1. Introduction

Over the past few years, Caltrain has developed a heightened appreciation for the importance of fire safety issues associated with their passenger vehicles and locomotives. This is consistent with ongoing United States Federal Railway Administration (FRA) evaluations of their own regulations, guidelines and procedures as well as FRA initiatives with the railroads they regulate. These initiatives include the Passenger Rail Equipment Safety Standards (PRESS) program. This program has included a major focus on fire hazard assessments addressing not only vehicles, but also the anticipated fire performance of those vehicles and associated personnel and first responders in their specific working environments.

1.1 FRA Requirements

As part of the Federal efforts in the railroad fire safety area, a requirement was recently adopted by the FRA which mandates that authorities providing commuter and inter-city passenger rail service conduct a comprehensive, system wide Fire Safety Analysis. The requirement is documented in 49 CFR Part 238.103(d) dated May 12, 1999[2] (Appendix I). The preliminary analysis associated with this requirement is required to be completed by January 10, 2001.

To address this requirement, Caltrain, a commuter rail serving the San Francisco Peninsula has retained Parsons Transportation Systems and Fire Cause Analysis, a Division of IFT, Inc. to conduct this analysis.

The analysis conducted has been performance based. The Caltrain system has been evaluated according to how well it meets specific performance and fire safety goals, rather than individual prescriptive requirements. In the Federal requirements calling for this analysis, the format of the Fire Safety Analysis is essentially left to the discretion of the individual railroad involved.

However, the analysis (preliminary and final) must be reasonably defined and determine what fire safety risks are acceptable to Caltrain. Any unacceptable risks, which might be found to be present by the project team, are to be documented (and included in the analysis report) and immediate mitigation schemes and/or recommendations are to be developed for implementation consistent with the Federal mandate.

The specific goal of the FRA requirements is to identify and mitigate any and all unacceptable fire safety risks on a system-by-system basis. In addition to the identification of such unacceptable fire safety risks, this analysis will aid Caltrain in the development of a prioritized mitigation strategy to address any other potential but less immediate fire safety hazards identified.

The identification process followed includes delineation of all potential ignition sources as well as potentially mitigating features found in vehicle and system designs. This includes construction features and designs used, heat/smoke detection systems if present, observed variations in vehicle construction materials from FRA guidelines (begun in 1979 and updated in 1989), as well as mandated fire performance criteria provided in the most current Federal regulations.

Importantly, the analysis also considers potential personnel responses including the availability of safe routes of egress of passengers from the interior of an effected car to areas of refuge/safe haven, training and potential actions by operating personnel and availability and accessibility of affected trains to first responders.

1.2 Scope

The scope of this study has involved a systematic evaluation of the levels of fire safety at Caltrain. Although the analysis included evaluations of the fire safety performance of individual components and systems, the evaluation of these systems and components was done in the context of the overall environment under which the system operates. Environmental factors evaluated which potentially affect fire safety levels include terrain, grade crossings, tunnels and bridges, other rail services utilizing Caltrain's right-of-way, and the population that utilizes Caltrain's services, to name a few.

Although we have listed several study methodologies in the following section, this study most closely follows the methodology contained in the American Public Transportation Association (APTA) RP-PS-005-00, *Recommended Practice for Fire Safety Analysis of Existing Passenger* Rail *Equipment*. In addition, the APTA methodology has been complimented by the utilization of other system analysis methodologies discussed below.

Finally, Caltrain stations or maintenance facilities have not been included in this analysis. This is due in part to the fact that the focus of our scope is the fire safety of operating commuter trains carrying passenger and crew in their operating environment. Also, the passenger cars do not physically enter either of these facilities except in the case of a shed in the San Jose maintenance facility. In the case of the stations, passengers waiting for the arrival of a train do so on an open platform and as such, there are no areas in a station for smoke or products of combustion from a burning train/consist to accumulate. Therefore, safety, points of refuge and egress of passengers to and from the stations is not affected by train operations.

1.3 System Evaluation

In approaching this analysis, FCA personnel undertook to review all available operational records that might have contained fire incident information having potential impact on the safety of Caltrain personnel and passengers. Other data sources that covered longer periods than available through Caltrain were also reviewed. In addition, fire safety related operating protocols were reviewed, vehicles evaluations were conducted and safety practices scrutinized.

Individual daily morning reports covering the last seven years and compiled by Caltrain were reviewed to assemble the fire incident information presented here. Approximately 2800 reports from the years 1992 through October 2000 (excluding 1997-those reports were unavailable) were reviewed. Any report that included reference to a fire - or an incident that had the potential to develop into a fire – was annotated and included for specific analysis. These led to a total of 345 incidents being categorized.

Contact was established with first responders associated with the Caltrain right-of-way and interviews were conducted to evaluate their experiences related to fire hazards associated with the Caltrain system independent of the information provided directly by Caltrain.

Caltrain operating personnel were also interviewed and practices and records evaluated.

In summary, the following steps were performed:

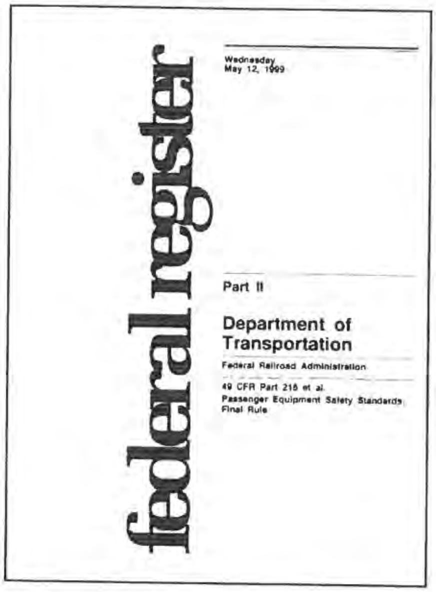
1. A review of fire safety record keeping methodologies followed at Caltrain as well as by its Amtrak contract operator.
2. Interviews with Caltrain and Amtrak (contractor) operating personnel.
3. Vehicle evaluations. Vehicle designs were evaluated through:
   - Replicate inspections of vehicle types and generations of vehicles within vehicle types.
   - Review of available vehicle design data.
   - Review of purchasing and specification approaches and associated documents.
   - Reviews of maintenance practices
   - Egress and emergency access design related issues
   - Fire testing of components where necessary
4. Safety practice evaluations. Safety practices were evaluated through:
   - A review of the training of operating personnel
   - A review of the operational practices followed by operating personnel.
   - A review of the training and contingency planning with first responders and other stakeholders consistent with FRA 239[2]
   - A review of the draft Caltrain System Safety Program Plan (SSPP)[7]
   - Interviews with Caltrain operating personnel and items reviewed by reference
   - A review of the operating environment focusing on egress and right of way accessibility issues.
   - A reviews of track charts
   - Observations and inspections of selected features of the right of way including tunnels.

For a list of all documents reviewed and other items considered see Appendix VI.

1.4 Methodology

As previously indicated, the study conducted has been performance-based. We believe this is consistent with the intent of the FRA, which has not prescribed a specific methodology or methodologies to be used by the railways in conducting the required analysis. However, in addressing the preparation of a fire safety analysis for procuring new passenger equipment the FRA requirements state that MIL-STD-882D (which is a system safety based approach) or another formal alternative should be used as a guide to the methodology for the study.

As such, FCA has utilized the approaches and references described below and others as noted to assist in conducting this analysis for Caltrain:


federal register

Wednesday
May 12, 1999

Part II

Department of Transportation

Federal Railroad Administration

49 CFR Part 216 et al.
Passenger Equipment Safety Standards; Final Rule

1. Department of Transportation-Federal Railroad Administration-49 CFR Part 216 et al. Passenger Equipment Safety Standards; Final Rule-May 12, 1999 [2]

As noted above, the FRA Final cited does not prescribe a methodology for conducting a fire safety systems analysis of rail passenger systems. However, the need for and applicability of systems methodologies can be discerned from the concerns voiced by the FRA in its regulations. Those concerns for example have resulted in requirements intended to lead to the identification and mitigation of unacceptable fire safety risks, which may be unique to each system evaluated. As such, the methodology used in this Caltrain study has been developed to accomplish the following per FRA regulations:

- Identify and prioritize foreseeable fire hazards inherent in the design of the particular set of equipment and the environments in which these operate on a given railroad.
- Analyze the features of each type of passenger car ventilation systems such that these systems will not adversely affect the lethality potential of a fire incident affecting the passenger car.
- Identify components that demonstrate an unacceptable fire risk potential, and/or which can foreseeably lead to an unsafe condition due to overheating.
- Identify any unoccupied train compartments in the rolling stock, which may pose a fire hazard. Analyze the benefit and efficacy of including fire/smoke detection devices in these compartments.
- Assess the condition of existing fire safety equipment, such as fire extinguishers, and provide recommendations for additional equipment or features if necessary.

2. American Public Transportation Association (APTA) RP-PS-005-00 – Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment [1]

APTA petitioned the FRA related to the rule text and noted that in conducting the required fire safety analyses each individual railroad would be required to make critical, subjective judgments concerning fire safety. APTA also noted that railroads, particularly those without in-house engineering staffs, would need additional specific guidance to assist them in making the subjective judgments required.

In addressing this issue APTA, through a voluntary industry-working group, developed the above captioned document to assist individual passenger railroad operators in preparing the required fire safety analysis. Listed below are the steps found in APTA's *Summary of Recommended Fire Safety Analysis Steps:*

1. Compile, as accurately as possible, an historic record of equipment fire incidents. If necessary, operating histories of other railroads using similar equipment and/or operating in similar environments may be used.
2. Implement a program to keep complete and accurate fire incident records. Also, establish a reliable method(s) to retrieve fire incident data.
3. Take an inventory, from a fire safety point of view, of each type/design of equipment used in passenger service.
4. Determine the number and characteristics of significantly different operating environments present on the railroad.
5. Determine the number of categories of equipment and service in operation on the railroad. *A separate fire safety analysis must be done on each category.*
6. Develop a list of significant ignition sources for each category of equipment and service.
7. Assess the hazard severity impact, considering existing fire safety design features and other countermeasures, for each category of equipment and service.
8. Identify fire scenarios that could result in personal injury to passengers and crewmembers.
9. Estimate the frequency of occurrence and the consequences of the fire scenarios/incidents resulting from ignition source hazards not resolved in Step 8. Use these estimates to determine the priority of remedial action.
10. Develop and execute a fire safety remedial action plan for any category of equipment and service that has an unacceptable fire risk rating.
11. Apply countermeasures to fire hazards that pose unacceptable risks in terms of the likelihood of the selected fire scenarios/incidents and re-evaluate.
12. Monitor, track, and update the fire safety remedial action plans.

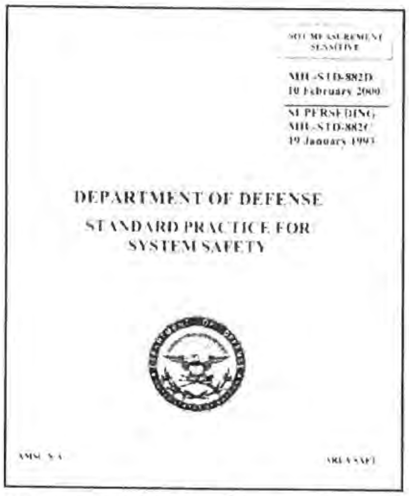
3. American Society for Testing and Materials (ASTM) E 2061-00, Guide for Fire Hazard Assessment of Rail Transportation Vehicles [3]

> ASTM Designation: E 2061 – 00
>
> **Guide for**
> **Fire Hazard Assessment of Rail Transportation Vehicles[1]**
>
> This standard is issued under the fixed designation E 2061; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ASTM E 2061 uses a performance-based approach to assess fire safety in rail transportation vehicles. Their approach requires developing all crucial fire scenarios that must be considered, and evaluating the effect of all foreseeable rail car contents/components as well as rail passenger vehicle design factors which could potentially affect the level of resulting fire hazard.

The steps to be used in conducting a fire hazard assessment are detailed in Item 7 of the guide, which we have summarized below:

- Develop and identify the fire safety objectives to be achieved.
- Specify the design being assessed such that the fire safety performance of the design can be tested and/or modeled.
- Specify the fire scenarios for which the design must meet the fire safety objectives.
- Specify the assumptions made, such as environmental conditions.
- Use testing and calculations to determine whether the objectives will be met by a specified design for a specified fire scenario.


NOT MEASUREMENT SENSITIVE

MIL-STD-882D
10 February 2000

SUPERSEDING
MIL-STD-882C
19 January 1993

DEPARTMENT OF DEFENSE
STANDARD PRACTICE FOR
SYSTEM SAFETY

AMSC N/A
AREA SAFT

4. Department of Defense-Standard Practice for System Safety-MIL-STD-882D; 10 February, 2000 [4]

This standard practice was developed to address the management of environmental, safety, and health risks that may be encountered in the development, test, production and disposal of DOD systems. The requirements in this standard are intended to ensure identification and understanding of all known hazards and their associated risks. Consistent with the methodologies previously listed, the objective of the standard is to achieve *acceptable mishap risk* through a systematic analysis of the hazards associated with each system. The methodology recommended by the standard is summarized below:

- Document the system safety approach; i.e., identify each hazard analysis and mishap risk assessment process used.
- Identify hazards through a systematic hazard analysis of system hardware, the environment in which the system is to be used, and the intended use of the system.
- Assess the severity and probability of the mishap risk associated with each identified hazard.
- Identify mishap risk mitigation alternatives and their effectiveness.
- Reduce the mishap risk to an acceptable level through an approach mutually agreeable to all of the stakeholders.
- Verify mishap risk reduction and mitigation through appropriate analysis, testing and inspection.

- Review the hazards and acceptance of residual mishap risk by the appropriate authority.
- Track the hazards, their resolution/closures, and the residual mishap risk.

5. National Fire Protection Association (NFPA) 130-Standard for Fixed Guideway Transit and Passenger Rail Systems-2000 Edition [6]

NFPA 130

Standard for

Fixed Guideway Transit and Passenger Rail Systems

2000 Edition

In contrast to the methodologies detailed above, NFPA 130 takes an essentially prescriptive approach to fire safety. This is in part due to the fact that the purpose of this standard is to establish *minimum requirements* to provide a *reasonable degree* of fire safety. However, it does allow performance-based approaches to be used provided the approach yields equivalent or superior fire safety to that provided by the standard.

Appendix D of the standard suggests a series of rather dated test and evaluation procedures for conducting a Fire Hazard Assessment of passenger car rail vehicles. The goal of the NFPA's assessment is to provide adequate time for evacuation in the event of a fire before the vehicle compartment becomes untenable, and to prevent a self-propagating fire.

The methodology recommended by NFPA is to conduct hazard load calculations. This methodology compares heat and visible smoke heat release rates developed during standard tests. The tests recommended by NFPA are ASTM E 906-*Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products*, and ASTM E 1354-*Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*. Using these tests, the btu and smoke values for all items are totaled. This total value is then divided by the volume of the vehicle to convert the value to btu/cu. ft. The maximum permissible value of the heat hazard load is 80 btu/cu. ft.

It is important to note that this standard does have some things in common with the methodologies previously discussed. The commonalties are contained in Section 1-3 of the standard. That section states "*fire safety shall be achieved through a composite of facility design, operating equipment, hardware, procedures, and software systems that are integrated to provide requirements for the protection of life and property from the effects of fire.*" That section suggests a systematic approach to considering fire safety solutions. It also indicates "*the level of fire safety desired for the whole system shall be achieved by integrating the required levels for each subsystem.*"

F. Society of Fire Protection Engineers (SFPE) Engineering Guide to Performance Based Fire Protection Analysis and Design of Buildings [5]

Although this guide was written for the design and analysis of buildings, the principles detailed in the guide are applicable to a variety of systems. The general steps applicable from the SFPE methodology to the analysis being conducted here are as follows:

- Define the project scope.

- Identify fire safety design goals.
- Define stakeholder and design objectives.
- Develop performance criteria.
- Develop Design Fire Scenarios.
- Evaluate the system design performance per the stakeholder and design objectives.
- Where the design does not meet the objectives, develop a mitigation strategy to meet the design objectives, or modify the design objectives.

For the evaluations required to address the FRA regulations and to execute the required fire hazard analysis for Caltrain, FCA developed an overall analytical framework. This framework addressed the requirements (summary five points presented above) in the final FRA rule by addressing as a minimum, the 12 steps of the APTA recommended practice.

The APTA methodology has been used as an outline to accomplish the necessary tasks since it was by far the most detailed in addressing the parameters of commuter railroad fire safety issues.

However, knowing that there could be additional factors worthy of consideration in conducting the analysis, the other documents listed were reviewed and where appropriate their contents were systematically applied in conducting this study for Caltrain. These approaches, it turned out, each addressed some but not all of the items called for in the APTA methodology. To summarize how the FRA requirements and the analytical frameworks available inter-related, the steps for each methodology were enumerated and are summarized and compared with the APTA methodology by task in the table below.

Table 1: Comparison of Fire Hazard Assessment Approaches

APTA Task	APTA RP Step Number	FRA Requirements	ASTM E-2061	Mil Spec 882	NFPA 130*	SFPE Methodology
Compile Fire Safety History	1	1,3,4				
Implement Improved Fire Safety Record Keeping	2	na				
Inventory Equipment	3	1,3,4,5				
Determine Operating Environment	4	1,	4	2		
Categorize Equipment	5	1,2	2			
Categorize Significant Ignition Threats by Equipment type	6	1,3	3	2		
Assess Hazard Severity Impacts	7	2,3,4	5	1, 2		4
Identify relevant Fire Scenarios	8	1,2	3			5
Develop Frequency Estimates	9	1		1, 3		
Prepare Remedial Action Plan	10	na		5,7		7
Prepare Countermeasures Plan	11	5		4		
Monitor System	12	na		6,7,8		
A. Objective not explicitly stated - may correspond to item 10			1			1,2,3,6
B. Identify System Safety Approach Used				1		
C. Not a stepwise analysis currently						

From the table, it can be seen that the FRA methodology is most closely addressed by the APTA methodology. In fact, the only step in the APTA methodology not in the FRA methodology is step 12, "Monitor, track, and update the fire safety remedial action plans." Not surprisingly, since the FRA methodology was developed from it, MIL-STD 882D is the next closest methodology to that developed by APTA. The ASTM standard, as well as the SFPE methodology is more general and objective driven, while NFPA-130 is not a step-wise analysis.

2. The Caltrain System

Caltrain is a single line rail commuter system located principally along a peninsula bounded on the north by the city of San Francisco and the South by Gilroy. The majority of service (in terms of numbers of passengers) operates on the 48 miles between San Francisco's 4th and King Street terminus and the Tamien Caltrain /Light Rail station in central San Jose.

In the future it is likely that service will be extended at the south end toward the Monterrey area and to the north further into the city of San Francisco. In addition, electrification of the entire system is under development and a link utilizing an existing RR bridge and trestle system from Caltrain lines across the San Francisco bay to Fremont is being developed. The latter development will lead to a second Caltrain line.

The Caltrain system has been developed along one of the oldest RR right-of-ways in the western United States where as early as the 1870's, steam powered commuter trains ran North and South between San Francisco and San Jose.[8].

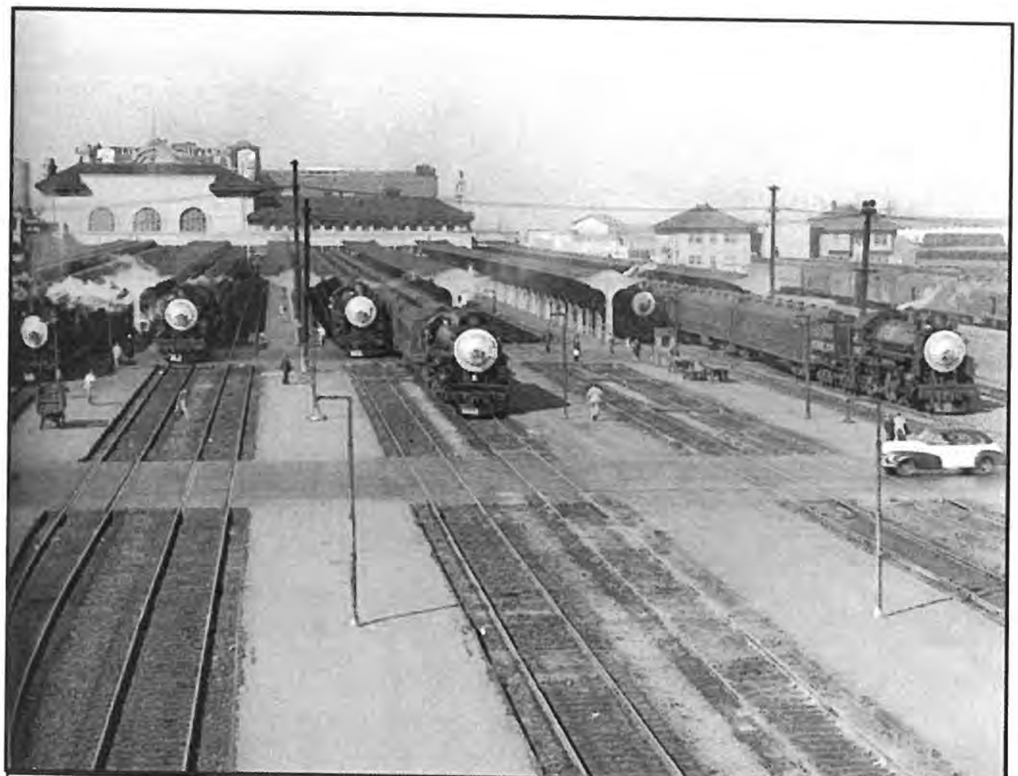


Figure 3: Townsend Terminal in San Francisco, 1952, photo from "Southern Pacific's Coast Line" by John R. Signor (1994)

Originally part of the Southern Pacific (SP) rail network, the State of California bought the right-of-way from SP in the early 1970's. Subsequently, three counties (Santa Clara, San Mateo and San Francisco) purchased the SP right-of-way from the state and formed the "Joint Powers Board" (JPB) to operate the railway as a commuter service originally intended to serve the San Francisco Peninsula.

Prior to the formation of the JPB, SP operated the right-of-way for the state. After the formation of the JPB, the state conveyed ownership of the existing rolling stock to the JPB. Amtrak now operates the rolling stock under contract for the JPB. In addition, the staff for JPB-Caltrain is hired and employed by the San Mateo Transit Authority (Samtrans). Caltrain operates three divisions: Rail Services, which oversees rail activities with the contract operator (Amtrak); Planning and Engineering Division, whose chief activity at this time is planning the rebuilding and electrification of the railroad; General Administration, whose duties include risk and safety assessment. Throughout the various transfers of ownership, SP has maintained a right to access the right-of-way for diminishing levels of freight transport from outside the peninsula area to the southern end of the city of San Francisco.

Figure 4: 1928 Brochure, from "Southern Pacific's Coast Line" by John R. signor (1994)

2.1 Right Of Ways

Caltrain's right-of-way consists of approximately 78 miles of track (San Francisco to Gilroy). There are 35 stations distributed over this right-of-way. Nine stations are staffed (4th and King, Millbrae, Burlingame, San Mateo, Hillsdale, Palo Alto, California Avenue, Sunnyvale, and San Jose Diridon). Seven of the stations (Millbrae, Burlingame, San Carlos, Menlo Park, Palo Alto, Santa Clara, San Jose) are listed on the National Register of Historic places. Approximately 28,000 commuters per day utilize the system.

The San Jose Operations Control Center (located near the Diridon Station) provides continuous supervision over all phases of Caltrain's operations. Supervision is managed through computerized dispatching, radio communications, and real-time information systems. Amtrak manages and directs the Control Center. The Control Center coordinates assistance for any difficulties encountered on the Caltrain system. The right-of-way between Tamien Station (San Jose) and Gilroy is under the direct supervision of the Union Pacific (UP) dispatch facility located in Omaha, Nebraska.

The Samtrans Rail Safety Officer coordinates the oversight of safety and health issues with Rail Services and Planning and Engineering Staff. The Samtrans Rail Safety Officer also monitors compliance with the System Safety Plan and all local, state and Federal regulations.

2.2 Operating Environment

Between San Francisco and San Jose, the right-of-way travels through an urban environment, with an average population density of approximately 8,000 persons per sq. mi. Between San Jose and Gilroy, the operating environment becomes significantly more rural, with an average population density of 100 persons per sq. mi.

Figure 5: Caltrain ROW in San Mateo County, FCA photo

The right-of-way consists of a minimum of two tracks, one for each direction except for a short single-track section 18.5 miles long on the UP right-of-way south of San Jose. Four railroads (described below) in addition to Caltrain operate on the JPB right-of-way. Taken together, 80 trains operate on the right-of-way.

Caltrain itself operates 68 scheduled passenger trains per weekday (eight of which also provide service on the 30 mile segment between Tamien Station in San Jose and Gilroy during peak periods), with a reduced number on weekends and holidays.

The following rail operations also use Caltrain's ROW primarily to some extent:

1) The San Joaquin Regional Rail Commission (ACE) operates two round-trips between Stockton and San Jose. This service utilizes the JPB right-of-way between the San Jose Diridon Station and Santa Clara Junction.
2) Amtrak West operates one inter-city service (the Coast Starlight) between Santa Clara Junction and Gilroy as it travels between Seattle and Southern California.
3) Capitol Corridor Service operates four round-trips between San Jose and Sacramento, which utilizes the JPB right-of-way between the San Jose Diridon Station and Santa Clara Junction.
4) All of the Caltrain ROW is shared with SP freight service, which currently operates one round-trip train between South San Francisco and Santa Clara (between 7:00pm and 5:00am), and a second local round trip between San Jose and the Port of Redwood City (between 7:00pm and Midnight) per day.

All five railroads operate under the direction of Amtrak dispatching personnel when using the JPB's right-of-way.

There are no major bridges on the Caltrain ROW and all formerly wooden bridges have been replaced by non-combustible concrete structures.

There are 53 public grade crossings between San Francisco and San Jose, and an additional 28 public grade crossings between San Jose and Gilroy. All are protected with warning devices at a minimum. Several private crossings pass through ranch properties south of San Jose.

The communities through which Caltrain operates have all been offered the opportunity to establish a divided roadway, with Caltrain tracks installed on moderately graded earthen mounds and/or bridge structures to eliminate grade crossings. Given the population density and increasingly urbanized characteristics of the operating environment and the significant number of collisions and accidents associated with Caltrain's grade crossings, this would seem to be a desirable approach. However, due to concerns related to the perception of having communities divided by RR tracks, many communities prefer to keep the older style cross traffic approaches requiring continued operations with grade crossings.

The right-of-way includes four tunnels, which are all located on the northern end of the right-of-way. The tunnels are all brick/masonry lined, and are two tracks in width. Currently the tunnels are unventilated, and do not have emergency lighting, or dedicated fire/emergency exits or passenger platforms. The maximum tunnel length is 3547 feet.

2.3 Vehicle Description

The primary Caltrain fleet of rolling stock includes of 23 diesel locomotives operating in push-pull mode with 94 gallery style bi-level passenger cars. Of the latter 21 are cab cars and the balance 73, are trailers.

The set of 94 gallery cars were all designed and built by Nippon Sharyo Seizo Kaisha of Japan but were purchased in two generations with the initial purchases begun in the early 1980's [currently being rehabilitated] and a newer generation of similar vehicles currently being delivered.

Figure 6 VRE coaches and Gallery cab car, FCA photo

There are two types of passenger cars, cab cars and trailer cars. Both are similar in appearance with the major difference between the two car types being the addition of an operator's control cab to the upper level at the "front" of each cab car. Control cab design allows for complete operation of the locomotive and consists when the locomotive is in the push mode.

Caltrain operates 23 passenger locomotives and two switching locomotives for work trains. The passenger locomotives are based on F-40 designs. Twenty of the locomotives were manufactured in 1985, and overhauled/refurbished in 1999-2000. The remaining three was manufactured in 1999.

A typical train (consist) in weekday service is made up of one locomotive and 4 passenger cars, and weighs approximately 375 tons. However, Caltrain may run up to seven cars when serving special events, such as San Francisco Giants baseball games.

The fleet also includes an additional 14 older single-level passenger cars of which 2 are cab cars. These were acquired recently from the Virginia Rail Express ("VRE" cars). By way of background, the VRE cars were purchased to accommodate occasional additional ridership associated in general with major events occurring along the Caltrain right-of – way such as

San Francisco Giants baseball games, and events at the San Jose Arena or at Stanford University.

3. Fire Incident Data

Caltrain's available fire incident data - including data relating to potential fire incidents - was extensively reviewed along with data for a longer period from other sources. The data from those review activities is presented here. In addition, pertinent data for other local sources as well as national sources were also considered in this process.

3.1 Local Fire Data

3.1.1 Caltrain Daily Reports

Caltrain's "daily reports" are created on a daily basis in part from "unusual occurrence reports" filled out by trainpersons and are mainly for review by senior operating personnel. In addition to the unusual occurrences, the "daily reports" also includes operational data such as late trains and the like. The "unusual occurrence" reports themselves are currently handwritten by conductors and train-persons.

In November 2000 daily reports from 1993 through 2000 were reviewed by the authors with the exception of reports for the year 1997 which were missing. Some 1993 were water damaged in storage and could not be read. All instances of fires and/or potential fires were flagged in those reports and the results summarized in the table below. It was noted that the terms used in the reports tended to be quite broad and the narratives were not especially descriptive or inclusive of details.

The totals in the raw data suggest an average of 6 to 7 incidents per year with fire or potential fire-related consequences noted by train personnel.

Table 2: Daily Report Incidents

Incident Category	1993	1994	1995	1996	1997	1998	1999	2000	Totals
Fire aboard train		1		1			0	2	4
Smoke reported on train	5	3	1	1			2	3	15
Burnt train/engine parts							4	0	4
Fire adjacent to tracks	1					1	1	6	9
Diesel spill or gas leak near tracks						1	1	3	5
Odor of smoke reported	1		1					1	3
Ruptured fuel tank (no fire)	2								2
Natural disaster	1					1	2		4
Totals	10	4	2	2	N/A	3	11	15	47

3.1.2 Amtrak Data

The database/record keeping system provided on a contract to Caltrain by Amtrak was reviewed. According to Amtrak personnel interviewed the "Amtrak Safety Information System" [ASIS], data on every significant incident related to safety.

Information inputted into this system is gathered from three sources, which parallel the three subcontracting functions provided by Amtrak to Caltrain. They are as follows:

- Operations related events compiled from unusual occurrence reports generated by Caltrain personnel.
- Maintenance related events compiled from maintenance records of any incident that required vehicle repairs(this is also entered into the AMTRAK ARROW database which details vehicle maintenance activities).
- Safety and security related events compiled from Amtrak's safety and security monitoring function for Caltrain.

All of the information above is entered into ASIS daily at its Washington, DC facility after receipt by fax from the parties generating the specific incident data.

By comparing these classes of information, it is in theory possible to determine if a reported incident is serious or even valid.

For example, should a train-person or security person report "smoke in car", the follow-up should be a maintenance check. If that check shows nothing wrong there should (but may not) be a record in the maintenance log on the date of occurrence or the next calendar date. If mechanical follow-up work was necessary the severity of a fire-related or overheating incident may be reflected in the number of days the equipment remained in the shop.

3.1.3 First Responder Data

Data available through "First Responder" CFIRS (California Fire Incident Reporting System) reports was reviewed. In this case, a single public record detailing a fire incident at Caltrain (see the discussion regarding the August 11, 2000 fire below) was located. Consistent with this low rate of occurrence, none of the First Responders polled at any of the Fire or Police Departments serving the Caltrain right-of-way could recall any serious fire incident involving Caltrain and most could recall no fire incidents of any kind involved with vehicles.

The First Responders polled were unanimous in indicating that their typical call involving Caltrain was an automobile/train collision, or a pedestrian fatality. Interestingly, one of the First Responders polled (South County (San Mateo) Fire Authority) indicated that the number of Caltrain incidents has dramatically dropped over the past year in his jurisdiction (Belmont-San Carlos). This is because Caltrain has raised the right-of-way, reducing the number of grade crossings in this area.

The first 2 fire incident reported in 2000 occurred in August. On August 11th, the City of Santa Clara Fire Department responded to a "fire" (after being dispatched by Caltrain's San Jose Center) in the rear of locomotive 910. Upon discovery of smoke by the Engineer, the locomotive was shut down and the consist coasted into the Santa Clara Station. The fire self-extinguished, and no action was taken by the Santa Clara Fire Department. Although at least 50 passengers were disembarked and shuttled by bus, this was done as a courtesy to the passengers because of the delay in getting a replacement locomotive to the consist. The locomotive was pulled to the yard. The narrative reported "...broken electrical terminal to dynamic braking grid, blower motor burnt, fire extinguished itself." Interestingly, the Santa Clara Fire Marshal when interviewed was unaware of this incident..

The second fire, on August 26th was reported exterior to the car on the rear trucks of cab car 401. Passengers were evacuated and the fire extinguished by the crew using fire extinguishers. Passengers then re-boarded. The narrative listed "a debris fire in brake rigging of cab car 401."

Of the three instances of smoke reported in the period reviewed, one came from "a defective holding circuit in the automatic brake valve," another from a "shorted cooling fan contractor" and the third from "shorted batteries." Only the first two incidents actually resulted in delays, which were recorded as being between 9 and 26 minutes.

In 1999 no fires were reported on trains, but burnt wires, fuses, brakes, power contactor, resistor and bearings were identified in 4 reported instances. These events caused either no delay or delays between 3 and 25 minutes. A "defective wire in a control panel" and "grease being thrown out of a traction motor" resulted in reports of smoke and delays from 13 to 54 minutes. No fire departments/first responders were notified in *any* of these cases.

In conclusion, apart from the fire on August 11, 2000, none of the events that generated fire or smoke were serious enough to call the fire department and minimally affected train service. However they do appear bona-fide in terms of warranting recordation as to incident and outcome. They also attest to the robust nature of the Caltrain equipment in that none of these led to any fire growth or extension endangering passengers, crew or equipment.

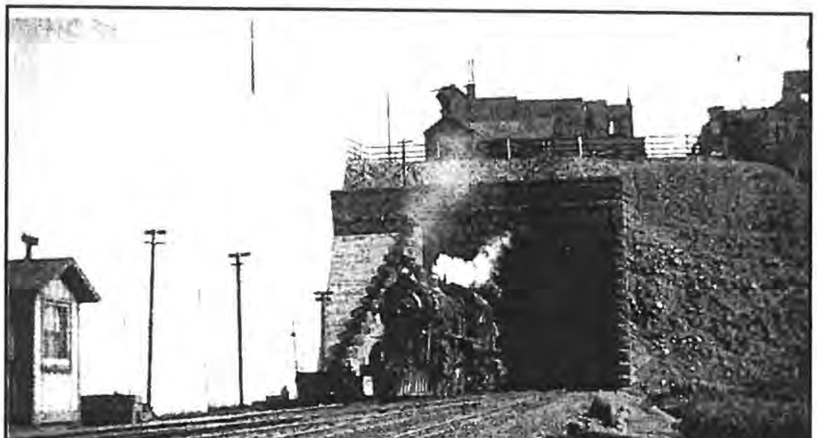


Figure 7: Train emerging from tunnel No.2 on the Bayshore, From "Southern Pacific's Coast Line" by John R. Signor (1994)

Overall, an analysis of Caltrain's schedule, suggests that the system provides approximately 33 billion (3.26×10^{10}) passenger miles per year. This translates to one (potential) "fire" related incident every 8 billion passenger miles based on the raw data available for that period only.

It should be noted that none of these incidents resulted in injuries to passengers or crew and that no other data has been located showing any unusual or serious fire incidents since the early 1980's when Caltrain operations succeeded the Southern Pacific commuter operations which ran along the same ROW since before the beginning of the 20th century.

3.2 National Statistics

One large commuter railroad, METRA serving the Chicago area, features rolling stock that includes gallery cars similar to those found at Caltrain and push-pull DMU operations. METRA is also significantly larger than Caltrain both in track miles and ridership and has a very long history of operation. Fire incident statistics and scenarios based on METRA operations occurring elsewhere in the USA will be commented on in the fire hazard assessment portion of this report.

3.2.1 SAMIS

The FTA keeps records including those relating to fire incidents in public transportation as a function of its statistical database – SAMIS [9]

As can be seen from the statistics in the table below, the experience at Caltrain is consistent with the national data for rail passenger vehicles, which shows virtually no incidence of serious fires attributable to this mode of transportation.

Table 3: FTA SAMIS Fire Incident Data Summary

	1990	1991	1992	1993	1994	1995	1996	1997
Deaths	0	0	0	0	0	1	0	0
Deaths per million vehicle miles	.000	.000	.000	.000	.000	.000	.000	.000
Fires-vehicles	64	44	52	66	79	57	70	77
Fires per million vehicle miles	.300	.205	.237	.295	.342	.241	.289	.309
Injuries	1	11	12	22	39	26	22	19
Injuries per million vehicle miles	.005	.051	.055	.098	.169	.110	.091	.076

3.3 Data Collection

3.3.1 Current Fire Incident Data Collection at Caltrain

In order to assist Caltrain in implementing an improved program to acquire and accumulate fire safety records, current record keeping approaches have been reviewed. Those observations are documented here.

The existing data collection methods used at Caltrain appear sound and *potentially* effective. A significant amount of baseline information is currently collected and cataloged locally which describes events occurring on trains and in the maintenance shop. This information has implications and potential utility beyond facts related solely to fire safety issues, such as safety in areas where greater day-to-day risk exists, as from crossing accidents, or simple slip and fall injuries to passengers.

Figure 8: Emergency door release, FCA photo

Conductors' "unusual occurrence reports" provide, in theory, the most comprehensive raw data related to fire incidents or potential fire incidents occurring during revenue operations.

The computer based tracking system ASIS is intended to encompass conductors' observations through "unusual occurrence reports" after evaluation as to whether or not these are sufficiently serious to be included. None of the incidents identified in our manual search were identified in a search of this database.

Caltrain – AMTRAK shop maintenance records can also provide information related to fire-related incidents as well as mechanical malfunctions related to overheating and show little or no such occurrences taking place. Theoretically, if fire-related incidents occurred requiring that a car be "shopped" as for a reason identifiable from a search of the maintenance fields utilizing key words of "fire, smoke, ignition or arson", the outcome of that work could be checked.

If an incident as noted by a conductor citing "smoke in car" in his daily report leads to no maintenance activity beyond a check for a fault at the end of the day, then it is apparent that the event was a transient; for example, dust smoking from contact with an electrical heater element. Conversely, if the car was out of service for repairs for one or more days, then the source of the request for a non-routine maintenance check was bona-fide and necessary work done.

One specific set of reports not reviewed in this study, because they are relatively new, are those required in 49 CFR 225.25 sections mandating completion of "Initial Rail Equipment Accident/Incident Record" (Form FRA F 6180.97) or an equivalent but without application of the >$6600 reporting threshold which is just now being used by AMTRAK, Caltrain's contract operator[1].

In the experience of the authors of this report, application of the >$6600 FRA incident reporting threshold has limited the number of fire related incidents being reported. This is because the vast majority of these do not exceed $6600 in damage and there has been an interpretation in the field that appropriate incidents for reporting are those involving non-fire related incidents such as strikes, derailments and other non-fire related equipment failures taking place during revenue operations.

3.3.2 Recommendations for enhanced data collection:

The data APTA's methodology recommends recording is available from a variety of Caltrain and Amtrak sources. However, it is not collected or organized in a coherent manner. Given the data currently collected and compiled at Caltrain through the sources listed above, the missing component is the need to provide more detailed, compiled information related to fire safety issues that affecting passengers and crew. The recording should include the following:

- A place to specifically identify fire related data from *all* incidents and;

[1] A check of Caltrain FRA records indicates no incidents surpassing the $6600 threshold in recent years related to fire incidents.

- A step to "close the loop" on all such incidents to list or identify an outcome for incidents identified as cited above.

These can be initiated through activities with the contract operator of safety, security, operations and maintenance activities. An alternative way to undertake this may be to develop an approach involving handheld data collection appliances. For conductors reporting "unusual occurrences" the information would be directly downloadable to a database. This would replace handwritten documents and would provide a searchable, raw database for fire as well as other incidents of interest to Caltrain management.

Implicit in this suggestion is the adoption of some sort of keyword system, which at a minimum would be consistent with approaches found in the NFIRS (National Fire Incident Reporting System) and NFPA FIDO (Fire Incident Data) databases.

For the reader's information, NFPA data administration personnel have informed the authors of this Caltrain fire hazard assessment study that the U.S. Fire Administration (USFA) and the individual state fire reporting organizations (generally the offices of state fire marshals) are in the process of implementing NFIRS 5.0, a major upgrade to the existing National Fire Incident Reporting System (NFIRS). This new system includes three digit incident types, and is designed to better document all types of emergency responses, not just fires.

It is our opinion, that the Caltrain staff can revise record keeping to include features of this system or at least make these features addressable in searches of Caltrain databases. Information on NFIRS 5.0 may be found at *http://www.nfirs.fema.gov/*.[2]

Finally, an overwhelmingly large number of trivial but potentially fire-related incidents take place and can be identified when searching keywords such as "fire," smoke," arson," and "ignition." Most of these turn out to inconsequential, which is why they are disregarded when compiling ASIS data. However, in all cases, completion of the second item above and compilation of that data would be valuable in determining how the Caltrain's rail passenger vehicles have been designed, specified, built, and operated in a manner that is primarily a "fail-safe system" from the fire safety perspective.

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[2] Interestingly, the aviation industry has a system for documenting near misses and other events that could have been serious, but were not. The maritime industry is also in the process of developing a system to document similar incidents that they refer to as "precursor" events. These sorts of "precursor" events go beyond those involving fire. The reason that they are being consider here is that when most serious incidents occur, multiple problems or failures occurred at the same time leading to a high level of seriousness for the resulting incident. If such precursor events can be identified before they contribute to a serious "top event" sort of incident or consequence, all would benefit.

Information about these systems may be found at the following two web sites.:
http://nasdac.faa.gov/internet/fw_learn.htm and http://www.uscg.mil/hq/g-m/moa/docs/blue.htm

4. Fire Safety Mitigation

Mitigation activities take several forms at Caltrain.

Mitigation begins with the training of operating personnel and first responders. It is also addressed through programmatically addressing system safety concerns including emergency operations, egress issues and responses to specific foreseeable emergency situations along Caltrain's various operating environments.

4.1 Training

4.1.1 Conductors & Train operators

Caltrain's conductors and train operators are Amtrak personnel operating under contract to the JPB. These individuals are trained initially and provided with ongoing, in-service training including training to address fire incidents, medical emergencies, passenger evacuations and approaches to managing and informing passengers of conditions during emergencies.

Portions of "Prepare 2000", CSC 102, which is a current safety training course used by AMTRAK personnel are included in Appendix II. In reviewing these materials it was noted that while they do contain generic materials addressing operational emergencies including fires in tunnels, there is no particular training related to the specific features found on the Caltrain right-of-way.

4.1.2 Dispatchers

Dispatchers undergo training in terms of response to emergency situations with the greatest importance being given to summoning first responders who are specifically identified by system mileposts.

4.1.3 First Responders

The first responders contacted by the authors, indicated that they have very little familiarity with Caltrain rolling stock in any aspects with the exception of grade-crossing related incidents. Fire service personnel expressed little knowledge of Caltrain's physical operations in their jurisdictions but indicated that the frequency of fire-related calls for Caltrain operations led them to consider the associated fire risk to be quite low.

The Caltrain System Safety Program Plan (discussed in detail below) calls for one annual field exercise to be held for first responders with the addition of two "table-top" exercises per year. If this were to occur, this level of training would be sufficient, with one caveat. First Responders should receive "hands-on" training to familiarize themselves with the various types of passenger cars operated by Caltrain, should be given access to the more challenging operating areas and a list of the communication protocols for their jurisdiction.

4.2 Emergency Operations

The Caltrain Emergency Operations Center is located in San Jose, adjacent to the Amtrak dispatch facility. A secondary emergency operations center with communications capabilities is located in the Samtrans headquarters building.

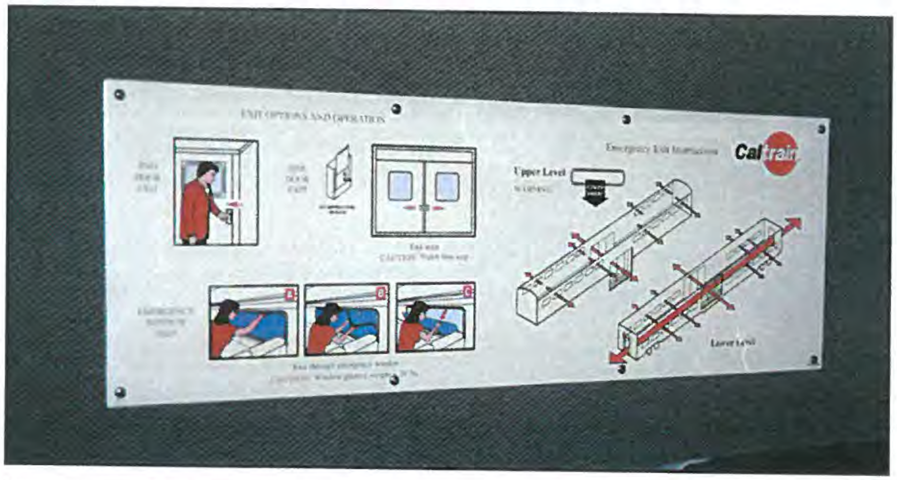


Figure 9 Emergency signage in gallery car, FCA photo

Hazardous operations take two forms at Caltrain; 1) the hazardous activities adjoining the ROW and impacting the various types of operating environments there and 2) the hazardous materials hauled on the Caltrain ROW.

In the case of the former, no particular activities adjoining the Caltrain ROW are intrinsically dangerous in an unusual way. Normal structural fire hazards do exist but none are unusual from a systematic perspective. These include pipelines, which are found in some areas buried well below the surface. Caltrain's rolling stock is likely to interact with these. As part of freight operations, hazardous materials such as petrochemicals are hauled on the Caltrain right-of-way, but this does not occur during Caltrain's commute fleet operating hours.

Emergency existing issues of importance are considered, in this assessment, to be of two forms. Exiting from a potentially fire affected car and finding a safe haven remote from the fire threat.

4.2.1 Exiting from Passenger Cars

Emergency exiting from passenger vehicles en route is accomplished by exiting from the affected passenger car to an adjacent car through doors at the end of each car. In most cases, when the train is stopped passengers will be evacuated from center vestibules to grade since walkways exist adjacent to track-ways at grade or on bridges. If necessary, emergency exit windows can also be used. In all cases, the preferred means of evacuating passengers from a fire-affected car is through the door into the adjacent car, if it is safe to do so, and avoid evacuating passengers onto the right-of-way.

Caltrain employees are trained to use the PA system to keep passengers informed of the status of an incident and to forward instructions from the crew. If a decision is made to exit passengers from the train, the conductor can use the PA system microphones located in each car to tell the passengers in the entire train what actions they are to follow.

4.2.2 Right of way conditions/areas of refuge.

Figure 10: Gallery car emergency window, FCA photo

In most cases, exiting from cars to grade can be accomplished without incident if evacuation to an adjoining car is impractical or otherwise not possible. Once passengers reach grade and no further hazards exist (such as the hazard posed by passing trains, fall from a raised structure, collision with another vehicle at a grade crossing) then the passengers be deemed safely evacuated from the incident vehicle.

Caltrain passenger cars are equipped with emergency lighting and emergency exits are marked with luminescent signs to be visible in the dark. This helps ensure a safe exit at night or in a dark tunnel.

The only area of operation where intuitively obvious safe havens do not exist are in the Caltrain tunnels. However, the tunnels on the Caltrain system are relatively short and are wide enough for passengers to walk through readily. However, there are no designated walkways there, nor emergency lighting, ventilation or communications. Given that these tunnels are relatively short it is unlikely that a loaded train in revenue service would ever be brought to a stop in a tunnel except in the case of derailment, collision or an earthquake. From a regulatory perspective the tunnels should be considered as existing, no- conforming structures with hazards , which can be addressed through engineering analysis.

4.3 System Safety Program Plan

Caltrain's System Safety Program Plan (SSPP) dated July, 2000 is currently in draft form.

This document is being developed to ensure the safety of Caltrain's passengers, employees and the communities within which it operates.

The draft has been developed to comply with the American Public Transit Association (APTA) guidelines from the *Manual For The Development of System Safety Program Plans for Commuter Railroads.*

The SSPP was reviewed for content specific to fire safety and the following *indirect* references were found:

- Safety Inspections, Hazard Identification, and Resolution Process (Pg. 8, 21)
- Safety Training and Education (pg. 8)
- Emergency Response Procedures (pg. 9)
- Accident/Incident Reporting and Investigation (pg. 30)
- Facilities Inspection (pg. 35)
- Maintenance Inspection/Repairs (pg. 42)
- Emergency Response Planning Coordination and Training with invitations to municipal fire departments; calls for two table top drills per year (pg. 54)
- Employee Safety Program (pg. 66)
- Hazardous Materials Programs (pg. 67)
- Highway-Rail Grade Crossings (pg. 89)
- Internal Safety Management Assessment Process (pg. 96)
- In-depth safety examinations are formal audits done on a four-year cycle and items slated for particular review include fire safety (i.e. exit signs, sprinklers, extinguishers) (pg. 16-1)

No direct references or practices are included which detail what is to be done by affected personnel in the case of various types of fire incidents (e.g. a fire in a train, a fire on the adjoining right-of-way, a fire following a collision) with specificity.

4.4 Vehicle Specifications

Figure 11: Bi-modal car at BART station under construction, FCA photo

An inventory, from a fire safety perspective, was taken of each type/design of Caltrain equipment used in passenger service. The fleet is summarized in the table below and vehicle characteristics are discussed:

4.4.1 Passenger Cars

4.4.1.1 Gallery Cars:

The bi-level gallery cars are the passenger cars used in day-to-day operations. The single level VRE cars discussed later in this section are used only for overflow, special events or to add capacity when needed in an emergency and are relatively few in number.

In terms of Caltrain nomenclature for the Gallery cars, each passenger car has an A-end and B-end. When a cab car is being used as the consist control car, the B-end is referred to as an F-end.

In both cab and trailer type gallery cars, a toilet room is located on the left side of the A-end of the car. Both types of cars provide two levels of seating on either side of the center vestibule of the car.

The upper levels of the car have single seats along each side. The lower levels of the cars have double seating on each side. The A-end and B-end seating orientations are opposite, with both facing the car center. Stairs on each side of the center entrance vestibule give access to the upper level of seating. The interior design permits both types of cars to accommodate up to 100 standing passengers.

Table 5: Seating capacities for the Nippon Sharyo cars:

Car Type	Serial Numbers	Seating Capacity	Crush Capacity	Bike Capacity	Restroom	Disabilities
99 Cab Cars*	4021-4026	92	192		Yes	No
Cab Cars	4000-4020	115	215	24	Yes	No
99 Trailers*	3852-3866	122	222		No	Yes
Trailers	3800-3851	**	242 (248)		No	No
VRE	non-sequential***				No	No

*"99" denotes refurbished cars

****142 passengers when equipped for persons with disability, or 148 otherwise**

***V800 & V803 (cab cars), V301, V304-V306, V308, V309, V311, V314, V401-V404

Figure 12: Gallery cab car, FCA photo

Although slight differences exist between the original, refurbished cars and the new gallery cars, they both share the same, general design features. In the gallery cab cars, six bicycle racks are provided on the lower level B-end along with seating for 20 passengers. The right side of the lower level of the A-end has provisions for two wheelchairs, and seating for 30 passengers. On the trailer car, both levels of the A-end are configured in the same way as the cab car. The trailer's B-end has no provision for bicycles, and therefore can seat 44 passengers on the lower level and 26 passengers on the upper level.

4.4.1.2 VRE Cars

The 14 VRE cars owned by Caltrain were purchased in April 2000. They were bought to help mitigate overflow at special event such as San Francisco Giants baseball games. The

VRE cars have stainless car shells and were built by BUDD in 1956. Prior to their use on the VRE, the Massachusetts Bay Transit Agency operated them in the Boston area.

Their DMU individual diesel engines were removed in 1982 and rebuilt by Morrison-Knudsen (M-K). The cars were originally manufactured as self-powered diesel cars (with a diesel engine on the roof of each car).

4.4.2 Fire Safety in the Cars

With the exception of the newly acquired VRE cars (for which Caltrain has little documentation), there are specifications associated with all passenger car vehicles purchased and refurbished by Caltrain. These all reflect accepted specification practices, which were state- of- the- art at the times when those transactions took place. Fire safety related sections of these specifications can be found in Appendix III.

As noted earlier, two generations of gallery style cars are in use at Caltrain. The older generation of cars is the subject of a rebuild program currently being completed. When this program is completed, the interior materials in all bi-level cars will have interior materials will have fire related properties consistent with FRA rules and NFPA Guidelines/Standards in effect since the mid - 1990's.

4.4.2.1 Detection Devices

All bathrooms in the gallery cars are equipped with single-station smoke detectors audible locally.

No other unoccupied compartments exist on the passenger cars. The four, small conductor and electrical compartments do not have detection equipment but are fire stopped where penetrations to the floors occur.

No other fire detection or smoke detection was found on passenger vehicles or locomotives.

Figure 13 Toilet inside a Caltrain gallery car, Caltrain photo

4.4.2.2 Electrical system

Each passenger car uses 480 power ("hotel power") provided by a generator in the locomotive via car-to-car and under-car cabling. This cabling is robust and has not been the subject of fire incidents. The electrical power (either at 480 Volts or stepped down) is used to provide space heat through baseboard resistance heaters, HVAC via dedicated HVAC units above the boarding vestibule of each car and energy for regular lighting and miscellaneous accessories.

Auxiliary power is provided by batteries, which are ganged together and located outside the cars' stainless steel battery boxes in under-car locations. It appears that various generations of battery types and materials do exist and that these are susceptible and responsive to the levels of maintenance provided, which directly impacts their performance. Overall battery performance and involvement in fires appears minimal. There is one report of a fire suppression related- injury to a Caltrain trainman about 5 years ago.

All wire insulation used in the gallery style cars appears to be of contemporary design and configuration. The under-car 480-volt cables are insulated with durable chlorinated rubber insulation.

4.4.2.3 HVAC system

Environmental conditions in each car are separately controlled by controls in each vehicle. An engineer can turn off all systems unilaterally, but cannot control a single car. Heating is provided by baseboard resistance heaters (convection type) and HVAC systems. HVAC, utilizing a blower and associated components on the Gallery cars, are located above the entry vestibule of each car and airflow from this central location is directed to each separate end compartment. No separate controls exist for fire-related operation of HVAC equipment but train crews are instructed to turn off HVAC equipment if a smoke or fire related incident occurs.

4.4.3 Locomotives

Caltrain operates 23 passenger locomotives and two switching locomotives for work trains.

Figure 14: Interior of locomotive cab, FCA photo

The passenger locomotives are based on F-40 designs, and are equipped with 16-645E3B diesel engines that are rated for 3200 tractor horsepower. They are based on similar freight locomotive designs of the SD40-2 & GP40-2 series. The first 20 locomotives were manufactured between 1985 and 1987, and were subsequently refurbished/rebuilt by Alstom Corp. in 1999-2000. The remaining three locomotives were manufactured in 1999. Both the rebuilt and the earlier versions of the locomotives have air and electric brakes. The rebuilt locomotives have dynamic braking grids, as well.

Unlike their freight predecessors these passenger locomotives have full-body construction, with traction motor gearing for up to 90 miles per hour. Each also includes a 425 kilowatt, 480 volt, 60 Hz., 3-phase direct drive head end power generator used to supply power for lights and HVAC to the passenger cars. The F40 locomotives have four axles and fuel tank capacities between 1400 gallons to 1900 gallons depending on the date the locomotive was built.

5. Operating Environments

Fire safety issues of the Caltrain's operating environment, that is the features of the terrain surrounding its ROW have been evaluated through a review process. To accomplish this, Caltrain operating staff personnel and the fire safety engineers of the FCA project team reviewed and characterized the various aspects of Caltrain operations and ROW which have a potential to impact fire safety levels there such as emergency response or egress of passengers and crew.

The Caltrain system operates a single, north-south line servicing communities from San Francisco in the North to Gilroy in the south. The terrain traversed by these lines can be characterized as moderate Mediterranean in the north to hot and typically dry in the south. Occasional rains occur in the winter months and modest creeks traverse the ROW from west to east.

Most of the terrain is flat, but there are hills in the northern portion (in and adjacent to San Francisco) creating the need for tunnels. Elsewhere the right-of-way travels through mostly level terrain along the flood plain of San Francisco bay and then in a valley going toward the southern end of operations at Gilroy. Due to the presence of rivers and creeks draining to SF Bay there are several bridges and trestles which, being originally of wood construction, have in large part been replaced by concrete structures. All of the right-of-way routing is based on pre- existing rail lines and infrastructure dating to steam operations of the SP from the 1870's.

Key features of the Operating environment important to potential fire safety issues include:

5.1 Tunnels

Figure 15: Tunnel south of San Francisco, FCA photo

The system includes four tunnels (see table below). All are located just south of the San Francisco terminal at 7th and Townsend Streets.

The tunnels on the Caltrain system are wide enough for passengers to walk in readily. However, designated walkways do not exist there, nor does emergency lighting or ventilation or communications. Given that these tunnels are relatively short, except in the case of a derailment or collision in a tunnel or because of earthquake related damage, it is unlikely that a loaded train in revenue service would ever be brought to a stop in a tunnel

All of the tunnels were constructed for use with freight originally and all are lined with brick or masonry.

In all cases there is physical room to walk between a stopped passenger car and the tunnel wall or between the tracks and two stopped trains. However, conditions under foot are not favorable as loose ballast exists in these unlit tunnels. The presence of walking space is consistent with California PUC General Order No. 26, which also requires a 5 foot walk way between tracks in tunnel centers. This feature provides assurance of assistance for both passenger egress and first responder access.

None of the tunnels are used for freight traffic during Caltrain commute fleet operating hours.

Access to tunnel bores by emergency vehicles is available in all cases, save for the north end of tunnel 4 to which only access on foot is available. Paved or crushed rock access roads exist to the mouths of all other tunnels.

Tunnel lengths are such that it is unlikely that any train would (or could due to braking distances involved) stop in a tunnel due to a fire-related emergency.

Table 6: Caltrain Tunnel Inventory

Tunnel	Length (ft.)
1	1817
2	1087
3	2364
4	3547

All tunnels on the Caltrain system have been equipped with repeaters to provide improved communications capability for the trains to the San Jose Dispatch Center. This capability is not available for first responder use on the scene.

5.2 Grade Crossings

The system includes 81 grade crossings. All public crossings are equipped with warning devices as are a portion of the private crossings. Due to the number of incidents occurring at grade crossings the risk and hazard of such incidents has been considered in this analysis.

While all public crossings are guarded, Caltrain operations have sustained a significant number of incidents at grade crossings presumably due to population density and characteristics of the population using these grade crossings. No incidents accompanied by fire have occurred during Caltrain's operating history and none are recalled from commuter operations preceding these on the same ROW

5.3 Trestles and Bridges

Grade Separated operations – There are several bridges on the Caltrain system traversing rivers and sloughs and seasonal creeks. Consistent with California PUC General Order No. 118 all of these are equipped with a minimum 2 foot wide walkway and a suitable railing on both sides of trestles and bridges leading to ground level. This feature provides assurance of assistance for both passenger egress and first responder access.

In addition, significant portions of the Caltrain right-of-way are on raised mounds mimicking what original trestles, which were subsequently covered with earth. These provide some challenge for first responders as well as passengers and crew exiting trains in an emergency. However, again, consistent with PUC General Order No. 118 all such include a walkway providing both egress and access necessary for safe operations.

5.4 Emergency access

Remote operating environments – Most of the Caltrain system is accessible to first responders fairly readily based on accessibility via frequently occurring grade crossings, and secondary service roads paralleling much of the right-of-way at grade.

Areas creating challenges to first responder access – in addition to tunnels – are those without immediate road access. These occur on less than 3% of the right-of-way. These areas are described as:

Urban limited access areas that include the following:

> Areas where private properties back up onto the right-of-way inhibiting ready access;
>
> Areas where the right-of-way is in a cut and/or adjoins another rail passenger operation – such as the BART line being developed in the San Bruno area where there is limited road access.

An example of the latter is the bridge at 42nd Street in San Francisco, which poses access challenges to first responders.

5.5 Hazardous Operations

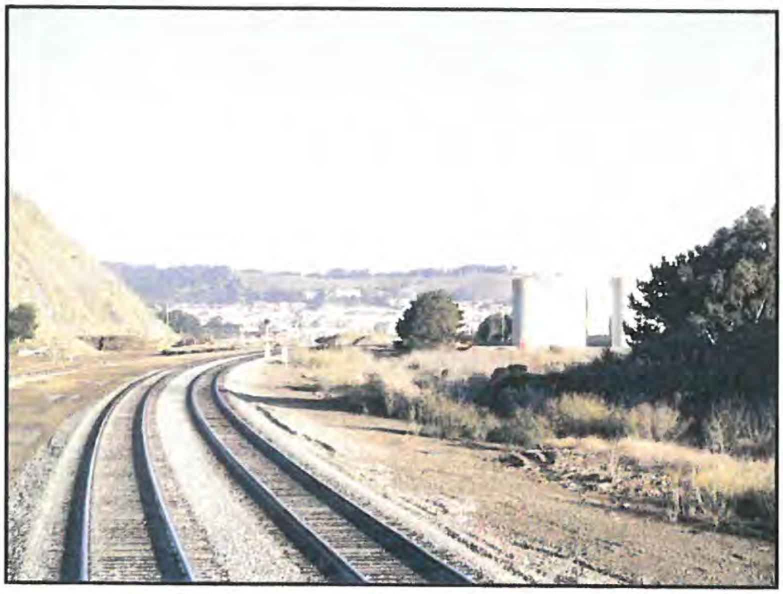


Figure 16: Tracks adjoining tank farm, South San Francisco, FCA photo

There are a limited number of facilities along Caltrain's ROW that pose a hazardous materials threat. Petrochemical operations exist near the San Francisco Airport tank farm. However, all hazardous facilities are sufficiently remote from passenger train operations to make them a remote risk unless a catastrophic explosion occurred while a passenger train rode by.

Likewise, pipelines present along Caltrain routes, such as the ones associated with airport operations and previous Southern Pacific operations, are buried 5 feet deep and provide sufficient safeguard for Caltrain passengers and crews in the event of a derailment or collision along these routes.

5.6 Hazardous materials

The Caltrain right-of-way is shared with freight operations of the Union Pacific railroad. These lines ship mixed freight and occasionally HAZMAT, but not during normal Caltrain commute fleet operating hours. However, the No. 1 mainline track serving the Newhall Yard may be used for freight service between San Jose and Santa Clara at any time. The two significant freight yards are the Newhall yard near San Jose and the [old] SP yard in San Bruno.

In the event of a collision between a Caltrain consist and a freight train some risk does exist for the discharge of HAZMAT and/or an ignition of freight. However, given the frequency of combined operations, this level of risk is quite low.

6. Fire Scenarios

Predominant fire scenarios to evaluate Caltrain vehicle properties are all hypothetical since none have led to serious involvement of car interiors and/or threatened passengers in 18 years of service. The scenarios outlined below involve potential sustained ignitions occurring either within a car or outside a car and then burning into a car through a (melted) window opening. No scenarios involving a serious under car fire is probable based on equipment location and historical data.

Examples of these and other less destructive scenarios can be found in descriptions of fire incidents that have occurred at another railroad with similar equipment but a significantly longer operating history and a larger number of vehicle miles.

In one case, a locomotive struck an automobile resulting in a fire, that exposed the exterior of a passenger car to a significant fire plume fueled by gasoline and burning automotive car parts. The fire from the burning vehicle eventually ignited polycarbonate windows that melted, but *well after passengers had been safely evacuated from the affected car.* This was followed by the ignition of seat coverings and some interior components under the high heat fluxes present. Interestingly, the seat cushioning materials, which appear to be composed of FR neoprene from the mid 1980's, performed extremely well, did not ignite and responded to the fire much as full-scale fire testing in the laboratory would have predicted.

An another fire scenarios borne out in historical data relates to an incident in an unoccupied car where a smoldering object was placed into a plastic waste container that ignited light combustibles there. This caused smoke to be observed by train operating personnel who called first responders and extinguished the small fire. No significant damage was done to the car in question and this scenario is unlikely on Caltrain where most waste receptacles are metallic.

Other hypothetical scenarios can be developed based on the equipment present in the vehicles, and on passenger activities. These include heater and HVAC related incidents, and on vandalism in particular. However, no such incidents have been reported.

No sustained undercar fires have been reported or discovered in this work to have occurred which have led to fire damage penetrating into the passenger compartment of either car design.

7. Vehicle Evaluation

Quantities of combustible materials and their relation to ignition sources were considered in the following analysis.

Because passenger vehicle types are quite dissimilar, these are considered separately. The bi-level gallery cars and the locomotives which are used every day of the year and provide for the vast majority of the passenger movement and capacity are considered first.

7.1 Gallery Cars

Figure 17: Seating inside a gallery car, FCA photo

Vehicle finish materials used in the refurbishment of the initial Caltrain cars as well as the newly procured cars have been evaluated. Materials include polymeric materials for signage and coatings, floor coverings, carpeting, and wall and ceiling finish materials. Combustible material matrices for the new and re-built Gallery Cars have been reviewed. All were consistent with FRA Guidelines and NFPA 130 Standard at the time.

Evaluations also included review of the "Decorative Material Folio of Bi-Level Cars" provided to Caltrain under Contract No 04-994100 from Nippon Sharyo Seizo Kaisha, Ltd.

7.1.1 Ignition Categories

The requisite reviews have been conducted to consider and develop information related to probable fire ignitions as well as potential fire growth on Caltrain passenger vehicles in service.

All cars include shock resistant polycarbonate windows, which are combustible, but require significant energy to be applied before they will ignite. Such ignition cannot be affected without a large flame (with a heat release rate in excess of 40 kilo-watts) being present.

Each generation of trailer car was separately reviewed from a viewpoint of (a) potential for unwanted ignition, (b) potential for fire growth and (c) egress issues.

Design features potentially affecting fire safety of passengers include the overall design with implications for passenger egress and first responder access. Another design issue is the presence of the HVAC units in the center of each car along with the electrical controls and cabinets. Seat designs are similar in all vehicles.

Design of waste receptacles is good and this feature should be considered as a positive approach to fire mitigation.

7.1.2 Potential for unwanted ignition

Sources of potential unwanted ignitions in the cars are primarily related in one way or another to the electrically powered services provided to the cars in the form of 480 Volt power used to energize lighting and heating systems. These cables carrying the 480-volt power are isolated from the car interior by the floor system which includes either a stainless a steel panel, an insulated air-space and/or a plymetal upper floor membrane.

Power is conditioned (as at 5 KW undercar transformers used to provide power for lighting) and transitioned at junction box locations under the car toward its center and run into end use areas in metallic raceways which are fire stopped using third party listed and labeled fire stopping materials.

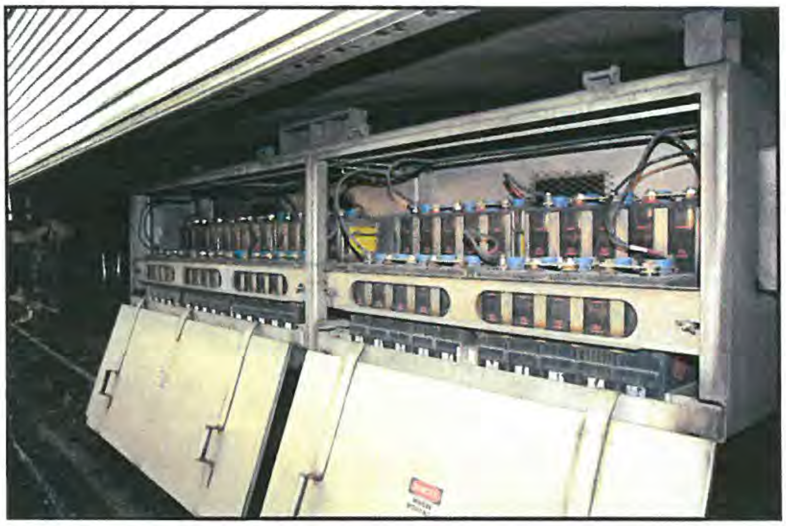


Figure 18: Undercar battery boxes in gallery cars. FCA photo

Controls in the electrical cabinets include switches and breakers as well as relays. No history of fire exists to suggest sub-standard performance at these locations, which are not specifically separated from the car interiors by fire resistive constructions.

The undercar battery box locations also include an airspace separating the stainless steel battery boxes from the car floor. Both of these features adequately separate these potential sources of ignition from car interiors.

Other potential sources of unwanted ignitions exist in the form of electrical baseboard heaters which may on occasion smoke if foreign elements (debris, dust) are introduced into them or lighting components such as ballasts which currently carry code compliant thermal protection against high temperatures.

An additional source of unwanted ignitions can be from passengers who intentionally set a fire or who may smoke in an out of service car in a station and carelessly discard a match or cigarette. Targets for ignition under the former scenario will most frequently be seats or waste materials such as paper in receptacles.

Bathrooms now have smoke detectors allowing for local alarm if a smoke release occurs there.

In terms of seats, both seat coverings and foam cushioning are consistent with state of the art in this area. These are resistant to all foreseeable open flame ignition sources. They can be expected to resist all attempts at arson including a concerted arson attempt, which would have to involve a separate fuel such as wadded up newspaper or a flammable liquid.

Additional threats potentially leading to ignition are those associated with a smoldering source left by a passenger impacting either seating or trash in a receptacle. In the case of the former smoldering ignition of the seating system used on Caltrain is not probable. Such smoldering if it takes place will *only* take place on an out of service car or one in service but not occupied by passengers since ignition will be proceeded by smoke which will warn the passengers or crew of the impending ignition.

7.1.3 Ignition Characteristics

Potential for fire growth - no materials are used on the newer or rebuilt older vehicles known to propagate fire sufficiently rapidly to cause a foreseeable life safety threat.

7.1.4 Egress Issues

Potential exiting issues for trailer cars revolve around debarking and the need to safely egress the vestibule area from the upper level via a single route. Debarking in an emergency does not present an unusual challenge since movement can be affected through end doors to an adjoining car in most foreseeable cases and/or exiting to grade can be readily undertaken by all but non-ambulatory passengers.

Figure 19 Emergency window instructions, FCA photo

Manual operation of doors is possible in all such cases and emergency window exits also are available if needed under upright or derailed conditions.

A need to safely egress the vestibule area of a passenger car from the upper level may provide a challenge if smoke or flame were to develop at the car center as associated with an electrical fault as at one of the electrical cabinets. This is in part because no 2nd exit exists from the upper gallery sections for routine use. A secondary emergency route would exist by climbing down from the gallery section, but this cannot be considered a normal evacuation route for emergencies and it is not one that would be available to people with disabilities. Notes on gallery seating include (a) upper gallery seating would not be used by disabled persons and (b) no history exists to suggest that a second exit from the gallery area is needed.

The car design also is such that it is unlikely that a firefighter in an air pack would be able to access the gallery area due to clearances at stairways necessitating self evacuation by passengers in an emergency from gallery areas.

It was noted that the emergency exit windows towards the car – center vestibule areas coincide (in certain cases reviewed) with seating recommended for seniors or those with disabilities. This is an issue appearing to relate primarily to signage and may be treatable as such.

7.2 Locomotives

The Caltrain locomotives do not include any fire or smoke detection equipment. The engineer has a clear view of the condition of his vehicle at all times and access to all necessary areas. The locomotives are equipped with 20 # dry chemical fire extinguishers, which are adequate to control small fires, which may occur. These are maintained on a routine, regular basis.

There is no history of repeated fire on these locomotives and there is no historical suggestion of an ongoing fire problem or unusual potential for unwanted ignitions. In the unlikely event of an unwanted fire taking place, no threat appears to exist to train crews or passengers unless that fire takes place in an underground location larger than an underpass or overpass.

7.3 VRE Cars

The primary finish materials (wall and ceiling linings) of the VRE cars are metallic and do not appear to pose a threat in terms of ease of ignition.

No specifications for these materials are available and attempts continue to develop information on them from the original rebuilds by Morrison-Knudsen car-builders, now defunct.

Figure 20: VRE seat before fire test, WH photo

7.3.1 Ignition Categories

The requisite reviews have been conducted to consider and develop information related to probable fire ignitions as well as potential for fire growth on Caltrain's VRE passenger vehicles in service.

The VRE cars were reviewed from a viewpoint of (a) potential for unwanted ignition, (b) potential for fire growth and (c) egress issues.

Glazing Materials: All cars include shock resistant polycarbonate windows, which are combustible, but require significant energy to be applied before they will ignite. Such ignition cannot be effected without a large flame (with a heat release rate in excess of 40 kilo-watts) being present.

Design features: The single level design with associated implications for passenger egress and first responder access as well as presence of the HVAC units overhead at the ends of each car.

Seat designs include FR foam and coverings showing excellent ignition resistance. Their performance was consistent with the requirements of the FRA regulations for new vehicles as well as State of California Technical Bulleting 133 (Flammability Testing Procedure for Seating Furniture for Use in Public Occupancies). These properties were confirmed in recent tests, the report for which may be found in the Appendix.

No specific waste receptacles are present in the VRE cars and the familiar, free standing "Amtrak Trash Bag" is currently used.

7.3.2 Potential for unwanted ignition

Sources of potential unwanted ignitions in the cars are primarily related in one way or another to electrically powered services provided to the cars in the form of 480 Volt power used to energize lighting and heating systems. These cables carrying the 480 volt power are isolated from the car interior by the floor system.

Controls are located in electrical panels (which include switches and breakers, as well as relays) at both ends of the car. No history of fire exists to suggest sub-standard performance at these locations, which are not specifically separated from the car interiors by fire resistive constructions.

Although the cars are equipped with under-car battery enclosures, no batteries are contained within the enclosures. The only batteries with which the cars are equipped are re-chargeable types integrated within the emergency exit signs. These batteries present negligible potential sources of ignition for car interiors.

Other potential sources of unwanted ignitions exist in the form of electrical baseboard heaters, which may on occasion smoke if foreign elements (debris, dust) are introduced into them.

Figure 21: VRE seat after fire test. WH photo

An additional source of unwanted ignitions can be from passengers who intentionally set a fire or who may smoke in an out of service car in a station and carelessly discard a match or cigarette. Targets for ignition under the former scenario will most frequently be seats or waste materials such as paper in receptacles.

Both seat coverings and foam cushioning are consistent with state of the art in this area. They are resistant to all foreseeable open flame ignition sources. They can be expected to resist all attempts at arson including a concerted arson attempt, which would have to involve a separate fuel such as wadded up newspaper or a flammable liquid.

Additional threats potentially leading to ignition are those associated with a smoldering source left by a passenger impacting either seating or trash in a receptacle. In the case of the former smoldering ignition of the seating system used on Caltrain is not probable. Such smoldering if it takes place will *only* take place on an out of service car or one in service but not occupied by passengers since ignition will be proceeded by smoke which will warn the passengers or crew of the impending ignition.

7.3.3 Ignition Characteristics

Potential for fire growth - no materials are used on the newer or rebuilt older vehicles known to propagate fire sufficiently rapidly to cause a foreseeable life safety threat.

7.3.4 Egress Issues

No unusual egress issues appear to exist in these older style cars for able-bodied passengers. Doors with stairs and trap door are found at all four corners of the cars making access to grade readily accessible to both passengers and first responders.

Manual operation of doors is possible in all such cases and emergency window exits also are available if needed under upright or derailed conditions.

7.4 Vehicle Summary

The analysis of the three Caltrain vehicle types concluded:

Potential sources of overheat – No equipment has been identified on Caltrain vehicles whose potential for unacceptable performance during over heat presents an unacceptable risk

Existing Fire Safety Equipment – Fire safety equipment available is adequate. Provided observed maintenance levels of this equipment are continued, these items will meet needs for foreseeable fire related emergency conditions

8. Hazard Severity Impact Assessment

The hazard severity and impact of the existing fire safety design features and countermeasures for each category of equipment and service at Caltrain were assessed. This provides an overview and pinpoints the more challenging combinations of rail car design features with relation to fire performance and particular aspects of the Caltrain operating environment.

In addition, the frequency of occurrence and the consequences of a variety of fire scenarios including the most challenging foreseeable ones have been detailed. These have, in turn been considered in combination with the key features of the operating environment to calculate the system's fire risk.

In a previous section, key features of the Caltrain operating environment having different and or important potential impacts on fire safety where characterized as listed below. Each was considered in light of system fire safety design features and passenger and crew operations.

1. Tunnels
2. Grade Crossings
3. Trestles, Bridges, Grade Separated Operations,
4. Urban Limited Access Areas
5. Urban Remote Operating Environments
6. Hazardous Materials Threats

In reviewing the six categories above, numbers four and five can be consolidated in as much as they each create similar challenges to first responders as well as passengers and crew when effecting safe egress based on evacuation and access features present.

This results in the following groups of operating environments requiring evaluation:

1. Tunnels
2. Grade Crossings
3. Urban Limited Access Areas and Urban Remote Operating Environments
4. Trestles, Bridges, Grade Separated Operations,
5. Hazardous Materials Threats

Each of these features above is subject to analysis based on the following factors -

A. Key features present potentially leading to the occurrence of a fire

B. Key features present potentially leading to reduced access for first responders

C. Key features present potentially leading to reduced egress and or fire/some related injuries for passengers, crew of first responders

Thus the operative question being addressed in this portion of the fire hazard assessment is *how will each of items 1 - 5 above impact an outcome in items A-C?*

Next, the analysis assessed the fire risk of likely fire scenarios associated with the Caltrain vehicles and operations patterns, based on Caltrain historical data and the experience of similarly equipped railroads.

Consistent with this, *hazard severity* has been categorized according to APTA's accepted numerical values and definitions described below:

8.1 Measures of Hazard Severity

- **Catastrophic:** Fire involving loss of life due to the impossibility of evacuation and/or lack of adequate smoke control.
- **Serious:** Fire that may cause lost time injuries (such as smoke inhalation), or hospitalization. Evacuation of the train is required. The fire may also cause serious property loss.
- **Significant:** A limited fire that does not cause lost time injuries or hospitalization. Evacuation of train vehicles may occur, but is not required for life safety.
- **Negligible:** Small fires that do not cause any injuries or evacuation. Fire department response is not necessary.

The probability of an event that has a severity characteristic consistent with the levels listed can be categorized as follows:

8.2 Measures of Hazard Probability

- **Frequent:** More than two occurrences/year, or one occurrence per $6x\ 10^6$ vehicle miles.
- **Probable:** More than one occurrence per 3 years or $3.6x\ 10^7$ vehicle miles, but less than two occurrences per year or one per $6x10^6$ vehicle miles.
- **Occasional:** More than one occurrence per 15 years or $2x\ 10^8$ vehicle miles, but less than one occurrence per 3 years or $3.6x10^7$ vehicle miles.
- **Remote:** More than one occurrence per 75 years or $1x\ 10^9$ vehicle miles, but less than one occurrence per 15 years or $2x10^8$ vehicle miles.
- **Improbable**: Less than one occurrence per 75 years or $1x10^9$ vehicle miles.

Once particular measures of *Hazard Probability* and *Hazard Severity*, are assigned to a scenario along judgments may be systematically made as the acceptability of the risk for that scenario and a potential event can be categorized in one of classes listed below based on the characteristics present:

8.3 Risk Acceptability

1. **Unacceptable Risk**—poses immediate threat to personnel safety; correct or control immediately.
2. **Acceptable-Short Term Risk**—may pose a threat to personal safety; formulate corrective action plans and implement on a priority basis.
3. **Acceptable-Mid-Term Risk**—deemed acceptable or unavoidable risk after review by persons with appropriate authority.
4. **Acceptable Risk**—not deemed to be a risk.

By using the concepts outlined above, the following "Fire Risk Index Matrix" has been developed for use in a two-way analysis. This is done by assigning a particular probability to the occurrence of an event [y-axis], and assessing this against probable severity of an occurrence [x-axis] as follows:

Table 7: Risk Index Matrix

Hazard Probability	Hazard Severity: Catastrophic	Serious	Significant	Negligible
Frequent	1	1	1	3
Probable	**1**	**1**	**2**	**3**
Occasional	1	2	2	4
Remote	**2**	**2**	**3**	**4**
Improbable	3	3	3	4

In producing the list above, assigned values correspond to the latter list; i.e.; unacceptable through acceptable to each confluence of probabilities and severity indices as shown in the table.

In utilizing the information and approach presented in the text above, it is important to consider the nature of the information on previous fire history and fire incidents available for analysis in this project. Base records from day to day operations for slightly less than half of Caltrain's operating life have been reviewed and records from primary sources (such as first responders) have been reviewed going back about 20 years. Likewise, secondary sources (Caltrain specific data bases, anecdotal information) have also been reviewed which account for an unspecified period.

In terms of system mileage figures (considered to be 1.6 million vehicle miles per year), available, referring to Section 8.2, **Measures of Hazard Probability** and Table 7 **Risk Index Matrix,** given the approximately 20 years of Caltrain operation and the vehicle mileage involved *does not allow* any judgment to be made beyond the "occasional" level based strictly on mileage or years of Caltrain operation. Using engineering judgment to specifically address this segment of the analytical process, one can increase the assessment basis to "remote" *only*. This means that for any event having a potentially "catastrophic" **Hazard Severity,** the most unlikely risk outcome based on the available Caltrain information only will be "Acceptable-Short Term Risk".

Acknowledging this possibility for younger commuter railroads, the APTA process has recommended using figures from other railroads, hopefully utilizing similar vehicles in a similar operating environment. In the case of Caltrain, METRA in the Chicago area constitutes a quite similar operation in terms of vehicles and operating environment.

METRA *has* operated in excess of 1000 trains per week on a system totaling approximately 500 miles serving 1.25 million passengers per week. Thus, it can reasonably be concluded that the absence of – for example – a train – tanker truck collision accompanied by a fire – *a potentially catastrophic event* –a **Hazard Probability** of "improbable" can be reasonably invoked.

The availability of 20+ years of commuter operations on the Caltrain ROW *as well as its use for many years earlier in Southern Pacific service for commuter operations without notable fire problems* is significant for consideration as well.

8.4 Operating Environment

This analysis has specifically examined the hazard severity associated with the key features of the operating environment listed earlier, with the following results:

8.4.1 Tunnels

8.4.1.1 Key features potentially leading to a fire

As was previously discussed, there are four tunnels in the Caltrain right-of-way. The longest is Tunnel 4 at 3547 feet. There are no design features – mechanical equipment or construction materials -in Caltrain's tunnels that lead to or exacerbate a fire occurring in a consist.

As noted, the tunnels are not equipped with ventilation systems, lighting of any kind, or communications that would be consistent with new construction for passenger use under NFPA 130. However, the chance of a fire in a tunnel itself is negligible due to the lack of ignition sources, or combustible materials.

Since the tunnels are dual track, the probability of a collision between trains is negligible, and therefore the probability of a collision accompanied by a fire is also negligible. The relative shortness of the tunnels makes it highly unlikely that a train would stop within a tunnel in a fire emergency in any case except for a collision or an earthquake.

8.4.1.2 Key features potentially leading to reduced access for first responders:

As previously indicated, access to tunnel bores by emergency vehicles is available in all cases, save for the north end of Tunnel 4. Paved or crushed rock access roads exist at the mouths of all other tunnels. No walking challenges are present in the latter case.

The size of the tunnel's bores is adequate for first responder access on foot and unlikely to be appropriate by vehicles. However, tunnel lengths are such that it is highly unlikely that any train would stop in a tunnel during a fire emergency. Even if a fire emergency were discovered just prior to a train entering a tunnel, the braking distances involved would almost certainly carry the train through the tunnel.

Therefore, even though the tunnel bores provide limited access to first responders, it is our opinion that the features of the tunnels (short length, low number in relation to the length of the right-of-way, good interior clearances) make the probability of reduced first responder access to a train during a fire emergency negligible.

8.4.1.3 Key features potentially leading to reduced egress for passengers/crew.

All of the tunnels are lined with brick or masonry. The tunnels are not equipped with ventilation systems, lighting of any kind, or communications, nor are they equipped with passenger platforms/walkways.

However, in all cases there is physical room to walk between a stopped passenger car and the tunnel wall, or between the tracks and a stopped train, although conditions under foot are not favorable, as loose ballast exists in these unlit tunnels. This is consistent with California PUC General Order No. 26, which also requires a 5 foot walk way between tracks in tunnel centers. This feature provides assurance of assistance for both passenger egress and first responder access.

Again, even though passenger and crew evacuation of a train while in a tunnel is problematic, the features of the tunnels described above make the probability of a train being forced to stop within a tunnel in a fire emergency negligible.

8.4.2 Grade Crossings,

8.4.2.1 Key features potentially leading to a fire

The system has 81 grade crossings.

Grade crossings are the only feature of the Caltrain operating environment that has an inherent potential for ignition. This is related to the large numbers of crossings and rail traffic, the system's predominately urban environment leading to a great deal of crossing traffic, which has resulted in a significant number of automobile/train collisions during the system's existence.

However, the research conducted indicates that none of these collisions between automobiles and trains have resulted in fire incidents along the Caltrain right-of-way. No evidence of fires with trucks has been found although the potential for such incidents is real.

8.4.2.2 Key features potentially leading to reduced access for first responders:

Grade crossings inherently lend themselves to access to first responders.

8.4.2.3 Key features potentially leading to reduced egress for passengers/crew

There are no features of grade crossings that would reduce the ability of passengers and crew to exit a train during a fire incident.

None of the grade crossings are covered. Therefore, there are no areas that would allow the accumulation of smoke or products of combustion to accumulate outside near a stopped train.

8.4.3 Urban Limited Access Areas and Remote Operating Environments

8.4.3.1 Key features potentially leading to a fire

Features inherent in the above captioned areas that potentially lead to a fire occurring, include normal ROW fire sources such as fires caused by transients and vandalism or structural fires adjoining the Caltrain ROW. These could result in ignition of grass fires in areas adjoining the right-of-way. These scenarios presents a negligible life safety threat to the passengers and crew of the train.

8.4.3.2 Key features potentially leading to reduced access for first responders:

The areas captioned above are estimated to occur on less than 3% of the Caltrain ROW by the project team. They are described as:

- Areas where private properties back up to the right-of-way inhibiting ready access;
- Areas where the right-of-way is in a cut and/or adjoins another rail passenger operation – such as the BART line being developed in the San Bruno area where there is limited road access. Another example of this is the Caltrain operation adjoining the 22nd Street San Francisco station where the right-of-way operates in a cut and where there is no direct road access since the facility is serviced by stairways. Likewise, the bridge at 42nd Street in San Francisco poses access challenges to first responders.

In the former case, access roads along the relatively wide Caltrain ROW provide ready access from frequent crossing locations and in the latter case the crossings will lead to access as well which in some case may have to be on foot for short distances.

8.4.3.3 Key features potentially leading to reduced egress for passengers/crew

There are no features of these limited access urban areas that would reduce the ability of passengers and crew to exit a train during a fire incident. Walkways present along the ROW will also aid in these efforts.

Figure 22: Bridge over Caltrain tracks, FCA photo

8.4.4 Trestles, Bridges and Grade Separated Operations

8.4.4.1 Key features potentially leading to a fire

The system has several bridges, and areas where the right-of-way is run on raised earthen mounds as in grade separated areas where communities have elected to eliminate grade crossings in favor of underpasses. None of these features will lead to the occurrence of a fire.

8.4.4.2 Key features potentially leading to reduced access for first responders:

Per California PUC General Order No. 118, all bridges, trestles, and grade separated operations on Caltrain ROW are equipped with a 2 ft. wide walkway and a railing on both sides of the trestles and bridges leading to grade.

The provision of General Order No. 118, combined with the dense infrastructure of the area through which the system operates provides readily available first responder access. The only limitation or challenge to such access will be where a climb is needed to reach a location if access is made immediately adjacent to such raised areas.

8.4.4.3 Key features potentially leading to reduced egress for passengers/crew

There are no features of grade crossings, bridges and trestles, etc. that would reduce the ability of passengers and crew to exit a train during a fire incident.

None of the grade crossings or bridges/trestles along the system right-of-way is covered. Therefore, there are no areas that would allow the accumulation of smoke or products of combustion to accumulate outside the train vehicles. Since the bridges and trestles of the right-of-way comply with General Order No. 118, the probability of passenger and crew's egress being adversely affected by a fire incident is negligible.

8.4.5 Hazardous Material Threats

8.4.5.1 Key features potentially leading to a fire

There are a limited number of hazardous materials facilities adjoining the Caltrain right-of-way. One such situation exists near SF Airport. All of these facilities are sufficiently remote from passenger train operations that it is unforeseeable that – short of a catastrophic explosion occurring simultaneously with a passenger train being present adjacent to the explosion location – the presence of these facilities present an unacceptable fire risk to Caltrain operations.

Similarly, pipelines along Caltrain routes – associated with airport operations and previous SP operations - are buried at a depth of 5 feet. This provides a sufficient safeguard to Caltrain passengers and crews in the event of a derailment or collision along these routes.

Hazardous materials shipments – Shared right-of-way with freight operations – The Caltrain right-of-way is shared with freight operations of the UP railroad. These lines do not operate during normal Caltrain operating hours. In the event of a collision between a Caltrain consist and a freight train some risk does exist for discharge of HAZMAT and or an ignition of freight. However, given the frequency of combined operations, this level of risk is negligible.

8.4.5.2 Key features potentially leading to reduced access for first responders

The areas where shared operations exist, and where the right-of-way adjoins hazardous materials operations/facilities are well served by access roads. None of these areas are in remote access areas, or in urban limited access areas.

8.4.5.3 Key features potentially leading to reduced egress for passengers/crew

There are no features in areas where hazardous materials may coexist with passenger train operations that would lead to reduced egress for passengers and/or crew.

8.5 Fire Scenarios

A wide variety of likely fire scenarios associated with Caltrain operations have been evaluated as part of this analysis in order to assess their probable severity when occurring in the various operating environments. The scenarios analyzed were chosen based on an analysis of the features of Caltrain's equipment, operating environments, ridership, known fire incidence history associated with commuter rail operations and engineering judgment.

Assessing probable fire performance of Caltrain's equipment in service is difficult since Caltrain has not experienced a significant fire in its lifetime and those incidents which have occurred have in large part been result of minor equipment failures or aging which may have resulted in smoke but which did not result in flame, fire risk to passengers or crew or significant property damage.

Therefore, the minor fires recorded in the historical data reviewed from all sources, and the experiences of other railroads with similar equipment were reviewed and invoked. From historical data, and an examination of other similar systems fire scenarios of concern emerged and are presented below:

1. A *smoldering object* placed in a plastic, uncovered waste container during a lay-over. This ignited light combustibles in the container. In this case on another RR, such an incident caused smoke to be observed by train operating personnel who called first responders and also extinguished the small fire.

2. *Vandalism scenarios* involving introduced solid fuels such as paper have been considered and would produce minimal damage and no significant fire growth. Liquid fuels introduced would have a similar effect unless *these were introduced in large quantities* and a determined arsonist were involved. No design features could mitigate damage from the latter class of scenarios and existing exiting would be adequate should such an unlikely incident take place on a loaded train.

3. *A consist striking an auto or truck resulting in a fire.* In this case similar incidents have occurred on two different commuter railroads leading to different outcomes. Neither resulted in injuries to passengers or crew. In the first case, a cab car struck a passenger vehicle, dragging it along the car resulting in ignition. The resulting fire exposed the exterior of the passenger car to a significant fire plume fueled by gasoline and automotive car parts. The fire from the burning vehicle eventually ignited polycarbonate windows – *well after passengers had been safely evacuated from the effected car* – which melted. This was followed by ignition of seat coverings and some interior components under the high heat fluxes present.

   In a second similar situation, a cab car struck a truck stopped on a grade crossing and the cars fuel tank ignited. No injuries resulted and no fire penetration occurred into the car. The fire was quickly extinguished by first responders.

4. A serious scenario which has never occurred at Caltrain or any other commuter RR in the US to our knowledge would involve collision between a commuter train and a loaded tank truck - such as a gas tanker – provides a worst or potentially catastrophic case.

5. A composite scenario relating to fires originating in exterior electrical equipment mounted under cars is consistent with reports from several sources. In all cases with Caltrain such recent incidents have all been tended to by train personnel

where such fires have self-extinguished or the personnel have extinguished them with onboard safety equipment. No braking equipment below cars is electrically equipped (as with brake grids) and no propulsion equipment exists there.

6. Scenarios involving an on board fire or right of way fire in a Caltrain tunnel have been considered. Lack of fuel in the tunnels and the reliability and known fire performance of the vehicles lead to the conclusion that the hazard severity of such incidents is negligible.

8.5.1 Fire Risks

From Caltrain's data, the system has historically averaged approximately 5.3 "fire/heat/smoke" incidents per year, or one incident every 302,000 (3.02×10^5) miles in the years for which detailed data is available. Assuming that these incidents are all "fires," they would be classified with a probability of "frequent". However, evaluation of the data shows that only one of these resulted in first responder response and in that case the fire self extinguished. None of the other incidents were serious and most resulted in no action being taken.

In a vacuum, Caltrain's accumulated mileage (1.14×10^7) only allows us to say that a "**Measure of Hazard Probability"** of some type of fire incident occurring is "probable" based *strictly* on the APTA RP approach. Knowing that operations have taken place for over 20 years without a serious or significant fire incident allows the observed "**Measure of Hazard Probability"** to be increased to "occasional" as a limit based *strictly* on operating mileage and system age.

As discussed earlier, the METRA system in Chicago provides an analogous system with significantly longer operation for ready comparison. Thus, referring to the table "**Measure of Hazard Probability"** presented earlier, based on years of operation or composite mileage from earlier operations or similar operations at METRA in Chicago, it is appropriate to find that a substantial history free of serious fires exists at Caltrain based on its current vehicles and operating environment and all available fire incidence information.

Therefore, based on historical data and data from other similar systems, we have classified the severity and probability, and the corresponding fire risk from the matrix presented earlier, as follows:

The key features of the operating environment discussed above may be classified as "Negligible" in terms of their impact on the severity of a fire incident. Therefore, their fire risk severity index, per our matrix, is assigned a value of "**-Acceptable**."

Similarly, if we examine the three fire scenarios of concern presented above, *none of which it must be emphasized have not occurred on the Caltrain system*, the scenarios which have the potential for being most severe are collisions between a train and motor vehicles at grade crossings. Given that these scenarios have not occurred despite numerous collisions, their potential severity has been assigned a value of "**Significant**," for car - train collisions and trucks not carrying combustibles in collisions with trains. For trucks carrying flammable liquids involved in collisions with trains the potential severity has been assigned a value of "**Catastrophic**".

Evaluation of relevant incidents represented by the scenarios according to their probability has been conducted. Those that are significant are related to potential grade crossing incidents.

Such incidents involving ignition of an automobile or truck not carrying a flammable liquid in conjunction with a collision are deemed to have a risk index of (**Acceptable-Mid-Term Risk**—deemed acceptable or unavoidable risk after review by persons with appropriate authority) which is the product of "**significant** severity" and "**remote** probability". It is important to note that this is a compound probability and is dependant not only of the collision occurring which is a probable or occasional event but this MUST be accompanied by an ignition to present a fire related risk.

Likewise, for a similar scenario but one involving a tank truck loaded with a flammable liquid which ignites as a result of the collision, a risk index of "3" also results but as the product of an a "**catastrophic** (1)" severity and "**improbable** (5)" probability of occurrence. These observations are consistent with risks that must be acknowledged but for which available or cost-effective mitigation solutions do not exist.

Thus, dependant on interpretation of the data available, this last scenario - and even the preceding one – can not be given an rating of acceptable Mid Term Risk or higher without invoking data from another, older railroad with a significantly longer operating history.

Finally, it seem appropriate here to note that the Caltrain system copes with a difficult ROW environment with respect to crossing accidents and description of the two scenarios described involving trains striking vehicles stopped on grade crossings is consistent with current operating conditions.

None of the other scenarios evaluated present any "Unacceptable" or "Acceptable-Short Term" risks.

9. Discussion and Comments

The fire incidents noted, researched and reviewed and those described above have not led to any reported injury to a Caltrain passenger. Fires or fire-related incidents have occurred which led to extremely minor damage but neither the scenarios involved or the scope of the damage suggests them to be indicative of an intrinsic or serious problem.

The current record keeping system at Caltrain captures essential data related to fire incidents at the base level. This material can be assembled (with appropriate effort) into an effective fire safety database.

The passenger vehicles themselves pose no egress problems and are consistent with or exceed FRA regulations.

No unusual ignition sources exist in any of the cars based on the evaluations conducted.

No operating environment hazards suggest any concerns beyond those addressed routinely through due diligence planning and activities as currently carried out routinely.

The system safety plan draft is consistent with the recommendations of the APTA working group that developed the RP noted earlier. However the draft plan does not contain any section related directly to fire safety. This is apparently a result of the exemplary fire safety record that commuter trains have developed over the years.

Perhaps the most important observation that can be made is the fact that the fire safety systems in place at Caltrain function quite well. In all cases serious fire incidents threatening passengers or crew have been avoided. A challenge of that situation is providing enhanced record keeping capabilities to provide and answer the question as to "how has [systematic high level of fire safety] this been accomplished" – i.e., how have potentially threatening incidents been mitigated and prevented from becoming serious in essentially all cases examined?

It is particularly important to note from a FHA perspective how the Caltrain vehicles are used. While some conditions may exist, such as older and somewhat undocumented features on the VRE cars the combination of 2+ train persons per train, high level of familiarity with the trains by their riders, lack of challenges to evacuation of riders – such as exists on other commuter railroads – leads to a fairly high level of confidence in how the overall system – composed of train design features, staffing and ROW operating environment – has and will continue to function in an emergency.

10. Conclusions

1. This preliminary fire hazard assessment finds that no imminently hazardous fire safety related conditions exist at Caltrain that require immediate attention.
2. It will be important to develop the existing information gathering system further to identify incidents that are serious or potentially serious and track them to completion to determine why a particular outcome was reached.
3. In interviewing Caltrain's maintenance personnel, and researching past fire incidents, it was apparent that fires, smoke and excessive heating incidents may or may not be recorded in the various maintenance databases maintained by Caltrain/Amtrak unless the incident caused a delay. This practice can result in loss of data as when smoke may occur and passengers are moved by a conductor to an adjoining car without stopping the train
4. Lighting, and emergency communications and access issues related to the operating environments in Caltrain's tunnels have not been addressed in depth previously due to a good ongoing safety record.
5. No Egress issues related to the vehicles exist except for the improbable circumstance of a train being stopped in a tunnel.
6. Minor conflicts appear to exist regarding recommended seating at emergency window locations, which are also coincident with seating for seniors/persons with disabilities.
7. The Caltrain SSPP Draft Report should be developed to either implicitly or explicitly address fire safety issues which in particular related to its operating environment and the training of train persons. These may (or should) be addressed elsewhere in existing Caltrain operating personnel training which specifically address train operations in fire emergency utilizing scenario based approaches
8. Improvements in hands-on training with Caltrain's rolling stock by first responders is encouraged. Such training could be held at least annually to allow first responders to become familiar with the interior lay-out of Caltrain passenger car features including how evacuations might take place and how they might or might not enter passenger vehicles while wearing SCBA [airpacks]. Such training could also provide emphases on passenger extraction from emergency exit windows, and familiarization with passenger car cutting points as well as power and propulsion systems.

11. Recommendations

1. JPB establish an electronic database under the direction and control of the Samtrans Safety Officer of all fire, excessive heating and smoke incidents.
2. Fire safety issues associated with Caltrain's tunnels in particular lighting and communications be evaluated
3. Evaluate and potentially address conflicts, which appear to exist regarding recommended seating at emergency window locations, which are also coincident with seating for seniors/persons with disabilities.
4. Review the Caltrain SSPP to ore directly or completely address fire safety issues.
5. Revise first responder training to provide local fire and police with routine familiarity with Caltrain vehicles and the environments presenting challenges to which they may be called to respond.
6. Additional site specific familiarization and training of first responder personnel is encouraged so that first responders from jurisdictions along the Caltrain ROW will be familiar with both terrain characteristics in areas for which they are responsible and general characteristics of Caltrain vehicles.

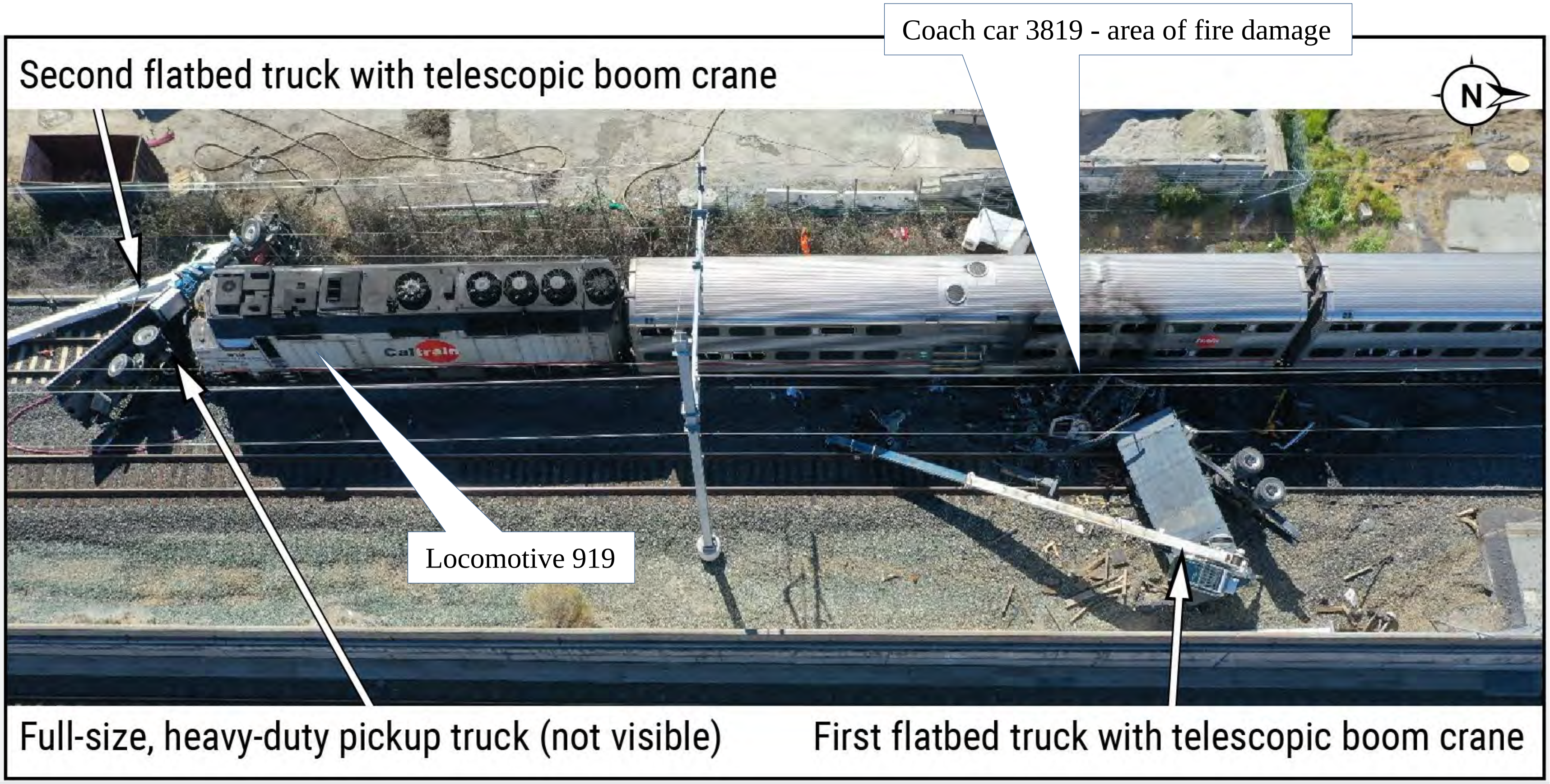
7.

12. References

1. APTA RP-PS-005-00-Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment, The American Public Transportation Association, 2000.
2. Federal Register, Part II, Department of Transportation, Federal Railroad Administration, 49 CFR Part 216 et al. Passenger Equipment Safety Standards; Final Rule, May 12, 1999.
3. ASTM E 2061-00, Guide for Fire Hazard assessment of Rail Transportation Vehicles, American Society for Testing and Materials, February 10, 2000.
4. MIL-STD-882D, Standard Practice for System Safety, Department of Defense, February 10, 2000.
5. The SFPE Guide to Performance-Based Fire Protection-Analysis and Design of Buildings, Society of Fire Protection Engineers and National Fire Protection Association, The SFPE Task Group on Performance-Based Analysis and Design, Eric R. Rosenbaum, P.E., Chairman, Quincy, MA, 2000.
6. NFPA 130-Standard for Fixed Guideway Transit and Passenger Rail Systems-2000 Edition, Technical Committee on fixed Guideway Transit Systems, National Fire Protection Association, Inc., Frank J. Cihak, Chair, Quincy, MA, February 11, 2000.
7. Caltrain System Safety Plan-July 2000 Draft
8. Signor, John R., 1994. Southern Pacific's Coast Line, Signature Press, Wilton, Ca. 95693.
9. U.S. Department of Transportation, Safety Management Information Statistics (SAMIS), 1997 Annual Report.

– End of Exhibit –

Exhibit 5. Wreckage Distribution / Aerial Imagery Map - Annotated[1, 2]



The train and maintenance vehicles after the collision. (Photograph courtesy of the San Bruno Fire Department.)

[1] The image [map] depicts the locomotive, the 1st passenger coach car (# 3819), and a small segment of the 2nd passenger coach car (# 3829), in which the remainder of the train has been omitted from this map, as that equipment was essentially undamaged in the accident.

[2] Source: aerial imagery, as made available to the investigation, from responded UAV [unmanned aerial vehicle] resources (also referred to as aerial 'drones'), to which annotated data (describing select attributes / physical elements of the site) is correspondingly inserted in the image. See further [Internet] https://www.ntsb.gov/investigations/Pages/RRD22MR007.aspx

Exhibit 6. Execution of the Emergency Response Activities - Chronology (Timeline)[1]

Based upon Timeline data of the Survival Factors investigation and supplementary evidentiary data obtained[2], a tabulation was compiled, as presented below, which describes a summarization of relevant key / significant activities that occurred in the emergency services response to the accident.

Tabulation Legend - data source nomenclature / abbreviations

~	approximate, or approximately
AFFF	Aqueous Film Forming Foam [fire suppression foam]
BC	Battalion Chief
CAD	San Mateo County - Computer Aided Dispatch report (of the incident)
Capt	Captain [command officer of a responding apparatus]
E52, E61	SBFD apparatus; engine [agency designation number]
EMS	emergency medical services (generic)
FF	firefighter (generic)
IC	Incident Command
LER	Locomotive Event Recorder
MCI	mass casualty incident
FNL	NTSB / Crashworthiness / FD Response Group debriefing / response execution review, of the emergency services agency / command officers, as documented in notations of Group Chairperson in the Field Notes Logbook
PSAP	Public Safety Answering Point[3]
radio	radio communication (recording)
RIT	Rapid Intervention Team
SBFD	San Bruno Fire Department
SMC-PSC	San Mateo County – Public Safety Communications – agency data
So San Fran	South San Francisco FD
Source	source of the data element as cited for that specific Timestamp activity described
Timestamp	the time at which the described activity had occurred[4]
Transc	interview transcript (of the individual referenced)

[1] Source: on-scene observations of, and field notations recorded by the SF Group Chair, and as further described.

[2] Data source of the tabulation were the individual Timeline data [documentation] of the identified agencies, and as further described.

[3] Ref, and as further described in [Internet] http://www.nena.org/.

[4] All activities occurred on March 10, 2022, in which all timestamps are Pacific Standard Time.

Timestamp[5]	Activity Summary	Source
10:34:45 a.m.	Collision of Caltrain commuter train No. 506 with railroad construction project equipment.	LER
10:34:56	First [incoming] 911 call, from the accident site, was received by the local PSAP (i.e., SBPD), and then transferred to SMC-PSC, to report the incident. This call was followed by a number of subsequent calls reporting the incident.	CAD
10:35:05	Call [911] type determined: [initially identified as a] structure fire	CAD
10:36:47	System [automated] decision what resources to dispatch to the scene	CAD
10:36:53	Notification to SBFD; a request to respond resources to the scene, location reported as [intersection of] San Felipe Ave and Huntington Ave	CAD
10:37:18	1st SBFD apparatus (E51) is enroute to the scene	CAD
10:37:43	SBFD Battalion Chief [command officer] is enroute to the scene. SBFD BC, while enroute to scene, radioed request [to Dispatch] to contact Caltrain, to issue an all-stop of train operations, for both directions, in the area of the reported SBFD response scene [an acknowledgement to this was subsequently received]	CAD FNL
	Prior to arrival of SBFD resources at the scene, personnel of the San Bruno Water Division, using a backhoe / loader / tractor (that was situated at a property lot used by that Department)[6], cleared away several sections of the [chain link] fence that was situated along the eastern boundary of that property lot, to afford access to the accident scene by responding SBFD personnel / resources.	FNL
	Prior to arrival of SBFD resources at the scene, Caltrain on-board train crew initiated an evacuation of the train	Transc
10:39:54	SBFD BC arrived at the scene	CAD radio

[5] Timestamps of telephone calls indicate the time in which the call initiated.

[6] i.e., an equipment and materials storage lot / yard, situated immediately adjacent to the railroad property, as utilized by the City of San Bruno / San Bruno Water Division (ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/456/Water)

	SBFD BC establishes / identifies the IC post site at the scene (i.e., initiated Incident Command process), reported [to Dispatch] smoke showing SBFD BC performs his initial ‘size-up’ [assessment as to an appropriate response that would be needed], assigns E51 to commence fire suppression	FNL
10:39:54	1st SBFD apparatus (E51) arrived at the scene, which was followed by the subsequently dispatched (E52) SBFD apparatus Initiates initial assignment; fire suppression	CAD FNL
10:41:30	SBFD BC heard radio report of a possible burn victim at the site; BC responded with a response upgrade (see next activity)	CAD FNL
10:43:29	SBFD BC upgraded the SBFD response to a structure fire response with a level 1 MCI response	CAD FNL
10:45:16	SBFD T51 [ladder truck] arrived at the scene; was approached by a civilian who notified them of a nearby burn victim; IC was notified, in which T51 rendered initial aid to that burn victim, in which that burn victim was transferred to the services of a responding ambulance.	CAD FNL
10:45:56	SBFD BC assigned E52 to conduct primary search and evacuation of the train; the E52 Capt later advised the train was cleared (search completed)	CAD FNL
10:46:17	SBFD E61 arrived; was assigned fire suppression of the 1st coach railcar [3819]; at that point a segment of the aft section of that railcar appeared to be heavily involved in fire. Accessed the west side of the train through the opened fence of the property lot. T51 was subsequently assigned to support E61 in the fire suppression of the 1st coach railcar; SCBA used, no AFFF, suppression using only water. E 51 working to suppress fire at the front of the locomotive, and the crashed vehicle at that location.	CAD FNL
10:47:44	A Safety Officer was designated by IC; queued at the staging area.	CAD FNL
10:49:53	BC17 [Batt Chief, So. San Fran] assigned the North Division (north end of the train).	CAD FNL

	FF access to burning Vehicle # 2 (located on the E side of the 1st coach), for suppression, was through the vestibule of the 1st coach. Access to the area of the 1st coach was also through the vestibule of the 1st coach.	
10:52:01	E63 arrived on-scene; assigned to Medical Group (ambulance support, helped setup triage). Reported multiple victims.	CAD FNL
10:54:04	Med17 (So San Fran) medical unit arrived on-scene. IC noted multiple ambulances were on-scene at that point; staged nearby.	CAD FNL
10:57:30	2nd Alarm issued by IC; responding apparatus to be staged at San Felipe Ave / Huntington Ave staging area. Responding resources included a Quint (So San Fran), E37 and BC8 (Central County), E64 and E65 (So San Fran), BC120 (No County / Daly City), Air Truck (SCBA support; Colma Vol FD)	CAD FNL
11:00:27	Request placed to PG&E [electric utility] to respond to the scene, to check electric lines above the accident site (as a precautionary measure, to assure integrity / no prospective hazards). PG&E later arrival indicated the utility did not have [overhead] infrastructure in that area that would affect responder safety (i.e., the electric lines above the accident site were elements of the railroad maintenance project).	CAD FNL
11:01:57	1st responding unit [E37] of 2nd Alarm arrived on-scene, followed shortly thereafter by the remaining responding units.	CAD FNL
11:06:25	BC8 arrived on-scene; assigned South Division (i.e., the FF crews involved in the clearing of [assuring no remaining passengers / crew in] the train cars). Search completed shortly thereafter; [verbal] reported negative on any passengers / crew in the train cars.	CAD FNL
11:06:29	IC reports (to Dispatch) 10 Walking wounded, 1 critical, Level 3 MCI", which was updated ~ 2 min's later to 12 to 15 minor injuries.	CAD
11:07:29	RIT (Quint 62) established at the scene (available for immediate response).	CAD FNL

~ 11:14	FF crews reported [verbally] fire suppression completed (both Divisions, i.e., the front of the train, and the 1st coach railcar); no rekindle reported, Overhaul operations to subsequently commence.	FNL
11:27:56	3rd Alarm issued by IC; specifically for Overhaul operations at the scene.	
11:39:31	Notation in CAD: NTSB [RPH staff] contacted the agency (inquiring information on the incident); subsequent inquiries were also received.	CAD
12:01:56	IC requested aerial drone support to respond to the scene.	CAD
	SBFD comment: command officer(s) maintained a presence at the scene during Overhaul, and subsequent, due to [1] this being an MCI, [2] the volume of responding emergency services support agencies (e.g., accounting of resources, etc.), and [3] this being a relatively ‘hi-profile incident’ (media attention, NTSB inquiry / [which evolved into] investigation site, etc.).	FNL
13:10:37	Notation in CAD: MNP has drone in the air.	CAD
13:40:48	Notation in CAD: To all first responders – per Caltrain, no first responders to remove any evidentiary items in place, leave all items O/S [on-scene].	CAD
16:28:05	IC operations terminated at the scene.	CAD FNL

– End of Exhibit –

Exhibit 7.

Roster of Principal Responding Jurisdictional Emergency Services Agencies / Organizations[1]

Agency / Organization - Role	Agency / Organization - Name	Location[2]
9-1-1 Call Processing / Emergency Services (Fire Department and EMS), and Law Enforcement Response Requests[3]	San Bruno Police Department - Communications[4, 5]	San Bruno, CA
Fire / Rescue / Emergency Services Responses	San Bruno Fire Department[6]	San Bruno, CA
Fire Department / EMS Dispatching	San Mateo County – Public Safety Communications[7]	Redwood City, CA
Emergency Medical Services / Ambulance Response	American Medical Response (AMR)[8]	Burlingame, CA
Law Enforcement (Police)	San Bruno Police Department[9]	San Bruno, CA
Law Enforcement Dispatching	San Bruno Police Department - Communications[10]	San Bruno, CA

– End of Exhibit –

[1] Source: SBFD document [describing the SBFD response to the incident], ref emails from the SBFD Chief, to the Group Chairperson, [subject line] “Responding Agencies List request”, dated 3/11/2022.

[2] Principal operational, and/or administrative office(s).

[3] i.e., this agency is the primary Public Service Answering Point (PAP) agency for the designated municipal jurisdiction.

[4] ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/756/Organizational-Information

[5] Such a facility or operation is also referred to as a Public Safety Answering Point (PSAP), as further described in [Internet] http://www.nena.org/.

[6] ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/294/Fire.

[7] ref, and for further information, see [Internet] https://www.smcgov.org/911dispatch.

[8] This organization operates under contract with San Mateo County to provide Emergency Medical Services (EMS) response / support to the municipal jurisdictions of San Mateo County, ref, and for further information, see [Internet] https://www.amr.net.

[9] ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/472/Police.

[10] ref, and for further information, see [Internet] https://www.sanbruno.ca.gov/756/Organizational-Information

Exhibit 8.

Roster of Apparatus and Other Emergency Services Resources – Response List[1]

Fire Department Agencies

SBR	San Bruno Fire Department
CEN	Central County Fire Department
SOF	South San Francisco Fire Department
NCF	North County Fire Authority
CLM	Colma Volunteer Fire Department
MNF	Menlo Park Fire Protection District

Law Enforcement Agencies

San Bruno Police Department
San Mateo County Sheriff's Office
Daly City Police
South City
San Mateo
Burlingame Police Department
Belmont Police
Menlo Park Police
Redwood City Police Department

EMS Agencies

American Medical Response

San Bruno Fire Department – Collective Response List
(ref BF22-836 Fire and EMS Unit list)

Initial Dispatch

BC16
E51
E52
Q62
E61

[1] Source: SBFD document [describing the SBFD response to the incident], ref emails from the SBFD Chief, to the Group Chairperson, [subject line] "Responding Agencies List request", dated 3/11/2022.

Updated initial (T51 in place of Q62)

BC16
E51
E52
T51
E61

CH16 attach
PR16 attach
PR16a attach
PR16b attach

1st Alarm

E63
BC17
E81

Level 1 MCI

Med 17

2nd Alarm

BC8
BC120
Q62
E37
E64
E65
BS86

Level 2 MCI

Level 3 MCI

3rd Alarm

T34
E38
E32
E92
BC20
E35

MEDIC Units (AMR)

AMR201
M662
M802
M42
M47
M34

Miscellaneous

MNF Drone

– End of Exhibit –

– End of Report –