

Annular Space Condensation at LNG Terminals – Summary of responses received (March 2021)

Questions	<i>1. Have you experienced annular space condensation at the tanks in your terminal(s)? Yes / No</i>	<i>2. In which cases have you observed this phenomenon?</i> <ul style="list-style-type: none"> • Ship Discharge • Long programmed shutdown • Significant tank pressure variations • Other (please explain) 	<i>3. How long does it take between the operation referred to in question 2 and the moment when condensation is detected?</i> <ul style="list-style-type: none"> • < 1 hour • > 1 hour and < 12 hours • > 12 hours and < 24 hours • > 24 hours 	<i>4. Do you have predefined mitigation actions for this phenomenon?</i> <ul style="list-style-type: none"> • Yes • No 	<i>5. How long does it take for the LNG to go back to its normal state since condensation is detected?</i> <ul style="list-style-type: none"> • A few hours • A day • A week • More than a week 	<i>6. What are the immediate actions that your terminal takes, to reverse the condensation in the annular space?</i> <ul style="list-style-type: none"> • lower the pressure • increase the pressure • maintain the same pressure • Other (please explain) 	<i>7. Do your tanks have any system to remove/eliminate the annular space condensation?</i> <ul style="list-style-type: none"> • please explain
Member 1	No. Use of full double shell storage. Doom roof instead of suspended deck.	NA	NA	NA	NA	NA	NA
Member 2 (not occurring directly to	Yes, but not in the terminal where the member worked	During cargo discharging operation and subsequent				Implementation of additional checks at the base foundation when	



that member, but sharing experience)		emission of gas bubbles to atmosphere from the base slab. The operator made this observation when there was water on the base slab where bubbles were seen.				the surface would be wet (during rain)	
Member 3	Yes	<ul style="list-style-type: none">• Significant tank pressure variations• Other (please explain): LNG subcooled liquefaction	> 1 hour and < 12 hours	Yes, it goes away without doing anything, but decreasing the pressure will boil off condensed liquids.	A few hours	<ul style="list-style-type: none">• maintain the same pressure• Other (please explain): potentially you can lower it as well.	No, we have full containment tanks, and no penetrations are allowed. We have 2 of the 3 tanks with N2 purge in annular space, but not sure if this helps or not.
Member 4	Yes,	Error in settings of ESD for overfill (did not carry out this operation due to insufficient knowledge). Tank was almost filled to full designed level, as it seems it wasn't overfilled, condensation was detected at	> 1 hour and < 12 hours: 4hrs after ships unloading (tank filling).		More than 48 hours	<ul style="list-style-type: none">• lower the pressure	Tanks do not have designed system to remove condensation.



		annular space sensors. Alarm (Low Temperature).					
Member 5	Yes	• Significant tank pressure variations	• > 1 hour and < 12 hours	No	A week	• Lower the pressure • Maintain the same pressure	No
Member 6	Yes, we have experienced this phenomenon 4 times. Among these 4 occurrences, 3 were minor ones and 1 was "major". For minor cases, it was partial condensation. It means that only 1 or 2 peripheral temperature transmitters located at annular space bottom went below -150°C. For major case, it was more severe condensation. All peripheral TT went below the alarm	Ship discharge mainly. Was the case for major event. Significant tank pressure variation. For one minor case, the phenomenon was observed during a reloading operation when our tank pressure was quite high. The reloading operation took place 1,5 days after precedent unloading.	• > 1 hour and < 12 hours	Yes. We have a permanent nitrogen blanketing of annular space in each tank via the purge ring located at annular space bottom. N2 injection flowrate is 150 Normal liters/hr/tank. No other predefined mitigation actions so far. Under study as part of last event (major case) return of experience	For minor cases: 21h, 26h and 198h For major case: 321h	No specific action for minor cases. For major case, lower tank pressure and empty tank. Temperatures rose back only once tank emptied and tank pressure increased.	Cf question 4. Annular space permanent blanketing with nitrogen. To be investigated further since phenomenon occurred despite the system. N2 injection flowrate is quite low but limited due to concerns about potential fluidization of perlite.



	threshold set @-159°C.						
Member 7	Yes, in the Condensate tank.	It happens due to colder ambient T than condensate storage T.				It is handled by draining the annular space on demand	
Member 8	No					Stop Operation in the Tank (Ship discharge, filling tank, In tank Pumps); Maintain tank pressure stable, Re-check "annular space" Temperature Indicators; Continuous Monitoring by DCS; Consider the possibility of injecting N2 in order help the evaporation of the LNG	