DUTCH
SAFETY BOARD

Summary
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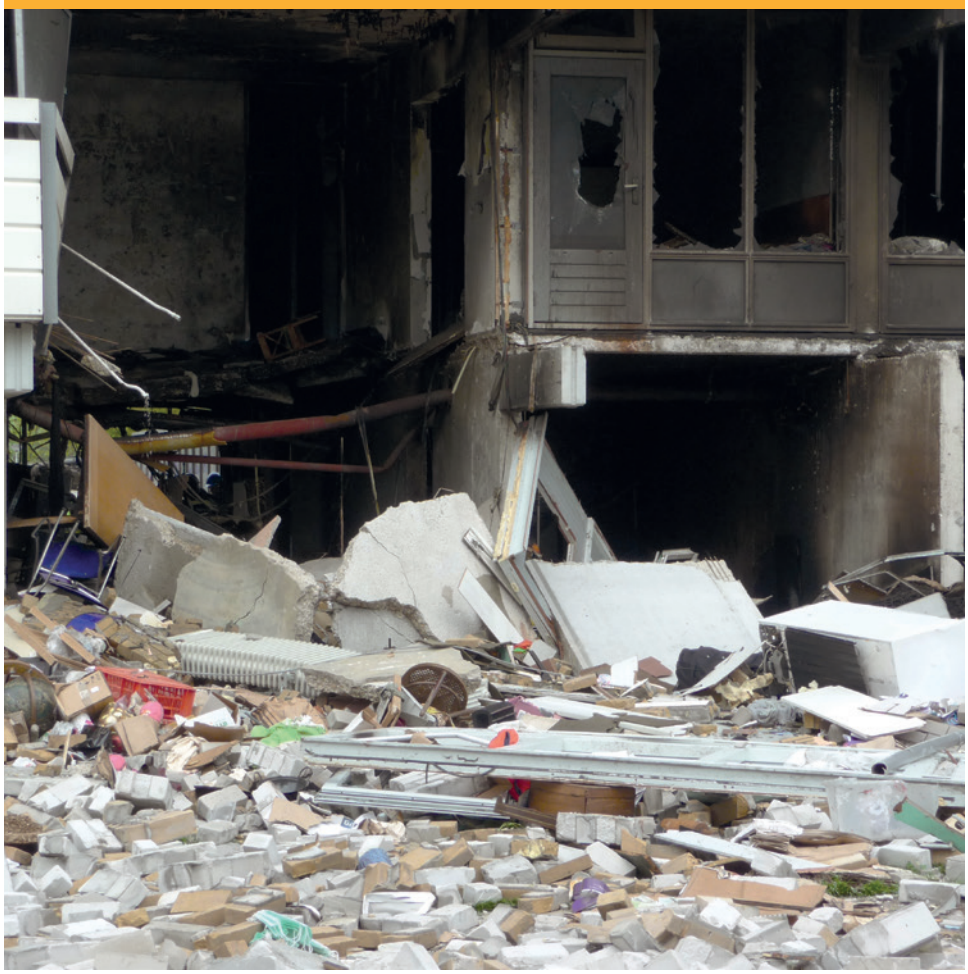
Lessons from the gas explosion in Diemen



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Lessons from the gas explosion in Diemen

The Hague, May 2015

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Dutch Safety Board

The aim in the Netherlands is to limit the risk of accidents and incidents as much as possible. If accidents or near accidents nevertheless occur, a thorough investigation into the causes, irrespective of who are to blame, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Board itself selects the issues it wishes to investigate, mindful of citizens' position of independence with respect to authorities and businesses. In some cases the Dutch Safety Board is required by law to conduct an investigation.

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NB: The full report is published in the Dutch language. If there is a difference in interpretation between the Dutch report and English summary, the Dutch text will prevail.

SUMMARY

Reason for the investigation

On 4 September 2014 an explosion occurred in De Beukenhorst, an apartment building in Diemen. Demolition work was taking place that day to renovate a lift of the building. An iron pipe sleeve in the foundations of the entrance near the lift was thought to be an empty pipe, which the workmen attempted to remove with a crane. What the workmen on the construction site were unaware of at that time was that the pipe contained an operative gas line. Beyond the sight of the workmen, the manipulations by the crane caused a connecting unit of the gas pipe to detach allowing gas to escape and flow into the apartment building. The gas accumulated in various spaces on the ground floor of the building and subsequently ignited. Two people died during the explosion and 15 people were injured. The material damage was huge. Alternative accommodation was found for around 200 residents covering the days after the accident; 32 apartments were so severely damaged that they were uninhabitable for months.

Gas leakage resulting from construction and excavation work frequently occur in the Netherlands. In 2013 more than five thousand disruptions to gas lines occurred as a result of excavation damage. In three quarters of all cases connection pipes were affected, i.e. the pipes that connect users to the gas main. The explosion in Diemen shows that in certain circumstances a gas leak can have extremely serious consequences. During its investigation into the causes of the accident, the Dutch Safety Board found that while the contractor did request information about the presence of underground pipes during preparations for the excavation work, a crucial lacuna occurred in the process of collecting information. A second category of causes relates to the actual execution of the work, in which not all aspects of the designated guideline on prudent excavation practices were adhered to. Thirdly, the manner in which the parties concerned acted after a gas leak had occurred, had an impact on the consequences of the explosion that followed. The Dutch Safety Board wishes to formulate lessons learned from these three topics in order to improve safety during excavation work and to avoid a repetition of the Diemen incident.

Exchanging information on connection pipes in the gas network

One of the main causes of the accident was that the contractor had no information about the presence of a house service connection pipe in its working area. This initially relates to the fact that house service connection pipes do not fall under the scope of the Underground Grids (Information Exchange) Act (WION) and have an exceptional status in the exchange of information with the Cables and Pipelines Information Centre (KLIC). At the time the WION was drafted, network operators (mainly the municipalities) insisted on an exception clause because the integral inclusion of all house service connection pipes (of all networks, including the sewerage system, for instance) in the digital information system would be very labour-intensive, and too costly as a result.

The WION stipulates that excavation contractors (the parties responsible for excavation work) must submit notification of the intended excavation work in advance to the KLIC (when mechanical equipment is used). The KLIC is responsible for passing on information about underground cables and pipes owned by network operators to excavation contractors. Network operators use a Geographic Information System (GIS) which contains the location of the cables and pipes in their network. Most gas network operators have recorded most connection pipes in the GIS, with the exception however of two major network operators. To them, drawings of the connection pipes that have not been incorporated into the GIS are only available as loose-leaf drawings.

The information on connection pipes near the De Beukenhorst apartment building had not been included in the GIS of the network operator concerned (Liander) at the time the contractor submitted notification of the excavation work. The contractor stated in the KLIC online notification system for excavation work that it wanted to receive separate drawings of the house service connection pipes. The contractor used the address automatically generated by the system as the 'closest address' for this purpose. However, in reality this address was located beyond the contractor's intended working area. This meant that the contractor received a drawing of an irrelevant house service connection whilst it lacked the information about the house service connection that was in fact located in its working area. Unaware of the information mix-up that had occurred in processing the notification of excavation submitted, the contractor began the work assuming that it had received all the information about the gas pipes located in its working area.

In the current situation, in which separate drawings of house service connections must be requested separately, obtaining the correct (relevant) details about house service connections depends on how familiar the excavation contractor is with the local situation. Especially where apartment buildings are concerned, there is a greater likelihood of the excavation contractor receiving incomplete or incorrect information given that the situation surrounding house service connections in the case of stacked buildings may not be clear. Moreover, connection pipes in the gas network are potentially more dangerous because these pipes are always located close to buildings and if a gas leak occurs, there is a risk that gas will accumulate inside a building.

The Dutch Safety Board concludes that connection pipes in the gas network pose a higher risk in the event of excavation damage. This safety risk is caused by the fact that network operators are under no obligation to provide information on connection pipes when notification of excavation work is submitted. This means that until such time as a network operator has vectorised location information about house service connections (vectorisation in this case means recording location details in the GIS that provides input for a notification of excavation), the area information in a notification of excavation will not contain any information about house service connections. The forthcoming amendment of the WION does not provide a swift solution to this problem, given that a lengthy transitional period of eight years has been proposed for the vectorisation of connection pipes.

Prudent excavation practices

To minimise the risk of excavation damage to cables and pipes it is vital that excavation contractors take measures to avoid it. Interested parties have therefore drawn up the 'Prudent Excavation Practices' guideline. Working in accordance with this guideline provides clients, excavation contractors (under whose responsibility excavation work is carried out) and the actual diggers the tools with which to carry out excavation work prudently and therefore safely.

There was no lack of clarity in the agreements and collaboration between the client, the contractor and the sub-contractor in the De Beukenhorst project on the division of responsibility for working safely with respect to the presence of underground pipes. The contractor was in charge and took the necessary action to obtain information about underground pipes. However, a number of observations can be made about the manner in which the parties concerned took responsibility for carrying out the excavation work safely. In particular, this concerns the fact that the contractor failed to submit notification of excavation shortly before commencing the excavation work to ensure that it had the latest information about the underground pipes, and the contractor's decision to remove an unknown pipe without knowing for certain what type of pipe it was. When carrying out the work, the contractor, which only carries out excavation work on an ad hoc basis, was not fully aware of all the requirements and backgrounds that must be taken into account to ensure 'prudent excavation practices'. This equally applies to the actual digger (the sub-contractor), because he could have pointed out to the contractor that removing the unknown pipe conflicts with the principle of 'prudent work practice'.

Whilst making preparations for the work, the housing association, as the client, did not actively obtain information about the underground pipes which might have been relevant to the contractor. In this regard the housing association failed to undertake every effort to ensure that the contractor could perform the work as safely as possible and failed to act as a prudent client.

The Dutch Safety Board believes that safe work practice and thus responsible business practice is contingent on compliance with the 'Prudent Excavation Practices' guideline. Apart from agreeing on who would submit notification of the excavation work, the parties involved in making preparations for the De Beukenhorst construction project failed to ensure that they would work in accordance with the 'Prudent Excavation Practices' guideline, which is the standard applied not only by the sector but also by the supervisory authority. Working in accordance with the guideline could, for instance, have been incorporated into the Health and Safety Plan for both the design and execution phases.

Action taken after discovering excavation damage to a gas pipe

During the investigation into the manner in which the parties acted after detecting excavation damage to a gas pipe, apart from the explosion in Diemen, a similar gas explosion was examined that had taken place in The Hague on 10 November 2014. In the incidents in Diemen and The Hague, in accordance with the applicable agreements the parties concerned had telephoned the network operator to report a gas leak. Based on the information given during the telephone conversation, the staff member of the Fault-Clearing Service had not assessed the report as 'very urgent'. The staff member failed to adhere to the network operator's questioning protocol. No further action was undertaken

on site other than waiting for the gas technicians to arrive. The fire brigade had not been alerted either. During both incidents, bystanders and residents had not been actively warned and the workers remained in the area where gas had been detected. The 'Prudent Excavation Practices' guideline, however, describes the evacuation of an excavation site as one of the measures to be taken after discovering a gas leak. The Dutch Safety Board furthermore believes that the fire brigade should have been alerted on account of the proximity of buildings.

Failure to take precautionary measures at the excavation site in Diemen can be explained by the fact that none of those present on the work site had any notion of how dangerous the actual situation was. The danger was hidden from view, inside, behind the facade of the apartment building and the leaking gas pipe could not be seen directly. Moreover those present did not smell the gas continuously, but in 'whiffs'. Because the gas had accumulated in the building and only flowed into the outside air in small quantities, those present believed that the outflow of gas was no great concern.

The staff of the network operators' Fault-Clearing Service who had been notified of and had assessed the gas leak likewise failed to recognise the acute unsafe situation. They are required to gain a picture of a remote situation based on sketchy information given by telephone. A binding questioning protocol that does not offer the option of skipping questions can help Fault-Clearing Service staff recognise hazardous situations. This is particularly important if the notifying party itself, as was the case in Diemen and The Hague, does not indicate that the situation carries a high risk.

The Dutch Safety Board concludes that during the explosions in Diemen and in The Hague casualties occurred because workers at the excavation site and bystanders found themselves close to the gas leak. The fact that those present failed to move to a safe distance or were not sent away relates to the assessment of the dangerous situation at that time. In hindsight the dangerous situation was underestimated by both the groups of workmen on site and the network operators' Fault-Clearing Services. The immediate proximity of buildings was a major hazard risk indicator, but was not recognised as such in either case.

Recommendations

The Dutch Safety Board views the events that resulted in the gas explosion in Diemen as a combination of circumstances with significant instructional value for all parties involved in excavation work. Based on the investigation into this explosion, the Dutch Safety Board has established that there are three topics where improvements can be made to ensure that the risks of excavation damage to gas pipes and thus the risk of explosion can be controlled more effectively.

Information about house service connections in the gas network

In the Dutch Safety Board's opinion, improving the exchange of information on house service connections in the gas network will reduce the risk of accidents, such as that in Diemen. This can be achieved by ensuring in the shortest term possible that all house

service connections are visualized directly in the area information obtained when submitting notification of excavation work. The Dutch Safety Board has formulated the following recommendations:

To the Minister of Economic Affairs:

1. Ensure that house service connections to the gas network directly fall within the scope of the WION to ensure that the exceptional status of these pipes in the WION is eliminated. One way of doing so is to include the mandatory provision of location information on house service connections to the gas network without a transition period in the draft amendment of the WION.

In the run-up to implementing the first recommendation, the Dutch Safety Board recommends that the gas network operators make the necessary preparations. Moreover, during the period in which separate drawings of house service connections must still be requested, increased vigilance is called for when notification of excavation work in the vicinity of a high-rise building is submitted.

To the gas network operators, namely Cogas Infra en Beheer, DELTA Netwerkbedrijf, Endinet, Enexis, Liander, RENDO Netwerken, Stedin and Westland Infra:

2. Ensure that house service connections to the gas network are vectorised and included as quickly as possible in the Asset Registration System (BMR), so that those connections are highlighted directly in the area information obtained when submitting notification of excavation work and there is no need for the excavation contractor to ask for separate loose-leaf drawings of house service connections. Coordinate with the supervisor of Gas Act compliance (State Supervision of Mines (SodM)) to agree on a realistic but ambitious time frame in which to implement this. During the period in which information on house service connections still need to be requested separately, the network operator must proactively inform the excavation contractor about house service connections to the gas network if excavation work is carried out in the vicinity of complex buildings with multiple connecting pipes.

Work in accordance with the 'Prudent Excavation Practices' guideline

The Dutch Safety Board believes that safe work practice and thus responsible business practice is contingent on compliance with the 'Prudent Excavation Practices' guideline. 'Prudent excavation practices' as set out in the guideline should take precedence for both clients and excavation contractors. This equally applies to contractors who are less familiair with excavation works, such as construction companies. We call on the sector associations of the relevant parties involved to promote this process.

To the sector organisation Bouwend Nederland, Aedes (the National Organisation for Housing Associations), and the Association of Netherlands municipalities (VNG):

3. Bring to your members' attention that during excavation work, even if performed on an ad hoc basis, safe work practice is contingent on compliance with the 'Prudent Excavation Practices' guideline. The objective is to ensure that your members safe-guard the work practice set out in the 'Prudent Excavation Practices' guideline in

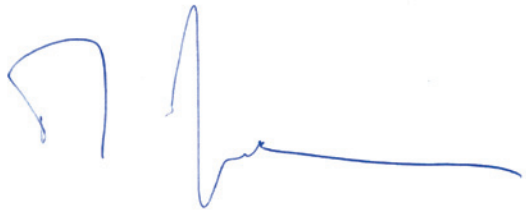
their work processes if excavation work subject to the WION is to be carried out. One way of doing so is to include the relevant instructions in the guideline in the contract and in the Health and Safety Plan for the design and execution phases in the preparatory phase of construction projects.

Taking action in the event of excavation damage to gas pipes

The Dutch Safety Board considers that the assessment of dangerous situations by network operators when excavation damage to gas pipes is reported must be improved, to ensure that reports involving the risk of a gas explosion are recognised as such and that appropriate measures are imposed.

To the sector organisation for energy network operators (Netbeheer Nederland) and the gas network operators, Cogas Infra en Beheer, DELTA Netwerkbedrijf, Endinet, Enexis, Liander, RENDO Netwerken, Stedin and Westland Infra:

Improve the ability of the Fault-Clearing Services to recognise high-risk situations when excavation damage is reported by telephone. Train the staff of the Fault-Clearing Services to use binding questioning protocols to enable them to identify hazard risk indicators and instruct the party making the report to take appropriate precautionary measures.



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