

Crash ID: 150527

Accident Narration

A bus with 20 passengers started the trip at around 20:00, Tuesday, 26 May, 2015 from Udonthani to Chiangmai. In the morning, the bus was travelling across the mountainous area between Phitsanulok and Lamphang. On the downhill section before the Phakham intersection in Lamphang, the driver found a malfunction of the braking system and couldn't slow down the bus, as reported by one of the bus passengers. The bus, then continued to travel straight at intersection and first collided with a Van (V2) and second a sport utility vehicle (V3) at rear end. **Figure 1** shows the location of the accident scene. After the impact with the vehicles, the bus ran off road, hit the electric pole, intruded into the residential houses, and finally stopped there. The van lost control, rotated and hit the roadside objects (electric pole, signpost and tree), and deflected back to the roadway. Due to the impact with roadside objects, 3 passengers inside the van ejected together with the seat and rested on the footpath. Likewise, SUV (V3) also lost control after the impact by bus, run off road, and rested near the bus. The diagram showing the schematic sequence of the crash is shown in **Figure 2**.

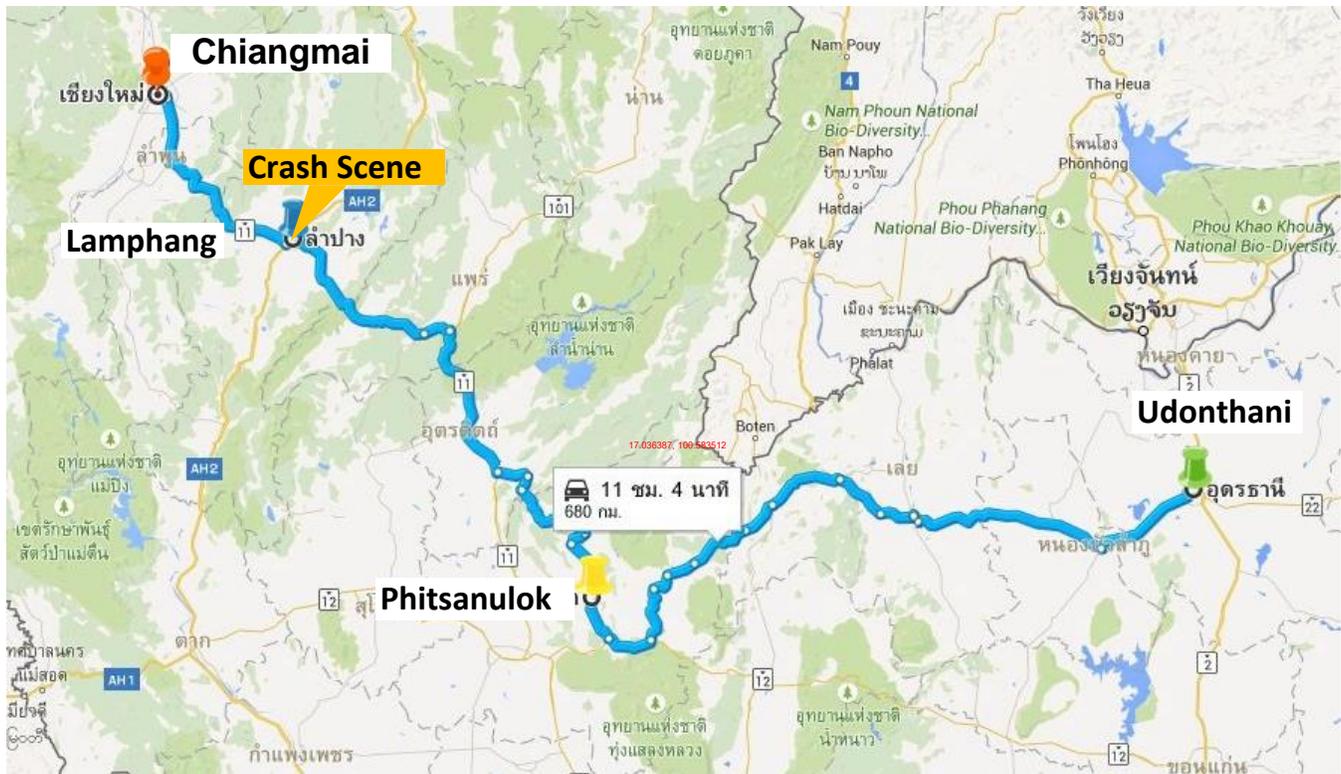


Figure 1 Accident location

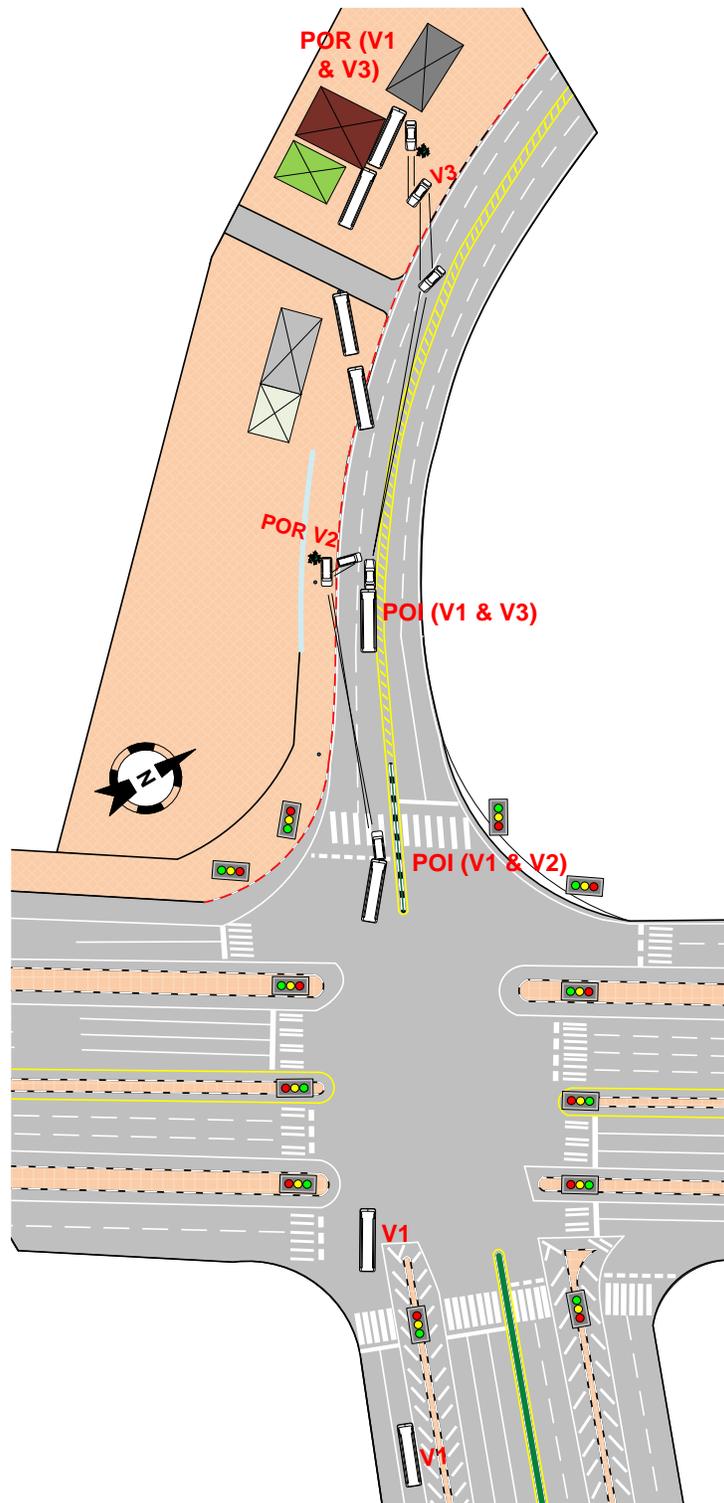


Figure 2 Schematic sequence of the crash

During the investigation, TARC interviewed with some passengers of bus and van, manager of the bus company, investigating police officer and witnesses. According to one of the bus passengers, the bus started its trip at 20:00 pm, 26th May 2015, from Udonthani and stopped at Nongbualamph and Loei province to pick up the passenger. The victim added that, during the trip the bus encountered some mechanical problems and stopped two times. When the bus was

passing through the mountainous area, about 10 km before the crash scene (palad intersection), the driver experienced a problem in changing gear and suddenly stopped with its engine off. The driver continued driving and when it reached to the downhill section (about 900 m before crash scene), the driver tried to use low gear but he couldn't success and the brake malfunctioned. The bus driver informed the passengers about the brake failure and warned them to move to the right side of the bus and hold tight. At the intersection, the bus rammed two vehicles and stopped at roadside at about 122 m from the first POI.

Out of 20 occupants inside the bus, 2 were dead and 18 sustained injury. One passenger of the van was dead and 7 suffered serious and slight injuries in this accident. There were 2 occupants in the SUV, and both of them had minor injury. The summary of the injury information of crash victims is shown in **Table 1**.

Table 1 Summary of Crash Victims

Vehicle	Fatality	Severe Injury	Moderate Injury	Minor Injury
V1-Bus	2	7	3	8
V2-Van	1	5	-	2
V3-SUV	-	-	-	2

Vehicle Information

Bus

Vehicle number 1, the bus, was a six wheel bus, white-blue in color, manual transmission, and rear-wheel driven. The bus dimensions were 3.3 m high, 12.2 m long and 2.30 m wide. The wheelbase was 6.35 m. The original structure of the bus and the dimension details are shown in **Figure 3 & Figure 4**. The bus was manufactured in 1981 and the last maintenance was done in December 2014.



Figure 3 Original Structure of the bus

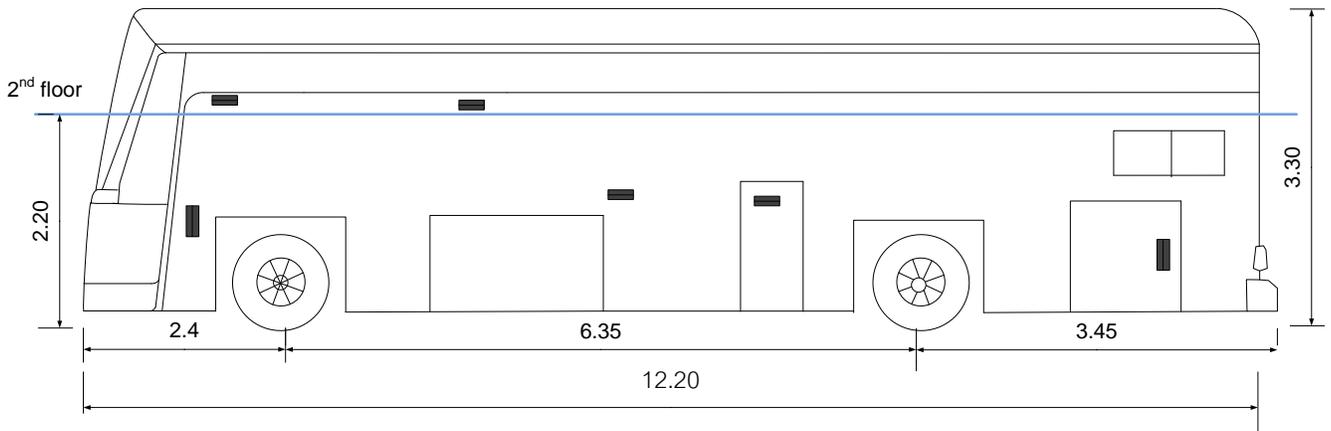


Figure 4 Dimensions of the bus

There were a total of 31 passenger seats with seat belt installed. The seating configuration consists of 10 rows with 20 seats on the right side and 8 rows with 9 passenger seats on the left side of the bus. Two seats were in the front part of the bus for the driver. Two point lap seat belts were installed in the bus (**Figure 6**) but the passenger did not wear a seat belt at the time of the accident. There were 4 doors, including an emergency door, in the bus, two on each side. One side of the seat was fixed by a hook on the bus body near the walkway, while another set of bolts was fixed into the sidebar. The seating configuration of the bus and the position of doors is shown in **Figure 5**.

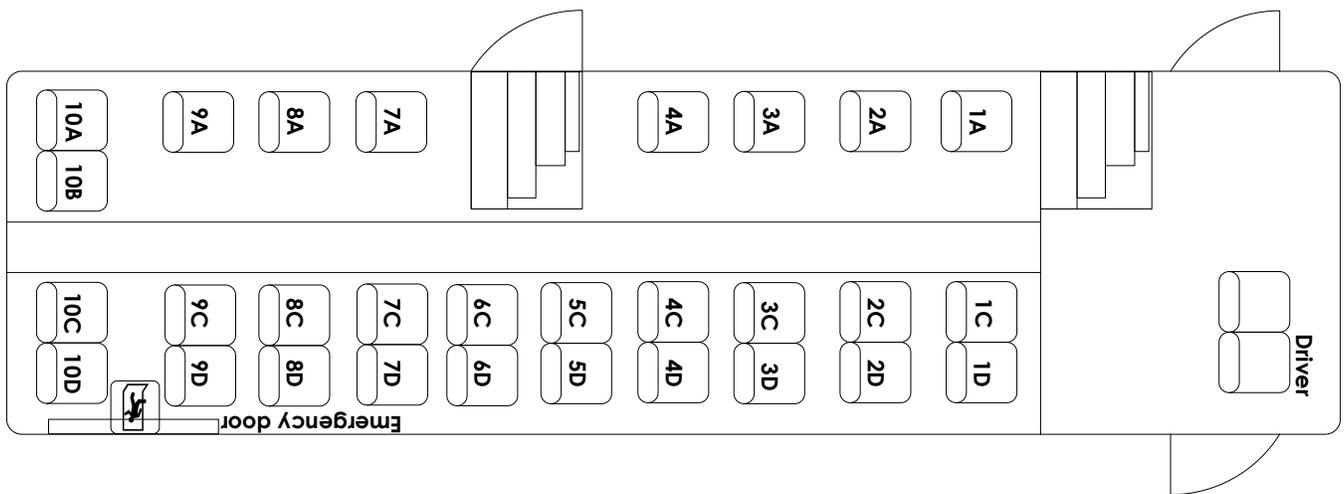


Figure 5 Seating Configuration



Figure 6 Seat installation and seat belts

The bus belonged to a tour company named “Chakapong tour Co., Ltd.” that runs intercity double decker VIP bus in Thailand. It can be seen from previous accident data that each year from 2012 to 2015, there have been an accident of the bus that belongs to this company. In 21 April 2012, there was a bus accident due to brake failure killing 6 people and 25 injured in Phrae Province. In 8 April 2013, another accident occurred due to brake failure and running off road in loei Province where 5 people died and 51 injured. Similarly, in 17 October 2014, a bus plunged into the ravine area due to speeding and poor visibility, killing one people and 18 injured in Phrae Province.

Damages of the bus

The front part of the bus was heavily damaged due to impact with the houses. After running off the road, the bus intruded into the house so the left front side of the bus was observed to be more damaged by the impact. The roof and the supporting pillar of the second floor in left side were collapsed as can be seen in **Figure 7**. **Figure 9** shows the position of the bus after the impact with house. The concrete beam, slab and roof of the house intruded causing the severe damage in front part.

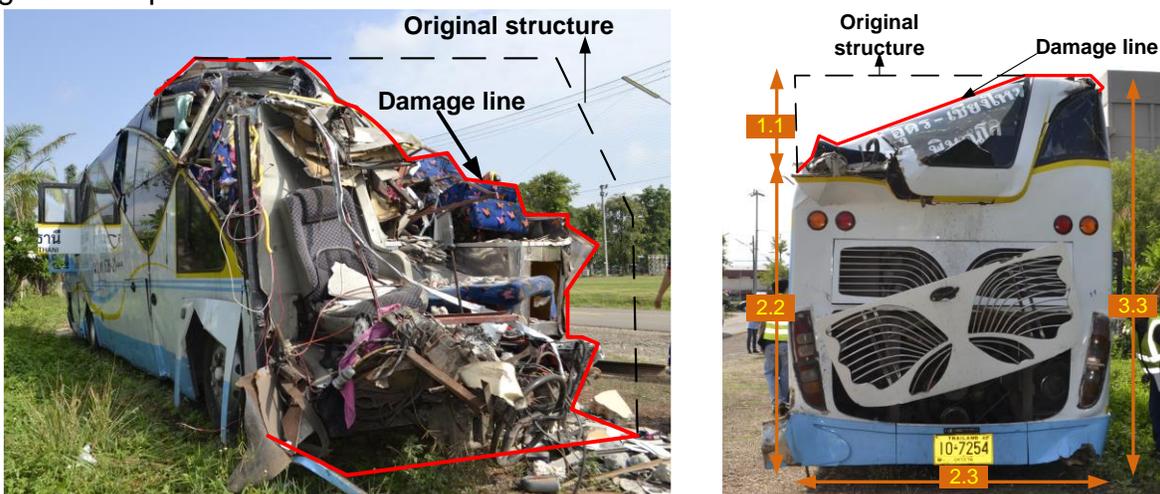


Figure 7 Front and rear view of the bus

TARC measured the frontal deformation of the bus and found that the damage extended up to 3.37 m in the roof of the bus. The deformation at the first and second floor was 0.97 m and 1.74 m respectively. The roof at left side of the bus touched the second floor as can be seen in **Figure 7**. The overall length of the bus after the crash was 11.40 m. The deformation on the front part of the bus is shown in **Figure 8**.

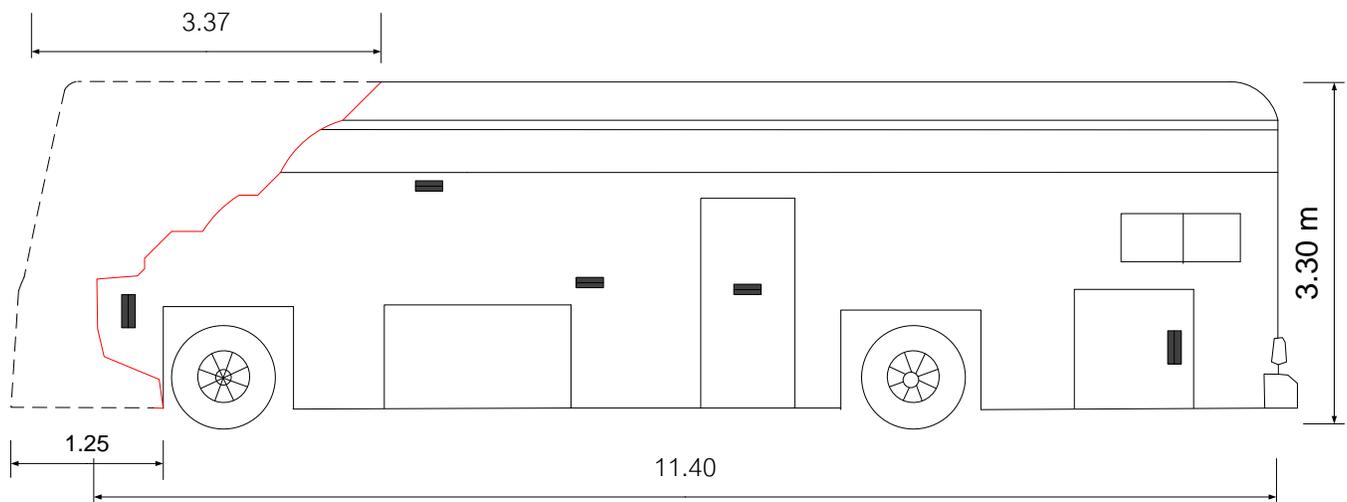


Figure 8 Deformation on the front part of the bus (left side view)



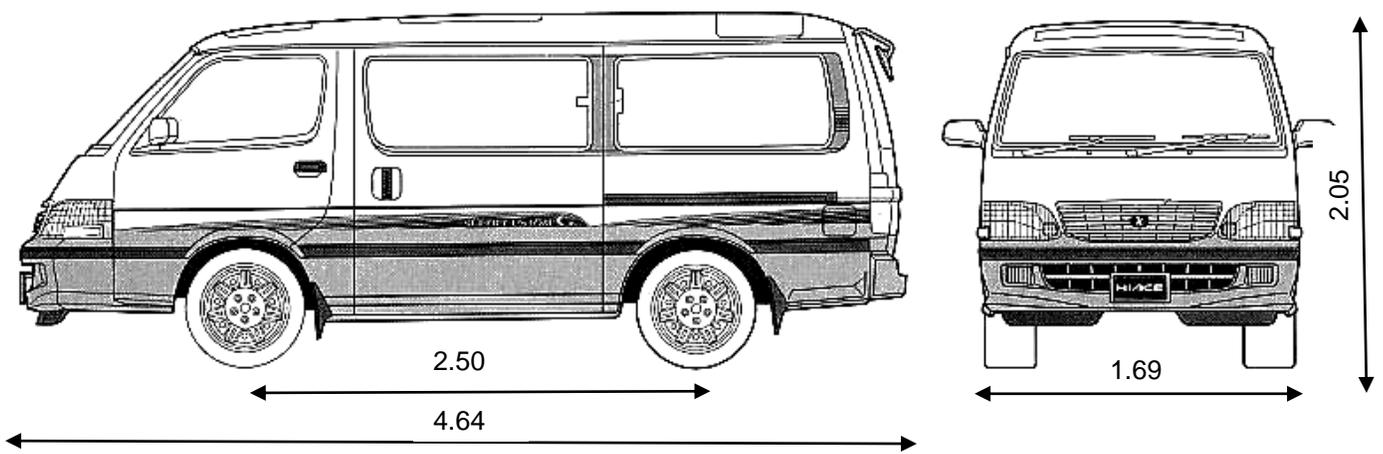
Figure 9 Intrusion of frontal part of bus into the house



Figure 10 Damaged bus

Van

The van (V2) was a 1995 Toyota Hiace 2.5 Manual window van, diesel engine, white in color. The engine type was water cooling serial 4 cylinder OHC turbo. The original dimension of the van was 4.64 m long, 1.69 m wide and 2.05 m high.



There were a total of 8 occupants inside the van. In front, there was a driver and one passenger. Rest of the passengers were sitting at the back seat of the van. 5 of the passengers were school children and 3 were adults including driver. In total, there were 12 seats inside the van, two in front and 10 at the back. 3 point seat belt was installed in the front two seats while no seat belt was observed to be installed at the back seat. During the crash, the seats were unhooked and scattered inside the van (**Figure 12**) and also first row seat (no.2, 3 & 4) (**Figure 11**) ejected out of the van together with the passenger (**Figure 14**). One of the passengers seating in the first row (no.3) ejected out and died on scene. At the time of accident, the driver was using seat belt, while the front passenger was not using seat belt as shown in **Figure 13**. According to the interview with front passenger, he was holding the handrail when the bus impacted with the van. During the investigation, it was observed that the front passenger's seat belt was strapped behind the seat.

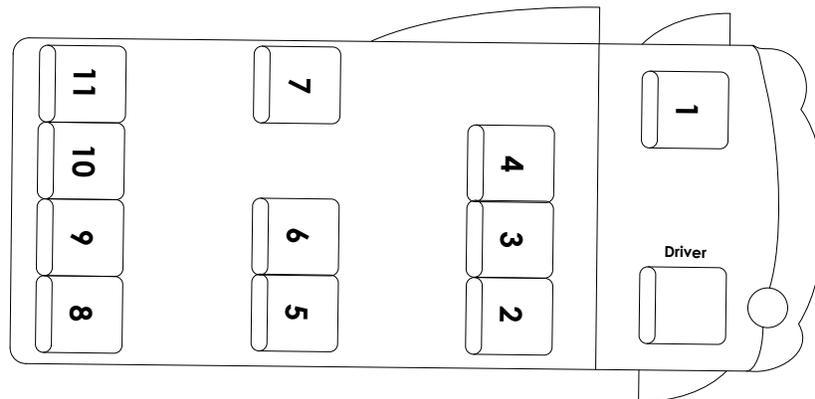


Figure 11 Seat configuration of the van



Figure 12 Scattered seat inside the van



Figure 13 3-point seat belt at front seat

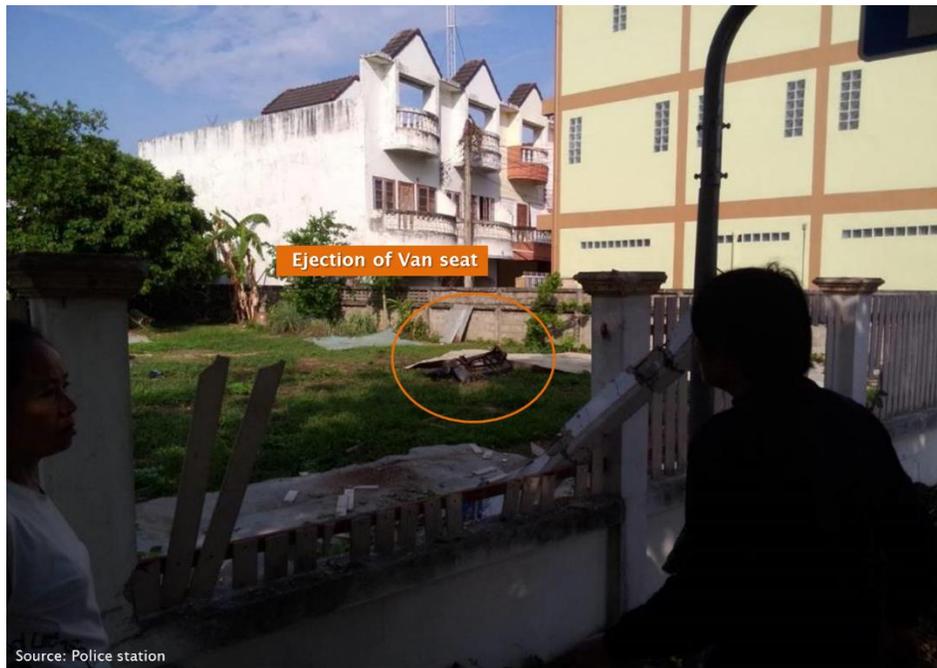


Figure 14 Ejected seat from van near the crash scene

Damage of Van

Heavy damages were observed in rear and right side of the van as shown in **Figure 15 & Figure 16**. The deformation at the rear side was due to impact by the bus while the deformation in the right side was due to collision with the roadside objects (tree, sign post and electric pole). In addition, the van had some damage in front part as well. The wind shield was broken and the driver's door was damaged by the crash.



Figure 15 Van damage

After the impact with the bus, the van lost control and hit the tree, sign post and electric pole, hence there were three distinct deformation on the right side of the van (**Figure 16**). The maximum deformation by the tree and electric post was 25 cm and by the sign post was 15 cm. The deformation was 14 cm throughout the rear part. Diagram showing the deformation is shown in **Figure 17**.

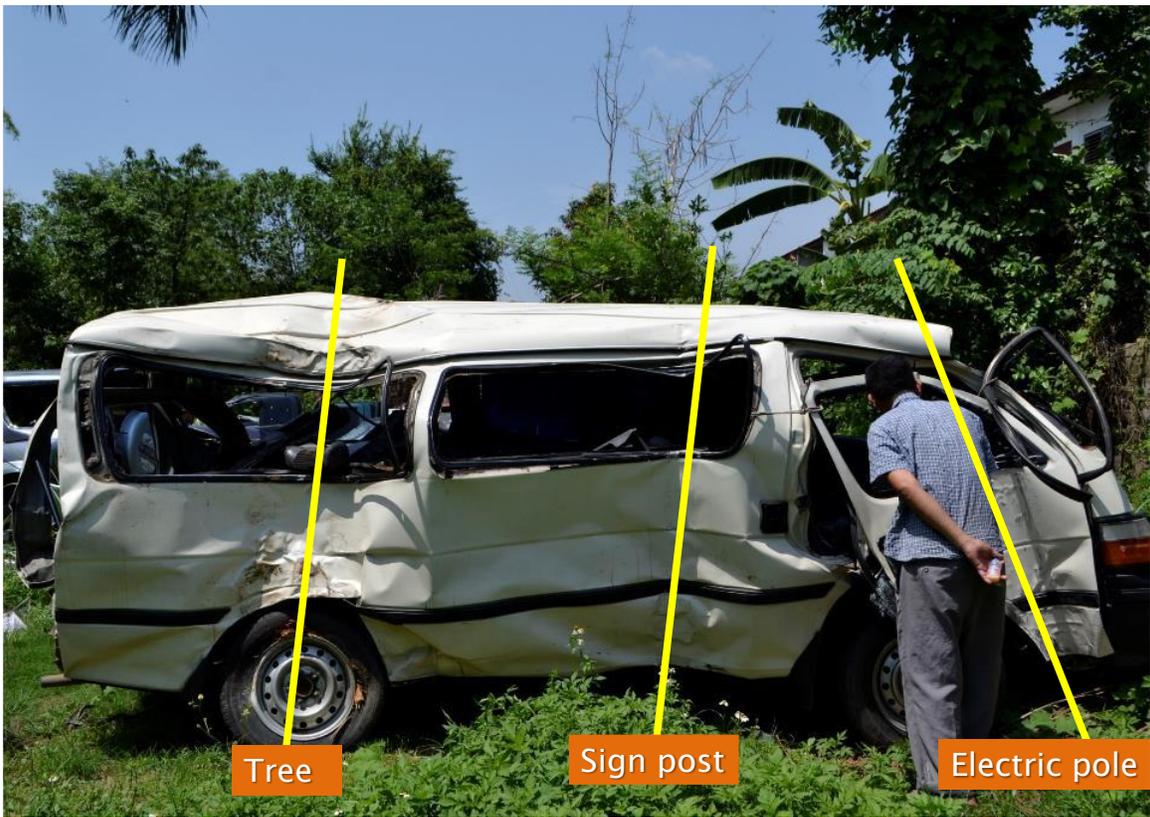


Figure 16 Deformation in right side of van

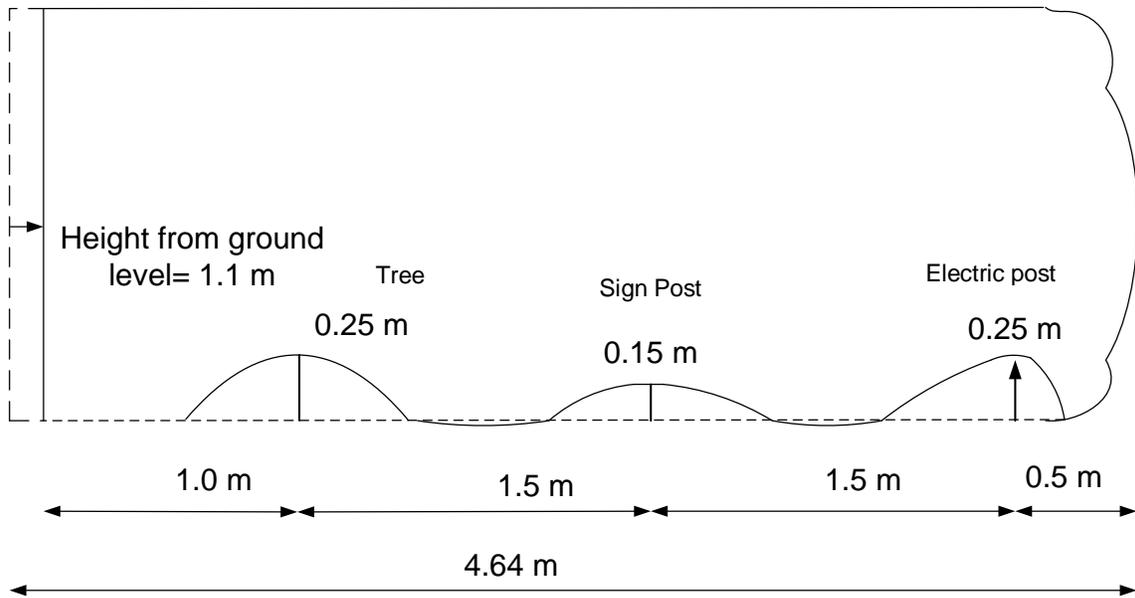


Figure 17 Deformation of the van

Sports utility vehicle (SUV)

SUV (V3) was a Toyota Hilux 3.0 D, Sports Rider, 3000 cc, blue grey in color. The original structure of SUV is shown in **Figure 18**. The dimension of SUV was 4.30 m long, 1.50 m wide,

1.70 m high and 2.80 m wheelbase. Seat belt was installed in the front seat of the SUV and both driver and front passenger used seatbelt at the time of accident.



Figure 18 Original Structure of SUV

Damage of SUV

SUV had major damage at rear end due to impact by bus. The deformation was measured to be 23 cm at the height of 45 cm from ground level. Rear window and rear bumper were broken. No significant damage was observed in frontal part of the SUV.



Figure 19 Damage of SUV

Driver's Information

The bus driver was 44 years old male. He was granted a driver license of Type 4 since XXX. The existing license has been validated for the period until 2017. The driver had 10 years of experience for driving a bus. The driver started his trip at 8:00 pm from Udonthani and pickup passenger at Nongbualamphu and Loei province. According to the bus company manager, normally the bus driver used to get changed in Phitsanulok province but in this case, the driver wasn't changed. The driver drove for about 10:30 hours continuously from origin to the crash scene. According to the interview with the bus driver's wife, the driver was not familiar with the road and bus both. Normally, the driver used to use the route from Nakhonphanom to Chiangrai.

Highway Information

The bus was approaching from highway no. 11 and intersects the Asian highway 1. The crash occurred on the west approach of Phakhan Intersection in highway no. 1019. The intersection is signalized intersection. At the crash scene, the road is a straight, levelled section, however the highway no. 11 has 3% downhill slope for about 820 m before the intersection approach as shown in **Figure 20**.



Figure 20 Highway information

Before the crash, the bus was travelling in highway no 11, 2 lane in each direction. At the intersectional approach, the bus used left turn lane, which was 2 lane with 3.34 m lane width. **Figure 21** shows the Approach of the intersection from hwy. no 11.



Figure 21 Approach of intersection from hwy no.11

The bus collided with the van at the beginning of Highway no 1019 leaving the intersection as shown in **Figure 22**. It has 3.0 m wide outer lane and 3.3 m wide inner lane. The width of the footpath is 4.5 m in both direction. The road has a 1.50 m wide raised median. The cross section of the road at POI between bus and van is shown in **Figure 23**.



Figure 22 Highway information

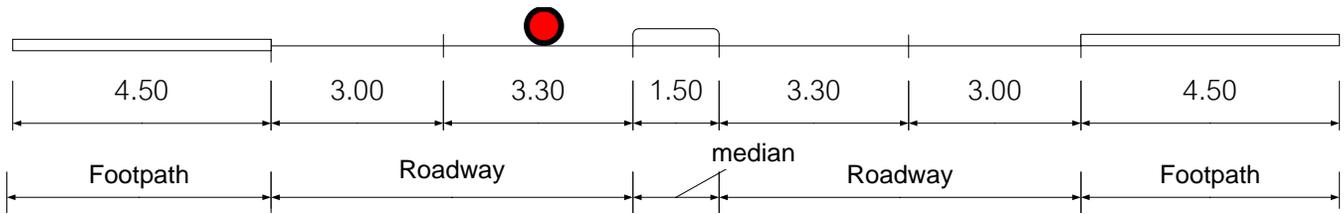


Figure 23 Cross- section of the road at POI between bus and van

After the bus hit the van, the van lost control and hit the roadside tree and electric post. **Figure 24** shows the cross-section of the road at POI between van and tree. The road has 3.0 m wide outer lane, 3.3 m wide inner lane and 6.0 m footpath. The tree is located at 1.8 m far from the edge of the pavement. The median is undivided types in this section.

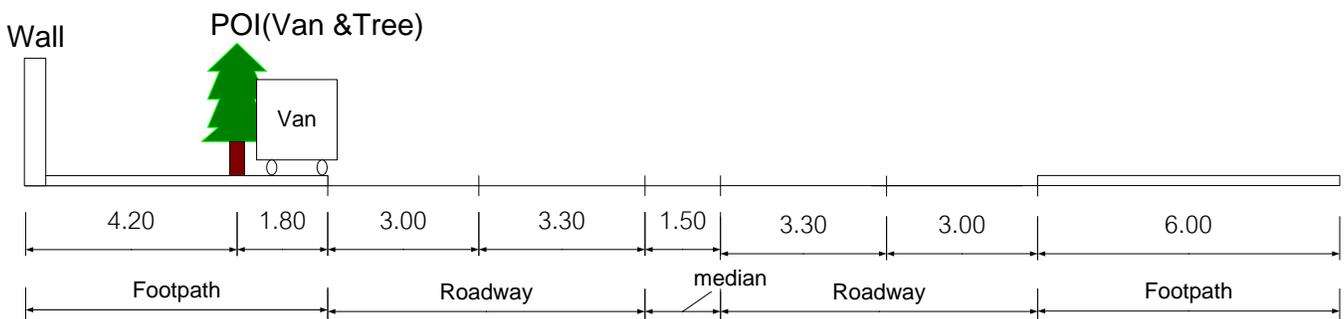


Figure 24 Cross section of the road at POI between Van and roadside tree

Figure 25 shows the cross section of the road at POR of bus and SUV. The bus rested at 10 m far from the edge of the roadway. The road has 3.0 m wide outer lane, 3.3 m wide inner lane and 1.50 m wide median.

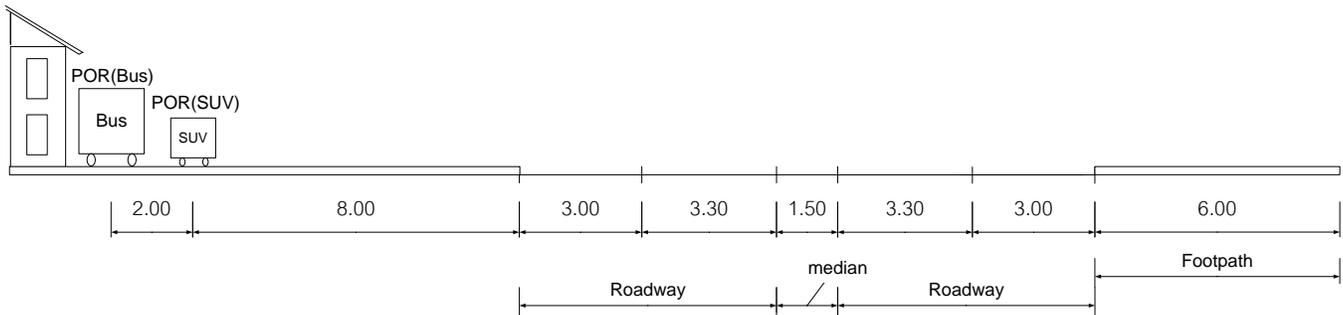
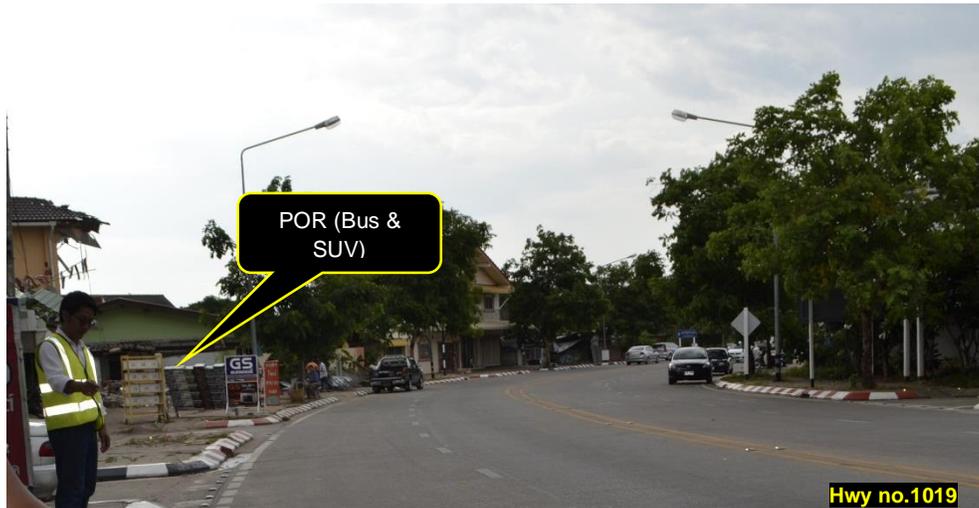


Figure 25 Road section at POR of bus and SUV

Physical Evidences

There were several physical evidences present in the crash scene that guided TARC team to determine the pre-crash, crash and post-crash motion of the bus, van and SUV. Also, the CCTV footage was examined thoroughly to find out crash pattern, speed of the bus and others. The physical evidences associated with the crash events can be categorized in three parts, pre-crash, crash and post-crash, and hence presented below:

Pre- crash

As mentioned in earlier section, the bus was approaching the intersection using left turn lane while the Van and SUV were approaching from thorough lane. The SUV was ahead of the van. The bus continued straight in order to go to Hwy no 1019. The pre-crash path of the vehicles is shown in **Figure 26**.

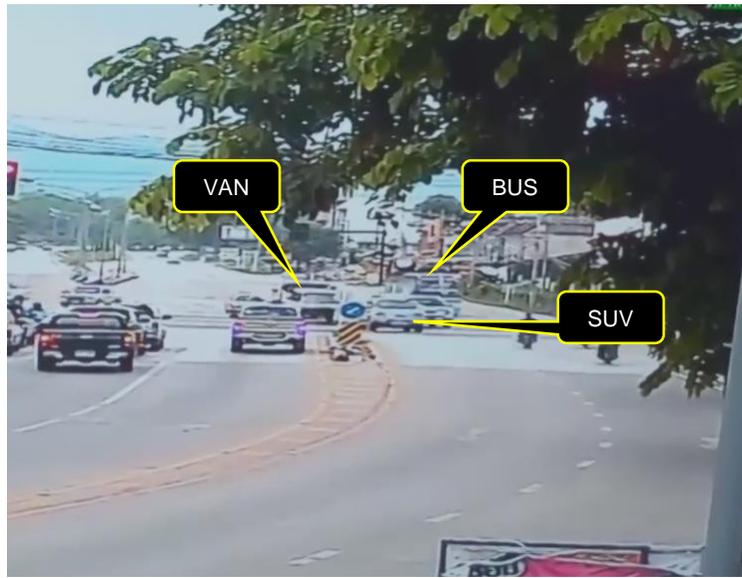


Figure 26 Pre-crash position of vehicles

Crash

The bus collided with the van at the zebra crossing line as can be seen in the footage (Figure 27). There was a deep scratch on the pavement and a fresh skid mark made by the van's tire at the zebra crossing line as shown in Figure 28. Based on these evidences, TARC determined the point of impact of bus and van. POI was taken as a reference point to measure other evidences present in the crash field.

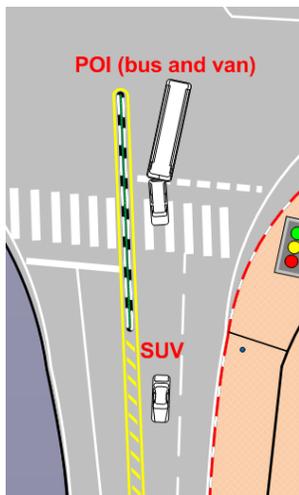


Figure 27 POI between bus and van

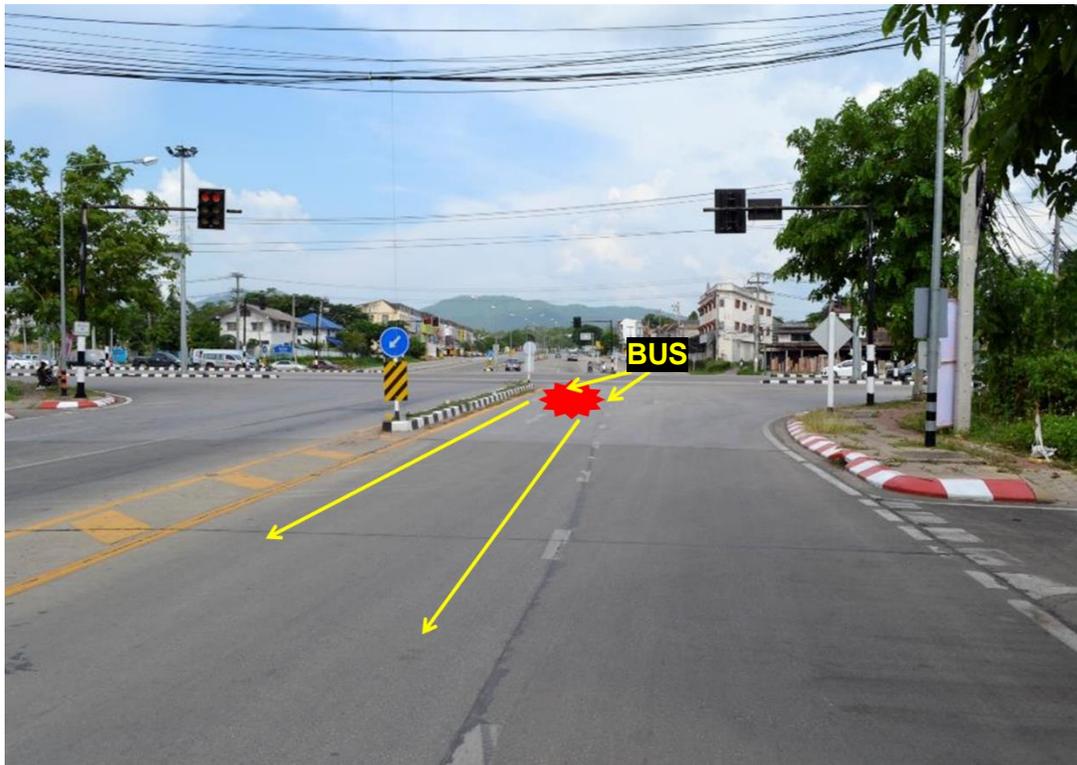


Figure 28 Evidences showing the POI of bus and Van

After the first impact, the van lost its control, rotated and hit the roadside objects (electric pole and tree), and deflected back to the roadway (**Figure 29**). The right side of the van collided with the tree. There were several evidences presented in the crash field. A long tire marks in different orientation starting from the first POI to the roadside tree, shows that the van rotated for about 50 m anticlockwise before hitting the tree **Figure 31**. **Figure 30 & Figure 32** show wreckage of the tree and the damaged electric poles. The van rested near the tree, at about 52 meter from first POI.

Meanwhile the van hit the roadside objects, the bus collided with the SUV as can be seen in **Figure 29**. Second POI between bus and SUV was about 55.70 m far from the first POI.

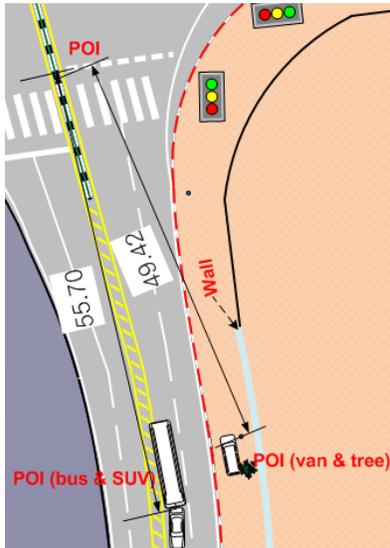


Figure 29 POI between bus and van, and rotation of van before impact

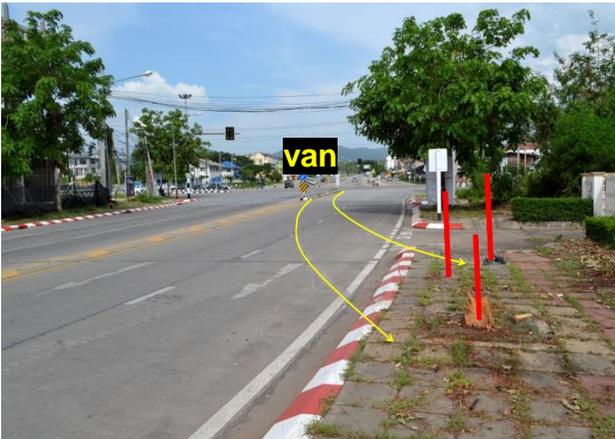


Figure 30 Wreckage of electric poles and tree (collided by van)



Figure 31 Tire marks of van on the curb



Figure 32 Damaged electric poles, trees and POR of van

Post-Crash

After the impact with SUV, the bus run off road at about 75 m far from the POI. **Figure 33** shows the post-crash motion of bus and SUV before coming to rest. The bus and SUV rested at about 121 m far from POI, 8 m far from the edge of the roadway. The bus hit the electric poles and houses before coming to rest.



Figure 33 Post crash motion of bus and SUV

Tire marks of bus were imprinted on the curb, indicating the point where the bus left the roadway as shown in **Figure 34 & Figure 35**.



Figure 34 Tire marks showing the bus running off the road



Figure 35 Tire marks of bus directed to the house

Figure 36 shows the post-crash path of SUV after the impact. The SUV lost control and run off road at about 60 m from second POI. There were several scratches and tire marks on the roadway from second POI that runs to POR, which helped the team to find out the post-crash motion of the SUV. SUV rested in a rotated position near POR of bus.

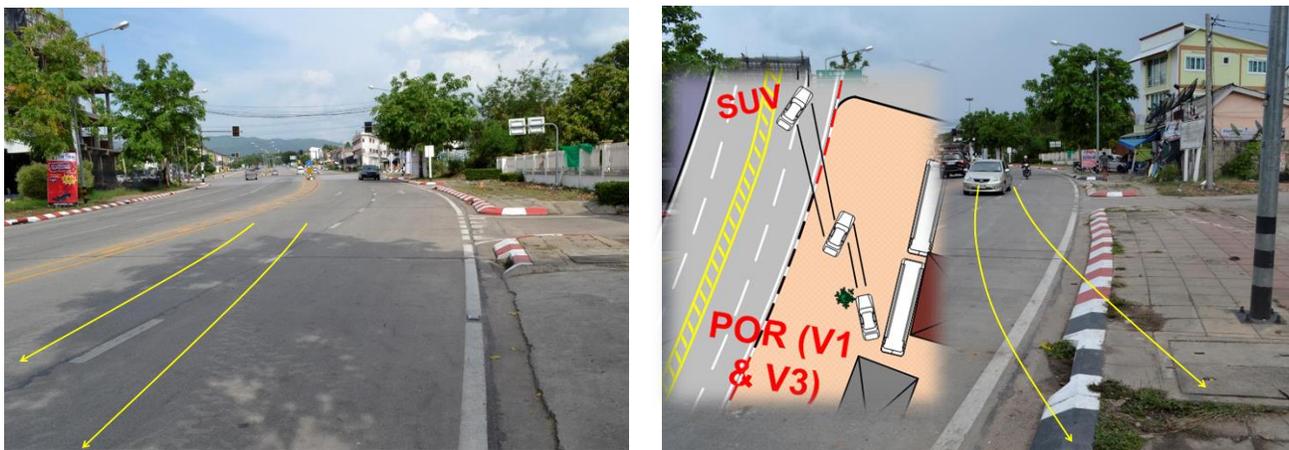


Figure 36 Post crash path of SUV

Injury Information

There were 3 fatalities, 12 severe injuries, 3 moderate injuries and 12 minor injuries reported from this crash. **Figure 37** shows the diagram of seating position of the occupants by severities in bus, van and SUV. Degree of severity are indicated by different colors. The red color shows

fatalities, orange shows severe injuries, yellow shows moderate and green shows the minor injuries. Similarly, unspecified occupants are shown in blue and white indicates empty seats.



Figure 37 Injury Information and seating position of occupants

There were 20 casualties from the bus. The four passenger sitting in the front left row of the bus sustained severe injury resulting 2 fatalities. It is because the bus collided to the houses with its left front side and had severe damage. Majority of the passengers in right row received only minor injury, however, the driver, who was in right front, was severely injured as illustrated in **Figure 37**. In right row, the seating position of four passengers were unknown, among them, one was severely injured.

Similarly, among the 8 occupants inside the van, one passenger, who was sitting in the middle seat of front row (no.3) died in this accident as shown in **Figure 37**. During the investigation, it was observed that the front row seat (no.2, 3 & 4) was ejected together with the passengers. All passengers including

driver of van received severe injury except front passenger and a passenger sitting in the middle seat of second row (no. 6).

There were 2 occupants inside SUV and both of them sustained minor injury only.

The detail of injuries information of all casualties is shown in **Table 2**.

Table 2 Details of Injury information of casualties

Bus :20 Casualties						
Person	Seat	Gender	Age	Level of injury	Description	AIS
1	1A	M	44	Fatal	- Multiple Injury	6
2	2A	M	34	Fatal	- Multiple Injury	6
3	3A	F	19	Severe	- Severe head injury	5
4	4A	F	21	Severe	- Severe head injury - Brain edema	5
5	8A	F	24	Severe	- Fracture of forearm	3
6	9A	M	41	Severe	- Blunt chest injury - Pneumothorax - Pulmonary contusion - Blunt abdominal injury	4
7	10A	M	36	Moderate	- Multiple facial injury	3
8	1C	M	28	Severe	- Fracture carpal bone	3
9	5C	F	N/A	Minor	- Muscle strain	1
10	8C	N/A	N/A	Minor	N/A	1
11	9C	M	N/A	Minor	N/A	1
12	1D	F	N/A	Minor	N/A	1
13	8D	N/A	N/A	Minor	N/A	1
14	9D	M	N/A	Minor	N/A	1
15	10D	M	20	Minor	- LW at face	2
16	Driver	M	44	Severe	- Severe head injury - Blunt chest injury	5
17	Unknown	M	58	Severe	- Mild head injury - Open skull fracture	5
18	Unknown	M	16	Moderate	- Mild head injury	3
19	Unknown	M	42	Moderate	- Blunt abdominal injury	3
20	Unknown	M	N/A	Minor	N/A	

Van : 8 Casualties						
Person	Seat	Gender	Age	Level of injury	Description	AIS
1	1	M	8	Minor	- LW at left ear	2
2	2	M	61	Severe	- Multiple ribs fracture	4
3	3	F	59	Fatal	- Multiple injury	6
4	5	F	7	Severe	- Artery and ligament injury of right leg	4
5	6	M	7	Minor	- Mild head injury	2
6	7	F	11	Severe	- Fracture left femur	4
7	10	F	7	Severe	- Severe head injury	5

8	Driver	M	59	Severe	- LW at right leg - Right knee dislocation - Right iliac bone fracture - Nerve depression	4
---	--------	---	----	--------	--	---

SUV : 2 Casualties						
Person	Seat	Gender	Age	Level of injury	Description	AIS
1	1	F	57	Minor	- Muscle strain	1
2	1	M	57	Minor	-Abrasion wound on right leg	1

LW: laceration wound

Accident Contributing Factors

Human factor

Long Hours of Driving

The driver started his journey from Udonthani at about 20:00. The crash happened in the early morning, at around 06:30. He had been driving for roughly 10.5 hours before the crash occurred. No alcohol related to driving was found and from medical reports. The graphic chart of driving hours is shown in **Figure 38**.



Figure 38 bus travelling hour

Unfamiliar to road and bus

According to the bus driver's wife, the driver was not familiar to this route and bus both. She added that it was their first time in that road.

Vehicle factor

Brake System on Downhill

Driving on a long distance of mountainous section requires high skills of driving maneuver, especially for heavy vehicles which are equipped with an air brake system. Generally, the mechanism of air brake system starts by taking filtered air from the atmosphere, compressing it, and keeping it in high-pressure reservoirs. When applying the brakes, this high pressure air is routed to the operating cylinders on the brakes, which actuate the braking hardware and slow the vehicle (Wikipedia, 2009). The air brake system used for heavy vehicles is separated into two parts, the supply system and the control system. While the engine is working, the compressed air is routed through the air compressor system and stored in the reservoir. When the driver presses on the brake pedal, the supply line from the trailer brake circuit receives air from the air tank. However, when applying the brakes more frequently, it is possible that the engine could not supply the compressed air into the tank as it used to and cause a shortage of air in the system. In this case, the bus traveled on the hilly section for long distance before the

bus driver found the error in the brake system while on the downhill section. The driver tried to change to lower gear but could not success.

There is a possibility of air leaking. However, if detected by the valves, the entire supply system will be shut down automatically. The post investigation could not determine whether this former scenario took place since most of the system was destroyed in the crash.

In addition, there were no reports blaming the awareness of the driver. He was not found drowsy, under the influence of drug or alcohol or inattentive according to passengers and staff statements.

Bus age and condition

The bus was manufactured in 1981, which means the age of the bus is 34 years old. Post-crash investigation shows that the bus mechanical equipment's, frame were old and rusted.

Speed



Figure 39 measurement of Intersection

From the CCTV footage, the pre-crash speed of the bus was calculated. Point A is the stop line of Hwy no.11 at intersection, from where the bus continued straight to Hwy. no 1019 as shown in **Figure 39**.

Time travelled by bus from point A to POI = 3.6 seconds from footage.

Distance from point A to POI = 80 m from field measurement.

Hence, the speed of the bus during the impact was around 80 km/hr.

Injury Contributing Factors

Vehicle factor

Restrain system and seat strengthening

There were 20 passengers sitting in the bus. Out of the total, two (males) were reported to be fatal, seven were severely injured and the rest of them slightly injured. None of the occupants in the bus used seat belts during the accident. The source of injuries of the occupants inside bus was the interior of the bus: broken glass, seat, armrest etc. Similarly, no seat belt was installed at the back of van. And the seat was not properly strengthen which caused the scattering of seat inside the van and even ejection outside. According victims statements, people bouncing on each other and the seats detaching from their position caused harm to the occupants during the event of crash. Also, some occupants ejected together with seat resulting one fatality. So, the main cause of injury inside the van was the poor seat strengthening and restrain system.

Seat belts designed to hold the occupants in place against harmful movements can help significantly reduce this kind of injuries. It is known that the change in an unrestrained occupant's speed in a collision can result in injuries. Generally, if a restraint system is employed, it forces the occupant to change speed while the vehicle is changing speed, thereby lengthening his deceleration time and decreasing the severity of his injuries (TARC, 2008). Additionally, it prevents occupant's ejection and redirects the force from the collision without any serious injury. By using seatbelt, risk to get serious injury is reduced by 40-60% (Napal, 2002). Therefore, the seatbelt is the most important protection device in case of vehicle collisions.

Road and Environment factor

Roadside hazard

After the impact, the van collided with the roadside objects: tree, electric poles and signpost that caused heavy deformation on the van and injured the passenger inside. The passenger ejected out from the van during the impact increasing the injury severity. The roadside objects have the potential to be hit by errant vehicles running off the road. Roadside furniture is generally designed to be located outside of the road. However, it could be life-threatening when hit by errant vehicles. This fact is among the findings of the investigation by TARC (2007) which shows that many errant vehicles and their users experience severe damages and injuries as a result of loss of control, running off the road, and finally hit rigid objects at the roadside area.