Processdel	Beskrivning
	urluftningsventil kan troligtvis minimeras eller helt elimineras med planerad punktventilation.
Process cell 291 & 321 - Die & Casting	Frågan kring explosiv atmosfär i och kring utrustningen behöver utredas vidare i detaljprojekteringen i samråd med leverantör. Explosiv atmosfär kan troligtvis minimeras eller helt elimineras med planerad punktventilation.
Process cell 341, 347 & 371 TD stretching	Ja
Process cell 566 - Extraction Paraffin oil with DCM	Ja
Process cell 566 - Drying DCM from base film	Ja
Cisterner och rörledningar DCM	Ja
Gasåtervinning	Ja
Vätskeseparering	Ja
Dekanteringstankar	Ja
Waste water tank	Ja

If an explosive atmosphere can form to such an extent that specific protective measures become necessary to maintain the health and safety of workers, the explosive atmosphere is referred to as a dangerous explosive atmosphere. A cumulative volume of more than 10 liters of explosive atmosphere should always be considered a dangerous explosive atmosphere, regardless of the size of the area.

Table 3. Handling of flammable substances inside and outside the equipment and whether a hazardous explosive atmosphere is possible.

Process	Description
Process cell 214 – Resin feeding main extrusion	Yes

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Process	Description
Process cell 271 - Mixture by Extrusion	The issue regarding explosive atmospheres inside the equipment needs to be further investigated during Detailed Design in consultation with the supplier. The explosive atmosphere around the bleeding valve can likely be minimized or eliminated with planned local ventilation.
Process cell 291 & 321 - Die & Casting	The issue regarding explosive atmospheres inside and around the equipment needs to be further investigated during Detailed Design in consultation with the supplier. The explosive atmosphere around the bleeding valve can likely be minimized or eliminated with planned local ventilation.
Process cell 341, 347 & 371 TD stretching	Yes
Process cell 566 - Extraction Paraffin oil with DCM	Yes
Process cell 566 - Drying DCM from base film	Yes
Tanks and piping for DCM	Yes
Gas recovery	Yes
Liquid separation	Yes
Decantation tanks	Yes
Waste water tank	Yes

3.5 HINDRAS BILDANDET AV EXPLOSIV ATMOSFÄR PÅ ETT TILLFÖRLITLIGT SÄTT? / IS THE FORMATION OF HAZARDOUS EXPLOSIVE ATMOSPHERES RELIABLY PREVENTED?

Att bildandet hindras på ett *tillförlitligt* sätt innebär att vidtagna tekniska och organisatoriska åtgärder är så omfattande att man inte under några driftsförhållanden eller störningar som rimligen kan förutses behöver ta hänsyn till att en explosion kan uppstå.

Tabell 4. Bedömning om farlig explosiv atmosfär hindras på ett tillförlitligt sätt.

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Processdel	Beskrivning
Process cell 214 – Resin feeding main extrustion	Nej
Process cell 271 - Mixture by Extrusion	Frågan kring explosiv atmosfär inuti utrusningen behöver utredas vidare i detaljprojekteringen i samråd med leverantör. Explosiv atmosfär kring urluftningsventil kan troligtvis minimeras eller helt elimineras med planerad punktventilation.
Process cell 291 & 321 - Die & Casting	Frågan kring explosiv atmosfär kring utrustningen behöver utredas vidare i detaljprojekteringen i samråd med leverantör. Explosiv atmosfär kan troligtvis minimeras eller helt elimineras med planerad punktventilation.
Process cell 341, 347 & 371 TD stretching	Ja, med hänsyn till den höga luftomsättningen bedöms utbredningen av explosiv atmosfär vara försumbar.
Process cell 566 - Extraction Paraffin oil with DCM	Nej, koncentrationen förväntas kontinuerligt ligga inom brännbarhetsområdet.
Process cell 566 - Drying DCM from base film	Nej
Cisterner och rörledningar DCM	Nej, koncentrationer ovan den övre brännbarhetsgränsen brukar normalt sett inte betraktas som tillförlitligt förhindrande av explosiv atmosfär.
Gasåtervinning	Nej
Vätskeseparering	Nej
Dekanteringstankar	Nej. Med tillräcklig ventilation till gasåtervinningen kan det vara möjligt att minimera eller eliminera förekomsten av explosiv atmosfär.
Waste water tank	Nej

Preventing formation in a *reliable* manner means that the technical and organizational measures taken are so comprehensive that, under any operating conditions or foreseeable disturbances, there is no need to consider the possibility of an explosion occurring.

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Table 4. Assessment if the formation of hazardous explosive atmospheres is reliably prevented.

Process	Description
Process cell 214 – Resin feeding main extrusion	No
Process cell 271 - Mixture by Extrusion	The issue regarding explosive atmospheres inside the equipment needs to be further investigated during Detailed Design in consultation with the supplier. The explosive atmosphere around the bleeding valve can likely be minimized or eliminated with planned local ventilation.
Process cell 291 & 321 - Die & Casting	The issue regarding explosive atmospheres inside and around the equipment needs to be further investigated during Detailed Design in consultation with the supplier. The explosive atmosphere around the bleeding valve can likely be minimized or eliminated with planned local ventilation.
Process cell 341, 347 & 371 TD stretching	Yes, considering the high air exchange rate, the spread of the explosive atmosphere is assessed to be negligible.
Process cell 566 - Extraction Paraffin oil with DCM	No, the concentration is expected to continuously remain within the flammability range.
Process cell 566 - Drying DCM from base film	No
Tanks and piping DCM	No, concentrations above the upper flammability limit are generally not considered reliably preventing the formation of an explosive atmosphere.
Gas recovery	No
Liquid separation	No
Decantation tanks	No, with sufficient ventilation to gas recovery, it may be possible to minimize or eliminate the presence of an explosive atmosphere.
Waste water tank	No

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3.6 DELA IN OMRÅDEN MED FARLIG EXPLOSIV ATMOSFÄR I ZONER SÅ ATT TÄNDKÄLLOR FÖREBYGGS / DIVIDE AREAS WITH HAZARDOUS EXPLOSIVE ATMOSPERE IN ZONES TO PREVENT IGNITION SOURCES

Där explosiv atmosfär inte kan elimineras helt och hållet ska områden klassas in i zoner enligt punkt 1.3. Där explosiv atmosfär uppstår eller kan uppstå är det viktigt att identifiera möjligt förekommande tändkällor och eliminera dessa alternativt tillse att tändkällorna inte är aktiva i den explosiva zonen.

I SS-EN 1127–1 finns 13 typer av tändkällor för explosiv atmosfär definierade. De som bedöms kunna vara aktuella i verksamheten är:

1. Heta ytor som kan antända en explosiv atmosfär om yttemperaturen överskrider gasens eller dammets tändtemperatur.
2. Mekaniskt alstrade gnistor som kan uppstå genom friktion, slipning eller slag.
3. Elektrisk utrustning som kan ge upphov till ljusbågar och liknande elektriska urladdningar.
4. Statisk elektricitet som alstras genom rörelse och friktion av människor, fluider och maskiner. Om brister finns i potentialutjämningen eller ickeledande material förekommer i hanteringen kan stora laddningar och farliga gnistor uppstå, exempelvis då en person tar i ett föremål. Eftersom gnistor alstrade av personer endast kan ha en maximal ekvivalent antändningsenergi av 10 mJ, bortsett från vid hantering av stora ledande verktyg, behöver ingen hänsyn tas till statisk elektricitet från personer i explosiv atmosfär med DCM, eftersom DCM har en minsta antändningsenergi på 9100 mJ. Vid gasåtervinningen kan hänsyn till tändkällan dock krävas, på grund av högre temperaturer och tryck.
5. Öppna lågor som är de mest effektiva tändkällorna och därför aldrig får finnas inom ett klassat område.
6. Blixtnedslag

Samtliga områden där explosiv atmosfär förväntas uppstå eller kan uppstå delas in i zoner enligt avsnitt 1.3. Vilka zoner som uppstår samt vilka tändkällor som förväntas vara aktuella beskrivs

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översiktligt i Tabell 5. Sammanfattande beskrivning över riskkällor och zonernas utbredning finns i Bilaga 2.

Tabell 5. De zoner som bildas i och utanför utrustning samt aktuella tändkällor för områdena.

Processdel	Zoner	Aktuella tändkällor
Process cell 214 – Resin feeding main extrustion	20/21/22	Heta ytor, mekaniskt alstrade gnistor, elektrisk utrustning, statisk elektricitet, heta arbeten, blixtnedslag.
Process cell 271 - Mixture by Extrusion	TBD	Heta ytor, mekaniskt alstrade gnistor, elektrisk utrustning, statisk elektricitet, heta arbeten, blixtnedslag.
Process cell 291 & 321 - Die & Casting	TBD	Heta ytor, mekaniskt alstrade gnistor, elektrisk utrustning, statisk elektricitet, heta arbeten, blixtnedslag.
Process cell 566 - Extraction Paraffin oil with DCM	0	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag.
Process cell 566 - Drying DCM from base film	0/1	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag.
Cisterner och rörledningar DCM, samt utblås från säkerhetsventiler	0/2	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag
Gasåtervinning	TBD	Heta ytor, mekaniskt alstrade gnistor, elektrisk utrustning, statisk elektricitet, heta arbeten, blixtnedslag
Vätskeseparering	TBD	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag
Dekanteringstankar	1	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag.
Waste water tank	1	Heta ytor, elektrisk utrustning, heta arbeten, blixtnedslag.

In areas where an explosive atmosphere cannot be completely eliminated, they should be classified into zones as described in section 1.3. Where an explosive atmosphere occurs or may

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occur, it is essential to identify potential ignition sources and either eliminate them or ensure that the ignition sources are not active within the explosive zone.

In SS-EN 1127-1, 13 types of ignition sources for explosive atmospheres are defined. Those that are considered relevant to the operation are:

1. Hot surfaces that can ignite an explosive atmosphere if the surface temperature exceeds the ignition temperature of the gas or dust.
2. Mechanically generated sparks that can occur through friction, grinding, or impact.
3. Electrical equipment that can generate arcs and similar electrical discharges.
4. Static electricity generated by the movement and friction of people, fluids, and machinery. If there are deficiencies in grounding or non-conductive materials are present in handling, significant charges and dangerous sparks can occur, for example, when a person touches an object. Since sparks generated by individuals can only have a maximum equivalent ignition energy of 10 mJ, except when handling large conductive tools, no consideration needs to be given to static electricity from individuals in an explosive atmosphere with DCM, as DCM has a minimum ignition energy of 9100 mJ. However, consideration of ignition sources may be required in the gas recovery area due to higher temperatures and pressures.
5. Open flames, which are the most effective ignition sources and must never be present within a classified area.
6. Lightning strikes.

All areas where an explosive atmosphere is expected to occur or may occur are divided into zones with guidance from standard SS-EN 60079-10-2. The zones that arise and the expected relevant ignition sources are briefly described in Table 5. A comprehensive description of the sources of risk and the extent of the zones can be found in Appendix 2.

Table 5. ATEX zones formed within and outside equipment and potential ignition sources in the areas.

Process	Zones	Potential sources of ignition
Process cell 214 – Resin feeding main extrustion	20/21/22	Hot surfaces, Mechanically generated sparks, electrical equipment, static electricity, open flames, lightning strikes.

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Process	Zones	Potential sources of ignition
Process cell 271 - Mixture by Extrusion	TBD	Hot surfaces, mechanically generated sparks, electrical equipment, static electricity, open flames, lightning strikes.
Process cell 291 & 321 - Die & Casting	TBD	Hot surfaces, mechanically generated sparks, electrical equipment, static electricity, open flames, lightning strikes.
Process cell 566 - Extraction Paraffin oil with DCM	0	Hot surfaces, electrical equipment, open flames, lightning strikes.
Process cell 566 - Drying DCM from base film	0/1	Hot surfaces, electrical equipment, open flames, lightning strikes.
Tanks and piping DCM, and exhaust from safety valves	0/2	Hot surfaces, electrical equipment, open flames, lightning strikes.
Gas recovery	TBD	Hot surfaces, mechanically generated sparks, electrical equipment, static electricity, open flames, lightning strikes.
Liquid separation	TBD	Hot surfaces, electrical equipment, open flames, lightning strikes.
Decantation tanks	1	Hot surfaces, electrical equipment, open flames, lightning strikes.
Waste water tank	1	Hot surfaces, electrical equipment, open flames, lightning strikes.

3.7 FÖREBYGGS ANTÄNDING AV EXPLOSIV ATMOSFÄR PÅ ETT TILLFÖRLITLIGT SÄTT /IS THE IGNITION OF HAZARDOUS EXPLOSIVE ATMOSPHERES RELIABLY PREVENTED?

På anläggningar där explosiva atmosfärer bildas eller kan bildas, är det viktigt att göra en bedömning om identifierade tändkällor förebyggs på ett tillförlitligt sätt.

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Tabell 6. Bedömning om antändning av explosiv atmosfär förebyggs på ett tillförlitligt sätt.

Processdel	Beskrivning
Process cell 214 – Resin feeding main extrustion	Verifieras under detaljprojektering
Process cell 271 - Mixture by Extrusion	Verifieras under detaljprojektering
Process cell 291 & 321 - Die & Casting	Verifieras under detaljprojektering
Process cell 566 - Extraction Paraffin oil with DCM	Verifieras under detaljprojektering
Process cell 566 - Drying DCM from base film	Verifieras under detaljprojektering Vattenuppvärmda spolar bedöms ej utgöra tändkälla om temperaturen understiger kriteriet för T1 (T<450 °C)
Cisterner och rörledningar DCM	Verifieras under detaljprojektering
Gasåtervinning	Verifieras under detaljprojektering
Vätskeseparering	Verifieras under detaljprojektering
Dekanteringstankar	Verifieras under detaljprojektering
Waste water tank	Verifieras under detaljprojektering

At facilities where explosive atmospheres form or can form, it is important to assess whether identified ignition sources are reliably prevented.

Table 6. Assessment if ignition of hazardous explosive atmospheres is reliably prevented.

Processdel	Beskrivning
Process cell 214 – Resin feeding main extrustion	To be verified i Detailed Design
Process cell 271 - Mixture by Extrusion	To be verified i Detailed Design

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Processdel	Beskrivning
Process cell 291 & 321 - Die & Casting	To be verified i Detailed Design
Process cell 566 - Extraction Paraffin oil with DCM	To be verified i Detailed Design
Process cell 566 - Drying DCM from base film	To be verified i Detailed Design Water-heated coils are not considered an ignition source if the temperature remains below the criterion for T1 (T < 450 °C).
Cisterner och rörledningar DCM	To be verified i Detailed Design
Gasåtervinning	To be verified i Detailed Design
Vätskeseparering	To be verified i Detailed Design
Dekanteringstankar	To be verified i Detailed Design
Waste water tank	To be verified i Detailed Design

3.8 BEGRÄNSA SKADORNA AV EN EXPLOSION GENOM BYGGNADSTEKNISKA OCH ORGANISATORISKA SKYDDSÅTGÄRDER / LIMIT THE DAMAGES OF AN EXPLOSION THROUGH ARCHITECTURAL AND ORGANIZATIONAL PROTECTIVE MEASURES

Ytterligare åtgärder kan krävas om det under detaljprojekteringen framkommer att antändning av explosiv atmosfär inte kan förebyggas på ett tillförlitligt sätt.

Additional measures may be required if it is determined during detailed design that ignition of an explosive atmosphere cannot be reliably prevented.

3.9 VIDTA GENERELLA ÅTGÄRDER / GENERAL MEASURES

I detta avsnitt redogörs för generella åtgärder som berör mer eller mindre hela anläggningen. Dessa åtgärder utgör exempelvis organisatoriska rutiner för utfärdande av arbetstillstånd. Åtgärderna utgör även sådana som ger en ökad flexibilitet inför framtida förändringar av verksamheten och åtgärder som höjer det generella skyddet mot explosionsrisker.

Tekniska åtgärder

Potentialutjämning ska finnas i fall där statisk elektricitet kan utgöra tändkälla. Detta för att förhindra potentialskillnader vilka skulle kunna antända explosiv atmosfär. Potentialutjämningens funktion ska verifieras regelbundet.

All utrustning och alla komponenter som installeras inom klassade områden ska vara utförda enligt föreskrifterna:

- AFS 2016:4 – Utrustning för potentiellt explosiva atmosfärer
- ELSÄK-FS 2016:2 – Elsäkerhetsverkets föreskrifter om elektrisk utrusning om elektriska skyddssystem avsedda för användning i potentiellt explosiva atmosfärer,

dvs EX-klassad utrustning ska användas. Det är viktigt att märkskylt/bruksanvisning följs vid installation av EX-klassad utrustning. Det är lätt att missa att för mekaniska utrustningar står normalt nödvändiga skydd endast i bruksanvisningen och framgår ofta inte på märkskylten.

Organisatoriska åtgärder

Den som vistas i explosionsfarlig miljö eller utför arbete som kan påverka explosionssäkerheten ska ha lämplig utbildning, kunskap om explosionsrisker och skyddsåtgärder samt färdigheter i säkert handhavande. Skriftliga rutiner ska finnas för att säkerställa säkert arbete, exempelvis genom regelbundna kontroller av potentialutjämning samt hur personal ska agera vid läckage eller brand. Även rutiner för säkert underhåll av utrustning i klassade områden ska finnas. Extra viktigt i en dammig miljö är att städrutiner finns. Tänk särskilt på sådana platser där damm ansamlas och som är svåra att nå, exempelvis balkar i tak. En generell regel som kan användas är att om det blir fotspår i dammet där man går, är det dags att städa. Dammlagret är då för tjockt.

Utfärdande av arbetstillstånd

Innan arbete som inte är rutin påbörjas i klassat område eller på säkerhetsutrustning ska arbetstillstånd utfärdas av en person med särskilt ansvar för denna uppgift. Ett arbetstillstånd ska innehålla de villkor och instruktioner som krävs för en säker hantering.

Säker avställning och driftklarhetsverifiering

Rutiner för säker avställning och driftklarhetsverifiering ska finnas och tillämpas vid underhållsarbete eller tillfälliga stopp på utrustningar och anordningar i eller för explosiv atmosfär. Detta innebär att underhållsarbete som kan orsaka gnistbildning eller

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heta ytor ej ska utföras inom zonklassade områden innan dessa har gasfrihetsförklarats.

Uppföljning av olycksfall och tillbud

Olycksfall och tillbud ska utredas, dokumenteras och riskbedömas. Arbetet får inte återupptas efter ett explosionsolycksfall eller allvarligt tillbud förrän en ny riskbedömning visat att arbetet kan utföras säkert.

Generellt i verksamheten

Förbud mot öppna lågor ska införas. Skyltning (se Tabell 6) ska finnas i alla utrymmen där explosiv atmosfär kan förekomma.

Brandsläckare ska finnas att tillgå i utrymmen där brännbart material hanteras.

In this section, general measures are explained, which affect more or less the entire facility. These measures include, for example, organizational procedures for issuing work permits. The measures also include those that increase flexibility in the face of future changes in operations and measures that enhance general protection against explosion risks.

Technical Measures

Grounding should be in place where static electricity can serve as an ignition source. This is to prevent potential differences that could ignite explosive atmospheres. The function of grounding should be regularly verified.

All equipment and components installed in classified areas should be in accordance with the regulations:

• AFS 2016:4 - Equipment for potentially explosive atmospheres

• ELSÄK-FS 2016:2 - Swedish Electrical Safety Authority's regulations on electrical equipment and electrical protection systems intended for use in potentially explosive atmospheres, i.e., Ex-classified equipment should be used.

Organizational Measures

Anyone in an explosive hazardous environment or performing work that could affect explosion safety should have appropriate training, knowledge of explosion risks, protective measures, and skills in safe handling. Written procedures should be in place to ensure safe work, such as regular checks of grounding and how personnel should respond to leaks or fires. Procedures for the safe maintenance of equipment in classified areas should also be in place. In a dusty environment, it's especially important to have cleaning routines in place. Pay particular attention to areas where dust accumulates and is difficult to reach, such as beams in the ceiling. A general rule that can be applied is that if footprints

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appear in the dust as you walk, the dust layer is too thick and it's time to clean.

Issuing Work Permits

Before non-routine work begins in a classified area or on safety equipment, a work permit must be issued by a person specifically responsible for this task. A work permit should contain the conditions and instructions required for safe handling.

Safe Shutdown and Operational Readiness Verification

Procedures for safe shutdown and operational readiness verification should exist and be applied during maintenance work or temporary stops on equipment and devices in or for explosive atmospheres. This means that maintenance work that may cause sparking or hot surfaces should not be performed within zone classified areas until they have been declared gas-free.

Follow-up on Accidents and Incidents

Accidents and incidents should be investigated, documented, and assessed for risk. Work must not resume after an explosion accident or a serious incident until a new risk assessment shows that the work can be done safely.

General Operations

A ban on open flames should be implemented. Signs should be present in all areas where explosive atmospheres may occur.

Fire extinguishers should be available in areas where flammable materials are handled.

Briab – The right side of risk

David Winberg

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BILAGA 1 – FÖRTECKNING ÖVER BRANDFARLIGA VAROR / APPENDIX 1 – INVENTORY OF FLAMMABLE SUBSTANCES

BILAGA 2 – FÖRTECKNING ÖVER RISKKÄLLOR / APPENDIX 2 – INVENTORY OF EXPLOSION HAZARDS

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Bilaga 1 – Förteckning över brandfarliga varor

/ Appendix 1 – Inventory of flammable substances

Pos Nr	Brandfarlig vara (vätskor)		Flam-punkt ºC	Explosionsgränser			Flyktighet		Relativ densitet för gas eller ånga till luft (Luft=1)	Tändtemperatur ºC	Explosionsgrupp resp. temperatur-klass		Annan information och anmärkningar
	Namn (Ämne)	Sammansättning		g/m³	LEL Vol %	UEL Vol %	Ångtryck 20 ºC, kPa	Kokpunkt ºC					
1	Paraffinolja	C_nH_{2n+2}	>112					218		≥325		T2	
2	Diklormetan	CH_2Cl_2	*		13	22	47	40	2,9	605	IIA	T1	Pga. hög antändningsenergi på 9100 mJ erhålls ingen flampunkt vid standardiserad provning.

Pos Nr	Brandfarlig vara (damm)		Partikel-storlek (median) µm	Explosionsgränser LEL	Antändningstemperatur		Kst-värde Bar*m/s	Dammklass	Risk för damm explosion		Annan information och anmärkningar
	Namn (Ämne)	Sammansättning		g/m³	Tänd-temperatur °C	Glöd-temperatur °C			Ja	Nej	
3	Polyeten	$(C_2H_4)_n$	96	60	410	Smälter	69	St1	x		Information från GESTIS DUST-EX Vid andra partikelstorlekar kan värdena förändras.

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Pos Nr	Flammable substance (liquids)		Flash-point ºC	Flammability limits			Volatilty		Relative density for gas or vapor to air (Air=1)	Auto ignition temperature ºC	Apparatus group and Temperature class		Other information and remarks
	Name (substance)	Chemical formula		g/m³	LEL Vol %	UEL Vol %	Vapor pressure 20 ºC, kPa	Boiling point ºC					
1	Paraffin oil	C_nH_{2n+2}	>112					218		≥325		T2	
2	Dichloromethane (DCM)	CH_2Cl_2	*		13	22	47	40	2,9	605	IIA	T1	Due to the high ignition energy of 9100 mJ, no flash point is obtained in standardized testing.

Pos Nr	Flammable substance (dust)		Particle-size (median) µm	Flammability limits LEL	Ignition temperature		Kst-value Bar*m/s	Hazard class	Dust explosion hazard?		Other information and remarks
	Name (substance)	Chemical formula		g/m³	Tänd-temperatur °C	Glöd-temperatur °C			Yes	No	
3	Polyethylene	$(C_2H_4)_n$	96	60	410	Melts	69	St1	x		Information from GESTIS DUST-EX At other particle sizes, the values can change.

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Bilaga 2 – Förteckning över riskkällor

/Appendix 2 – Inventory of explosion hazards

Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering		Ref	Drifttemp tryck (3)		Fas	Typ	Grad	Till-gänglig-het	Typ av zon	Utsträckning		Referens till	
			(1)	(2)	°C	kPa	(4)	(5)	(6)	(7)	0-1-2	Vertikalt m	Horisontalt m		
1	Anslutning Big bag	Process cell 214	S	3	R	A	D	M	M	A	22	1 m ovan anslutning och ned till golvnivå	1 m i alla riktningar från anslutning från big bag	SS-EN 60079-10-2, Annex A, A.3	Local ventilation at connection locations for fitting to material infeed hopper. Material hopper is held at a lower pressure to reduce risk of material leaks. Big bag connection points to use a positive connection to the powder infeed hopper to prevent leaks.

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Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering		Ref	Drifttemp tryck (3)		Fas	Typ	Grad	Till-gänglig-het	Typ av zon	Utsträckning		Referens till	
			(1)	(2)	°C	kPa	(4)	(5)	(6)	(7)	0-1-2	Vertikalt m	Horisontalt m		
2	Main extruder feeding, från anslutning av big bag till extruder	Process cell 214	K	3	R		D	-	-	-	20 21/22	Invändigt i utrustningen, från big bag till hopper. Invändigt i resterande del av utrustningen fram till extruder	Invändigt i utrustningen, från big bag till hopper. Invändigt i resterande del av utrustningen fram till extruder	SS-EN 60079-10-2, Annex A, A.1.1	PJ2100724-P1-2 single line anger en ATEX-klassificering som motsvarar zon 21/22. Vilken klassning som gäller för respektive del beror på exemelvis inbyggda materialspärrar. Detta utreds vidare i detalj-projekteringen i samråd med leverantör.
3	Extruder	Process cell 271	K	1	200-250	?	V	-	-	-	TBD	Invändigt i utrustningen	Invändigt i utrustningen		Frågan kring explosiv atmosfär inuti utrusningen behöver utredas vidare i detaljprojekteringen i samråd med leverantör.
4	Urluftningsventil	Process cell 271	P	1	200-250	?	G	M	TBD	TBD	TBD	TBD	TBD		Information om förväntat läckageflöde behövs. Zonen kan troligtvis minimeras eller helt elimineras med planerad

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Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering	(1)	Ref (2)	Drifttemp tryck (3) °C	kPa	Fas (4)	Typ (5)	Grad (6)	Till-gänglig-het (7)	Typ av zon 0-1-2	Utsträckning Vertikalt m	Horisontalt m	Referens till	
															punktventilation (500 m³/h).
5	Die and casting	Process cell 291 & 321	P	1	200-250	A	V	M	TBD	TBD	TBD	TBD	TBD		Explosiv atmosfär kan troligtvis minimeras eller helt elimineras med planerad punktventilation. (1000 + 10 000 + 1 000 m³/h).
6	Extraction bath	Process cell 566	K	2	R	A	V	M	M	B	0	Invändigt i badet, ovan vätskeyta	Invändigt i badet, ovan vätskeyta	EN 60079-10-1 Bilaga C och Bilaga D	
7	Drying DCM from base film	Process cell 566	K	2	?	A	V	M	M	B	0	Invändigt i torkutrymmet.	Invändigt i torkutrymmet.	EN 60079-10-1 Bilaga C och Bilaga D	
8	Öppning där basfilmen lämnar inneslutning efter torkning	Process cell 566	P	2	R	A	V	M	M	B	1	2,5 m ovan öppning och ned till golvet	2,5 m i alla riktningar från öppning	EN 60079-10-1 Bilaga C och Bilaga D	Zon baserad på värdena för diffusa utsläpp, 97 kg/h, och ett luftflöde på 135 m³/h

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Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering	(1)	Ref (2)	Drifttemp tryck (3) °C	kPa	Fas (4)	Typ (5)	Grad (6)	Till-gänglig-het (7)	Typ av zon 0-1-2	Utsträckning Vertikalt m	Horisontalt m	Referens till	
9	Frånluftskanal från extraktionsbadet till gasåtervinning	Process cell 566	K	2	R	A	G	N/A	N/A	N/A	0	Invändigt i kanalen	Invändigt i kanalen	Koncentrationen i kanalen ligger mellan 12-15 % enligt Compression condensation recovery device technical requirements, vilket är inom brännbarhets-området för DCM	
10	DCM-cisterner	DCM Tank Farm	K	2	R	A	V	-	-	-	0	Invändigt cistern ovan vätskeytan	Invändigt cistern ovan vätskeytan		Koncentrationen ligger normalt sett ovan UFL.
11	Säkerhetsventiler DCM-cistern	Ovan tak DCM Tank Farm	S	2	R	A	G	N	M	B	2	TBD	TBD		Utbredning av zon bestäms i detalj-projekteringen
12	Waste water tank	DCM Tank Farm	P	2	R	A	V	-	-	-	1	Invändigt cistern ovan vätskeytan	Invändigt cistern ovan vätskeytan		Cisternen förväntas enbart innehålla DCM i händelse av ett tillbud med läckage av DCM i tankfarmen. Riskkällan bedöms därmed som primär i stället för kontinuerlig.

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Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering		Ref	Drifttemp tryck (3)		Fas	Typ	Grad	Till-gänglig-het	Typ av zon	Utsträckning		Referens till	
			(1)	(2)	°C	kPa	(4)	(5)	(6)	(7)	0-1-2	Vertikalt m	Horisontalt m		
13	Rörledningar DCM		K	2	R	?	V	-	-	-	0	Invändigt i rörledningar	Invändigt i rörledningar		Koncentrationen ligger normalt sett ovan UFL.
14	Dekanteringstankar		P	2	R	A	V	TBD	TBD	TBD	1	I tank ovan vätskeyta	I tank ovan vätskeyta		Vatten ligger ovan DCM och förhindrar avdunstning, typ av utsläpp reduceras därför från kontinuerlig till primär. Med tillräcklig ventilation från tank till gasåtervinning kan zonen reduceras till zon 2 eller helt elimineras.
15	Gasåtervinning														Klassning kompletteras under detaljprojekteringen av anläggningen.

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Pos Nr	Riskkälla		Typ av utsläpp	Brandfarlig vara				Ventilation			Riskområde				Annan information och anmärkningar
	Benämning	Placering		Ref	Drifttemp tryck (3)		Fas	Typ	Grad	Till-gänglig-het	Typ av zon	Utsträckning		Referens till	
			(1)	(2)	°C	kPa	(4)	(5)	(6)	(7)	0-1-2	Vertikalt m	Horisontalt m		
16	Vätskeseparering														Klassning kompletteras under detaljprojekteringen av anläggningen.

(1) K – Kontinuerlig
P – Primär
S – Sekundär

(2) Anger numret från bilaga 1.

(3) R – Rumstemperatur
A – Atmosfärstryck
U - Utomhustemperatur

(4) D – Damm
G – Gas
KG – Kondenserad gas
V – Vätska

(5) N – Naturlig
M – Mekanisk

(6) H – Hög
M – Medelgod
L – Låg

(7) B – Bra
A – Acceptabel
D – Dålig

Eventuella aspirationsöppningar, bypassfunktioner, sprängbleck och tryckvacuumventiler kan också ge upphov till klassade zoner. Detta ska fastställas i Detailed Design.

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position		Ref	Temp / Pressure (3)		Phase	Type	Effect-iveness	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
			(1)	(2)	°C	kPa	(4)	(5)	(6)			Vertically	Horisontally		
1	Big bag connection	Process cell 214	S	3	R	A	D	M	M	F	22	1 m above connection and down to floor level.	1 m in all directions from big bag connection	SS-EN 60079-10-2, Annex A, A.3	Local ventilation at connection locations for fitting to material infeed hopper. Material hopper is held at a lower pressure to reduce risk of material leaks. Big bag connection points to use a positive connection to the powder infeed hopper to prevent leaks.
2	Main extruder feeding, from big bag connection to the extruder	Process cell 214	C	3	R		D	-	-	-	20 21/22	Inside equipment, from big bag to hopper. Inside remaining equipment to the extruder	Inside equipment, from big bag to hopper. Inside remaining equipment to the extruder	SS-EN 60079-10-2, Annex A, A.1.1	PJ2100724-P1-2 single line indicates an ATEX classification that corresponds to Zone 21/22. The specific classification for each part depends on factors such as built-in material barriers. This will be further

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position	(1)	Ref (2)	Temp / Pressure (3)		Phase (4)	Type (5)	Effect-iveness (6)	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
					°C	kPa						Vertically	Horisontally		
															investigated during the detailed design phase in consultation with the supplier.
3	Extruder	Process cell 271	C	1	200-250	?	L	-	-	-	TBD	Inside equipment	Inside equipment		The issue regarding the explosive atmosphere inside the equipment needs to be further investigated during the detailed design phase in consultation with the supplier.
4	Urluftningsventil	Process cell 271	P	1	200-250	?	G	M	TBD	TBD	TBD	TBD	TBD		Information about the expected leakage flow is needed. The zone can likely be minimized or completely eliminated with planned local ventilation (500 m3/h).

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position		Ref	Temp / Pressure (3)		Phase	Type	Effect-iveness	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
			(1)	(2)	°C	kPa	(4)	(5)	(6)			Vertically	Horisontally		
5	Die and casting	Process cell 291 & 321	P	1	200-250	A	L	M	TBD	TBD	TBD	TBD	TBD		The explosive atmosphere can likely be minimized or completely eliminated with planned local ventilation (1000 + 10,000 + 1000 m3/h).
6	Extraction bath	Process cell 566	C	2	R	A	L	M	M	G	0	Inside extraction bath, above liquid surface	Inside extraction bath, above liquid surface	EN 60079-10-1 Bilaga C och Bilaga D	
7	Drying DCM from base film	Process cell 566	C	2	?	A	L	M	M	G	0	Inside drying chamber	Inside drying chamber	EN 60079-10-1 Bilaga C och Bilaga D	
8	Opening where the base film exits the enclosure after drying.	Process cell 566	P	2	R	A	L	M	M	G	1	2,5 m above opening and down to floor level.	2,5 m in all directions from opening.	EN 60079-10-1 Appendix C & D	Zone classification based on the values for diffuse emissions, 97 kg/h, and an airflow of 135 m3/h.

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position		Ref	Temp / Pressure (3)		Phase	Type	Effect-iveness	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
			(1)	(2)	°C	kPa	(4)	(5)	(6)			Vertically	Horisontally		
9	Exhaust air duct from extraction bath to gas recovery	Process cell 566	C	2	R	A	G	N/A	N/A	N/A	0	Inside duct	Inside duct	The concentration in the duct is between 12-15%, according to the Compression Condensation Recovery Device technical requirements, which falls within the flammable range for DCM.	
10	DCM tanks	DCM Tank Farm	C	2	R	A	L	-	-	-	0	Inside tank above liquid surface	Inside tank above liquid surface		The concentration is normally above UFL.
11	DCM Tank safety valves	Above roof DCM Tank Farm	S	2	R	A	G	N	M	G	2	TBD	TBD		Extent to be decided in Detailed Design.
12	Waste water tank	DCM Tank Farm	P	2	R	A	L	-	-	-	1	Inside tank above liquid surface	Inside tank above liquid surface		The tank is only expected to contain DCM in the event of an incident involving a DCM leak in the tank farm. Therefore, the source of risk is considered

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position	(1)	Ref (2)	Temp / Pressure (3)		Phase (4)	Type (5)	Effect-iveness (6)	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
					°C	kPa						Vertically	Horisontally		
															primary rather than continuous.
13	DCM Piping		C	2	R	?	L	-	-	-	0	Inside piping	Inside piping		The concentration is normally above UFL.
14	Decantation tanks		P	2	R	A	L	TBD	TBD	TBD	1	Inside tank above liquid surface.	Inside tank above liquid surface.		Water is present above the DCM and prevents evaporation, which reduces the type of release from continuous to primary. With sufficient ventilation from the tank to gas recovery, the zone can be reduced to Zone 2 or eliminated.

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Pos Nr	Hazard		Type of release	Flammable substance				Ventilation			Hazardous area				Other information and remarks
	Name	Position		Ref	Temp / Pressure (3)		Phase	Type	Effect-iveness	Availa-bility (7)	Zone 0-1-2	Extent		Reference to	
			(1)	(2)	°C	kPa	(4)	(5)	(6)			Vertically	Horisontally		
15	Gas recovery														Classification shall be performed in Detailed Design.
16	Liquid separation														Classification shall be performed in Detailed Design.

(1) C – Continuous, P – Primary, S – Secondary
(2) Number from Appendix 1.
(3) R – Room temperature, A – Atmospheric, O – Outdoor temp
(4) D – Dust, G – Gas, CG – Condensed gas, L – Liquid
(5) N – Natural, M – Mechanical
(6) H – High, M – Medium, L – Low
(7) G – Good, F – Fair, P – Poor

Any aspiration openings, bypass functions, explosion relief panels, and pressure vacuum valves can also give rise to classified zones. This should be determined during the Detailed Design phase.

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Appendix 2 - Evacuation analysis

Analytical dimensioning of evacuation conditions

2023-07-07

Rev. Date:
2023-09-01

PROJECT NAME
Senior Material, Eksilstuna

STATUS
Basic Design

PROPERTY AND MUNICIPALITY
Grönsta 1:35, Eskilstuna

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Briab
The right side of risk

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Content

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1. Introduction

This scenario analysis has been carried out on behalf of *Logistic Contractor Entreprenad AB* to investigate whether it is possible to design the fire protection for the production facility in the property Grönsta 1:35 in Eskilstuna in a different way than stated in general advice in section i 5:331 Walking distance to escape route in BBR.

The purpose of the fire technical investigation is to investigate when critical conditions arise within the studied premises and what maximum evacuation time exists for people staying within the store's fire cell.

The goal is to use fire gas filling and evacuation simulation to demonstrate that people's exposure to fire and fire gases during evacuation does not exist based on accepted acceptance criteria and dimensioning fire and evacuation scenarios.

1.1. Background

Senior Material (Europe) AB is planning for a large-scale plant for the production of separator materials for lithium-ion batteries in Eskilstuna. The facility consists of a main building of about 24,000 m2, divided into two blocks (B1 and B3), and several complementary buildings (U01-U02, U03, U04, U05, U10).

Fire protection within the premises concerned is dimensioned for business class 1.

The analysis evaluates whether people have time to vacate the premises before critical levels are reached.

1.2. Scope and boundaries

The document is limited to only the evacuation from production areas within B1 and finished goods warehouses within B3.

Long walking distances within evacuation corridors are verified in the appendix to this document.

1.3. Regulations and governing documents

The analysis follows the methodology and input data specified in BBRAD 3, the National Board of Housing, Building and Planning's general advice on analytical design of building fire protection (BFS 2011:27 with amendments up to and including BFS 2013:12).

In other respects, governing regulations consist of:

- The National Board of Housing, Building and Planning's building regulations, BBR 29 (BFS 2011:6 with amendments up to and including 2020:4).

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1.4. Foundation

The following table sets out the basis for the opinion:

ACTION	STATUS	DATING	ESTABLISHED BY
A-drawing, F2-A--40-1-S01100001 A-Drawing, F2-A--40-1-S01200001	Basic design Basic design	2023-06-07 2023-06-07	Tengbom

1.5. Quality management system

This report is subject to self-monitoring according to the instructions in Briab's quality management system, which is certified according to ISO 9001. The self-monitoring is covered by an administrator check and a quality review conducted by a specially appointed quality controller within Briab. During the inspection, a special checklist is used to ensure that the relevant requirements have been met. The checklist looks different depending on the type of assignment and document. Revisions of documents shall normally be subject to the same checks as above. Minor formal changes that do not affect the design in general may be made by the administrator himself. In such cases, this must be stated in the document.

1.6. Revisions and self-monitoring

The date and date of revision as well as the administrators and quality reviewers for all produced versions of this document are summarised in the table below:

DATE	STATUS	ADMINISTRATOR	QUALITYCONTROL
2023-09-01	Basic Design	Stephanie Axelsson	Jonathan Rosenqvist
2023-07-07	Basic design	Stephanie Axelsson	Lucas Andersson

Revisions to this document are marked with a sidebar line.

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2. Basic prerequisites

This chapter describes the technical conditions and the need for verification that forms the basis for fire gas filling and evacuation simulations.

2.1. Building description

The main building is approximately 24,000 m² and consists of two different blocks. Parts of the building have two floors while the rest is a single floor and mezzanine for installations. Under the building there is also a basement, as part of floor 1, with space under the installation floor.

Block 1 (B1) contains production process areas and cleanroom equipment on the ground floor. On the second floor are the air handling spaces for the production process.

Block 3 (B3) contains different types of storage facilities as well as hazardous waste areas. Staff facilities in the form of changing rooms are located on the first floor and office space and lunchrooms are on the second floor.

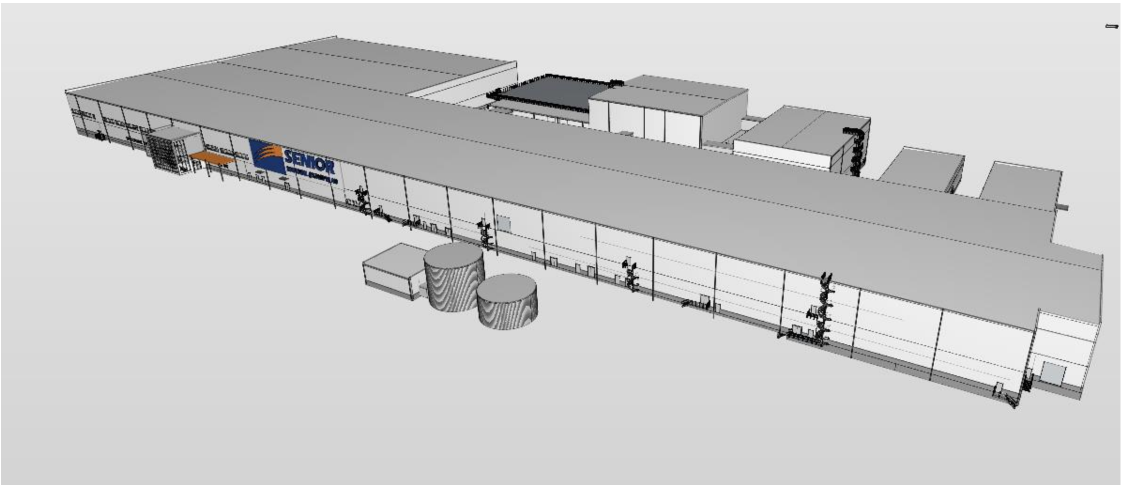

Figure 1 Image of the building in 3D model.

Table x and figure X below illustrate the personnel numbers and distribution used in the simulation.

Table 1 - Number of persons.

BUILDING PART	PLAN	BUSINESS CLASS	NUMBER OF PEOPLE (PEOPLE)
Production area floor 1	*1*	*1*	*110*
Production area floor 2	*2*	*1*	*40*
Finished goods inventories	*1*	*1*	*150*
Total number of people inthe models*:*			***150/model***

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2.1.1. Fire technical installations

The building is designed with comprehensive fire and evacuation alarms in accordance with SBF 110:8 with acoustic alarm devices and illuminated guidance markings at changes of direction and above escape routes.

Automatic water sprinkler system is installed in the building in accordance with SBF 120:8. The sprinkler has an RTI value of 50 $ms^{1/2}$ and an activation temperature of 68oC.

2.2. Evacuation

Evacuation from production areas on the ground floor takes place via an evacuation corridor to stairwells out into the open air.

Evacuation from installation spaces on level 2 above production areas takes place via door in façade to external sprial stairs to the open air or via stairwells further out into the open air.

Evacuation from finished goods warehouses takes place via an evacuation corridor, on to stairwells out into the open air, or via doors in the façade, directly to the open air or over another fire cell and further out into the open air.

Doors in the escape route are at least 0.9 m wide, with a minimum height of 2.0 meters.

Walking distance according to simplified dimensioning exceeds 60 meters with regard to furnishings within production areas and finished goods warehouses. The longest walking distance is about 90 meters.

2.3. Verification needs

The design of the facility means that the building is partly designed in a different way than described in the general advice in BBR 29, whereupon the fire protection is verified with analytical dimensioning.

The following chapter describes the requirements based on the affected regulations and its subordinate general advice and hence what verification needs exist with the current design.

Regarding evacuation safety, the text of the regulation in BBR 5:31 states the following:

> *"Buildings shall be designed in such a way as to allow adequate evacuation in the event of fire. Adequate evacuation means that persons who are spaced, with sufficient safety, are not exposed to falling building parts, high temperature, high heat radiation, toxic fire gases or poor visibility that impede evacuation to a safe place. (BFS 2011:26)."*

Provided that all simulated evacuation scenarios have a positive margin against "time until critical conditions occur", the deviations described below according to simplified dimensioning are considered to be verified analytically and the text of the regulation in BBR 5:31 is considered to be fulfilled.

BBR 5:331 Walking distance to escape route

Since the building has been assigned to business class 1, the maximum permitted walking distance is 45 meters according to the general advice under section 5:331, with automatic watersprinklers you can make a technical change that allows walking distance 60 meters. The parts where this walking distance is exceeded are on floor 1 in finished goods warehouse and

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the production area with regard to furnishings and installations, whereupon walking distance in accordance with general advice does not allow for satisfactory evacuation.

Furthermore, the general advice in section 5:331 gives examples of walking distances that provide the opportunity for satisfactory evacuation:

> *"Walking distance to the nearest escape route or to another fire cell should not exceed the distances in Table 5:331. Distances to an escape route should be measured for the most adverse case..."*

Om persontätheten är liten samtidigt som berörda personer till största delen kan förväntas ha god lokalkännedom.	I garage och vissa lokaler i verksamhetsklass 1 såsom kontor, lager-, hantverks- och industribyggnader. Bostäder i verksamhets-klass 3 samt i verksamhetsklass 5B.	45 m

It must therefore be verified that the transfer to the escape route does not take so long that an unacceptable personal risk arises as a result of the longer walking distance to the escape route in relation to general advice.

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3. Method for analytical dimensioning

BBRAD 3 states that the following steps should be included in an analytical verification:

- Identification of verification needs
- Verification of satisfactory fire protection
- Verification check
- Documentation of fire protection design

Identification of verification needs means that deviations from simplified dimensioning are identified. Simplified dimensioning means that you achieve the regulatory requirements by fulfilling the general guidelines. All deviations from simplified dimensioning shall be compiled and analysed.

The verification of fire protection is based on a risk identification where possible stresses on the building's fire protection are identified. Based on the risk identification, the analysis must then show that the regulations in sections 1 (regarding fire protection) and 5 of BBR are met. Verification takes place in this document through scenario analysis of the fire and evacuation process.

In order to determine whether an unacceptable exposure to fire and fire gases exists during evacuation, the evacuation process within the production area and the finished goods warehouse has been studied when a fire occurs. Based on this, a scenario analysis is performed of a number of fire gas filling and evacuation simulations in the building where the scenarios are studied to check that all have time to evacuate before critical conditions arise.

After the verification has been carried out, it shall be checked. First, it should be checked that all deviations from simplified dimensioning are verified. Then the analytical verification should be reviewed by a person who has not previously been involved in the project.

Documentation of the design of the fire protection must be incorporated into the building's fire protection documentation.

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4. Risk identification

The current design entails longer walking distances than stated in the general advice in BBR, which leads to longer evacuation times and a risk of people being trapped in the event of a fire.

The BBR states that people should not be exposed to critical conditions. It must be possible to evacuate with sufficient safety and not be exposed to high temperatures, high heat radiation and poor visibility that affect the evacuation to a safe place.

In the risk identification, consideration has been given to the nature of the operations and various workshops regarding the risk to check how dangerous the various substances within the business are.

Based on the above, we have then chosen a verification method to solve the issue based on a quantified approach with input data in accordance with BBRAD.

The selected fire positions are presented in the scenario analysis. These are selected taking into account different types of operations and input data for dimensioning fires with this in mind have been taken into account.

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5. Scenario analysis

In the building in question, the proposed design means that analytical design must be applied in accordance with the verification needs described in 2.2 in those parts of the building where simplified design is not practiced.

It will be verified through scenario analysis of fire gas filling, simulation of productionareas and finished goods warehouses in combination with evacuation simulation of the building thatpeople are not exposed to critical conditions in the event of fire.

Verification is based on studying when critical conditions in relation to the applied acceptance criteria endure in fire gas filling simulation, available evacuation time (ASET). This is related to the pre-evacuation time (notice time and preparation time) and the transfer time, required evacuation time (RSET).

The starting point is that if the required evacuation time is less than the available evacuation time, safe evacuation is deemed possible, i.e. (RSET)<(ASET).

5.1. Fire gas filling and evacuation simulations

Fire gas filling is done through preliminary work in PyroSim of geometry and input data which is used for calculation with Fire Dynamics Simulator, FDS, and result processing is performed in Smokeview but also Pyrosim. The calculation means that the combustion and smoke flow of the fire is simulated using CFD calculation, which means that a larger volume is divided into smaller parts where the flow of fire gases is calculated in each subvolume.[1][2][3]

Geometry used for calculations is imported via A-drawings according to the documentation presented in section 1.4.

Evacuation simulation has been conducted using Pathfinder. Pathfinder primarily examines the movement of individuals with pre-defined behavior through flow calculations. To account for pre-evacuation time, i.e., the time it takes for individuals to decide to move towards an evacuation route, a delay with some variation is applied to individuals in the simulation. This variation results in when individuals in the simulation choose to initiate movement towards an evacuation route.

The established pre-evacuation times for each design fire and evacuation scenario can be found in section 5.3. Movement is initiated based on these pre-established times, personnel flows, walking speeds, and more, as outlined in the design scenarios in section 5.4.

The evacuation simulation involves allocating the design population, consisting of 150 individuals for each scenario, throughout the premises based on the information provided in section 5.1 of this document. Please refer to the figures below.

[1] PyroSim, version 2023.1.0426, developed by Thunderhead engineering.

[2] Fire dynamic simulator – CFD model adapted for fire gas flows, version FDS 6.8.0, developed by NIST (National Institute of Standards and Technology).

[3] Smokeview - Postprocessor for FDS, version SMV 6.8.0, developed by NIST (National Institute of Standards and Technology).

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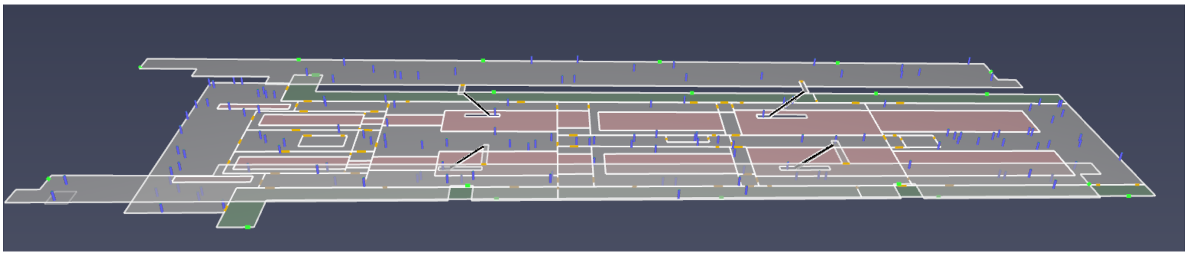

Figure 2 Overview of geometry in Pathfinder with people distribution within the production area.

Within the production area, it is assumed that 60% choose the upper evacuation corridor as this leads to the main entrance and 40% choose the lower evacuation corridor. The distribution is based on the fact that most people choose to walk towards the main entrance, but since this is a workplace and all doors are assumed to be known to people staying in the building, a large part are still expected to be inclined to choose a different route. This in combination with the fact that some spaces are only accessible from the lower escape route.

In the sensitive scenario *blocked escape route*, doors to the upper escape corridor are blocked.

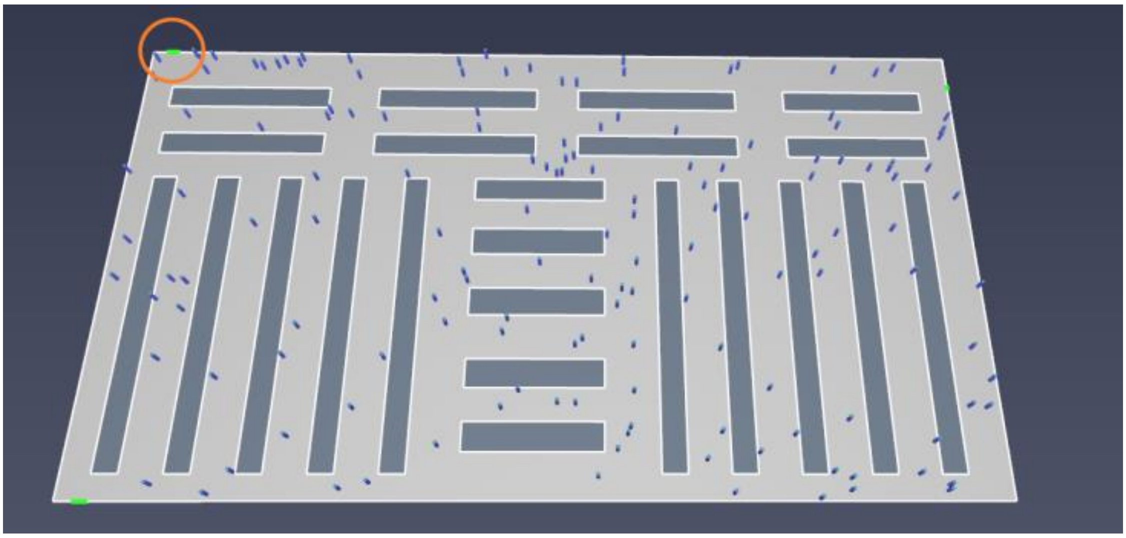

Figure 3 Overview of geometry in Pathfinder with people distribution within finished goods warehouses.

Within finished goods warehouses, 60% are expected to use the door leading to the escape corridor from which you reach the main entrance, see circled in the figure above and 40% distributed to the remaining doors. This with the same reasoning as for the production area. In the susceptibility scenario, the escape *route blocked* doorway is blocked.

5.2. Acceptance criteria (evacuation)

BBRAD 3 specifies several design parameters for acceptable exposure to evacuation in the event of fire (visibility, temperature, thermal radiation, heat dose, temperature and toxicity).

Heat radiation and heat dose are not considered relevant to study in this case as evacuation should not take place in direct connection with the fire. Given the large volume of air that is filled with smoke and the smaller fires that are dimensional, the risk of toxicity reaching critical levels is assessed marginally. Therefore, like heat dose, this parameter has not been

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studied. By studying the temperature, it is checked that the heat effect on the evacuees is sufficient to verify that the exposure is acceptable.

Deterioration of visibility in the current building is expected to occur at an earlier stage of the various scenarios than the remaining parameters and will therefore be the primary dimensioning parameter.

Acceptance criteria for evacuation and possibility of evacuation are therefore based on the following design parameters in Table 2.

Table 2 – Design acceptance criteria for acceptable evacuation exposure.

METRIC	DESIGN ACCEPTANCE CRITERION
Visibility, 2.0 m above floor	10 m general
Temperature, 2.0 m above floor	Max 80° C

5.3. Compilation of escape times

Total evacuation time = perception time + preparation time + transfer time. The perception time is obtained from the FDS simulation (detection time/smoke propagation time), the preparation time is made based on a log-normal distribution in the Pathfinder simulation and the transfer time is simulated in the Pathfinder.[4]

The detection time is set to 40 seconds based on the detection time of the fire alarm (the time taken from the detectors in the FDS simulation).

There is a fire alarm with an acoustic alarm device (bell) in the premises, according to BBRAD, the preparation time can therefore be set to 60 seconds for those who see the fire, which will be relevant for the people who are closest to the fire on floor 1 in the production area.

Preparation time of 60 s is considered applicable taking into account that there are people monitoring the entire process from different control rooms, which means that you can quickly detect a fire within the building.

For those people who do not see the fire directly, e.g. because they are in another space, the time is set 210 seconds because they are in one space without being able to directly see the fire. The reason why 210 seconds is stated, which is what is stated in BBRAD for department stores, is because there are no times specified for inventory or production, but this is considered both conservative and representative of current operations.

A log-normal distribution has been set for all evacuation scenarios, as this has proven to be most representative compared to a real evacuation scenario.[5]

[4] Variation in preparation time during evacuation (Report 5543), 2017, Martin Forssberg and Jesper Kjellström, Fire Technology, Lund University

[5] Variation in preparation time during evacuation (Report 5543), 2017, Martin Forssberg and Jesper Kjellström, Fire Technology, Lund University

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Based on these conditions, the total escape time is thus 100–250 seconds depending on whether you perceive the fire directly or not. To get a realistic distribution of when people start to evacuate, a log-normal distribution is applied (min: 100, µ: 180, max: 250, σ: 10).

The table below summarises the detection times and preparation times for each scenario.

Table 3 – Results summary for fire and evacuation scenarios. Input of the log-normal distribution used (min, with, max, deviation).

SCENARIO	DURATION OF PERCEPTION [S]	PREPARATION TIME [S]*
ScAEs1	40	100,250,180,10
ScAEs3-1	40	100,250,180,10
ScAEs3-2	160	220,400,320,10
ScAEs3-3	40	100,250,180,10
ScBEs1	40	100,250,180,10
ScBEs3-1	40	100,250,180,10
ScBEs3-2	150	240,420,350,10
ScBEs3-3	40	100,250,180,10

The evacuation of people who see the fire starts first, after approx. 100–210 seconds. People who perceive the fire late start to evacuate after 250-390 seconds. See table above for more input.

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5.4. Simulated fire and evacuationscenarios

The following sections describe the dimensioning fire and evacuation scenarios in the building.

The different fire scenarios are abbreviated "*Sc* Y *Es* X-Z" where "***Y***" describes fire placement and "X" required fire scenario according to BBRAD 3 and "Z" which failing technical system, for example "*ScAEs3-1"* means Fire placement A, required fire scenario 3, and failing technical system 1".

See table below for summary of simulated scenarios.

Table 4 - Summary simulated scenario.

AREA	SCENARIO	EXPLANATION
Production area	ScAEs1, ScAEs3-(1-3)	approx. 8,2 MW brand
Finished goods inventories	ScBEs1, ScAEs3-(1-3)	approx. 6,3 MW brand

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5.4.1. Production area – ScAEs1

The dimensioned fire and evacuation scenario is based on required fire scenario 1 according to BBRAD 3, which constitutes a worst *likely* case regarding the fire with fully functional fire technical systems. The location of the fire can be seen below.

This is a western likely location of the fire because the fire starts on level 1 in a place where it is open up to the roof, which means that smoke quickly spreads to level 2.

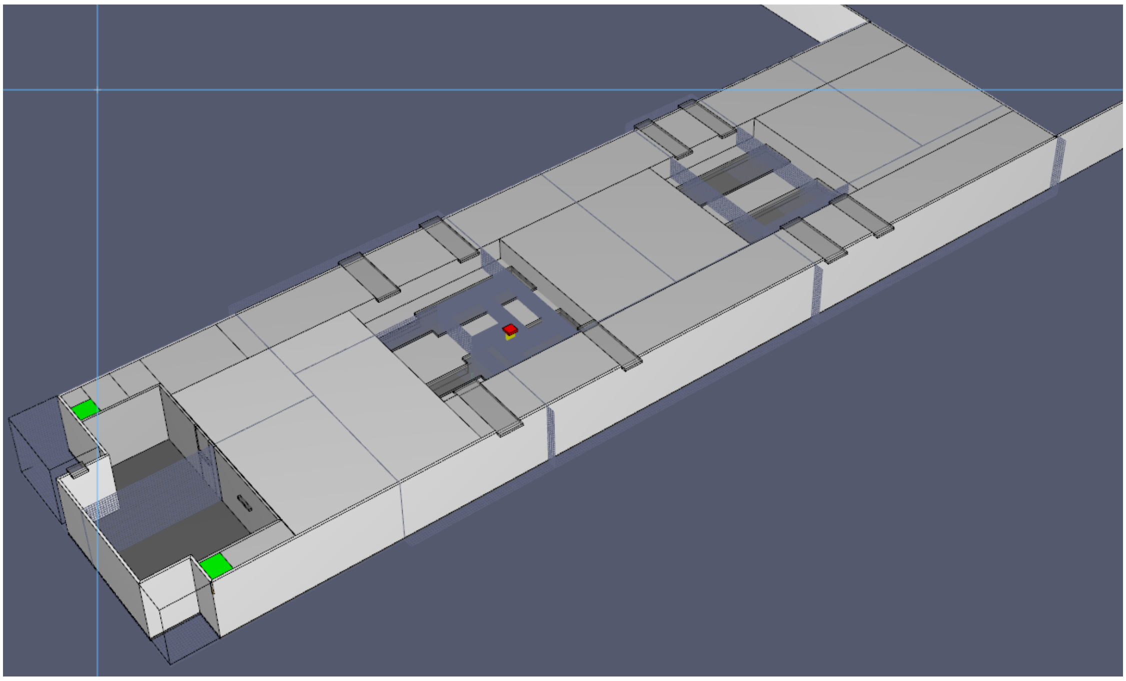

Figure 4 Location of the fire in the production area, see red square to the left in the middle.

Smoke detectors have been placed at ceiling height adjacent to the fire to calculate activation times. Since the fire alarm is installed according to SBF 110:8, the coverage area for each detector must be at least 100 m^2, this is what has been used as a guideline value when placing detectors.

Design power development

The design power development of the fire is represented by an "alpha-t^2 curve". The growth rate has been chosen at 0,19 kW/s^2 (Ultrafast) taking into account the combustible substance paraffin oil.

Sprinkler activation is considered to occur after 4 minutes and is calculated using DetactT2 from NIST to modify the power development for sprinkler-controlled fire according to BBRAD 3. The resulting power development curve is shown below.

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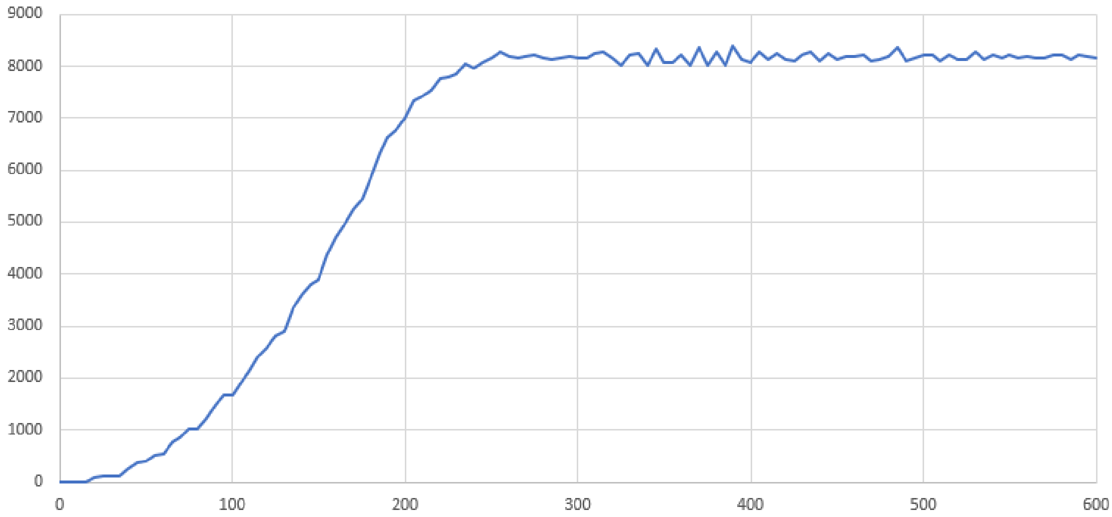

Figure 5 Design impact development for fire and evacuation scenario 1 (ScAEs1).

Input and grid control
The input data for the fire combustion model in the dimensioning fire scenario has been selected in accordance with the required fire scenario 1 in BBRAD 3. The selected combustion input and grid resolution are presented in the table below:

Table 5 – Input data for ScAEs1 gas filling

GRID SIZE	HEAT OF COMBUSTION	SOOT, CARBON MONOXIDE, CARBON DIOXIDE
Fire domain: 0,125 x 0,125 x 125 m Outside fire domain: 0,25 x 0,25 x 0,25 m Far from fire domain: 0.5 x 0.5 x 0.5 m	46,2 MJ/kg	Soot: 0,1 g /g Carbonmonoxide (CO):0,1 g/g

The size of the calculation domain's subvolumes, grid, has been checked against the *Quality Manual for fire technical analyses at Swedish nuclear facilities*[6] to ensure that a realistic result is obtained for the simulation of the fire. Studied parameters are seen in the table below.

Table 6 — Checking grid resolution at the time of fire.

GRID SIZE	FIRE SIZE	D*/H >0.5?	D*/DX >15?	Q* = 0.3–2.5?
0,125 x 0,125 x 0,125 m	2.0 x 2.0 m	No, 0.16	Yes, 17.68	Yes, 0.95

[6] Nystedt, Frederick; Frantzich, Håkan, Quality manual for fire technical analyses at Swedish nuclear facilities, 2011, Lund University

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All parameters are within the prescribed span, whereupon the grid is judged to be performed with sufficiently good resolution to simulate the fire progression and fire gas filling in a satisfactory manner.

Speed of movement and maximum flows through doors and stairs
Evacuation takes place through doors are known to evacuees the maximum flow through doors is therefore set to 1.1 p/sm in accordance with BBRAD 3.

The walking speed is generally set at 1.5 m/s and 0.6 m/s in stairs in accordance with BBRAD 3. No persons with disabilities are expected to be in the premises covered by this evacuation analysis.

5.4.2. Production area – ScAEs3-1, ScAEs3-2 & ScAEs3-3

The designed fire and evacuation scenarios ScAEs3-1, ScAEs3-2, and ScAEs3-3 represent a less likely worst-case scenario where the same fire is combined with a malfunctioning fire protection system.

In ScAEs3-1, the effect of an evacuation route being blocked is studied. In ScAEs3-2, the effect of a malfunctioning fire alarm system is studied, and in ScAEs3-3, the effect of a malfunctioning automatic water sprinkler system is studied. The fire is the same as in ScAEs1, as described in section 5.4.1.

Smoke detectors have been placed at ceiling height near the fire to calculate activation times.

Designing Effect Development
See section 5.4.1.

Input and grid control
See section 5.4.1.

Pre-escape time
The pre-escape time is based on the notice time and preparation time.

Scenario ScAEs3-1 – Blocked escape route
Is the same as in ScAEs1, see section 5.3 for these parameters.

Scenario ScAEs3-2 – Misworking fire/evacuation alarm
The perception time is set at 160 seconds and is based on when the smoke has spread along 2/3 of the ceiling. When the smoke covers 2/3 of the ceiling, the majority of the people in the production area and on the second floor should have become aware of the fire. Please refer to the figure below for the smoke spread after 160 seconds.

The preparation time for those who see the fire, which will be relevant for the people who are closest to the fire on floor 1 in the production area, is set to 60 s according to BBRAD.

For those people who do not see the fire directly, e.g. because they are in another space, the time is set 240 seconds because they are in one space without being able to directly see the fire. The reason why 240 seconds is specified, which is what is stated in BBRAD for department stores without fire alarms, is because there are no times specified for stock or production, but this is considered both conservative and representative of current operations.

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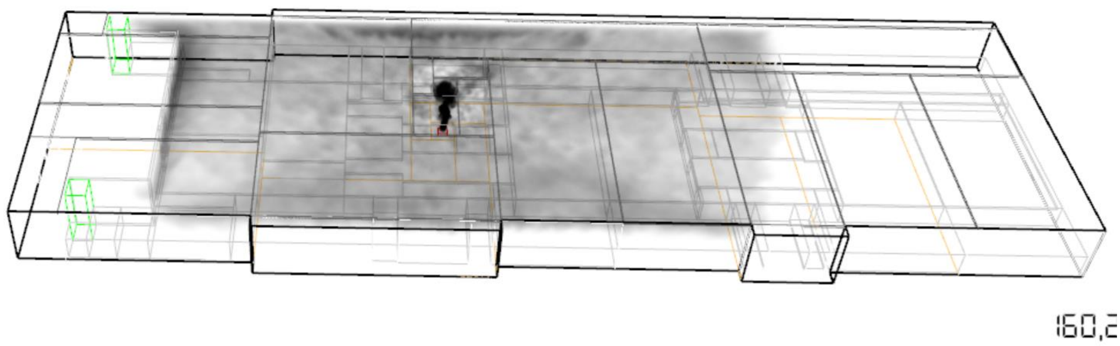

Figure 6 – The smoke spread after 2/3 partof the roof is filled with smoke.

A log-normal distribution has been assumed for all evacuation scenarios, as this has proven to be the most representative when compared to a real evacuation scenario.

Based on these assumptions, the total pre-evacuation time becomes 220-400 seconds, depending on whether individuals perceive the fire immediately or not. To obtain a realistic distribution of when people begin to evacuate, a log-normal distribution is used (min: 220, µ: 330, max: 400, σ: 10).

Scenario ScAEs3-3 – Misworking sprinkler
Is the same as in ScAEs1, see section 4.3 for these parameters.

Speed of movement and maximum flows through doors and stairs
Is the same as in ScAEs1, see section 5.4.1 for these parameters.

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5.4.3. Finished goods inventories – ScBEs1

The dimensioned fire and evacuation scenario is based on required fire scenario 1 according to BBRAD 3, which constitutes a worst *likely* case regarding the fire with fully functional fire technical systems. The location of the fire can be seen below.

The fire is placed in the middle of the warehouse as spread in four directions, which is considered to constitute the western scenario from an evacuation point of view.

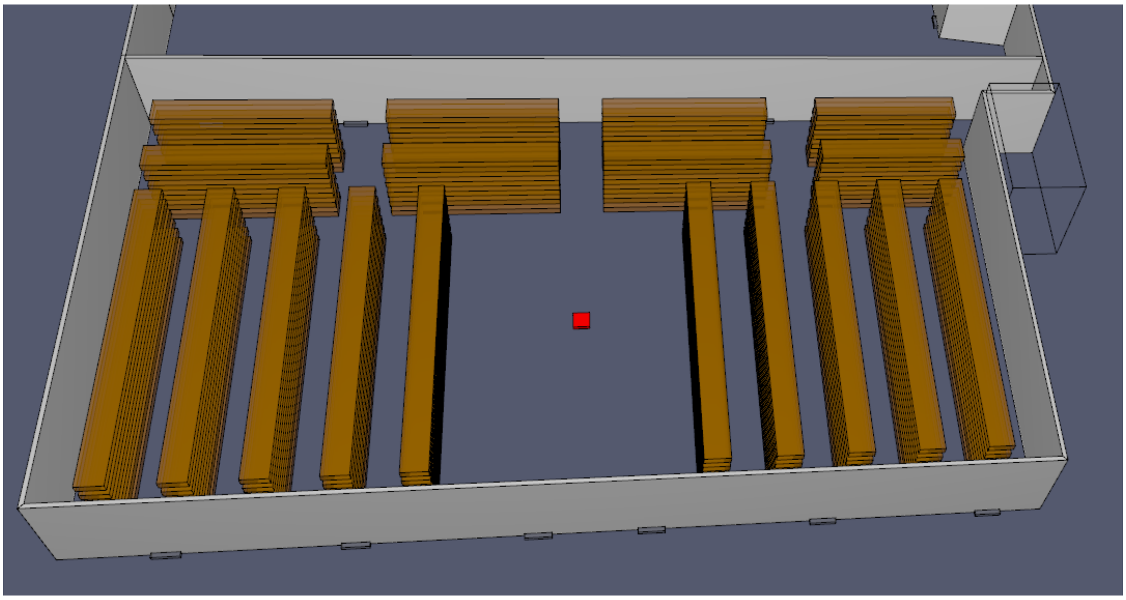

Figure 7 – Location of the fire in finished goods warehouse, see red square in the middle of the figure.

Smoke detectors have been placed at ceiling height adjacent to the fire to calculate activation times. Since the fire alarm is installed according to SBF 110:8, the coverage area for each detector must be at least 100 m^2, this is what has been used as a guideline value when placing detectors.

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Design power development
The design power development of the fire is represented by an "alpha-t^2 curve". The growth rate has been chosen at 0.047kW/s^2 (Fixed) taking into account stored material.

Sprinkler activation is considered to occur after 5.8 minutes and is calculated using DetactT2 from NIST to modify the power development of sprinkler-controlled fire according to BBRAD 3. The resulting power development curve is shown below.

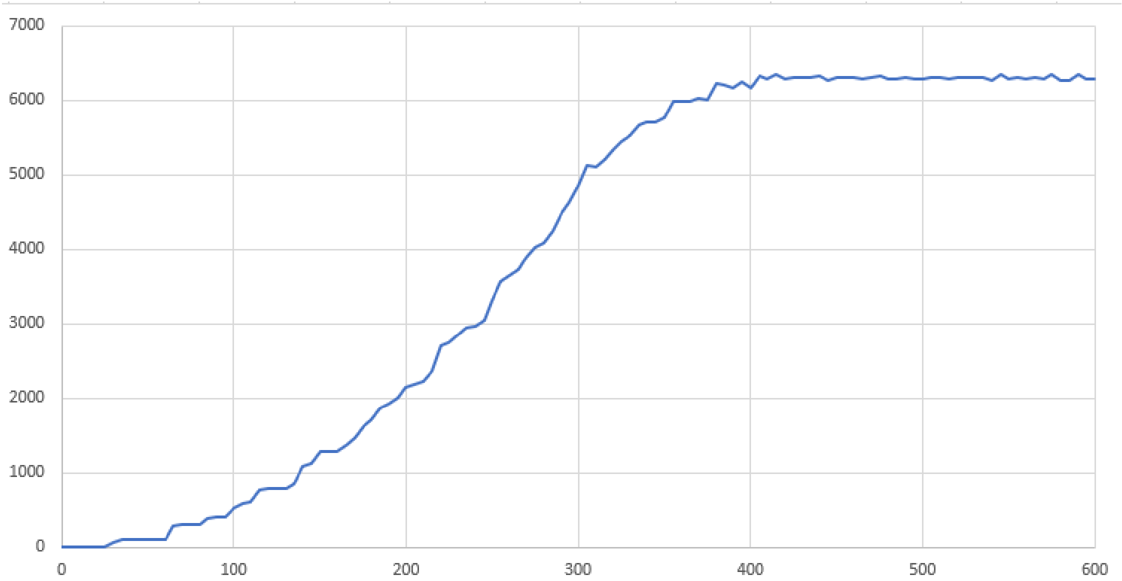

Figure 8 Design effect development for fire and evacuation scenario 1 (ScBEs1).

Input and grid control
Is the same as in ScAEs1, see section 5.4.2 for these parameters.

Speed of movement and maximum flows through doors and stairs
Evacuation takes place both through doors are known and notorious to evacuees. About 60% are expected to use a known door and 40% are expected to use an unknown door.

Maximum flow through doors is set to 1.1 p/sm for known doors and 0.75 p/sm for unknown doors.

The walking speed is generally set at 1.5 m/s in accordance with BBRAD 3. No persons with disabilities are expected to be in the premises covered by this evacuation analysis.

5.4.4. Finished goods – ScBEs3-1, ScABs3-2 & ScABs3-3

The designed fire and evacuation scenarios ScBEs3-1, ScBEs3-2, and ScBEs3-3 represent a less likely worst-case scenario where the same fire is combined with a malfunctioning fire protection system.

In ScBEs3-1, the effect of an evacuation route being blocked is studied. In ScBEs3-2, the effect of a malfunctioning fire alarm system is studied, and in ScB-Es3-3, the effect of a

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malfunctioning automatic water sprinkler system is studied. The fire is the same as in ScBEs1, as described in section 5.4.3.

Smoke detectors have been placed at ceiling height near the fire to calculate activation times.

Design power development
See section 5.4.3.

Input and grid control
Is the same as in ScAEs3-1, ScAEs3-2 and ScAEs3-3 see section 4.4.25.4.2

Pre-escape time
The pre-escape time is based on the notice time and preparation time.

Scenario ScBEs3-1 – Blocked escape route
Is the same as in ScBEs1, see section 5.4.3 for these parameters.

Scenario ScBEs3-2 – Misworking fire/evacuation alarm
The perception time is set at 180 seconds and is based on when the smoke has spread along 2/3 of the ceiling. Therefore, the majority of the people in the production area and on the second floor should have become aware of the fire. Please refer to the figure below for the smoke spread after 180 seconds.

The preparation time for those who see the fire, which will be relevant for the people who are closest to the fire on floor 1 in the production area, is set to 60 s according to BBRAD.

For those people who do not see the fire directly, e.g. because they are in another space, the time is set 240 seconds because they are in one space without being able to directly see the fire. The reason why 240 seconds is specified, which is what is stated in BBRAD for department stores without fire alarms, is because there are no times specified for stock or production, but this is considered both conservative and representative of current operations.

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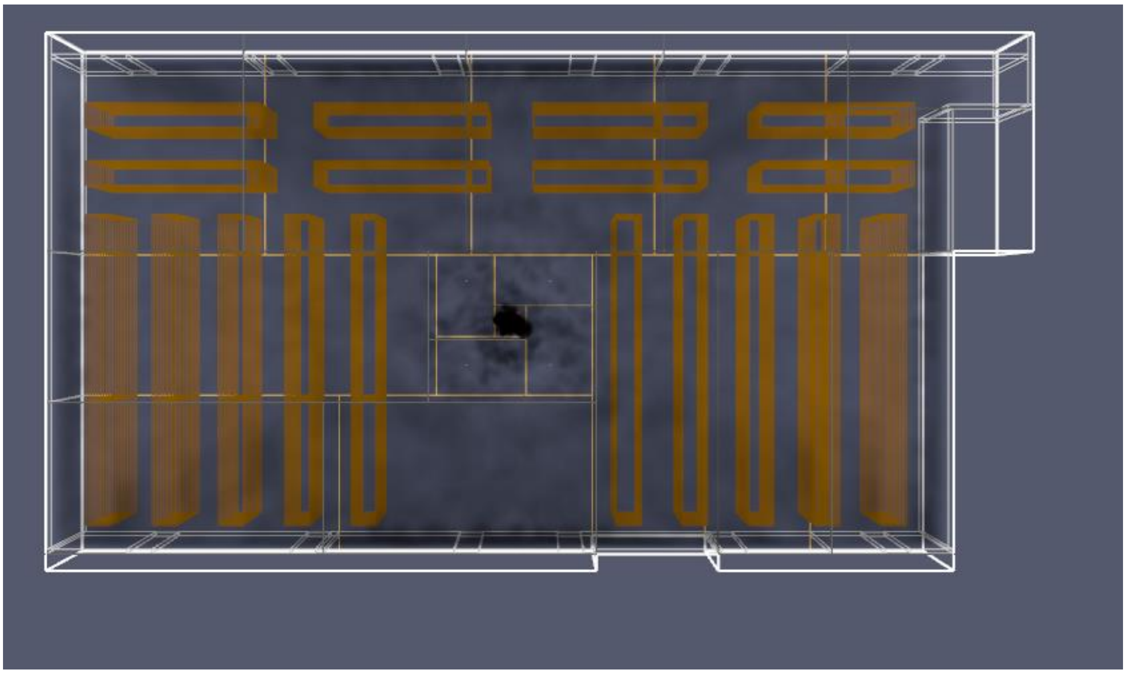

Figure 9 – The smoke spread after 2/3 part of the roof is filled with smoke.

A log-normal distribution has been set for all evacuation scenarios, as this has proven to be most representative compared to a real evacuation scenario.[7]

Based on these assumptions, the total pre-evacuation time becomes 240-420 seconds, depending on whether individuals perceive the fire immediately or not. To obtain a realistic distribution of when people begin to evacuate, a log-normal distribution is used (min: 240, μ: 350, max: 420, σ: 10).

Scenario ScBEs3-3 – Misworking sprinkler
Is the same as in ScBEs1, see section 5.3 for these parameters.

Speed of movement and maximum flows through doors and stairs
Evacuation takes place both through doors are known and notorious to evacuees. About 60% are expected to use a known door and 40% are assumed to use an unknown door.

Maximum flow through doors is set to 1.1 p/sm for known doors and 0.75 p/sm for unknown doors.

The walking speed is generally set at 1.5 m/s in accordance with BBRAD 3. No persons with disabilities are expected to be in the premises covered by this evacuation analysis.

[7] Variation in preparation time during evacuation (Report 5543), 2017, Martin Forssberg and Jesper Kjellström, Fire Technology, Lund University

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5.5. Summary of results

The following tables compile the results based on whether the acceptance criteria for the possibility of safe evacuation are met and whether critical conditions arise. Full results can be found in the appendix to this report.

Table 7 – Results for fire and evacuation scenarios.

SCENARIO	ASET < 10 M [S] + 0 M	ASET < 10 M [S] + 5.5 M	RSET [S] + 0 M	RSET [S] + 5.5 M	TEMP > 80 C [S] +0 M	TEMP > 80 C [S] +5.5 M	TIME TO CRITICAL LEVEL[S]	QUEUE TIME < 8 MIN?	APPROVED?
ScAEs1	>295	>270	295	270	>295	>270	>600	JA	JA
ScAEs3-1	>304	>270	304	270	>304	>270	>600	JA	JA
ScAEs3-2	>441	>407	441	414	>441	>407	>600	JA	JA

SCENARIO	ASET < 10 M [S]	RSET[S]	TEMP > 80 C [S]	TIME TO CRITICAL LEVEL[S]	QUEUE TIME < 8 MIN?	APPROVED?
ScBEs1	>347	347	>347	>600	JA	JA
ScBEs3-1	>300	300	>300	>600	JA	JA
ScBEs3-2	>514	514	>514	>600	JA	JA

Scenario ScAEs3-3 and ScBEs3-3, malfunctioning sprinklers, are not reported in the results summary above as this is covered in the others that constitute worse scenarios with regard to to evacuation.

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6. Discussion and conclusion

The conducted simulations demonstrate that there are acceptable conditions for evacuation in the event of a fire in both the production area and the finished goods warehouse. Critical conditions do not arise in the respective areas (+0.0, +5.5) where evacuees are located in the studied fire and evacuation scenarios.

Several conservative assumptions underpin the results, making them robust and on the "safe side" regarding potential uncertainties in assessments, such as the fire's location, input data for evacuation simulations, and more.

In the analysis, sensitivity analyses have been based on a more conservative scenario where the fire is larger than the one recommended in BBRAD. According to BBRAD, walking distances should not exceed 80 meters. However, the analysis shows that evacuation occurs before critical conditions arise, even though the longest walking distance is approximately 90 meters. Furthermore, the building is equipped with an automatic water sprinkler system, automatic fire and evacuation alarms, as well as emergency lighting. Walking distances are conservatively calculated, and practical possibilities to take a shorter route, for example, by cutting through or passing through the plastic film production area, have not been considered.

BBR 5:331 is considered fulfilled because all evacuating individuals in all simulated scenarios manage to evacuate before critical conditions arise in the relevant areas.

Based on the conducted scenario analysis, the fire protection for the property Grönsta 1:35 in Eskilstuna is assessed to meet the studied regulations 5:31 and 5:334 in BBR 29, provided that:

- Geometries are according to the information provided in this document.
- Comprehensive fire and evacuation alarms are installed in the building to ensure early fire detection.
- The number of evacuation routes and escape paths and their widths are maintained as specified in this document; doors and stairs must not be blocked without verification against this document first.

The analysis is only valid for the current project and depends on project-specific conditions. Therefore, conclusions from this analysis cannot be directly applied to other projects. The parts affected by the renovation are mainly designed in accordance with general guidelines in BBR 29.

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Appendix – Simulation FDS/Pathfinder

Visibility
The tables in the sections for visibility show visibility when the last person leaves the premises in the evacuation process within the dimensioning scenario.

Within the production area, there are different plus heights on the floor, which means that we must measure visibility two meters above each floor level. Level 1 is placed with floor level of +0.0 m and floor 2 is placed with floor level of +5.5m.

Temperature
In the tables in the sections for temperature, smoke gas temperatures are reported when the last person leaves the premises in the evacuation process within the dimensioning scenario. Red fields illustrate concentrations corresponding to critical conditions (80°C).

Like the sieve, the temperature will be measured two meters above each floor level.

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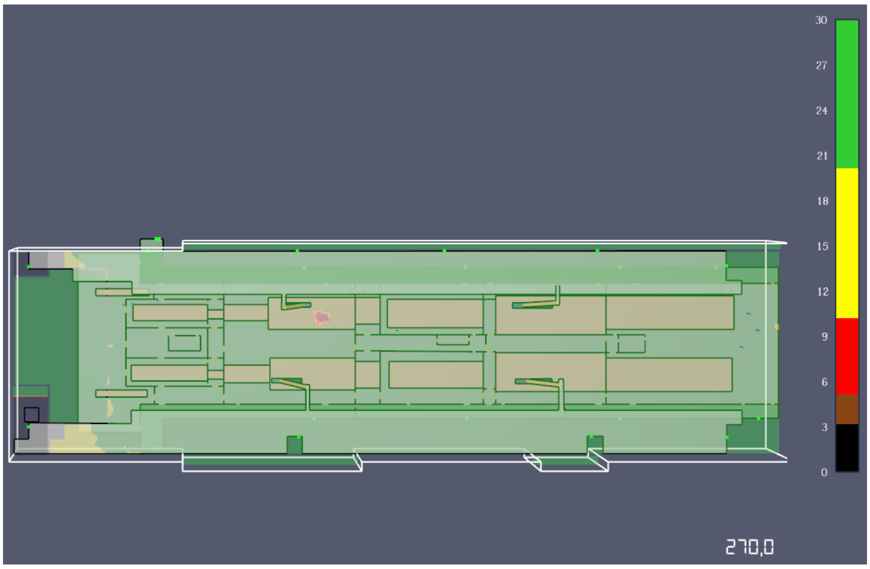
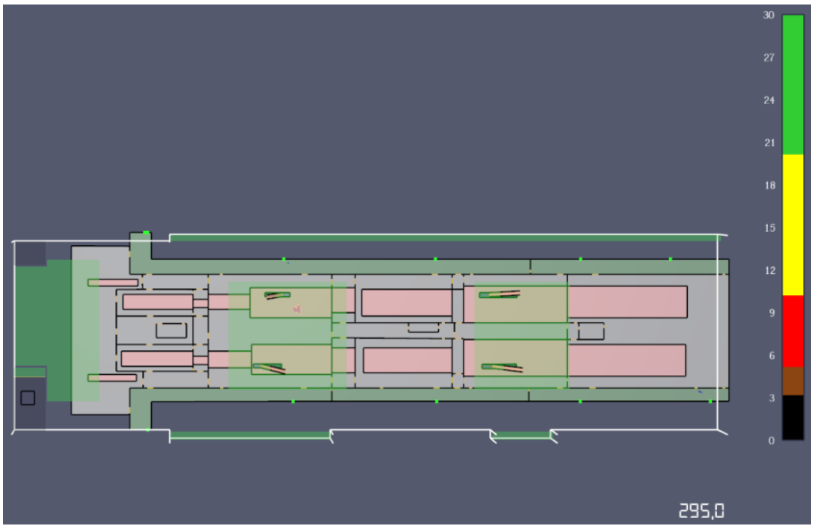
Production area – ScAEs1

Visibility

Table 8 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
270	
	All persons have reached the escape route (stairwell) on floor 2. Visibility does not fall below 10 meters anywhere.
+0,0M	
295	
	All persons have reached the escape route (corridor) on level 1. Visibility does not fall below 10 meters anywhere.

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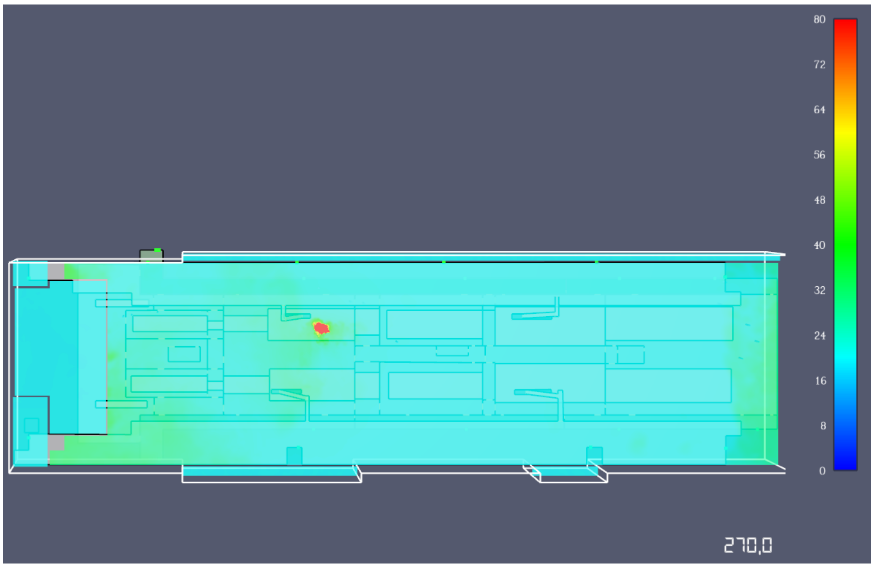
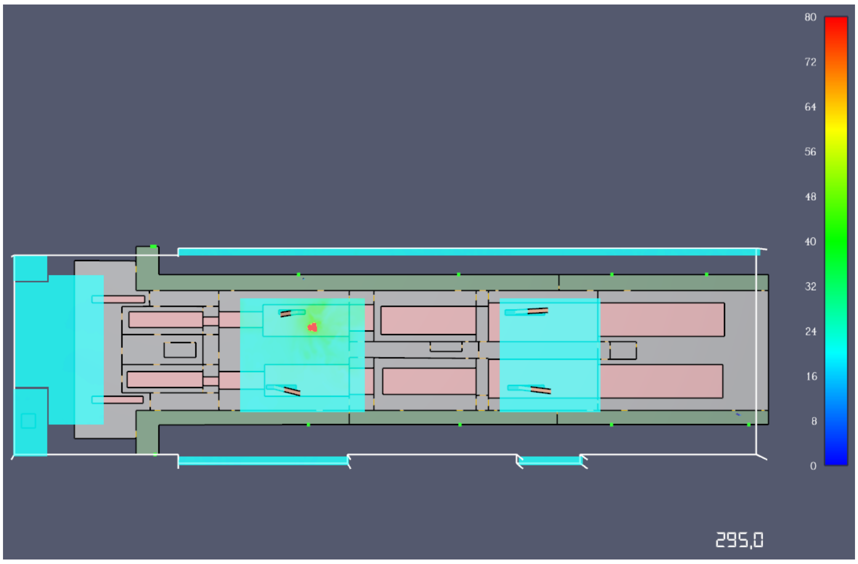
Fire gas temperature

Table 9 – Smoke temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
270	
	The temperature 2 meters above floor level is between 20-30 degrees when everyone has evacuated from floor 2.
+0,0M	
295	
	The temperature 2 meters above floor level is between 20-30 degrees when everyone has evacuated from floor 1.

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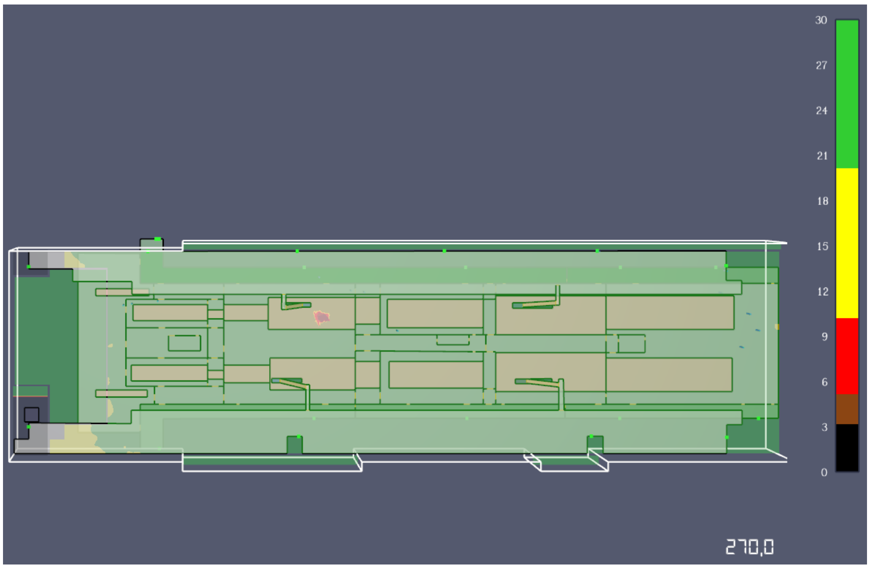
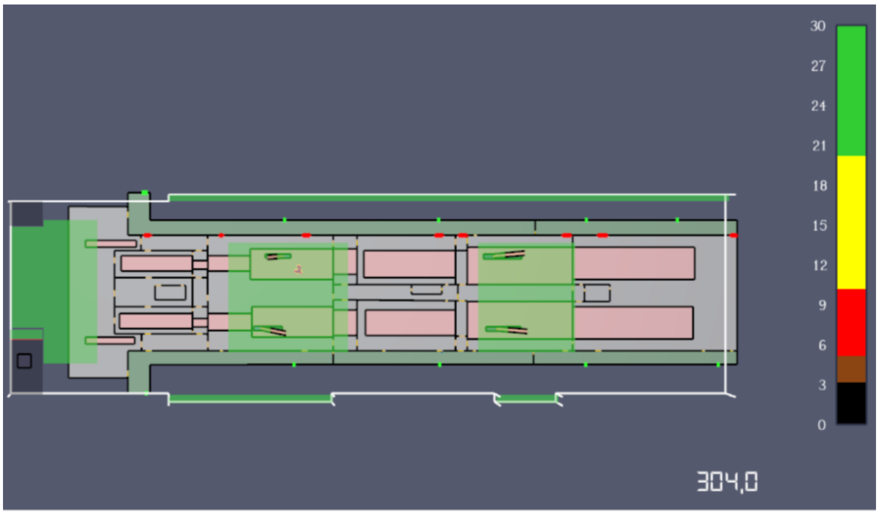
Production area – ScAEs3-1

Visibility

Table 10 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
270	
	All persons have reached the escape route (stairwell) on floor 2. Visibility does not fall below 10 meters anywhere.
+0,0M	
304	
	All persons have reached the escape route (corridor) on level 1. Visibility does not fall below 10 meters anywhere.

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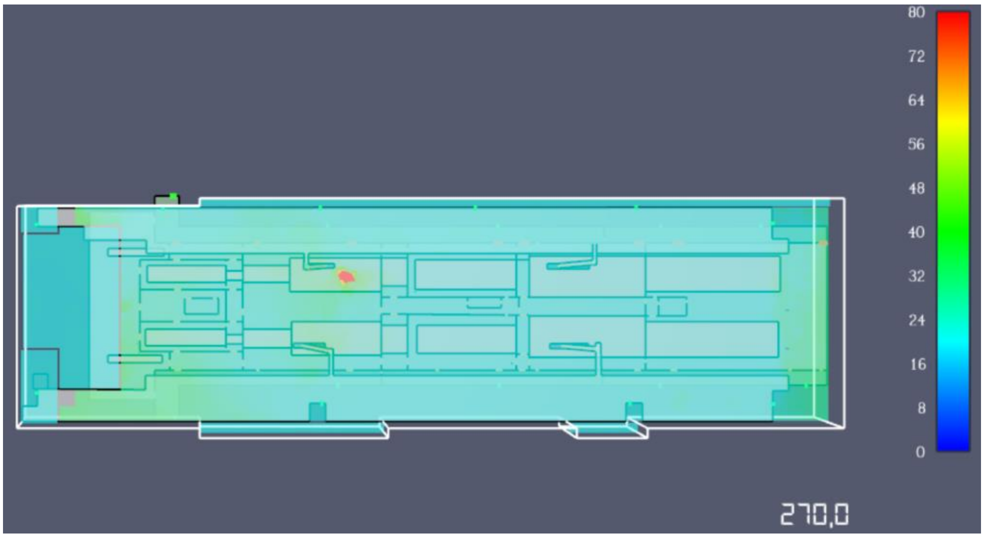
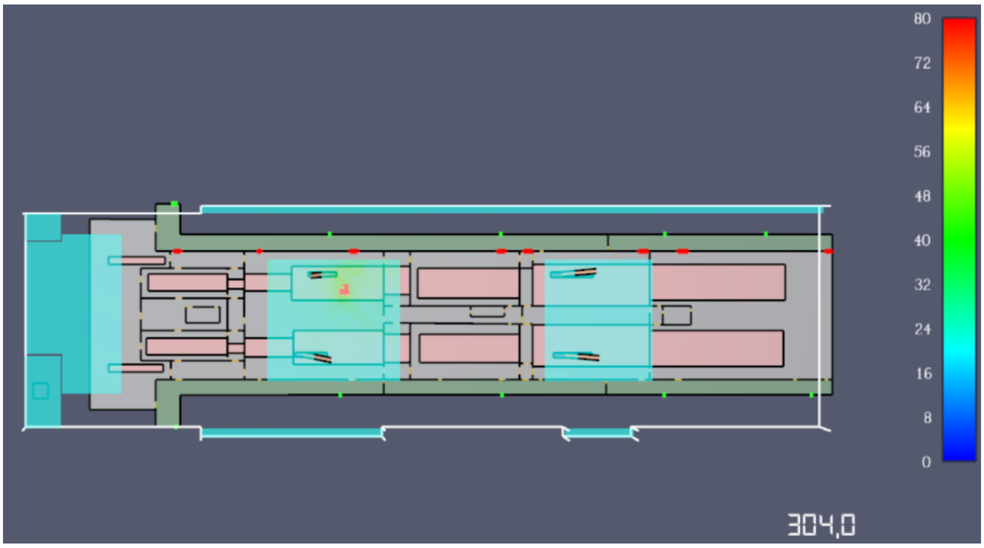
Fire gas temperature

Table 11 – Smoke temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
270	
	The temperature 2 meters above floor level is between 20-30 degrees when everyone has evacuated from floor 2.
+0,0M	
304	
	The temperature 2 meters above floor level is between 20-30 degrees when everyone has evacuated from floor 1.

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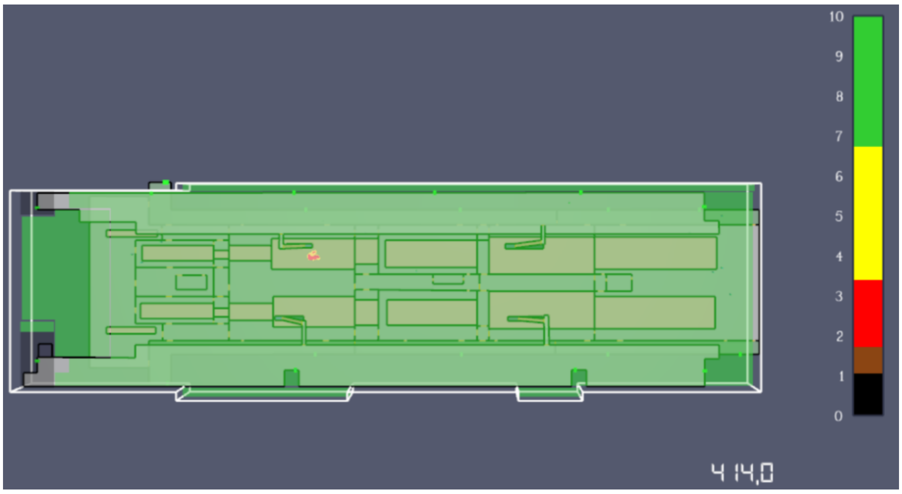
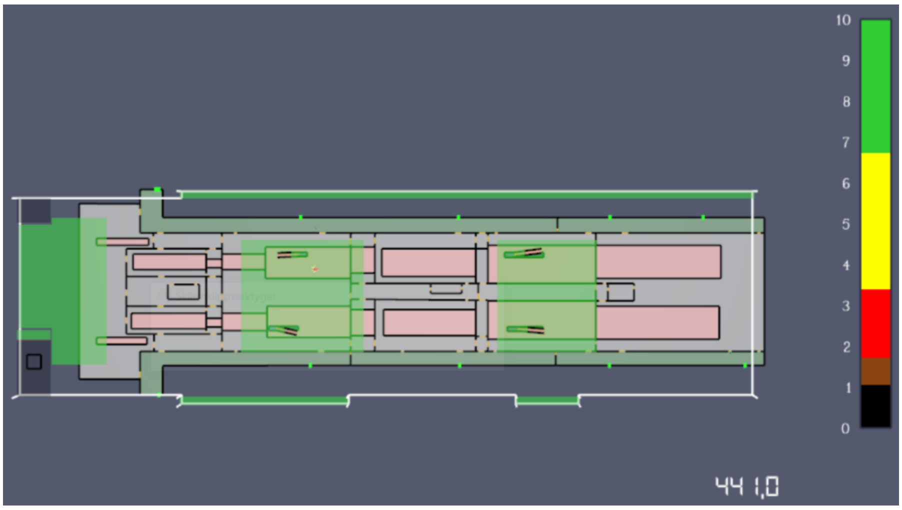
Production area – ScAEs3-2

Visibility

Table 12 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
414	
	All persons have reached the escape route (stairwell) on floor 2. Visibility does not fall below 10 meters anywhere.
+0,0M	
441	
	All persons have reached the escape route (corridor) on level 1. Visibility does not fall below 10 meters anywhere.

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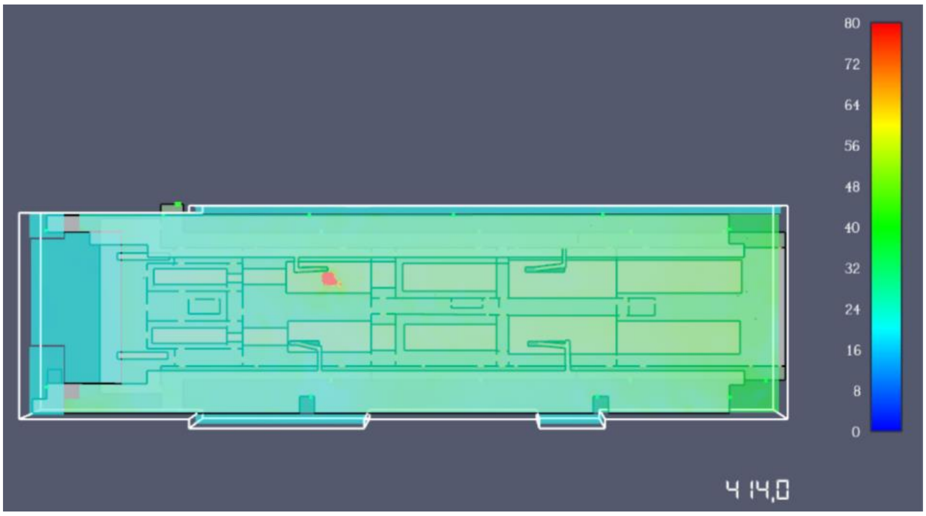
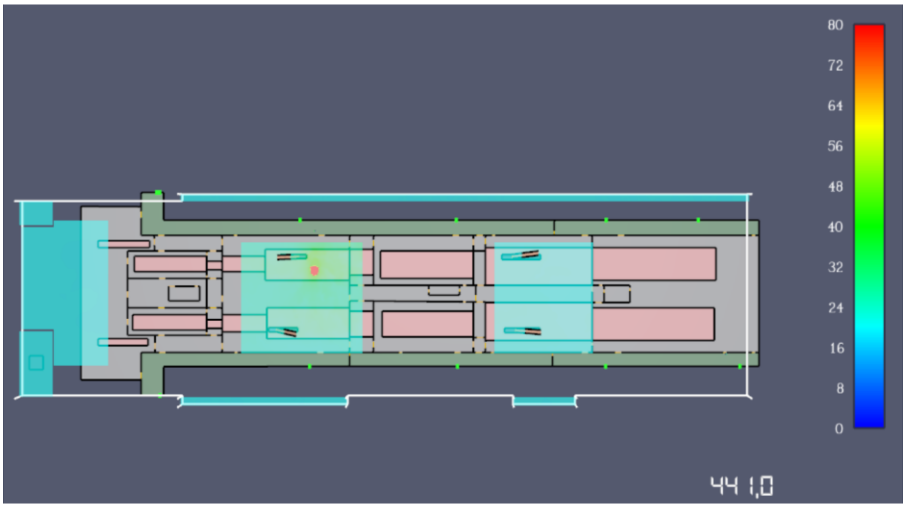
Fire gas temperature

Table 13 – Smoke temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+5,5M	
414	
	The temperature 2 meters above floor level is between 20-40 degrees when everyone has evacuated from floor 2.
+0,0M	
441	
	The temperature 2 meters above floor level is between 20-40 degrees when everyone has evacuated from floor 1.

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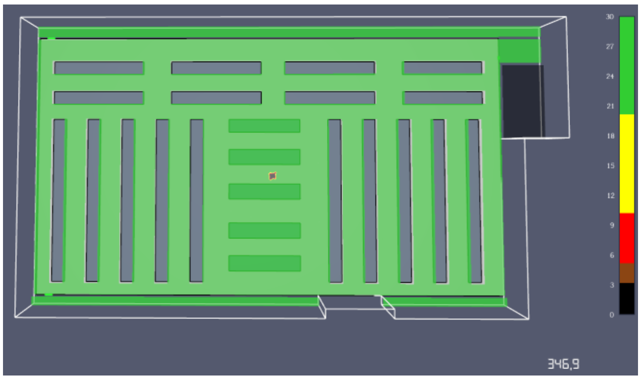
Finished goods inventories – ScBEs1

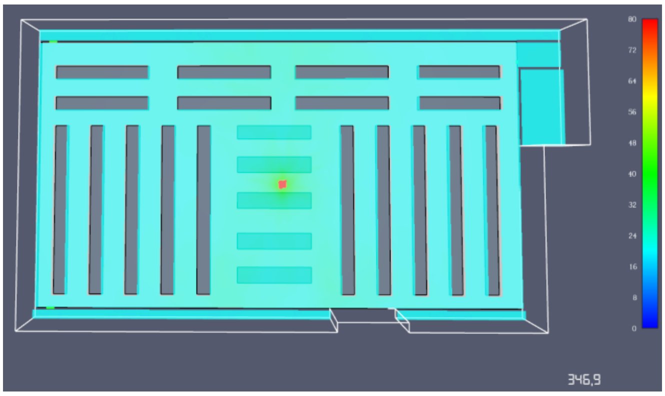
Visibility

Table 14 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
347	
	All persons have been evacuated. Visibility does not fall below 10 meters anywhere.

Fire gas temperature

Table 15 – Smoke gas temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
347	
	The temperature 2 meters above floor level is between 20-55 degrees when everyone has evacuated from floor 1.

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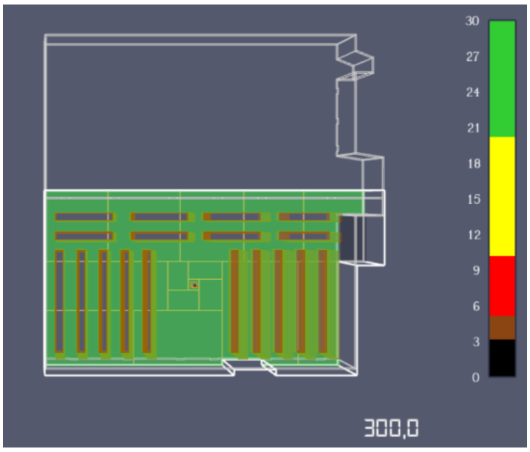
Finished goods inventories – ScBEs3-1

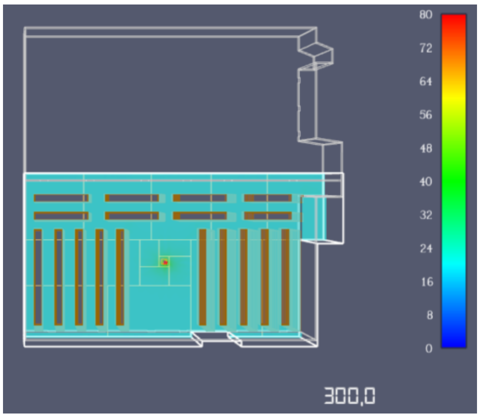
Visibility

Table 16 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
300	
	All persons have been evacuated. Visibility does not fall below 10 meters anywhere.

Fire gas temperature

Table 17 – Smoke gas temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
300	
	The temperature 2 meters above floor level is between 20-30 degrees when everyone has evacuated from floor 1.

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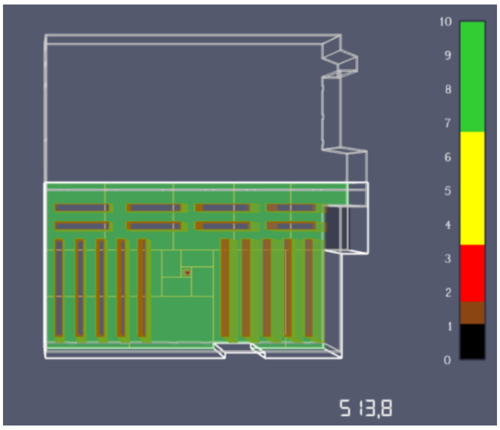
Finished goods inventories – ScBEs3-2

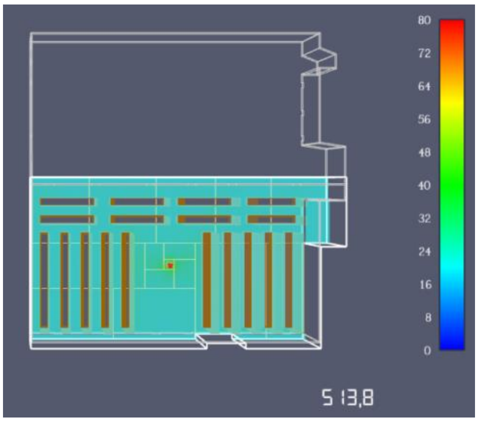
Visibility

Table 18 – Visibility in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
514	
	All persons have been evacuated. Visibility does not fall below 10 meters anywhere.

Fire gas temperature

Table 19 – Smoke gas temperatures in the smoke filling and evacuation scenario.

Time[s]	Evacuation process/Visibility
+0,0M	
514	
	The temperature 2 meters above floor level is between 20-35 degrees when everyone has evacuated from floor 1.

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Firewater Risk Assessment

New construction of industrial building

2023-07-07

PROJECT NAME	STATUS	PROPERTY IDENTIFYER AND MUNICIPALITY
Senior Materials, Eskilstuna	First version	Grönsta 1:5, Eskilstuna
CLIENTS	**ASSIGNMENT MANAGER**	**CASE ENGINEER**
Logistic Contractor Entreprenad AB	Johan Norén Phone: 08-406 66 06 Mail: johan.noren@briab.se	Frida Hansson Frida.hansson@briab.se 010-203 80 38

Briab
The right side of risk

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Content

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1. Introduction

1.1. Background

Briab Brand & Riskingenjörerna AB has been commissioned to carry out a firewater risk assessment for Senior Material (Europe) AB's (hereinafter Senior) new factory in Eskilstuna. Senior manufactures separator film for lithium-ion batteries.

1.2. Purpose and Goal

The purpose of the firewater risk assessment is to analyze risks related to the company's operations that can cause serious damage to the environment and to analyze the amount of firewater and its impact during an extinguishing operation.

1.3. Scope and Delimitation

The focus of the firewater investigation is to identify and investigate how the impact of an extinguishing operation on the environment can be limited. The investigation is limited to the planned operations within the properties Grönsta 1:5, Grönsta 2:18 and Grönsta 2:52.

1.4. Foundation

ACTION	ESTABLISHED BY	DATE
Initial Design HAZID Final Report	MTO Safety	June 2023
Fire Protection Description Advance Copy-Basic Design	Briab	2023-07-07
Stormwater Management, Overview, Building Permit Document	Inviatech AB	2023-06-30
Firewater investigation Basis for applying for an environmental permit	Verifire	2022-01-24
Fire water Basis for application for environmental permit	Verifire	2022-01-24

1.5. Quality System

This report is subject to self-monitoring according to the instructions in Briab's quality management system, which is certified according to ISO 9001. The self-monitoring is covered by an administrator check and a quality review conducted by a specially appointed quality controller within Briab. During the inspection, a special checklist is used to ensure that the relevant requirements have been met. The checklist looks different depending on the type of assignment and document. Revisions of documents shall normally be subject to the same checks as above. Minor formal changes that do not affect the design in general may be made by the administrator himself. In such cases, this must be stated in the document.

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1.6. Revisions and self-monitoring

The date and date of revision as well as the administrators and quality reviewers for all produced versions of this document are summarized in the table below:

DATE	STATUS	ADMINISTRATOR	CONTROL
23-06-30	First version	Frida Hansson	David Winberg

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2. Risk assessment method

This section describes concepts and definitions related to risk assessment. Furthermore, the methodology used in the current analysis is described.

2.1. Risk

The concept of risk can be interpreted in different ways. In the context of safety-related matters, the term is understood as: "*The probability of an event multiplied by the magnitude of its consequence, which can be qualitatively or quantitatively determined.*"

2.2. Governing Documents

2.2.1. Environmental Code (1998:808)

The general consideration rules in the second chapter of the Environmental Code (1998:808) apply to all operators and aim primarily to prevent harm to human health and the environment. It is in these rules that other environmental requirements in the Environmental Code are based, therefore the consideration rules must be used in all contexts where the provisions of the Environmental Code apply. Risk assessment of an activity is an important tool for complying with the general rules of consideration. [1] The precautionary principle of the Environmental Code requires that an activity where there is a risk of negative impact on people and the environment must take the necessary measures, hence the need for firewater management.Figure 1 below describes the different aspects to consider.

Figure 1. Summary of the general rules of consideration presented in Chapter 2 of the Environmental Code (1998:808).[1]

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2.2.2. Act (2003:778) on protection against accidents

The Act (2003:778) on protection against accidents [2] Chapter 2. Section 2 states that:

> *'The owners or occupiers of buildings or other installations shall, to a reasonable extent, keep equipment for extinguishing fire and for saving life in the event of fire or other accident and otherwise take the necessary measures to prevent fire and to prevent or limit damage resulting from fire."*

The above requirements apply to all facilities and usufruct holders in Sweden.

2.2.3. Accident risks and EIA

The publication aims to contribute to systematic work on risk and safety issues in the process of environmental impact assessment of activities. An established process helps to increase understanding of the issues and the quality of EIA documents. An increased understanding and knowledge hopefully also help to streamline the process and reduce the risk of risk issues being overlooked. [3]

2.3. Risk management process

Risk management involves systematic and continuous work to control or reduce the risk of accidents within a given system. Managing risks is a continuous process that involves inventorying, analyzing, evaluating, and taking security measures as well as follow-up and communication to interested parties. Schematically, the process can be described asFigure 2.

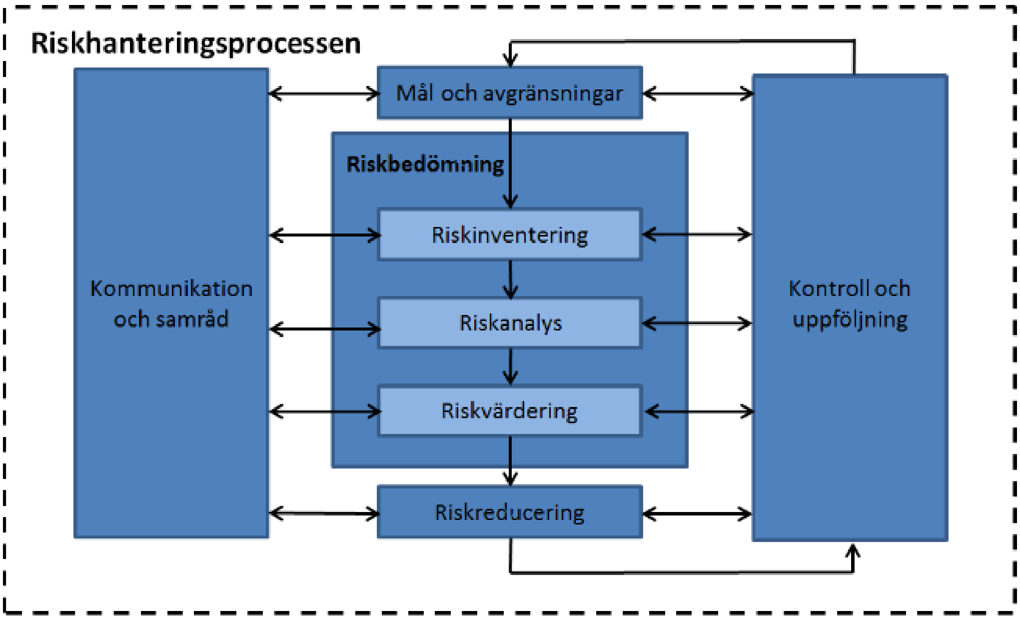

Figure 2. Risk management process according to ISO 31000 [4]

2.4. Method

The method in this risk investigation has been based on the recommendations that MSB has developed for risk investigations for hazardous activities and safety reports:

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1. Establishment of context – Review and description of purpose, goals and scope as well as determination of valuation criteria to use for the business.
2. Review of relevant authority statement.
3. Description of the activity and its surroundings.
4. Risk identification – Inventory of potential sources of risk on site.
5. Rough risk analysis – Analysis of relevant risks based on established context.
6. In-depth risk analysis for severe scenarios.
7. Risk assessment – Assessment of whether the risks are acceptable or not.
8. Development of relevant risk mitigation measures – Establishment of a list of risk management measures.

2.5. Principles and Methods of Risk Assessment

As starting points for the evaluation of risk, the following four principles are often used:[5]

- Reasonableness principle - Risks that can be eliminated or reduced by technically and economically reasonable means must always be addressed (regardless of the level of risk).
- Proportionality principle - The overall level of risk of an activity should be proportionate to the benefits in terms of, for example, products and services that the activity entails.
- The distribution principle - The risks should, in relation to the benefits of the activity, be fairly distributed within society.
- Disaster avoidance principle - If risks materialize, this should be in the form of events that can be managed by existing resources rather than in the form of disasters.

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3. The Site

The property where Senior intends to build its new factory is located about 3 km east of Eskilstuna, within Svista. At present, Senior has an existing building on the property Grönsta 2:52, while the new parts will take up the other properties. These properties have previously consisted of undeveloped forest land. The Senior operations consist of warehouse operations and Stensa recycling. In the planned facility, all production will take place indoors, with staff working shifts. Chemical storage will take place in separate buildings.

Figure 3.

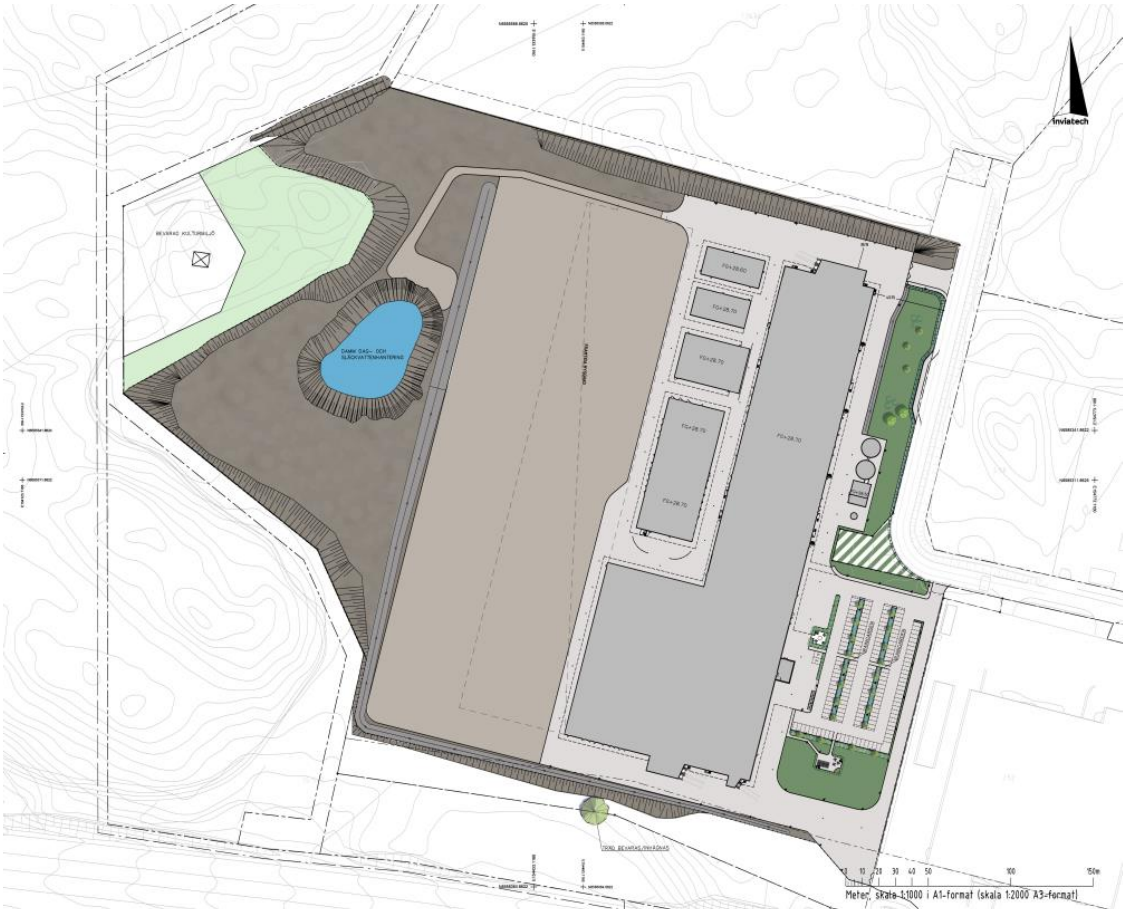

Figure 3. Overview of Senior's planned expansion. Senior's existing operations can be seen at the bottom right of the picture.

3.1. Process Description

Senior manufactures the separator film that is used between anode and cathode in a lithium-ion battery. A separator is a permeable membrane that separates the anode from the cathode, while allowing the transport of ions through the battery cell. The process of manufacturing separator film can be carried out in different ways depending on the desired type, quality and area of use of the final battery.

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The process of producing Senior's separator film can be divided into two different parts:

1. Manufacture of base film
2. Coating the base film with ceramic material

Manufacture of base film:
A polyethylene (PE) powder is mixed with paraffin oil at high temperature to form a molten plastic mass.

Casting:
The mixture is pressed out in a very thin even layer on a roller. The mixture is quickly cooled on the surface of the roller to form a so-called base film.

Stretching and formatting:
The film is rolled and stretched in different batches so that the polymer chains in the raw film are correctly positioned and the thickness of the film is reduced.

Extraction:
To obtain the final separator film, the paraffin oil, which is initially used to mix the polyethylene powder, needs to be removed from the film. This is done by extracting paraffin oil with solventet dichloromethane (DCM). This is done in a closed part of the plant and the solvent is recirculated to the process to be used again. The film is dried before moving to the next stage.

The use of dichloromethane:
As mentioned above, DCM will be used to extract paraffin oil from the base film. DCM and paraffin oil are then taken care of to be recycled in a liquid separator. In the production lines there is air extraction where a certain amount of DCM is departed to a closed process ventilation system to be led to a gas recovery system.

Annealing:
The film is annealed at high temperature to eliminate any internal stresses in the film and to optimize the structure.

Reeling and cutting:
Finally, the film is cut into a suitable width and wound on a roll.

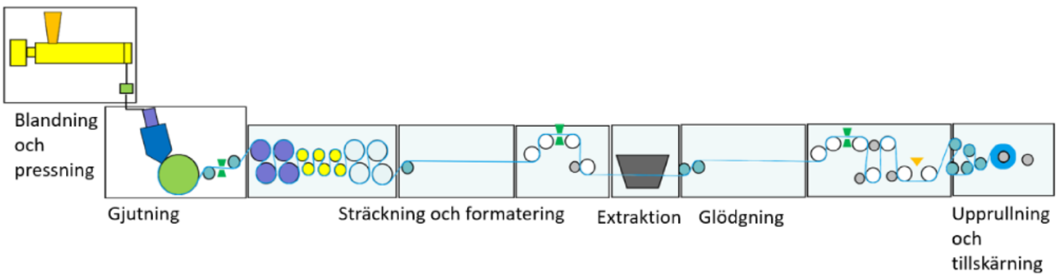

Figure 4. Shows the manufacture of base film[6] .

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3.2. Chemical Management

Table 1 presents the maximum amounts that are expected to be handled.

The main chemicals used for coating the separator film are bohemite and alumina. The water-based slurry to be used for coating is made in two different ways, either with bohemite or with aluminum oxide, which is then mixed with purified water and small amounts of sodium carboxymethylcellulose (CMC), polyvinyl alcohol, waterborne acrylic polymer, ammonium polyacrylate and polyether siloxane copolymer.

DCM is a volatile solvent with rapid evaporation. DCM can pose an explosion hazard to the business, but the ignition energy required to ignite the vapours is significantly higher compared to many other solvents. The substance poses a risk of poisoning if inhaled, ingested and if exposed to the skin is severely damaged, and toxic and corrosive gases/vapours (phosgene and hydrogen chloride) are formed. DCM is not acutely toxicological for the environment, but the substance is persistent and suspected of causing cancer.

Paraffin oil is a combustible liquid, but because the flash point exceeds 100 °C it is not classified as flammable.

Polyethylene powder is combustible and can give rise to explosive dust atmospheres.

Table 1 – Chemicals handled and storage quantities.

SUBJECT	CAS NUMBER	PHASE	MAXIMUM STORAGE (TONNES)	STORAGE
Polyethylene	9002-88-4	Powder 0.1-0.5 mm	1 600	550 kg/pack
Paraffin oil	8012-95-1	Liquid (99.5% purity)	530	Tank
DCM	75-09-02	Liquid (99.5% purity)	2 200	Tank
Bohemia	1318-23-6	Powder 0.2-1µm	650	20 kg/pack
Alumina	1344-28-1	Powder 0.2-1µm	470	20 kg/pack
PVA	9002-89-5	Fluent	2	25 kg/barrel
CMC	9000-11-7	Powder	1	25 kg/package
Waterborne acrylic polymer	-	Liquid, glue, 15-50% solid content	80	25 kg/barrel
Ammonium polyacrylate	9003-03-6	Fluent	15	25 kg/barrel
Polyurethane foam siloxane copolymer	134180-76-0	Fluent	20	20 kg/barrel
Lubricant	-	Fluent	2	1 kg/barrel

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3.3. Soil conditions and water management

Within the property, the soils vary between sandy moraine, glacial clay and primeval rock. The permeability of the soil varies between low and medium, see [7][8]Figure 5.

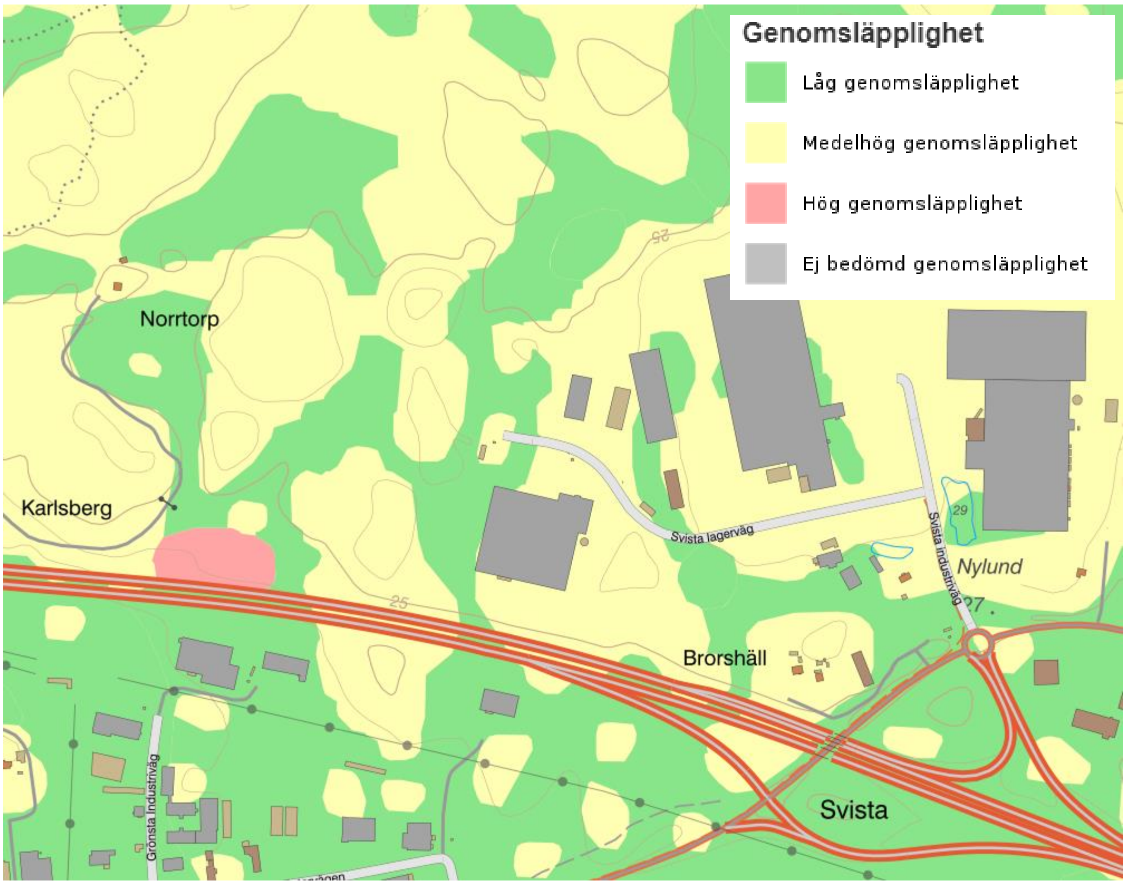

Figure 5. SGU's Map Viewer – permeability.

The pavement in the production areas will be designed with asphalt and green surfaces. The surfaces that will be paved will be assessed as hardened with low risk of soil infiltration. The surfaces that will be green areas are assessed as permeable, if contaminated firewater reaches the surfaces, soil remediation may be needed.

A dam will be built in the area to handle stormwater and firewater. All water is led via the stormwater wells to a common pipe with an inlet to the dam, see Figure 6. The dam should be designed with a volume that can handle a 20-year rain in combination with dimensioning firewater volume. A 20-year rainfall for the property has been calculated at 1100 m^3. At the outlet of the dam there is a well, sampling well and sluice hatch, which must be closed in case of fire to prevent contaminated firewater from reaching the treatment plant.

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Figure 6. Stormwater and firewater management.

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3.4. Fire protection and the rescue service's response

The facility's fire protection is under design at the building permit stage when this document has been produced. The building will meet the requirements set out in BBR 29, and be dimensioned for building class Br2 and occupancy class 1, with the exception of those parts where large amounts of flammable material are produced and processed where occupancy class 6 applies. These parts shall be technically separated from other areas in fire resistance class EI 60.

The main building, extension building U01/U02, will be equipped with an automatic water sprinkler and will thus be carried out without fire sectioning. Other ancillary buildings are less than 1250 m^2.

As a result of ongoing risk analyses, building U03, tank farm will also be equipped with automatic water sprinklers.

The design of fire and evacuation alarms is under investigation as automatic water sprinklers may be desired to be performed as Pre-Action sprinklers and with regard to possible measures from ongoing risk analysis. With automatic water sprinklers and fire alarms, fire detection and alarms to the emergency services can be expected to take place at an early stage of the fire process.

The sprinkler system is generally carried out in hazard class HHP, with a water resistance of 12.5 mm/min and the working surface of 260 m^2. In spaces with storage of raw materials in racks, the sprinkler system is carried out with ESFR sprinklers according to SBF 120 Appendix P. The system will be supplied from its own sprinkler water tank with a volume of 800 m^3.

Additional technical systems that are under investigation and may be relevant are automatic gas extinguishing systems in confined spaces and smoke ventilation.

The area will be equipped with its own fire hydrant network with a capacity of 2,400 l/min, which is supplied from its own fire water tank with a volume of minimum 400 m^3.

The emergency services Eskilstuna are expected to be on site within 10 minutes, from the time the emergency services are alerted.

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4. Risk assessment

This section identifies, describes and analyses accident scenarios that may have adverse effects on persons and the environment within the installation and in its surroundings.

4.1. Protection value

The aspect that are considered worthy of protection are the land on and around the property, and that the business must be able to collect the firewater. The plant is not located near any water source or watercourse that could lead pollution to a sensitive recipient.

Adjacent to the properties is a listed area. A ditch with macadam will be built between the listed area and the facility.

4.2. Identified Scenarios

To identify worst-case probable accident scenarios, the risk assessments made for Senior were used. Based on this work, the following accident scenarios were considered relevant to study in more detail regarding the assessment of risks with firewater management:

- Fire in theduck farm
- Fire in loading/unloading
- Fire inp ro production
- Fire in warehouses

These scenarios have been assessed as the most relevant and those that will be able to generate a larger amount of firewater, which needs to be managed. These scenarios are risk assessed with respect to risks related to firewater management in section 4.3.

4.3. Risk Assessment

Below is an account of the assessment that has been made for the identified fire scenarios for Senior materials.

Table 2. Shows the identified risk scenarios for Senior facility in Eskilstuna.

RISK	ASSESSMENT
1. Fire in Tank Farm	In the tank farm, DCM and paraffin oil will be stored in separate fire cells with bunding. The spaces must also be equipped with automatic water sprinklers. A fire could occur in the event of a leak with subsequent ignition of DCM or paraffin oil, although both chemicals are relatively difficult to ignite. The scenario could give rise to large volumes of firewater from sprinklers and the rescue service's efforts, both to cool cisterns and to extinguish the fire. The emergency services can extinguish with water or with water with foam mixture. The scenario is considered to be dimensioning and will be investigated further with regard to firewater volumes and collection possibilities.

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2. Fire during loading/unloading	At the unloading site, DCM and paraffin oil are unloaded to the tank farm. A fire could occur in the event of a leak during unloading with subsequent ignition. A fire in the tanker may also occur. The loading and unloading site will be equipped with an automatic water sprinkler and designed as a hardened surface with drainage to a collection tank in the embankment. In case of overfilling, the collection tank will overflow into the embankment. The scenario is estimated to give rise to a lower need for firewater compared to fire in the tank farm and will therefore not be investigated further.
3. Fire in productionbuilding	Fire in the production hall can potentially mean the spread of fire over a very large area, as the building is not divided into fire sections. However, in the case of a functioning automatic water sprinkler, the probability of extensive fire spread is low. However, in the event of malfunctioning sprinklers, extensive fire spread cannot be ruled out. The production hall also includes large volumes of DCM in the extraction baths, and fire spread to these could significantly complicate the extinguishing effort with regard to toxic fire smoke. Two scenarios will be investigated further, fire with functioning automatic water sprinkler and fire without the impact of automatic water sprinkler, to ensure that the business can handle dimensioning firewater volumes in both cases.
4. Fire in warehouses	Fire in warehouses can potentially mean the spread of fire over a large area in a space with a high fire load. However, when working automatic water sprinklers with ESFR sprinklers, the probability of extensive fire spread is low, since the system is dimensioned to extinguish a fire through early activation and very high water flows. However, in the event of malfunctioning sprinklers, extensive fire spread cannot be ruled out. Two scenarios will be investigated further, fire with functioning automatic water sprinkler and fire without the impact of automatic water sprinkler, to ensure that the business can handle dimensioning firewater volumes in both cases.

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5. Firewater investigation

There are mainly four types of extinguishing agents; water, foam, gas and powder. These have different effects on both firefighting and the environment. Usually, one or a combination of these is used to extinguish fires. Of these, firewater is generated when water and foam are used, but not when gas or powder is used. The impact of firewater on the environment is directly dependent on how *much firewater* is needed to extinguish the fire, what *pollutants* it brings and *in what concentrations* these are present, how *sensitive the surroundings* are and how good the *collection possibilities* and preparedness for this type of event within the business are. Collection of firewater is not always practicable, depending on the conditions of the soil (infiltration, runoff, etc.) and the quantities generated during the extinguishing. If contaminated firewater is collected, it is usually then collected by tankers and taken for destruction.

How the firewater is spread in the environment depends on *how the soil is composed* and on *the proximity to different recipients worthy of protection*. These recipients worthy of protection can be drinking water sources, groundwater, stormwater systems or other recipients. If the soil is highly permeable, infiltration into groundwater can occur, and if the surrounding area consists of hardened surfaces, surface runoff to stormwater wells or watercourses occurs nearby.

5.1. Pollutants in firewater and smoke emissions

What contaminants may be present in the firewater depends entirely on the activity in which the fire occurs. It can consist of chemicals used in the area that is flushed with without being part of the fire or residues from the combustion process in the fire, but also various additives in the firewater that is applied to the fire. Examples of probable substances that could be spread in nature with the firewater from fire in the machine hall are presented below.

DCM

DCM carries a risk of poisoning if inhaled, swallowed and if exposed to severe skin. DCM is not acutely toxicological for the environment, but the substance is persistent and suspected of causing cancer.

Polycyclic aromatic hydrocarbons, PAHs

, are hydrocarbons containing at least one aromatation ring found in coal and petroleum and formed during the combustion of organic matter. The more aromatations the molecule contains, the lower the solubility it has in water. PAHs are therefore spread with particles from combustion and end up in soil and sediment. PAHs are very harmful to health and should therefore not be spread in nature.

When hydrogen is

combined with any of the halogens, a hydrogen halide (HCl, HBr, HF, HI) is formed, and in plastic fires these are likely products. They are all easily soluble in water and can therefore follow the firewater out. These substances are all acids that, if in contact with water bodies, contribute to the acidification of the same. Combustion of DCM can give rise to HCl.

Dioxins

Polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are formed when organic matter is burned together with materials containing chlorine, such as DCM. [8]Dioxins are difficult to break down and therefore remain in the environment for a long

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time. High levels of dioxin affect the nervous system but can also damage brain development.[8]

Nitrogen and sulphur compounds Oxidation of
nitrogen and sulphur-containing materials occurs during combustion of these and involves the formation of SO_x and NO_x. The substances can in turn react with water to form sulphuric acid and nitric acid respectively, which act as highly acidifying. NO_x also contributes to the formation of ground-level ozone and contributes to eutrophication in soil and water.

5.2. Firewater volumes

The volume of firewater that occurs is determined by how much water is needed to extinguish the fire and how much of the water evaporates during extinguishing. In fires in industrial areas, evaporation is often relatively low, about 10% of the water used evaporates [9].

The total amount of firewater generated in a fire scenario can be considered to consist of three components:

1. Sprinkler water.
2. Leakage of liquid chemicals.
3. fire-fighting water resulting from rescue services' response work.

The sum of the three volumes constitutes the total firewater volume.

5.3. Firewater volumes from identified fire scenarios

The investigation will calculate on five different scenarios, in order to assess which scenario will generate the largest volume of firewater. These have been described in section 4.2

Calculation will be performed on the following scenarios:

- Fire in the tank farm
- Fire in production building, with and without sprinkler activation
- Fire in warehouse, with and without sprinkler activation

Calculation of firewater volumes in case of fire in DCM embankment.

The scenario assumes a DCM leak that covers the entire surface of the embankment and then ignites. The embankment must be designed so that all firewater can be collected.

The flow and time have been determined using the guidance of the emergency services. The maximum area of the fire is 542 m^2. At an effort for 30 min and with 6 l/m ^{2}min of firewater, this results in a total volume of firewater of 98 m^3:

$$V = 30 \cdot 0{,}006 \cdot 542 = \ 98\, m^3$$

Taking into account uncertainties in the calculations, it is recommended that the amount of firewater that the embankment should dispose of is increased by 50%, which gives a total volume of about 150 m^3.

The bund for paraffin oil is slightly smaller, 346 m^2, which gives a total firewater volume of 94 m^3, including a 50 % safety margin as above.

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Calculation of firewater volumes in the event of a fire in the Production Hall
In the event of a fire in the production hall, the firewater volume is calculated on the basis that the entire efficiency surface of the sprinkler system is activated. This is a very conservative assumption since there are normally only 1-4 sprinkler heads that have time to activate before the fire is controlled or extinguished [11]. In view of this, no extra margin is taken for the fire water of the emergency services.

With an operating area of 260 m 2, 12,5 l/m ^{2}min and 90 minutes of activation, this gives a total firewater volume of 293 m^3:

$$V = 0{,}0125 \cdot 260 \cdot 90 = 293\ m^3$$

If the sprinkler system does not activate, the fire will be able to spread to a larger part of the production hall. The dimensioning fire to be used in analytical dimensioning for evacuation scenarios according to BBRAD 3 gives a fire output of about 10 MW after 8 minutes. This is estimated to correspond to a fire area of about 10-30 m^2. Taking into account that the response time is approximately 10 minutes, and the complexity of the building may entail a longer time before extinguishing begins, a larger fire area should be assumed when calculating the firewater volume. This is set at 1250 m^2, corresponding to the maximum allowable fire section for buildings without automatic water sprinkler system. This is a considerably larger area compared to what is estimated in the evacuation scenario and is therefore considered a conservative estimate. In the event of such a large fire, it is not really likely that the emergency services will make an internal effort, but instead focus on protecting other parts of the building to reduce the risk of fire spreading.

Real Fire Data is a study by Stefan Särdqvist from 1998 where 307 fires in non-homes in London were investigated with regard to, among other things, water consumption. The study proposes a relationship between the area of the fire ([9]*A* [m ^{2}]) and the required firewater volume (*V* [m^3]) according to the following equation:

$$V = 0{,}11 \cdot A^{1{,}1}$$

The dimensioning firewater volume will then be 280 m^3:

$$V = 0{,}11 \cdot 1250^{1{,}1} = 280\ m^3$$

Calculation of firewater volumes in the event of a fire in warehouses
In the event of a fire in storage, the firewater volume is calculated on the basis that 4 out of 12 ESFR sprinklers in the efficiency surface are activated and kept in operation for 60 minutes. Since ESFR sprinklers are designed to activate quickly and extinguish a fire, the assumption that the entire surface of action would be activated at the same time is considered too conservative. Four sprinkler heads with a flow of 1 120 l/min each for 60 minutes give a total firewater volume of 269 m^3:

$$V = 4 \cdot 1120 \cdot 60 = 269\ m^3$$

If the sprinkler system does not activate, the fire will be able to spread to a larger part of the warehouse. With the same reasoning as for the production hall, the maximum fire area is set at 1,250 m^2, resulting in a total firewater volume of 280 m^3.

The estimated amounts of firewater are just under 300 m^3 in all scenarios, with the exception of the embankment fire which is 150 m^3. It is therefore recommended that the dam for stormwater and firewater be dimensioned for a firewater volume of 300 m^3. Compared to

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statistics for 4000 fires (mainly in various types of industries, warehouses and waste facilities), this is a relatively large volume. The study shows that a volume of 288 m^3 [13] was sufficient to extinguish 99.8% of the fires studied when responding to the emergency services.

5.4. Firewater collection and handling

Collection stormwater pond

The stormwater pond will be dimensioned to be able to handle a 20-year rain at the same time as the dimensioning firewater volume, which means a total capacity of 1,400 m^3. It is considered highly unlikely that such an extensive fire, as the dimensioning scenarios assume, would occur in connection with a 20-year rainfall. This means that in most cases there will be capacity to collect even larger volumes of firewater. For example, there is capacity to collect the entire sprinkler water tank's volume of 800 m^3 at the same time as a 5-year rainfall. The capacity of the stormwater pond is thus considered robust.

Since most of the surfaces around the production buildings are paved, the risk of ground infiltration is considered low. The hardened surfaces will also lead the firewater to the stormwater pond. The pipeline from the stormwater pond is constructed with a sluice hatch that can be closed in the event of a fire to ensure that the contaminated firewater is not released to the treatment plant.

Collection in the tank farm

The embankment capacity in the tank farm with DCM/paraffin oil should be designed to collect 150 m^3 and 94m^3 of firewater, respectively, in addition to the volume of stored chemicals.

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6. Conclusion and recommendations

Senior's facility in Eskilstuna handles large amounts of combustible chemicals and other combustible materials. This, in combination with a large building area, can generate large volumes of firewater, which in this investigation has been estimated to amount to 300 m^3. The stormwater dam is designed for a capacity of 1,400 m^3, which means that it can handle both a 20-year rain and the dimensioning firewater volume at the same time. This also means that capacity will usually be available for even larger firewater volumes.

Furthermore, in the design phase, it must be ensured that the lock located on the stormwater pipe is closed in the event of a fire, preferably that this happens automatically in the event of a fire alarm or sprinkler activation.

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Verification of the building’s fire protection

Robustness analysis

Construction of a new industrial building

2023-09-01

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PROJECT NAME	STATUS	PROPERTY AND MUNICIPALITY
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CLIENT	**PROJECT RESPONSIBLE**	**ASSIGNEE**
Logistic Contractor Entreprenad AB	Johan Norén	Stephanie Axelsson

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