# ISC Webinar Questions

## Q1 is ammonia flammable, what is the MIE? Which conditions favour flammability?

As per the Globally Harmonised System of Classification, ammonia is categorised as a flammable gas, and this is the description that will be found on its *Material Safety Datasheet* (MSDS).

Ammonia fires and explosions are very rare, however, owing to some of its unique physical properties. Firstly, it takes a huge amount of spark-energy to ignite ammonia, and its auto-ignition temperature is also unusually high. Perhaps more importantly, ammonia will not burn in the open air, as it is doubtful that the required concentration of 15+% could ever be attained.

Despite these characteristics, there are precedents for ammonia explosions. Trevor Kletz has a whole subchapter in *What Went Wrong?* entitled *I didn't know that ammonia can explode*.

If we compare some of the characteristics of ammonia and methane (natural gas), both of which were released in the Jonava incident, it is easy to see what caused the fire:

**Categorisation:**
Ammonia: Category H221 flammable gas
Methane: Category H220 extremely flammable gas

**Minimum ignition energy of mixture in air:**
Ammonia: 680 mJ
Methane: 0.3 mJ

**Auto-ignition temperature:**
Ammonia: 651°C
Methane: 580°C

**Flammability range:**
Ammonia: 15 – 28%
Methane: 5 – 15%

## Q2 Were the responders trained or briefed through HAZOP or similar hazard analysis methods on managing ammonia releases under different conditions?

I haven't heard of HAZOP being used as a tool used in incident response.

## Q3 How much of ammonia was released?

7,000 tonnes.

## Q4 With the plant being situated so close to the river, was there any spill of ammonia directly into the river? And what clean up was required if applicable?

As mentioned by Mindaugas there was no spill to the river. This is supported by the reference material that I have been able to find.

## Q5 What was the real cause of tank failure?

The official investigation concluded that a rollover had occurred and that the sudden release of gas overwhelmed the relief valves. In reality, the relief valves were not large enough to cope with the steady boil-off generated by the warm ammonia, with the term 'thermal overload' best describing this.

The excessive pressures generated in the tank resulted in its failure. However, this failure was unusual in that it occurred at the base of the tank rather than at its roof-to-shell seam. Some engineers at the Russian design house presented a conference paper on the failure mode of the tank from a civil/structural point of view.

https://scholarsmine.mst.edu/cgi/viewcontent.cgi?article=2913&context=icchge

## Q6 What is the occupancy of the white building today?

As mentioned by Mindaugas, the white building in the vicinity of the modern day ammonia storage tank houses the reliquification compressors, and 4 people work there.

## Q7 Why is a 10,000 tonne atmospheric pressure cryogenic ammonia tank not equipped with a bundwall?

There is no isolation embankment and it is not needed, because the current tank design is a tank within a tank, that is, if the inner tank ruptures, all the ammonia will collect in the outer tank and liquid ammonia will not enter the environment.

## Q8 Was there an inert gas blanketing system in place?

Yes, but if a lot of ammonia spills out, it still won't help.

## Q9 Have there been any technological advancements in ammonia storage, detection systems, or containment measures since the incident that might prevent similar events from occurring today?

Yes, as I mentioned, all possible security measures were installed during the construction of the new storage facility.

## Q10 I assume the tank overpressure scenario was not identified. Was a HAZOP conducted? (perhaps not given the date), and if not, were there any investigation recommendations about more systematic hazard identification?

A HAZOP was carried out during the construction of the new storage facility

## Q11 The modern tank, is that a full containment tank?

Yes, it's a full isolation tank.

## Q12 Was the air-gapped base design of the tank contributory to the incident? If it was on a concrete apron with electric base heating (like an LNG tank), would the tank still have failed?

The structural solutions of the old tank certainly had an impact on the accident; if the design had been different, the accident might not have happened, but this is impossible to verify.

**Q13 What I see in the modern plant shown here is no secondary containment dike, or am I mistaken?**

Yes, there is no isolation embankment and it is not needed, because the current tank design is a tank within a tank, that is, if the inner tank ruptures, all the ammonia will collect in the outer tank and liquid ammonia will not enter the environment.

**Q14 Given recent advances in process hazard analysis techniques and greater awareness of low probability, high consequence process safety accidents, are there any examples of retrospective land use planning regulation reviews to ensure exposure of public to toxic gas release is minimised?**

There is a safety zone around the factory where no economic activity is permitted, but the size of the safety zone has not been changed either after the accident or at the present time.

**Q15 Dr Ewan Stewart mentioned that there was no safety culture at the time as there is today, may I ask for a few safety controls applied due to this incident? And if there are others points that come to mind that have been applied not just because of this incident to give us as examples please do say.**

I think I answered this question a couple of times during the webinar.

**Q16 What kind or type of mitigative barrier should be installed on ammonia tank? (especially for spray system to absorb ammonia, just in case leakages occurred)**

Capturing ammonia with water is a good idea, and a fire truck that sprays water as a mist is a great way to do this. Depending on the amount of ammonia released, you may need more than one truck.

**Q17 Were safety auditing and training carried on periodic basis and being hazardous installation was it closely monitored by the staff?**

As I mentioned in the presentation, this is done periodically.

**Q18 What has been learned from the technical emergency response methods during this accident and are these learned lessons still being used in the current plans?**

Yes, a lot has been learned from each such accident, and when predicting possible accident scenarios, this is undoubtedly assessed and measures are planned to minimise the consequences.

**Q19 Can anyone take the webinar on Isobutylene, c4 affiliate handling and storage, hazards and risk management And emergency response plant for iso-butylene?**

I don't know much about iso-butylene. May be one for Deb to investigate.

**Q20 The tank ruptured at that time was a single-sided ammonia tank, insulated using perlite is that correct?**

Yes, that's correct. The tank was carbon steel with a wall thickness of 20-35mm. It was thermally insulated with 700mm of perlite covered by a steel jacket.

## Q21 Was there inspection carried out at this tank before the rupture?

Yes, periodically inspections.

## Q22 As I understood your presentation - was there also a failure to deliver the design of the tank and facility? a common scenario in the USSR.

I'm not sure. I did see some media speculation around whether the tank was constructed properly, however I've tried to stick to the established facts.

Certainly the containment wall should have resisted the impact if it had been built to its 400mm thickness specified during the design. This would have contained the released ammonia, which would have then evaporated over five-six days according to one source.

## Q23 Were often poor quality materials got through the soviet controlled inspection processes?

Yes, it is likely that this was one of the causes of the accident.

## Q24 What kind of inspection can company do to find similar failure like this tank before the accident?

I am not a specialist in inspecting pressure equipment, so I cannot answer this question.

## Q25 Was an Occupied Building Risk Assessment (OBRA) carried out based on the location/distance of the white building from the ammonia tank?

OBRA assessment not performed.

## Q26 In HAZOP we recognised practice – 'no double jeopardies' when analyse nodes. So, with this accident whether refrigeration loop fails and warm ammonia back flow to tank - should we abandon concept of 'no double jeopardies ' when conducting HAZOP?

A HAZOP would definitely have identified both the back flow and loss of reliquefication as sources of overpressure, and an action would have been raised to eliminate or reduce the backflow.

I don't know the exact details of the operator error that allowed the backflow, and so it is difficult to answer. API 521 defines double jeopardy as "the simultaneous occurrence of two or more unrelated causes of overpressure" and states that this is "not a basis for design". A reliquefication loop relies on various pumps, compressors, valves and instruments. As such, I'd maybe consider it as a control which may or may not be available at the time of the relief event rather than a cause of overpressure in itself. As such, I would have thought that the PSV sizing should take no credit for the reliquefication being online.

## Q27 With condition of worker not use proper PPE as mandated by Company, flaw design of tank due to cost cutting, not adequate isolation (that cause back flow warm ammonia to tank) – May I see this company have no proper safety culture at that time?

Yes, in 1989 there was no talk of safety culture and the term was only used in general 15-20 years ago. One of the highlights of this presentation is the importance of safety culture in the chemical industry.

## Q28 NPK smoke to be stopped needs 3 days – do we know why? fast decomposition reaction or area of NPK that difficult to access?

Very good question. For two days, the accident liquidation commission decided how to stop the decomposition of the NPK. The most terrible idea came from the military, they proposed bombing the NPK warehouse from the air with military fighter jets. Imagine what would have remained of the entire factory after the bombing. The factory specialists suggested using large amounts of water from fire trucks, which was done after two days and after 24 hours the decomposition of the NPK was stopped, but two days were lost.

## Q29 What safety feature are mandatory for liquid Ammonia Tanks?

The article *The Safety and Integrity of Ammonia Storage Tanks* published in the *Indian Fertilizer Scene Annual 2014* was my go-to reference for ammonia tank safety when writing this article. This is available here:

ammoniaknowhow.com/wp-content/uploads/2017/02/2014-Venkat-The-safety-and-integrity-of-ammonia-storage-tanks.pdf

## Q30 Dr Ewan Stewart mentioned that there was no safety culture at the time as there is today, may I ask for a few safety controls applied due to this incident?

We don't know the exact measures that were put in place, although we can draw some conclusions by looking at the present-day facility. *ARIA Report #717* draws on the soviet investigation, and the recommendations therein may give the best clues as to the controls applied.

https://www.aria.developpement-durable.gouv.fr/wp-content/files_mf/FD_717_jonova_1989_ang.pdf

## Q31 As part of the investigation, is there a link where the findings are available, detailing recommendation especially in engineering and design?

I understand that there were both Soviet and Lithuanian investigations. I have not sighted these reports, however I hope that these will one day surface. The most comprehensive and accessible reference for engineering and design findings and recommendations are:
https://www.aria.developpement-durable.gouv.fr/wp-content/files_mf/FD_717_jonova_1989_ang.pdf

https://www.icheme.org/media/10446/xi-paper-02.pdf

The following link addresses the tank failure mode:
https://scholarsmine.mst.edu/cgi/viewcontent.cgi?article=2913&context=icchge

And the link below link disproves the rollover theory:
https://ureaknowhow.com/wp-content/uploads/2023/10/2023-Dharmavaram-A-Fictional-Expectation-of-a-Rollover-in-an-Ammonia-Storage-Tank.pdf

The final good link is the Russian book "Catastrophes of the 20th Century", which an overview of the learnings in emergency management:
https://www-booksite-ru.translate.goog/localtxt/kat/ast/rofy/7.htm?_x_tr_sl=ru&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=sc#16

I have gathered lots of other press clipping, news sites, and videos which I have translated to English. I am keen to share this information with anyone that is interested.