AIR LIQUIDE
GLOBAL E&C SOLUTIONS

Helium Operators Familiarization Program

Unit 324/325 – Trips and interlocks

Dec 2012 I Vincent HELOIN

Course Agenda

- **Overview of trips implemented in units 324 and 325 : Philosophy**

- Overview of interlocks

- The RAT list

- What would happen in case of Turbine Trips ?

324 – Liquefiers trips

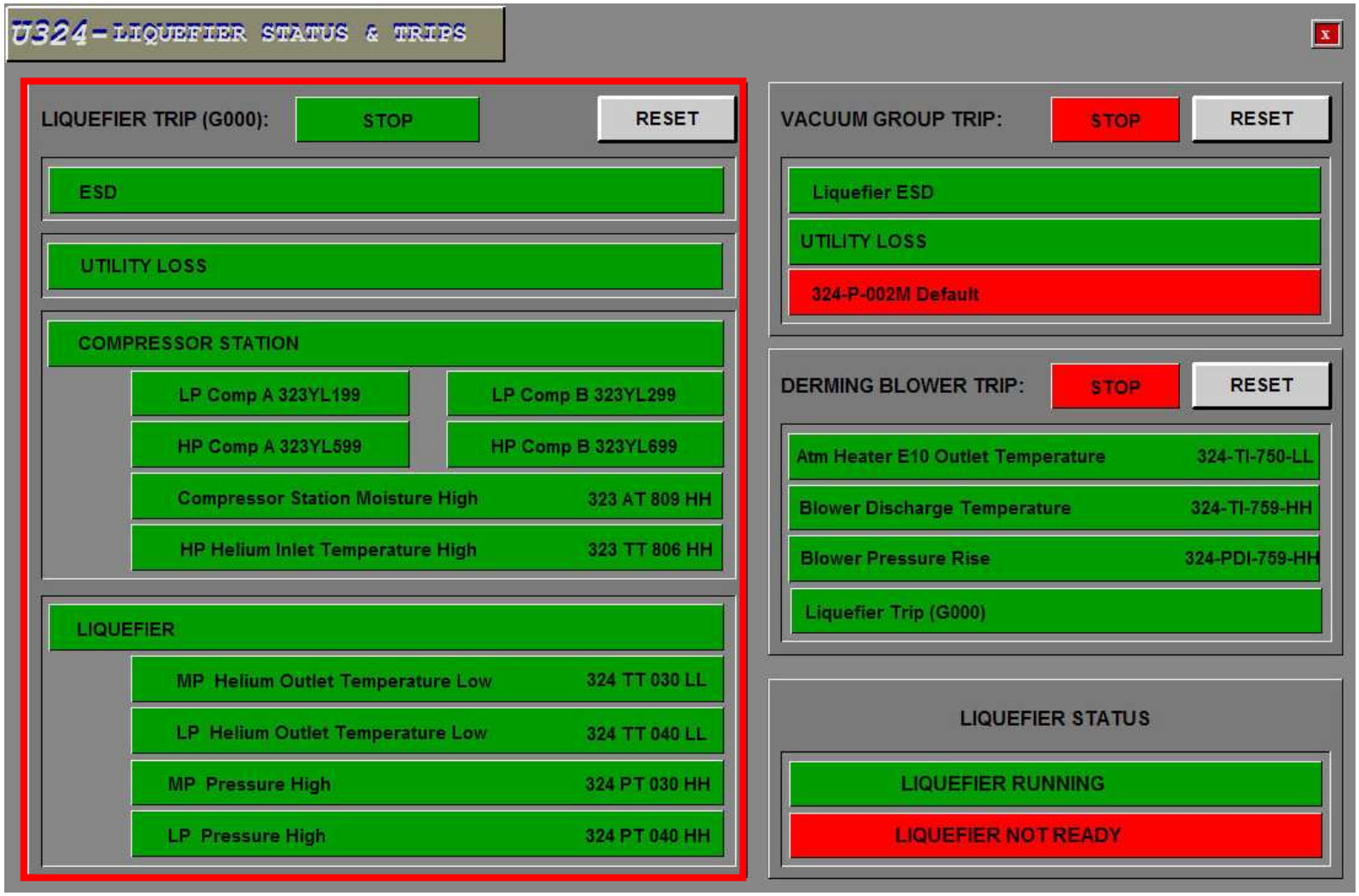
The following events will lead to a liquefier trip:

- ESD (Emergency Shut Down)
- Utility Loss (Air, Water Electricity)
- Compressor Station Loss (Loss of LP OR HP Compressors)
- Compressor Station Moisture High (323AT 809 HH >60℃)
- Compressor Station Temperature High (323TT 806 HH)
- MP Helium Outlet Temperature Low (324TT030 LL<-15℃ & 324XV030 A Open)
- LP Helium Outlet Temperature Low (324TT040 LL<-15℃ & 324XV040 A Open)
- MP Pressure High (324PT 030 HH & 324 XV030 A Open)
- LP Pressure High (324PT 040 HH & 324 XV040 A Open)

Nota : In case of a trip All valves will return to their Failure Position except :

- **Bearing Supply**
  - If WCS is ON , 324 XV 050 stays open to maintain bearing flow.
  - If WCS is OFF,324 XV 050 closes. The bearing capacity allows safe turbines stop.
- **Turbine Bearing Vent Valve** 324 XY X24 is not Affected by the Liquefier Trip.
- **Vacuum Group** stays in operation

324 – Liquefier Status



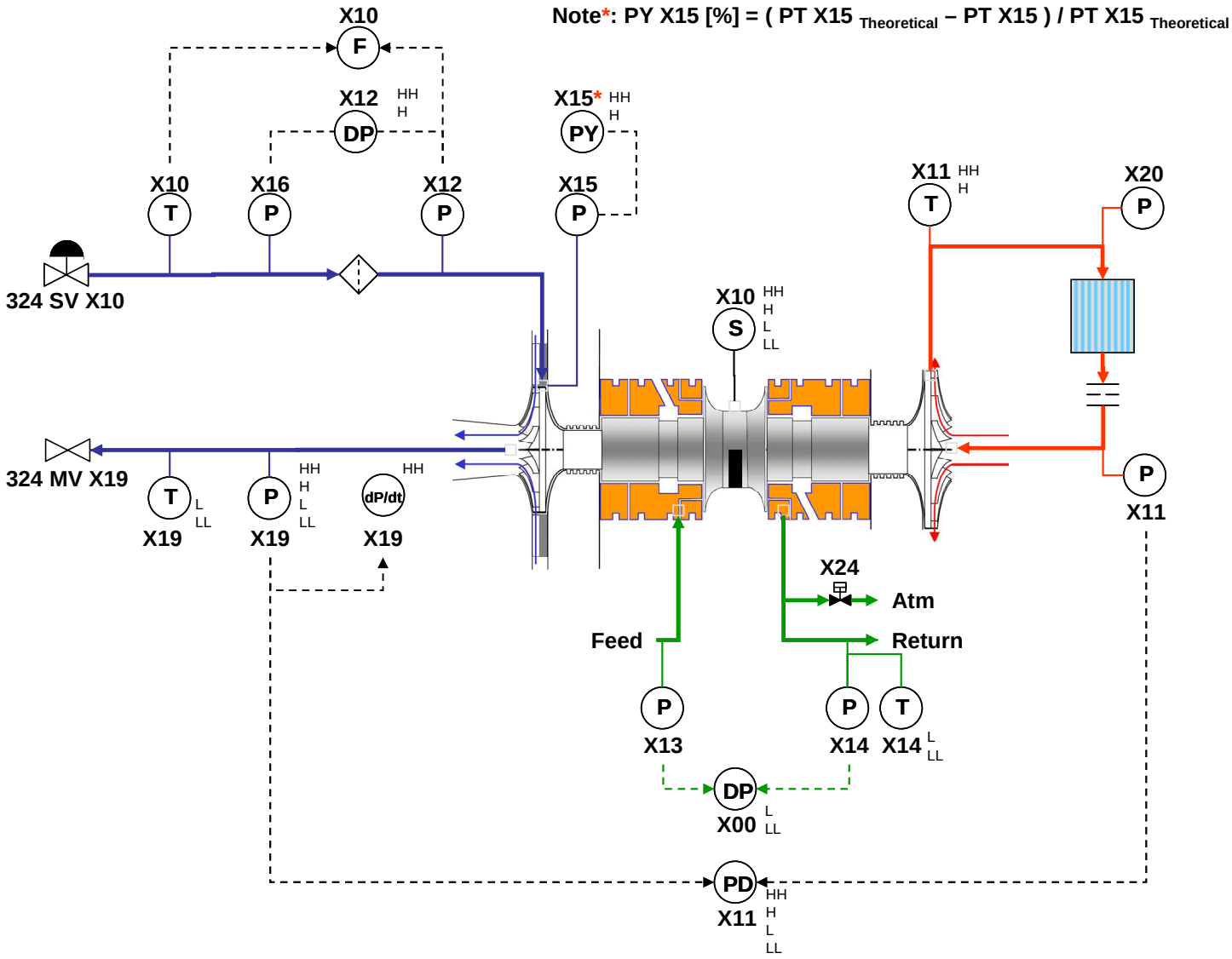
324 – Overview of turbines protection

The following events will trip the Turbines (not the liquefier)

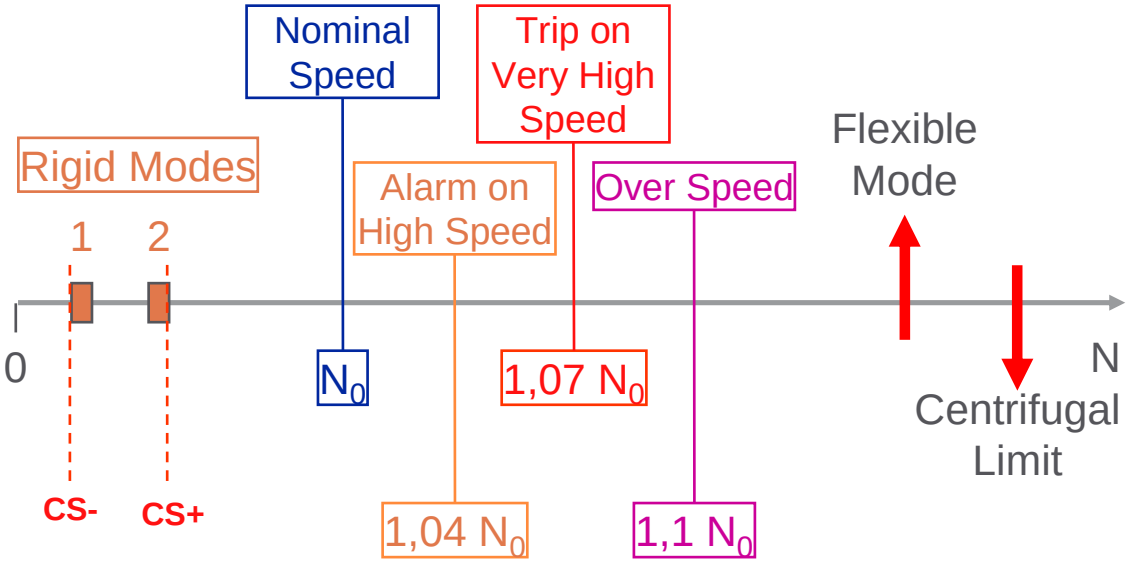
- **Speed low & valve open:** Valve or Turbine stuck
- **Speed on Critical speed :** Mechanical Integrity
- **Over Speed :** Mechanical Integrity

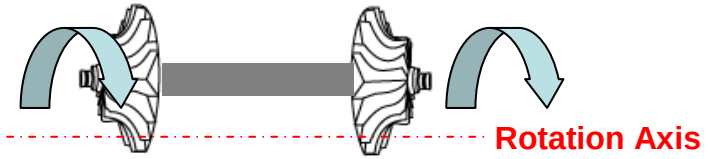
- **Bearings Pressure Head (Px13)** Sufficient Bearings Stiffness
- **Bearings Return Temperature (Tx14)** No Cold leak from process to bearing return
- **Process Discharge Pressure (Px19)** Back pressure resulting thrust on bearings
- **Process Discharge Temperature (Tx19)** Low discharge temperature
- **Brake Press. vs Discharge Press. (PDx14)** Diff Pressure resulting thrust on bearings
- **Brake temperature (Tx11)** Lack of cooling on Brake heat exchanger
- **Inlet Wheel Pressure (Tx15)** Turbine wheel clogged and resulting thrust on bearings
- **Filter Clogging (PDx12)** Turbine Inlet Filter clogged

324 – Turbines Instrumentations

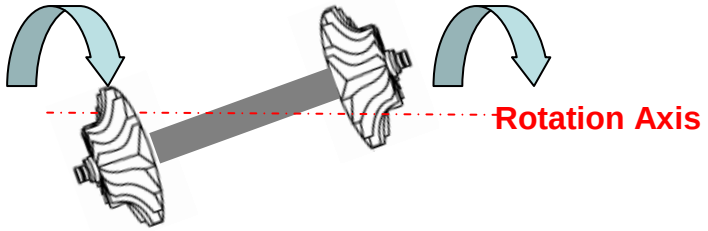


Speeds Trip





First Rigid Mode
Cylindrical - 0 Node



Second Rigid Mode
Cylindrical - 1 Node

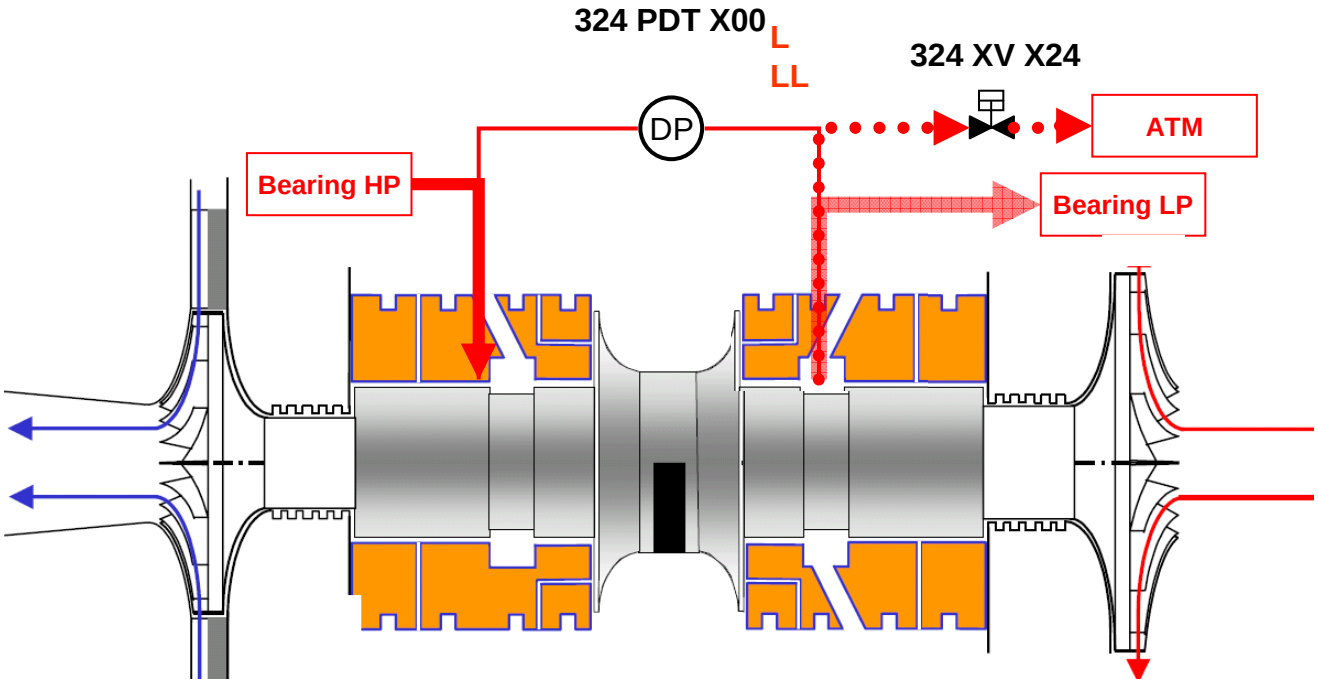
Alarm in case of ~104% of Nominal Speed
TRIP in case of ~107% of nominal Speed.
Alarm In case Turbine stays more than 30s in Critical Speed zone
TRIP In case Turbine stays more than 180s (3min) in Critical Speed zone

324 – Turbine Trip - Bearing Pressure Head

324 PDT X00 between the Bearings FEED (From HP) and RETURN Gas (LP).

-> Provide bearing stiffness.

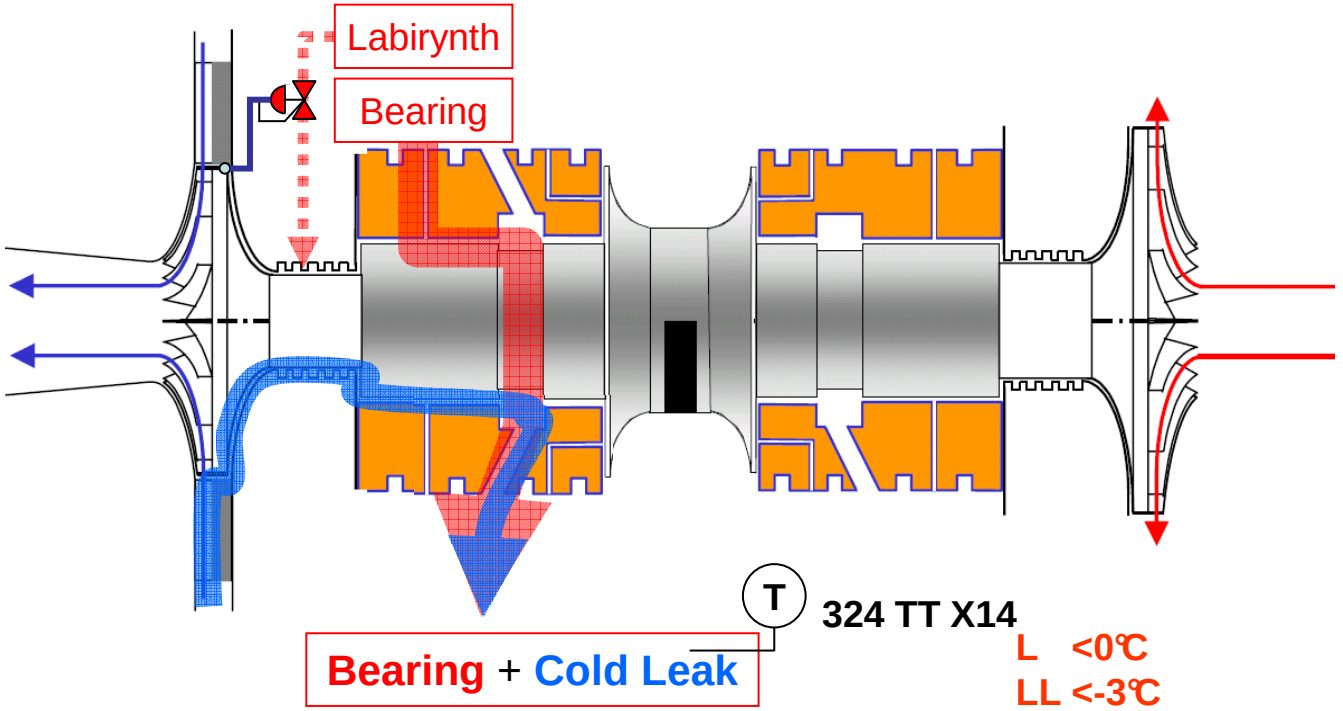
-> In case of compressors ESD, a capacity supplies enough gas to allow a safe shutdown of turbines.



324 – Turbine Trip - Bearing Return Temperature

Seal (Process / Bearing) : Labyrinth Seal

Limitation of the leak : Gas seal adjusted with a PCV in order to get a small leak from process to the bearing

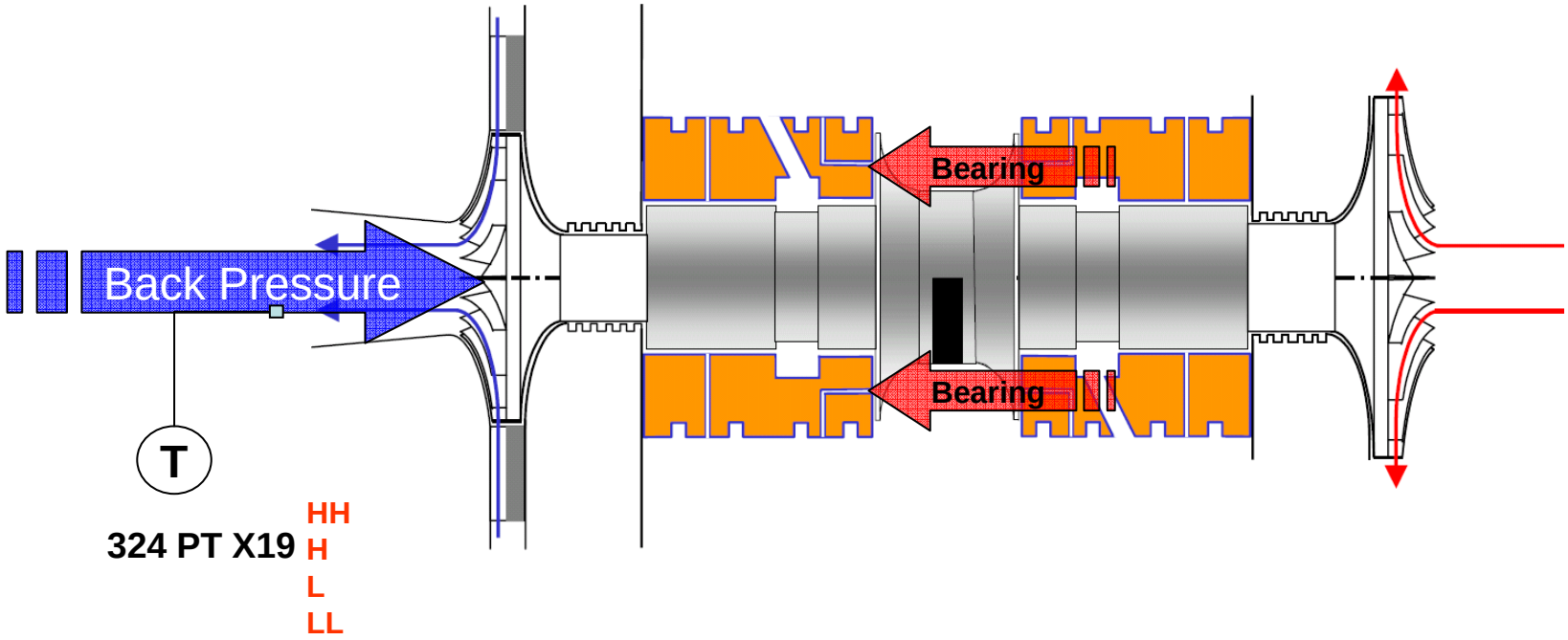


In case of bad adjustment, cold leak may cool down the bearing leading to a mechanical contractio. As tolerances are very low, this contraction could damage the turbine.

324 – Turbine Trip - Discharge Pressure

The Turbine Back Pressure has a direct impact on the Turbine Axial Load.

- Changes of the back pressure can result is excessive forces and eventually in a turbine failure
- In case of quick pressure change, the turbine trip (>0.2 Bar / sec)

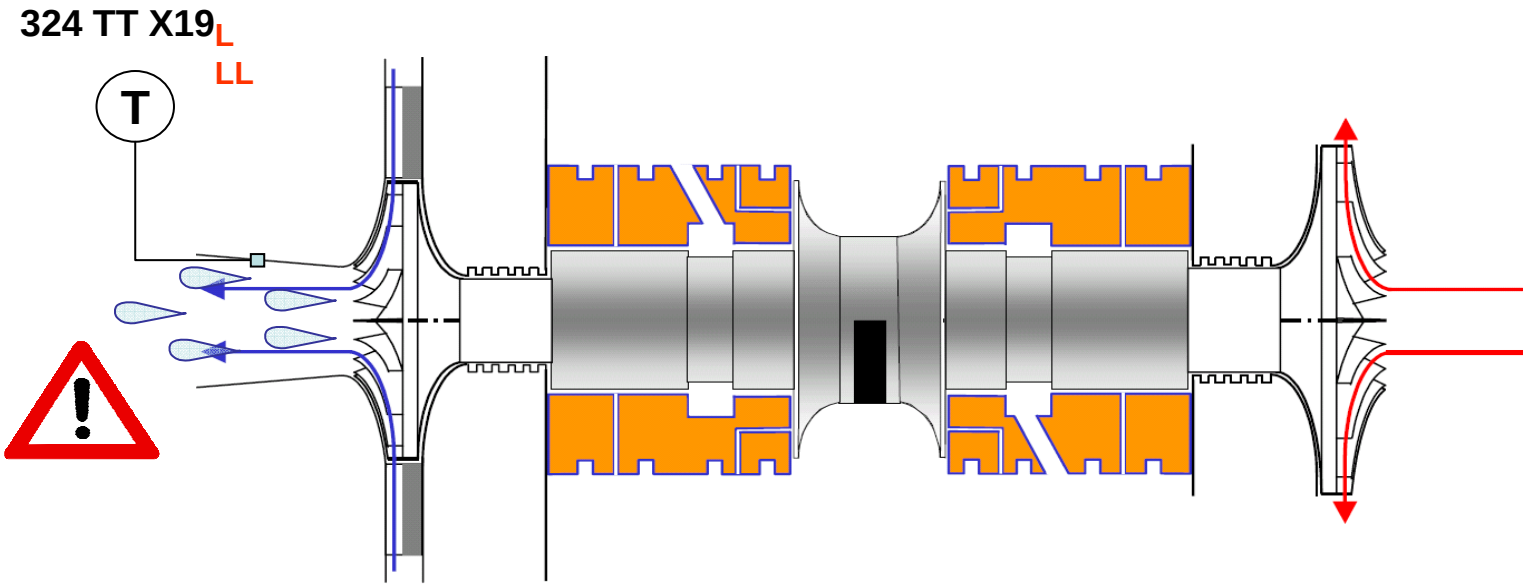


324 – Turbine Trip - Discharge Temperature

Low Temperature will primarily result in high flow in the Turbine.

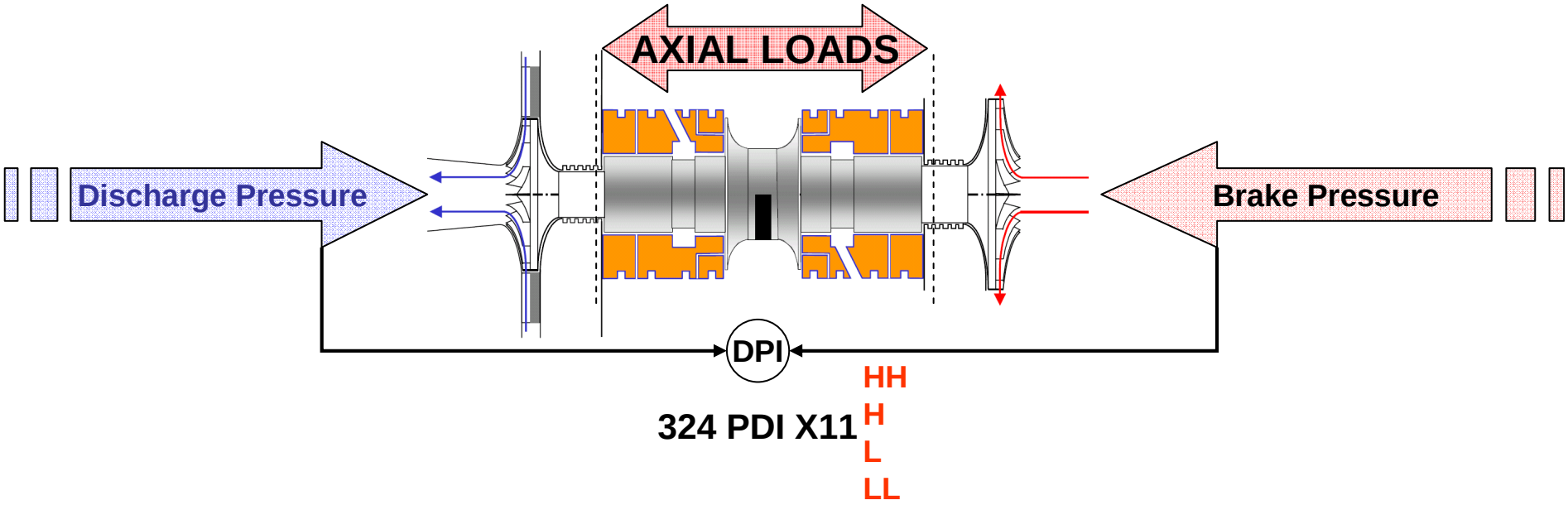
In case of T5 and T6, Low Temperature could lead to biphasic flow, which can result in a turbine failure

Only T5 and T6 has LL Trip



324 – Turbine Trip - Brake Pressure vs Discharge Pressure

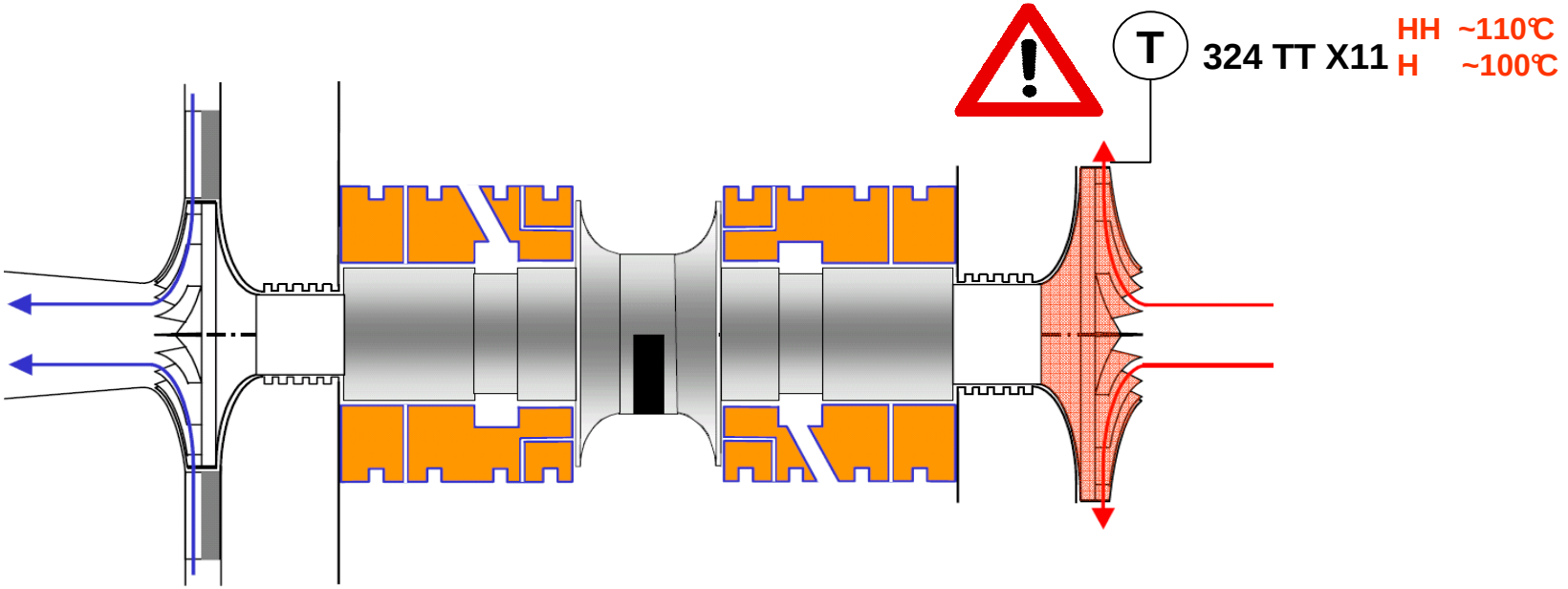
The Brake pressure has also a direct impact on the turbine axial loads that are opposed to Discharge Pressure.



324 – Turbine Trip - Brake Temperature

High Temperature cannot be stand by aluminium. Temperature can increase due to :

- High Power
- Lack of cooling water



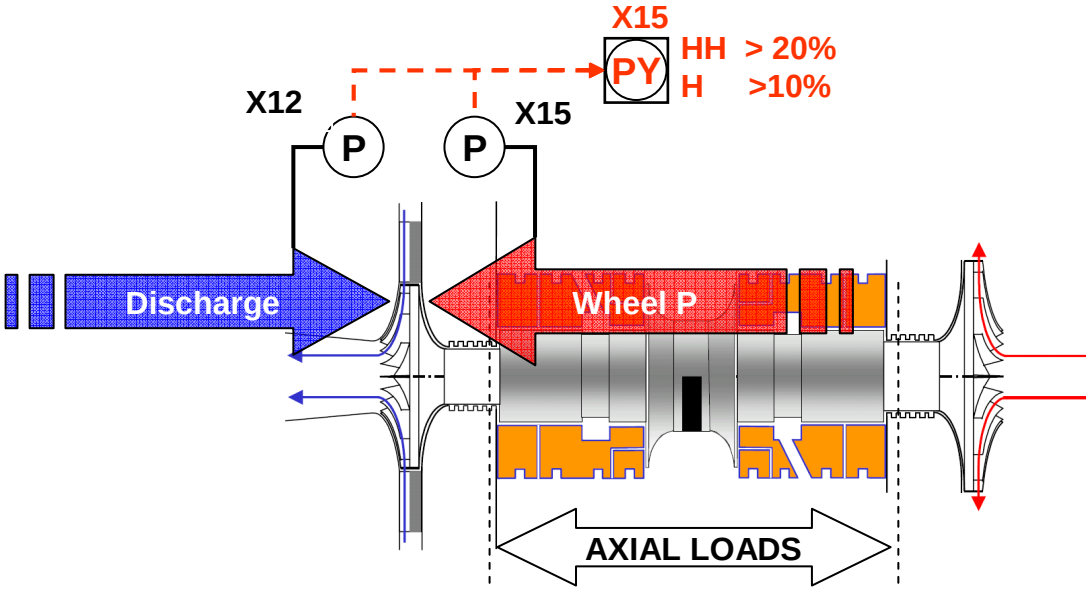
324 – Turbine Trip - Inlet Wheel Pressure

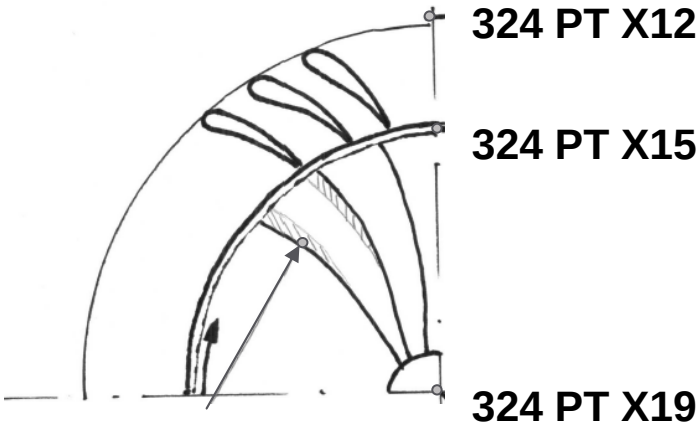
Modification of Inlet Wheel Pressure has a strong impact on Axials Loads.

Increase of Inlet Wheel Pressure indicates clogging of the turbine inlet due to impurities.

As process conditions change, a comparison of the actual value to theoretical value allows to verify possibility of clogging

324 PY X15 = (324 PT X15 Theoretical – 324 PT X15 Actual) / 324 PT X15 Theoretical





Accumulation of Contaminant

Course Agenda

- Overview of trips implemented in units 324 and 325 : Philosophy
- **Overview of interlocks**
- Review of RAT list
- What would happen in case of Turbine Trips ?

324 – Overview of blower protection 324 K 001

The following events will interlock the blower :

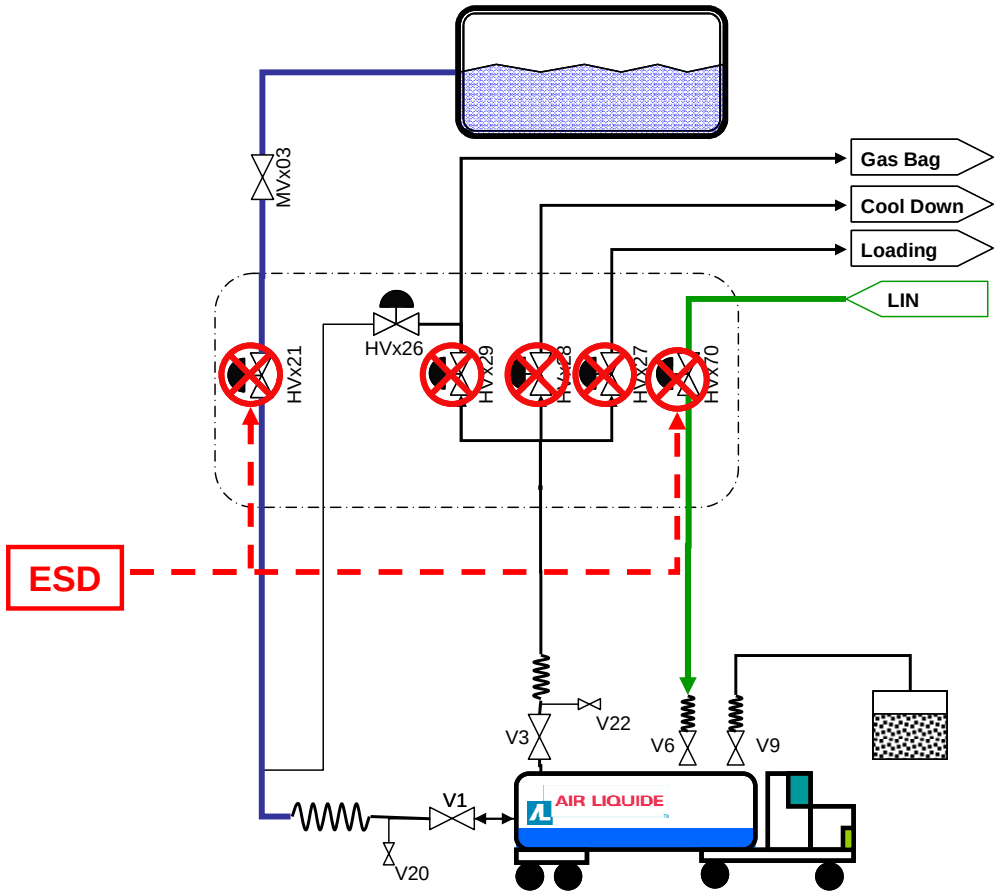
- **Low temperature at blower inlet**
  - 324TT750 < -25℃ during 3 sec
- **Over delta pressure on blower**
  - 324PDI750 > 800 mb
- **Overheating on blower**
  - 324TT759 > 145℃

324 and 325 – Overview of interlocks

- **Purge pump protection**
  - 324 SDV 900 will close if purge collector pressure exceeds pump design pressure (1,1bar abs)
- **Diffusion pump protection**
  - Pump will stop in case of overheating
- **Protection against overfilling of LN2 tank**
  - Filling valve will close in case of high level, high pressure
- **Protection against overfilling of LHe tanks**
  - Filling valve (325 PV x01) will close in case of high pressure
- **Overheating due to Joule Thomson effect**
  - At ambient, He expansion through a valve will rise the gas temperature.
  - If helium is flown in a closed loop for a long time, and temperature rises up to 50℃
  - the cold end bypass valve will be closed 324 HV 803.
- **Lack of performance**
  - 324 HV 805 (distribution bypass) is closed to avoid loss of production

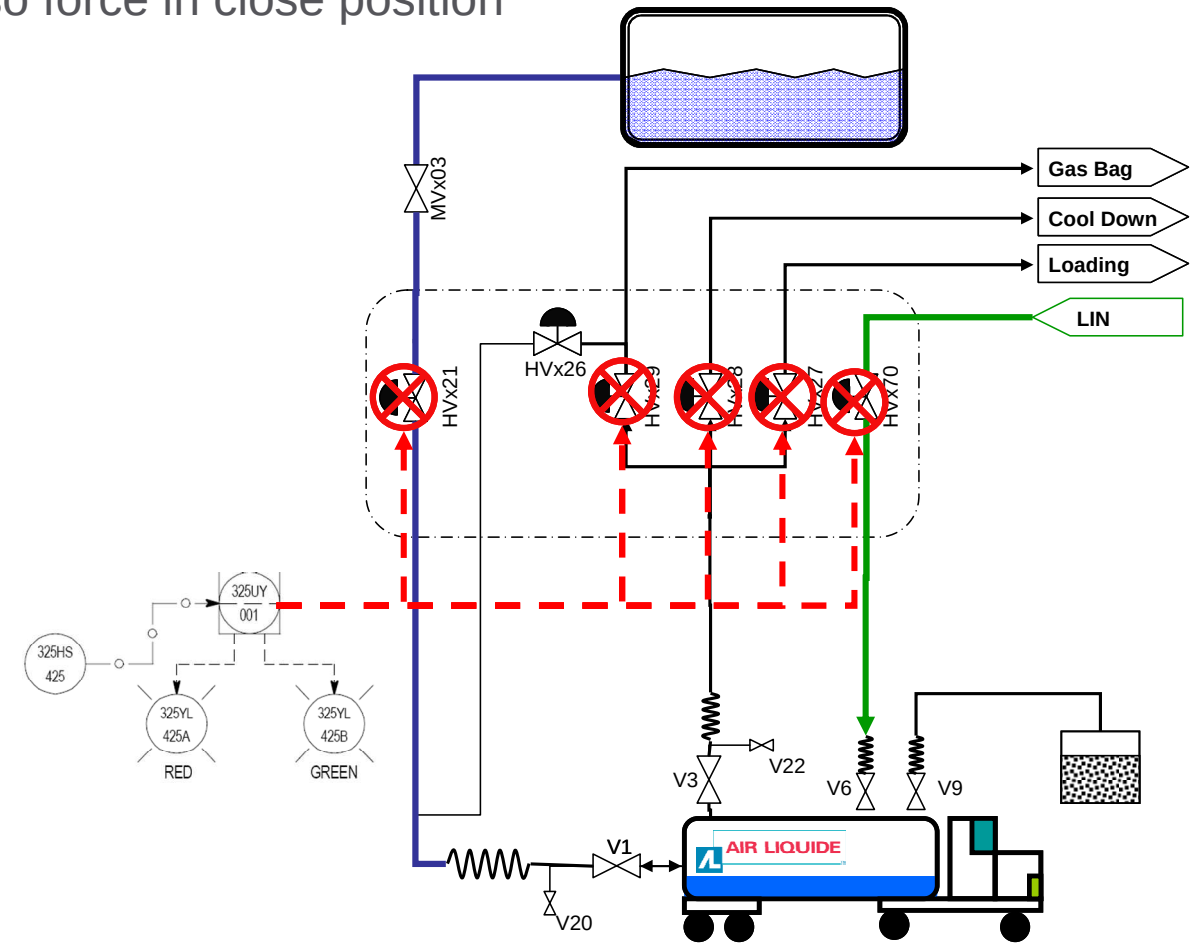
325 – Loading Bays : ESD

- In case of activation of the ESD all the valves will close



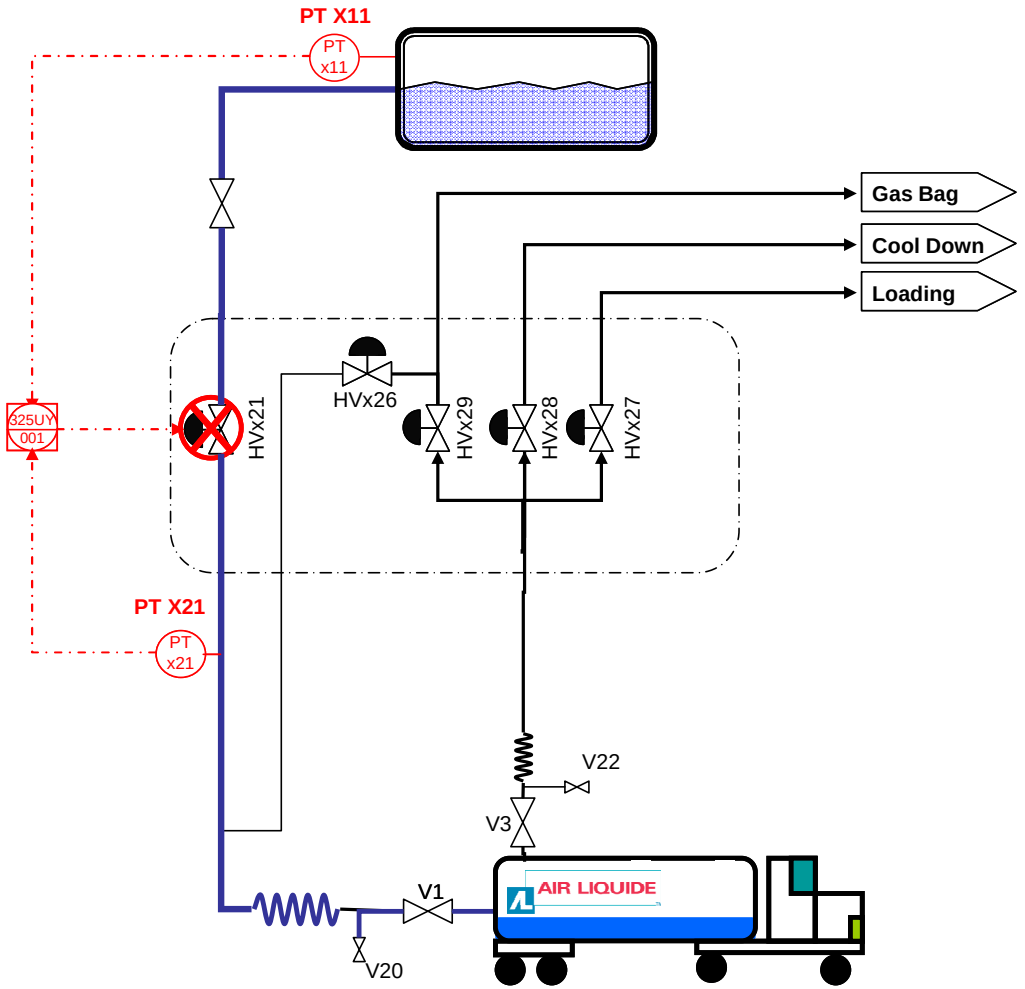
325 – Loading Bays : Hand Switch Interlock

- **Hand Switch not in loading position,**
  - ⇨ Loading valves (325 HV x21 and HV x70) are forced in close position.
  - ⇨ Return valves are also force in close position



325 – Loading Bays : Loading Valves Helium

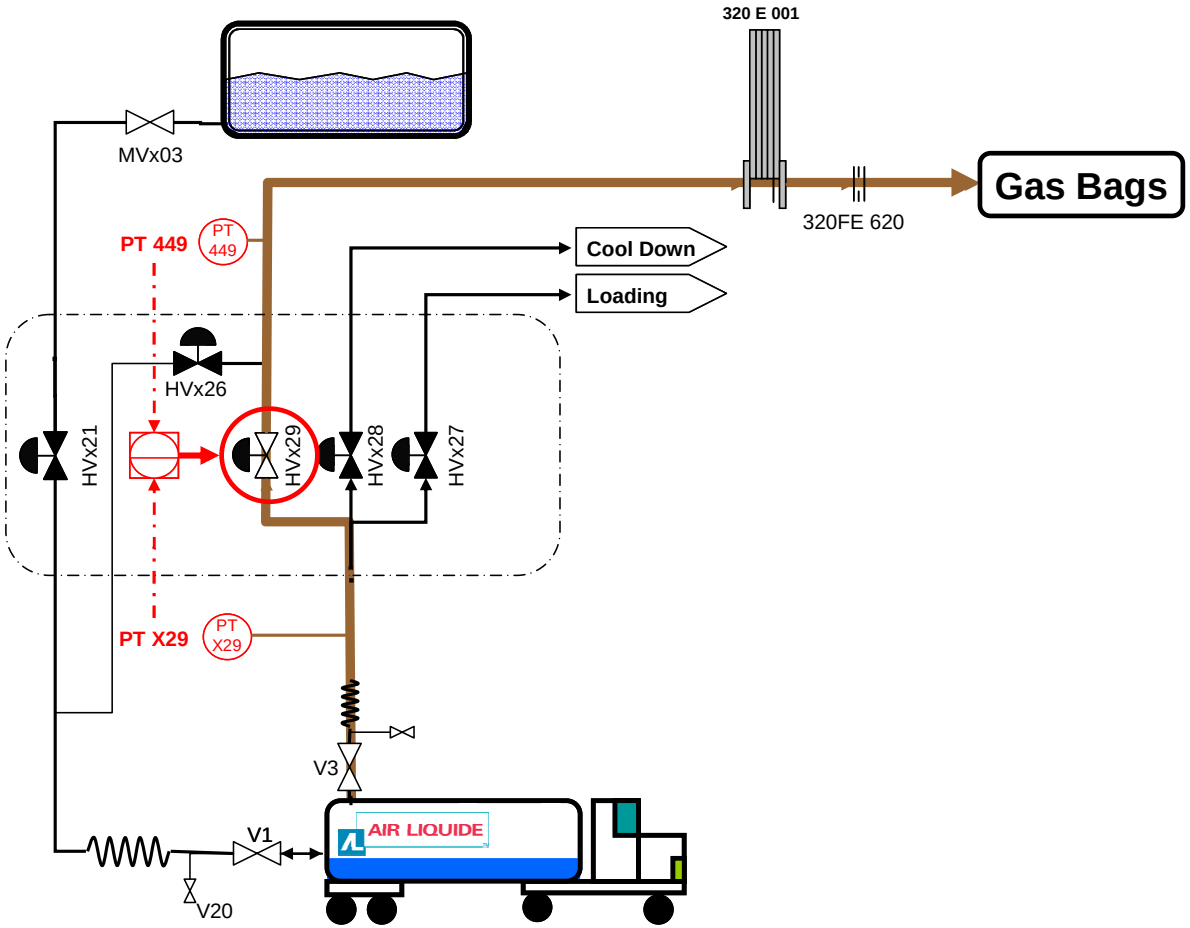
- INTERLOCK : 325 PT x21 > 325 PT x11 + 50 mbar → CLOSE 325 HV X21



325 – Loading Bays : Valves to Gas Bag

- If the Gas Bag line pressure is higher than mobile container outlet pressure the valve (325 HV x29) is forced in close position:

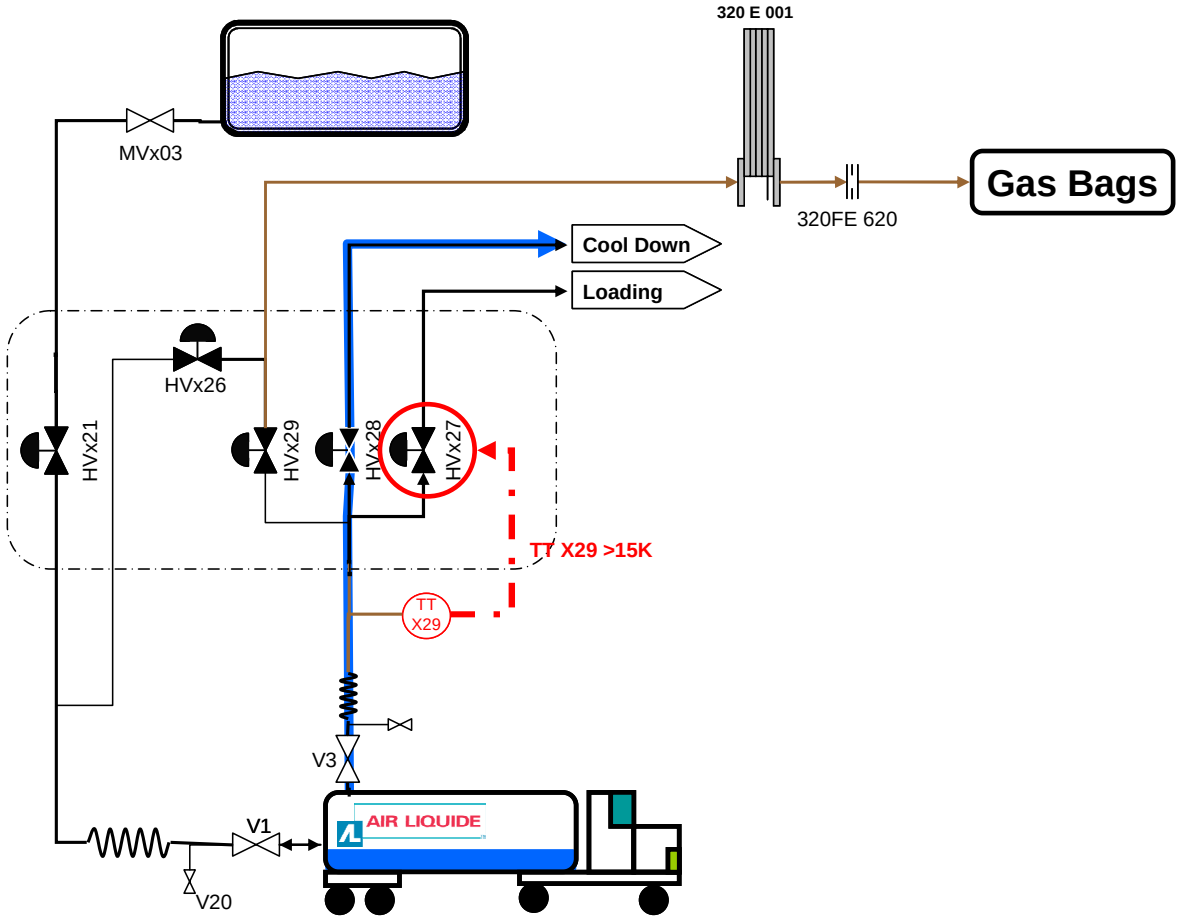
  INTERLOCK : 325 PT x29 < 325 PT 449 + 50 mbar → CLOSE 325 HV X29



325 – Loading Bays : HVx27 - Cool down line

- If the temperature vapour from mobile container is higher than 15K, the valve 325 HV x27 is force close.

  INTERLOCK : 325 TT x29 > 15 K → CLOSE 325 HV X27



Course Agenda

- Overview of trips implemented in units 324 and 325 : Philosophy
- Overview of interlocks
- **Review of RAT list**
- What would happen in case of Turbine Trips ?

Review of RAT list

- See HE2-V-007-A-014

Course Agenda

- Overview of trips implemented in units 324 and 325 : Philosophy
- Overview of interlocks
- Review of RAT list
- **What would happen in case of Turbine Trips ?**

T1 / T2 Trips

In case of T1/T2 Trip

→ MP Decreases but HP will increases.

→ HV810A & HV321 will open

→ The Temperature Gradient of the cold box will change(warmer)

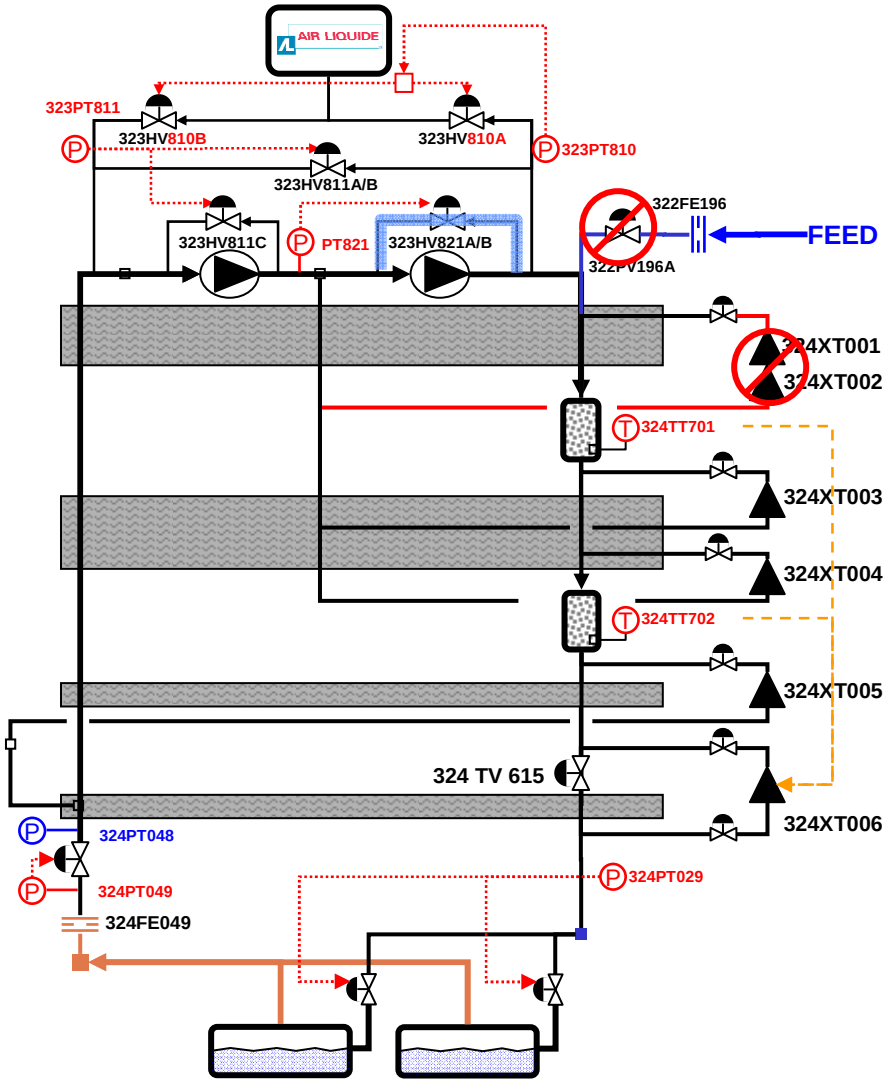
→Ads.80K are likely to be too warm. By-pass will open and the feed inlet valve will close.

→ As Temperature increased, production will be reduce (Attenuation of T6).

-> Production will continue as long as Buffer Pressure is enough. (~1 hour production max)

-> If Drum Pressure too low T5 & T6 is attenuated…

→ The operator could reduce the production (customer attenuator on T6) as much as possible to keep the system in cold operation state as long as possible.

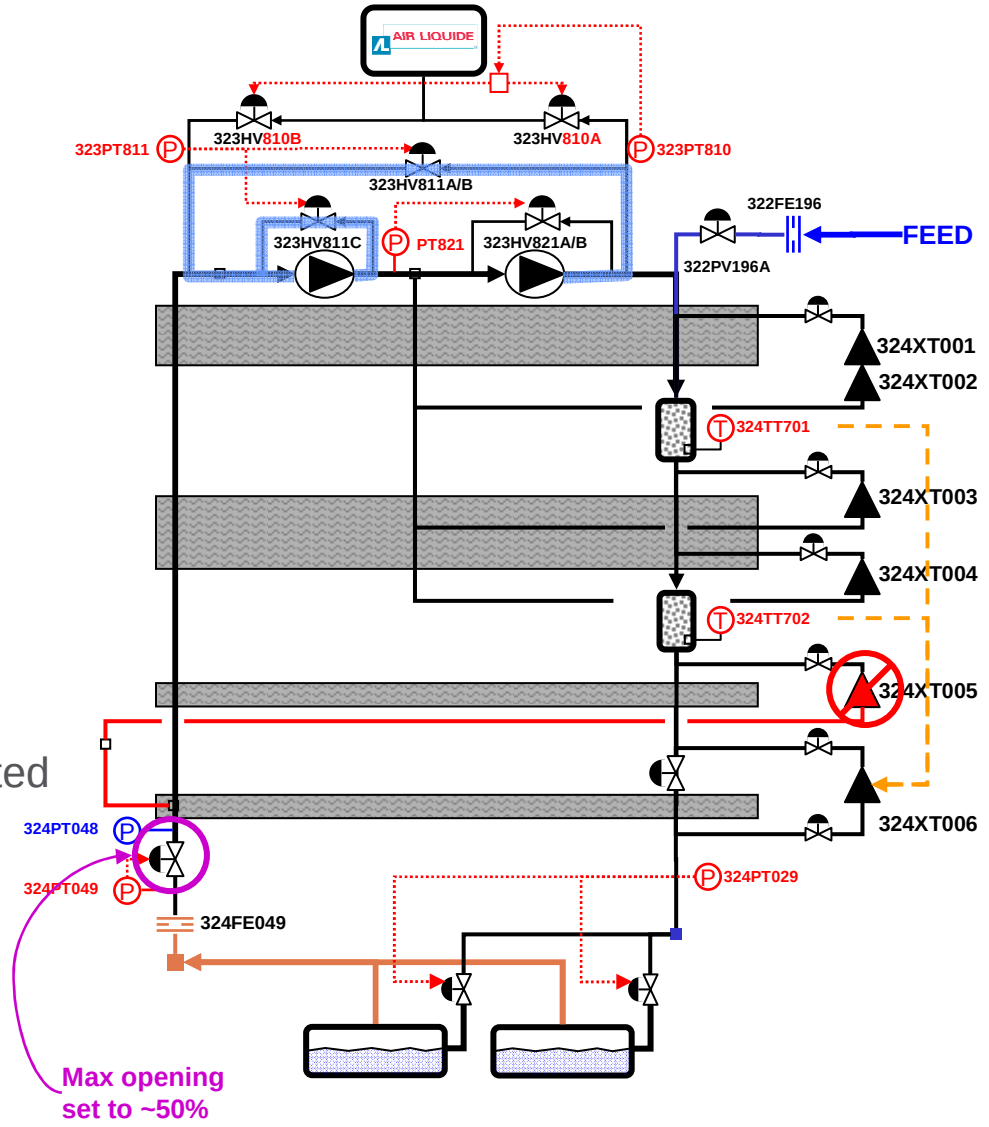


T5 Trips

T5 is the only Turbine on LP.
Its flow is ~ 50% of the total LP Flow
(T5 = 430 g/s and LP = 880g/s)

In case of T5 Trip

-> HP increases & LP decreases.
-> 323PC811 will adjust to maintain LP pressure.
-> T6 inlet temperature will increase -> Less capacity.
-> Vapour fraction will increase in JT valves
->T1, T2, T3 and T4 are likely to be attenuated by the low discharge temperature



T6 Trip

In case of T6 Trip

→ HP will increases and HV810A will open
TV615 will open @ 50%
→ TV615 will then be in regulation mode.
→ More vapour flash will be produced in JT valve