



ID	49845	Status	Date
Risk Area	Risikovurdering: Helse, miljø og sikkerhet (HMS)	Created	26.08.2022
Created by	Pål Martin Benum	Assessment started	26.08.2022
Responsible	Pål Martin Benum	Measures decided	
		Closed	

Risk Assessment:**CAT, Master's student, 2022, Pål Benum**

Valid from-to date:

8/26/2022 - 8/26/2025

Location:

NTNU, Gløshaugen

Goal / purpose

Studying the kinetics of the oxidation of NO to NO₂ using Ru promoted with Mn and Fe on Al₂O₃ support.

Background

The gases Involved in the process are mainly NO, NO₂, O₂, H₂, and N₂.

Reaction Conditions:

1. The typical feed for the process consists of 10% NO, 6% O₂, and 15% H₂O.
2. Argon (Ar) is used as the inert gas in the process.
3. Pressure: 1–10 bar
4. Temperature: 150 – 450 degrees C.
5. Catalyst weight: 500 mg

An FTIR instrument is used in the setup for gas analysis. Gas detectors are placed inside the setup for measuring NO and H₂. Additionally, three portable detectors for H₂, NO & NO₂ are present inside the setup.

Water is introduced into the feed stream using a Controlled Evaporator Mixer (CEM). The water vapor generation system contains N₂ pressured water tank fitted with a filter (15 µm) at the outlet, a liquid flow controller (typical flow range = 2 g/h), also carrier gases O₂ and Ar, a temperature-controlled mixer and evaporation device.

Description and limitations



The research activities will be carried out as part of the Catalysis group at IKP, NTNU. The work involves a literature review, reactor modifications, experimental activities, simulation, and modelling.

Three catalyst supports consist of either aluminum oxide in gamma-phase (γ -alumina / γ -Al₂O₃), titanium dioxide (TiO₂), silicon dioxide (SiO₂), cerium oxide (CeO₂) and/or zirconium dioxide. The active materials are Pt and Ru. The support materials will be calcined before catalyst synthesis.

Promoters Used include, but are not limited to:

1. Ag;
2. Pt

Several characterization techniques will be used to characterize the prepared catalysts and study their surface-specific and temperature-related properties. Few listed techniques are BET, TPR, TPD, XRD, XPS, and S(T)EM. The ones utilized in this project will most likely only be XRD, TPR, BET & BJH and Chemisorption.

List overall chemicals used:

Synthesis - Al₂O₃, TiO₂, H₂O, Pt(IV)(NO₃)₄ solution, Pt 15% w/w, AgNO₃, PEG, HNO₃.

Location of Activity measurements:

ChemHallD 2nd floor at rig 2.1

Limitations of Experimental Work:

The rig/setup requires a refill of liquid N₂ every 12 hours. Hence, overnight work or work outside normal working hours cannot be avoided.

Prerequisites, assumptions and simplifications

Prerequisites:

1. The setup users must undergo proper training by authorized personnel;
2. Protective equipment like gloves, lab coat, and goggles, etc should be used at all times;
3. The lab scheduler must be updated when in use;
4. Apparatus card to be up to date;

Steps for setup switch off procedure:

1. The immediate closure of all the gas bottles in use;
2. Cutting off the electricity to the whole setup. (In case of emergency, an emergency button located on the setup will be activated for safety)

Safety measures related to spreading of Covid-19 infection:

1. Wash hands before you start the experiment and after when you exit the lab;
2. Use of nitrile gloves, and goggles in the lab;
3. Disinfection with ethanol (strength: 70% or more) on all surfaces you are in contact with (before and after the use), specifically door knobs – card reader with code panel, keyboard, mouse, screen, desk, and FTIR;
4. Avoid direct contact with your face before cleansing your hands;
5. Keep 1m distance from colleagues and other personnel at all times.
6. All lab activities are pre-planned and updated in the IKP activity 2020 Teams group for enabling other setup users to be aware of common lab usage.

Overnight work or work after working hours:

1. Liquid N₂ refill every 12 hours;
2. Catalyst preparations and characterizations, depending on the availability of the instruments.

Attachments



NO_Flowscheme_Colour_Coded_10.pdf
PEG.pdf
NO_Wiringscheme_Colour_Coded.pdf
Nitric Oxide.pdf
Oxygen.pdf
Hydrogen.pdf
Mn(NO3)2.4H2O.PDF
Unit_card_K5216_IKP.pdf
KMnO4.pdf
Silver Nitrate.pdf
HNO3.pdf
Argon.pdf
Cerium IV oxide.pdf
CobaltNitrate.pdf
gamma-Alumina_support.pdf
Pt(IV) nitrate solution, Pt 15 ww.pdf
NOx_Apparatus_Card_Jithin.doc
OSHA3990.pdf
ZrO2.pdf
Titanium (IV) oxide.pdf
RUTHENIUM-99-9---200-MESH-P (1).pdf

References

[Ingen registreringer]

Summary, result and final evaluation

The summary presents an overview of hazards and incidents, in addition to risk result for each consequence area.

Hazard: Characterization Techniques

Incident: Chemisorption

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: BET & BJH

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: XRD

Consequence area: Helse Risk before measures: Risiko after measures:

Hazard: Handling of Catalyst Chemicals

Incident: γ -Al₂O₃

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: Pt(IV)(NO₃)₄

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: Ruthenium(III) chloride hydrate

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: Fe(NO₃)₃ x 9H₂O

Consequence area: Helse Risk before measures: Risiko after measures:

**Hazard: Handling of Catalyst Chemicals****Incident: Mn(NO3)2 x 4H2O**

Consequence area: Helse Risk before measures: Risiko after measures:

Hazard: Use of High Pressure Gases**Incident: Inhalation of inert gasses due to leaks**

Consequence area: Helse Risk before measures: Risiko after measures:
Ytre miljø Risk before measures: Risiko after measures:

Incident: Pressure Disk Burst

Consequence area: Helse Risk before measures: Risiko after measures:
Ytre miljø Risk before measures: Risiko after measures:

Incident: Inert Gas Leak

Consequence area: Helse Risk before measures: Risiko after measures:

Incident: Expansion & Depletion of Oxygen - Uncontrollable

Consequence area: Helse Risk before measures: Risiko after measures:
Ytre miljø Risk before measures: Risiko after measures:
Materielle verdier Risk before measures: Risiko after measures:

Hazard: Use of Reactant Gases (NO, H2 and NO2)**Incident: Gas Leak**

Consequence area: Helse Risk before measures: Risiko after measures:
Ytre miljø Risk before measures: Risiko after measures:



Hazard: Use of Reactant Gases (NO, H2 and NO2)

Incident: Fire

Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Ytre miljø	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	

Incident: Explosion

Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Ytre miljø	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	

Incident: Formation of NOx gasses & Inhalation to respiratory system

Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Ytre miljø	Risk before measures:		Risiko after measures:	

Hazard: Heated Surfaces

Incident: Skin Burns

Consequence area:	Helse	Risk before measures:		Risiko after measures:	
--------------------------	-------	-----------------------	--	------------------------	--

Final evaluation

Organizational units and people involved

A risk assessment may apply to one or more organizational units, and involve several people. These are listed below.

Organizational units which this risk assessment applies to

- Institutt for kjemisk prosesssteknologi

Participants

Jithin Gopakumar

Abubakar Bampoye

Estelle Marie M. Vanhaecke

Readers

[Ingen registreringer]

Others involved/stakeholders

[Ingen registreringer]

The following accept criteria have been decided for the risk area Risikovurdering: Helse, miljø og sikkerhet (HMS):

Helse



Materielle verdier



Omdømme



Ytre miljø



Overview of existing relevant measures which have been taken into account

The table below presents existing measures which have been taken into account when assessing the likelihood and consequence of relevant incidents.

Hazard	Incident	Measures taken into account
Characterization Techniques	Chemisorption	Personnel Safety Measures
	Chemisorption	HSE Documentation
	Chemisorption	Personnel Safety Measures
	Chemisorption	HSE Documentation
	BET & BJH	Personnel Safety Measures
	BET & BJH	HSE Documentation
	BET & BJH	Gas Handling
	BET & BJH	Ventilation
	BET & BJH	Dust Mask
	BET & BJH	Personnel Safety Measures
	BET & BJH	HSE Documentation
	BET & BJH	Dust Mask
	BET & BJH	Ventilation
	BET & BJH	Gas Handling
	XRD	Personnel Safety Measures
XRD	HSE Documentation	
XRD	Dust Mask	
Handling of Catalyst Chemicals	γ -Al ₂ O ₃	Personnel Safety Measures
	γ -Al ₂ O ₃	HSE Documentation
	γ -Al ₂ O ₃	Personnel Safety Measures
	γ -Al ₂ O ₃	HSE Documentation
	Pt(IV)(NO ₃) ₄	Personnel Safety Measures
	Pt(IV)(NO ₃) ₄	HSE Documentation
	Pt(IV)(NO ₃) ₄	Other Safety Measures
	Pt(IV)(NO ₃) ₄	Personnel Safety Measures
	Pt(IV)(NO ₃) ₄	HSE Documentation
	Pt(IV)(NO ₃) ₄	Dust Mask
	Pt(IV)(NO ₃) ₄	Ventilation
	Pt(IV)(NO ₃) ₄	Other Safety Measures
	Ruthenium(III) chloride hydrate	Personnel Safety Measures
Ruthenium(III) chloride hydrate	HSE Documentation	
Ruthenium(III) chloride hydrate	Dust Mask	
Ruthenium(III) chloride hydrate	Ventilation	



Handling of Catalyst Chemicals	Fe(NO ₃) ₃ x 9H ₂ O	Personnel Safety Measures
	Fe(NO ₃) ₃ x 9H ₂ O	HSE Documentation
	Fe(NO ₃) ₃ x 9H ₂ O	Dust Mask
	Fe(NO ₃) ₃ x 9H ₂ O	Ventilation
	Mn(NO ₃) ₂ x 4H ₂ O	Personnel Safety Measures
	Mn(NO ₃) ₂ x 4H ₂ O	HSE Documentation
	Mn(NO ₃) ₂ x 4H ₂ O	Dust Mask
	Mn(NO ₃) ₂ x 4H ₂ O	Ventilation
Use of High Pressure Gases	Inhalation of inert gasses due to leaks	Ventilation
	Inhalation of inert gasses due to leaks	Ventilation
	Pressure Disk Burst	Other Safety Measures
	Pressure Disk Burst	Gas Handling
	Pressure Disk Burst	Ventilation
	Pressure Disk Burst	Ventilation
	Pressure Disk Burst	Gas Handling
	Pressure Disk Burst	Other Safety Measures
	Inert Gas Leak	Leak Testing
	Inert Gas Leak	Gas Handling
	Inert Gas Leak	Ventilation
	Inert Gas Leak	Leak Testing
	Inert Gas Leak	Ventilation
	Inert Gas Leak	Gas Handling
	Expansion & Depletion of Oxygen - Uncontrollable	Other Safety Measures
	Expansion & Depletion of Oxygen - Uncontrollable	Leak Testing
	Expansion & Depletion of Oxygen - Uncontrollable	Gas Handling
	Expansion & Depletion of Oxygen - Uncontrollable	Ventilation
	Expansion & Depletion of Oxygen - Uncontrollable	Leak Testing
	Expansion & Depletion of Oxygen - Uncontrollable	Ventilation
Expansion & Depletion of Oxygen - Uncontrollable	Gas Handling	
Expansion & Depletion of Oxygen - Uncontrollable	Other Safety Measures	
Use of Reactant Gases (NO, H ₂ and NO ₂)	Gas Leak	Personnel Safety Measures
	Gas Leak	Other Safety Measures
	Gas Leak	Gas Handling
	Gas Leak	Ventilation
	Gas Leak	Personnel Safety Measures
	Gas Leak	Ventilation



Use of Reactant Gases (NO, H2 and NO2)	Gas Leak	Gas Handling
	Gas Leak	Other Safety Measures
	Fire	Other Safety Measures
	Fire	Gas Handling
	Fire	Ventilation
	Fire	Ventilation
	Fire	Gas Handling
	Fire	Other Safety Measures
	Explosion	Personnel Safety Measures
	Explosion	HSE Documentation
	Explosion	Other Safety Measures
	Explosion	Leak Testing
	Explosion	Gas Handling
	Explosion	Ventilation
	Explosion	Personnel Safety Measures
	Explosion	HSE Documentation
	Explosion	Leak Testing
	Explosion	Ventilation
	Explosion	Gas Handling
	Explosion	Other Safety Measures
Formation of NOx gasses & Inhalation to respiratory system	Formation of NOx gasses & Inhalation to respiratory system	Personnel Safety Measures
	Formation of NOx gasses & Inhalation to respiratory system	Ventilation
	Formation of NOx gasses & Inhalation to respiratory system	Personnel Safety Measures
	Formation of NOx gasses & Inhalation to respiratory system	Ventilation
Heated Surfaces	Skin Burns	Personnel Safety Measures
	Skin Burns	HSE Documentation
	Skin Burns	Personnel Safety Measures
	Skin Burns	HSE Documentation

Existing relevant measures with descriptions:**Personnel Safety Measures**

Protective Equipment:

- Use Lab coat and goggles;
- Gloves for handling gas cleaning liquid (different gloves);
- Proper gloves must be used while handling and refilling liquid nitrogen in the MKS-FTIR gas analyzer.

Covid-19 Measure:

- Disinfect the common surfaces, such as computer keyboard, mouses, machine surfaces, and panels;
- Disinfection to be carried out using ethanol (strength: 70% or higher); and
- Distance from other personnel (approx. 2m);.



HSE Documentation

The laboratory will always be equipped with a room card and the instrument should have an updated copy of the risk assessment, operating instructions, and apparatus card.

The manuals will include emergency stop procedures for the setup. The phone number of the rig in charge personnel will be provided.

Dust Mask

Reduces risk of inhalation of particles when exposed to the materials used.

Leak Testing

The reactor and gas line connections must be tested for leaks before heating the reactor.

Ventilation

The setup/rig is enclosed inside a cabinet with proper ventilation equipment.

Gas Handling

Installation & Change of Gas Cylinders:

1. Any changes to the gas bottles will be performed by authorized personnel.

Gas Detectors:

1. Existing gas bottles will be checked for leaks near the bottle mouth.

2. There is an NO gas detector installed in the rig cabinet.

3. There are portable detectors capable of measuring NO, H₂ and NO₂ (used mainly for leak testing).

Other Safety Measures

o Gas & Fire alarm is present in Kjemi 5 Hall D

o A fire extinguisher is available for all lab users;

o Emergency shower/eye washer is available for all lab users;

o Ventilation: All off-gases from the reactor are directed to the ventilation system present in the lab;

Working Regulations at NTNU (after working hours)

NTNU students and employees are not allowed to work alone after 7 pm and during the weekends.

Working after 19:00 or on the weekends, you need to be at least 2 in the lab or in the building with regular check-ups (every 30 minutes). Both of the people need to have access to the labs.

Risk analysis with evaluation of likelihood and consequence

This part of the report presents detailed documentation of hazards, incidents and causes which have been evaluated. A summary of hazards and associated incidents is listed at the beginning.

The following hazards and incidents has been evaluated in this risk assessment:

- **Characterization Techniques**
 - Chemisorption
 - BET & BJH
 - XRD
- **Handling of Catalyst Chemicals**
 - γ -Al₂O₃
 - Pt(IV)(NO₃)₄
 - Ruthenium(III) chloride hydrate
 - Fe(NO₃)₃ x 9H₂O
 - Mn(NO₃)₂ x 4H₂O
- **Use of High Pressure Gases**
 - Inhalation of inert gasses due to leaks
 - Pressure Disk Burst
 - Inert Gas Leak
 - Expansion & Depletion of Oxygen - Uncontrollable
- **Use of Reactant Gases (NO, H₂ and NO₂)**
 - Gas Leak
 - Fire
 - Explosion
 - Formation of NO_x gasses & Inhalation to respiratory system
- **Heated Surfaces**
 - Skin Burns



Detailed view of hazards and incidents:

Hazard: Characterization Techniques

Incident: Chemisorption

Cause: Radiation Exposure to Eyes

Cause: Spills on skin

Cause: Inhalation or digestion during preparation

Likelihood of the incident (common to all consequence areas): **Likely (3)**

Kommentar:

[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:





Incident: BET & BJH

BET surface area analysis and BJH pore size distributions.

Cause: Inhalation or digestion during preparation

Cause: Spills on skin

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

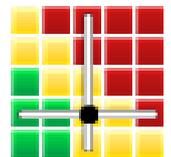
[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:



Incident: XRD

Cause: Inhalation or digestion during preparation

Cause: Spills on skin

Cause: Radiation Exposure to Eyes

Likelihood of the incident (common to all consequence areas): **Likely (3)**

Kommentar:

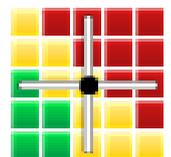
[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:



**Hazard: Handling of Catalyst Chemicals**

Incident: γ -Al₂O₃

Cause: Inhalation or digestion during preparation

Cause: Spills on skin

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

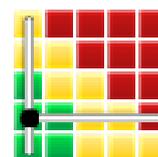
Kommentar:

Not classified as health hazards and is not environmentally dangerous.

Consequence area: Helse

Assessed consequence: **Small (1)**

Comment: Not classified as health hazards and is not environmentally dangerous.

Risk:

**Incident: Pt(IV)(NO3)4**

Cause: Inhalation or digestion during preparation

Cause: Spills on skin

Cause: Splash onto eyes

Cause: Oxidizing by fire

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

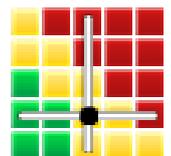
Kommentar:

The use of PPE in the form of lab goggles, dust masks, and nitrile gloves protects the person handling the chemicals from ingestion, inhalation, and spills onto the eyes and skin. The chemical is handled in a well-ventilated area and kept away from potential oxidizers and heat.

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: May intensify fire; oxidiser.
May be corrosive to metals.
Causes severe skin burns and eye damage.
May cause an allergic skin reaction

Risk:

**Incident: Ruthenium(III) chloride hydrate**

Cause: Fire (flammable solid)

Cause: Dust Fire

Cause: Spills on skin

Cause: Inhalation or digestion during preparation

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

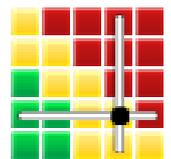
Kommentar:

The use of PPE in the form of lab goggles, dust masks, and nitrile gloves protects the person handling the chemicals from ingestion, inhalation, and spills onto the eyes and skin. The chemical is handled in a well-ventilated area and kept away from potential oxidizers and heat.

Consequence area: Helse

Assessed consequence: **Very large (4)**

Comment: Harmful if swallowed - category 4 for acute oral toxicity.
Can cause irritation to eyes and skin if spilled, causes burns by all exposure routes.

Risk:

Incident: Fe(NO₃)₃ x 9H₂O

Cause: Inhalation or digestion during preparation

Cause: Oxidizing by fire

Cause: Spills on skin

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

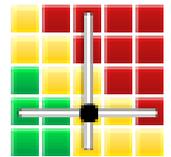
Kommentar:

The use of PPE in the form of lab goggles, dust masks, and nitrile gloves protects the person handling the chemicals from ingestion, inhalation, and spills onto the eyes and skin. The chemical is handled in a well-ventilated area and kept away from potential oxidizers and heat.

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: May intensify fire; oxidizer (category 3).
Causes skin irritation.
Causes serious eye irritation.
May cause respiratory irritation - category 3 for specific target organ toxicity.

Risk:**Incident: Mn(NO₃)₂ x 4H₂O**

Cause: Inhalation or digestion during preparation

Cause: Spills on skin

Cause: Oxidizing by fire

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

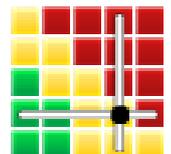
Kommentar:

The use of PPE in the form of lab goggles, dust masks, and nitrile gloves protects the person handling the chemicals from ingestion, inhalation, and spills onto the eyes and skin. The chemical is handled in a well-ventilated area and kept away from potential oxidizers and heat.

Consequence area: Helse

Assessed consequence: **Very large (4)**

Comment: May intensify fire; oxidizer
Harmful if swallowed.
Causes severe skin burns and eye damage
May cause damage to organs through prolonged or repeated exposure.
Category 4 for acute oral toxicity, with the brain as a target organ.

Risk:

Hazard: Use of High Pressure Gases

Incident: Inhalation of inert gasses due to leaks

Cause: Cause

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

Kommentar:

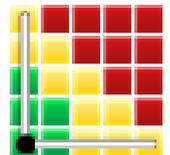
Proper ventilation is present and leakage test is done regularly.

Consequence area: Helse

Assessed consequence: **Small (1)**

Comment: [Ingen registreringer]

Risk:

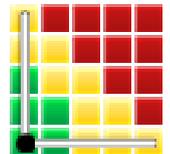


Consequence area: Ytre miljø

Assessed consequence: **Small (1)**

Comment: [Ingen registreringer]

Risk:



Incident: Pressure Disk Burst

Cause: Gas release into the box from the ventilation inlet

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

Kommentar:

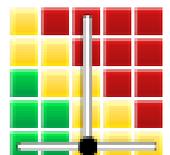
[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:



**Consequence area: Ytre miljø**

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:**Incident: Inert Gas Leak**

Cause: Improper closure of gas inlet/outlet valves

Cause: Loose connections to/from the reactor

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

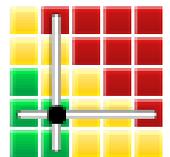
Kommentar:

[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Medium (2)**

Comment: [Ingen registreringer]

Risk:**Incident: Expansion & Depletion of Oxygen - Uncontrollable**

Cause: Cause

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

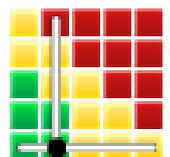
Kommentar:

[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Medium (2)**

Comment: [Ingen registreringer]

Risk:

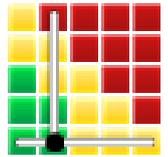


Consequence area: Ytre miljø

Assessed consequence: **Medium (2)**

Comment: [Ingen registreringer]

Risk:

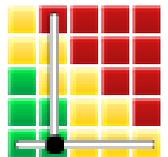


Consequence area: Materielle verdier

Assessed consequence: **Medium (2)**

Comment: [Ingen registreringer]

Risk:





Hazard: Use of Reactant Gases (NO, H2 and NO2)

Incident: Gas Leak

Cause: Loose connections to/from the reactor

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

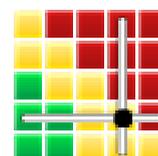
Leak test with inert gas prior to the introduction of hazardous gasses should reduce the likelihood of gas leakage.

Consequence area: Helse

Assessed consequence: **Very large (4)**

Comment: [Ingen registreringer]

Risk:

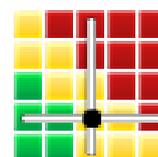


Consequence area: Ytre miljø

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:



Incident: Fire

Cause: Cause

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

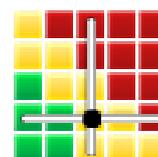
[Ingen registreringer]

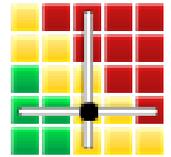
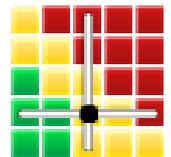
Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

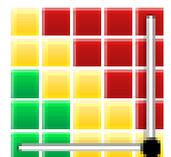
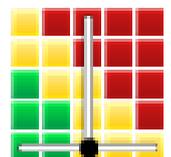
Risk:



Consequence area: Ytre miljø*Assessed consequence:* **Large (3)***Comment:* [Ingen registreringer]**Risk:****Consequence area: Materielle verdier***Assessed consequence:* **Large (3)***Comment:* [Ingen registreringer]**Risk:****Incident: Explosion**

Cause: Cause*Likelihood of the incident (common to all consequence areas):* **Unlikely (1)***Kommentar:*

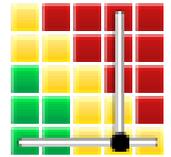
[Ingen registreringer]

Consequence area: Helse*Assessed consequence:* **Catastrophical (5)***Comment:* [Ingen registreringer]**Risk:****Consequence area: Ytre miljø***Assessed consequence:* **Large (3)***Comment:* [Ingen registreringer]**Risk:**

Consequence area: Materielle verdier

Assessed consequence: **Very large (4)**

Comment: [Ingen registreringer]

Risk:**Incident: Formation of NOx gasses & Inhalation to respiratory system**

Cause: Cause

Likelihood of the incident (common to all consequence areas): **Likely (3)**

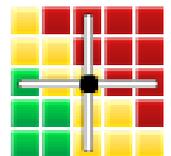
Kommentar:

There may be NOx formation(e.g during the calcination process), where the source is from the cobalt nitrate mostly.

Consequence area: Helse

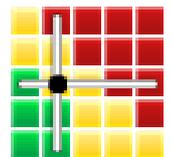
Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:**Consequence area: Ytre miljø**

Assessed consequence: **Medium (2)**

Comment: [Ingen registreringer]

Risk:



Hazard: Heated Surfaces

Incident: Skin Burns

Cause: Skin coming in contact with hot surface

Likelihood of the incident (common to all consequence areas): **Likely (3)**

Kommentar:

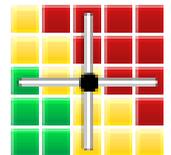
[Ingen registreringer]

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: [Ingen registreringer]

Risk:





Overview of risk mitigating measures which have been decided:

Below is an overview of risk mitigating measures, which are intended to contribute towards minimizing the likelihood and/or consequence of incidents:

Overview of risk mitigating measures which have been decided, with description:



Detailed view of assessed risk for each hazard/incident before and after mitigating measures