APPENDIX Ia

Summary of Selected NTSB Accident Reports

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
February 9, 1996	RAR-97-01 Railroad Accident Report Near Head-on Collision and Derailment of Two New Jersey Transit Commuter Trains Near Secaucus, New Jersey	fatal: 3; serious: 10; minor: 148; none: 247	3,328.6	"failure of the train 1254 engineer to perceive correctly a red signal aspect because of his diabetic eye disease and resulting color vision deficiency, which he failed to report to New Jersey Transit during annual medical examinations Contributing to the accident was the contract physician's use of an eye examination not intended to measure color discrimination."	SYNOPSIS New Jersey Transit (NJT) commuter train 1254 collided head-on with NJT commuter train 1107 (track intersected at 30° angle). Train 1254 consisted of a cab car, 4 coach cars, and a locomotive unit. Train 1107 consisted of a cab car, 5 coach cars, and a locomotive unit. Train 1254 was traveling at 18 mph when it struck train 1107 which was traveling at 53 mph **SEPARATION** - n.a. **CAR INTEGRITY** - On Train 1254, all 5 cars sustained damages; the roof of the lead car was sheared off on the right side near the front end. - On Train 1107, 5 of 6 cars suffered some degree of damage; the locomotive unit sustained major intrusion and crush damage to the engineer's side of the locomotive. **TRACK QUALITY** - n a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures (i.e., inadequate color vision testing requirements) - fitness for duty

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
January 6, 1996	RAR-96-04 Railroad Accident Report of Collision of Washington Metropolitan Area Transit Authority Train T-111 with Standing Train at Shady Grove Passenger Station, Gaithersburg, Maryland	fatal: 1; serious: 0; minor: 0; none: 2	between 2,000-2600	"the failure of Washington Metropolitan Area Transit Authority (WMATA) management and board of directors (1) to fully understand and address the design features and incompatibilities of the automatic train control system before establishing automatic train operation as the standard operating mode at all times and in all weather conditions, (2) to permit operating department employees, particularly Operations Control Center controllers and supervisors, to use their own experience, knowledge, and judgment to make decisions involving the safety of Metrorail operations, and (3) to effectively promulgate and enforce a prohibition against placing standby trains at terminal stations on the same track as incoming trains. Contributing to the severity of the injuries to the train operator was the disproportionate amount of crush sustained by the lead cars of the colliding trains."	SYNOPSIS Washington Metropolitan Area Transit Authority (WMATA) Metrorail subway train No. T-111 rear-ended a standing, unoccupied gap train. Train T-111 consisted of 2 "married" pairs of cars. constructed by Breda Costruzioni Ferroviarie, S.p.A. The gap train consisted of 3 "married" pairs Breda cars. NTSB calculated that Train T-111 was moving at between 22-29 mph. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures (i.e., WMATA decision to completely and suddenly replace its policy on intermittent routine manual train operation with an essentially untested policy of full-time automatic train operation; Operations Control Center controllers did not have authority to use their own experience, knowledge, and judgement to make decisions involving the safety of Metrorail operations; etc.) • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system (i.e., under extreme low-adhesion conditions, the specified stopping distances are longer than can be safely accommodated by the automatic train control block design) **CAR INTEGRITY** - On Train T-111, the impact on lead car (3252) sheared the huck bolt fasteners attaching the bolster to the side sills, broke the welds attaching the transverse members of the draft sill to the side sill, and sheared off the ends of the side sill. The ends of the side sills remained attached to the front end sill The side sills, once free of the end underframe assembly, moved outward and allowed the end underframe assembly to move rearward as a unit relative to the body shell. The lead car of the gap train telescoped approximately 21 feet into the car 3252. - On the lead car of the gap train, several of the huck bolts attaching the end underframe bolster to the side sills sheared, and the weld attaching the transverse members of the draft sill to the side sill failed catastrophically. The ends of the side sills at the attachment to the end sill cracked but did not fail as they did on car 3252. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** - n.a.

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
June 5, 1995	RAR-96-03 Railroad Accident Report Collision Involving Two New York City Subway Trains on the Williamsburg Bridge in Brooklyn, New York	fatal: 1; serious: 2; minor: 64; none: 3	2,300	"the failure of the J train operator to comply with the stop indication because he was asleep, and the failure of the train to stop within the block because of inadequate braking distance between signals on the Williamsburg Bridge. Contributing to the accident were the New York City Transit's inadequate measures for ensuring employee compliance with proper radio procedures."	SYNOPSIS New York City Transit (NYCT) J subway train rear-ended a stopped NYCT M subway train. Each of the trains had 8 cars. The J train had all R-40 series cars. The M train had all R-42 series cars. Estimated approach speed of J Train was 18 mph; M Train was stopped. **SEPARATION** • SUPERVISORY/MANAGEMENT - failure to follow standard operating practices (i.e., M train operator failed to inform command centre of stops at red signals) • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system (i.e., insufficient spacing for emergency braking stopping distance) **CAR INTEGRITY** - Lead car of J train, 4461, partially telescoped about 17' into car 4664. - On the M train, the first 4 cars reported no damage and the next 3 suffered cracked bonnets (the hood that projects over a railcar) and bent anticlimbers (flanges). The eighth and last car suffered massive carbody intrusion. The anticlimber and front structure were pushed in about 7 feet. The floor was penetrated, and had buckled upward and inward. The vacant operator's cab in the back of the car was totally crushed; no survival space remained. - On the J train, all eight cars suffered some degree of damage. The lead car experienced massive carbody intrusion on the operator's cab end. The anticlimber and front structure were pushed in about 7 feet The interior floor was penetrated, and had buckled upward and inward. The entire end of the car was essentially destroyed up to the horizontal cross member over the center pin. The front seat opposite the operator's cab was totally crushed. The operator's cab was totally crushed with no survival space remaining, and the rear wall of the cab was displaced backward The remaining cars suffered damage to the draft gear and related parts, cracked bonnets, and bent anticlimbers. **TRACK QUALITY** - n.a **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - fitness for duty (i.e , J train operator fatigued)

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
February 9, 1995	RAR-96-01 Title: Collision and Derailment of Two Subway Trains Metropolitan Transportation Authority New York City Transit in Brooklyn, New York,	fatal: 0; serious: 0; minor: 15; none: 139	in excess of 1,500	"the inadequate oversight and compliance program of the Metropolitan Transportation Authority/New York City Transit to ensure that train operators comply with the published operating rules. Contributing to the collision was the design modification to the automatic key-by feature of the automatic stop arm that enabled the operator of the M train to pass a stop signal contrary to the published operating rules that require stopping at a red signal unless permission to pass is granted by Rapid Transit Operations."	SYNOPSIS New York City Transit (NYCT) M line subway train rear-ended a stopped B line subway train. Both trains consisted of self-propelled cars, operated in 2-car pairs built by the St. Louis Car Manufacturing Corporation. The B train consisted of 10 R-40 type cars. The M train consisted of 8 R-42 type cars. Estimated speed of train 12 just before impact was 13-17 mph. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs / procedures (i.e., lack of oversight testing of compliance with critical speed and signal operating rules) • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system (i.e., key-by feature, and lack of overspeed protection). **CAR INTEGRITY** - On the M train, the lead car underrode the anticlimber of the rear car on the B train, causing extensive damage; the anticlimber was pushed in 5 to 6 feet, and the interior floor of the car was penetrated and buckled upward and inward; the right front corner post, the right front collision post, and the operator console were displaced aft. - The fourth car on the M train was derailed and the collision post on the right side was bent about 1 foot inward and over and was torn on the bottom from the horizontal member The car interior had some penetration at the right rear and its ceiling was displaced downward and backward. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures (i.e , lack of procedures for radio accountability)

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
May 16, 1994	RAR-95-02 Amtrak Train 87 Derailment after colliding with Intermodal Trailer from CSXT Train 176 Selma, North Carolina	fatal: 1; serious: 1; minor: 120; none: 318	3,730	"failure of the CSX Intermodal Corporation to properly secure the intermodal trailer to the flat car on CSXT 176 and the failure of the CSX Intermodal Corporation to have in place a comprehensive inspection program."	SYNOPSIS Amtrak train 87 struck an intermodal trailer on the 51st car of CSX Transportation Inc. (CSXT) freight train R176-15 (CSXT 176). After the collision, both Amtrak locomotive units and the next 17 cars derailed. Train 87 consisted of a 2-unit locomotive, a material handling car, 2 baggage cars, 10 coach cars, 2 lounge cars, a buffet car, a sleeper car, and a dining car. CSXT train 176 consisted of a 3-unit locomotive and 52 cars (50 loaded and 2 empty) with a total of 4, 449 trailing tons and length of 6,188 ft. At the time of collision, CSXT 176 was traveling at 35 mph. **SEPARATION** - n.a **CAR INTEGRITY** - Amtrak train 87, rupture of fuel tank on lead unit. The sheet metal that covered the right side of the front hood and the control compartment was torn and collapsed inward 1.5 feet. The seats for the engineer and the assistant engineer had separated from their attachment points. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - inadequate programs / procedures (i.e., inadequate inspection program) - failure to follow standard operating practices (i.e., failure to properly secure trailer)

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Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
January 18, 1993	RAR-93-03 Collision between Northern Indiana Commuter Transportation District Eastbound Train 7 and Westbound Train 12 near Gary, Indiana	fatal: 7; serious: 6; minor: 89; none: 95	854	"inattentiveness of the engineer on train 7, resulting in his train passing a stop signal and partially blocking the westbound track Contributing to the severity of the accident was the failure of the engineer on train 12 to take timely action to slow or stop his train before the collision. Contributing to the severity of the injuries was the breach of the passenger compartment in the lead cars of both trains."	SYNOPSIS Northern Indiana Commuter Transportation District (NICTD) commuter train 12 struck train 7 in a corner-to-corner collision. Passenger rail cars (MU locomotives) in trains 7 and 12 complied with FRA locomotive safety standards in 49 CFR 229.141. Train 7 and train 12 consisted of 2 and 3 passenger cars, respectively. Estimated speed of train 12 at time of derailment was 32 mph. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures , i.e., NTSB concluded that the incident could have been prevented had a positive train separation system been in place and operational. **CAR INTEGRITY** - on Train 7, the entire left front corner post structure, which included the door structure and the front of the car, was missing from floor to roof. The car body sidewall separation extended about 27 feet. A single, large segment of car body wall had intruded and rotated into the car, and it was wedged at 90° to its initial orientation across the compartment against the opposite wall. - on train 12, there was a major separation from the left corner of the front end, extending along the left side to and including the third window; this separation extended about 27 feet. The front left corner post structure was displaced about 1 foot inward and about 2 feet rearward from floor to roof. - on lead cars of both trains, seats were bent in the opposite direction to their normal mounted position and were torn from their floor mountings. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - fitness for duty (the train 7 engineer's inattentiveness to his signal indications and the train 12 engineer's lack of initiative to slow his train).

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Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
July 31, 1991	RAR-93-02 Derailment and Subsequent Collision of Amtrak Train 82 with rail cars on Dupont Siding of CSX Transportation, Inc. at Lugoff, South Carolina	fatal: 8; serious: 12; minor: 65; none: 344	2,880	"opening of the switch points under Amtrak train 82 because of a poorly maintained switch as a result of inadequate track inspections, switch maintenance, and management oversight."	SYNOPSIS The last 6 passenger cars of Amtrak train 82 derailed and collided with the first of nine hopper cars that were parked on the siding. Train 82 consisted of 2 diesel-electric locomotives, 3 baggage cars, and 15 passenger cars. Estimated speed of train 82 was 79 mph. **SEPARATION** - n.a. **CAR INTEGRITY** - 6 passenger cars derailed. 1 showed minor damage, 3 showed substantial damage, 2 had severe damage on their left sides. **TRACK QUALITY** • SUPERVISORY/MANAGEMENT - inspection & maintenance, i.e., inadequate inspection, documentation and manpower (i.e., poorly maintained switch) **SYSTEM INTEGRITY** - n.a.
Dec. 12, 1990	RAR-92-01 Derailment and Collision of Amtrak Passenger Train 66 with MBTA Commuter Train 906 at Back Bay Station, Boston, Massachusetts	fatal: 0; serious: 14; minor: 438*; none: 656 * after the accident an additional 175 passengers reported injuries	12,675	"failure of the apprentice locomotive engineer to reduce speed in sufficient time to negotiate the curve into Back Bay station as a result of inadequate supervision provided by the locomotive engineer. Contributing to the accident was Amtrak's failure to provide adequate quality control oversight for its locomotive engineer training program, including the adequacy of selection and training for apprentices and selection and training of engineers who serve as supervisors to apprentices during on-the-job training. Also contributing to the accident was Amtrak's failure to have advance warning devices for a speed reduction for the curve entering Back Bay station"	SYNOPSIS Amtrak passenger train 66 derailed and struck Massachusetts Bay Transit Authority (MBTA) commuter train 906. Train 66 consisted of a 2-unit locomotive, 2 material handling cars, 5 passenger cars, 1 dining car, and 2 baggage cars. Train 906 consisted of 1 locomotive, 6 passenger cars, and 1 control car. The speed of Amtrak train 66 was 76 mph on a 9°30' curve; MBTA train 906 was moving at 5-10 mph. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures , i.e., lack of adequate oversight • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system (lack of advance warning devices for speed reduction). **CAR INTEGRITY** - on Amtrak train 66, the two-unit locomotive and five cars were destroyed and 1 car was significantly damaged. On MBTA train 906, the locomotive and one care were destroyed. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - training/experience

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Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
March 7, 1990	RAR-91-01 Derailment of Southeastern Pennsylvania Authority (SEPTA) Commuter Train 61 Philadelphia, Pennsylvania	fatal: 4; serious: 6; minor: 154; none: 19	2,000	"failure of the Southeastern Pennsylvania Transportation Authority to have an adequate program of inspection, maintenance, and quality control to detect the defective motor support system. Contributing to the accident was the failure of the State of Pennsylvania to have effective safety oversight programs for mass transit systems"	SYNOPSIS Southeastern Pennsylvania Transportation Authority (SEPTA) Market-Frankford Subway Elevated (MFSE) train 61 derailed in a tunnel. Train 61 consisted of 6 cars constructed in 1960 by the Budd Car Company. Each car weighed approximately 46,760 pounds. Estimated speed of train 61 at time of derailment was 25-30 mph. **SEPARATION** - n a. **CAR INTEGRITY** - The fourth car (818) derailed and its left side collided with steel 12-inch by 12-inch H beam uprights. The car's body was sheared open for 30 feet and was almost severed near the midpoint. The ceiling panels of car 181 had several cracks between the Bend and the first vent fan. The ceiling between the first and second fan had cracks on the right panel. The left panel was missing. The ceiling panels between the third and fourth fans were destroyed. The roof had been pushed down until it was only 55 inches above the floor The panel between the fourth fan and the A end showed minor cracking. 90% of the interior lights were shattered or missing. The only vertical grab rails that remained secured to the ceiling were between the fourth ceiling fan and the A end. The floor of the car had been deformed, displaced, and crushed in several areas. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - inadequate maintenance (i.e., inadequate inspection, maintenance, and record keeping programs).

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
March 10, 1989	RAR-90-01 Rear-end collision of two New York City Transit Authority Trains 103rd Street Station, New York, New York	fatal: 0; serious: 1; minor: 40; none: 477	360	"the improper application of a jumper wire in the signal circuit Contributing to the cause of this accident was the failure of New York City Transit Authority (NYCTA) management to require proper repairs to the signal circuit in a timely manner Contributing to the severity of the accident was the operation of train 428 into the 103rd Street Station at a speed in excess of the posted speed, in part as a result of the failure of the NYCTA management to furnish a reasonable means for operators to determine speed."	SYNOPSIS New York City Transit Authority (NYCTA) subway train 428 rear-ended stopped NYCTA revenue collector train 3A. Train 428 consisted of 10 R-62A type, self-propelled electric subway cars, built between 1984 and 1987 by Bombardier, Inc. Train 3A consisted of two 1950's vintage R-21 type cars. Estimated approach speed of train 428 was 18 mph; train 3A was stopped. **SEPARATION** • FAILURE OF SIGNAL SYSTEM - maintenance (i.e., failure of management to require timely repairs and reporting of signal system maintenance) **CAR INTEGRITY** - On train 428, the lead car sustained major structural damage. The end door was buckled, sheet metal was torn, and the door was pushed inward 6 inches,. The left front of the car was deformed rearward 14 inches and the roof panel was separated from the left front corner. The sheet metal on the left corner was separated from the side, a vertical fame member was deformed and the left front window was displaced rearward 2 inches. - on train 3A, the last car had damage to the undercarriage and floor near the center that extended from the rear end of the car inward 51 inches. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - fitness for duty (i.e., operating train without corrective eye glasses) - training/experience (i.e., excess speed)

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
Nov. 12, 1987	RAR-88-05 Rear-End Collision of Amtrak Massachusetts Bay Transportation Authority Commuter Trains, Boston, Massachusetts	fatal: 0; serious: 1; minor: 226; none: 415	207 5	"the display of an improper wayside signal aspect resulting from a signal system that was improperly designed; the failure of the engineer of Amtrak/Massachusetts Bay Transportation Authority train 8114 to operate in compliance with a restricting cab signal indication; and Amtrak supervisors' failure to properly supervise operating employees and to follow up on reported signal failures."	SYNOPSIS Amtrak/MBTA Commuter Train 8114 rear-ended Amtrak/MBTA Commuter Train 8110, near the apex of a 9° 30′ curve. Train 8110 consisted of 1 diesel-electric locomotive unit, 6 coach cars, and 1 control car; Train 8114 consisted of 1 diesel-electric locomotive unit, 5 coach cars, and 2 control cars. Estimated approach speed of Train 8114 was 20 mph, Train 8110 was stopped. **SEPARATION** • SUPERVISORY/MANAGEMENT - failure to follow standard operating practices (i.e., failure to document verbal reports of cab signal flips) • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system, i.e , the automatic train control system on train 8114 did not provide positive separation between trains 8114 and 8110. These automatic train control systems will stop the train if the engineer fails to take appropriate action However, they also will permit a train to be operated at speeds up to 20 mph, through stop and proceed or stop wayside signal indications, if the train speed has been reduced below 20 mph and the engineer has also acknowledged the audio warning of the cab signal change. Further, the suppression feature of the system will permit the engineer to use power and brakes even when a situation requires braking only. **CAR INTEGRITY** - on train 8114, there was major crush damage to control car 1403. At the engineer's control position, the cab was displaced 4 5 feet rearward, the floor was displaced 2 5 feet beyond the left outboard side. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - training/experience

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

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January 4, 1987	RAR-88-01 Rear-End Collision of Amtrak Passenger Train 94, The Colonial and Consolidated Rail Corporation Freight Train ENS-121, on the Northeast Corridor, Chase, Maryland	fatal: 16; serious: 10; minor: 164; none: 484	16,561	"the failure, as a result of impairment from marijuana, of the engineer of the Conrail train ENS-121 to stop his train in compliance with home signal 1N before it fouled track 2 at Gunpow, and the failure of the FRA and Amtrak to require and Conrail to use automatic safety backup devices on all trains on the Northeast Corridor. Contributing to the accident were: 1) the failure of the brakeman of ENS-121 to observe signal aspects and to alert the engineer when they became restrictive; 2) the failure of the crewmembers of train ENS-121 to make the required automatic cab signals test (ACS); 3) the muting of the ACS alerter whistle on the lead unit of train ENS-121; and 4) the inadequacies of the FRA oversight of Amtrak's and Conrail's supervision of corridor trains. Operation of Amtrak train 94 at 124 mph, rather than its restricted speed of 105 mph, contributed to the severity of the accident."	SYNOPSIS Amtrak Passenger Train 94 rear-ended Conrail Train 121. Train 94 consisted of 2 electric locomotive units and 12 passenger cars; Train 121 consisted of 3 diesel-electric freight locomotive units. Estimated approach speed of Train 94 was 120-125 mph, Conrail Train 121 was stopped. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures (Amtrak's dispatching and management emphasis on on-time performance rather than safety was probably a problem; failure of Amtrak and FRA to ensure that Conrail trains with no safety backup device) - failure to follow standard operating practices (i.e., failed to observe or comply with the "approach" aspect of signal, failed to obtain properly working console radio, failure to make the required predeparture tests, failure to call out signals) - speed (i.e., excessive speed of Amtrak Train 94) **CAR INTEGRITY** - The rear Conrail locomotive unit, both Amtrak locomotive units, and the head three passenger cars were destroyed. The middle Conrail locomotive unit was heavily damaged, and the rear nine cars of the passenger train sustained varying degrees of damage. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY / MANAGEMENT - fitness for duty (i.e., engineer impaired) - training/experience (i.e., dispatcher not trained to avoid conflicts between Amtrak and Conrail trains without safety backup system)

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August 23, 1986	RAR-87-04 Collision and Derailment of Southeastern Pennsylvania Transportation Authority Single Car Train 167 69th Street Terminal Upper Darby, Pennsylvania	fatal: 0*; serious: 11; minor: 35; none: 11 *one passenger died 4 months later without ever having been discharged from the hospital	225	"the failure of the operator to remove propulsion power from the car and his failure to use all available means to stop the car. Contributing to the accident was the failure of SEPTA to adequately train the operator to use all means available to stop the car "	SYNOPSIS Southeastern Pennsylvania Transportation Authority (SEPTA) single-car train 167 overrode the bumping block at the end of the track, derailed, and penetrated a terminal wall. Car 167 was a 60-series car built by the Brill Company in 1927 and rebuilt in 1931. The speed of train 167 was 20-25 mph. **SEPARATION** • FAILURE OF SIGNAL SYSTEM - design of signal (train control) system (i.e., deadman feature was not fail-safe) **CAR INTEGRITY** - forward end wall of the car was displaced rearward from about 1 foot at the top to about 5 feet at the floor level 7 of the 28 bench seatbacks were bent forward at various angles; 1 seatback was torn loose. 2 seatmounts were torn loose, and 1 was twisted. 3 seats were displaced upward by 8 to 12 inches **TRACK QUALITY** - n a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - training/experience (i.e., operator not proficient in emergency procedures) - inadequate maintenance (i.e., inadequate standards and procedures and ineffective training programs) OTHER • NO INDEPENDENT SAFETY AUTHORITY

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May 7, 1986	RAR-87-02 Rear-End Collision Between Boston and Maine Corporation Commuter Train No. 5324 and Consolidated Rail Corporation Train TV-14, Brighton, Massachusetts	fatal: 0; injured: 153; none: 402	102 2	"the failure of the engineer of train No. 5324 to properly interpret and comply, due to inattention or distraction, with the speed restriction mandated by the stop and proceed aspect of a wayside signal located to the rear of train TV-14 "	SYNOPSIS Boston and Maine Corporation commuter train no. 5324 struck Conrail train TV-14. Train TV-14 was stopped and the impact occurred on a 2°8′ curve. Train 5324 consisted of a type F-10 diesel electric locomotive, and 4 passenger coaches. Train TV-14 consisted of 3 locomotive units and 72 cars; however, at the time of the collision, the road locomotive and 24 cars had been removed. At the time of collision, B&M train 5324 was traveling at 50 mph. **SEPARATION** • SUPERVISORY/MANAGEMENT - inadequate programs/procedures (i.e., inadequate inspection of engineer's performance, failure to comply with speed restriction). **CAR INTEGRITY** - Damage to train TV-14 was not extensive. - The damage to passenger coaches on train 5324 was extensive. The lead control coach was damaged at the front truck and at welds to the car body. The draft gear pocket was expanded and the centre sill was cracked There were cracks between the centre sill and floor and between the floor and floor beams. The end doors on the forward end of the coach and the step platforms were jammed because of a slight frame warp. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** - n.a.

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
August 17, 1984	RAR-85-11 Rear-End Collision of Two Chicago Transit Authority Trains near the Montrose Avenue Station, Chicago, Illinois	fatal: 1; serious: 4; minor: 45; none: 1	not listed	"the failure of the motorman of train No. 135 to apply the track brakes while the train was rolling downhill. Contributing to the accident was the failure of the Chicago Transit Authority to assure that the motorman was skilled in emergency procedures."	SYNOPSIS Chicago Transit Authority (CTA) train 135 rear-ended CTA train 143. Train 135 consisted of 8 CTA 6000-series cars built in 1956-57 by the St. Louis Car Company; the underframes of the cars were designed to withstand a 100,000 pound force applied over a 4" by 24"area of the face of the anticlimber. Train 143 consisted of 8 cars of the 2,200- and 2,600-series, built by the Budd Company between 1969 and 1984. Approach speed of Train 135 was less than 20 mph, Train 143 was stopped. **SEPARATION** • SUPERVISORY/MANAGEMENT - failure to follow standard operating practices **CAR INTEGRITY** - on train 135, the deformation of all cars was as expected, except for car 6648, the second car from the rear in train 135. The No. 2 ends of cars 6648 and 6647 were crushed inward 4 feet and 1 ½ inches, respectively. The rearward collapse of the No. 2 end of car 6648 caused the 3/4-inch plywood floor to split across the entire width of the car just aft of the rear seat leg/floor attachment fittings of seats adjacent to the fatally injured passenger. The manner in which the anticlimbers engaged at impact bent the end of car 6648 downward, resulting in a crushing of the car which buckled the floor upward 53 inches. Although depressing of the end of the car accounts for part of the crushing, it appears that car 6648 had sustained weakening of some of its structural members which made it susceptible to failure under the forces in this accident. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - training/experience

Table Ia-1: Summary of Selected NTSB Railroad Accident Reports (cont'd)

Date	Report Number & Title	Injuries	Damages ($000's)	Probable Cause (as determined by NTSB)	Synopsis, & IRR (Institute for Risk Research) Cause Category(s) (Detailed cause category as defined for the current risk analysis)
July 23, 1984	RAR-85-09 Head On Collision of National Railroad Passenger Corporation (Amtrak) Passenger Trains Nos. 151 and 168, Astoria, Queens, New York, NY	fatal: 1; serious: 10; minor: 130; none: 220	3,199	indeterminate	SYNOPSIS Amtrak passenger trains Nos. 151 and 168 collided head-on. Train 151 consisted of an AEM-7, a.c. electric locomotive and 5 cars. Train 168 consisted of an AEM-7, a.c. electric locomotive, 5 coaches, 1 parlor car and 1 baggage car. Both trains were moving at about 30 mph on a 0°45′ curve. **SEPARATION** - n.a. **CAR INTEGRITY** - The predominant type of damage to the locomotives and coaches of both trains was end crush damage. - On train 151, the operating compartment of the locomotive was displaced rearward about 2 feet at the floor and about 6 inches at the roof. The engineer's and fireman's seats were broken loose from the floor attachments. - On train 168, the same general crush damage was evident on the locomotive but not as severe as on train 151. - The vestibules of the first coach behind the locomotive of each train were crushed inward to the passenger compartment bulkhead. The side doors were either crushed or inoperative because of frame deformation. The end doors leading from the vestibules into the passenger compartments were in various positions and conditions. A large number of seat locking devices were broken in the first and second head cars of both trains. - Other coaches in the trains had similar damage, but the severity of the damage decreased as their location in the trains placed them farther from the locomotive. **TRACK QUALITY** - n.a. **SYSTEM INTEGRITY** • SUPERVISORY/MANAGEMENT - training/experience[1] (i.e., F Tower operator did not exhibit a confidence in his understanding and application of manual block rules.)

[1]Could also be classified as "SEPARATION" failure; note NTSB unable to determine probable cause.

Source: NTSB Railroad Accident Reports.

APPENDIX Ib

Complementary Analysis of FRA Data

To begin to identify potential incremental risks, an analysis of passenger rail accidents was done. Table Ib-1 summarizes the accident data by railroad. The data are grouped into the following categories:

- Passenger Railroads;
- Amtrak (separated out from other "Freight Railroads on which Passenger Trains Operate" because of its unique role as the main provider of long-distance rail passenger service);
- Freight Railroads on which Passenger Trains Operate; and
- Other (which essentially represents freight-only railroads).

It is important to note that there is a substantial amount of variability in the accident rates (per million train miles and per million passenger miles) for individual railroads. For example, for passenger railroads, the range in total accident rate is from 0.59 to 7.2, i.e., more than one order of magnitude. Also, there is not enough data in a single year to produce statistically significant estimates. In particular, there is very little data on collisions and on passenger railroads (few collisions). However, the following conclusions can be taken from Table Ib-1:

- The accident rate for *all railroads* is 3.85 per million train miles, which breaks down by accident type as follows:

  collisions: 0.31 per million train miles; derailments: 2.71 per million train miles; other: 0.84 per million train miles.
- *Passenger Railroads* have the lowest overall accident rate, i.e., 2.86 per million train miles, which breaks down by accident type as follows:

  collisions: 0.23 per million train miles; derailments: 1.01 per million train miles; other: 1.62 per million train miles.
- The accident rate per million train miles for *Freight Railroads on which passenger trains operate* is 3.67, which breaks down by accident type as follows:

  collisions: 0.30 per million train miles; derailments: 2.65 per million train miles; other: 0.72 per million train miles.

  The high proportion of derailments relative to passenger railroads is to be expected as longer and heavier freight trains deteriorate track and infrastructure at a faster rate than would passenger operations. This sub-category had the most data and therefore the most stable frequency estimates.
- Amtrak's accident rate per million train miles was 3.07, which breaks down by accident type as follows:

  collisions: 0.12 per million train miles; derailments: 1.68 per million train miles; other: 1.27 per million train miles.

  Amtrak's record for 1996 is similar to that of *passenger railroads* with the main difference being that Amtrak had a higher proportion of derailments. The increased derailments is consistent with the higher number of derailments for Freight Railroads on which passenger trains operate.
- The accident rate for the *Other* category is 6.26 per million train miles, which breaks down by accident type as follows:

  collisions: 0.48 per million train miles; derailments: 4.64 per million train miles; other: 1.15 per million train miles.

Table Ib-1: Summary of Accident Data By Railroad, 1996 (Source: FRA, 1997)

	Total Train Miles	Passenger Miles	Number of Accidents: Collisions	Number of Accidents: Derailments	Number of Accidents: Other	Accident Rate (per million train miles): Collisions	Accident Rate (per million train miles): Derailments	Accident Rate (per million train miles): Other	Accident Rate (per million train miles): Total	Accident Rate (per 10 __6 Passenger miles)
PASSENGER RAILROADS										
Alaska Railroad Corp	861,756	14,748,739	0	5	0	0 00	5 80	0 00	**5.80**	0 339
Long Island Rail Road	8,171,689	2,074,296,403	4	16	21	0.49	1.96	2.57	**5.02**	0.020
Massachusetts Bay Transit Authority	1,688,552	209,695,666	0	0	1	0 00	0.00	0.59	**0.59**	0 005
Metro North Commuter Railroad Co.	7,432,638	1,772,601,338	1	6	18	0.13	0.81	2.42	**3.36**	0.014
Northern Indiana Commuter Trans	714,143	100,704,437	0	0	2	0.00	0 00	2 80	**2.80**	0 020
Northeast Illinois Regional Commuter	3,381,424	684,399,679	0	4	3	0.00	1.18	0.89	**2.07**	0.010
New Jersey Transit Rail Operations	7,767,180	1,095,799,668	3	5	4	0 39	0 64	0 51	**1.54**	0 011
Port Authority Trans Hudson	2,019,297	290,190,118	0	0	0	0.00	0.00	0.00	**0.00**	0.000
Penninsular Commuter (San Mateo County)	442,246	0	0	0	0	0 00	0.00	0 00	**0.00**	n a.
Southern California Regional Rail	1,249,366	198,765,202	0	2	7	0.00	1.60	5.60	**7.20**	0.045
Southeastern Pennsylvania Trans.	5,066,606	301,194,372	1	1	7	0 20	0 20	1.38	**1.78**	0 030
subtotal (passenger railroads)	38,794,897	6,742,395,622	9	39	63	0	1.01	1 62	**2.86**	0.016
			8%	35%	57%					
AMTRAK (Nat'l Railroad Passenger Co)	33,840,497	5,218,443,714	4	57	43	0 12	1 68	1 27	**3.07**	0.020
			4%	55%	41%					
FREIGHT RAILROADS ON WHICH PASSENGER TRAINS OPERATE										
Burlington Northern Santa Fe Corp	145,803,928	276,797,050	21	362	99	0 14	2.48	0 68	**3.31**	1 741
Consolidated Rail Corp.	45,727,919	0	21	150	7	0.46	3.28	0.15	**3.89**	n.a.
CSX Transportation	83,486,310	71,941,314	27	123	38	0.32	1 47	0 46	**2.25**	2 613
Denver & Rio Grande Western Railroad	7,680,491	0	5	37	3	0.65	4.82	0.39	**5.86**	n.a.
Illinois Central Railroad Co	7,949,030	0	8	44	24	1 01	5 54	3 02	**9.56**	n a.
Norfolk Southern Corp.	63,655,055	0	27	101	35	0.42	1.59	0.55	**2.56**	n.a.
Soo Line Railroad Co	9,874,119	0	7	70	32	0 71	7 09	3 24	**11.04**	n a
Southern Pacific Transportation Co.	43,893,368	0	14	124	28	0.32	2.83	0.64	**3.78**	n.a.
Union Pacific Railroad Co	115,272,529	522,106,548	26	357	99	0 23	3 10	0 86	**4.18**	0 923
Delaware & Hudson Railway Co.	1,742,818	0	0	8	0	0.00	4.59	0.00	**4.59**	n.a.
Guilford Railroad System	1,066,519	0	0	1	1	0 00	0 94	0 94	**1.88**	n a
Wisconsin Central Ltd. (also Railway)	5,042,370	648,548	4	32	14	0.79	6.35	2.78	**9.92**	77.095
subtotal (freight w/ passeng)	531,194,456	871,493,460	160	1,409	380	0 30	2 65	0 72	**3.67**	2 236
OTHER										
All others including: Grand Trunk Western Railroad, Inc , Kansas City Southern Railway Co , Alton & Southern Railroad, Bangor & Aroostook, etc										
subtotal (other)	67,093,510	754,327,066	32	311	77	0 48	4 64	1 15	**6.26**	0 557
			8%	74%	18%					
total all railroads	670,923,360	13,586,659,862	205	1,816	563	0 31	2 71	0 84	**3.85**	0 190
			8%	70%	22%					

The high rate of derailments for the *"Other"* category (i.e., 4.64) relative to *passenger railroads* (i.e., 1.01) and *Freight Railroads on which passenger trains operate* (i.e., 2.65) is to be expected, as the "other" category comprises mostly freight operations which tend to deteriorate track quality at a faster rate than would passenger or a mix of passenger and freight operations, assuming an equal volume of trains. Passenger trains using freight railroad track tend to use the highest quality track on the freight rail system.

Ib-2: Analysis of Accident Causes by Type ofAccident (All Data, 1996)

To identify the causes of accidents that would likely have increased frequency under the joint running situation, an analysis was done of the breakdown of accidents in 1996 by cause and type. Table Ib-2 shows that "human factors" is the leading cause of "collisions" and "other (excluding highway-rail crossing)" accidents and a major source of all types of accidents, accounting for 78% of all collisions, 23% of derailments, and 49% of other accidents (excluding highway-rail crossing accidents). The main exception is the case of derailments, for which the leading cause was "signal and track." More detailed breakdowns of the causes of collision and derailment accidents are needed to identify potential target areas for the development of mitigation measures to reduce incremental risk. Figure Ib.1 illustrates the breakdown of detailed causes for collisions due to "human factors." The 159 collisions attributed to "human factors" are represented in the figure. Figure Ib-1 provides some preliminary insight as to where to improve on procedures, training etc.

Figure Ib-2 shows the breakdown of detailed causes for derailments due to "track & signal" for the 1996 data. The 870 derailments attributed to "track & signal" are represented in the figure. Figure Ib.4 provides some insight as to where to improve on infrastructure, inspection, maintenance, etc. to mitigate incremental risk due to derailments arising from a joint-use situation.

Table Ib-2
Accident Type by Cause, 1996

Cause / Type	Human Factors	Equipment Failures	Signal & Track	Highway-Rail Impacts	Other	Total
Total	784	318	954	138	390	2,584
% of total	30%	12%	37%	5%	15%	100%
Collisions	159	13	9	0	24	205
% of Collisions	78%	6%	4%	0%	12%	100%
Derailments	417	259	870	0	270	1,816
% of Derailments	23%	14%	48%	0%	15%	100%
Other	207	46	75	0	94	422
% of Other	49%	11%	18%	0%	22%	100%
Hwy-Rail Crossing	1	0	0	138	2	141
% of Hwy-Rail Cross.	1%	0%	0%	98%	1%	100%

Source: (FRA, 1997).

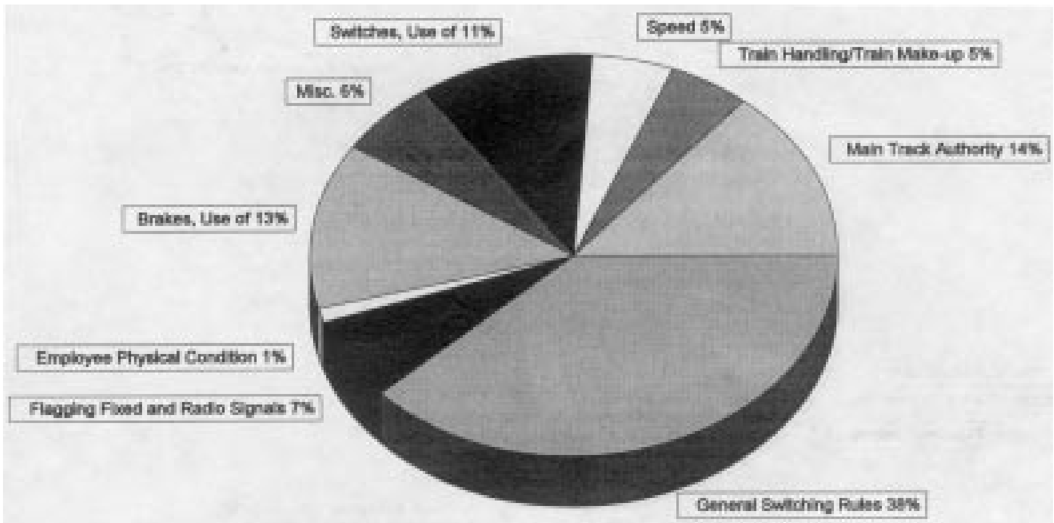


Figure Ib-1:

Collisions Due to Human Factors by Detailed Cause, 1996

Source: FRA, 1997; Table 20

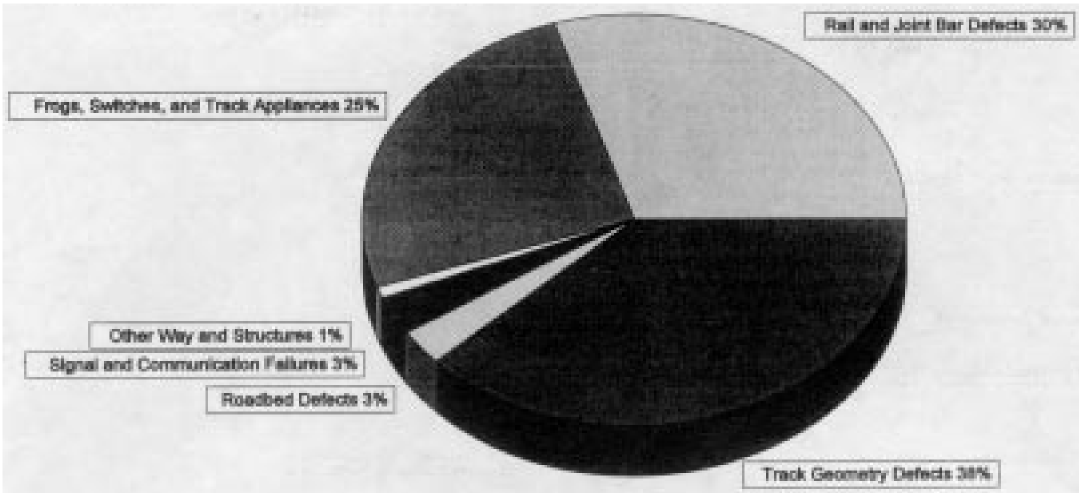


Figure Ib-2:

Derailments Due to Track & Signal by Detailed Cause, 1996

Source: FRA, 1997; Table 22

Ib-3: Analysis of FRA Accident Causes of Serious Collisions and Derailments (Passenger Train Data, 1992-1996).

An analysis of FRA data for serious passenger train collisions and derailments was done by FRA cause categories. Table Ib-3 shows the breakdown by cause class (i.e., "Operating Practices", "Mechanical & Electrical Failures", "Track, Roadbed, and Structures", and "Miscellaneous"). The main cause of collisions is "Operating Practices", whereas the main cause of derailments (excluding "Miscellaneous") is "Track, Roadbed, and Structures". The detailed causes are shown in Table Ib-4.

Figure Ib-3 shows the breakdown of FRA causes for the main cause class of Collisions, i.e., "Operating Practices." As shown in Figure Ib-4, of the 14 collisions involvements attributed to operating practices, 50% are due to "Main Track Authority", 36% are due to "Flagging, Fixed, Hand, and Radio Signals", and 14% are due to "Speed".

Figure Ib-5 shows the breakdown of FRA causes for the main cause class of Derailments (excluding "Miscellaneous"), i.e., "Track, Roadbed, and Structures." As shown in Figure IB-6, of the 14 collision involvements attributed to operating practices, 56% are due to "Track Geometry Defects," 11% are due to "Rail and Joint Bar Defects," 11% are due to "Roadbed Defects," 11% are due to "Frogs, Switches and Track Appliances," and 11% are due to "Other Way and Structures."

Table Ib-3
Summary of Serious Passenger Train Collisions and Derailments (mainline track, 1992-1996).

FRA Cause Class	Collisions	Derailments
Operating Practices	14	8
Mechanical and Electrical Failures	3	1
Track, Roadbed and Structures	1	9
Miscellaneous	6	12
Grand Total	24	30

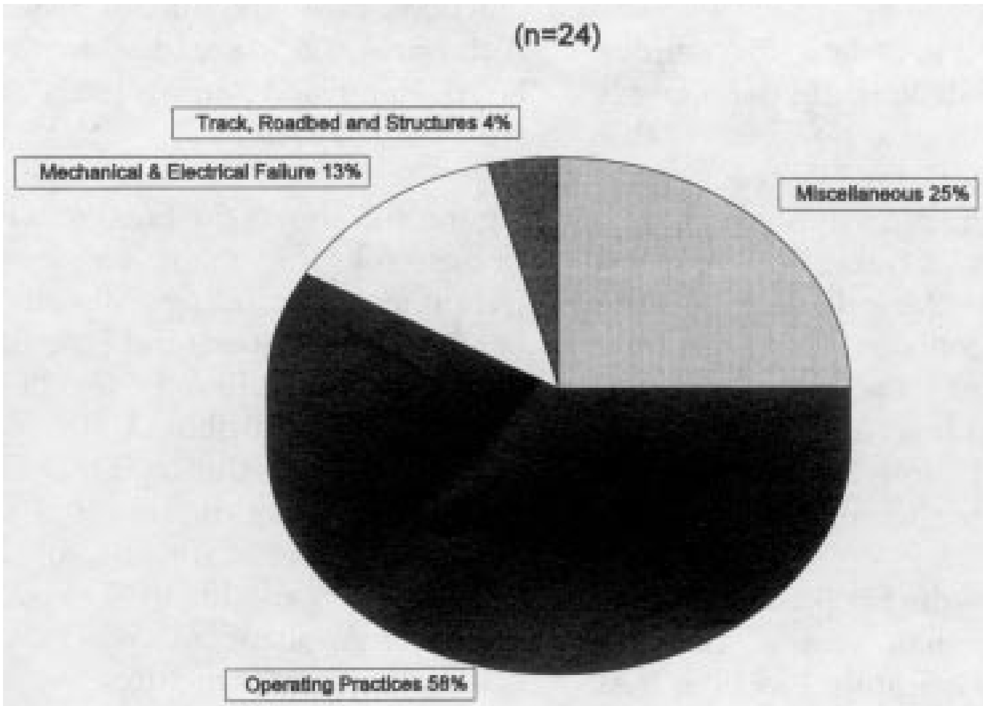


Figure Ib-3
Serious Passenger Collisions on Mainline Track by FRA Cause Category (1992-1996)

Source: Derived by IRR from FRA Data

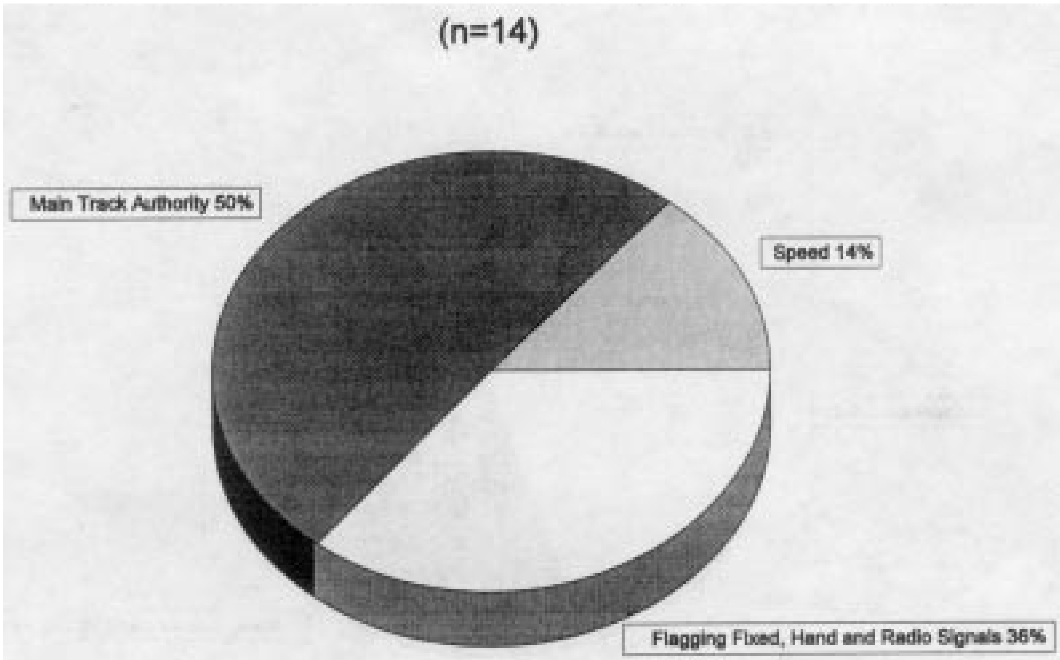


Figure Ib-4
Breakdown of Serious Passenger Collisions on Mainline Track Due to "Operating Practices" Cause (1992-1996)

Source: Derived by IRR from FRA Data

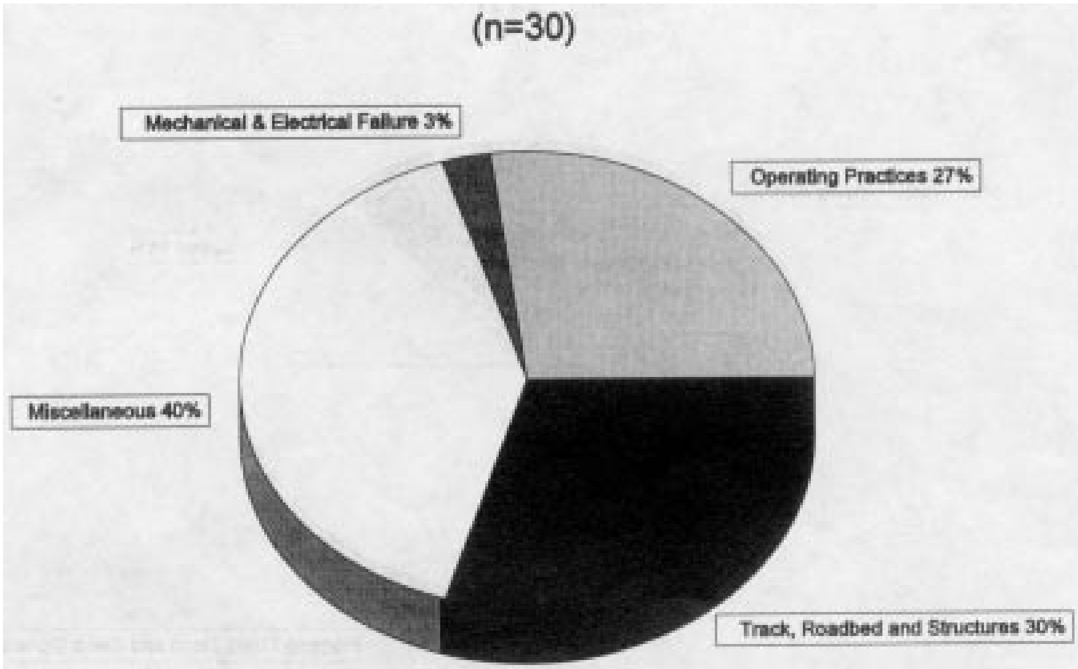


Figure Ib-5
Serious Passenger Derailments on Mainline Track by FRA Cause Category (1992-1996)

Source: Derived by IRR from FRA Data

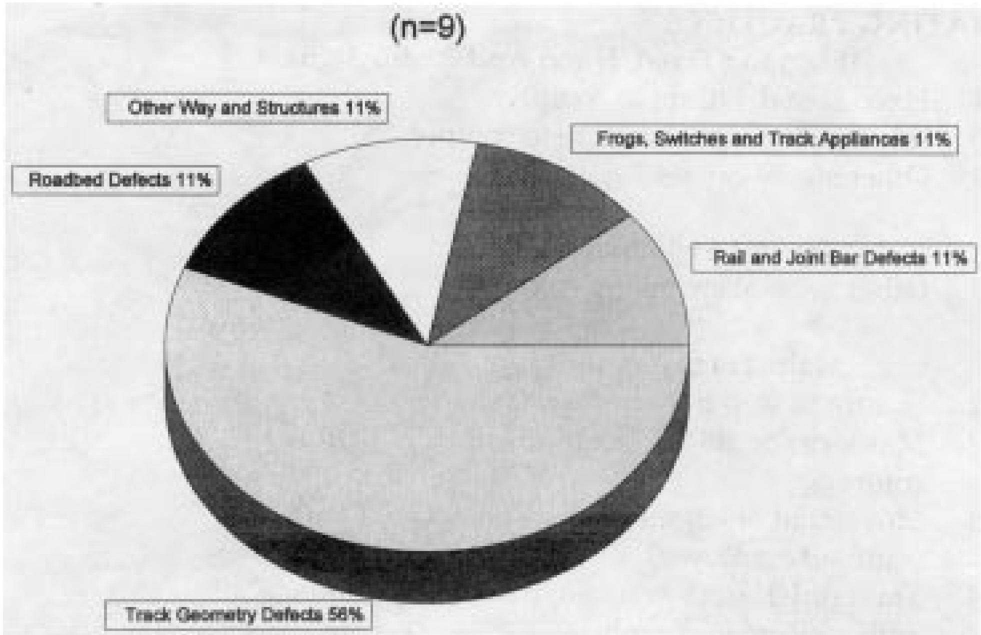


Figure Ib-6
Breakdown of Serious Passenger Derailments on Mainline Track due to "Operating Practices" by FRA Cause (1992-1996)

Source: Derived by IRR from FRA Data

Table Ib-4
Serious Passenger Train Accidents (1992-1996) by FRA Cause

		Collisions	Derailments
OPERATING PRACTICES			
	Flagging Fixed, Hand And Radio Signals		
H204	Fixed signal, failure to comply	2	1
H216	Interlocking signal, failure to comply	1	1
H299	Other signal causes	2	0
	Subtotal	5	2
	General Switching Rules		
H399	Other general switching rules	0	1
	Subtotal	0	1
	Main Track Authority		
H401	Failure to stop train in clear	2	0
H402	Motor car or on-track equipment rules, failure to comply	1	0
H403	Movement of engine(s) or car(s) without authority (railroad employee)	1	0
H404	Train order, track warrant, track bull., or timetable auth., failure to comply	0	1
H499	Other main track authority causes	3	1
	Subtotal	7	2
	Train Handling/Train Make-up		
H501	Improper train make-up at initial terminal	0	1
	Subtotal	0	1
	Speed		
H605	Failure to comply with restricted speed	2	0
	Subtotal	2	0
	Switches, Use Of		
H705	Moveable point track from improperly lined switches	0	1
H799	Use of switches, other	0	1
	Subtotal	0	2
MECHANICAL AND ELECTRICAL FAILURES			
	Brakes		
E04C	Other brake components damaged, worn, broken, or disconnected	1	0
	Subtotal	1	0
	Truck Components		
E49C	Other truck component defects, (CAR)	1	0
	Subtotal	1	0
	Wheels		
E60L	Broken flange, (LOCOMOTIVE)	0	1
	Subtotal	0	1
	General Mechanical and Electrical Failures		
E99L	Other mechanical and electrical failures, (LOCOMOTIVE)	1	0
	Subtotal	1	0

Table Ib-4 Serious Passenger Train Accidents (1992-1996) by FRA Cause (Cont'd)

		Collisions	Derailments
TRACK, ROADBED, AND STRUCTURES			
	Roadbed Defects		
T002	Washout/rain/slide/flood/snow/ice damage to track	0	1
	Subtotal	0	1
	Track Geometry Defects		
T102	Cross level of track irregular (not at joints)	0	1
T103	Deviation from uniform top of rail profile	0	1
T109	Track alignment irregular (buckled/sunkink)	0	1
T110	Wide gage (due to defective or missing crossties)	0	1
T199	Other track geometry defects	0	1
	Subtotal	0	5
	Rail and Joint Bar Defects		
T299	Other rail and joint bar defects	0	1
	Subtotal	0	1
	Frogs, Switches and Track Appliances		
T314	Switch point worn or broken	0	1
	Subtotal	0	1
	Other Way and Structures		
T499	Other way and structure defect	0	1
	Subtotal	0	1
	Signal and Communications Failures		
S013	Other communication equipment failure	1	0
	Subtotal	1	0
MISCELLANEOUS			
	Loading Procedures		
M201	Load shifted	1	0
	Subtotal	1	0
	Unusual Operational Situations		
M402	Object or equipment on or fouling track (motor vehicle-not at highway-rail Xing)	1	0
M404	Object or equipment on or fouling track, other	2	0
	Subtotal	3	0
	Other Miscellaneous		
M501	Interference (other than vandalism) with RR operations by nonrailroad employee	0	1
M503	Vandalism of track or track appliances	0	8
M505	Cause under investigation	2	3
	Subtotal	2	12
	GRAND TOTAL	24	30

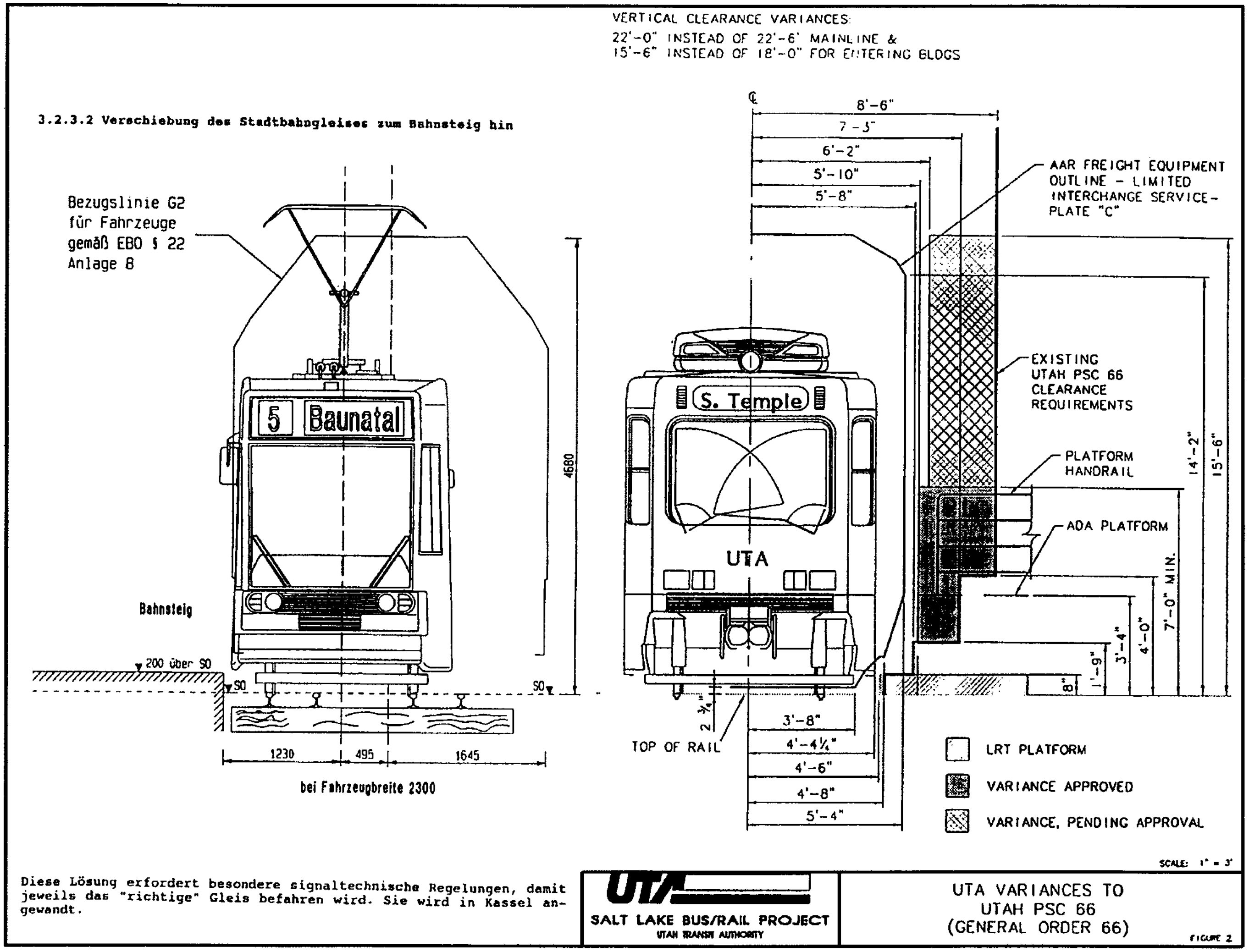
APPENDIX J
Overseas Joint Use Exhibits

Railroad/LRT, Overseas/N. American - Clearances and Remedies Contrasted
Exhibit J1

Category 2 and 3 DMU Railcar Modularity
Exhibit J2

Sanriku Railway Shared Track Promotion
Exhibit J3

Karlsruhe Rail Passenger System Diagram
Exhibit J4

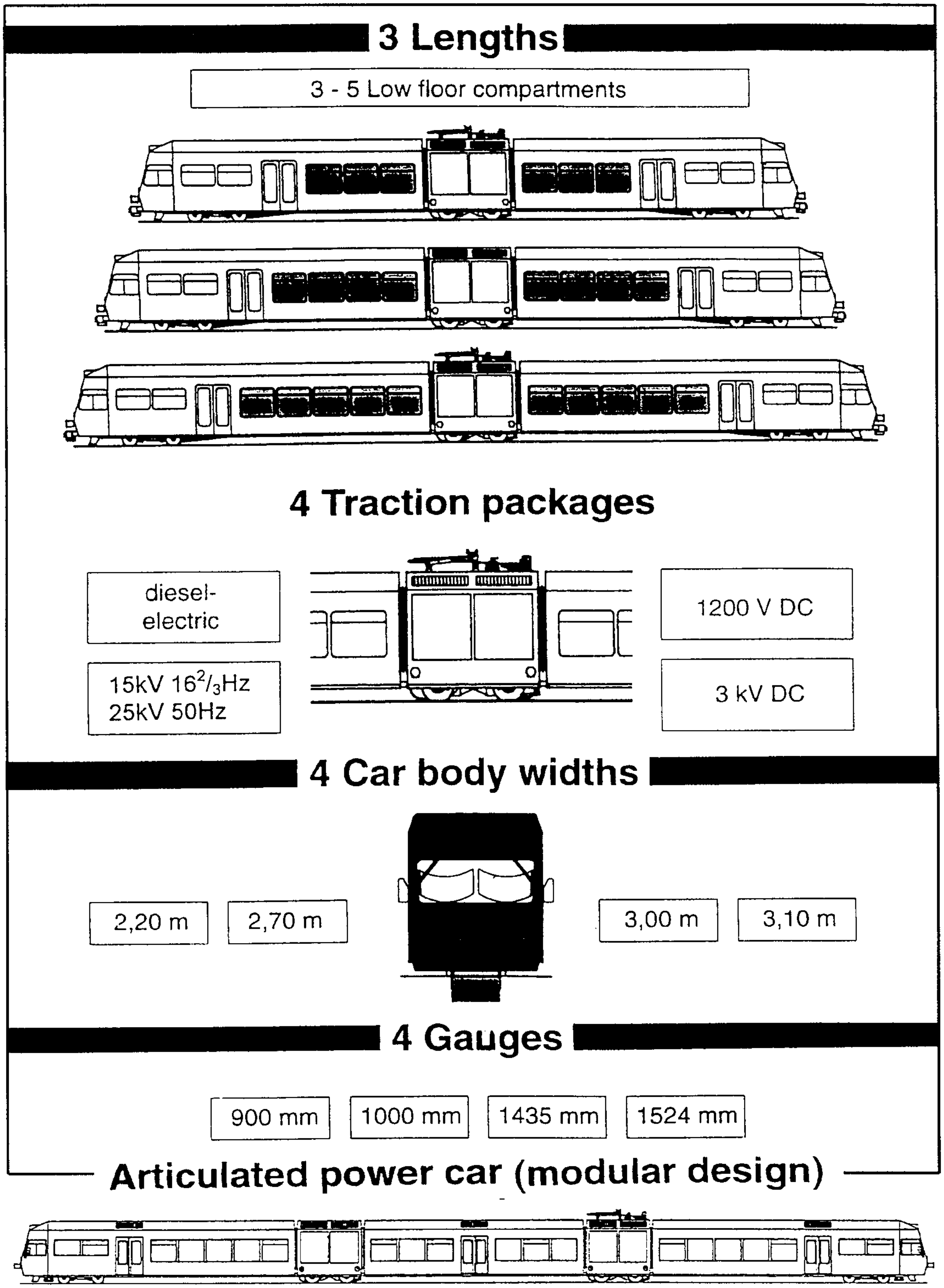


Variances to Utah PSC 66 (General Order 66)

TWO DIFFERENT SOLUTIONS TO SAME PROBLEM IN JOINT USE - FREIGHT RAILROAD CLEARANCE AT LRT STATIONS:
Kassel, Germany (left) uses gauntlet track (note offset freight car(EBO) profile) for its low platform/low floor LRVs.
Salt Lake City uses bridge plates and state granted variances for high bloc/high floor SD-100 LRVs

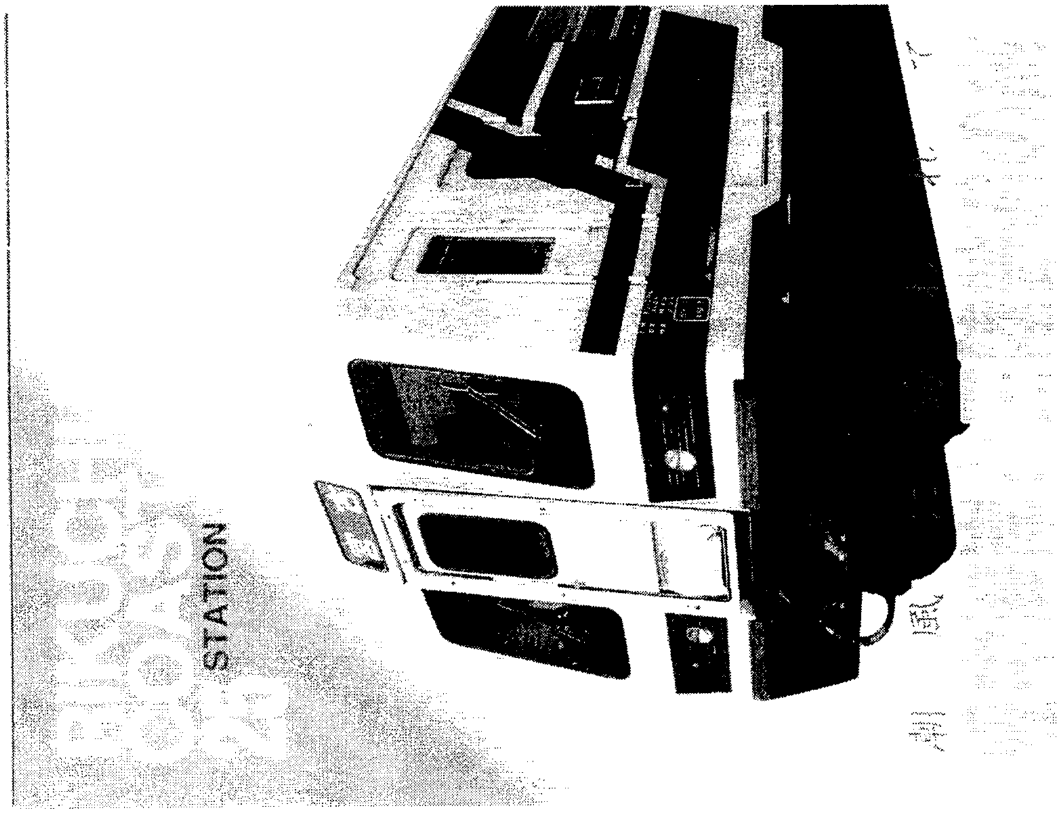
Category 2 and 3 DMU Railcar Modularity

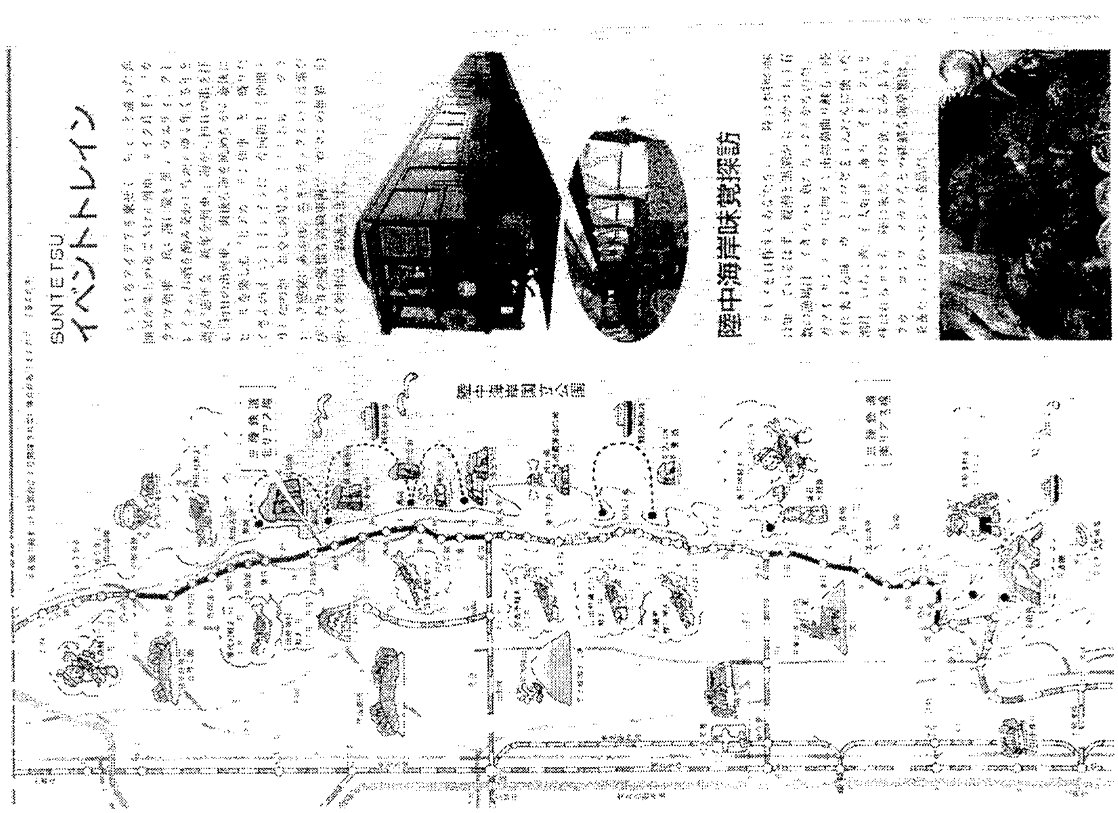
Exhibit J2



courtesy ABB Daimler-Benz Transportation (Schweiz)

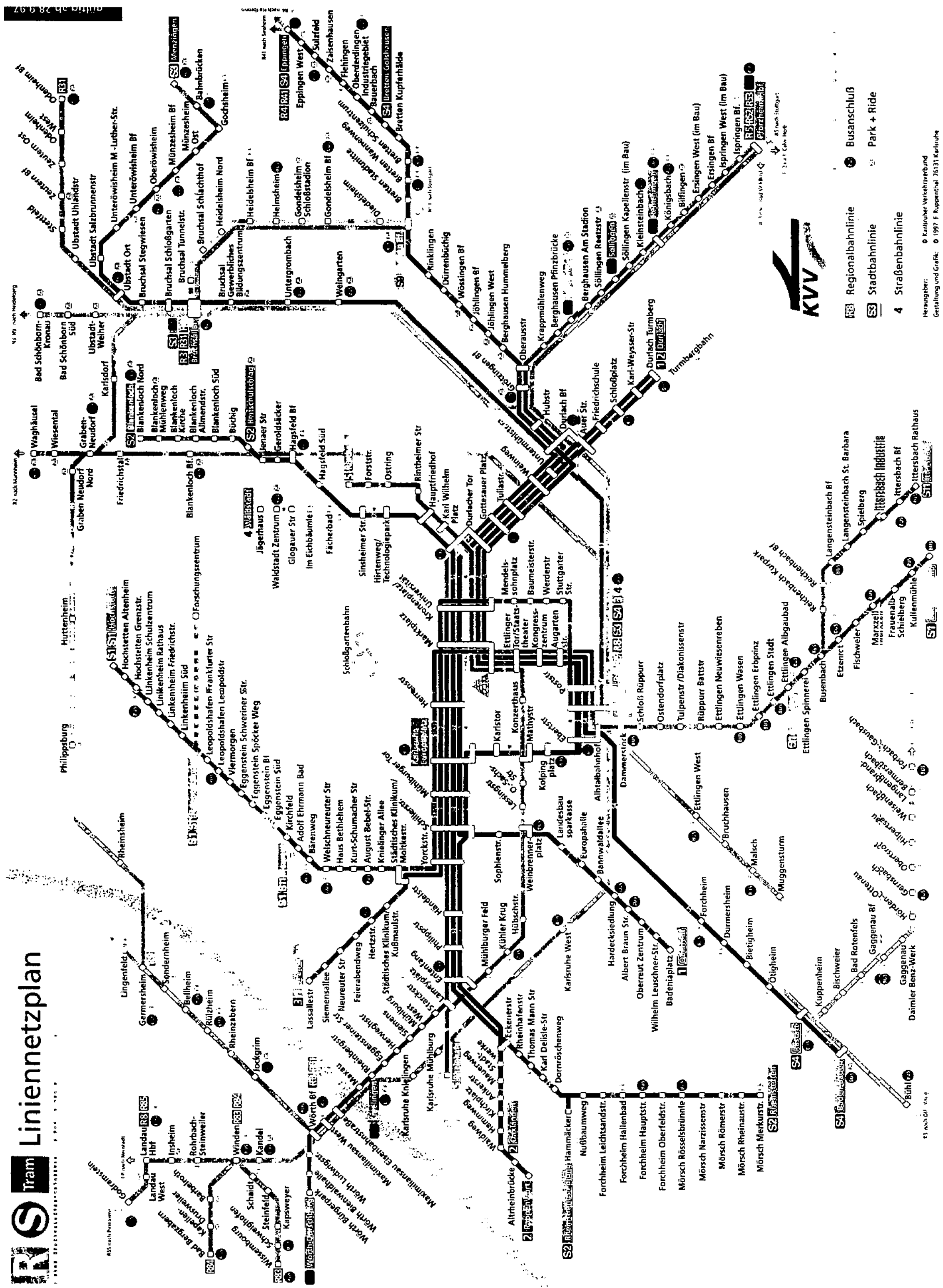
Exhibit J3





Karlsruhe Rail Passenger System Diagram

Exhibit J4



APPENDIX Ka
INVENTORY OF JAPANESE RAILWAYS FOR JOINT USE

This appendix contains a matrix of those Japanese railways that participate in joint use of track/reciprocal running or have potential for such. It is provided as a resource for subsequent researchers. This is the starting point for a process employed by the research team to reduce the candidate railways to the six case studies that are described in detail. The following paragraphs explain the columns in the table:

- First column, "Commutersheds" are comparable to U.S. Urbanized Areas (UZAs) but are defined by typical weekday commuter patterns focused on a core city (or cities). Included without separation are the nation's three major conurbations – the Kanto Region (focused upon the core cities of Tokyo, Yokohama, Kawasaki, and Chiba), the Kansai Region (containing the core cities of Osaka, Kyoto, Kobe, and Wakamatsu), and the Nagoya Region (containing the core cities of Nagoya, Gifu, and Toyohashi). Because of the interwoven intricacy of rail lines and their participation in reciprocal running, it is not possible to separate these regions into smaller units.

- Second column, "Operator" Corporate Names are listed alphabetically for each urban place. Translations of common suffixes appear at the end of the table as they might appear in direct Japanese translations.

- Third column, "Track Gauge" is shown in millimeters. 1435mm = 4'8½"; 1372mm = 4'6"; 1067mm = 3'6"; 762mm = 2'6"; and 609 = 2'0". Inasmuch as the conventional intercity Japan Rail track gauge is 1067mm,[1] only railways of that gauge can interchange freight cars with the national railway network. Nevertheless, several railways of other gauges – particularly "standard" - 1435 mm – participate in reciprocal running with railways of like gauge. There are a few instances of shared trackbed with three-rail multi-gauge track. There are also railways of 1372mm (4'6") gauge which participate together in joint use of track. The railways of 762 mm and 609 mm gauge are isolated and do not participate in joint use.

- Fourth column, "Sector" identifies whether the operator is national railway (i.e., Japan Rail), private, or Third Sector. Municipal operations are generally regarded as "private" (i.e., not national) in Japan, but in this table "municipal" systems are identified as such. A separate explanation of "Third Sector" (public/private joint ventures) appears earlier in Chapter 8.

- Fifth column, Rail "Mode": DCR = diesel commuter rail; ECR = electric commuter rail; HRT = heavy rapid transit; HSR = high-speed rail; ICR = intercity rail; IND = industrial (but carries passengers); INT = interurban; LRT = light-rail transit; StR = street railway; and TRy = tourist railway (or vintage trolley). Japan Rail-Hokkaido, Japan Rail-Nishi, and Oigawa Railway also operate steam on regular mainlines, and Hakodate City Transport, Hiroshima Electric Railway, and Tosa Electric Railway operate vintage trolleys on regular street railway trackage.

- Sixth column, "Status" has been observed in order to convey an image of the operator. Some of these railways have been purpose-built in recent decades for such reasons as to open new land for residential development; their facilities and equipment are generally quite modern. Some are older railways that have more recently been rebuilt or upgraded as – for example – their territory has changed from rural to suburban. Others are going-concern railways that have brought themselves up to date by purchase of new rolling stock or acquisition of second-hand rolling stock with remaining economic life.[2] "In transition" indicates that they are in the process of upgrading, or in a few instances, diminishing.

- Seventh column, "Propulsion": Electric or diesel operation is noted. "Transition" refers to either the temporary operation of diesel rolling stock until electrification is implemented, *or* the process is underway to discontinue electrification and use diesel rolling stock. Cable propulsion systems (funiculars) are not in the list, but rack-assistance railways are included.

- Eighth column, "Setting" or Type Territory Served: Japanese land-use and development is more akin to U.S. and Canadian practice than to European, so the simple categorization as urban, rural, and intercity as railway settings can easily be understood by North American readers.

This tabulation represents the first sifting of candidate operators for further examination, the goal having been to select no more than six for which additional data would be arrayed. The final sifting was subjective, inasmuch as the intention was not to find six similar candidates, but rather to find six candidates demonstrating a variety of joint-use circumstances that might be applicable in North America.

The following tabulation is also useful as an inventory of all major Japanese rail passenger transportation services.

ENDNOTES - APPENDIX Ka

1. The high-speed intercity Shinkansen network is 1435mm (4' 8 1/2") gauge.

2. The 'cascading' of Japanese railway rolling stock is a separate and interesting topic. The purchase of new rolling stock by the larger, more prosperous railways generally means that the older rolling stock will be handed down to lesser railways. 'Standardization' is an unplanned result. But it often involves some of the factors that enter into any introduction of joint use or reciprocal running, such as changing the catenary voltage from 600vDC to 750vDC or 1,500vDC, adding threshold extenders to fill the gap between second-hand rapid transit cars, and station platforms set back to accommodate standard freight cars (yes, secondhand heavy rapid transit cars are often thoroughly refurbished as modern interurban cars with comfortable seating, on-board fare-collection, etc.).

SELECTION MATRIX OF JAPANESE RAILWAYS WITH REGARD TO THEIR POTENTIAL PARTICIPATION IN JOINT-USE OF TRACK OR RECIPROCAL RUNNING

1 commutershed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
multiple (Except for Shinkansen, this Japan Rail Group of rail-ways operates in all the lis-ted commuter-sheds – either on its own rails or on trackage rights.)	Higashi-Nihon Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel	intercity urban rural
	Hokkaido Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel	intercity urban rural
	Kyushu Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel	intercity urban rural
	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel steam	intercity urban rural
	Shikoku Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel	intercity urban rural
	Shinkansen Passenger Railway Company	1435	Japan Rail	HSR	modern	electric	intercity
	Tokai Passenger Railway Company	1067	Japan Rail	ICR ECR DCR	modern	electric diesel	intercity urban rural
Aizu-Waka-matsu	Aizu Railway	1067	Third Sector	INT	re-equipped	transition	rural
Akita	Akita-Nairiku Jokan Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
	Yurikogen Railway	1067	Third Sector	INT	re-equipped	diesel	rural
Mutsu+Ohata	Shimokita Transport	1067	Third Sector	INT	in transition	diesel	rural
Fukui	Fukui Railway Co.	1067	private	INT	modern	electric	intercity
	Keifuku Electric Railway Co.	1067	private	INT	modern	electric	intercity
Fukuoka	Fukuoka City Transport Bureau	1067	municipal	HRT	modern	electric	urban
	Nishi Nippon Railway Co.	1435	private	INT	modern	electric	intercity
	Nishi Nippon Railway Co.	1067	private	LRT	re-equipped	electric	urban
Fukushima	Abukuma Railway	1067	Third Sector	INT	new	electric	intercity
	Fukushima Transport Bureau Co.	1067	municipal	LRT	re-equipped	electric	urban

1 commutershed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Fukuyama	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	INT	modern	electric	suburban
Hakodate	Hakodate City Transport Bureau	1372	municipal	StR	re-equipped	electric	urban
Hamamatsu	Enshu Railway Co.	1067	private	LRT	rebuilt	electric	urban
	Tenryuhamamatsu Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
Hirado+Matsu-ura	Matsu-ura Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
Hirosaki	Konan Railway Co.	1067	private	INT	in transition	electric	urban
	Konan Railway Co.	1067	private	INT	in transition	diesel	urban
	Tsugaru Railway Co.	1067	private	INT	in transition	diesel	rural
Hiroshima	Hiroshima Electric Railway Co.	1435	private	StR+LRT	re-equipped	electric	urban
	Nishikigawa Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	INT	re-equipped	electric diesel	suburban diesel
Hitoyoshi+Ni-shima	Kumagawa Railway	1067	Third Sector	INT	re-equipped	diesel	rural
Kagoshima	Kagoshima Transport Bureau Co.	1435	private	StR	re-equipped	electric	urban
Kamaishi	Sanriku Railway	1067	Third Sector	INT	partly new	diesel	intercity
Kanazawa	Hokuriku Railway Co.	1067	private	LRT	re-equipped	electric	urban
	Noto Railway	1067	Third Sector	INT	re-equipped	electric	rural
Kansai	Arida Railway Co.	1067	private	INT	in transition	diesel	rural
	Eizan Electric Railway Co.	1435	private	LRT	re-equipped	electric	urban
	Hankai Electric Tramway Co.	1435	private	LRT	in transition	electric	urban
	Hankyu Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Hanshin Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Hojo Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Hokushin Express Electric Railway	1435	Third Sector	HRT	new	electric	urban
	Kamogawa Railway	1435	Third Sector	INT	re-equipped	electric	urban
	Kansai Kokusai Kuko Connecting Railway	1067	Third Sector	INT ECR	new	electric	urban
	Keifuku Electric Railway Co.	1435	private	LRT	re-equipped	electric	urban
	Keihan Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Keihan Electric Railway Co.	1435	private	LRT	rebuilt	electric	urban
	Kinki Nippon Railway Co.	1435	private	INT	modern	electric	intercity

1 commutershed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Kansai (con'td)	Kinki Nippon Railway Co.	1067	private	INT	modern	electric	intercity
	Kishu Railway Co.	1067	private	INT	in transition	diesel	rural
	Kita-Kinki Tango Railway	1067	Third Sector	INT	new	transition	intercity
	Kita-Osaka Express Electric Railway Co.	1435	Third Sector	HRT	modern	electric	urban
	Kobe Electric Railway Co.	1067	private	INT	modern	electric	intercity
	Kobe-Company Railway Co.	1435	Third Sector	HRT	modern	electric	urban
	Kobe City Transport Bureau	1435	municipal	HRT	new	electric	urban
	Kyoto Company Railway	1435	Third Sector	HRT	new	electric	urban
	Kyoto City Transport Bureau	1435	municipal	HRT	new	electric	urban
	Miki Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Mizuma Railway Co.	1067	private	INT	in transition	electric	rural
	Nankai Electric Railway Co.	1067	private	INT	modern	electric	urban
	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	INT	modern	electric	intercity
	Nose Electric Railway Co.	1435	private	LRT	rebuilt	electric	urban
	Ohmi Railway Co.	1067	private	INT	modern re-equipped	electric diesel	intercity
	Osaka-fu Toshi Kaihatsu Co.	1067	municipal	INT	modern	electric	urban
	Osaka City Transport Bureau Company Railway	1435	municipal	HRT	in transition	electric	urban
	Sagano Sightseeing Railway	762	Third Sector	TRy	new	diesel	rural
	Sanyo Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Shigaraki-kogen Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Umekoji-Koen	1067	private	StR	vintage	electric	urban
Kanto	Chiba Kennai Railway Co.	1435	Third Sector	INT	new	electric	intercity
	Chiba Express Electric Railway	1435	Third Sector	INT	new	electric	urban
	Chichibu Railway Co.	1067	private	INT	modern	electric	rural
	Choshi Electric Railway Co.	1067	private	LRT	in transition	electric	rural
	Enoshima-Kamakura Sightseeing Co.	1067	private	LRT	re-equipped	electric	urban
	Fuji Express Co.	1067	private	INT	modern	electric	intercity
	Gakunan Railway Co.	1067	private	LRT	re-equipped	electric	urban
	Hakone-Tozan Railway Co.	1435	private	INT	re-equipped	electric	mountain
	Hitachi Electric Railway Co.	1067	private	LRT	re-equipped	electric	urban
	Hokuso Kaihatsu Railway Co.	1435	Third Sector	INT	new	electric	urban
	Ibaraki Transport Co.	1067	private	INT	in transition	electric	rural

1 commutershed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Kanto (con'td)	Isumi Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Izu-Hakone Railway Co.	1067	private	INT	re-equipped	electric	rural
	Izu Express Co.	1067	private	INT	modern	electric	intercity
	Jomo Electric Railway Co.	1067	private	INT	modern	electric	intercity
	Joshin Electric Railway Co.	1067	private	INT	modern	electric	intercity
	Jutaku Toshi Seibi Kodan	1435	municipal	INT	modern	electric	intercity
	Kanto Railway Co.	1067	private	INT	re-equipped	diesel	rural
	Kashima Railway Co.	1067	private	INT	in transition	diesel	rural
	Keihin Express Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Keio-Teito Electric Railway Co.	1372	private	INT	modern	electric	intercity
	Keio-Teito Electric Railway Co.	1067	private	INT	modern	electric	intercity
	Keisei Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Kodan Railway	1435	Third Sector	INT	new	electric	intercity
	Kominato Railway Co.	1067	private	INT	in transition	diesel	rural
	Mo-oka Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Narita- Airport Company Railway	1067 1435	Third Sector	INT	new	electric	intercity
	Odakyu Electric Railway Co.	1067	private	INT	modern	electric	intercity
	Rindoko Fuamiri Bokujo	762	private	TRy	new (rack)	electric	rural
	Sagami Railway Co.	1067	private	INT	in transition	electric	intercity
	Seibu Railway Co.	1067	private	INT	modern	electric	intercity
	Shin-Keisei Electric Railway Co.	1435	private	INT	modern	electric	intercity
	Sobu-Nagareyama Electric Railway Co.	1067	private	LRT	re-equipped	electric	urban
	Teito Kosukudo Kotsu Eidan	1435	municipal	HRT	modern	electric	urban
	Teito Kosukudo Kotsu Eidan	1067	municipal	HRT	modern	electric	urban
	Tobu Railway Co.	1067	private	INT	modern	electric	intercity
	Tokyo Express Electric Railway Co.	1067	private	INT	modern	electric	urban
	Tokyo Express Electric Railway Co.	1372	private	LRT	in transition	electric	urban
	Tokyo Rinkai Transport Bureau	1067	Third Sector	HRT	new	electric	urban
	Tokyo-to Transport Bureau	1435	municipal	HRT	modern	electric	urban
	Tokyo-to Transport Bureau	1372	municipal	HRT	modern	electric	urban
	Tokyo-to Transport Bureau	1067	municipal	HRT	modern	electric	urban
	Toyo Company Railway	1067	Third Sector	HRT	new	electric	urban
	Watarase Keikoku Railway	1067	Third Sector	INT	re-equipped	diesel steam	rural
	Yagan Railway	1067	Third Sector	INT	new	electric	intercity

1 commutershed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Kanto (con'td)	Yokohama Company Railway	1435	Third Sector	HRT	new	electric	urban
	Yokohama City Transport Bureau	1435	municipal	HRT	new	electric	urban
Kitakyushu	Chikuho Electric Railway Co.	1435	Third Sector	LRT	modern	electric	urban
	Heisei-Chikuho Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
	Nishi Nippon Railway Co.	1435	private	LRT	in transition	electric	urban
Kitami	Hokkaido Chikuho Kogen Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
Kochi	Tosa Electric Railway Co.	1067	private	StR	in transition	electric	urban
Kumamoto	Kumamoto Electric Railway Co.	1067	private	LRT	in transition	electric	urban
	Kumamoto City Transport Bureau	1435	municipal	StR	re-equipped	electric	urban
	Minami Aso Railway	1067	private	INT	re-equipped	diesel	rural
Kurume	Amagi Railway	1067	Third Sector	INT	re-equipped	diesel	rural
Matsue+Yo-nago	Ichibata Electric Railway Co.	1067	private	INT	in transition	electric	intercity
Matsumoto	Higashi-Nihon Passenger Railway Company	1067	Japan Rail	INT	re-equipped	electric	intercity
	Matsumoto Electric Railway Co.	1067	private	LRT	re-equipped	electric	urban
Matsuyama	Iyo Railway Co.	1067	private	INT	re-equipped	electric	urban
	Iyo Railway Co.	1067	private	StR	in transition	electric	urban
Miyako	Sanriku Railway	1067	Third Sector	INT	part new	diesel	intercity
Miyazaki	Miyazaki Kuko Line	1067	Third Sector	INT	new	electric	intercity
Nagano	Nagano Electric Railway Co.	1067	private	INT	modern	electric	urban
	Shinano Railway Line	1067	Third Sector	INT	rebuilt	electric	intercity
	Ueda Transport Bureau Co.	1067	private	LRT	re-equipped	electric	urban
Nagasaki	Nagasaki Electric Tramway Co.	1435	private	StR	re-equipped	electric	urban

1 commuter shed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Nagoya	Aichi-Kanjo Railway	1067	Third Sector	INT	new	electric	urban
	Akechi Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Hakubatsu Meiji Mura	1067	private	VT TRy	vintage vintage	electric steam	rural rural
	Ise Railway	1067	Third Sector	INT	new	transition	intercity
	Kami-ida Connecting-sen Co.	1067	Third Sector	HRT	new	electric	urban
	Kinki Nippon Railway Co.	1435	private	INT	rebuilt	electric	intercity
	Kinki Nippon Railway Co.	1067	private	INT	rebuilt	electric	intercity
	Kinki Nippon Railway Co.	762	private	LRT	modern	electric	urban
	Nagaragawa Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Nagoya Railway Co.	1067	private	INT	modern	electric	intercity
	Nagoya Railway Co.	1067	private	LRT	modern	electric	urban
	Nagoya Railway Co.	1067	private	StR	in transition	electric	urban
	Nagoya City Transport Bureau	1435	municipal	HRT	in transition	electric	urban
	Nagoya City Transport Bureau	1067	municipal	HRT	in transition	electric	urban
	Sangi Railway Co.	1067	private	INT	in transition	electric	rural
	Tarumi Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Tokai Transport Jigyo	1067	Third Sector	INT	new	transition	urban
	Tokai Passenger Railway Company	1067	Japan Rail	INT	modern	electric	intercity
	Toyohashi Railway Co.	1067	private	INT	re-equipped	electric	urban
	Toyohashi Railway Co.	1067	private	StR	re-equipped	electric	urban
Nakamura+ Sukumo+ Shimizu	Tosa Kuroshio Railway	1067	Third Sector	INT	new	diesel	rural
Niigata	Kambara Railway Co.	1067	private	INT	in transition	electric	rural
	Niigata Transport Bureau Co.	1067	private	INT	in transition	electric	intercity
Nobeoka	Takachiho Railway	1067	Third Sector	INT	re-equipped	diesel	rural
Obihiro	Hokkaido Chikuho Kogen Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
Odate	Dowa Kogyo Co.	1067	private	INT	in transition	diesel	rural
Okayama+ Kurashiki	Dowa Kogyo Co.	1067	private	INT	in transition	diesel	rural
	Mizushima Rinkai Railway Co.	1067	private	INT	in transition	diesel	urban
	Okayama Electric Tramway Co.	1067	private	StR	modern	electric	urban
Sapporo	Azura Railway	1067	Third Sector	INT	in transition	diesel	rural
Sapporo (con'td)	Sapporo City Transport Bureau	1067	municipal	StR	modern	electric	urban

1 commuter shed	2 operator	3 track gauge (mm)	4 sector	5 mode	6 status	7 propul-sion	8 setting
Sendai	Higashi-Nihon Passenger Railway Company	1067	Japan Rail	INT	modern	electric	intercity
	Kurihara Electric Railway	1067	private	INT	in transition	transition	rural
	Sendai City Transport Bureau	1067	municipal	HRT	new	electric	urban
Shimabara+ Obama	Shimabara Railway Co.	1067	private	INT	in transition	diesel	intercity
Shizuoka	Shizuoka Railway Co.	1067	private	LRT	modern	electric	urban
Takada+Nao-etsu	Hokuetsu Express	1067	Third Sector	INT	new	electric	intercity
Takamatsu	Takamatsu Kotohira Electric Railway Co.	1435	private	INT	modern	electric	intercity
Tokushima	Asa Kaigan Railway	1067	Third Sector	INT	new	diesel	rural
Tottori	Chizu Express	1067	Third Sector	INT	new	diesel	intercity
	Wakasa Railway	1067	Third Sector	INT	re-equipped	diesel	rural
Towada	Towada Sightseeing Electric Railway Co.	1067	private	LRT	in transition	electric	rural
Toyama+ Takaoka	Kamioka Railway	1067	Third Sector	INT	re-equipped	diesel	rural
	Kensetsu-sho Hokuriku District Kensetsu Bureau	609	municipal	IND	in transition	diesel	mountain
	Kurobe Kyokoku Railway	762	private	INT	in transition	electric	rural
	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	INT	modern	electric	urban
	Kaetsuno Railway Co.	1067	private	LRT	in transition	electric	urban
	Toyama District Railway Co.	1067	private	INT	modern	electric	intercity
	Toyama District Railway Co.	1067	private	StR	in transition	electric	intercity
Ube	Nishi-Nihon Passenger Railway Company	1067	Japan Rail	INT	modern	electric	intercity
Yaizu+Fujieda +Shimada	Oigawa Railway Co.	1067	private	INT	vintage	electric	rural
	Oigawa Railway Co.	1067	private	INT	vintage	steam	rural
	Oigawa Railway Co.	1067	private	INT	new (rack)	electric	rural
Yonezawa	Yamagata Railway	1067	Third Sector	INT	re-equipped	diesel	intercity
50+ places	169 operators	5 gauges					

Chiho = District; Electric = Electric; Dentetsu = Electric Railway; Kaisha = Company; K.K. = *Kabushikigaisha* [company]; Kanko = Sightseeing; Kido = Tramway; Kosoku = Rapid; Kotsu = Transport; Kuko = Airport; Kyoku = Department or Bureau; Kyuko = Express; Renraku = Connecting; Passenger = Passenger; -sen = Line; -shi = City; and Tetsudo = Railway

APPENDIX Kb

This tabulation provides more detailed information on those systems screened for further examination. The goal was to select no more than six case studies for which additional data was obtained through a survey. The ones that were carried forward for further consideration are in bold in the two left columns:

FINAL MATRIX OF JAPANESE RAILWAYS WITH REGARD TO THEIR POTENTIAL PARTICIPATION IN JOINT-USE OF TRACK OR RECIPROCAL RUNNING

place or facility	participants	electric	diesel	in transition	LRT	INT	HRT	ECR/ICR	JR	pvt*	3rd	frt	urban	Inter-city	rural
Fukuoka (Fukuoka)	Fukuoka City Transport Bureau	●					●			●			●		
	Kyushu Passenger Railway Company	●						●	●			●	●	●	●
	Nishi Nippon Railway Co.	●		●	●					●			●		
Abukuma (Fukushima)	**Abukuma Railway**	●				●					●			●	●
	Fukushima Transport Bureau Co.	●			●					●			●		
	Higashi Nihon Passenger Railway Company	●						●	●			●		●	●
Gakunan (Kanto)	**Gakunan Railway Co.**	●			●					●		●	●		
	Higashi-Nihon Passenger Railway Company	●						●	●			●		●	●
Hankyu network (Kansai)	**Hankyu Electric Railway Co.**	●				●				●			●	●	●
	Hanshin Electric Railway Co.	●				●				●			●	●	
	Kita-Osaka Express Electric Railway Co.	●					●				●		●		
	Kobe Company Railway Co.	●					●				●		●		
	Osaka City Transport Bureau Company Railway	●					●			●			●		
	Sanyo Electric Railway Co.	●				●				●			●	●	●
Ise (Nagoya)	**Ise Railway**		●	●		●					●				●
	Tokai Passenger Railway Company		●					●	●			●		●	●
Keihan network (Kansai)	Eizan Electric Railway Co.	●		●	●					●			●		
	Kamogawa Railway	●				●					●		●		
	Keihan Electric Railway Co.	●			●	●				●			●	●	
	Kinki Nippon Railway Co.	●				●				●			●	●	●

place or facility	participants	electric	diesel	in transition	LRT	INT	HRT	ECR/ICR	JR	pvt*	3rd	frt	urban	Inter-city	rural
Keihan network	Kyoto Company Railway	●					●				●		●		
	Kyoto City Transport Bureau	●					●			●			●		
Sanriku (Kamaishi+ Miyako	Higashi-Nihon Passenger Railway Company		●			●		●	●					●	●
	Sanriku Railway		●			●					●	●	●	●	●
Tozai (Kanto)	**Higashi-Nihon Passenger Railway Company**	●						●	●				●		
	Teito Company Transport Eidan	●					●			●			●		
Tsurumai (Nagoya)	Nagoya City Transport Bureau	●					●			●			●		
	Nagoya Railway Co.	●				●				●			●	●	●
	Tokai Passenger Railway Company		●		●			●	●			●		●	●

* = including municipal

This does not fully represent the final selection. The Abukuma Railway, for example, was dropped from consideration in order to include the Nagoya Railway's lines at Gifu.

APPENDIX Kc
MATRIX OF PACIFIC RIM CONURBATIONS AND THEIR POTENTIAL PARTICIPATION IN JOINT USE OF TRACK OR RECIPROCAL RUNNING

The possibilities for Pacific Rim examples of joint-use were reduced from a review of nations and urban places to the 36 places that have fixed-guideway urban transportation systems and are identified on the following table. The cities selected for further examination are highlighted.

ECR = electrified commuter rail; DCR = diesel commuter rail; HRT = heavy rapid transit; INT = interurban; LRT = light-rail transit; StR = street railway; FUN = funicular; P-M = people-mover; AC = aerial cableway; FY = ferry; ■ = existing; ❍ = under construction or planned; note: all places are served by motor bus services.

city and nation	fixed-guideway mode							other
	ECR	DCR	HRT	INT	LRT	StR	other	
Agaña, Guam (U.S.A. territory)							P-M❍	
Anshan+Liao-yang, People's Republic of China	■	■				■	ETB	
Beijing (Peking), People's Republic of China			■				ETB	
Ch'ang-ch'un, People's Republic of China					❍		ETB	
Chengdu, People's Republic of China		■					ETB	
Ch'ia-i, Republic of China (T'ai-wan)	■	■						
Chongqing (Chunking), People's Republic of China		■					ETB FUN	AC
Dalian (Talien)(Dairen), People's Republic of China					❍	■		
Djakarta, Republic of Indonesia	■		❍		❍			
Guangzhou (Canton), People's Republic of China			❍				ETB	FY
Hangzhou (Hangchow), People's Republic of China							ETB	
Hanoi, Socialist Republic of Viet Nam						1	ETB	
Harbin (Pinkiang)(Ha-erh-pin), People's Republic of China						2	ETB	
Hsin-chu, Republic of China (T'ai-wan)	■	■			❍			
Jilin, People's Republic of China							ETB	
Kaohsiung, Republic of China (T'ai-wan)	■	■	❍		❍			
Khabarovsk, Russia						■		
Komsomol'sk-na-Amure, Russia						■		
Kowloon+Victoria, Hong Kong, People's Republic of China	■		■			■	FUN	FY
Kuala Lumpur, Malaysia	■	■			■		P-M	
Kunming, People's Republic of China		■3					ETB ❍	
Manila, Republic of The Philippines		■			■		4	
Nanjing (Nanchang), People's Republic of China			❍					
P'yongyong, People's Republic of [North] Korea	■		■		■	■	ETB	
Pusan, Republic of [South] Korea	■		■			5		
Seoul+Inch'ŏn, Republic of [South] Korea	■		■			6		
Shanghai, People's Republic of China			■				ETB	
Shen-yang (Mukden)+Fushun, People's Republic of China				■			ETB	
T'ai-pei, Republic of China (T'ai-wan)	■	■	■				P-M	FY
Tai-yuan, People's Republic of China							ETB	
Tianjin (Tientsin), People's Republic of China			■				ETB	
Tou-liu, Republic of China (T'ai-wan)	■	■						

city and nation	fixed-guideway mode							other
	ECR	DCR	HRT	IN T	LR T	StR	other	
Tuen Mun, Hong Kong, People's Republic of China	❍				■			FY
Vladivostok, Russia						■		
Wu-han, People's Republic of China							ETB	7
Xi'an (Sian), People's Republic of China		■					ETB	

1 Hanoi had streetcars until replaced by electric trolley buses in 1987
2 Harbin had streetcars until 1987
3 Kunming diesel commuter rail includes two track gauges (meter and standard)
4 Manila did have streetcars and electric trolley buses
5 Pusan did have streetcars
6 Seoul did have streetcars and interurbans
7 Wuhan has two separate electric trolley bus networks