Normative Document for Light Rail Safety

Version 5.0

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1 Introduction

This Normative Document and accompanying User Instructions provide information on how the safety of light rail systems can be studied and evaluated. A reader's guide is provided in section 1.2. Furthermore, the chapters of the Normative Document and User Instructions parallel each other, so that sections bearing the same numbers in both documents complement each other.

A separate, brief summary is also available in addition to the Normative Document and User Instructions.

Light rail

The term 'light rail' refers to a rail transport system aimed at integrating urban with public transport infrastructure in terms of light rail and bus services or optimising light rail and bus networks, whether or not in combination with heavy rail services. Within the context of cities and their suburbs, this aim is referred to as 'agglomeration' or 'agglo' in short. Examples of light rail systems are:

- Light rail vehicles that serve an urban district by using the general railway network;
- Light rail vehicles that serve an urban district by using a dedicated railway network in combination with the general railway network;
- Light rail vehicles that provide connections to (medium-sized) cities by also using the general railway network;
- Regional secondary lines;
- Dedicated light rail.

Light rail is therefore an umbrella term for 'customised rail transport'. All light rail systems must therefore be designed to meet specific transport needs; in other words, technological solutions must be tailored to the actual particulars of a given transport situation.

Infrastructure and vehicle operators are by definition the parties that must realise this customised rail transport. This situation can have adverse consequences, however. Firstly, there is always the risk that each light rail project will be implemented according to its own, individual technical specifications. Secondly, having new parts developed for every project is inefficient and, thirdly, purchasing components that fulfil the same function for each network is not cost-effective. Such components are, after all, expensive because they can only be made in limited production runs.

Light rail developments therefore require a measure of uniformity that, at the same time, does not unduly restrict the scope of individual projects to address specific situations and needs. Achieving this aim at the initiative of the government is in the joint interest of the government, implementing organisations and the business sector.

Safety is also a key factor, however. The development of individual light rail systems must therefore be governed by clear and uniform principles in relation to safety, hence this Normative Document for Light Rail Safety. This aspect is further explained in the following sections.

1.1 The Normative Document

The Normative Document for Light Rail Safety (hereinafter to be referred to as the ‘Normative Document’) sets out the guiding principles for light rail safety and, as such, specifies safety requirements for the development and operation of light rail systems. It expressly does not take financial and efficiency aspects into consideration.

The Normative Document is not established in law but, rather, constitutes a policy rule that can be deviated from subject to the provision of proper substantiation for any such deviation. This Normative Document is binding for projects financed by the national government and those that primarily make use of heavy rail infrastructure. For other projects, the principal can declare its applicability on a voluntary basis.

The purpose of the Normative Document is to ensure the development of safe light rail systems. This aim is achieved by remaining open to all kinds of safety solutions within the parameters set by the government in the area of safety. **The Normative Document may not therefore by any means result in a simple mathematical calculation of the safety of a light rail project. The Document must, rather, be used by decision-makers as an aid with which to formulate and test their respective philosophies on safety.**

A working plan that ensures the traceability of safety through verification and validation can be drawn up on the basis of the Normative Document. The Normative Document also clearly defines the respective duties and roles of the parties involved.

Simple or cost-effective measures that have risk-reducing effects and therefore enhance rail safety must always be taken, even if quantitative requirements have been met.

Light rail systems sometimes make use of a heavy rail network (national, regional or urban) as well. In such cases, the proper integration of safety requirements and systems is a key requirement in ensuring the safety of the light rail system in question.

Reason for the Normative Document
The aspect of safety must be properly considered in advance in order to prevent delays in the implementation of light rail projects or preclude the need for additional investments. Safety in this case means the prevention of injuries and fatalities resulting from the operation and use of the rail transport system.

Applying safety measures common in heavy rail systems to light rail projects without qualification can result in high costs that hamper project realisation. Costs should not by any means be cut, however, by omitting to put adequate safety measures in place. Equally, options that undermine safety in the longer term must be avoided. The detrimental effect on safety of the first course of action is obvious. The latter approach may solve the realisation issue in the short term but could lead to shortcomings in safety as a result of operational alterations introduced at some point in the future. As is usually the case, everything seems fine as long as no accidents take place. If an accident does take place, however, considerable efforts are often required to put adequate measures in place, and at high costs.

Potential safety risks must therefore be considered at an early stage. In addition, prevention must already be properly incorporated into the design process. Safety is primarily of importance at the many interfaces between, respectively, the operational process, the maintenance of infrastructure and vehicles, the railway and vehicle systems and the railway traffic control system.

If a light rail system comprises a combination of heavy rail and tram or metro systems, technologies from both types of rail transport may be applied. The project's principal must ascertain the safety-related consequences of using technologies in this way.

The driver of a tram, for example, is a participant in road traffic and must therefore act accordingly to avoid collisions. The mode of transport is vulnerable but its speed is relatively low and tram drivers are trained to respond to other traffic. By contrast, speeds in heavy rail systems are higher but the safety measures put in place are designed to accommodate such speeds. A heavy rail network is therefore equipped with safety technology such as the Automatic Train Control (ATC) System and the vehicles that use the network have greater collision strength. The driver of a heavy rail vehicle primarily responds to signals given by technical systems and not, like a tram driver, to traffic signals. Applied separately and therefore operating independently of each other, both concepts lead to safe railway systems. Will this remain the case, however, if trains and trams make use of the same railway network; in other words, if heavy rolling stock and light vehicles travel on the same railway lines?

Target group of the Normative Document
The Normative Document is primarily intended for principals and developers of light rail projects. Principals can use the Normative Document to embed safety in their design processes. For other parties involved in projects, the working method set out in the Normative Document provides a guarantee that the aspect of safety is incorporated into the decision-making process and meets the required standards.

Policy principles
The safety policy for rail transport is set out in the Rail Safety Policy Document [ND1] of the Dutch Ministry of Transport, Public Works and Water Management. This Policy Document was published in July 1999 and addressed by the House of Representatives in February 2000. The document serves as the foundation for the incorporation and implementation of safety systems in light rail projects. Among other things, Chapter 2 states:

> *Due to the responsibility the Minister of Transport, Public Works and Water Management bears for the national railway network, there is a strong emphasis on train transport and therefore on railways. This does not mean, however, that no attention is devoted to other forms of rail transport in the Netherlands.* ***This Policy Document also serves as a guideline for safety policy relating to other forms of rail transport such as, among others, (express) tram and metro services and future light rail systems.***
>
> *The primary purpose of the Policy Document is to structure internal safety policy and link this policy to existing, external safety policy, which means that opinions are expressed in relation to*

safety shortcomings in rail transport. Based on their respective legal powers, government authorities, transport companies and infrastructure users are subsequently responsible for policy implementation.

With regard to rail transport, the Policy Document focuses on the safe transport of people and goods and *on ensuring safe working conditions for individuals employed in the railway sector.*

The Policy Document defines a number of steps that must be taken in relation to the development of policy instruments, namely:

1. Formulate the standards to be maintained for the social risk of rail transport, elaborate these standards and test them in terms of feasibility.
2. Prepare a description of how integral safety studies must be carried out.
3. Formulate a policy rule that ensures that integral safety studies are carried out when designing new public transport projects and when making large-scale changes.
4. Together with other parties involved, develop safety requirements for light rail operations.

To facilitate completion of the first step, the Normative Document sets out requirements relating to social risk in addition to those concerning personal risk. With regard to the second and third steps, the integral safety studies, the Normative Document describes the way in which these studies must be carried out and specifies the parties responsible for the results in the various phases of the preparation of the plan. Together with the realisation process, risk criteria constitute the outcome of the fourth step, i.e. a policy instrument that establishes safety requirements in relation to light rail projects.

Design phase

Within the context of further implementing the Policy Document, the Directorate-General for Mobility of the Ministry of Transport, Public Works and Water Management asked Railinfrabeheer and Railned to prepare a Normative Document for Light Rail Safety.

Version 4.1 of this Normative Document was made available for perusal to parties active in the railway sector such as transport companies, municipal authorities, provincial authorities and consultancy firms. To prepare a definitive version, the Normative Document Updating Working Group was set up in 2002. This working group evaluated the experience acquired in light rail projects in two workshops. The results obtained by the working group were used together with previously submitted commentary to prepare the present Version 5.0 of the Normative Document, which was presented to the minister concerned for adoption as the definitive version.

This Normative Document is the result of the contributions and collaborative efforts made by the following organisations and individuals:

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A Light Rail Safety Committee will be set up to manage the Normative Document and keep it up to date.

1.2 Reader's guide

Chapter 2 specifies the normative, quantitative safety requirements that light rail projects must satisfy while Chapter 3 describes the processes that must be adhered to. These processes must control, for example, the way in which projects are organised, the allocation of duties, planning, quality and the budget. Chapter 4 contains a checklist that can be used in the development of light rail projects. In addition, a list of abbreviations and terms used has been included and references are made to the relevant documents.

The Normative Document for Light Rail Safety is accompanied by explanatory User Instructions (see also the summary).

In addition, the Normative Document includes four appendices:
- Appendix A is a list of abbreviations
- Appendix B is a list of terms
- Appendix C comprises related safety documents, and
- Appendix D specifies references (documents)

2 Risk criteria

This chapter defines the quantitative safety requirements (risk criteria) of the Normative Document. Section 2.1 gives the actual definitions while section 2.2 describes the general principles underlying the risk criteria.

The usual distinction is made in the Normative Document between personal risk (2.3) and social risk (2.4). Standards applicable to personal risk are used to protect individuals: every person has a right to a certain level of safety. Standards applicable to social risk, on the other hand, reflect the social sense of an acceptable level of safety. This sense manifests itself in exceptionally stringent standards in relation to accidents involving many victims (group risk) and in standards for users of railway crossing points, unauthorised persons and individuals who commit suicide. Requirements concerning social and personal risk differ and both sets of requirements must be met.

2.1 Definitions

'Fully safe' basic system concept
Light rail traffic based on a safety concept that aims to guarantee a safe railway line on the basis of technical systems and an operating environment which excludes other road traffic and pedestrian traffic.

'Driver responsibility' basic system concept
Light rail traffic based on a safety concept that aims to guarantee a safe railway line based on driver responsibility in terms of appropriately adapting the direction and speed of travel to the wider environment.

Signed crossing points, crossing points and passenger crossing points
Signed crossing point
A level crossing point at which a train or tram railway intersects with a road and which is indicated by crossbucks (St Andrew's Crosses).

Crossing point
A level crossing point at which a train or tram railway intersects with a road.

Passenger crossing point
A level crossing point at which a train or tram railway intersects with a footpath intended solely to enable passengers to access platforms.

Parallel railway
A train or tram railway that parallels a road or is flanked by road traffic lanes.

Risk bearers
Passengers

Persons in trains, boarding or disembarking from trains and on platforms, and persons travelling to and from platforms, including those making use of stairs, escalators and lifts to do so. Persons who are at railway stations for professional reasons and those with suicidal tendencies are not considered to be passengers.

The ‘passengers’ category can be subdivided as follows:
- persons in trains
- persons boarding or disembarking from trains
- persons on platforms or travelling to and from platforms, including those making use of stairs, escalators to do so

Unauthorised persons
Persons who are in the rail traffic system without due authorisation, not including those with suicidal tendencies.

The ‘unauthorised persons’ category can be subdivided as follows:
- unauthorised persons on platforms
- unauthorised persons at other locations

Users of signed crossing points
Persons on signed crossing points, not including persons who are on such crossing points for professional reasons, persons on service crossing points and those with suicidal tendencies.

The ‘signed crossing point users’ category can be subdivided as follows:
- persons on passenger crossing points (whether or not on one which connects neighbourhoods)
- persons on other signed crossing points (whether or not on one which is public)

Crossing point users
Persons on crossing points that are not signed. Not included in this category are persons who are at such crossing points for professional reasons, persons on service crossing points and those with suicidal tendencies.

The ‘crossing point users’ category can be subdivided as follows:
- persons on passenger crossing points (without an inter-neighbourhood connection)
- persons on other crossing points

Persons with suicidal tendencies
Persons who apparently intend to use the rail traffic system to commit suicide.

Personnel
Persons who are in the rail traffic system for professional reasons.

The ‘personnel’ category can be subdivided as follows:

Train personnel:

- train drivers

- train attendants (including surveillance personnel, assistants who provide travel information and train managers)
- other (catering personnel and persons conducting surveys on trains)

Infrastructure employees:
- Employees engaged in relation to the supply of power (including work at power substations), signals and maintenance (railways, ballast, sound barriers and signed crossing points)

Equipment employees:
- yardmen/women (including radiolocation operators)
- other (carriage and wagon examiners, technicians who deal with malfunctions and suppliers of equipment)

Other personnel:
- assistants, catering personnel on platforms, platform supervisors, customs officials and suppliers

Wider environment
The environment outside the rail traffic system but affected by it.

Road traffic
Road traffic includes pedestrians, vehicle drivers and users of bicycles and mopeds, of vehicles for the disabled, of vehicles not on rails, horse riders, persons controlling riding animals, draught animals or cattle, and drivers or passengers of carriages, irrespective of whether such carriages are pulled by draught animals or not.

2.2 General principles

- Chapter 2 applies in its entirety to all light rail (sub)sections based on the ‘fully safe’ basic system concept.
- Requirements relating to users of signed crossing points and crossing points (specified in section 2.4) and the ALARA principle (specified in section 2.4) apply to light rail (sub)sections based on the ‘driver responsibility’ basic system concept.
- These requirements apply to light rail vehicles, infrastructure and the operation of light rail systems as a whole.
- All figures relate to the death of persons.
- Full-time work is assumed with regard to personnel. Adjustments must be made on a pro rata basis for part-time work.
- The number of passenger kilometres travelled a year on a given railway line is estimated on the basis of transport value studies, excluding subsections that are based on the ‘driver responsibility’ basic system concept. If these estimates change during a project, the risk criterion applied in that project must be adjusted on a pro rata basis.

- The total number of passenger kilometres travelled a year in the Netherlands is the most recent annual figure for heavy rail and light rail networks, excluding subsections based on the ‘driver responsibility’ basic system concept, available at the time the request for the figure was submitted. The annual figure provided at the time the request was submitted applies for the duration of the project in its entirety and must be used to determine the standard to be applied.
- The number of railway line kilometres concerns the light rail section, excluding subsections based on the ‘driver responsibility’ basic system concept.
- In addition to the ALARA principle, the Rail Safety Policy Document must also be adhered to with regard to unauthorised persons and persons with suicidal tendencies.
- The actual values of the risk criteria must be requested from the supervisor.

Handling risk criteria
Even if all realistic measures have been taken, analysis may still reveal that an outcome does not meet the applicable risk criterion. In such cases and as part of retaining or obtaining an operating permit, the supervisor must be consulted with the aim of determining ways in which the transport system in question can be approved. In the review process, the supervisor will focus primarily on the following:

1. The question as to whether the ‘transgression’ in terms of risk is caused mainly by specific light rail characteristics. If this is indeed the case, the supervisor will not grant approval. Specific light rail characteristics include:
   - the low collision strength of light rail vehicles relative to heavy rail vehicles
   - the higher probability of a light rail vehicle becoming derailed as a result of a collision with road traffic at a signed crossing point
   - the risk associated with boarding and disembarking from light rail vehicles
2. If the ‘transgression’ in terms of risk is rooted in factors other than specific light rail characteristics, the supervisor may opt to approve operations with regard to these characteristics. Such approval may be subject to limiting conditions concerning, for example, railway employees and persons with suicidal tendencies.

If the risk criterion is not met and the retention or acquisition of an operating permit to make use of the main railway network is thus compromised, the following steps can be taken as part of the review process to increase the likelihood of an operating permit being granted:

a. carry out calculations and conduct a close study into whether the correct assumptions were made
b. make a comparison of how the situation would be if the transport system had been built as a heavy rail one
c. review specific light rail risks and determine whether a higher level of safety is achieved relative to a heavy rail situation
d. assess the usefulness and necessity of safety measures and specify, with accompanying substantiation, the measures that were not taken

The basic principle remains a standard based on case histories in the Netherlands as a whole. Standards based on particular railway sections and the application of a ‘standstill principle’ with regard to such standards result in an inaccurate reflection of the level of safety if serious accidents occurred on that particular railway section during the period under review. The application of a standstill principle based on a standard linked to a particular railway section is therefore unacceptable.

The purpose of a closer review is to enable the supervisor to determine whether all possible measures have been taken to make the light rail project in question as safe as possible.

2.3 Personal risk

The following table provides an overview of the maximum average personal risk for risk bearers. Section 2.4 sets out the social risk. Definitions of terms used are given in section 2.1 of the User Instructions.

Risk bearers	Light rail system Maximum average personal risk
Passengers	1.4×10^{-10} per passenger kilometre
Train personnel	Minimum standstill and 1×10^{-4} per person a year
Infrastructure employees and equipment employees	1×10^{-4} per person a year
Wider environment	1×10^{-6} per person a year

For train personnel, standstill means that the safety risk of train personnel must be smaller or at least equal to the existing safety risk of train personnel.

The existing safety risk of train personnel is the most recent progressive average as calculated over the preceding ten years available at the time the request was submitted. Any changes that took place during that ten-year period are taken into account. The figure must be requested from the supervisor and applied for the duration of the project in its entirety.

2.4 Social risk

Group risk for passengers, personnel and the wider environment

Risk bearers	Light rail system Maximum group risk (number of fatalities a year)
The sum total of passengers, personnel and the wider environment	$\frac{10}{N^2} * \frac{\text{Projected number of passenger kilometres travelled a year}}{\text{Total number of passenger kilometres travelled in the Netherlands a year}}$ $N \geq 2$

The group risk for passengers, personnel and the wider environment concerns the annual frequency of incidents involving N or more victims, where N is the number of fatalities resulting from a single event.

Users of (signed) crossing points
The ‘standstill principle’, risk budget settlement and ALARA apply for users of signed crossing points on railway (sub)sections based on the ‘fully safe’ basic system concept.

Additional regulations apply to the new construction of passenger crossing points on railway (sub)sections based on the ‘fully safe’ basic system concept.

The ALARA principle applies to (signed) crossing point users on railway (sub)sections based on the ‘driver responsibility’ basic safety concept. In addition, a calculation of the safety risk for (signed) crossing point users must be made for purposes of substantiation, the foregoing insofar as possible on the basis of available case histories.

Standstill
For signed crossing point users, the safety risk means that the risk for signed crossing point users on the railway section must be smaller than or at least equal to the safety risk for signed crossing point users on the railway section in existence. The unit used to express safety risk is the number of fatalities a year. For a newly constructed signed crossing point the figure is 0 (zero).

The safety risk of the existing light rail section is the progressive average as calculated over the preceding ten years available at the time the request was submitted. Any changes that took place during that ten-year period are taken into account. The figure referred to must be requested from the supervisor and applied for the duration of the project in its entirety.

The maximum risk budget for signed crossing points is the sum total of the risks of all individual signed crossing points. If a signed crossing point is removed, the risk for the crossing point in question as calculated on the basis of historical data is deducted from the project risk. Account must be taken in this regard of the fact that the risk level of the remaining signed crossing points may increase.

Pursuant to the ALARA principle, no reduction (for instance through removal) of existing safety features such as automatic half barriers (AHBs) may occur at crossing points.

Risk budget settlement
If the ‘standstill’ criterion for signed crossing points is not met, the following procedure applies:

1. Determine the risk prognosis using, among other things, the data provided by the supervisor.
2. Use any surplus of the risk budget to introduce measures internal to the project that are relevant to signed crossing points.
3. If the risk budget is not fully spent in the manner specified in point 2 above, use the remainder of the budget for purposes external to the project by means of a financial contribution of the Directorate-General for Mobility of the Ministry of Transport, Public Works and Water Management. Details of the relevant Directorate-General for Mobility procedure can be obtained from the Inspectorate for Transport, Public Works and Water Management.

Passenger crossing points
A situation might arise in which, contrary to the national policy on signed crossing points, a new passenger crossing point must nevertheless be added to a railway (sub)section based on the ‘fully safe’ basic system concept. Moreover, measures taken and risk budget settlement may not be sufficient to meet requirements pertaining to standstill and risk budget settlement.

In such cases, an operating permit for a passenger crossing point can be granted subject to a number of conditions set out in Appendix C of the User Instructions.

ALARA
The As Low As Reasonably Achievable (ALARA) principle applies to all light rail projects. The probability of accidents occurring in a rail transport system that result in injury must be kept as low as reasonably and practically possible.

3 Process requirements

Section 3.1 of this chapter details the respective roles of parties involved in the realisation of a light rail project. Section 3.2 describes the process of realisation based on the so-called lifecycle. The same method is applied in section 3.3 with respect to railway network operation.

3.1 Roles in relation to design, realisation and operation

Principal
The principal puts the project out to tender and bears responsibility for ensuring that safety standards are met.

Standards setter
The standards setter establishes generic requirements pertaining to safety and functionality in the interests of society at large.

Decision maker
The decision maker decides on implementation of a light rail system in terms of, for example, the choice of railway line and giving the go-ahead for realisation. A decision maker may also be a controlling body that checks whether the plans submitted fit within the mobility policy.

Designer
The designer is responsible for the design and development of transport, infrastructure and operation, including scheduling.

Builder
The builder is responsible for the construction and installation of the infrastructure or mode of transport.

Supervisor
The supervisor is responsible for ensuring that safety standards are continuously complied with during the project and during operation of the railway system. In addition, the supervisor advises the standards setter and keeps the parties involved informed.

Assessor
The assessor is responsible for determining as an independent party whether the safety standards are being complied with in terms of process and performance (Independent Safety Assessor, ISA).

Permit provider
The permit provider establishes design-related requirements for purposes of prevention and the management of emergencies.

Infrastructure manager
The infrastructure manager is responsible for the management and maintenance of infrastructure, and must also ensure that the infrastructure can be used safely and without hindrance. Maintenance is often outsourced.

Transporter
The transporter is responsible for the realisation and maintenance of the transport process, and for the management and maintenance of railway vehicles.

Traffic controller
The traffic controller indicates available capacity and ensures safe control of the traffic process.

Emergency organisation
The sum total of emergency organisations that provide emergency services or contribute to restoration following emergencies.

3.2 Design and realisation

General principles

- The phased plan of the Normative Document (set out in sections 3.3. and 3.4) applies to all light rail projects.
- The principal bears and will continue to bear final responsibility for safety, though can delegate duties.
- The principal may be assisted in all phases by other parties/stakeholders.
- Requirements in the Normative Document apply only insofar as safety is concerned.
- Outcomes must be documented together with the basic assumptions and substantiation applicable to them.
- These requirements apply to light rail vehicles, infrastructure and operation as a whole.
- A light rail system must satisfy the safety requirements set out in the Rail Safety Policy Document [ND1].

Associated safety documents
The light rail system must satisfy the safety requirements set out in the Rail Safety Document [ND1], [ND2] (EN 50126), [ND3] (Railned Acceptance Requirements) and applicable national and European standards. The list of other national and European standards must be requested from the supervisor. In the case of conflict between different requirements within one document or between requirements in various documents, the most restrictive requirement shall prevail.

In addition to the foregoing, there are the requirements set out in documents EN 50128 [RD1], ENV 50129 [RD2], and IEC 61508 [RD3]. These requirements are only mandatory insofar as they are specified in the list of the supervisor referred to above.

3.3 Requirements governing design and realisation: the lifecycle

The NEN-EN 50126 [ND2] standard is used in relation to the lifecycle of light rail projects. The model used in this regard, the so-called V Approach, is set out in this chapter specifically in terms of light rail in the Netherlands (see Figures 2 and 3).

Each step of the lifecycle concerning design and realisation is explained in section 3.3. Section 3.5 describes the lifecycle steps in relation to operation. Chapter 4 contains a checklist in the form of a point-by-point summary of duties that must be executed in each step of the lifecycle.

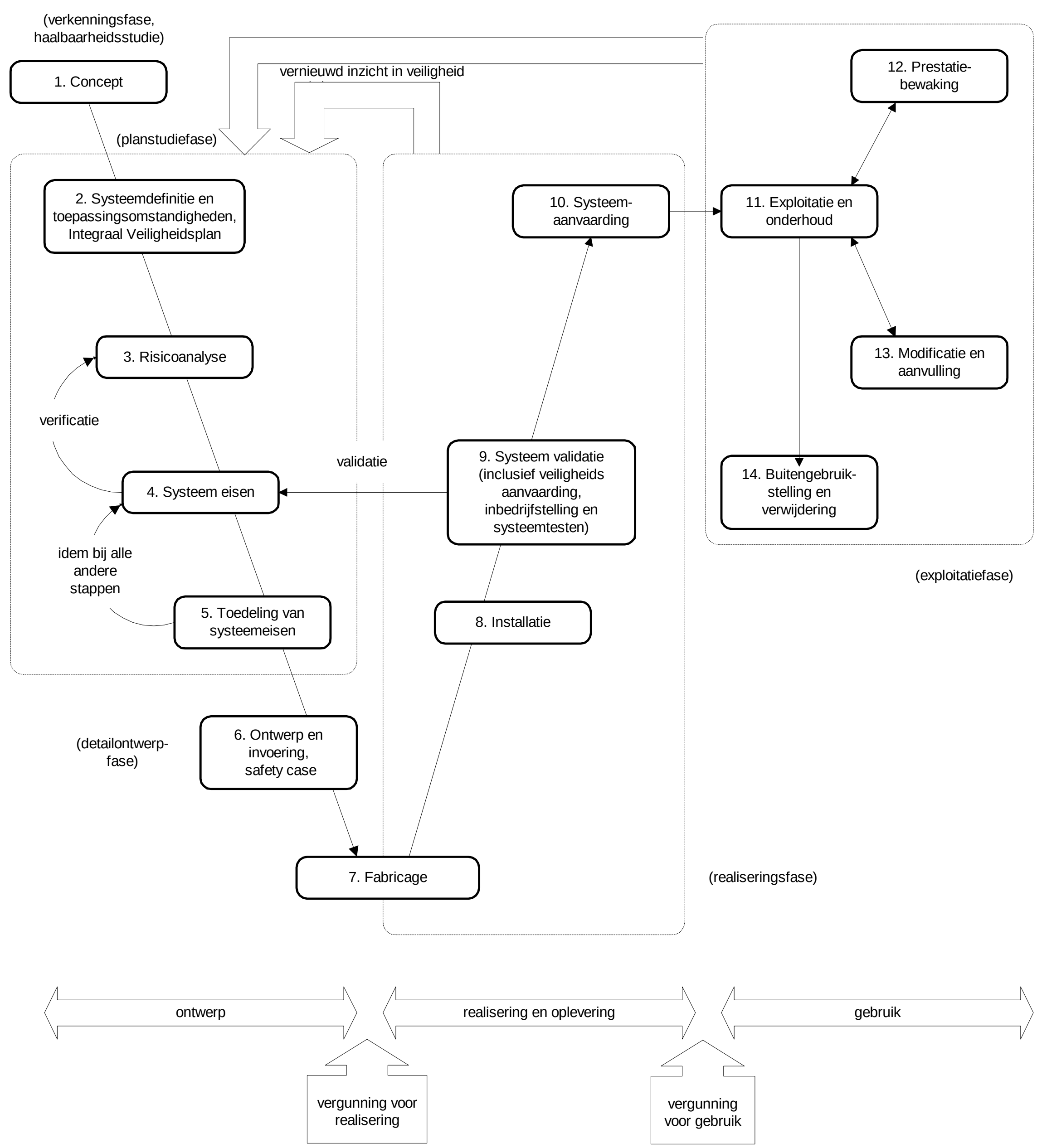

Figure 1: The 14 steps in the lifecycle of a project [ND2].

Different parties will interact with each other on several occasions during the development, realisation and operation of a light rail system. The way such interaction may be organised is clarified in this section and in Figure 1. The parties involved in a given project must decide for themselves how roles are to be allocated and relationships arranged within the project and record these allocations and arrangements in the Integral Safety Plan (ISP; see step 2 of the lifecycle).

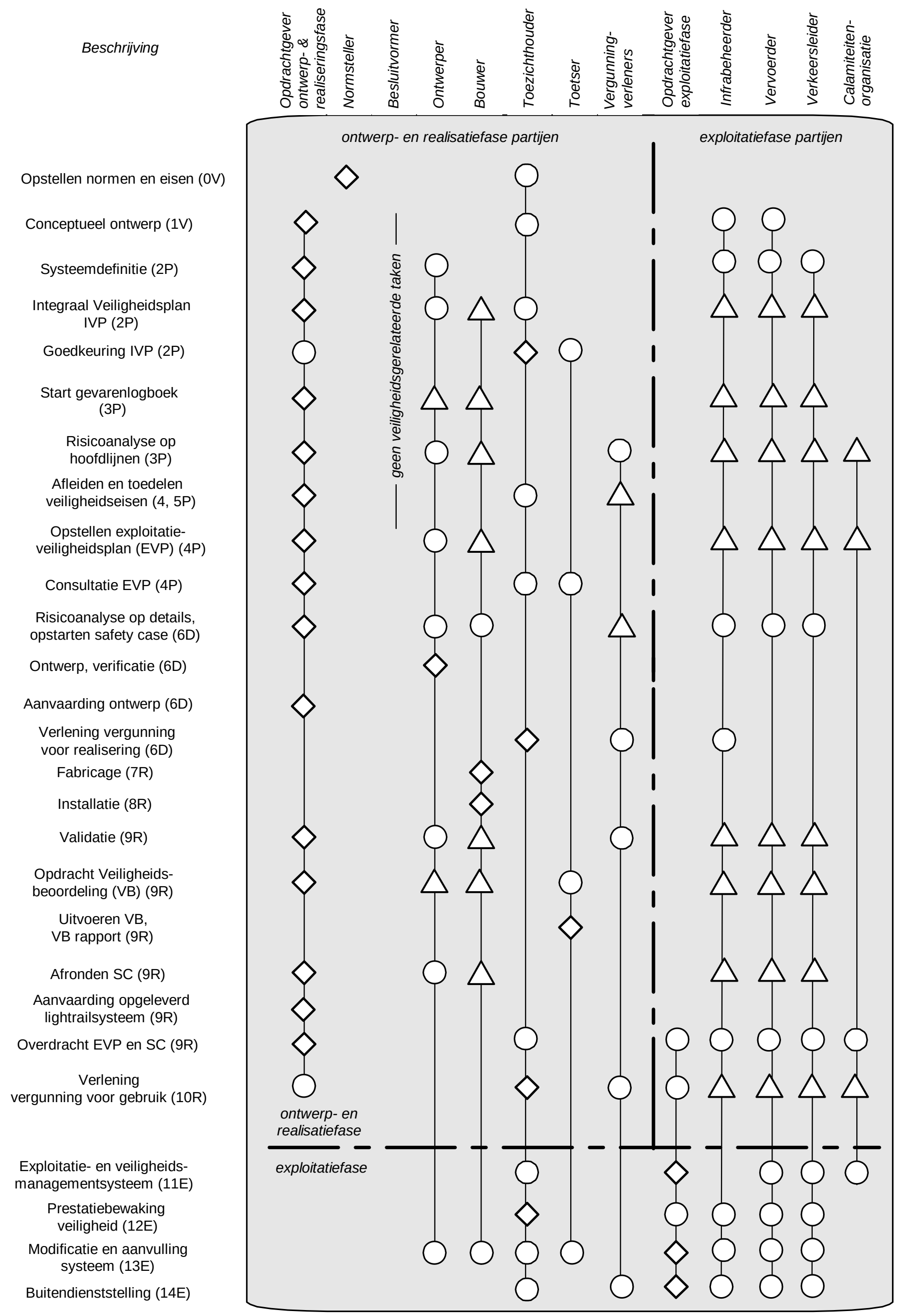
Beschrijving
Opdrachtgever ontwerp- & realiseringsfase
Normsteller
Besluitvormer
Ontwerper
Bouwer
Toezichthouder
Toetser
Vergunning-verleners
Opdrachtgever exploitatiefase
Infrabeheerder
Vervoerder
Verkeersleider
Calamiteiten-organisatie
ontwerp- en realisatiefase partijen
exploitatiefase partijen
geen veiligheidsgerelateerde taken
Opstellen normen en eisen (0V)
Conceptueel ontwerp (1V)
Systeemdefinitie (2P)
Integraal Veiligheidsplan IVP (2P)
Goedkeuring IVP (2P)
Start gevarenlogboek (3P)
Risicoanalyse op hoofdlijnen (3P)
Afleiden en toedelen veiligheidseisen (4, 5P)
Opstellen exploitatie-veiligheidsplan (EVP) (4P)
Consultatie EVP (4P)
Risicoanalyse op details, opstarten safety case (6D)
Ontwerp, verificatie (6D)
Aanvaarding ontwerp (6D)
Verlening vergunning voor realisering (6D)
Fabricage (7R)
Installatie (8R)
Validatie (9R)
Opdracht Veiligheids-beoordeling (VB) (9R)
Uitvoeren VB, VB rapport (9R)
Afronden SC (9R)
Aanvaarding opgeleverd lightrailsysteem (9R)
Overdracht EVP en SC (9R)
Verlening vergunning voor gebruik (10R)
ontwerp- en realisatiefase
exploitatiefase
Exploitatie- en veiligheids-managementsysteem (11E)
Prestatiebewaking veiligheid (12E)
Modificatie en aanvulling systeem (13E)
Buitendienststelling (14E)

Figure 2: The possible allocation of roles and documents (non-exhaustive list) involved in a light rail project; the parties involved in a given project must make unequivocal arrangements concerning the allocation of roles and record these arrangements in the Integral Safety Plan (ISP).

In Figure 2, ◊ stands for the responsible party, O for an implementing or participating party and Δ for the supply of information. The project's timeframe is indicated by the vertical axis. The 'Description' column indicates the respective number(s) of the lifecycle step(s) involved as indicated in Figure 1 followed by the letter of the phase in question (E = exploratory phase, P = planning study phase, D = detailed design phase, R = realisation phase, O = operational phase). Definitions of the parties are given in section 3.1.

Step 0: Preparation of safety documents

This lifecycle step does not form part of the project phases and has therefore been designated as step 0. Advised by the supervisor, the standards setter establishes the normative safety requirements and prepares the associated safety documents.

Outcome:

- Generic safety specification. This is a collection of safety specifications that apply to the light rail system and includes specifications relating to the railway vehicles, procedures, utilisation and capacity.

Step 1: Concept

Supported by the supervisor, transporter and infrastructure manager where necessary, the principal describes the wider environment applicable to the light rail system and the associated user requirements. The principal must also record the relevant safety aspects when doing so.

Outcome:

- Safety report. This report sets out the findings and problem areas relating to safety.

Step 2: System definition

The principal defines the light rail transport system, the wider environment relevant to it and the circumstances applicable to utilisation.

In addition, the principal prepares the Integral Safety Plan (ISP), specifying the parties involved in the project and their respective roles, and setting out the allocation of duties in detail. The ISP must be based on the principle that each party will apply the EN 50126 [ND2] standard only insofar as this standard is relevant to it. The principal must direct the parties to do so and set specific preconditions in this regard.

The ISP must also provide a description of the way in which the principal will consolidate the safety cases of the project consortium into a single whole. In addition, the principal must specify the data and/or risk analyses and/or safety cases it will require from each party for the preparation of an integral system risk analysis and safety case.

The principal selects an assessor. Submitting the selection of the assessor to the supervisor is recommended. The principal must finally submit the ISP to the supervisor for approval and to the assessor for perusal.

Outcomes:

- Description of the system and circumstances applicable to utilisation. The preconditions set in the description of the system must not hinder safe operation. The description of the system must also contain sufficient data to enable the parties involved to carry out risk analyses for the subsystems for which they are responsible. Above all, the description of the system must define the interfaces between the responsibilities of the various parties involved.

- Specification of location and operation. This specification must set out where and how the system will be utilised. Examples in this regard are turning and yard movements as well as possible traffic lines.
- Location-specific system and safety specification. Based on the generic safety specification and (step 0) and description of location and operation, this document must specify how system and operational safety will be realised.
- Integral Safety Plan (ISP); see Appendix A of the User Instructions.

Step 3: Risk analysis

The principal carries out a system risk analysis in broad terms in order to allocate safety-related responsibilities and provisional risk budgets to the parties involved. In carrying out this analysis, the principal must consult the supervisor and use the latest knowledge, methods and insights into case histories.

In addition, the principal must contact the relevant permit providers to determine whether they have set design-related requirements (in the case of combined use with heavy rail, also consult the Delta List).

The principal must also start a hazard log in order to collect details about possible accidents and hazards, and in order to compile safety documentation for purposes of verifying safety management. From this point onwards, the designer, builder, infrastructure manager, transporter and traffic controller must supply data for the hazard log.

Outcomes:

- Risk analysis [ND2, 6.3]. The risk analysis must be based on the established safety requirements and must be structured in such a way as to ensure that risk budgets can be allocated to parties in an objective manner. To this end, the principal must distinguish between risk bearers and primary hazards. In addition, the risk analysis must be detailed enough to enable the principal to use it to account for the safety of the light rail system.
- Hazard log [ND2, 6.3].

Step 4: System safety requirements

The principal uses the risk analysis to formulate system safety requirements and prepares a detailed programme in order to ensure that these requirements can be met. The principal must subsequently use the system safety requirements to determine the acceptance tests. If new information becomes available or if further detail is required, the principal must adjust the risk analysis and associated documents accordingly.

The principal prepares a draft of the Operational Safety Plan (OSP). The definitive version of the OSP is published by the principal of the operational phase in step 10.

The principal publishes the definitive version of the ISP and makes the OSP available to the supervisor and assessor for perusal.

Finally, the principal designs the Failure Reporting, Analysis and Corrective Action System (FRACAS) and issues an instruction for the system to be built and made ready for installation.

Outcomes:
- Safety requirements at system level
- Acceptance plan. This is a plan detailing the way in which, in relation to the issue of an operating permit, safety will be demonstrated during acceptance
- Appropriately adjusted ISP, risk analysis and hazard log
- Design for FRACAS [ND2, 6.4]
- Operational Safety Plan (OSP)

Step 5: Allocation of the system safety requirements

Using the risk allocation, the principal establishes the subsystem safety requirements based on the system safety requirements. If necessary, the principal must adjust the allocation of risk budgets on the basis of new insights and findings in accordance with [ND2, 6.5]. The system and subsystem safety requirements in their entirety must be made available to the supervisor for purposes of information.

Outcomes:
- Requirements relating to subsystems, components and external systems/parties [ND2, 6.5].
- Appropriately adjusted ISP, risk analysis and validation plan.

Step 6: Design and introduction

The designer, builder, infrastructure manager, transporter and traffic controller perform their risk analyses, start their safety cases and forward these to the principal, who will coordinate the questions of parties and provide additional information. In addition, the principal will check or have a check carried out into whether the analyses and safety cases provided are sound and whether or not the parties are keeping to the risk budget. If this budget is not being adhered to, the principal can take the following action:
- demand that the party in question improve its part of the system
- allocate a budget increase to the party in question
- alter the description of the system
- appoint a different party to deliver the relevant system part.

The principal subsequently integrates the analyses and safety cases provided into the system analysis and consolidated safety case and thereby satisfy, among other things, requirements relating to the risk analysis as set out in [ND2, 6.3]. If a supplier does not keep to the risk budget allocated to it in the manner described in step 3 above, the principal will verify whether the risk budget can nevertheless be complied with at system level. If necessary, the principal must take appropriate action.

The principal will involve permit provider providers in design-related decisions that are relevant to them.

Once all designs have been received and finalised, the principal will verify whether the risk criteria have been met and subsequently decide, on the basis of the implementation plans and safety case(s), whether the light rail system may be built. This therefore means that the principal accepts the design.

The principal will then forward the design and safety cases to the supervisor and any other permit providers with the request to grant the permit or permits, such as a building permit, necessary for realisation.

In this step, the suppliers prepare the design and define the procedures required to ensure safety. It is important for these operational and maintenance procedures and manuals to be requested already at this stage. Doing so at a later stage is far more difficult, as by that time the design team is likely to be involved in other projects.

Outcomes:

- Design
- Operational and maintenance procedures
- Risk analysis
- Manufacturing process that is verifiably capable of producing subsystems and components that meet the applicable safety standards
- Installation plan, certification plan, operational launch plan, operational and maintenance plan, data collection and evaluation plan
- Generic application safety case [ND2, 6.6], [RD2, 5]
- Specific application safety case [ND2, 6.6], [RD2, 5]
- Results of safety verification and validation process (insofar as performed)

Step 7: Manufacture

The builder commences the manufacturing process and the collection of validation data.

Outcomes:

- Manufacturing documentation [ND2, 6.7].
- Validation documentation [ND2, 6.7] (see also step 9).

Step 8: Installation

The builder installs the components, subsystems and external facilities in accordance with the installation plan.

Outcomes:

- Installation documentation
- Validation results
- Updated ISP and hazard log

Step 9: System validation

Using the validation results of the builder and other parties, the principal completes system validation and adds the results to the safety case. In addition to validation, the principal also completes the specific application safety case.

The principal must ensure that its safety case is assessed by the independent assessor. To this end, the designer, builder and other parties must supply their information, which can also be provided as a safety case and possibly be assessed by an assessor.

The permit providers will check whether the requirements they formulated for step 3 of the lifecycle have been met.

Based on the specific application safety case and the safety assessment, the principal will decide whether it can accept the completed and validated system in terms of safety and grant clearance for operations to begin. Following acceptance, the safety case and OSP will be handed over to the principal of the operational phase (if the principal of this phase is a different party).

The principal of the operational phase will outsource the process associated with FRACAS.

Outcomes:

- Safety assessment report(s) [RD2, 5.5]
- Specific application safety case [ND2, 6.6, 6.9]; [RD2, 5]
- Delta List
- Validation documentation
- Risk analysis (appropriately adapted)
- Process for the collection and evaluation of operational data as a foundation for system improvement (FRACAS)

Step 10: System acceptance

The principal of the operational phase prepares the definitive version of the OSP and forwards it, together with documentation concerning the specific application safety case, to the supervisor and any other permit providers. In addition, the principal of the operational phase must also forward any applications for exemptions from the risk criteria. An operating permit must be applied for at the same time.

The supervisor will grant an operating permit for the light rail system in question on the basis of the OSP and safety case. Temporary, permanent and/or restrictive conditions may be attached to the permit.

Outcomes:

- Acceptance documentation (principal of realisation phase). The results of the acceptance test and validation process must be used to determine whether the system meets the established requirements.
- Operational safety plan (principal of operational phase). The infrastructure manager, transporter and traffic controller can use the principal's OSP to draw up their own OSP. If operations are to be launched in phases (trial runs), this process must be described separately in the OSP.
- Acceptance documentation for operational launch (supervisor). The supervisor will check whether the system can be used safely within the operational process as a whole and whether there are a sufficient number of trained personnel for operation and maintenance. This acceptance documentation concerns:
- Approval type:

  - transporter's safety system
  - approval of system in terms of infrastructure
  - approval of equipment in terms of type
- Authorisation to launch operations:
  - safety certificate (transporter)
  - approval of operations in terms of infrastructure
  - permission to use equipment
- Appropriately adapted hazard log.
- Complete set of operating and maintenance regulations (for both normal and disrupted operational circumstances).

3.4 Operation

This section of the chapter sets out the safety requirements that apply to the operation of the light rail system. Requirements governing operation are specified in steps 11 up to and including 14 of the lifecycle of a light rail project as presented above. The general principles and associated safety documents are the same as those referred to in section 3.2.

3.5 Requirements governing operation: the lifecycle

Step 11: Operation and maintenance
The principal must ensure that the required level of safety is maintained during operation and when maintenance work is being carried out. Among other things the principal must ensure, for example, that the system is operated in accordance with the operating instructions and maintained according to the maintenance instructions, making use of the safety management system described in the OSP when doing so. This system must define the respective roles of all parties involved.

Outcomes:
- Documentation of all safety-related duties performed
- Updated operation and maintenance documentation
- Updated FRACAS and hazard log

Step 12: Performance monitoring
In accordance with the OSP and FRACAS, the infrastructure manager, transporter and traffic controller must ensure that all statistical data on operational performance and safety is available on time during operation and when maintenance work is being carried out, as this will enable the supervisor to assess whether the system is being operated safely and take the necessary measures. The principal is responsible for maintaining an adequate level of safety. As the enforcer, the supervisor is responsible for coordinating and initiating corrective action.

The supervisor ensures that the system standards are permanently complied with.

Outcomes:
- Performance monitoring documentation (safety)
- Risk analysis

Step 13: Modification and augmentation
Any change to infrastructure, railway vehicles or method of operation may have an adverse effect on the previously achieved level of safety. For this reason, the principal, infrastructure manager, transporter and traffic controller must again proceed through the relevant steps of the lifecycle and appropriately adjust the safety case for every modification and augmentation. The supervisor must ensure that this occurs correctly.

The designer, builder and assessor can be engaged if new development work is required.

Outcomes:
- Modification and augmentation documentation. Sometimes this simply means adjusting the safety case, whereas on other occasions product development may be required
- Verification, validation and acceptance reports

- Appropriately adjusted OSP, safety case and hazard log
- Appropriately adjusted safety documentation
- A formulated process to manage system modifications and augmentations within the context of safety

Step 14: Discontinuation of operation and removal

Specific safety issues such as those related to asbestos, for example, arise when the system is taken out of operation. The infrastructure manager, transporter and traffic controller are responsible for ensuring that these issues are dealt with properly. The supervisor must exercise appropriate supervision while permit providers are responsible for granting the permits required.

Outcomes:

- Discontinuation of operation and removal plan and associated documentation
- Appropriately adjusted OSP and safety case

4 Checklist for light rail development

This chapter applies to all light rail projects and contains a point-by-point summary of the lifecycle of a light rail project as a supplement to the explanation provided in Chapter 3.

Step 1: Concept
- Describe the area involved, context and purpose of the light rail project.
- Describe the wider environment:
    - physical aspects
    - possible issues in relation to the system interface
    - social issues
    - political issues
    - legislative issues, byelaws and permits required
- Describe the performance of the current system in terms of safety:
    - consult the available statistics on accidents and case histories
    - identify existing problem areas in terms of safety
- Describe the existing approach to safety:
    - working method and management
    - quantitative objectives

Step 2: System definition
- Describe the infrastructure:
    - planned/existing railway line and associated characteristics
    - planned stations and associated characteristics
- Describe the operating profile:
    - type of trains
    - frequency of train services
    - number of passengers to be transported by time of a day and the stations served
    - train schedules of third parties with which interaction may occur
- Describe the operative circumstances:
    - buildings/residences in the vicinity of the railway line
    - the presence of concentrations of people with special care needs: schools, psychiatric institutions, hospitals
- Describe potential interaction with third parties:
    - other railway users
    - other road users
- Prepare an Integral Safety Plan (ISP). The ISP must specify the following:
    1. The policy and strategy aimed at the achievement of safety.
    2. The area to which the ISP applies.
    3. The right rail system.

4. The roles, responsibilities, powers and relationships of organisations that perform duties within the lifecycle.
5. The lifecycle of the system and the safety-related duties, also with respect to any secondary matters, that must be performed within the lifecycle.
6. The safety analysis, construction and assessment processes that must be adhered to and completed during the lifecycle.
7. Data of all safety-related lifecycle outcomes, such as documentation, equipment and software.
8. A process for drawing up the system's safety cases.
9. A process for approving the system in terms of safety.
10. A process for approving system modifications in terms of safety.
11. A process for analysing operational and maintenance performance to ensure that the level of safety achieved meets the established requirements.
12. A process for updating documentation relating to safety, such as the hazard log.
13. Interfaces with other associated programmes and plans.
14. Limitations and assumptions formulated in the plan.
15. The ways in which subcontractors will be managed.
16. Requirements for the periodic safety audits, safety analyses and safety assessments to be carried out during the lifecycle that are relevant to the safety of the system in question, including requirements governing the independence of personnel.

- Select an assessor and consult the assessor about the safety plan.
- Submit the ISP to the supervisor for approval.

Step 3: Risk analysis

- Systematically identify all foreseeable hazards. These hazards could be classified as follows:
    1. Collisions
    2. Accidents on signed crossing points
    3. Accidents involving passengers at stations or stops
    4. Derailments
    5. Accidents involving road traffic (including parallel railways)
    6. Collisions with people, animals and objects; instances of suicide
    7. Accidents in tunnels
    8. Collisions with personnel
    9. Other aspects

- Identify scenarios (sequences of events) that can lead to hazards.
- Evaluate the manifestation frequency of each hazard.
- Evaluate the possible consequences of each hazard.
- Evaluate the risk of each hazard for the system.
- Start a hazard log to ensure continuous attention to safety. This hazard log must be updated as soon as a hazard manifests itself or a new hazard is identified.
- Make an inventory of permit provider requirements in relation to safety.

Step 4: System safety requirements

- Specify the system safety requirements.
- Specify acceptance criteria applicable to the safety requirements.
- Prepare a plan for the demonstration and acceptance of safety requirements. This plan must at least include:
- a description of the system
- the principles governing the validation of the safety requirements
- the tests and analyses to be performed, including details about the environment, resources, facilities, etc. required
- details bout the validation programme (sequence and planning)
- procedures governing the action that must be taken if requirements are not met

- Design the Failure Reporting, Analysis and Corrective Action System (FRACAS).

Step 5: Allocation of the system safety requirements

- Specify the safety requirements governing the subsystems, components and external systems.
- Specify the acceptance criteria applicable to the subsystems, components and external systems.
- Specify the procedures applicable to the acceptance of the subsystems, components and external systems.
- Review the Integral Safety Plan (ISP) and validation plan to ascertain whether it is consistent with the allocation of the system safety requirements. Insofar as necessary, update both plans. Pay particular attention to the independence of personnel and to the interfaces between systems at which safety could be compromised.
- Present the system and subsystem requirements in their entirety to the supervisor for purposes of information.

Step 6: Design and introduction

- Design the subsystems in such a way as to ensure that they meet operational requirements.
- Build the subsystems in such a way as to ensure that they meet operational requirements.
- Prepare plans for installation, delivery, operation and maintenance, and for the collection of practical data and the evaluation of this data.
- Prepare a generic safety case of the system which demonstrates that it meets the established safety requirements.
- Insofar as meaningful in this phase, prepare a safety case on the basis of the generic safety case for system applications.
- Integrate the safety cases of suppliers in an overarching safety case.
- Check whether the light rail system meets the established risk criteria.
- Present the design and safety cases to the supervisor.

Step 7: Manufacture

- Verify and introduce the production process.
- Introduce supporting regulations for subsystems and components by, for example, preparing relevant documentation, operating and maintenance procedures and training material.

- Organise the production process in such a way as to ensure that the products meet the established safety criteria.

Step 8: Installation

- Assemble and install all subsystems, components and external aids to form the whole system.
- Document the installation of the system.
- Review and update the ISP once installation has been completed. This will enable all changes in the system and/or in procedures to be recorded and properly managed in later phases of the lifecycle.
- Start training personnel and put maintenance procedures in place, and a system that ensures sufficient reserve parts and resources.

Step 9: System validation

- Validate the total system according to the validation plan and record the process.
- Put the system into operation according to the operational launch plan and record the process.
- If necessary, initiate a trial run period.
- Prepare a safety case for applications of the system insofar as one was not already prepared as part of step 6.
- Put a procedure in place for the collection and evaluation of operational data as input for a process of continuous safety improvement.

Step 10: System acceptance

- Assess the outcomes of all verification and validation activity, in particular the specific application safety case.
- Accept the system if the assessment is positive.
- Record any remaining hazards (identified during the system validation or acceptance process) in the hazard log.
- The supervisor will grant an operating permit for the light rail system on the basis of the assessment.

Step 11: Operation and maintenance

- Monitor the performance of the light rail system in terms of safety.
- Ensure that the light rail system continues to meet safety requirements by:
  - carrying out regular reviews and updates of the operation and maintenance procedures
  - carrying out regular reviews of the training documentation
  - carrying out regular reviews and updates of the hazard log and safety case

Step 12: Performance monitoring

- Put a procedure in place for the collection of operational data and for deriving information concerning safety.
- Analyse the information about safety and use the outcomes of this analysis to improve the operation and maintenance procedures and the logistical support of the light rail system.

Step 13: Modification and augmentation

- Document the activities required for the modification or augmentation
- Prepare a safety plan for the modification or augmentation.
- If necessary, adjust the safety case.

Step 14: Discontinuation of operation and removal

- Document the activities required for the discontinuation of operation and removal.
- Update the hazard log.
- Prepare a safety plan for the discontinuation of operation and removal.
- If necessary, adjust the safety case.

Appendix A Abbreviations

BS	British Standard
CENELEC	European Committee for Electrotechnical Standardization
EN	European Standard
OSP	Operational Safety Plan
FRACAS	Failure Reporting, Analysis and Corrective Action System
HR	Heavy rail
ISA	Independent Safety Assessor
ISP	Integral Safety Plan
IVW	Inspectorate for Transport, Public Works and Water Management
LR	Light rail
RAMS	Reliability, Availability, Maintainability, Safety
SMS	Safety Management System

Appendix B List of Terms

Agglo: from ‘agglomeration’; the reference is to a city and its suburbs as a functional whole.

Decision maker: a party that makes decisions about the introduction of light rail systems in terms of, inter alia, the route of the railway line and issuing clearance for realisation. A decision maker may be associated with a controlling body that checks whether the plans submitted fit within the mobility policy.

Driver responsibility (basic system concept): light rail traffic based on a safety concept aimed at guaranteeing a safe railway line on the basis of driver responsibility for appropriately adjusting the direction and speed of travel according to circumstances in the wider environment.

Builder: builds and installs infrastructure or mode of transportation and ensures that the two form an operative whole.

Emergency organisation: the sum total of organisations that provide emergency services or contribute to restoration after emergencies.

Delta List: list of light-rail-system deviations relative to heavy rail standards. This list includes (references to) the associated risk analyses and the additional measures formulated on the basis of these analyses. In addition, the list demonstrates that the measures are suitable for this purpose.

Fatality: a condition resulting from injury which leads to death within 30 days of having sustained the injury.

Hazard: the possibility of injury and/or damage occurring.

Hazard log: the document that records or refers to all activities relating to safety management, identified hazards, decisions made and solutions adopted.

Operational launch: a generic term for activities performed to prepare a system or product for operation prior to demonstration that it meets the specified requirements.

Initiator: the party that initiates the development of a specific light rail system.

Integral Safety Plan (ISP): a documented collection of planned activities, resources and events and their associated timeframes. This plan is required for the introduction of the organisational structure, procedures, activities, professional expertise and resources that are required to ensure that a system or product will meet the requirements set out in a contract and/or as part of a given project.

Injury: human contact with a source of energy or substance that exceeds the human being’s physical and/or psychological capacity to absorb such contact.

Lifecycle: the series of activities and events that occur from the point at which a system is conceptualised to the point at which it is no longer viable and taken out of operation.

Light rail: a rail transport system aimed at integrating urban with public transport infrastructure in terms of light rail and bus services or optimising light rail and bus networks, whether or not in combination with heavy rail services. Within the context of cities and their suburbs, this aim is referred to as ‘agglomeration’ or ‘agglo’ in short.

Standard setter: establishes generic requirements relating to safety and functionality in the interests of society at large.

Neighbouring residents: individuals who do not reside within the boundaries of the rail traffic system but who are nevertheless affected by it.

Unauthorised person: a person present within the boundaries of the rail traffic system without due authorisation, not including persons with suicidal tendencies.

Designer: the designer is responsible for the design and development of transport, infrastructure and operation, including the service schedules.

Principal: puts a project out to tender and bears responsibility for ensuring that safety standards are met.

Signed crossing point: a level crossing point at which a train or tram railway intersects with a road and which is indicated by crossbucks (St Andrew’s Crosses).

Signed crossing point user: persons on signed crossing points, with the exception of persons who are at such crossing points for professional reasons, persons on service crossing points and those with suicidal tendencies. Depending on the location of a given incident, signed crossing point users can be subdivided into two groups:

- persons on passenger crossing points (whether or not with inter-neighbourhood connections)
- persons on other crossing points (whether public or otherwise)

Personnel: persons who are in the rail traffic system for professional reasons.

Rail traffic system: the sum total of people, resources and methods that make a direct contribution to rail traffic within a railway network.

Passenger: a person travelling in, or boarding or disembarking from a railway vehicle, on a platform or travelling to or from a platform, including one making use of stairs, an escalator or lift to do so. Persons engaged in these activities for professional reasons or those with suicidal tendencies are not considered passengers.

Passenger crossing point: a level crossing point at which a train or tram railway intersects with a footpath intended solely to enable passengers to access platforms.

Risk: the probability of an injury-causing hazard manifesting itself, as well as the seriousness of injury such a hazard could cause.

Risk analysis: an activity performed to ascertain the level of risk in a given environment and based on technical evaluation and mathematical models used to integrate the estimated consequences and frequency of a given incident.

Risk bearer: a person present in the rail traffic system who may sustain an injury or be killed as a result of a light rail system in operation.

Safety case: documented evidence that a product meets the specified safety requirements.

Parallel railway: a train or tram railway that parallels a road or is flanked by road traffic lanes.

Person with suicidal tendencies: a person who has the apparent intention to commit suicide in and by means of the rail traffic system.

Assessor (Independent Safety Assessor, ISA): an independent party that assess whether safety-related process and performance standards are being met.

Supervisor: exercises supervision on a project and subsequent operation of a project's outcome to ensure that safety standards are continuously met, advises the standard setter and provides information to the parties involved.

Validation: confirmation by means of investigation and the acquisition of objective evidence that certain requirements governing a specifically intended use have been met.

Safety: the absence of unacceptable risks.

Light Rail Safety Committee: a committee set up by the Dutch Ministry of Transport, Public Works and Water Management to process changes into and update the Normative Document for Light Rail Safety.

Safety Management System: the sum total of project management components and professional duties made available and performed throughout the lifecycle that enhance the level of safety.

Permit provider: sets requirements in relation to the design concerning the prevention and management of emergencies.

Verification: confirmation by means of investigation and the acquisition of objective evidence that specific requirements have been met.

Traffic controller: allocates available capacity and ensures the safe control of the traffic process.

Transporter: is responsible for the realisation and maintenance of the transport process and the management and maintenance of railway vehicles.

Fully safe (basic system concept): light rail traffic based on a safety concept aimed at guaranteeing a safe railway line on the basis of technical systems and an operating environment which excludes other road traffic and pedestrian traffic.
Crossing point: A level crossing point at which a train or tram railway intersects with a road.

Crossing point users: Persons on crossing points that are not signed. Not included in this category are persons who are at such crossing points for professional reasons, persons on service crossing points and those with suicidal tendencies. The ‘crossing point users’ category can be subdivided as follows, depending on the location of a given incident:

- persons on passenger crossing points (without an inter-neighbourhood connection)
- persons on other crossing points

Road traffic: pedestrians, vehicle drivers and users of bicycles and mopeds, of vehicles for the disabled, of vehicles not on rails, horse riders, persons controlling riding animals, draught animals or cattle, and drivers or passengers of carriages, irrespective of whether such carriages are pulled by draught animals or not [RD4].

Appendix C Associated safety documents

The associated safety documents listed below are normative; that is, they apply to the activities carried out within the context of a project. In the case of conflict between different requirements within one document or between the requirements in various documents, the most restrictive requirement shall be binding.

[ND1] Rail Safety Policy Document (*Kadernota Railveiligheid*), July 1999 version, Directorate for Traffic and Vehicle Safety of the Dutch Ministry of Transport, Public Works and Water Management.

The Rail Safety Policy Document sets out the national government's vision concerning the safety of rail transport in the Netherlands. Policy spearheads have been formulated for situations in which the level of safety is deemed to be insufficient.

[ND2] NEN-EN 50126, Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS), CENELEC.

[ND3] Railned, M-001; Rail Safety Approval Requirements governing Rolling Stock (*Toelatingseisen Rollend Materiaal Spoorveiligheid*), 24 June 1998.

Appendix D References

The following documents were used in the preparation of this Normative Document.

[RD1] EN 50128, Railway applications - software for railway control and protection systems.

This European standard specifies the methods that must be used to ensure the supply of software that satisfies requirements concerning the integrity of safety. These methods are based on system safety requirements. The document describes all five software integrity levels.

[RD2] ENV 50129, Railway applications – safety-related electronic systems for signalling.

This European standard specifies the requirements that apply to the acceptance and certification of safety-related electronic signalling systems. This standard furthermore specifies the hardware requirements and the combined hardware/software requirements. Requirements governing software are set out in [RD1].

[RD3] IEC 61508, Functional safety - safety-related systems.

International standard for electrical, electronic and programmable electronic safety-related systems. This standard is similar to the previous CENELEC standards referred to above but does not relate specifically to railway systems and has been listed here for purposes of information and as a supplement to the CENELEC standards.

[RD4] Dutch Traffic Code (*Reglement Verkeersregels en Verkeerstekens*, RVV 1990).

[RD5] BS 8800, Guide to occupational health and safety management systems, British Standard, ISBN 0 580 25859 9.

This British standard sets out requirements and guidelines for safety in the operational phase. The emphasis is on organisational aspects such as those concerning, inter alia, personnel, customers, suppliers and stakeholders.