

**INSTRUCTIONS:**

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discussed in t

HA-002 should be for the lane keeping assistance function as discussed in

Then come up with your own situations and hazards for the lane assistance

When finished, export your spreadsheet as a pdf file so that a reviewer can

Hazard ID			
	Operational Mode	Operational Scenario	Environmental Details
HA-001	OM03 - Normal driving	OS04 - Highway	EN01 - Normal condition
HA-002	OM03 - Normal driving	OS03 - Country Road	EN01 - Normal condition
HA-003	OM03 - Normal driving	OS01 - Any road	EN06 - Rain (slippery road)
HA-004	OM03 - Normal driving	OS04 - Highway	EN05 - Cross-wind (lateral force)

discussed in the lecture.  
discussed in the lecture.  
the assistance system. Fill in the HA-003 and HA-004 rows.  
viewer can easily see your work.

Situational Analysis		
Situation Details	Other Details (optional)	Item Usage (function)
SD02 - High speed	Driver distracted + gripping steering wheel loosely	IL01 - Correctly used
SD02 - High speed		IL02 - Incorrectly used
SD01 - Low speed	Night time + reflection of light on the road	IL02 - Incorrectly used
SD02 - High speed		IL01 - Correctly used

Situation Description	Function	Deviation
Normal driving on a Highway during normal condition	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 - Actor effect is too much
Normal driving on a Country road during normal condition.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 - Function always activated
Normal driving on any Road during rain	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV02 - Function unexpectedly activated
Normal driving on a Highway during crosswinds	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV02 - Function unexpectedly activated

Hazard Identification		
Deviation Details	Hazardous Event (resulting effect)	Event Details
Oscillating steering torque applied exceeds the limit.	EV00 - Collision with other vehicle	Lateral collision with vehicle on either left or right side.
Driver misusing LKA function and takes off hands from the steering wheel.	EV00 - Collision with other vehicle	Lateral collision with vehicle on either left or right side.
Oscillating steering torque applied unnecessarily.	During rain, reflection of headlights from oncoming cars on the road can cause camera to detect lane lines incorrectly and activate LDW feature	Lateral collision with vehicle on either left or right side.
Steering torque applied could be counter intuitive.	Combination of crosswind and steering torque could cause car to swerve badly.	Lateral collision with vehicle on either left or right side.

Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
Driver loses control of vehicle	E2 - Low probability	Normally people are alert during driving but there can be scenario which causes distraction for the driver, for e.g., billboards. Probability of this event happening is low.
Driver loses control of vehicle	E2 - Low probability	Since its risky to abuse LKA feature, driver wont be doing it quite often. Probability of this event happening is low.
Driver loses control of vehicle	E2 - Low probability	Occurrence of this event is happening less frequent so probability is low.
Driver loses control of vehicle	E2 - Low probability	Occurrence of this event is happening less frequent so probability is low.

### Hazardous Event Classification

<b>Severity (of potential harm)</b>	<b>Rationale (for severity)</b>	<b>Controllability (of hazardous event)</b>
S3 - Life-threatening or fatal injuries	High speed will have greater impact during the collision	C3 - Difficult to control or uncontrollable
S3 - Life-threatening or fatal injuries	High speed will have greater impact during the collision	C3 - Difficult to control or uncontrollable
S2 - Severe and life-threatening injuries	During rain, normally people don't drive fast, so impact could be less severe.	C3 - Difficult to control or uncontrollable
S2 - Severe and life-threatening injuries	High speed will have greater impact during the collision	C3 - Difficult to control or uncontrollable

	Determin
Rationale (for controllability)	ASIL Determination
If LWD applies torque in one direction, driver might react and apply torque in the opposite direction. This behavior can repeat and will cause car to swerve badly.	C
Since driver is depending on the LKA for the direction, direction can change if road condition change for example, curve ahead.	B
Traffic condition in the surroundings can change the outcome. Driver maybe able to control the car or maybe not. So picked the higher controllability.	C
Traffic condition in the surroundings can change the outcome. Driver maybe able to control the car or maybe not. So picked the higher controllability.	B

Definition of ASIL and Safety Goals
Safety Goal
The oscillating steering torque from LDW should be limited.
Time duration of LKA should be time limited to prevent the misuse of LKA as an autonomous driving.
LDW shouldn't be activated if its raining. Driver should remain in the control of the car.
If LKA is getting activated frequently during short time span, LKA should deactivate itself and let driver control the car.



EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - Headl

Hazard ID	
	Operational Mode
HA-001	Normal Driving

MORE EXAMPLES - Headlamp System

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

DNS - Headlamp System

Si	
Operational Scenario	Environmental Details
City Road	Normal Conditions

S	
Operational Scenario	Environmental Details
OS01 - City Road	EN01 - Normal conditions
OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

**Situational Analysis**

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the	Correctly Used

**Situation Analysis**

Situation Details (optional)	Other Details (optional)	Item Usage (function)
SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used
SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used
SD03 - High speed	Night time + Obstacle on the	IU01 - Correctly used
SD02 - High speed	Night time + Oncoming	IU01 - Correctly used
SD04 - High speed	Night time + Obstacle on the	IU01 - Correctly used

Situation Description	Function
Normal Driving on a City Road in Normal	Low beam illuminates the

Situation Description	Function
Normal Driving on City Road during Normal	Low beam illuminates the
Normal Driving on City Road during Snowfall	Low beam illuminates the
Normal Driving on Highway during Snowfall	Low beam illuminates the
Normal Driving on Country Road during Normal	Low beam illuminates the
Normal Driving on Country Road during Snowfall	Low beam illuminates the

Hazard Id	
Deviation	Deviation Details
Function not activated	Both headlights stop working

Hazard Id	
Deviation	Deviation Details
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working

entification		
Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
Front collision with obstacle	Vehicle crashes into the	Total loss of low beam

entification		
Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam
EV08 - Collision with other vehicle	Vehicle crashes into the	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night driving in the city is a regular

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night driving in the city is a regular
E1 - Very low probability	night driving in the city on
E2 - Low probability	High driving is part of regular
E4 - High probability	country driving is part of regular
E2 - Low probability	country driving is part of regular

Hazardous	
Severity (of potential harm)	
S1 - Light and moderate injuries	

Hazardous	
Severity (of potential harm)	
S1 - Light and moderate injuries	
S1 - Light and moderate injuries	
S3 - Life-threatening or fatal injuries	
S3 - Life-threatening or fatal injuries	
S3 - Life-threatening or fatal injuries	



**Event Classification**

<b>Rationale (for severity)</b>	<b>Controllability (of hazardous event)</b>
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

**Event Classification**

<b>Rationale (for severity)</b>	<b>Controllability (of hazardous event)</b>
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general
In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable
On highway speed of vehicle is expected to be high	C2 - Normally controllable
On country roads speed of vehicle is expected to be high	C1 - Simply controllable
On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable

	Determination of ASIL and
Rationale (for controllability)	ASIL Determination
At city speed, most drivers will be able to	QM

	Determination of ASIL and
Rationale (for controllability)	ASIL Determination
At city speed, most drivers will be able to	QM
On completely unilluminated city roads,	QM
When driving on highway with low beam, it	A
Since there is usually no other form of	B
Since there is usually no other form of	B

Safety Goals
Safety Goal
Total Loss of Beam Shall

Safety Goals
Safety Goal
Total loss of low beam
Total loss of low beam
Total loss of low beam
Total loss of low beam
Total loss of low beam

# Hazard & Risk Analysis Definition

## Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

## Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

## Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

## Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

## Environmental Details

ID	Scenario
EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)

EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

## Definitions

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Being towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks
road type
road type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

Remarks
Intended usage
Unintended usage (foreseeable)
not applicable or not relevant

[illegible]

road attribute
road attribute
not applicable or not relevant

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference
IU01 - Correctly used
IU02 - Incorrectly used
IU03 - N/A

Reference
EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)
EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)



EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

**Deviation**

ID	Deviation (Guideword)
DV01	Function not activated
DV02	Function unexpectedly activated
DV03	Function always activated
DV04	Actor effect is too much
DV05	Actor effect is too less
DV06	Actor action too early
DV07	Actor action too late
DV08	Actor action before
DV09	Actor action after
DV10	Actor effect is reverse
DV11	Actor effect is wrong
DV12	Sensor sensitivity is too high
DV13	Sensor sensitivity is too low
DV14	Sensor detection too early
DV15	Sensor detection too late
DV16	Sensor detection before
DV17	Sensor detection after
DV18	Sensor detection is reverse
DV19	Sensor detection is wrong
DV20	N/A

**Hazardous Events (possible effects)**

ID	Hazardous Event
EV-07	None
EV-06	Front collision with oncoming traffic
EV-05	Front collision with ahead traffic
EV-04	Front collision with obstacle
EV-03	Rear collision with trailing traffic
EV-02	Side collision with other traffic
EV-01	Side collision with obstacle
EV00	Collision with other vehicle
EV01	Collision with train
EV02	Collision with pedestrian
EV03	Car spins out of control
EV04	Car comes off the road
EV05	Car catches fire
EV06	N/A

Remarks	Reference
Activation error	<a href="#">DV01 - Function not activated</a>
Activation error	<a href="#">DV02 - Function unexpectedly activated</a>
Activation error	<a href="#">DV03 - Function always activated</a>
Quantitative error	<a href="#">DV04 - Actor effect is too much</a>
Quantitative error	<a href="#">DV05 - Actor effect is too less</a>
Timing error	<a href="#">DV06 - Actor action too early</a>
Timing error	<a href="#">DV07 - Actor action too late</a>
Sequence error	<a href="#">DV08 - Actor action before</a>
Sequence error	<a href="#">DV09 - Actor action after</a>
Logical error	<a href="#">DV10 - Actor effect is reverse</a>
Logical error	<a href="#">DV11 - Actor effect is wrong</a>
Quantitative error	<a href="#">DV12 - Sensor sensitivity is too high</a>
Quantitative error	<a href="#">DV13 - Sensor sensitivity is too low</a>
Timing error	<a href="#">DV14 - Sensor detection too early</a>
Timing error	<a href="#">DV15 - Sensor detection too late</a>
Sequence error	<a href="#">DV16 - Sensor detection before</a>
Sequence error	<a href="#">DV17 - Sensor detection after</a>
Logical error	<a href="#">DV18 - Sensor detection is reverse</a>
Logical error	<a href="#">DV19 - Sensor detection is wrong</a>
not applicable or not relevant	<a href="#">DV20 - N/A</a>

Remarks	Reference
	<a href="#">EV-07 - None</a>
	<a href="#">EV-06 - Front collision with oncoming traffic</a>
	<a href="#">EV-05 - Front collision with ahead traffic</a>
	<a href="#">EV-04 - Front collision with obstacle</a>
	<a href="#">EV-03 - Rear collision with trailing traffic</a>
	<a href="#">EV-02 - Side collision with other traffic</a>
	<a href="#">EV-01 - Side collision with obstacle</a>
	<a href="#">EV00 - Collision with other vehicle</a>
	<a href="#">EV01 - Collision with train</a>
	<a href="#">EV02 - Collision with pedestrian</a>
	<a href="#">EV03 - Car spins out of control</a>
	<a href="#">EV04 - Car comes off the road</a>
	<a href="#">EV05 - Car catches fire</a>
	<a href="#">EV06 - N/A</a>

**Exposure**

ID	Description
E0	Incredible
E1	Very low probability
E2	Low probability
E3	Medium probability
E4	High probability

**Severity**

ID	Description
S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries
S3	Life-threatening or fatal injuries

**Controllability**

ID	Description
C0	Controllable in general
C1	Simply controllable
C2	Normally controllable
C3	Difficult to control or uncontrollable

Duration (of situation)
Not specified
<1 % of average operating time
1 % to 10 % of average operating time
>10 % of average operating time

Remarks
No injuries
Light and moderate injuries
Severe and life-threatening injuries (survival probable)
Life-threatening injuries (survival uncertain), fatal injuries

Remarks
Controllable in general
99 % or more of all drivers or other traffic participants are usually able
90 % or more of all drivers or other traffic participants are usually able
Less than 90 % of all drivers or other traffic participants are usually ab

Frequency (of situation)
Occurs less often than once a year for the great majority of drivers
Occurs a few times a year for the great majority of drivers
Occurs once a month or more often for an average driver
Occurs during almost every drive on average

Probability of Injuries
AIS 0 and less than 10 % probability of AIS 1-6
More than 10 % probability of AIS 1-6 (and not S2 or S3)
More than 10 % probability of AIS 3-6 (and not S3)
More than 10 % probability of AIS 5-6

usually able to avoid harm
usually able to avoid harm
e usually able, or barely able, to avoid harm

Reference
E0 - Incredible
E1 - Very low probability
E2 - Low probability
E3 - Medium probability
E4 - High probability

Reference
S0 - No injuries
S1 - Light and moderate injuries
S2 - Severe and life-threatening injuries
S3 - Life-threatening or fatal injuries

Reference
C0 - Controllable in general
C1 - Simply controllable
C2 - Normally controllable
C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity	
		S0	S1
C1	E1	QM	QM
	E2	QM	QM
	E3	QM	QM
	E4	QM	QM
C2	E1	QM	QM
	E2	QM	QM
	E3	QM	QM
	E4	QM	A
C3	E1	QM	QM
	E2	QM	QM
	E3	QM	A
	E4	QM	B



erity	
S2	S3
QM	QM
QM	QM
QM	A
A	B
QM	QM
QM	A
A	B
B	C
QM	A
A	B
B	C
C	D