RISK AND SAFETY ASSESSMENT

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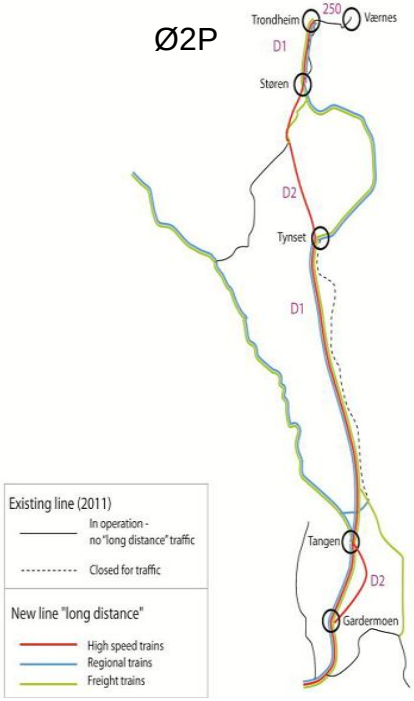
Risk and Safety

- Based on methods in Phase 2
  (*HSR Assessment Norway, JBV 2011)*

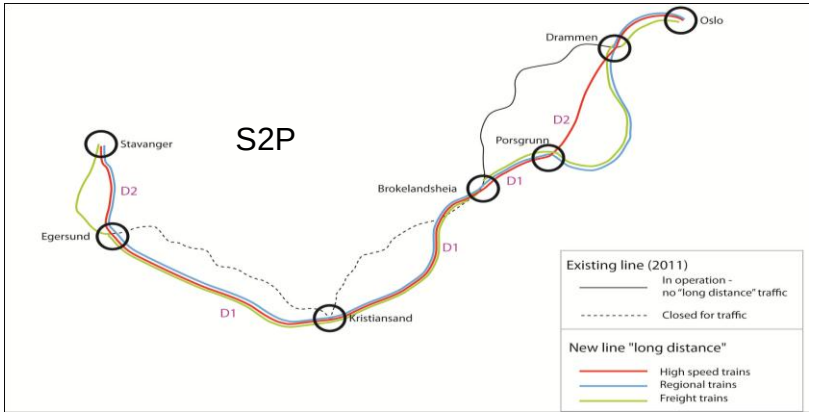
- Results from
  - Oslo - Trondheim, Ø2P
  - Oslo - Stavanger, S2P
  - Oslo - Bergen, H1P
  - Bergen - Stavanger, BS1P

Ø2P

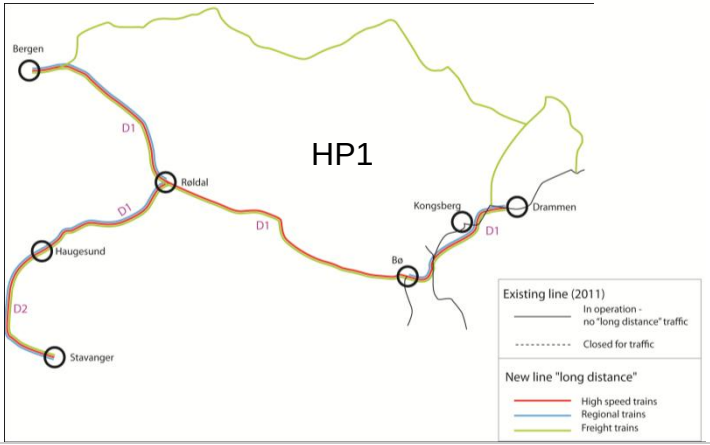


BS1P

S2P

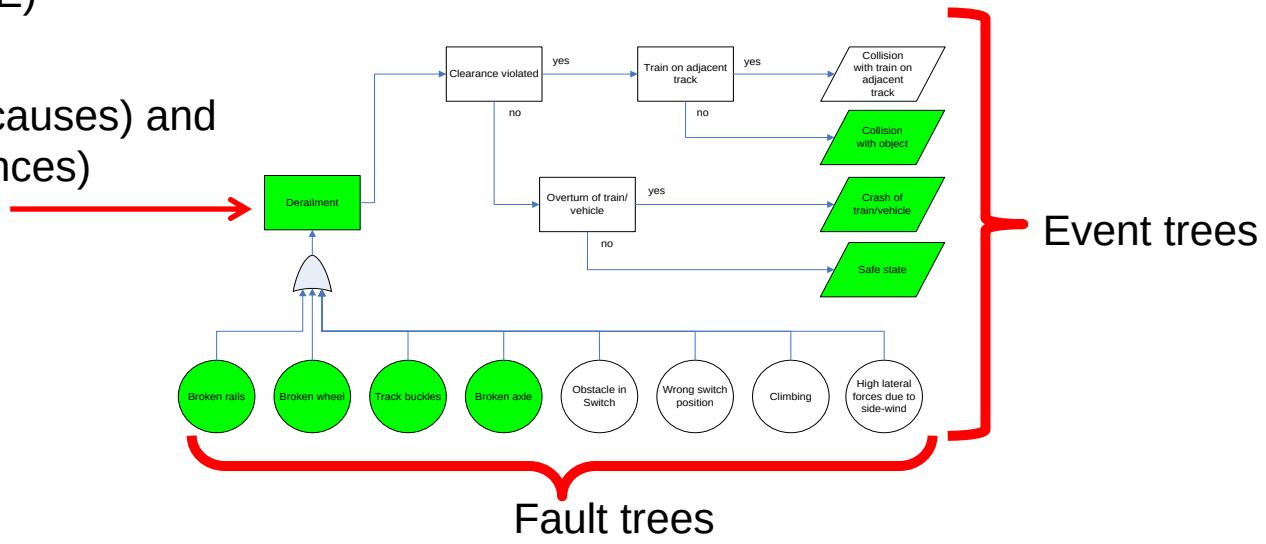


HP1



Risk assessment– method

- Assessment of the high speed line
- Model based on Norwegian and EU statistics from 2006 – 2010
- Type of accidents are based on the ERA-definition for reporting Common Safety Indicators in the EU
- Accident database from UIC (20 countries in Europe) and ERADIS (GE,FR,NO,SE)
- Combined fault trees (causes) and event trees (consequences)

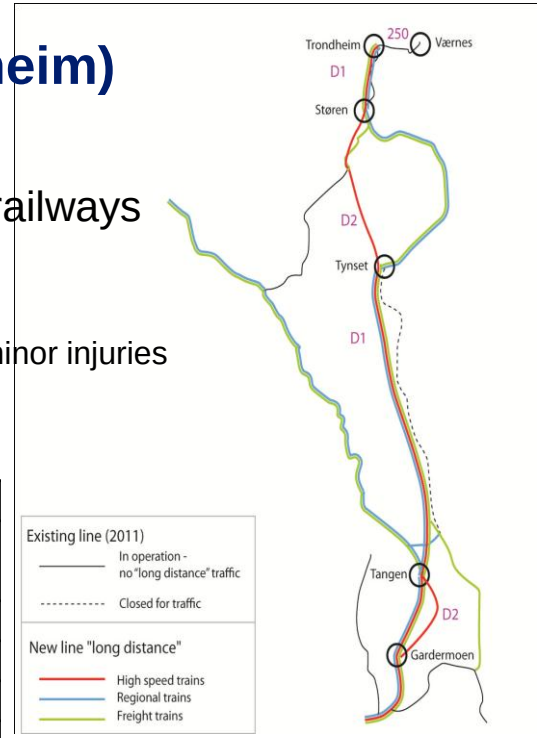


Risk assessment, results , Ø2P (Oslo-Trondheim)

Fatalities per year	2024 Norway	2024 O2P	2024 Norway + O2P
other	4,16	2,44	6,60
passenger	0,32	0,71	1,03
staff	0,31	0,59	0,90
total	4,78	3,74	8,52
with improvement factor	**4,34**	**2,66**	**7,00**

Norway = all conventional railways
O2P = HSR line

1 fatality = 10 major injuries = 100 minor injuries



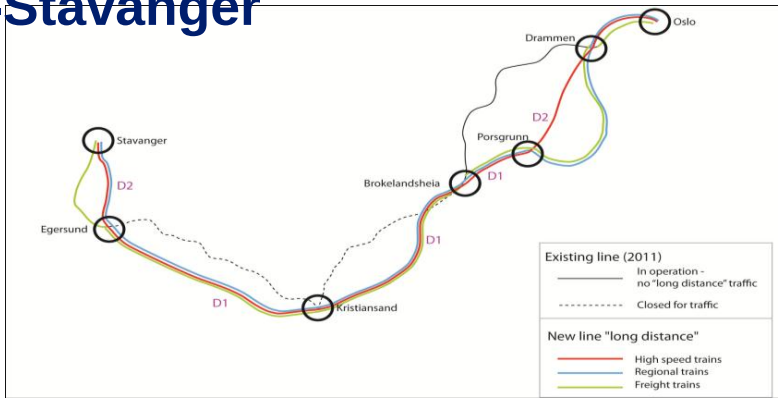
Fatalities per year	2043 Norway	2043 O2P	2043 Norway + O2P
other	4,16	2,84	7,01
passenger	0,32	0,82	1,14
staff	0,31	0,71	1,01
total	4,78	4,37	9,15
with improvement factor	**3,95**	**1,96**	**5,91**

The risk for fatalities / year will increase, but the number of fatalities/ passenger kilometer per year will decrease

Fatalities per year	2060 Norway	2060 O2P	2060 Norway + O2P
other	4,16	3,30	7,46
passenger	0,32	0,94	1,26
staff	0,31	0,83	1,14
total	4,78	5,08	9,86
with improvement factor	**3,75**	**1,53**	**5,28**

Risk assessment, results ‚S2P - Oslo-Stavanger

Fatalities per year	2024 Norway	2024 S2P	2024 Norway + S2P
other	4,16	1,81	5,97
passenger	0,32	0,57	0,88
staff	0,31	0,41	0,71
total	4,78	2,79	7,57
with improvement factor	**4,34**	**1,98**	**6,33**

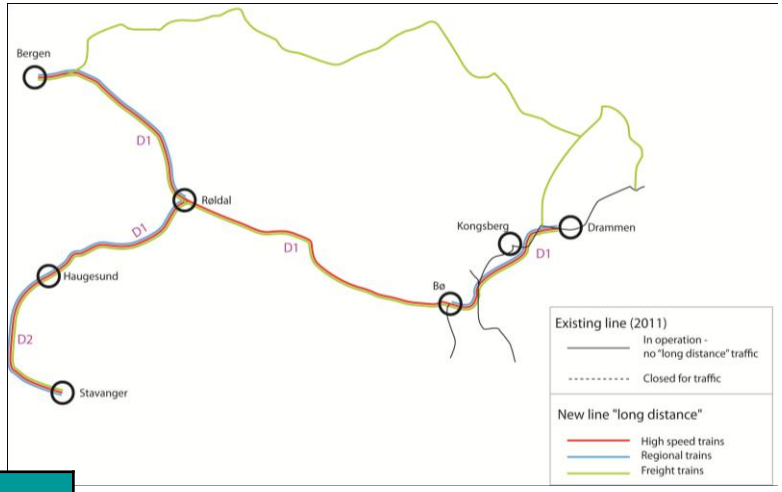


Fatalities per year	2043 Norway	2043 S2P	2043 Norway + S2P
other	4,16	2,06	6,22
passenger	0,32	0,63	0,95
staff	0,31	0,48	0,78
total	4,78	3,16	7,95
with improvement factor	**3,95**	**1,42**	**5,37**

Fatalities per year	2060 Norway	2060 S2P	2060 Norway + S2P
other	4,16	2,31	6,47
passenger	0,32	0,70	1,01
staff	0,31	0,55	0,85
total	4,78	3,55	8,33
with improvement factor	**3,75**	**1,07**	**4,82**

Risk assessment, results , H1P - Oslo - Bergen/Stavanger

Fatalities per year	2024 Norway	2024 H1P	2024 Norway + H1P
other	4,16	3,81	7,97
passenger	0,32	1,10	1,42
staff	0,31	0,84	1,15
total	4,78	5,75	10,54
with improvement factor	**4,34**	**4,09**	**8,44**



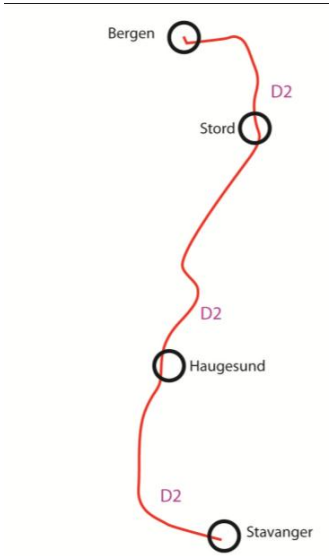
Fatalities per year	2043 Norway	2043 H1P	2043 Norway + H1P
other	4,16	4,35	8,51
passenger	0,32	1,25	1,57
staff	0,31	0,99	1,30
total	4,78	6,59	11,38
with improvement factor	**3,95**	**2,96**	**6,90**

Fatalities per year	2060 Norway	2060 H1P	2060 Norway + H1P
other	4,16	4,89	9,05
passenger	0,32	1,40	1,71
staff	0,31	1,15	1,46
total	4,78	7,43	12,21
with improvement factor	**3,75**	**2,24**	**6,00**

Risk assessment, results BS1P - Bergen - Stavanger

Fatalities per year	2024 Norway	BS1P	Norway + BS1P
other	4,16	0,24	4,41
passenger	0,32	0,16	0,48
staff	0,31	0,03	0,34
total	4,78	0,44	5,22
with improvement factor	**4,34**	**0,31**	**4,66**

Fatalities per year	2043 Norway	BS1P	Norway + BS1P
other	4,16	0,50	4,67
passenger	0,32	0,17	0,49
staff	0,31	0,09	0,40
total	4,78	0,77	5,55
with improvement factor	**3,95**	**0,34**	**4,29**



Fatalities per year	2060 Norway	BS1P	Norway + BS1P
other	4,16	0,55	4,71
passenger	0,32	0,18	0,50
staff	0,31	0,10	0,41
total	4,78	0,83	5,61
with improvement factor	**3,75**	**0,25**	**4,00**

Accident rates

The overall accident rates for high speed railways is estimated to be lower than for conventional train operation. This is due to:

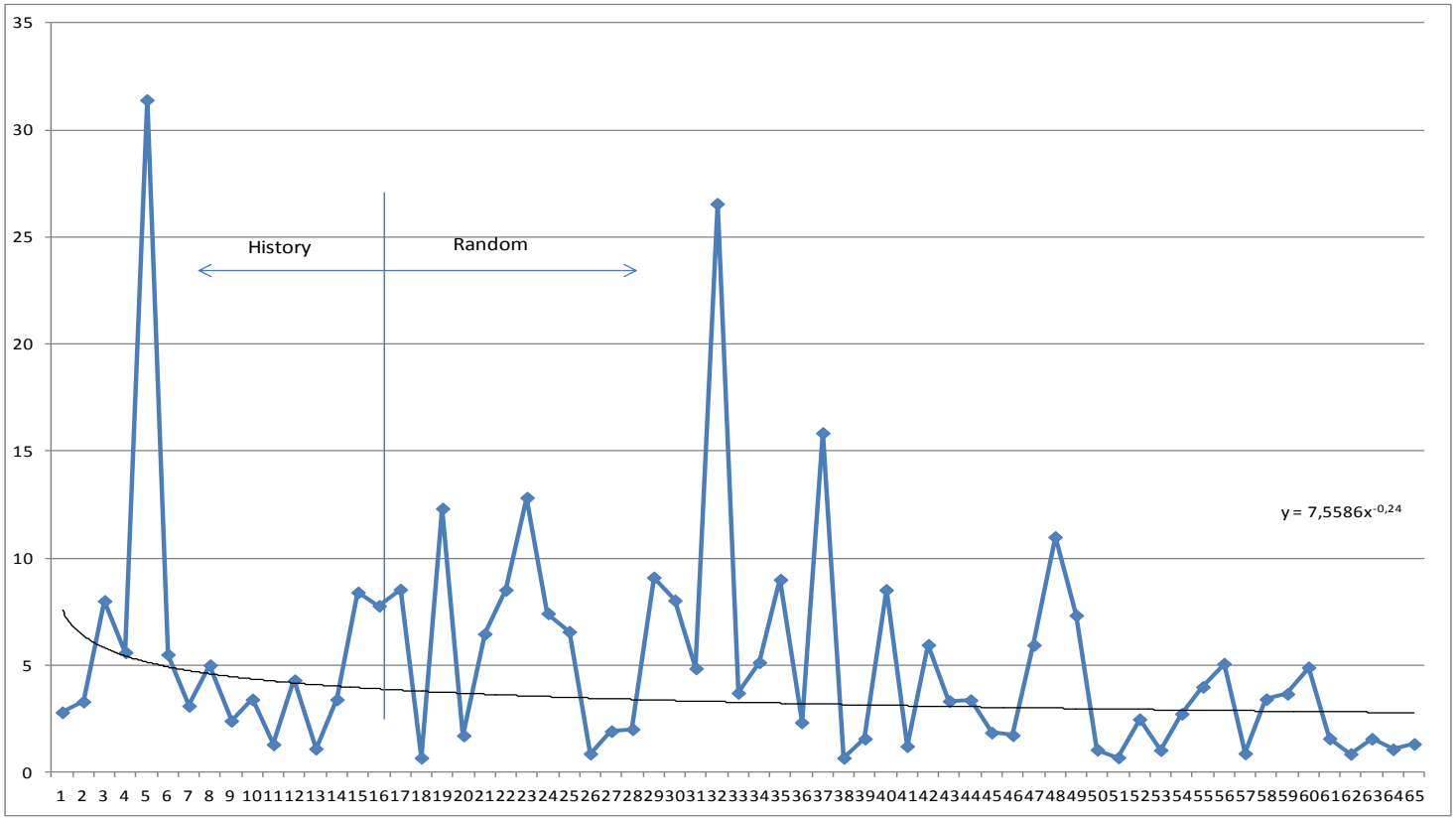
- No level crossing accidents
- Probability for collision train - train substantially lower because of more modern signaling systems and less mixed operation with freight trains
- Probability for collision train – object lower because of separation of track and environment (fences etc)
- Probability for derailment lower because of new or upgraded tracks
- Probability for person injured at platform lower because of less stations and safer boarding process

Accident rates

The reduced accident rate is somewhat compensated by higher impact for the accident scenarios:

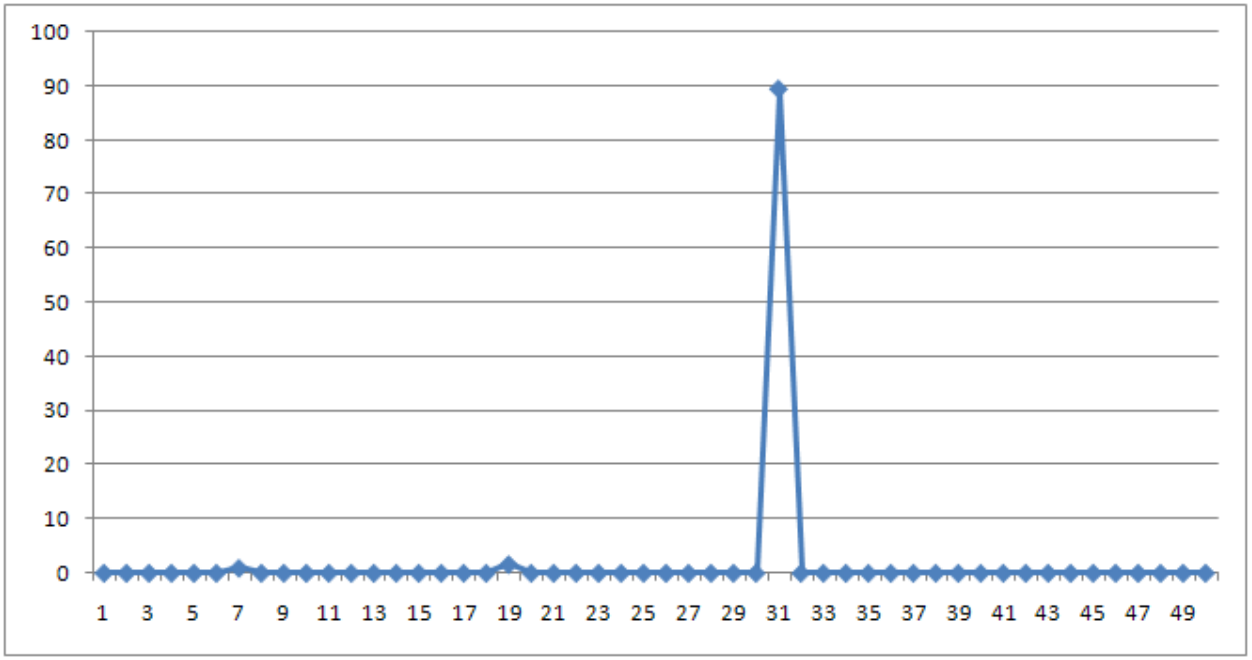
- Collision train - object
- Collision train - train
- Derailment

Distribution of annual fatalities – conventional rail



distribution of annual fatalities – conventional rail

Distribution of annual fatalities – High speed rail



distribution of annual fatalities - HSR

We recommend mitigation actions for continuous improvement of safety, for example:

Collision train - object

- Safety fences
- Obstacle detection via track sensors
- No track maintenance allowed during times in which trains are operating
- Prevention of vandalism
- Monitoring the track
- Safety equipment and methods

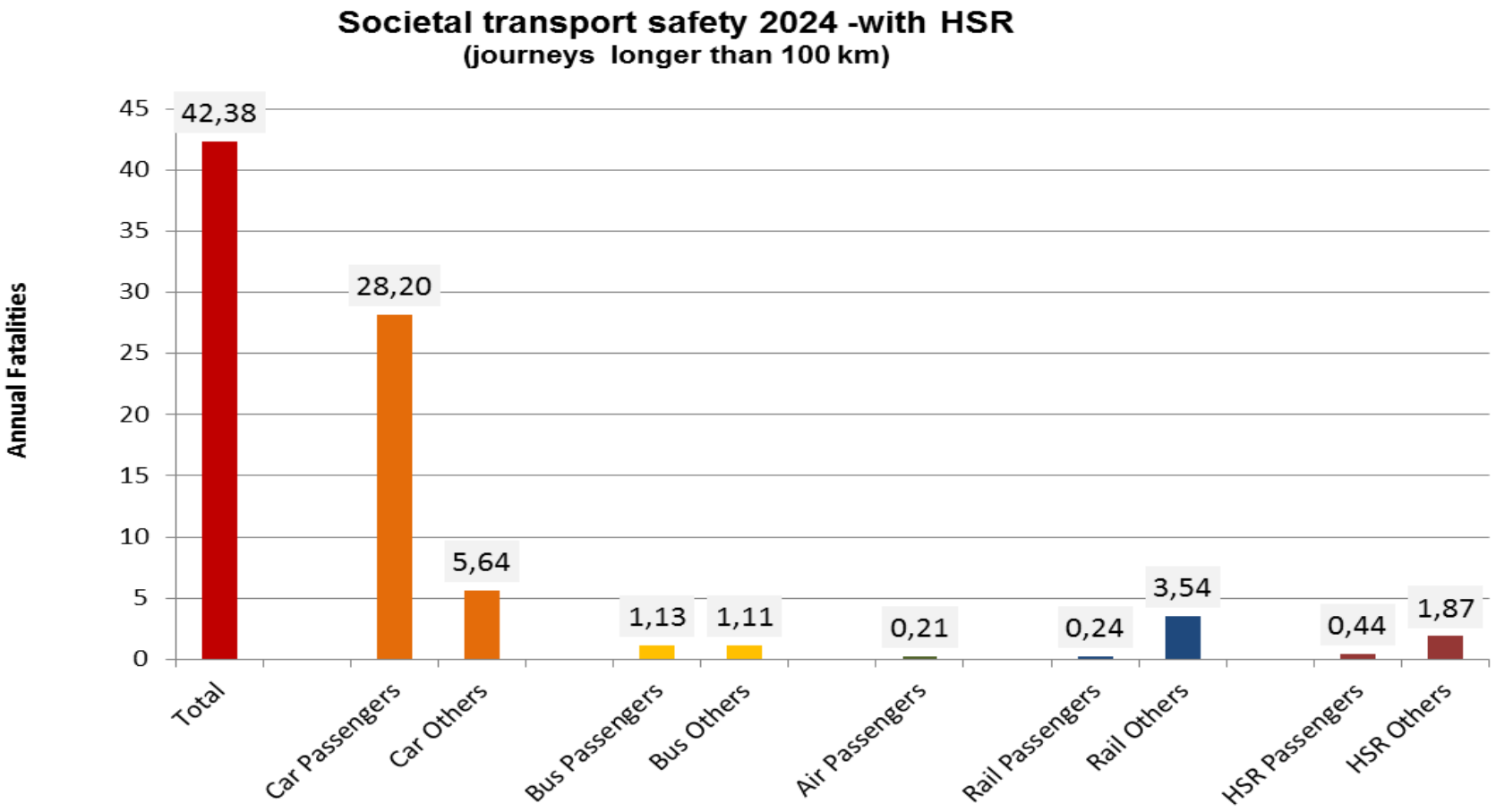
Derailment

- Infrastructure maintenance regime
- Track geometry requirements
- Design of rolling stock
- Monitoring the track

Safety - method

- Scope
  - To calculate the safety changes on the **Norwegian transport system** due to implementation of HSR on four different corridors.
  - To estimate the economical value of these safety changes.
- Data
  - Transported passenger and vehicle kilometres with and without HSR 2024, 2043 and 2060 (Atkins).
  - Change in transported lorry kilometres and train kilometres (Significance).
  - Calculated safety levels for HSR and conventional rail.
  - Calculated safety levels for other transports; car, lorry, airplane and coach.

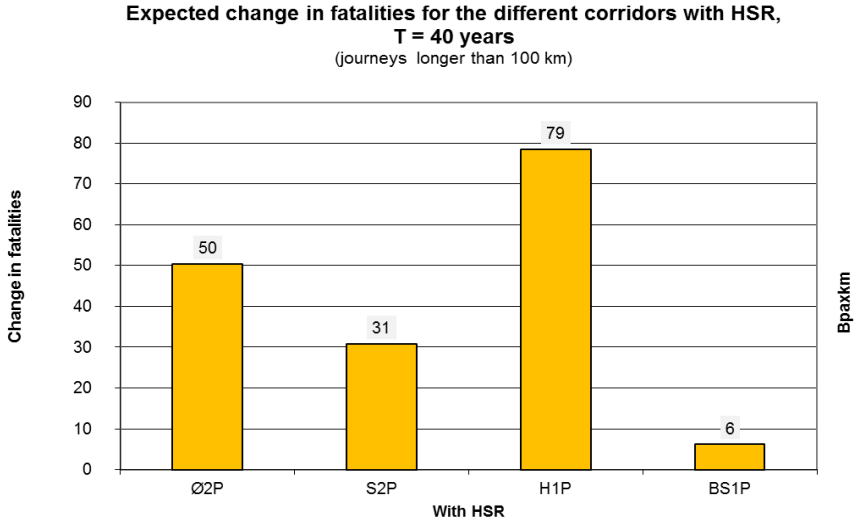
Transport safety, example Ø2P , year 2024

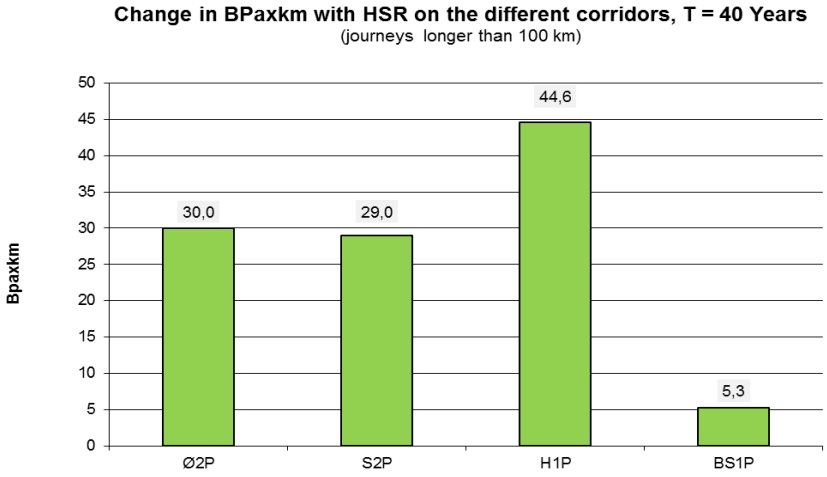


Comment: Today approximately 200 fatalities / year including journeys shorter than 100 km

Safety – results for corridors

- In the yellow diagram the accumulated change in fatalities over 40 years is shown (start 2024).
- In the green diagram the accumulated change in billion passenger kilometre is shown



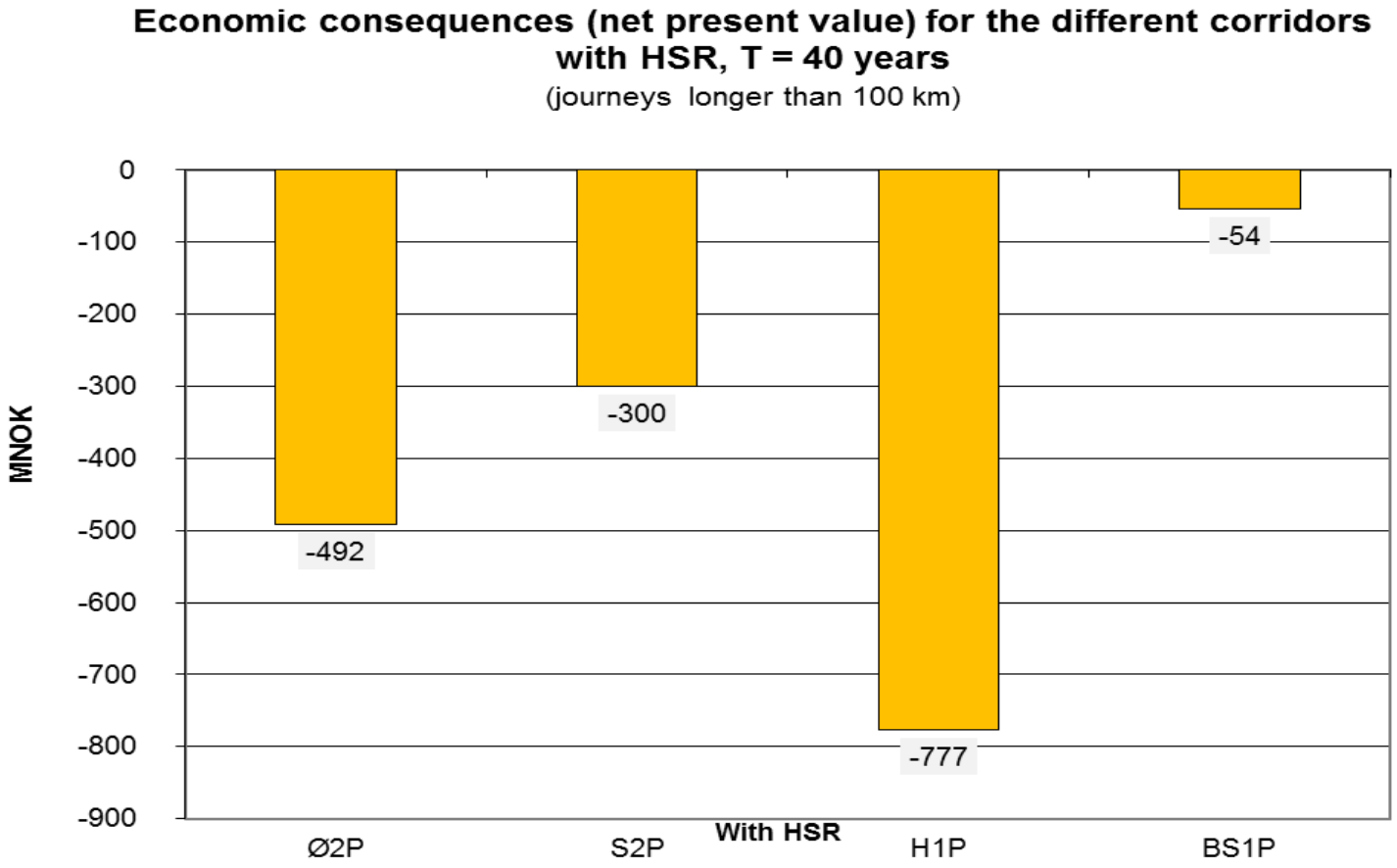


- The increase in fatalities is relatively limited, especially if one considers the increase in total transported passenger kilometres in Norway.

- S2P and BS1P are associated with a higher safety level for each additional billion passenger kilometres added to the Norwegian transport system.

Safety – economic valuation of safety for Ø2P

- Value of statistical life 20 MNOK (JBV, 2010) and discount rate 4.5 %.



Risk and safety – conclusions (1)

- The change in safety levels due to HSR implementation in the Norwegian transport system is relatively limited.

- HSR implementation might lead to an increase of total fatalities per year, with the current input data. Regardless of which corridor that is modelled. This is mainly because of increase in transport volumes.

- In comparison between the corridors, H1P results have the most substantial safety consequences and S2P have the least consequence.

Risk and safety – conclusions (2)

- An increase in fatalities in the total transport system may occur due to:
  - Large transfer of passengers from air traffic to HSR
  - Minor transfer of passengers from car to HSR
  - Only small volumes of the total amount of transported goods are moved from lorry to train, leading to marginal reduction of fatalities caused by lorries
  - Increase of the total passenger kilometres in Norway
- With additional risk mitigation measures the (relatively small) increase of fatalities will be reduced

Risk and safety – conclusions (3)

- The risk acceptance criteria is calculated to be within JBVs existing requirements
- Risk and safety shall not be the determining factor concerning the decision of HSR in Norway.

Thank you for listening

Questions?