

ID	System Level Hazard	2nd Level Hazard	Cause	Accident	Effect after accident	Severity	Functional safety measurements	other safety measurements
1	guidance of vehicle not ensured	loss of structural integrity of wheel or axcles	breakage of wheel rim or axcles	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	wheel defect detection system on train and hot box detectors and wheel defect detection on strategic places	periodic inspections / maintenance
		loss of structural integrity of bridge	earthquake / landslip	derailment	multiple effects possible: sliding and / or rolling over; in worst case vehicle falling from bridge	catastrophic	signalling system for detection of rail brakage	periodic inspections / maintenance
		loss of structural integrity of track / rail	earthquake / landslip	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	landslide warning system on critical parts of track	periodic inspections / maintenance
				derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	signalling system detects rail brakage in case of total fracture	periodic inspections / maintenance
			undercutting of track	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	landslide warning system on critical parts of track	periodic inspections / maintenance
		deformation of rail (lateral buckling)	high temperature	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	-	periodic inspections / maintenance
		loss of structural integrity of switch component	breakage of switch tongue	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	none (because end position detector, tongue detectors are not efficient for this hazard in case of switch of tongue while train movement)	none (because end position detector, tongue detectors are not efficient for this hazard in case of switch of tongue while train movement)

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		climbing	obstacle (e.g. stones, wood) on track	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	landslide warning system on critical parts of track	periodic inspections / maintenance; falling-object protective systems
			severe snow / large amount of ice on track, heavy snowfall,	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	snowslide warning system, snow shelter	periodic inspections / maintenance; snowshells
			foreign object (e.g. stones, snow, ice) in switch	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	end position detector, tongue detector at switches	periodic inspections / maintenance.
			inadequate high speed in curves	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	ETCS or F- ATC	periodic inspections / maintenance
2	vehicle´s stability not ensured	too high lateral forces	too high side wind	derailment	multiple effects possible: sliding and / or rolling over; collision with 3rd properties possible ; vehicle(s) may come into the other track and collision with mixed traffic possible (only in system-variant 1)	catastrophic	–	walls, windshells, closing track if information of heavy wind; no double tracks on one bank
3	adequate forward ordering not ensured	erroneous "system track holding/train routing"	signalling failure	Front or rear collision train ⇒ train	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	ETCS or F- ATC	periodic inspections / maintenance
			train detection failure	Front or rear collision train ⇒ train	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	axel counter at station	periodic inspections / maintenance
4	inadequate braking	insufficient brake force	failure of brake system	Front or rear collision train ⇒ train	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	emergency brake sytem	periodic inspections / maintenance
		too high deceleration	failure of brake system	tumble of passengers	None	marginal	–	periodic inspections / maintenance

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5	objects / obstacle in or besides track	vehicle on level crossing	level crossing failure/ human error	Side collision train ⇒ vehicle	only relevant in system-variant 1, multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	level crossing monitoring system / equipment (induction loops, infrared lightbarriers, radar etc.)	periodic inspections / maintenance
		loss of train integrity	failure of coupling system	Front or rear collision train ⇒ external coach	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	ETCS or F- ATC	ETCS or F- ATC
		loss structural integrity of tunnel	inadequate secure of construction (e.g. falling of rocks)	Front or side collision train ⇒ obstacle	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	-	periodic inspections / maintenance
		rocks in track	rock slide	Front or side collision train ⇒ obstacle	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	landslide warning system on critical parts of track	periodic inspections / maintenance
		trees in track	storm	Front or side collision train ⇒ obstacle	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	marginal	-	safety corridor at relevant track sectors
		animals in track	missing fencing	Collision train ⇒ animal(s)	damage on train	marginal	-	fences
		ice in track	snowslide	Front or side collision train ⇒ obstacle	multiple effects possible: force effect on third party and/or derailment and / or fire, explosion or pollution	critical	-	-
		vehicle in track (outside level crossings)	accident / defect of vehicle	Front collision train ⇒ vehicle	multiple effects possible: structural deformation of vehicle(s) may followed by derailment and / or fire, explosion or pollution	catastrophic	vehicle detection system on bridges that crosses the rail track	periodic inspections / maintenance
		person intrudes track	missing fencing	Collision train ⇒ person(s)	None	critical	-	-
		person on platform	inadequate process	Collision train ⇒ person(s)	None	critical	-	-
		personal in track	inadequate process	Collision train ⇒ person(s)	None	catastrophic	-	-
		maintenance vehicle / machines in track	inadequate process	Front collision train ⇒ train / vehicle	derailment, damages on train, inadequate force effect on third party, explosion (not meaning accident), fire (not meaning accident)	catastrophic	special requirements for operation / signalling	special requirements for operation / signalling
loading / parts of trains in track or dispersing	lost of loading / parts of trains	Front collision train ⇒ obstacle	derailment, damages on train, inadequate force effect on third party	catastrophic	-	-		

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6	loss of fire prevention	loss of onboard fire alarm- / fighting system	loss of / erroneous sensing	fire in rolling stock	multiple effects possible: smoke emission, loss of structural integrity of vehicle, inadmissibly increase of temperature, pollution (not meaning accident)	catastrophic	fire-alarm- / fighting monitoring system	periodic inspections / maintenance
			failure of fire extinguishing system	fire in rolling stock	multiple effects possible: smoke emission, loss of structural integrity of vehicle, inadmissibly increase of temperature, pollution (not meaning accident)	catastrophic	fire-alarm- / fighting monitoring system	periodic inspections / maintenance
		loss of tunnel fire-alarm- / fighting system	loss of / erroneous sensing	fire	multiple effects possible: smoke emission, loss of structural integrity of vehicle, inadmissibly increase of temperature, pollution (not meaning accident)	catastrophic	fire-alarm- / fighting monitoring system	periodic inspections / maintenance
			failure of fire extinguishing system	fire	multiple effects possible: smoke emission, loss of structural integrity of vehicle, inadmissibly increase of temperature, pollution (not meaning accident)	catastrophic	fire-alarm- / fighting monitoring system	periodic inspections / maintenance
7	adequate evacuation of passengers in case of emergency not ensured	adequate evacuation of passengers by onboard evacuation system in case of emergency not ensured	loss or failure of onboard evacuation system / equipment	multiple scenario possibles	multiple effects possible: inadmissibly increase of temperature and / or smoke emission in case of fire; panic reaction of passengers; passengers may stand on adjacent track(s)	catastrophic	-	operational procedure
		adequate evacuation of passengers by tunnel evacuation system in case of emergency not ensured	loss or failure of tunnel evacuation system / equipment	multiple scenario possibles	multiple effects possible: inadmissibly increase of temperature and / or smoke emission in case of fire; panic reaction of passengers; passengers may stand on adjacent track(s)	catastrophic	-	operational procedure
		adequate evacuation of passengers while train on bridge in case of emergency not ensured	loss or failure of bridges evacuation system / equipment	multiple scenario possibles	multiple effects possible: inadmissibly increase of temperature and / or smoke emission in case of fire; panic reaction of passengers; passengers may stand on adjacent track(s) (only in system-variant 1)	catastrophic	-	operational procedure
8	safe entry / exit of passengers / personal not ensured	entry / exit system failure	loss / failure of door system	improper force effect to passenger / personal	None	critical	door monitoring system	periodic inspections / maintenance
				pinched passenger	None	critical	door monitoring system	periodic inspections / maintenance
		operation failure	inadequate process	pinched passenger	None	critical	door monitoring system	operational procedure

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9	electrical hazards	inadequate distance to overhead line	track workers (incl. machines) in track	electrocution	fire (not meaning accident)	critical	–	special requirements for operation / signalling
			third party in track	electrocution	fire (not meaning accident)	critical	–	fencing, information
			third party on bridges overtrack	electrocution	fire (not meaning accident)	critical	–	fencing, information
10	chemical hazards	tightness of vehicle subsystems / components not ensured	subsystem- / component failure (e.g. hydraulic system, electrical power system etc.)	emission of dangerous goods (e.g. cooling medium, oil etc.), explosion	pollution, intoxication	marginal	–	periodic inspections / maintenance
		tightness of infrastructure subsystems / components not ensured	subsystem- / component failure (e.g. hydraulic system, electrical power system etc.)	emission of dangerous goods (e.g. cooling medium, oil etc.), explosion	pollution, intoxication	marginal	–	periodic inspections / maintenance
11	structural integrity of vehicle subsystems / components not ensured	tightness of vehicle subsystems / components not ensured	subsystem- / component failure (e.g. pneumatic system)	improper force effect to passenger / personal / third party	None	critical	–	periodic inspections / maintenance.
		tightness of infrastructure subsystems / components not ensured	subsystem- / component failure (e.g. pneumatic system)	improper force effect to passenger / personal / third party	None	critical	–	periodic inspections / maintenance
12	other hazards	disperse of ballast	high speed and ice on the train	improper force effect to personal / third party	None	critical	–	–
		adeqaute noise level not ensured	inadeqaute noise protection	noise limit exceeded	None	marginal	–	periodic inspections / maintenance