Sampling of particles in the working atmosphere during insulation with Pyrogel XT-E

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Summary

Equinor approves the insulation systems and products that are allowed to be used in projects. Pyrogel XT-E is such an approved insulation material. Due to concerns about high dust exposure of personnel at insulation sites using Pyrogel, Pyrogel (XT-E and XT-F) was reclassified to Equinor health hazard category 4 (red) in October 2018. The amount of dust generated during handling of Pyrogel where not known. Only a limited number of reports were available from other companies. It was in Equinor's interest to obtain quality sampling data of the amount dust generated during handling of Pyrogel in accordance with our recommended method. The test program was initiated late November 2018 and carried out December 10 – 14, 2018. The strategy was to perform mounting and demounting of the insulation Pyrogel XT-E following the Equinor's practice and the ISO contractor's detailed work procedure. The insulation work was performed on standard test rigs for insulation and included sampling of four mounting/demounting of Pyrogel XT-E, personal sampling and stationary sampling. In addition, dust sampling during demounting of the applied scaffolding was included. The test program was performed in an area with good access and shielded from the outside weather.

The results show that the insulators working with Pyrogel XT-E are exposed to dust concentrations considerably exceeding the Equinor OEL, both for total dust (average 24 mg/m^3, STD 10, OEL 6 mg/m^3) and respirable dust (average 11 mg/m^3, STD 4, OEL 3 mg/m^3). In order to control the exposure risk for the insulators, a PPE regime with fan assisted respirator with P3 filter, disposable coverall, and gloves, are needed.

The adjacent personnel can be exposed to Pyrogel XT-E if they are working close to the insulators. Specifically, directly above the insulators the dust concentration can be high. If there is no physical barrier between the insulation work area and adjacent workers above, the adjacent workers above need the same PPE regime as the insulators for sufficient control of Pyrogel exposure. Adjacent workers working directly below the insulation work area can use mask with P3 filter for respiratory protection if there is a physical barrier, e.g. tarpaulin, covering the floor between them. If there is no such barrier, the adjacent workers directly below the insulation work area needs the same PPE regime as the insulators. If the adjacent personnel are working in a distance closer than 3 meters to the insulation work area, they need the same PPE regime as the insulators. In a distance of 3 to 5 meters from the insulation work area in any direction (except directly above as previous specified), a mask with P3 filter is sufficient as respiratory protection. If the distance is more than 5 meters, a local risk assessment should be done to decide if the work can be performed without respiratory protection. Any transport inside the insulation work zone should be avoided by blocking with cordons. If transport through this zone is needed, the person should be wearing mask with P3 filter for respiratory protection. Outside the insulation zone transport can happen without dedicated PPE to control for Pyrogel exposure.

Scaffolders that are removing scaffolding that has been used for Pyrogel XT-E insulation, can be exposed to Pyrogel XT-E. Since it is not possible to fully clean the scaffolding from Pyrogel dust, i.e. there will be dust settled in cavities in structure, it is recommended to use a mask with P3 filter when demounting and restrict the period for such demounting to half a shift. If this is not possible and the demounting of scaffolding last for a full shift, a fan-assisted respirator is needed for the scaffolders. It is also recommended that scaffolders use disposable coveralls and gloves during demounting.

The conclusions are funded on the results from dust sampling when two insulators were mounting and demounting Pyrogel XT-E insulation on structures in an area with good access and shielded from the outside weather. If the conditions vary considerably from this, e.g. higher density of insulators (more than two), more condensed area (more structures, lower volume), and high air velocity (wind), it is highly recommended to do a local risk assessment to ensure that the risk reducing measures are sufficient for safe work. For all use of masks for respiratory protection other than the fan-assisted respirator, it is recommended that this is founded on individual fit-testing. Finally, it is recommended to perform site sampling during real insulation work to supplement the findings from this test program.

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1 Acknowledgement

The achievement of the test program that arranged for the results in this report, was based on a successful collaboration between Equinor, Aibel, Linjebygg and STS. All parties have been supportive in providing personnel, equipment and facilities to enable the test program to take place. A special thanks to the two insulators that volunteered as test persons and accepted to perform their professional work wearing sampling equipment while continuously being monitored and observed by strangers. Further, the collaboration with the occupational hygienists from Aibel's occupational health service are highly appreciated.

2 Background

Equinor approves the insulation systems and products that are allowed to be used in projects (TR1660 Piping and equipment insulation). Pyrogel XT-E and Pyrogel XT-F are such approved insulation materials with favorable qualities as:

- reduced thickness and weight
- robust, tolerate mechanical burden (i.e. withstand persons stepping on it)
- hydrophobic (water resistance) and breathable
- very good test results for CUI (corrosion under insulation)
- can be used for all Equinor's insulation classes

Pyrogel XT-E and Pyrogel XT-F has been applied in Equinor projects since 2013.

Due to health hazards associated with high dust exposure during handling of these two insulation products, Equinor reclassified Pyrogel XT-E and Pyrogel XT-F to health hazard category 4 (red) in Equinor's chemical management system (SF601.01, R-11753). The valid safety data sheets for Pyrogel XT-E (appendix 1) and Pyrogel XT-F (appendix 2), do not include hazardous contents in an amount resulting in hazard classification of the whole product in accordance with the European Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of substances and mixtures (CLP Regulation). Due to concerns about high dust exposure of personnel at insulation sites using Pyrogel, a process to reclassify to health hazard category 4 was started in May 2018. ISO contractors were involved in the process and the new classification was effectuated from October 2018. Red health hazard classification does not prohibit the use of Pyrogel XT-E or Pyrogel XT-F, however, risk assessment prior to using the product is required to ensure that the risk is controlled.

The amount of dust generated during handling of Pyrogel, both XT-E and XT-F, where not known. Only a limited number of reports were available for occupational hygiene sampling of dust in the workplace atmosphere (see chapter 11.6). They were mostly spot checks, i.e. a limited number of samples performed in relatively short time periods. The description of work procedure and handling were variable, and it was unclear if they were representative for insulation performed in accordance with the recommendation from Equinor.

It was in Equinor's interest to obtain quality sampling data of the amount dust generated during handling of Pyrogel in accordance with our recommended method. This was of relevance to several of Equinor projects, and the Dvalin and the Martin Linge projects decided to be sponsors of the test program for obtaining the necessary data. The test program was to take place at the Dvalin location at Aibel Haugesund, applying Pyrogel XT-E which is the insulation material used by Dvalin.

3 Aim

The aim of the test program was to obtain quality data of the particle concentration in the working atmosphere generated as a result of mounting and demounting of the insulation material Pyrogel XT-E. The sampling was to reflect the dust exposure for the insulators and for the adjacent personnel in the nearby area. The insulation and removal method were to be in accordance with the Equinor best practice work method. Further, the intention was that the results of the test program can be used by other projects as a basis for their local risk assessments.

The test program was initiated late November 2018 and carried out December 10 – 14, 2018. The subsequent analysis report from the laboratory was received January 3rd, and the report published January 25, 2019.

4 Strategy

The strategy to fulfil the aim was to perform mounting and demounting of the insulation Pyrogel XT-E following the Equinor's practice and the ISO contractor's detailed work procedure. The insulation work to be performed on two of Equinor's standard test rigs for insulation, located inside the rub hall in Aibel's facilities at Risøy, Haugesund. The test program to include sampling of at least three mounting of insulation and at least three demounting of insulation to obtain sufficient data. Time estimation indicated that such a test program would take one work week (Monday – Friday).

The sampling strategy included both personal exposure sampling of two insulators during performance of their work, and stationary sampling in their work zone and at regular distances from this work zone, both horizontally and vertically. The stationary sampling located in the centre of the work zone was to supplement the results from the personal exposure sampling of the insulators. The stationary sampling located horizontally to the work zone was to simulate what adjacent personnel working in 3-meter distance and in 5-meter distance from the work zone could be exposed to as a result of the insulation work (see Figure 1).

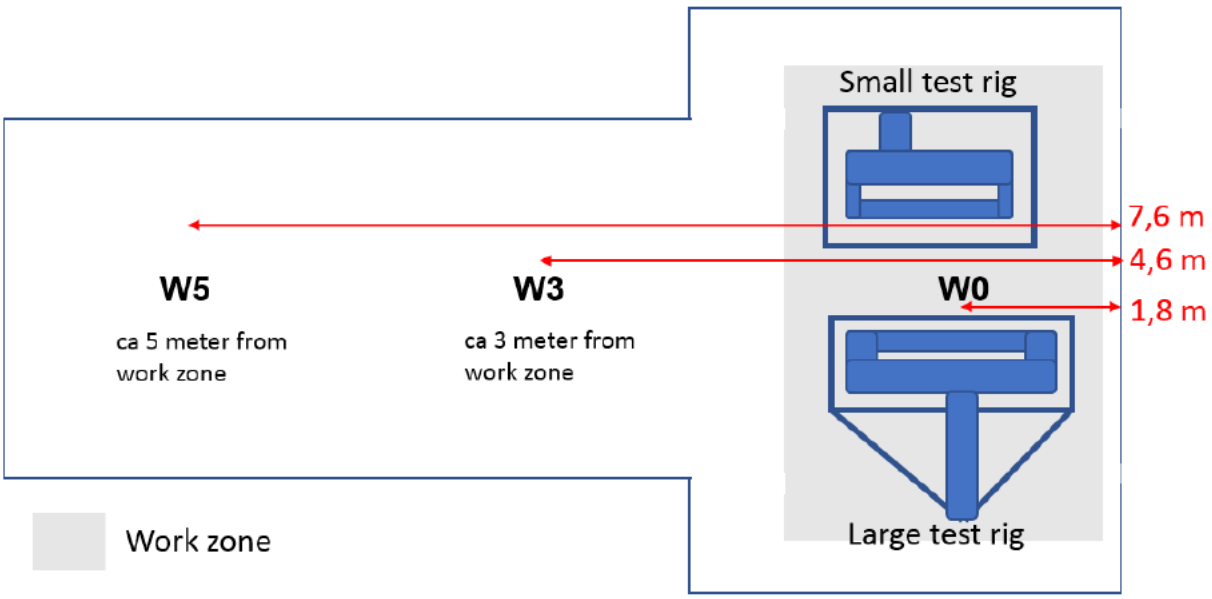


Figure 1: Sketch of sampling positions, looking from above to the scaffolding work level

The vertical samplers where located both above the work zone (ceiling) and below (lower floor) as well as in 3 meter and 5 meter distance, both for ceiling and lower floor (see Figure 2). The vertical samplers were to simulate what adjacent personnel working at levels above and below insulators could be exposed to as a result of the insulation work.

Scaffolding floor and tarpaulin on top of the floor acted as a partly physical barrier between work level and lower level, while there was no such barrier between work level and ceiling level.

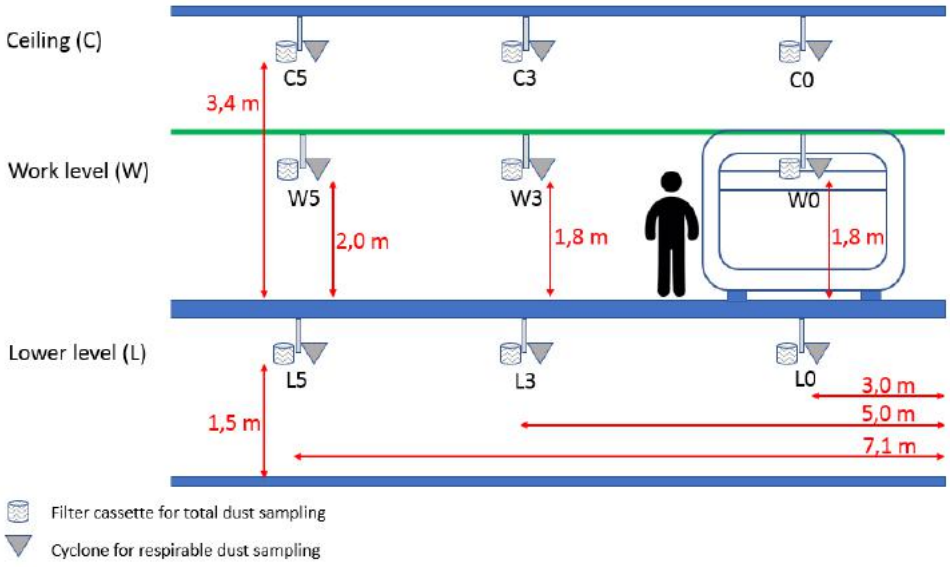


Figure 2: Sketch of sampling positions, looking vertically to the different levels

The sampling was to include sampling of total dust and sampling of the respirable dust fraction. Equinor occupational exposure limits are available for both of these (see chapter 8). The method for performing such sampling shall be in line with “Methods for sampling of pollutants in the work atmosphere” (The Norwegian Directorate of Labour). The principle is to collect particles in the air on filters, sucking the air through the filter with a pump with a known flow. The filters are weighted prior to sampling and after sampling by a laboratory (third party), and the results are given as mg/m^3.

During performance of the test program, the mounting and demounting of insulation took shorter time than originally estimated. After performance of four mounting and demounting of Pyrogel XT-E during the first four test days, the plan for the last test day was changed to include sampling of total dust and respirable dust during demounting of scaffolding. This sampling included personal sampling of four scaffolders during demounting of scaffolding and stationary sampling at three locations along the long wall of the rub hall.

5 Test facility

5.1 Rub hall

The tests were performed at Aibel’s industrial area in Haugesund, inside the “rub hall” located near the “Nordsjøhall”.

Figure 3: Outside of rub hall

Figure 4: Inside rub hall prior to installation of scaffolding

5.2 Scaffolding

A scaffolding was mounted inside the rub hall to provide for test facilities with air sampling at the work level, below the work level, and above the work level. Thus, the work level was elevated to enable sampling below, and structures in the ceiling enabled sampling above the work level.

Figure 5: Overview of scaffolding

In order to perform stationary air sampling simulating adjacent personnel, i.e. personnel working in the vicinity of the insulators, the scaffolding was built large enough to enable sampling at 3 meter and 5 meter distance from the insulators work centre.

Figure 6: Overview of size of scaffolding work level, including the insulators work area

5.3 Insulation test rig

Two Equinor standard insulation test rigs were applied when performing the mounting and demounting of Pyrogel XT-E insulation. One of them was located at Aibel's facilities (large test rig), and the other was borrowed from Kårstø (small test rig). The two test rigs were placed by truck in the inner area of the scaffolding, in the level named "work level".

Figure 7: Large test rig and small test rig and their location on the scaffolding work level

5.4 Insulation cutting tent

A dedicated insulation cutting tent for this test was built close to the entrance of the rub hall. No facilities were included inside the tent. Its only function was to provide a separate area where any necessary cutting of the Pyrogel insulation could take place.

Figure 8: Cutting tent for insulation with entrance sluice

6 Sampling equipment

6.1 Method

The sampling of total dust and respirable dust fraction has been performed in accordance with the recommendations given by the Norwegian Directorate of Labour “Methods for sampling of pollutants in the work atmosphere” [In Norwegian only] (reference 1). Active sampling with pumps sucking the air through a dedicated filter has been applied both for the personal and stationary sampling. In addition, sampling with direct reading instruments has been applied to supplement the filter sampling. The respirable fraction meets the definition of respirable dust (NS-EN-481): “The mass fraction of inhaled particles penetrating to the unciliated airways”.

Each filter has been used for the whole test day. It was not possible to differentiate between sampling only during mounting, sampling only during demounting etc. This was due to the need for a sufficient long sampling time to keep the detection limit of the method low (dependent on the air volume through the filter). Further, the additional time needed for changing filters during the sampling period, including pump flow reading before and after the change, was not compatible with the number of industrial hygienists and the large number of pumps (up to 22 running simultaneously).

6.2 Filters

6.2.1 Filters for respirable dust fraction

For collecting the respirable fraction of particles, i.e. particles that can penetrate to the deepest part of the lungs (alveoli), filter of type 37mm MCE (mixed cellulose ester, pore size 0.8 µm) was used. The laboratory (SINTEF Molab) weighed all the empty filters, mounted them in respiratory filter cassettes (37 mm SKC cyclone cassette), before sending the equipment to Equinor. “Blind” filters, i.e. filters that followed the same logistics as the rest of the filters except being used for the air sampling, were provided as well. Their intention was to correct for any exposure to the filters during transport and storage. During sampling, the respiratory filter cassette was mounted in a respirable sampling head (SKC Plastic cyclone) and fastened to the coverall in the breathing zone (personal sampling), or to a structure in corresponding height (stationary sampling).

Figure 9: Respirable sampling head

Figure 10:
Respirable filter cassettes (inside the sampling head during sampling)

6.2.2 Filters for total dust

For collecting the total dust, i.e. all particles regardless of size, filter of type 25 mm MCE (mixed cellulose ester, pore size 0.8 µm) was used. The laboratory (SINTEF Molab) weighed all the empty filters, mounted them in filter cassettes for total dust (25 mm black STK), before sending the equipment to Equinor. “Blind” filters, i.e. filters that followed the same logistics as the rest of the filters except being used for the air sampling, were provided as well. Their intention was to correct for any exposure to the filters during transport and storage.

Figure 11: Filter cassettes for total dust sampling

6.3 Pumps

All the pumps used for sampling particles in the air on filters were of the type Casella Tuff, rented from SINTEF Molab. They were pre-set by laboratory to operate with flow of 2.0 litre/minute for total dust collection and 2.2 litre/minute for respirable dust collection. Their actual flow was checked with a rotameter during start-up of all sampling, at the end of sampling, and several times in between.

Figure 12: Casella Tuff pumps

Figure 13: Casella Tuff pump with indication of functions

It was ordered a small excess of pumps (# 26) compared with the number of pumps that would operate simultaneously (# 22). This is due to the experience with robustness of such pumps regarding failure at long term operation, and in a low temperature environment.

It was stated a strategy for prioritization of pumps where pumps connected to a respirable filter cassette were prioritized above pumps connected to a total dust filter cassette. Further, the location of pumps in area 0 where prioritized above area 3, and area 3 prioritized above area 5. In vertical level, the work level had highest priority, followed by ceiling, and the lower level had lowest priority. This is due to the scaffolding flooring and tarpaulin in work zone will act as a physical barrier between work level and lower level, thus, it is expected to find lower concentration levels of dust in the lower level.

6.4 Direct reading instrument - counting in weight classes

Two instruments of type Dust Trak DRX Desktop Model 8533 TSI were used for personal sampling, indicating the amount of airborne particles the insulators were exposed to. One instrument of type Dust Trak DRX handheld Model 8533 TSI was used for stationary sampling, indicating the amount of airborne particles adjacent personnel in ca 3 meter distance was exposed to.

Figure 14: DustTrak DRX Model 8533 Desktop (left) and handheld (right)

The Dust Trak DRX separate the particles into five different size fractions before giving the results as the weight of each of the five fractions in mg/m^3:

- Total particles
- Respirable particles
- PM10 (particulate matter below 10 µm)
- PM2.5 (particulate matter below 2.5 µm)
- PM1 (particulate matter below 1 µm)

The particle size range for the instrument is 0.1 to 15 micrometres, and aerosol concentration range is 0.001 to 150 mg/m^3. The temperature operation range is 0 to 50ºC.

The instruments were calibrated by the vendor using emery oil and nominally adjusted to respirable mass with a test dust (Arizona dust). Certificates of calibration and testing are given in appendix 3,

6.5 Direct reading instrument - counting in numbers

One P-Trak Ultrafine particle counter, Model 8525 TSI was used as a mobile indicator of number of airborne particles both for insulators and adjacent personnel.

Figure 15: P-Trak Ultrafine Counter Model 8525

The particle size range is 0.02 to 1 micrometre, and its temperature range for operation is 0 – 38ºC. The instrument is of the type condensation nuclei counter. The particles are drawn through the instrument using a built-in-pump. They pass through a saturator tube where they mix with an alcohol vapor (iso-propanol). The particle/alcohol mixture is next drawn into a condenser tube where alcohol condenses on the particles causing them to grow into droplets that can be counted more easily. The droplets then pass through a focused laser beam, producing flashes of light that are sensed by a photodetector and counted to determine particle concentration.

7 Method

7.1 Insulation method

Equinor specify the insulation procedures through the document called Insulation Procedure Specification (IPS) Piping & Instruments. This gives the general technical requirements, qualification of personnel, notifications, inspection and test, insulation materials and accessories, and site test. In appendices sketches are given showing details of how Pyrogel insulation for straight run, T-piece and elbow pieces looks like when mounted. However, this procedure does not include the details for how the insulators shall work in order to obtain the required insulation quality. Such work procedure is given by the company performing the insulation.

For the test program the procedure given by Linjebygg, Aibel's insulation vendor, was applied. Equinor gave their comments to the proposed procedure in advance to ensure that it was in line with Equinor best practice. The revised procedure from Linjebygg is given in appendix 4. Some central content of the procedure (translated to English) are given below:

- Personal protection equipment: fan-assisted respirator, disposable coverall, long gloves (nitrile or latex) outside cut gloves during adjustment of product. During mounting, cut gloves are not necessary to wear.

- Adjustment of product shall take place in a suitable cutting tent.
- Material ready for use shall be transported in a closed bag.
- The work area shall be covered with scaffolding tarpaulin to prevent generation of dust to the surrounding areas and to other personnel.
- Before starting, the work area shall be blocked off.
- The work area shall be regularly cleaned to minimize dust generation.
- The material shall be stored in the packaging until its ready for use.
- Scissors or knife shall be used for adjusting the product. The product shall not be pulled since this will generate a lot of dust.
- A vacuum cleaner with HEPA filter shall be applied to clean the work place, do not sweep since this will raise the settled dust. Large pieces shall be picked up and packed in bags.
- For work on scaffolding: ensure that the scaffolding is cleaned prior to demounting.
- When demounting, the tarpaulin on the floor shall be removed in a way that reduce further spread of the dust.

Additional information for this test:

- the insulators used gloves of type Chemstar (orange, disposable gloves, Granberg).
- the insulators used Turbo respirators (Sundström), and the visor was cleaned with Des-spray from Kebco.
- the tarpaulin on the scaffolding floor at the work level was of type Monaflex.
- the Pyrogel XT-E used in the test was delivered from Kaefer and from Benarx. They were precutted as “fish”, preadjusted pieces for bends, some were pre-rolled, and some delivered as large rolls. It was pointed out by the insulators that the insulation material did not fit the test rig at the quality level they were used to in their regular work.
- the extent of using the cutting tent in this test was low, mainly due to the use of precutted materials.
- for one of the four removals, this was done with a gentle method as instructed by Equinor. The insulators worked in pair, and one embraced the insulation to avoid pop out when the other removed the tape. The removed material was immediately put in a bag.

Figure 16:
Insulator wearing respirator, disposable coverall, gloves

Figure 17:
Pyrogel XT-E stored in package before its ready for use

Figure 18: Scaffolding floor covered with tarpaulin

Figure 19: Cleaning by vacuuming

Figure 20: mounting insulation

Figure 21: Removal of insulation

7.2 Particle sampling with filters and pumps

7.2.1 Personal sampling

Filters collecting the respirable dust fraction and the total dust were mounted in the breathing zone of two insulators, outside the respirator. The pumps were clicked to the insulators belt. The pump flow was checked with a rotameter short after start-up.

Figure 22: Filters mounted in the insulators breathing zone

Figure 23: Pump mounted in insulators belt

Figure 24: Check of pump flow and sampling equipment

During breaks (lunch time ca 11 – 12 am, coffee break ca 3 – 3:30 pm) the personal sampling equipment were not stopped. The pump flow was checked and noted, the equipment was demounted from the persons and kept in a no/low exposed area until the person returned. This is one of several approaches for sampling equipment during breaks.

7.2.2 Stationary sampling

Filters collecting the respirable dust fraction and the total dust where mounted at three locations at the work level (W0, W3 and W5), three locations at the lower level (L0, L3 and L5) and three locations at the upper level (C0, C3 and C5). The stationary sampling at W0 was to supplement the results from the personal exposure sampling of the insulators. All the other stationary samplers were to simulate the dust exposure for adjacent personnel working at a distance horizontally or vertically away from the insulators. The filters were as far as possible located in the breathing zone level of a person, varying from 1.5 meter to 2 meters due to available structures for mounting.

The pump flow was checked with a rotameter short after start-up and several times during the sampling period.

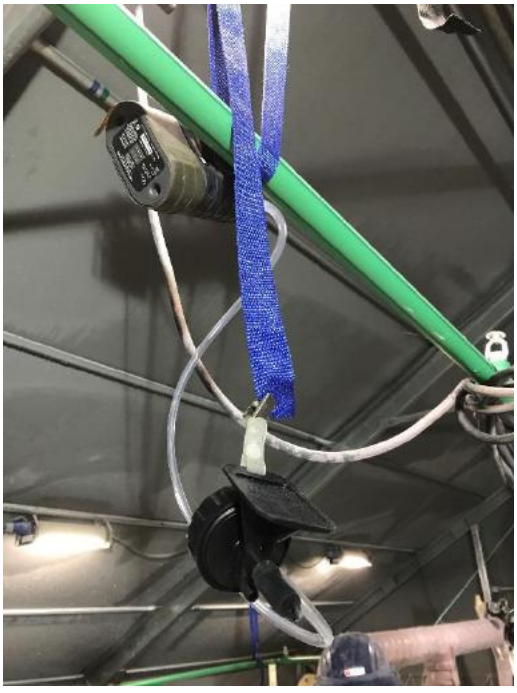


Figure 25: Stationary sampling at work level (W3)

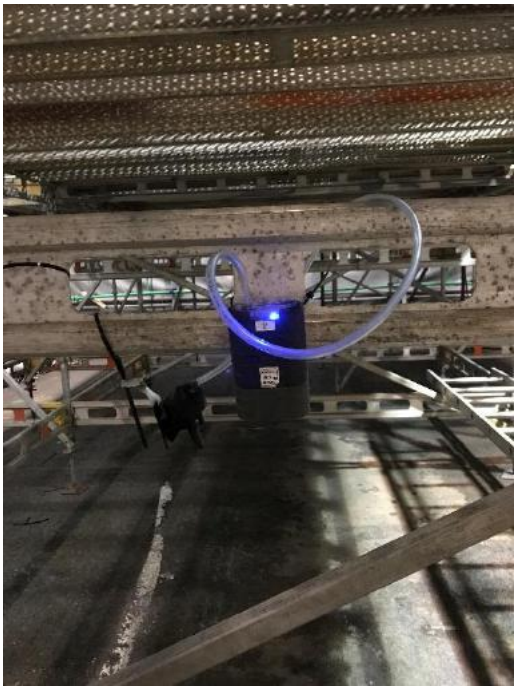


Figure 26: Stationary sampling at lower level (L5)

Figure 27: Check of pump flow, ceiling level (C0)

Figure 28: Check of pump flow, lower level (C3)

The stationary sampling equipment were not stopped during breaks. They continue to sample also during breaks. The pump flow was checked and noted before breaks and after every start-up of work after breaks.

7.3 Particle sampling with direct reading instruments

7.3.1 Personal sampling

The DustTrak DRX Desktops where placed in sacks and the sampling tube located in the breathing zone of the insulator, outside the respirator. Prior to every use, the zero-sampling check was performed with the instrument zero filter. The instruments were programmed to log the sampling data every second. After end of sampling, a photo was taken of the instrument display showing the results in numbers and as graphs. The data was exported to the software TrakPro for further handling and imported to Excel as ASCII files for statistics and graphs.

The personal sampling with DustTrak was to be used as an indicator for the personal sampling on filters.

Figure 29: Insulator with DustTrak DRX sampling

Figure 30: Display of DustTrak showing mass concentration

7.3.2 Stationary sampling

The DustTrak DRX handheld where placed on a stepladder at the work level, close to W3. The sampling tube was located in the height of the breathing zone. The intention was to have an indication of what the particle concentration would be for personnel working in 3-meter distance to the insulators.

Prior to every use, the zero-sampling check was performed with the instrument zero filter. The instrument was programmed to log the sampling data every second. After end of sampling, a photo was taken of the instrument display showing the results in numbers and as graphs. The data was exported to the software TrakPro for further handling.

The P-Trak ultrafine particle counter where placed closed to the DustTrak on the stepladder (to the right). The sampling probe was located in the height of the breathing zone. The P-Trak ultrafine particle counter was also used as a mobile instrument, and the probe was then placed in a dust cloud for instant information of variation in particle number.

Figure 31: Location of stationary sampling, ca W3

Figure 32: Location of sampling tubes

7.4 Climate measurements

The surrounding temperature, relative humidity and air velocity were measured twice a day. The measurement was performed on the work level. The instrument Almemo Datalogger 2690-8 with corresponding sensors was applied for the measurements.

Figure 33: Almemo data logger with sensors

Figure 34: Almemo data logger display

8 Occupational exposure limits

Equinor's occupational exposure limits (OEL) are given in TR0926 Working environment. The OELs are the same as the American Conference Governmental Industrial Hygienists (ACGIH) recommended threshold limit values, unless the national requirement is stricter. For irritating dust, the ACGIH does not have any threshold limit value. However, they state that "Particles not otherwise specified" may have adverse effects and recommends that airborne concentrations should be kept below 3 mg/m^3 for respirable particles, and below 10 mg/m^3 for inhalable particles until threshold limit values are established.

The following OELs are of relevance for exposure to dust from Pyrogel XT-E:

Table 1: Occupational exposure limits

What	**Equinor OEL 8 hour (mg/m^3)**	**Equinor OEL 12 hour (mg/m^3)**	Norway* 8 hour (mg/m^3)	Norway* 12 hour (mg/m^3)
Irritating dust - total dust	**10**	**6**	10	6
Irritating dust - respirable dust	**5**	**3**	5	3

*: Regulations concerning action and limit values (Lovdata, reference 2)

In addition, the recommendations from ACGIH that airborne concentrations should be kept below 3 mg/m^3 for respirable particles, and below 10 mg/m^3 for inhalable particles, are valid for Equinor.

If the results from occupational hygiene samplings exceeds 50% of the OEL, risk controls are needed to ensure safe work (TR0926). For concentrations levels below 50%, risk controls are evaluated based on professional judgement of the hazard, duration and frequency. Some business areas in Equinor has specific requirements (DPN, WR1146).

9 Personnel

9.1 Insulators

The insulators were two experienced insulators from the company Linjebygg.

9.2 Occupational hygienists

The occupational hygienists that carried out the sampling of airborne concentrations were a pool of five, with three working together in the field.

Table 2: Occupational hygienists involved in the sampling

Name	Company	Role	
Ellen Katrine Jensen	Equinor	Chief engineer HWE *Certified industrial hygienist**	
Kirsti Krüger	Equinor	Specialist HWE *Certified industrial hygienist**	
Ole Johnny Midtskogen	Equinor	WE engineer Martin Linge Industrial hygienist	
Knut Grove	International SOS	Director Working environment *Certified industrial hygienist**	Aibel's occupational health service
Ann Margot Whyatt	International SOS	Senior industrial hygienist *Certified industrial hygienist**	Aibel's occupational health service

*Certified industrial hygienist is a protected title for professionals who has met specific requirements for education and experience, and through examination has demonstrated knowledge and skills within the profession industrial hygiene.

In addition, Stamina, the occupational health service for Linjebygg, was invited to participate. They were not able to participate.

9.3 Material

The material discipline was represented with Knut Arne Magnussen, Principle Engineer operation & maintenance, in this test program.

9.4 Safety delegates

The main safety delegate from the Martin Linge project, Frank Johannessen Blazquez, represented the safety representatives in this test program.

In addition, safety delegates from Aibel participated in information meeting prior to the test, visited the test site, and participated in summary meeting at the end of the test.

9.5 Safety and sustainability

The SSU leader for the Dvalin project in Haugesund, Jon Bratteteig, represented SSU in this test program.

9.6 Other resources

- Monica Pettersen, Site Manager for the Dvalin project
- Wenche Eide, Project manager for the Dvalin project
- Kenneth Tjøsvoll, Aibel insulation
- Jan T. Bergsvåg, Linjebygg insulation
- Terje Svarberg, STS scaffolding

10 Results

10.1 Summary of test results – Test day 1

The results from test day 1, December 10, 2018, are used as an example, since this demonstrate the trends found for the other test days in a representative way. Further, this is the test day with the highest results in concentration levels for the insulators and represents the situation with highest dust concentration during the test program.

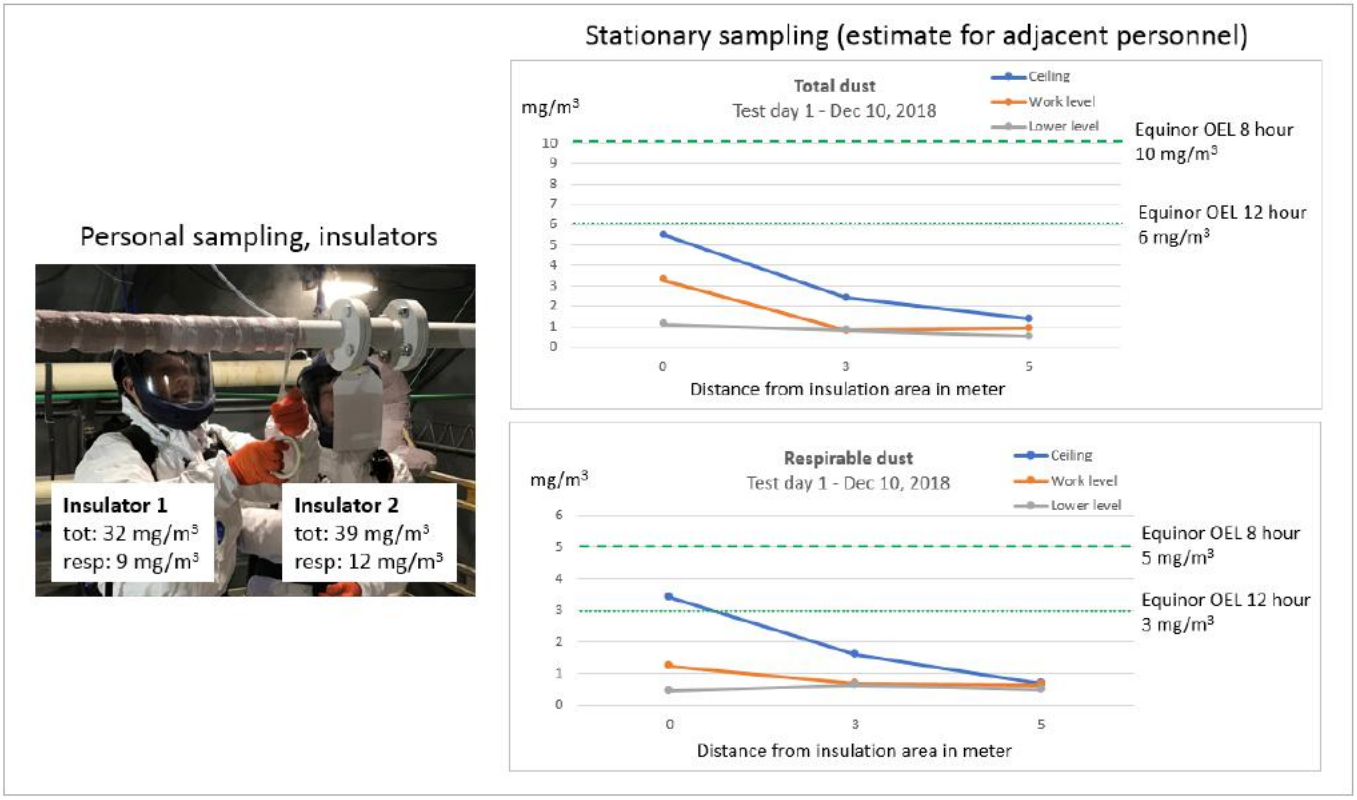


Figure 35: Total dust and respirable dust fraction, Test day 1

Figure 35 visualize the results given in chapter 10.4 and 10.5, for test day 1, December 10, 2018. The personal sampling results show that the insulators are exposed to a total dust level 6-7 times the occupational exposure limit (Equinor OEL 12 hour: 6 mg/m^3) and exposed to respirable dust level 3-4 times the occupational exposure limit (Equinor OEL: 3 mg/m^3).

The stationary sampling gives an estimate of what adjacent personnel working in a distance from the insulators could be exposed to. Close to the insulators (work level 0) the total dust level is 55% of the occupational exposure limit (Equinor OEL 12 hour: 6 mg/m^3) and the respirable dust level 40% of the occupational exposure limit (Equinor OEL: 3 mg/m^3). Moving away from the insulators horizontally (3 meter), the concentration reduce to 14% of OEL (total dust) and 22% of OEL (respirable) respectively. Moving further away horizontally (5 meter) there is approximately the same concentrations: 15% of OEL (total dust) and 21% of OEL (respirable) respectively.

The stationary sampling in the ceiling height show that in the area right above the insulators (ceiling 0), there is a higher concentration level compared to the stationary sampling at the work level. The total dust level is 92% of the OEL and the respirable dust level is 113% of the OEL. When moving 3 meters away from this area, the dust level decrease, the concentration is 40% of the OEL (total dust) and 53% of the OEL (respirable), respectively. Moving further away to a distance of 5 meters from the insulation work, the concentration is further reduced to 23% of OEL (total dust) and 22% of OEL (respirable), respectively.

For the level below the scaffolding, the lower level, the location right under the insulation work zone (lower level 0) has dust concentrations 18% of OEL (total dust) and 15% of OEL (respirable). In a 3-meter distance (lower level 3), the concentrations are 14% of OEL (total dust) and 21% of OEL (respirable). In a distance of 5 meter (lower level 5), the concentrations are 9% of OEL (total dust) and 16% of OEL (respirable).

10.2 Summary of results – insulators and nearby areas

Figure 36 gives the average concentrations of total dust for the four independent samplings performed on test day 1, 2, 3 and 4. The standard deviation for each average concentration is included. Equinor OEL for 8 hours (10 mg/m^3) and 12 hours (6 mg/m^3) is indicated.

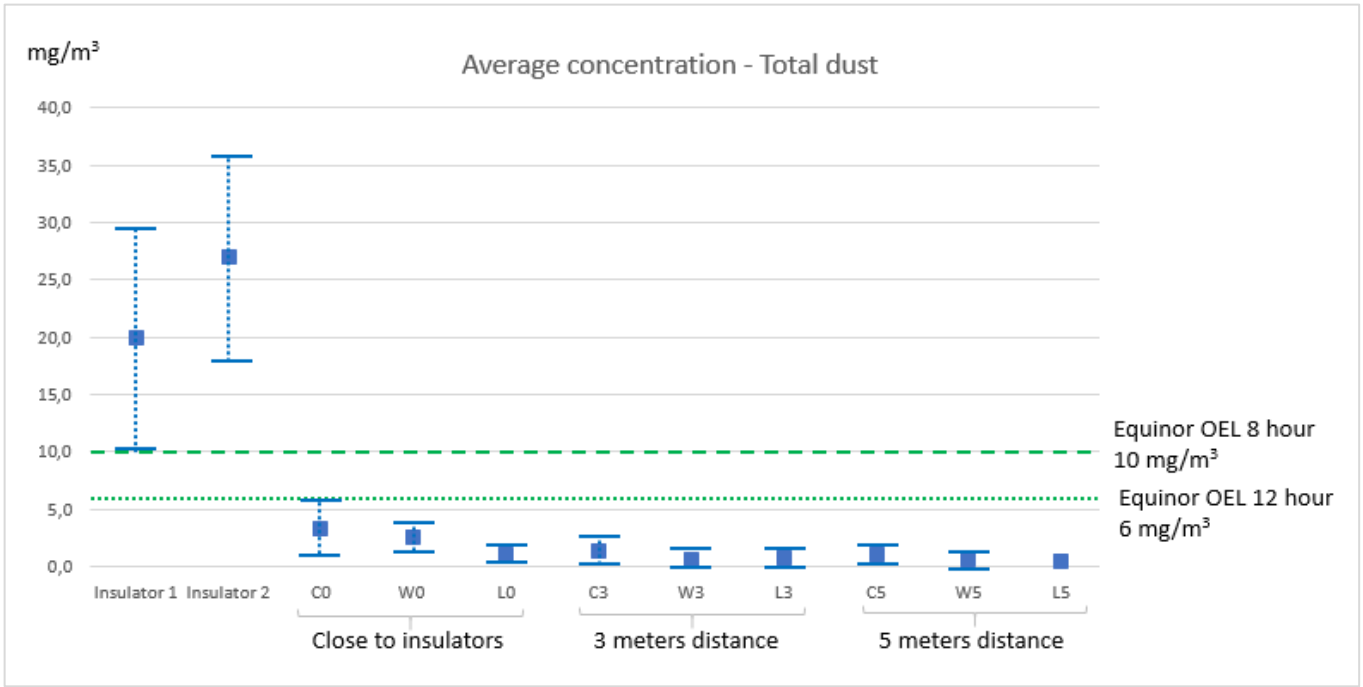


Figure 36: Average concentrations – Total dust

Figure 37 gives the average concentrations of respirable dust for the four independent samplings performed on test day 1, 2, 3 and 4. The standard deviation for each average concentration is included. Equinor OEL for 8 hours (5 mg/m^3) and 12 hours (3 mg/m^3) is indicated.

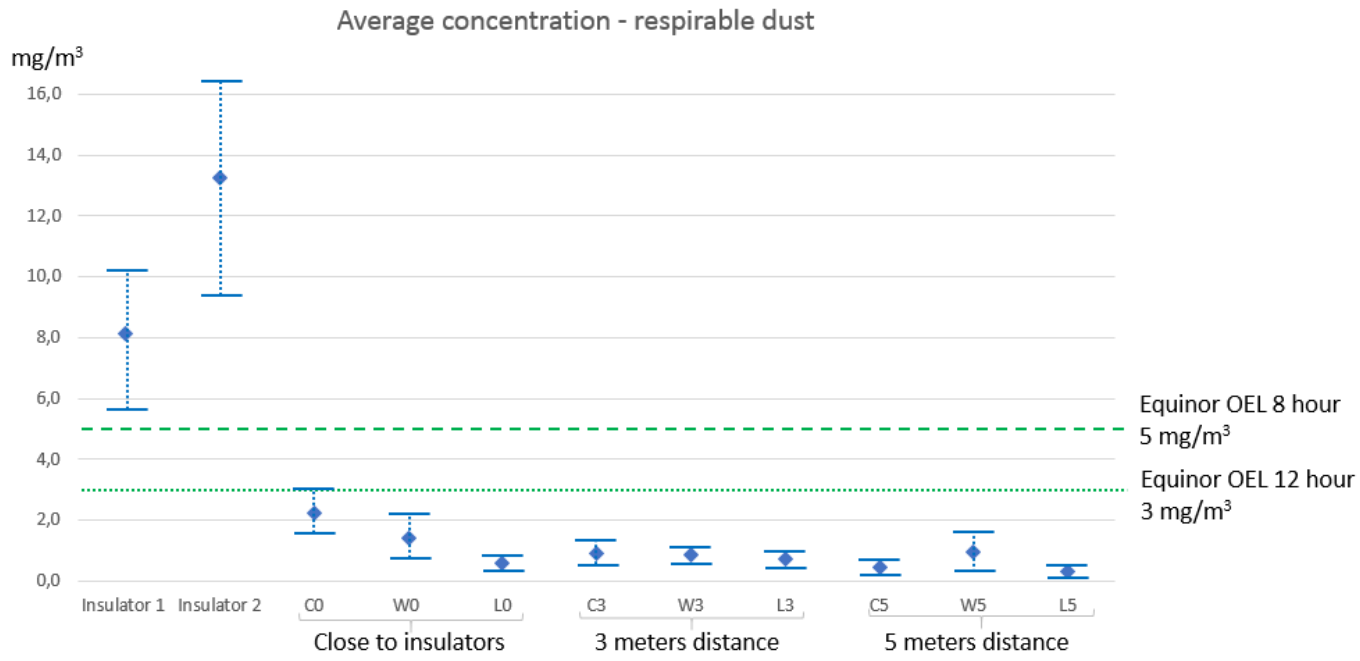


Figure 37: Average concentrations – Respirable dust

10.3 Summary of results – scaffolders

Figure 38 gives the total dust concentration for the personal sampling of four scaffolders during test day 5, and the stationary sampling along the wall of the rub hall. Equinor OEL for 8 hours (10 mg/m^3) and 12 hours (6 mg/m^3) is indicated.

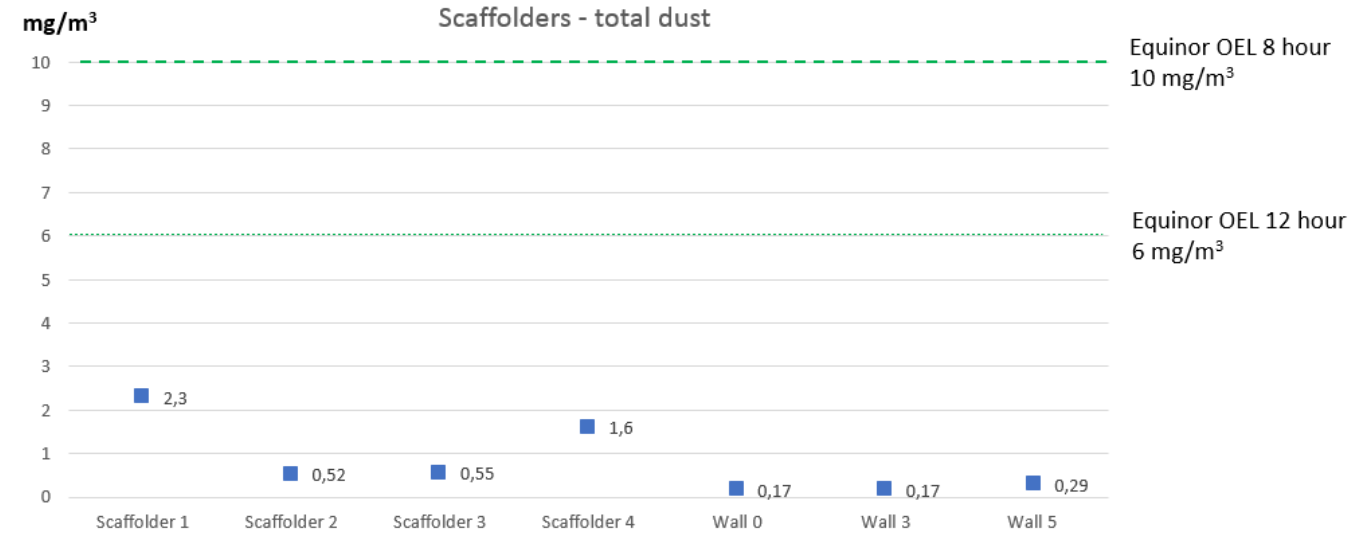


Figure 38: Total dust – scaffolders and stationary sampling along wall

Figure 39 gives the respirable dust concentration for the personal sampling of four scaffolders during test day 5, and the stationary sampling along the wall of the rub hall. Equinor OEL for 8 hours (5 mg/m³) and 12 hours (3 mg/m³) is indicated.

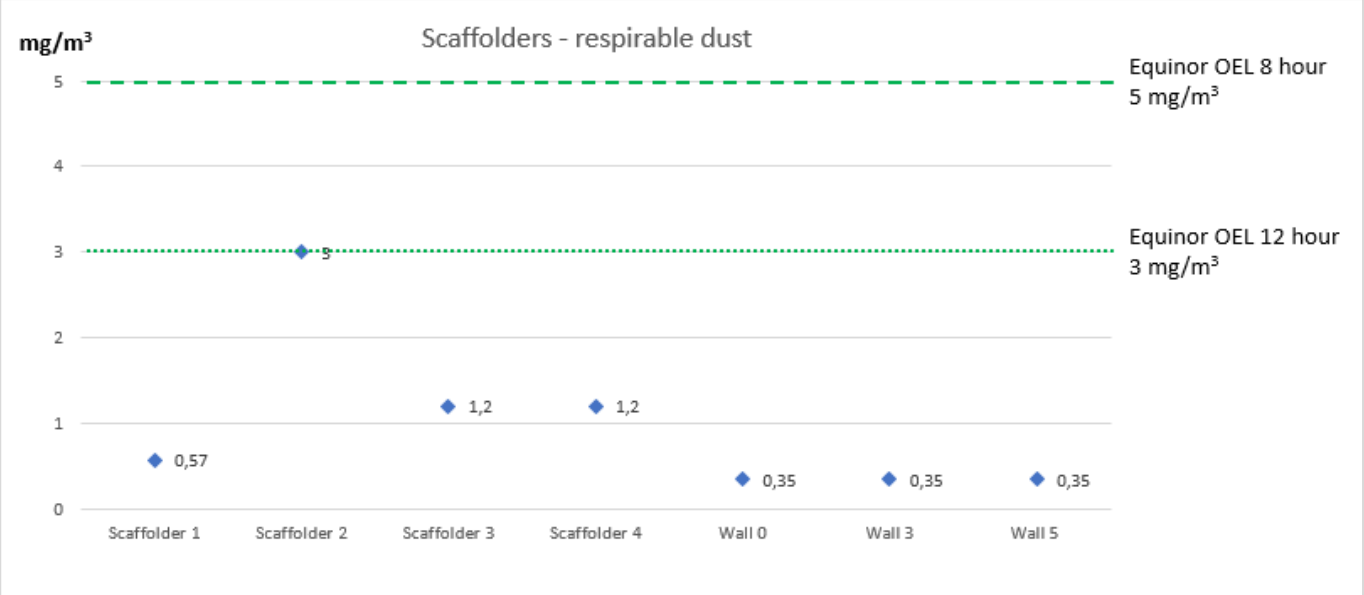


Figure 39: Total dust – scaffolders and stationary sampling along wall

10.4 Total dust

Table 3: Total dust sampled during insulation

	Insulator1 mg/m³	**Insulator2** mg/m³	**W0** mg/m³	**W3** mg/m³	**W5** mg/m³	**C0** mg/m³	**C3** mg/m³	**C5** mg/m³	**L0** mg/m³	**L3** mg/m³	**L5** mg/m³
Dec 10	32	39	3.3	0.8	0.9	5.5	2.4	1.4	1.1	0.8	0.5
Dec 11	20	22	3,5	0.9	1,0	3.6	1.4	0.9	1.0	*	*
Dec 12	20	29	2.7	0.5	0.3	2.4	1.2	*	*	0.6	*
Dec 13	8	18	**	0.2	0.3	1.5	0.3	*	*	*	*
Average	20	27	3.2	0.6	0.6	3.3	1.3	1.2	1.0	0.7	-
STD	10	9	0.4	0.3	0.4	1.7	0.9	0.4	0.1	0.1	-
Average	24										
STD	10										

*: No data. The pump at this location replaced a failing pump at a sampling site with higher priority (see chapter 6.3)

**: No data. When the pump failed, there was no available pumps to replace it.

Table 4: Total dust sampled during demounting of scaffolding

	Scaffolder1 mg/m³	**Scaffolder2** mg/m³	**Scaffolder3** mg/m³	**Scaffolder4** mg/m³	**Wall 0** mg/m³	**Wall 3** mg/m³	**Wall 5** mg/m³
Dec 14	2.3	0.5	0.6	1.6	0.17	<0.17	0.29

The raw data for these tables are given in appendix 5 Laboratory report - total dust and respirable dust.

10.5 Respirable dust

Table 5: Respirable dust sampled during insulation

	Insulator1 mg/m³	**Insulator2** mg/m³	**W0** mg/m³	**W3** mg/m³	**W5** mg/m³	**C0** mg/m³	**C3** mg/m³	**C5** mg/m³	**L0** mg/m³	**L3** mg/m³	**L5** mg/m³
Dec 10	9	12	1.2	0.7	0.6	3.4	1.6	0.7	0.4	0.6	0.5
Dec 11	7	11	1.6	0.9	0.7	2.4	0.8	0.1	1.0	0.7	*
Dec 12	6	11	0.4	7.9**	2.0	1.4	0.6	0.4	0.4	1.0	0.2
Dec 13	11	19	2.5	1.0	0.5	1.7	0.7	0.6	0.6	0.5	0.3
Average	8	13	1.4	0.9	0.9	2.2	0.9	0.4	0.6	0.7	0.3
STD	2	4	0.9	0.2	0.7	0.9	0.5	0.2	0.2	0.2	0.1
Average	11										
STD	4										

*: No data. The pump at this location replaced a failing pump at a sampling site with higher priority (see chapter 6.3)

**: Test data discarded. Evaluated to be highly unlikely (the total dust level sampled at the same time was 0.5; the value is tenfold higher than the other parallels for W3)

Table 6: Respirable dust sampled during demounting of scaffolding

	Scaffolder1 mg/m³	**Scaffolder2** mg/m³	**Scaffolder3** mg/m³	**Scaffolder4** mg/m³	**Wall 0** mg/m³	**Wall 3** mg/m³	**Wall 5** mg/m³
Dec 14	0.6	3.0	1.2	1.2	<0.35	<0.35	<0.35

The raw data for these tables are given in appendix 5 Laboratory report - total dust and respirable dust.

10.6 Fibre

A limited number of fibre sampling was included in the test program (4 samples). This was for additional information of the quality of the dust, i.e. the content of fibres. The laboratory report from the fibre sampling is given in appendix 6 Laboratory report – fibre counting. It was not detected fibre in the first three samples, and the concentration was 0.005 fibre/ml in the fourth sample. The Norwegian occupational exposure limit is 1 fibre/cm³ (1 cm³ = 1 ml) for MMMF/synthetic mineral fibre.

10.7 Direct reading instrument – counting in weight classes

The sampling result from the direct reading instrument DustTrak DRX is given in Figure 40 for total dust and in Figure 41 for the respirable dust fraction. This instrument was used for personal sampling of insulator 2. The test results are from test day 2.

The concentration levels varies a lot during the sampling period.

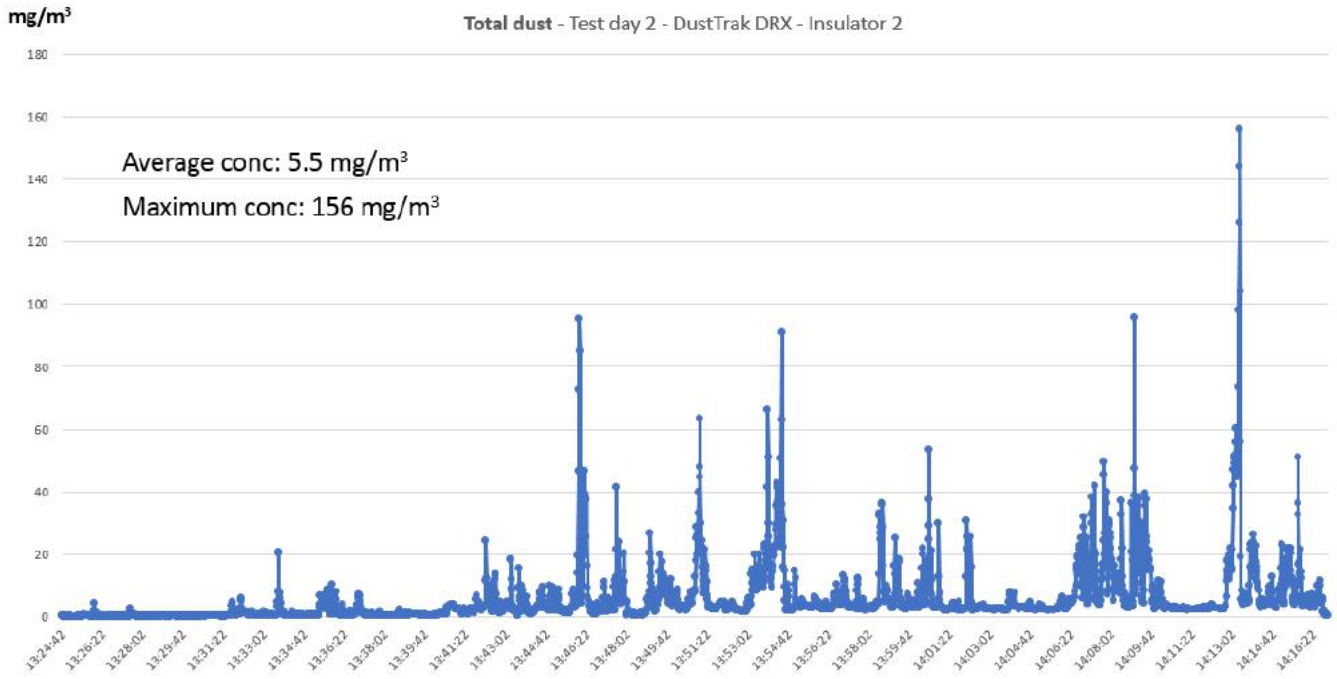


Figure 40: Total dust – variation in concentration during sampling period with direct reading instrument

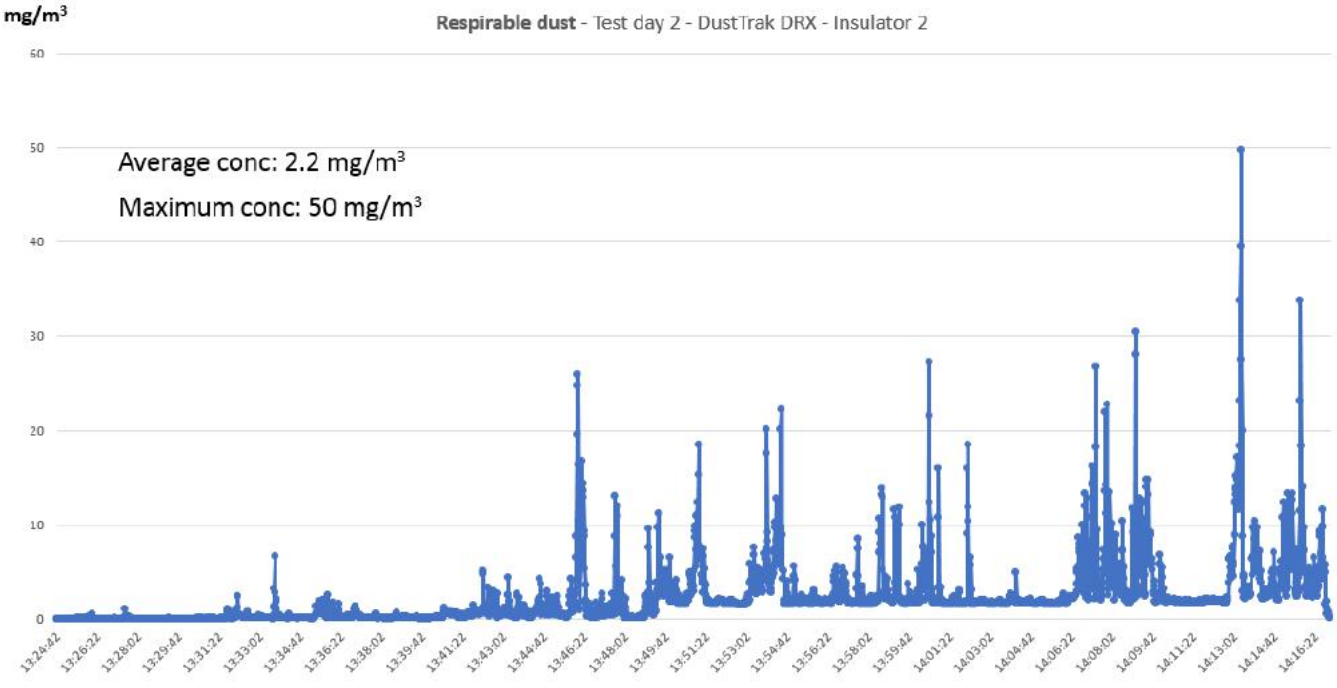


Figure 41: Respirable dust – variation in concentration during sampling period with direct reading instrument

Figure 42 show the respirable dust results from the DustTrak DRX instrument sampling in the breathing zone of insulator 2. It can be seen that the dust level varies when the insulator performs the demounting of insulation. During vacuuming, there is less peaks and in general lower concentration levels compared to demounting.

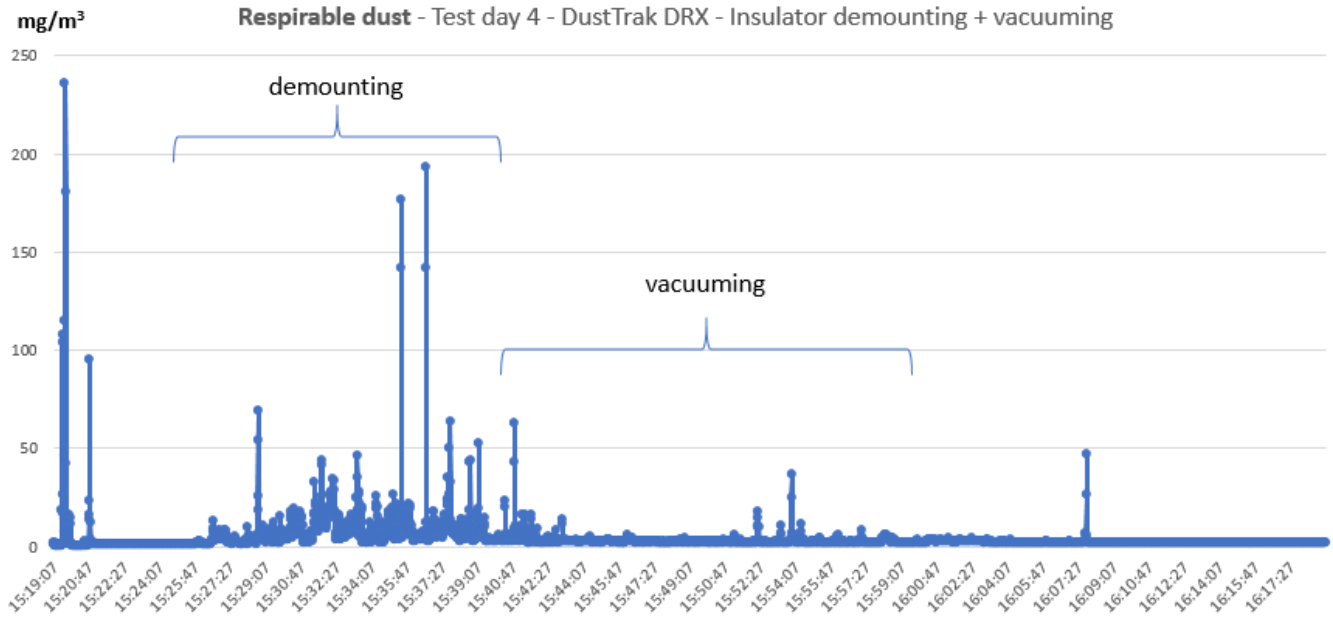


Figure 42: Respirable dust – variation in concentration when insulator 2 is demounting and vacuuming

Figure 43 show the respirable dust results from the stationary DustTrak DRX instrument located at approximately 3 meter distance from where the mounting of insulation took place. Although the values of dust concentration cannot be used directly, the figure show that the counted particles in the air represents low concentration (notice the scale on the y-axis).

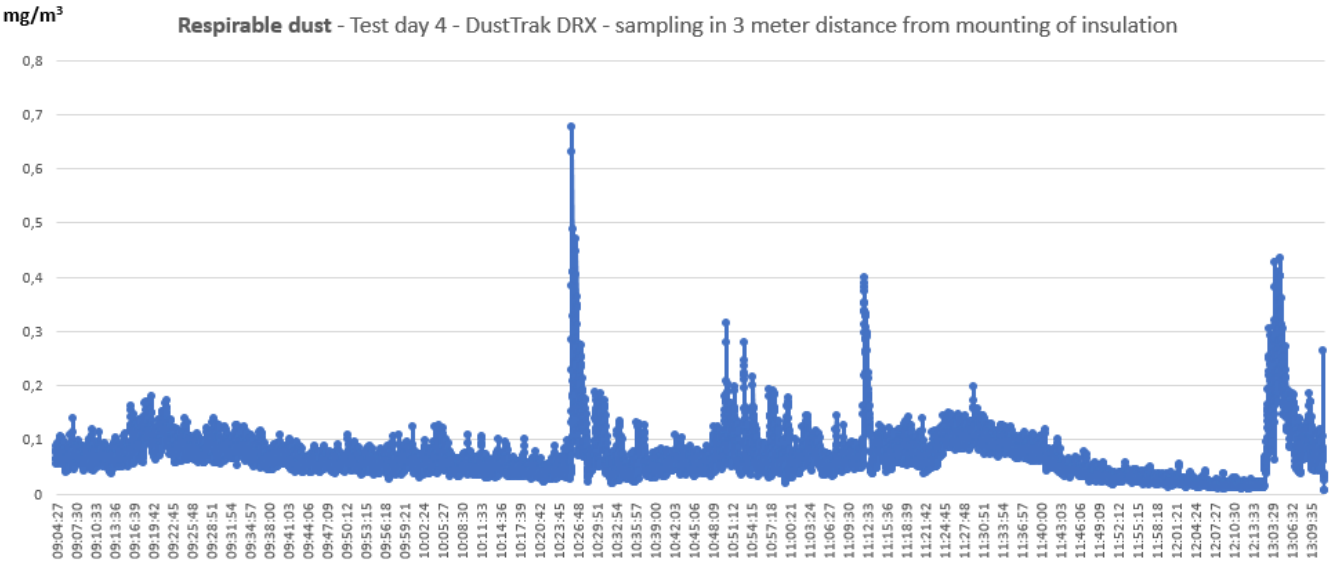


Figure 43: Respirable dust – variation in concentration during stationary sampling in 3 meter distance of insulation

10.8 Direct reading instrument – counting in number

The PTrak instrument did not work well for counting Pyrogel dust particles in the air. In an office or outdoor environment, the instrument gave adequate readings. There it could clearly be seen how the instrument counted significant more number of particles when stamping on carpeting floor (indoor) or when a car passed by (outdoor). However, when used in the test hall to count the variation in particle numbers for Pyrogel XT-E, the instrument failed. This was seen when putting the instrument probe in a dust cloud and there was no response in the particle number counted. Based on this, the PTrak instrument was not applied in the sampling.

10.9 Climate measurements

During the five test days, the temperature, relative humidity and air velocity were measured, and the values are given in Table 7.

Table 7: Temperature, relative humidity and air velocity at sampling dates

Date	Time	Temperature (ºC)	Relative humidity (%)	Velocity (m/s)
Dec 10, 2018	5:15 pm	6.3	85	0.04
Dec 11, 2018	10:30 am	2.8	85	0.04
	4:00 am	2.4	85	0.09
Dec 12, 2018	11:02 am	1.4	81	0.01
	3:23 pm	4.3	78	0.00
Dec 13, 2018	9:46 am	0.7	79	0.00
	4:23 pm	1.4	76	0.09
Dec 14, 2018	9:41 am	-0.6	66	0.08

10.10 Other findings

10.10.1 Dust settled on surfaces

During mounting and demounting of insulation, it was clearly seen that the Pyrogel XT-E dust settled on surfaces within the work area. This dust was distinctive with its pink colour. Examples of settled dust are shown in Figure 44 and 45.

Figure 44: Settled dust on horizontal surface

Figure 45: Settled dust on curved surface

After end of work day, settled dust was also found on the insulators. Figure 46 shows the settled dust on the respiratory helmet.

Figure 46: Settled dust on respirator helmet after end of work day

10.10.2 Moisture settled inside ceiling

There was observed droplets of water inside the ceiling of the rub hall. These droplets occasionally fell down on scaffolding and lower level.

Figure 47: Droplets inside ceiling

10.11 Overview of work performed during the different test days

10.11.1 Test day 1 - Insulation

Table 8: Description of work performed December 10, 2018

Time	What	Comment
	Preparation	
	Information meeting with participants	
3:15 pm	Test start	
3:15 pm	Mounting of insulation large test rig and 2/3 of small test rig	
6:20 pm	End of insulation and start of vacuuming	
6:35 pm	End of test	Total sampling time: 205 minutes
		Significant wind outside rub hall (weather forecast “yr.no” 14-15 m/s). The entrance into the hall, the gateway, was in close position most of the sampling period.

Note: the Pyrogel XT-E insulation delivered for this test did not have the custom-made quality that is required for a true insulation work. According to the insulators, if this had been a real insulation job they would have complained and returned the material since it would not be in accordance with the quality requirement of the insulation work. However, for this test it was the dust generation during work that was of interest, not the quality of the final insulation. As a consequence of not being of custom-made quality, there might be some additional adjustment of the insulation pieces at site that normally would not take place.

10.11.2 Test day 2 - Insulation

Table 9: Description of work performed December 11, 2018

Time	What	Comment
9:10 am	Test start	
9:12 am	Demounting of insulation starts	Regular method. Work in pair some part, work alone some part.
9:29 am	Demounting ends	
9:32 am	Vacuuming starts	Vacuumed tarpaulin floor and test rig structure.
9:38 am	Vacuuming ends	
9:38 am	Mounting of insulation on both test rigs	Mounting on bend before lunch, then the other parts.
4:22 pm	Demounting of insulation starts	Regular method. Work in pair some part, work alone some part.
4:47 pm	Demounting ends	
4:47 pm	Vacuuming starts	Vacuumed tarpaulin floor and test rig structure.
4:55 pm	Vacuuming ends	

4:55 pm	End of test	Total sampling time: 465 minutes
		Hardly any wind outside. The entrance into the hall, the gateway, was half open most of the sampling period.

10.11.3 Test day 3 - Insulation

Table 10: Description of work performed December 12, 2018

Time	What	Comment
9:50 am	Test start	
10:12 am	Mounting of insulation on both test rigs	Regular method. Work in pair some part, work alone some part.
3:38 pm	Demounting of insulation starts	Gentle method as instructed by Equinor. Work in pair, embrace insulation to avoid pop out when the tape is removed. Put the removed material immediately in a bag.
3:57 pm	Demounting ends	Demounting of small test rig 3:52 - 3:57
3:59 pm	Vacuuming starts	Vacuumed tarpaulin floor and test rig structure.
4:05 pm	Vacuuming ends	
4:55 pm	End of test	Total sampling time: 375 minutes
		There is visual humidity in the ceiling (small droplets inside), droplets fall to the floor occasionally. Hardly any wind outside. The entrance into the hall, the gateway, was half open most of the sampling period.

10.11.4 Test day 4 - Insulation

Table 11: Description of work performed December 13, 2018

Time	What	Comment
8:50 am	Test start	
8:50 am	Mounting of insulation on both test rigs	This was the last day of the insulation work. There was less insulation material available, thus, a more extensive use of the cutting tent and transport from cutting tent to the work area. The first transport was performed without using a closed bag. The deviation was observed, notice given, and the subsequent transport was in line with the procedure, i.e. transport in closed bag.
3:20 pm	Demounting of insulation starts	Regular method. Work in pair some part, work alone some part.

3:38 pm	Demounting ends	
3:40 pm	Vacuuming starts. The other operator cleans the area for tools and utilities, including folding the tarpaulin.	Vacuumed tarpaulin floor and test rig structure. End of test, more extensive vacuuming than previous. Vacuuming also include cutting tent. Waste handling.
4:05 pm	Vacuuming and waste handling ends	
4:05 pm	End of test	Total sampling time: 435 minutes
		There is visual humidity in the ceiling (small droplets inside), droplets fall to the floor occasionally. Hardly any wind outside. The entrance into the hall, the gateway, was half open most of the sampling period.

10.11.5 Test day 5 – Scaffolding

Table 12: Description of work performed December 14, 2018

Time	What	Comment
7:50 am	Test start	
8:50 am	Removal of entrance sluice to rub hall, outer part of scaffolding, ceiling mounting, adjustment of test rigs to prepare for lifting, truck lifting and transport of two test rigs (start 9:40, end 10:13), removal of inner part of scaffolding, cleaning.	No breaks in this removal process. Two of the scaffolders had climbing harness, two of them only work on ground level. Dust cloud could be seen when the scaffolding floor elements on the work floor were demounted. The floor elements were rotated 180^{o} and dropped on the neighbor element, dust source in cavities at the bottom side.
10:30 am	End of test	Total sampling time: 160 minutes
		Hardly any wind outside. The entrance into the hall, the gateway, was fully open during the sampling period.

11 Discussion

11.1 Suitability of the chosen strategy

11.1.1 Validity of the test results

The samplings performed in this test program show the exposure level of dust during performance of mounting and demounting of insulation in an area with good access and shielded from the outside weather. Due to the available space it was possible to include sampling at different distances and vertical levels. The extent of pumps and sampling instrumentation is very high compared to a “normal” sampling to verify concentration level and check towards occupational exposure limits. Thus, the facilities in the rub hall enable an enhanced test program and simulation of adjacent personnel working at various distances from the insulation work.

To simulate a real work situation as close as possible, the work procedure applied was given by the insulation company itself. Further, the insulators were asked to perform the work in a speed and sequence as for a regular work, including breaks and lunch. The insulators were regularly asked to confirm that this was the case during the four test days. Equinor was also present with insulation expertise that supervised that the insulation procedures were followed and gave feedback if any deviation was seen. Feedback from the insulators was that the work area was larger and with better access than what they usually had, and work intensity and procedure more or less the same as for a regular day. Carrying the sampling equipment, the sack with the particle counter, were unfamiliar, but the good accessibility compensated this minor inconvenience.

As far as we could check, the mounting and demounting of insulation performed in this test program is representative for work performed in an area with good accessibility and shielded from wind and precipitation.

11.1.2 Total dust and respirable dust levels

The results from the laboratory, i.e. weight of filters divided with the known volume of air pumped through them, were decoded with the sampling protocol giving the location of each filter. It was not possible to see a specific trend for the four test days with respect to dust concentration and the work performed. We had a hypothesis that test day 2 that included two times demounting and one-time mounting would result in the highest concentrations, and test day 3 with mounting + demounting in a gentle way would give the lowest concentration, but this was not the case. It was the first test day, the day with the shortest sampling time and only one mounting taking place that gave the highest concentrations. When comparing the results from insulator 1 and insulator 2, we saw that insulator 2 had higher concentration levels for all the test days, both for total dust and respirable dust. This might be due to between-worker differences in work performance. It also can be a result of some minor differences in work tasks: insulator 1 covered the work perform in the cutting tent and transport in addition to mounting and demounting of insulation, while insulator 2 mainly performed mounting and demounting work. It is not possible to conclude the reason for the differences based on these few observations. Based on this we treated all the four test days as representatives for insulation work days and found the average and the standard deviation for each of the two insulators, and the average and standard deviation when combining the results from insulator 1 and insulator 2.

The results from the stationary filter samplings were treated the same way, i.e. the average of the results and the standard deviation. However, for these the standard deviation was significantly lower than for the personal sampling.

11.1.3 Fibre counting

The laboratory report for the four fibre samples gave results 0 for three of the samples and a low value, 0.005 fibres/cm^3, for the fourth sample. This indicate that the fibre fraction in the generated dust from Pyrogel XT-E is negligible. This confirms that it is correct to categorize the generated dust from Pyrogel XT-E as “irritating dust”, and not as fibres.

11.1.4 Comparing with Equinor OEL

In this report we have included the Equinor OELs both for an 8 hour work day and for a 12 hour work day. When comparing the results, the 12 hours limits have been used. This is due to that the planned work days for insulation work in the Dvalin project is a 12-hour schedule. By including the 8-hour limit also in the most important figures, the results can be interpreted towards this limit for readers interested in another schedule than Dvalin’s.

11.1.5 Direct reading instruments for particles

The DustTrak DRX instrument can provide information of value for the sampling. Although the concentration level cannot be used directly from this instrument since the instrument is calibrated towards a standard dust (Arizona road dust) and not Pyrogel dust, it provides information of variation in dust concentration along the sampling. The reading from the instrument show that the dust concentration in the breathing air zone of the insulators is not constant. As can be seen from Figure 40 and 41, the dust concentration varies between peaks of variable height and periods of low concentration, typically reflecting the activities the insulators perform. This variation is not possible to see if only using the filter and pump method. After end of test day 3 the internal filter in both the DustTrak DRX instruments used for personal sampling had a considerable amount of Pyrogel dust (characteristic pink colour) inside. The filters were replaced with new filters. This finding confirms the considerable presence of Pyrogel dust in the sampling atmosphere, and that it is a tough environment for the direct reading instrument to operate in.

The PTrak instrument was not suitable for this sampling of Pyrogel dust as described in chapter 9.8. A reason for failing might be that the operation principle for the instrument, i.e. coating each particle with isopropanol to make them grow and then read the particle with a laser beam, was not suitable for the hydrophobic Pyrogel dust.

11.2 Insulators

The concentration of dust in the breathing zone of the insulators (outside the respirator), both for total dust and respirable dust, are several times the Equinor OEL for 12-hour work days. This is given in Figure 36 (total dust) and Figure 37 (respirable). Indication of how the dust concentration varies during the sample time are exemplified in Figure 40-42, i.e. there is peak exposure that might be considerably above the OEL for short periods. Risk reducing measures are mandatory to ensure a safe working environment for the insulators. The results confirm that the protection regime used by the insulators during the test, i.e. fan-assisted respirator with P3 filter, disposable coverall and gloves, are needed to ensure exposure control of Pyrogel XT-E. Principles and qualities of respiratory protection is given in appendix 7. This level of protection is needed both when mounting and demounting insulation, as well as cutting the material (cutting tent) and during cleaning and vacuuming of the work area. The experience from the test was that the two P3 filters in the fan-assisted respirator typically needs replacement after each work day.

In general, it is possible to reduce the amount of dust generated through adjusting the work procedures, i.e. gentle handling of the insulation material and vacuuming settled dust regularly. This will decrease the dust level in general for the area and have a positive impact for adjacent personnel. For the insulators working with Pyrogel in this test, the concentration level of dust is so high above the OEL that we do not see that it is possible to reduce the dust generation below the OEL with work procedure only. As long as the insulators work with Pyrogel XT-E, the given PPE regime needs to be followed.

11.3 Adjacent personnel

The aim of the stationary sampling in the test program was to simulate exposure to adjacent personnel at different distances and levels. However, being stationary means that they do not copy a real person in its movement and work performance. Thus, the assessment of the results for the stationary sampling needs to be a bit more conservative in its conclusion.

11.3.1 Within insulator work zone

The stationary sampling within the work zone, W0, had results significantly lower than the personal sampling of the insulators performing the work in this zone. This is not surprisingly since a personal sampling will follow the worker around and being present at all work situation, while the stationary sampling will only collect the dust at the specific point where the filter is located. The W0 results being significantly lower that the high dust concentration seen for the personal sampling in this area, does not mean that other personnel can work in this zone without the same PPE as the insulators. They have to be protected with the same PPE regime. For short work in the insulation zone lasting less than 30 minutes, a mask with P3 filter will be sufficient for exposure control (for example for inspections and insulation quality check).

11.3.2 Horizontally

Moving 3 meter away horizontally from the insulation zone to W3 reduced the dust concentration to a level below the OEL, and further away to a distance of 5 meter (W5) slightly reduced the concentration level. In this free field test area, the 3-meter distance seems to be sufficient for reducing the respirator regime from fan-assisted respirator to a mask with P3 filter (principles and details for mask given in appendix 7). However, if the surrounding environment is more condensed (structures), is influenced by air velocity in a way that can concentrate the dust, or have considerable lower volume, this protection might be insufficient. Further, if the number of insulators performing work in the work zone is higher (>2), the generation of dust in the area will increase. If this is the case, adjacent personnel needs the same protection regime as the insulators, i.e. fan-assisted respirator. This kind of assessment needs to be done site specifically. If in doubt, choose the best protection regime, fan-assisted respirator. Since the performed sampling in the test program ended at 5-meter distance, it is not possible to conclude precisely what the concentration of dust in the air might be at longer distances. The concentration will indeed decrease with the distance, but how far away it is safe with respect to no need of respiratory protection, cannot be concluded based on these test results.

11.3.3 Level above

Directly above the insulation work zone, the stationary sampling gave values at the OEL level. As long as there is no barrier between the insulation work area and adjacent personnel working above, the adjacent personnel need protection towards Pyrogel exposure. Directly above in a 3-5 meter distance, they need the same PPE regime as the insulators, fan-assisted respirators. If a barrier (tarpaulin) is included above the insulators, the adjacent workers directly above can reduce the respiratory protection to mask with P3 filter to control the exposure risk. Since the performed sampling in the test program ended at 5-meter distance, it is not possible to conclude precisely what the concentration of dust in the air might be at longer distances. See the recommendation given in 11.3.2. If the local structure or dust generation is of such nature that considerably Pyrogel dust might be concentrated and spread to the vicinity areas (for example: air velocity, more than two insulators working in the work zone), ensure that fan-assisted respirators are used by exposed personnel.

11.3.4 Level below

Directly below the insulation work zone, L0, the stationary sampling gave low concentration values compared with the OEL. This is due to the tarpaulin on the work floor acting as a physical barrier for the level below. As long as the tarpaulin is acting as a barrier, i.e. sufficient overlap between the individual pieces and no perforations, it is possible for adjacent personnel to work below with mask with P3 filter as respiratory protection. If there is no acting barrier between the work zone and the level below, there is a need for fan assisted respirators for adjacent personnel in this area as well. In 3-5-

meter distance (L3-L5) mask with P3 filter is recommended for all workers. Since the performed sampling in the test program ended at 5-meter distance, it is not possible to conclude precisely what the concentration of dust in the air might be at longer distances. See the recommendation given in 11.3.2. If the local structure or dust generation is of such nature that considerably Pyrogel dust might be concentrated and spread to the vicinity areas (for example: air velocity, structure cavities filled with dust), ensure that fan-assisted respirators are used by exposed personnel.

11.4 People passing by

Based on the test results from the stationary sampling, there is no indication that the personnel passing by the insulation area for transport purposes are exposed at a level of concern. Transport inside the insulation work zone should be avoided by blocking with cordons. If transport through is needed, the person should be wearing mask with P3 filter for respiratory protection. Outside the insulation zone transport can happen without dedicated PPE to control for Pyrogel exposure.

11.5 Scaffolders

Scaffolders that are removing scaffolding that has been used for Pyrogel XT-E insulation, can be exposed to Pyrogel XT-E. The personal sampling results from the four scaffolders gave result in the range 0.5 – 2.3 mg/m^3 for total dust and in the range 0.6 – 3.0 mg/m^3 for respirable dust. It is recommended that the scaffolding is cleaned by vacuuming prior to the demounting. Since it is not possible to fully clean the scaffolding from Pyrogel dust, i.e. there will be dust settled in cavities in structure, it is recommended to use a mask with P3 filter when demounting (see appendix 7 for details). When using the mask with P3 filter, the period for demounting of Pyrogel scaffolding should be restricted to half a shift. This is due to limited number of samples included in this test and a conservative approach that there may be more settled dust in a real scaffolding demounting situation. If it is not possible with time restriction, the respiratory protection should be improved to a better quality: fan-assisted. It is also recommended that scaffolders use disposable coveralls and gloves during demounting. Figure 46 show how the bottom part of the scaffolding floor element is turned 180^o during demounting, stirring up dust in cavities that vacuuming is not able to reach. It is assumed that Pyrogel dust leftovers in the scaffolding structure will be released during the demounting process and settle on the floor or surfaces in the removal area. Thus, vacuuming floor and structures after scaffolding removal is recommended. Such need can be based on visual inspection on site.

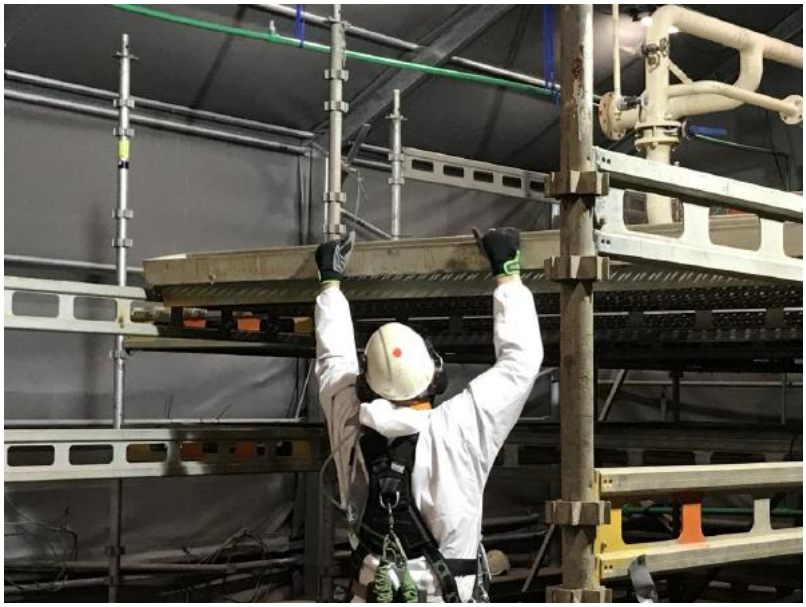


Figure 46: Scaffolder demounting floor, turning elements 180^o

11.6 Results from other studies

Equinor is aware that there has been performed sampling of Pyrogel XT-E by other companies since 2011. The summary of their findings is listed here:

- International SOS 2016
  - Dust sampling of Bilfinger personnel in prefabrication hall, Kanalarmen, Stavanger
  - Personal sampling 2 operators (total + respirable dust), 2 stationary sampling points (respirable dust)
  - Sampling time 64-325 minutes
  - For Pyrogel XT-E, the average for the personal sampling of total dust: 0.25 mg/m^3
  - For Pyrogel XT-E, the average for the personal sampling of respirable dust: 0.27 mg/m^3
  - For Pyrogel XT-E, the stationary sampling of respirable dust was below detection limit < 0.04 mg/m^3

- Stamina 2016a
  - Dust sampling of Beerenberg personnel at Nyhamna plant, Shell
  - In scaffolding warehouse and cutting tent: 10 personal samplings
  - Scaffolders: 10 personal full shift samplings
  - Insulators: 12 samplings
  - Scaffolding warehouse, total dust average 0.6 mg/m^3, respirable average: 0.1 mg/m^3
  - Scaffolders, total dust average 0.9 mg/m^3, respirable average: 0.2 mg/m^3
  - Cutting tent, total dust average 1.2 mg/m^3, respirable average: 0.3 mg/m^3
  - Insulators, total dust average 52 mg/m^3, respirable average: 13.5 mg/m^3

- Stamina 2016b
  - Dust sampling of Kaefer personnel during mounting and demounting of Pyrogel XT-E
  - 4 samples, total dust and respirable dust
  - Sampling time ca 30 minutes
  - Pyrogel XT-E: total dust 11 mg/m^3, respirable 7.1 mg/m^3
  - Pyrogel XT-E with lamination (aluminium foil): total dust 2.0 mg/m^3, respirable 2.0 mg/m^3

- Kokstad 2011
  - Dust sampling of Beerenberg personnel in “jacket department” Kokstad, Bergen.
  - 3 series, 9 samples, sampling time 28-74 minutes
  - Total dust: 2.7 – 13 mg/m^3, average 7.4 mg/m^3
  - Respirable dust: 6.7 – 9.8 mg/m^3, average 7.8 mg/m^3
  - Stationary sampling: 0.8 – 4.1 mg/m^3, average 2.2 mg/m^3

It is not easy to compare sampling result from different work activities and environments. However, the personal sampling of insulators (Stamina 2016a, Kokstad 2011) show significant concentration levels above the OEL (total dust and respirable). This is in line with our findings for the insulators.

12 Conclusions

12.1 Insulators

The insulators working with Pyrogel XT-E are exposed to dust concentrations considerably exceeding the Equinor OEL, both for total dust (average 24 mg/m^3, STD 10, OEL_{12} 6 mg/m^3) and respirable dust (average 11 mg/m^3, STD 4, OEL_{12} 3 mg/m^3). In order to control the exposure risk for the insulators, a PPE regime with fan assisted respirator with P3 filter, disposable coverall, and gloves, are needed.

12.2 Adjacent personnel

The adjacent personnel can be exposed to Pyrogel XT-E if they are working close to the insulators. Specifically, directly above the insulators the dust concentration can be high (C0; total dust: average 3 mg/m^3, standard deviation 2; respirable: average 2 mg/m^3, standard deviation 1). If there is no physical barrier between the insulation work and adjacent workers above, the adjacent workers above need the same PPE regime as the insulators for sufficient control of Pyrogel exposure. If there is a physical barrier, the adjacent workers above can reduce the PPE to a mask with P3 filter. If the distance to the workers above is more than 5 meters, a local risk assessment should be done to decide if the work can be performed without respiratory protection.

If the adjacent personnel are working in a horizontal distance to the insulation work area, any work closer than 3 meters need the same PPE regime as the insulators (W0-W3). If they work for less than 30 minutes (inspections, quality control), a mask with P3 filter can be used. In 3-5-meter (W3-W5) distance, a mask with P3 filter is sufficient as respiratory protection. If the distance is more than 5 meters, a local risk assessment should be done to decide if the work can be performed without respiratory protection.

If adjacent personnel are working directly below the insulation work (L0), it is assumed that the tarpaulin on the insulation work floor will act as a physical barrier towards the area below. If this is the case, workers directly below the tarpaulin can use mask with P3 filter as respiratory protection. If there is no acting barrier between the work zone and the level directly below, the adjacent personnel in this area needs the same PPE as the insulators. Adjacent workers at a distance of 3-5 meters (L3-L5), need respiratory protection of type mask with P3 filter. If the distance is more than 5 meters, a local risk assessment should be done to decide if the work can be performed without respiratory protection.

Any transport inside the insulation work zone should be avoided by blocking with cordons. If transport through this zone is needed, the person should be wearing mask with P3 filter for respiratory protection. Outside the insulation zone transport can happen without dedicated PPE to control for Pyrogel exposure. This is restricted to passing through only, and do not include any stop for inspection or short work tasks.

12.3 Scaffolders

Scaffolders that are removing scaffolding that has been used for Pyrogel XT-E insulation, can be exposed to Pyrogel XT-E (Total dust: average 1.2 mg/m^3, standard deviation 0.9; respirable dust; average 1.5 mg/m^3, standard deviation 1.0).

Since it is not possible to fully clean the scaffolding from Pyrogel dust, i.e. there will be dust settled in cavities in structure, it is recommended to use a mask with P3 filter when demounting and restrict the period for such demounting to half a shift. If this is not possible and the demounting of scaffolding last for a full shift, a fan-assisted respirator is needed for the scaffolders. It is also recommended that scaffolders use disposable coveralls and gloves during demounting

12.4 Specific conditions

The conclusions in this chapter are funded on the results from dust sampling when two insulators were mounting and demounting Pyrogel XT-E insulation on structures in an area with good access and shielded from the outside weather. It was also high-ceilinged, enabling the dust to rise upwards. If the conditions vary considerably from this, e.g. higher density of insulators (more than two), more condensed area (more structures, lower volume), and high air velocity (wind), it is highly recommended to do a local risk assessment to ensure that the risk reducing measures are sufficient for safe work. This can typically be to:

- insert physical barriers as tarpaulin around the insulation work zone,
- cordon off larger areas around the insulation work zone,
- increase cleaning frequency (vacuuming),
- provide respirators of better quality (from mask with P3 filter to fan-assisted respirators),
- introduce work time restriction.

13 Recommendations for risk control

13.1 Local risk assessments

The recommendations for risk control in this chapter are based on the experience and results from the sampling performed in the rub hall with free field and good accessibility to the structure of insulation interest. We have generalised the results as wide as we can. However, local conditions for projects and at installations may vary considerably from our test site and conditions. Thus, we highly recommend performing local risk assessments, and to verify the suitability and/or efficiency of the resulting risk control regime.

13.2 Verifying sampling on site

It is recommended to perform sampling of dust, respirable dust in particular, during real insulation work, i.e. mounting and demounting at the work site. The aim is to supplement the test program results with more sampling data and built up more experience of the amount of Pyrogel dust spread to neighbouring areas. Thus, this verification sampling can be performed for a fixed period. Such sampling should include both insulators and adjacent personnel. Further, the sampling should be performed and reported by the expert for this: an occupational hygienist. When more sampling results are available, this will improve the knowledge base that further risk management is built on.

13.3 Insulators

The personal sampling results clearly show that the insulators are exposed to dust levels significantly above the occupational exposure limit. Risk reducing measures are needed in order to ensure safe work for the insulators when they are performing their work. Such risk reducing measures are:

Preparation:

- Precutted material
- Consider using rolled material
- Transportation in closed bags

On work site:

- Use tarpaulin on floor to avoid dust falling to lower level
- Consider using tarpaulin as a barrier in directions towards adjacent personnel
- Keep the Pyrogel material in packing until use

- Gentle handling
- Work in groups (2 and 2)
- Gently embrace around structure when mounting the material
- Gently fastening
- Removal of waste in closed bags
- Regular vacuuming (HEPA filter) of surfaces to avoid built up of settled dust

Personal protection equipment (PPE):

- Fan-assisted respirator with P3 filter
- Disposable coverall
- Gloves

13.4 Adjacent personnel

13.4.1 Risk reduction through distance and PPE

Personnel working in the neighbouring area of the insulators, adjacent personnel, are recommended to keep a distance of 3 meters to the insulation work place. The insulation work site should be cordon off to attain this distance. When moving away from the insulation work zone, the concentration decrease.

Adjacent workers that work directly above the insulator work zone (3-5 meter) needs the same respiratory protection as the insulators: fan-assisted respirator with P3 filter. If a barrier is in place towards the insulators, i.e. tarpaulin, the respirator can be reduced to a mask with P3 filter.

Adjacent workers in a distance of 3-5 meters horizontally or below the insulation work zone need to wear masks with P3 filter for respiratory protection. This is also the case for adjacent workers directly below the insulators.

Any use of tarpaulin as a barrier between insulation work area and adjacent personnel needs to be checked, i.e. sufficient overlap between tarpaulin sheets, no large perforation in the tarpaulin (look for perforations and holes).

For all use of masks for respiratory protection other than the fan-assisted respirator, it is recommended that this is founded on individual fit-testing. Guideline for performing individual fit testing is given in Equinor's GL0470 (based on the Norwegian oil and gas recommendation 133).

A visualization of the recommended respiratory protection regime is given in Figure 47. See appendix 7 for further details of principles and qualities of respiratory protection.

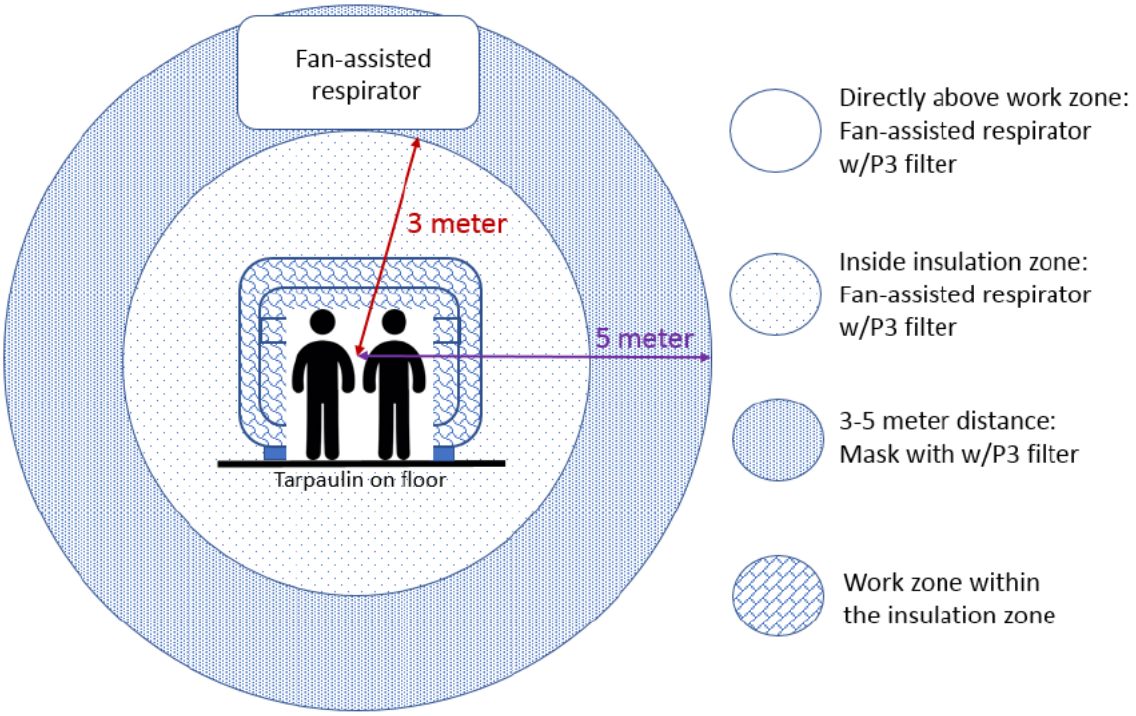


Figure 47: Visualization of recommended respirator protection

13.4.2 Risk reduction through barrier around insulation site

If a full barrier is in place around the insulators, i.e. a tent, the adjacent personnel do not need any additional PPE due to Pyrogel XT-E exposure. The quality of the tent with respect to act as a barrier towards the surroundings, need to be verified before making a decision not to wear PPE towards Pyrogel XT-E exposure for the adjacent personnel. Such verification can be to confirm that there are no sizeable openings (the tent need to have barriers on all sides, no continuously open entrance or large openings). Inside such a tent it is a high exposure zone, thus, personnel working there needs the same PPE regime as described for the insulators: fan-assisted respirator, disposable coveralls and gloves.

If only a partial barrier is possible, for example tarpaulins on some of the sides and openings in 1 or 2 directions, this is not sufficient as exposure control for adjacent personnel. Then a local risk assessment is needed to assess if a mask with P3 filter is a sufficient risk control or a fan assisted respirator is needed for the adjacent personnel.

13.5 Scaffolders

Scaffolders that work with demounting of scaffold where insulation with Pyrogel XT-E has been performed, can be exposed to Pyrogel XT-E in concentration levels at OEL. To control the exposure risk, they are recommended to use respiratory protection with half mask with P3 filter and restrict the work time to half a shift. If this is not possible, fan-assisted respirators are needed for full shift work. It is also recommended to use disposable coveralls.

For all use of masks for respiratory protection other than the fan-assisted respirator, it is recommended that this is founded on individual fit-testing. Guideline for performing individual fit testing is given in Equinor's GL0470 (based on the Norwegian oil and gas recommendation 133).

14 Abbreviations and definitions

ACGIH	American Conference of Governmental Industrial Hygienists
CUI	Corrosion Under Insulation
Insulation work area	The area (smaller than zone) where the insulators perform their work
Insulation work zone	The zone for insulation work cordon off for other than insulators
ISO	Insulation, Scaffolding and Surface (*O from Norwegian Overflate*)
Mask with P3 filter	A half mask or a full-face mask with a replaceable P3 filter. See appendix 7 for details
MCE	Mixed Cellulose Ester
MMMF	Man Made Mineral Fibres
OEL	Occupational Exposure Limit
PPE	Personal Protection Equipment
STD	STandard Deviation

15 Standards

NS-EN 481	Workplace atmospheres – Size fraction definitions for measurement of airborne particles, 1993
NS-EN 689	Workplace exposure – Measurement of exposure by inhalation of chemical agents – Strategy for testing compliance with occupational exposure limit values, 2018
TR0926	Working environment, Ver 6.01
TR1660	Piping and equipment insulation, Ver 6.01
GL0470	Fit testing of respiratory protective equipment
NOROG 133	Recommended guidelines for fit testing of respiratory protective equipment, 2013

16 References

Ref	Who	Title	Revision
1	The Norwegian Labour Inspection Authority	"Methods for sampling of pollutants in the work atmosphere" [In Norwegian only] *Metoder for måling av forurensninger i arbeidsatmosfæren*	https://www.arbeidstilsynet.no/tema/kjemikalier/metoder-for-maling-av-forurensninger-i-arbeidsatmosfaren/ Downloaded December 28, 2018
2	Lovdata	Regulations concerning action and limit values	https://lovdata.no/dokument/SFE/forskrift/2011-12-06-1358
3	The Norwegian Labour Inspection Authority	"Risk assessment and evaluation of exposure to chemical and biological pollutants" [In Norwegian only] *Kartlegging og vurdering av eksponering for kjemiske og biologiske forurensninger*	https://www.arbeidstilsynet.no/tema/kjemikalier/kartlegging-og-vurdering-av-eksponering-for-kjemiske-og-biologiske-forurensninger/
4	International SOS	Støvmålinger Prefab, Kanal-armen 8, utført for Bilfinger	Report 2016, sampling April 2016
5	Stamina Helse	Vurdering av støv- og fibereksponering ved isolering med Pyrogel XT-E. Beerenberg, Nyhamna.	Report 2016a, sampling September 2016
6	Stamina Helse	Vurdering av helsefare knyttet til eksponering for støv fra Pyrogel XT-E i Kaefer Energy AS	Report 2016b, sampling June – December 2015
7	Kokstad BHT	Rapport Beerenberg Kokstad støvmålinger	Report 2011, sampling performed November 2010

17 Appendices

Appendix 1 Safety data sheet Pyrogel XT-E 2016
Appendix 2 Safety data sheet Pyrogel XT-F 2016
Appendix 3 Calibration certificates
Dust-Trak DRX Model 8533 Desktop 1 and Desktop 2, and Model 8534 handheld
Appendix 4 Procedure for using Pyrogel [In Norwegian only] *Prosedyre for bruk av Pyrogel*
Appendix 5 Laboratory report - total dust and respirable dust [In Norwegian] *Rapport – totalstøv og respirabelt støv*
Appendix 6 Laboratory report – fibre counting [In Norwegian] *Rapport – fiber telling*
Appendix 7 Respiratory protection – principles and qualities

Appendices

Sikkerhetsdatablad

Pyrogel XT-E

Erstatter dato: 04.09.2013 Revisjonsdato: 29.02.2016

AVSNITT 1: Identifikasjon av stoffet/stoffblandingen og av selskapet/foretaket

1.1. Produktidentifikator

Handelsnavn: Pyrogel XT-E

Øvrig Informasjon: Krav om SDS: bortfaller Krav til sikkerhetsdatablad bortfaller fordi artikkelen er definert som et produkt i henhold til REACH.

1.2. Identifiserte relevante bruksområder for stoffet eller stoffblandingen og bruk som det advares mot

Anbefalte bruksområder: Isolasjon.

1.3. Opplysninger om leverandøren av sikkerhetsdatabladet

Leverandør

Firma: Benarx Solutions AS

Adresse: Postboks 273 Slåtthaug

Post nr.: 5851 BERGEN

Land: NORGE

E-post: waldemar.wergeland@beerenberg.com

Telefon: 55526600

1.4. Nødtelefonnummer

Giftsentralen: 22591300.

AVSNITT 2: Fareidentifikasjon

2.1. Klassifisering av stoffet eller stoffblandingen

CLP-klassifisering: Produktet skal ikke klassifiseres som farlig i henhold til regelverket for klassifisering og merking av stoffer og stoffblandinger.

2.2. Merkingselementer

Inneholder

Stoff: Silica gel, trimetylsilylert; Glassfiber; Jern(III)oksid; Aluminiumhydroksyd

Supplerende opplysninger

Vurdert ikke merkepliktig.

2.3. Andre farer

Ingen opplysninger.

AVSNITT 3: Sammensetning/opplysninger om bestanddeler

3.2. Stoffblandinger

Stoff	CAS Nr	EC-nummer	REACH-reg.nr.	Konsentrasjon	Merknader	CLP-klassifisering

Glassfiber				40 - 50%		
Silica gel, trimetylsilylert	68909-20-6	272-697-1		40 - 50%		
Aluminiumhydroksyd	21645-51-2	244-492-7		1 - 5%		
Jern(III)oksid	1309-37-1	215-168-2		1 - 5%		Aquatic Chronic 2;H411

Se fullstendige H-setninger under punkt 16.

AVSNITT 4: Førstehjelpstiltak

4.1. Beskrivelse av førstehjelpstiltak

Innånding: Flytt straks den eksponerte til frisk luft. Skyll nese og munn med vann. Kontakt lege hvis ikke alt ubehag gir seg.

Svelging: Ingen anbefaling angitt.

Hudkontakt: Vask huden grundig med såpe og vann. Fjern straks tilsølt tøy og vask grundig før det brukes igjen.

Kontakt med øyne: Skyll straks øynene med rikelig vann mens øyelokkene løftes. Kontakt lege hvis ubehaget vedvarer.

4.2. De viktigste symptomene og virkningene, både akutte og forsinkede

Hudirritasjon. Irritasjon i luftveiene. Øyeirritasjon.

4.3. Angivelse av om umiddelbar legehjelp og spesialbehandling er nødvendig

Ingen opplysninger.

AVSNITT 5: Brannslokkingstiltak

5.1. Slokkingsmidler

Egnede brannslokkingsmidler: Stoffet er ikke brennbart.

5.2. Særlige farer knyttet til stoffet eller stoffblandingen

Brann- og eksplosjonsfarer: Ikke relevant.
Farlige forbrenningsprodukter: Karbonmonoksid (CO). Karbondioksid (CO_2).

5.3. Råd til brannmannskaper

Bruk trykkluftmaske når produktet er involvert i brann.

AVSNITT 6: Tiltak ved utilsiktet utslipp

6.1. Personlige forsiktighetsregler, personlig verneutstyr og nødrutiner

For ikke-innsatspersonell: Ventiler godt. Unngå innånding av støv. Bruk nødvendig verneutstyr.

6.2. Forsiktighetsregler med hensyn til miljø

Bør ikke komme ned i avløp.

6.3. Metoder og materialer for oppsamling og rensing

Fjern mindre mengder søl med støvsuger.

Sikkerhetsdatablad

Pyrogel XT-E

6.4. Henvisning til andre avsnitt

Se § 7, 8 og 13.

AVSNITT 7: Håndtering og lagring

7.1. Forsiktighetsregler for sikker håndtering

Følg god kjemikaliehygiene. Bruk arbeidsmetoder som minimerer støvdannelse. Unngå innånding av støv. Unngå kontakt med huden og øynene. Vask hendene før pauser, før røyking og før inntak av mat og drikke.

7.2. Vilkår for sikker lagring, herunder eventuelle uforeneligheter

Oppbevares i godt lukket originalemballasje på et tørt, svalt og godt ventilert sted. Oppbevares adskilt fra: Syrer. Alkalier.

7.3. Særlig(e) sluttanvendelse(r)

Identifiserte bruksområder for dette produktet er beskrevet i punkt 1.2.

AVSNITT 8: Eksponeringskontroll/personbeskyttelse

8.1. Kontrollparametere

Yrkesmessig eksponeringsgrense

Stoffnavn	ppm	mg/m3	fiber/cm3	Bemerkninger	Anmerkninger
Glassfiber		5			
Jern(III)oksid (beregnet som Fe)		3		8 timer	
aluminiumløselige salter (beregnet som Al)		2		8t	

8.2. Eksponeringskontroll

Egnede tiltak for eksponeringskontroll:

Begrensning av eksponering på arbeidsplassen:
Sørg for god ventilasjon. Risikoen for innånding av støv skal gjøres minst mulig.

Spesifikke hygienetiltak:
Ta av tilsølte klær og vask huden grundig med såpe og vann når arbeidet er ferdig. Vask tilsølte arbeidsklær før de brukes igjen.

Personlig verneutstyr, beskyttelse av øyne/ansikt:

Bruk støvtette vernebriller ved risiko for støvdannelse.

Personlig verneutstyr, beskyttelse av hud:

Bruk beskyttelsesklær som dekker armer og ben.

Personlig verneutstyr, håndvern:

Bruk vernehansker av: Nitrilgummi. Naturgummi (lateks).

Personlig verneutstyr, åndedrettsvern:

Ved utilstrekkelig ventilasjon eller hvis det er fare for innånding av støv, må det brukes egnet åndedrettsvern med partikkelfilter (type P2).

AVSNITT 9: Fysiske og kjemiske egenskaper

Sikkerhetsdatablad

Pyrogel XT-E

Erstatter dato: 04.09.2013 Revisjonsdato: 29.02.2016

9.1. Opplysninger om grunnleggende fysiske og kjemiske egenskaper

Parameter	Verdi/enhet
Aggregattilstand	Tekstilmaterialer.
Farge	Rødbrun
Lukt	Ammoniakk
Løselighet	Løselighet i vann: Uløselig.
Eksplosive egenskaper	---
Oksidasjonsegenskaper	---

Parameter	Verdi/enhet	Anmerkninger
pH (bruksferdig oppløsning)	Ingen data	
pH (konsentrat)	Ingen data	
Smeltepunkt	Ingen data	
Frysepunkt	Ingen data	
Startkokepunkt og kokepunktintervall	Ingen data	
Flammepunkt	Ingen data	
Fordampningshastighet	Ingen data	
Antennelighet (fast stoff, gass)	Ingen data	
Antennelsesgrenser	Ingen data	
Eksplosjonsgrenser	Ingen data	
Damptrykk	Ingen data	
Damptetthet	Ingen data	
Relativ tetthet	Ingen data	
Fordelingskoeffisient n-oktanol/vann	Ingen data	
Selvantennelsestemperatur	Ingen data	
Nedbrytningstemperatur	Ingen data	
Viskositet	Ingen data	
Luktterskel	0,6 - 53 ppm	

9.2. Andre opplysninger

Øvrig Informasjon: Ingen opplysninger.

AVSNITT 10: Stabilitet og reaktivitet

10.1. Reaktivitet

Det er ingen kjent reaktivitetsrisiko forbundet med dette produktet.

10.2. Kjemisk stabilitet

Stabil under normale temperaturforhold og anbefalt bruk.

10.3. Mulighet for farlige reaksjoner

Ingen anbefaling angitt.

10.4. Forhold som skal unngås

Ekstreme temperaturer.

10.5. Uforenlige materialer

Sterke alkalier. Sterke syrer.

10.6. Farlige nedbrytingsprodukter

Ingen under normale forhold.

AVSNITT 11: Toksikologiske opplysninger

11.1. Opplysninger om toksikologiske virkninger

Forsøksdata

Toksikologisk informasjon

LD50 oral	Verdi: > 5000 mg/kg Kommentarer: Amorf Silica
LD50 oral	Verdi: > 10000 mg/kg Kommentarer: Jernoksid
LD50 oral	Verdi: > 2000 mg/kg Forsøksdyreart: Rotte Kommentarer: Aluminiymhydroksyd
LD50 dermal	Verdi: > 3000 mg/kg Kommentarer: Amorf Silica
LC50 innånding	Verdi: > 2000 mg/m3 Kommentarer: Amorf Silica
LC50 innånding	Verdi: > 210 mg/m3 Kommentarer: Jernoksid

Potensielle akutte effekter

Innånding	Høye konsentrasjoner av støv kan irritere luftveiene.
Hudkontakt	Langvarig eller gjentatt kontakt fører til uttørring.
Øyekontakt	Støv i øyene vil medføre irritasjon.
Svelging	Kan forårsake irritasjon i munn og hals.

AVSNITT 12: Økologiske opplysninger

12.1. Giftighet

Klassifiseres ikke som miljøskadelig.
Fisk: LC50 (Danio Rerio) >10,000 mg/l, 96h (Amorf Silica)
Fisk: LC50 (Salomo Trutta) >100 mg/l, 96h (Aluminiumhydroxyd)
Daphnia: EC50 (Daphnia Magna) > 10000 mg/ml, (Amorf Silica)
Daphnia: EC50 (Daphnia Magna) > 100 mg/ml (Jernoksid)
Mikroorganismer (Aktivert slam) >10000 mg/ml (Jernoksid)

12.2. Persistens og nedbrytbarhet

Ikke relevant.

12.3. Bioakkumuleringsevne

Bioakkumulasjon: Forventes ikke å være bioakkumulerende.

12.4. Mobilitet i jord

Produktet er uoppløselig i vann.

12.5. Resultater av PBT- og vPvB-vurdering

Ikke bestemt.

12.6. Andre skadevirkninger

Ingen opplysninger.

AVSNITT 13: Disponering

13.1. Avfallsbehandlingsmetoder

Produktet er klassifisert som farlig avfall: Nei

Avfallskategori: EAL: 170604 andre isolasjonsmaterialer enn dem nevnt i 17 06 01 og 17 06 03

AVSNITT 14: Transportopplysninger

14.1. FN-nummer: Ikke relevant.
14.2. FN-forsendelsesnavn: Ikke relevant.
14.3. Transportfareklasse(r): Ikke relevant.
14.4. Emballasjegrupper: Ikke relevant.
14.5. Miljøfarer: Ikke relevant.

14.6. Særlige forsiktighetsregler ved bruk

Ingen opplysninger.

14.7. Bulktransport i henhold til vedlegg II i MARPOL og IBC-regelverket

ikke relevant.

AVSNITT 15: Opplysninger om bestemmelser

15.1. Særlige bestemmelser/særskilt lovgivning om sikkerhet, helse og miljø for stoffet eller stoffblandingen

Spesielle hensyn: Lover og forskrifter:
Forskrift 2008 nr. 516. Forskrift om registrering, vurdering, godkjenning og begrensning av kjemikalier (REACH).
Forskrift om tiltaksverdier og grenseverdier for fysiske og kjemiske faktorer i arbeidsmiljøet samt smitterisikogrupper for biologiske faktorer.
Fastsatt 6. desember 2011 nr. 1358.

15.2. Vurdering av kjemikaliesikkerhet

Sikkerhetsdatablad

Pyrogel XT-E

Erstatter dato: 04.09.2013 Revisjonsdato: 29.02.2016

Øvrig Informasjon: Vurdering av kjemikaliesikkerhet er gjennomført: Nei

AVSNITT 16: Andre opplysninger

Referanser til litteratur og datakilder: Databladet er utarbeidet med basis i opplysninger gitt av produsenten.

Øvrig Informasjon: Versjon: 3.

Ansvarlig for Sikkerhetsdatablad: Benarx Solutions AS.

Leverandørmerknader: Opplysningene i dette sikkerhetsdatabladet er basert på opplysninger som var i vår besittelse på det tidspunkt sikkerhetsdatabladet ble utarbeidet, og er gitt under forutsetning av at produktet anvendes under de forhold som er angitt, og i samsvar med den anvendelsesmåte som er spesifisert på emballasjen eller i relevant teknisk litteratur. Ethver annen bruk av produktet, eventuelt i kombinasjon med andre produkter eller prosesser, skjer på brukerens eget ansvar.

Liste over relevante H-setninger

H411 Giftig, med langtidsvirkning, for liv i vann.

Dokumentspråk: NO

Sikkerhetsdatablad

Pyrogel® XTF

Revisjonsdato: 01.01.2016

AVSNITT 1: Identifikasjon av stoffet/stoffblandingen og av selskapet/foretaket

1.1. Produktidentifikator

Handelsnavn: Pyrogel® XTF

Synonymer: Silica aerogel-materialer

Øvrig Informasjon: HMS-datablad utarbeidet av: HMS.
Telefonnummer til klargjører: 508-691-1111.

1.2. Identifiserte relevante bruksområder for stoffet eller stoffblandingen og bruk som det advares mot

Anbefalte bruksområder: Høy-ytelses isolasjonsmateriale.

1.3. Opplysninger om leverandøren av sikkerhetsdatabladet

Leverandør

Firma: Aspen Aerogels A/S

Adresse: 30 Forbes Road

Post nr.: MA 01532 Northboroug

Land: USA

Telefon: +1 508 691 1111

1.4. Nødtelefonnummer

800-535-5053 fra USA og Canada
(INFOTRAC), +1 352 323 3500 internasjonalt

AVSNITT 2: Fareidentifikasjon

2.1. Klassifisering av stoffet eller stoffblandingen

CLP-klassifisering: Produktet skal ikke klassifiseres som farlig i henhold til regelverket for klassifisering og merking av stoffer og stoffblandinger.

Viktigste skadevirkninger: Klassifisering: Produktet er ikke klassifisert som et farlig materiale eller preparat i EU-direktivene 67/548/EEC og 1999/45/EC. Se avsnitt 11 for en full omtale av titandioksid.

Utseende og Lukt: Grått stoffmateriale uten karakteristisk lukt. Under visse forhold kan produktet ha en svak ammoniakk-lignende lukt.

Nødsituasjon Oversikt: Inhalering av store mengder støv fra produktet kan forårsake mekanisk irritasjon i luftveiene. Hudkontakt kan forårsake mekanisk irritasjon.

POTENSIELLE HELSEFARER:
Inhalering: Inhalering av svevestøv kan føre til mekanisk irritasjon i de øvre luftveiene.

Øyekontakt: Eksponering for støv fra dette produktet kan virke uttørrende og føre til mekanisk irritasjon i øynene.

Hudkontakt: Hudkontakt med støv fra dette produktet kan virke uttørrende og føre til mekanisk irritasjon på huden og i slimhinnene.

Hudabsorbering: Materialet vil ikke absorberes gjennom huden.

Svelging: Dette materialet er ikke ment å inntas (spises). Hvis inntatt i store mengder, kan materialet produsere mekanisk irritasjon og blokkering.

Akutte helsefarer Farer: Støv fra dette produktet er fysisk irriterende, og kan forårsake midlertidig irritasjon eller kløe i hals og/eller kløe og rødhet i øynene og på huden.

Kroniske helsefarer Faremomenter: I 2010 (basert på et arbeidsgruppemøte i 2006) omklassifiserte International Agency for Research on Cancer (IARC) titandioksid som «kan være kreftfremkallende for mennesker» (gruppe 2B), basert på et funn av karsinogenitet i forsøksdyr. I utkastet Titanium Dioxide Monografi (Vol. 93), konkluderte IARC med at det finnes utilstrekkelig med bevis i karsinogenitetstudiene på mennesker og at de «ikke antyder noen sammenheng mellom den yrkesmessige eksponeringen som fant sted i løpet av de siste tiårene i Vest-Europa og Nord-Amerika og økt risiko for kreft.» Se karsinogenitet for titandioksid. Se også avsnitt 11 for full omtale.

Medisinske forhold som forverres ved eksponering: Omfattende innånding av støv kan forverre allerede eksisterende kroniske lungelidelser, inkludert, men ikke begrenset til, bronkitt, emfysem og astma. Hudkontakt kan forverre eksisterende eksem.

AVSNITT 2 MERKNADER: Produktet er sammensatt av syntetisk amorft silikadioksid, ofte betegnet som silika gel eller utfelt, amorf silika. Amorf silika bør ikke forveksles med krystallinsk silika. Epidemiologiske studier antyder lav risiko for negative helseeffekter ved eksponering for amorf silika. Se avsnitt 11 for en full omtale av titandioksid.

KARSINOGENITET:

Titandioksid:
ACGIH: A4
NTP: Ikke oppført
IARC: 2B

Glassfiber (tekstilgrad):
ACGIH: A4
NTP: Ikke oppført
IARC: 3

Aluminiumtrihydrat:
ACGIH: Ikke oppført
NTP: Ikke oppført
IARC: Ingen

Amorf silika:
ACGIH: Ikke relevant
NTP: Ikke oppført
IARC: Ingen

2.2. Merkingselementer

Produktet skal ikke klassifiseres som farlig i henhold til regelverket for klassifisering og merking av stoffer og stoffblandinger.

2.3. Andre farer

AVSNITT 3: Sammensetning/opplysninger om bestanddeler

Sikkerhetsdatablad

Pyrogel® XTF

Revisjonsdato: 01.01.2016

3.2. Stoffblandinger

Stoff	CAS Nr	EC-nummer	REACH-reg.nr.	Konsentrasjon	Merknader	CLP-klassifisering
Methylsilylated silica	68909-20-6	272-697-1		40 - 55%		
Syntetiske, glassaktige fibre				40 - 50%		
Titandioksid	13463-67-7	236-675-5		4 - 6%		
Aluminiumtrihydratet	21645-51-2	244-492-7		0 - 5%		
Magnesiumhydroksid	1309-42-8	215-170-3		0 - 5%		
Proprietære pigmenter				< 1%		

Se fullstendige H-setninger under punkt 16.

Kommentar om bestanddel: Et produkt inneholder <1 % av et proprietært pigment hvorav elementets komponenter inkluderer jern og mangan.

AVSNITT 4: Førstehjelpstiltak

4.1. Beskrivelse av førstehjelpstiltak

Innånding: Gi frisk luft. Drikk vann for å rense halsen og puss nesen for å fjerne støv. Kontakt lege dersom plagene vedvarer.

Svelging: Materialet vil passere gjennom kroppen naturlig. Kontakt lege dersom det oppstår symptomer.

Hudkontakt: Skyll huden grundig med såpe og vann til den er ren. Såpen vil virke som et overflateaktivt middel for å fjerne materialet. Fjern kontaminerte klær og sko. Vask klærne før de brukes på nytt. Kontakt lege dersom det oppstår symptomer.

Kontakt med øyne: Skyll straks med store mengder vann i minst 15 minutter, mens lokkene løftes en gang i mellom.
Søk medisinsk behandling hvis det oppstår irritasjon som vedvarer.

4.2. De viktigste symptomene og virkningene, både akutte og forsinkede

4.3. Angivelse av om umiddelbar legehjelp og spesialbehandling er nødvendig

AVSNITT 5: Brannslokkingstiltak

5.1. Slokkingsmidler

Egnede brannslokkingsmidler: Bruk apparater egnet for omkringliggende brann og som passer til omgivelsene; normal påføring av vann med tåkedyse og/eller utelukkelse av luft med et teppe er vanligvis egnet for slukking av dette produktet ved påtennelse.

5.2. Særlige farer knyttet til stoffet eller stoffblandingen

5.3. Råd til brannmannskaper

Spesielle prosedyrer for brannslukkere:
Normale brannslukkingsprosedyrer bør følges for å unngå inhalering av røyk og gasser fra brannen.

Ualminnelig brann og eksplosjon Faremomenter:
Produktet er et ekstremt isolerende materiale. Ruller med materialet kan holde på varmen innenfor interne lag og antenne

brennbare materialer på nytt hvis varmen ikke fjernes.

Farlig dekomposisjon og/eller Forbrenningsprodukter:
De primære forbrenningsproduktene er karbonmonoksid og karbondioksid. Andre uvisse produkter kan frigis i små mengder.

Øvrig Informasjon:
Brennbart: Nei.
Temperatur for automatisk brennbarhet: Ikke relevant.
Flammepunkt: Ikke relevant.
Brennbarhetsgrenser (Nedre eksplosiv grense): Ikke relevant.
Brennbarhetsgrenser (Øvre eksplosiv grense): Ikke relevant.
Eksplosive data – sensitivitet til påvirkning: Ikke sensitiv.
Eksplosive data – sensitivitet til statisk utladning: Ikke sensitiv.

AVSNITT 6: Tiltak ved utilsiktet utslipp

6.1. Personlige forsiktighetsregler, personlig verneutstyr og nødrutiner

For ikke-innsatspersonell: Hold støvdannelse til et minimum. Sikre tilstrekkelig ventilering. Bruk personlig verneutstyr etter behov.

6.2. Forsiktighetsregler med hensyn til miljø

Materialet er ikke oppløselig. Skyll ikke ut i vannløp eller avløpssystemer.

6.3. Metoder og materialer for oppsamling og rensing

Begrens og samle opp materialutslipp for riktig avhending. Tørr støvsuging er den beste metoden for opprydding.

6.4. Henvisning til andre avsnitt

AVSNITT 7: Håndtering og lagring

7.1. Forsiktighetsregler for sikker håndtering

Aerogel-tepper danner støv når de håndteres. Yrkeseksponering til alt støv bør kontrolleres med standard yrkeshygieniske prosedyrer. Tørr støvsuging er den beste metoded for opprydding av støv. Fordi aerogel-støvet er hydrofobt, er ikke vann et effektivt støvoppsamlingsmiddel.

7.2. Vilkår for sikker lagring, herunder eventuelle uforeneligheter

Aerogel-tepper skal oppbevares i emballasjen frem til de er klare til bruk. Pakk ut materialet i arbeidsområdet. Dette vil bidra til å redusere området der støveksponering kan forekomme. Materialrester skal omgående pakkes i avfallsposer.

7.3. Særlig(e) sluttanvendelse(r)

AVSNITT 8: Eksponeringskontroll/personbeskyttelse

8.1. Kontrollparametere

Yrkesmessig eksponeringsgrense: Inneholder ingen stoffer som utløser rapporteringsplikt.

8.2. Eksponeringskontroll

Egnede tiltak for eksponeringskontroll: Ventilering: Punktavsug i samsvar med generell, industriell hygienepraksis anbefales for å begrense støv.

Arbeidshygiene: Oppbevar materialene i emballasjen inntil det er klart for bruk. Utstansing fremfor roterende eller andre kuttemetoder Tørr støvsuging med riktig filtrering foretrekkes fremfor feiing. Skyll grundig etter bruk av produktet. Vask klær ved støvete forhold. Vask

hendene før du spiser eller drikker.

Personlig verneutstyr, beskyttelse av øyne/ansikt: Vernebriller. Kjemiske beskyttelsesbriller kan brukes for å gi bedre beskyttelse mot støv.

Personlig verneutstyr, beskyttelse av hud: Langermede, langbente arbeidsklær anbefales også. Engangs-kjeledress bør vurderes for å redusere hudeksponering og komme seg vekk fra aerogel-støv inn i nærliggende områder.

Personlig verneutstyr, håndvern: Silika aerogel er hydrofobt (vannavstøtende), og kan føre til uttørring og irritasjon av hud, øyne og slimhinner. Av den grunn, bør nitril-, lateks-, eller andre ugjennomtrengelige hansker brukes ved håndtering av aerogel-tepper.

Personlig verneutstyr, åndedrettsvern: En riktig montert, NIOSH- eller CE-godkjent respirator bør brukes der ventilasjon ikke er tilgjengelig eller er utilstrekkelig for å opprettholde luftkonsentrasjoner under yrkeseksponeringsgrenser. Et program for åndedrettsvern som tilfredsstiller gjeldende lokale forskrifter skal iverksettes når forhold på arbeidsplassen tilsier bruk av en respirator.

AVSNITT 9: Fysiske og kjemiske egenskaper

9.1. Opplysninger om grunnleggende fysiske og kjemiske egenskaper

Parameter	Verdi/enhet
Aggregattilstand	stoffteppe; materialet er hydrofobt (vannavvisende)
Farge	grått.
Lukt	Ingen karakteristisk lukt. Under visse forhold, for eksempel ved høyelagringstemperaturer, kan produktet ha en svak ammoniakk-lignende lukt. Luktterskler: Rapporterte ammoniakkterskler varierer betydelig: 0,6 til 53 ppm.
Løselighet	Ikke oppløselig.
Eksplosive egenskaper	Ikke relevant.
Oksidasjonsegenskaper	ikke relevant.

Parameter	Verdi/enhet	Anmerkninger
pH (bruksferdig oppløsning)	Ingen data	
pH (konsentrat)	Ingen data	
Smeltepunkt	Ingen data	
Frysepunkt	Ingen data	
Startkokepunkt og kokepunktintervall	Ingen data	
Flammepunkt	Ingen data	
Fordampningshastighet	Ingen data	
Antennelighet (fast stoff, gass)	Ingen data	
Antennelsesgrenser	Ingen data	
Eksplosjonsgrenser	Ingen data	
Damptrykk	Ingen data	
Damptetthet	Ingen data	
Relativ tetthet	Ingen data	
Fordelingskoeffisient n-oktanol/vann	Ingen data	
Selvantennelsestemperatur	Ingen data	
Nedbrytningstemperatur	Ingen data	
Viskositet	Ingen data	
Luktterskel	Ingen data	

Sikkerhetsdatablad

Pyrogel® XTF

Revisjonsdato: 01.01.2016

9.2. Andre opplysninger

AVSNITT 10: Stabilitet og reaktivitet

10.1. Reaktivitet

10.2. Kjemisk stabilitet

Stabilt.

10.3. Mulighet for farlige reaksjoner

10.4. Forhold som skal unngås

Langvarig eksponering for temperaturer over anbefalte brukstemperatur som nevnt i teknisk datablad. Unngå forhold som fører til at store mengder støv spres i luften.

10.5. Uforenlige materialer

Unngå kraftige syrer og baser.

10.6. Farlige nedbrytingsprodukter

Under anbefalte bruksforhold forventes det ingen farlige nedbrytningsprodukter Farlige nedbrytningsprodukter, inkludert karbonmonoksid og andre forbrenningsprodukter, kan oppstå som følge av oksidasjon, oppvarming eller reaksjon med et annet materiale.

AVSNITT 11: Toksikologiske opplysninger

11.1. Opplysninger om toksikologiske virkninger

Forsøksdata

AKUTT TOKSISITET

Støv kan gi mekanisk irritasjon og tørrhet i øyne og på hud.

Syntetisk amorf silika

Oral LD50:	> 5 000 mg/kg
Inhalering LC50:	> 2 000 mg/m^3
Hud LD50:	> 3 000 mg/kg
Irriterte øyne:	Syntetisk amorf silika og silikater er ikke irriterende på hud eller øyne under eksperimentelle forhold, men kan føre til tørrhet ved langvarig og gjentatt eksponering.
Irritert hud:	Syntetisk amorf silika og silikater er ikke irriterende på hud eller øyne under eksperimentelle forhold, men kan føre til tørrhet ved langvarig og gjentatt eksponering.

Titandioksid

Oral LD50:	> 5 000 mg/kg
Inhalering LC50:	> 6 820 mg/m^3 (ALC/4 timer rotte)
Hud LD50:	> 10 000 mg/kg (kanin)
Irriterte øyne:	Lett irritasjon
Irritert hud:	Lett irritasjon

Aluminiumtrihydrat

Oral LD50:	> 5 000 mg/kg

(rotte)
Irriterte øyne: Lett irritasjon
Irritert hud: Ingen irritasjon

KRONISK TOKSISITET

Noen studier av langsiktig eksponering til amorf silika-støv antyder et potensiale for redusert lungefunksjon. I de undersøkte studiene karakteriseres denne effekten som forsterket ved røyking. I tillegg karakteriserte de undersøkte studiene den nedsatte lungefunksjonen som reversibel ved opphør av eksponering. Det finnes ingen tilgjengelige data for dette produktet angående hudallergi, irritasjon i luftveiene, reproduksjonstoksisitet, teratogen, embryotoksisitet, arvematerialskadelige eller synergistisk effekt.

KARSINOGENITET

I 2010 (basert på en 2006 Working Group møte) omklassifiserte International Agency for Research on Cancer (IARC) titandioksid (TiO2) til «muligens kreftfremkallende for mennesker» (gruppe 2B). Denne klassifiseringen var basert på *utilstrekkelig bevis* hos mennesker og *tilstrekkelig bevis* i forsøksdyr. I titandioksidmonografien (Vol. 93), konkluderte IARC at de menneskelige karsinogenitetsstudiene «ikke antydet en sammenheng mellom yrkeseksponeringen som fant sted i løpet av de siste tiårene i Vest-Europa og Nord-Amerika og økt risiko for

kreft.» (se side 273 av monografien). IARC-klassifiseringen av TiO2 i gruppe 2B var basert på den tilgjengelige informasjonen som ble omtalt i monografien, primært hos dyr (gnagere) ...

Den nylige IARC-klassifiseringen av TiO2 ble basert på *utilstrekkelig bevis* hos mennesker og *tilstrekkelig bevis* i forsøksdyr. IARC anser det for å være *utilstrekkelig bevis for carcinogenitet* ettersom de tilgjengelige studiene er av «utilstrekkelig kvalitet, konsistens eller statistisk styrke til å kunne fatte en konklusjon» eller «ingen data om kreft hos mennesker er tilgjengelig». IARC anser det for å være *tilstrekkelig bevis for karsinogenitet* i forsøksdyr når to eller flere uavhengige undersøkelser av en art som utføres på forskjellige tidspunkter, på forskjellige laboratorier eller under ulike protokoller, gir bevis på karsinogenitet. Gruppen 2B for TiO2-klassifiseringen ble basert på tre dyrestudier og fire studier på mennesker. I titandioksidmonografien (Vol. 93), konkluderte IARC med at de menneskelige karsinogenitetsstudiene «ikke antyder noen sammenheng mellom yrkeseksponeringen som fant sted i løpet av de siste tiårene i Vest-Europa og Nord-Amerika, og økt risiko for kreft.»

Amerikanske OSHA har foreløpig ingen regulering av titandioksid som kreftfremkallende (ref: OSHA Letter of Interpretation to North American Refractories Co, 11/19/97). Det amerikanske National Institute for Occupational Safety & Health (NIOSH) anbefaler for tiden at titandioksid betraktes som potensielt kreftfremkallende ved yrkeseksponering. Tidligere baserte NIOSH sin anbefaling på en kronisk inhaleringsstudie av rotter eksponert for 250 mg/m3 av fine titandioksid. Nylig har NIOSH derimot anbefalt at eksponeringsgrensene for inhalert titandioksid skal være på 2,4 mg/m3 for fine TiO2 og 0,3 mg/m3 for ultrafine (inkludert konstruerte nanoskala) TiO2 som TWA-konsentrasjoner på inntil 10 t/dag i løpet av en 40-timers arbeidsuke, ved hjelp av internasjonale definisjoner av respirabelt støv [CEN 1993; ISO 1995] og NIOSH-metode 0600 for prøvetaking av respirable partikler i luften [NIOSH 1998]. Se NIOSH Current Intelligence Bulletin Nr. 63 (2011), som er tilgjengelig på http://www.cdc.gov/niosh/docs/2011-160/.. NIOSH har indikert at de tumorigene virkningene av titandioksid ikke virker å være kjemisk spesifikke eller en direkte virkning av den kjemiske substansen i seg selv. Snarere synes disse effektene å være en effekt av partikkelstørrelse og overflateareal som forekommer gjennom en sekundær, genotoksisk mekanisme forbundet med vedvarende betennelse.

Staten California har inkludert titandioksid (som ubundne partikler i luften som kan inhaleres) i sin liste over kjemikalier som ifølge staten forårsaker kreft, med virkning fra 2. september 2012, under forskriftene California Environmental Protection Agencys Proposition 65. Se også avsnitt 15 under. The American Conference of Governmental Industrial Hygienists (ACGIH) klassifiserer ikke titandioksid som et menneskelig karsinogen (A4).

Ifølge produsenten anses glassfiber i dette produktet som tekstil-fiberglass og det er ikke klassifisert som karsinogent av ACGIH, IARC, NTP eller OSHA.

Sikkerhetsdatablad

Pyrogel® XTF

The International Agency for Research on Cancer (IARC – det internasjonale kreftforskningsbyrået) klassifiserer syntetisk amorf silika som mulig kreftfremkallende for mennesker (Gruppe 3).

MERKNAD TIL AVSNITT 11: Toksikologisk informasjon for syntetisk amorf silika er basert på litteraturgjennomgang.

AVSNITT 12: Økologiske opplysninger

12.1. Giftighet

12.2. Persistens og nedbrytbarhet

Ikke relevant for uorganiske material.

12.3. Bioakkumuleringsevne

Ingen forventet, grunnet produktets uløselige natur.

12.4. Mobilitet i jord

Ingen forventet, grunnet produktets uløselige natur.

12.5. Resultater av PBT- og vPvB-vurdering

12.6. Andre skadevirkninger

Ingen forventet.

Øvrig Informasjon

MERKNAD TIL AVSNITT 12: Den økologiske informasjonen er basert på litteraturgjennomgang for syntetisk amorf silika (CAS-nr 7631-86-9). Informasjon om aluminiumtrihydrat er basert på produsentens informasjon.

Forsøksdata

Akvatisk toksisitet

Syntetisk amorf silika	Fisk: LC50 > 10 000 mg/L (brakydaktyli rerio: 96 timer), metode OECD 203 Daphnia magna: EC50 > 10 000 mg/l (24 timer), metode OECD 202
Titandioksid	Fisk: LC50 > 1 000 mg/L (storhodet ørekyte 96 timer)
Treverdig aluminum	Fisk: LC50 > 10 000 mg/L

AVSNITT 13: Disponering

13.1. Avfallsbehandlingsmetoder

Avhend i et godkjent deponi i overensstemmelse med føderale, statlige/provinsielle, og lokale lovgivning. Dekk til avfallet umiddelbart for å unngå at støv blåser bort. Materialet klassifiseres ikke som farlig avfall i henhold til RCRA-forskriftene.

AVSNITT 14: Transportopplysninger

14.1. FN-nummer: Ikke relevant.
14.2. FN-forsendelsesnavn: Ikke relevant.
14.3. Transportfareklasse(r): Ikke relevant.
14.4. Emballasjegrupper: Ikke relevant.
14.5. Miljøfarer: Ikke relevant.

14.6. Særlige forsiktighetsregler ved bruk

14.7. Bulktransport i henhold til vedlegg II i MARPOL og IBC-regelverket

Sikkerhetsdatablad

Pyrogel® XTF

Revisjonsdato: 01.01.2016

AVSNITT 15: Opplysninger om bestemmelser

15.1. Særlige bestemmelser/særskilt lovgivning om sikkerhet, helse og miljø for stoffet eller stoffblandingen

Godkjenninger/begrensninger:

GJELDENDE EU-FORSKRIFTER
Produktet er ikke klassifisert som et farlig materiale eller preparat ifølge EU-direktivene 67/548/EØF eller 1999/45/EC. Aerogel isolasjonstepper anses som et element, ikke et stoff eller preparat, ifølge REACH-direktivet.

USAS FØDERALE FORSKRIFTER
CERCLA (Comprehensive Response Compensation and Liability Act): Produktet er ikke klassifisert som farlig eller innberetningspliktig under dette kravet.

SARA TITLE III (Superfund Amendments and Reauthorization Act): Produktet er ikke klassifisert som farlig eller innberetningspliktig under dette kravet.

311/312 FAREKATEGORIER: Materialene i dette produktet klassifiseres som farlig eller innberetningspliktig under dette kravet.

313 INNBERETNINGSPLIKTIGE INGREDIENSER: Materialene i dette produktet er ikke klassifisert som farlig eller innberetningspliktig under dette kravet.

TSCA: Alle kjemiske substanser i dette materialet er inkludert på eller unntatt fra oppføring på TSCA for
kjemiske substanser

STATLIGE FORSKRIFTER: Materialet på dette produktet vises på følgende statlige lister over farlig stoffer: CA, IN, KY, MA, MN, NC, NJ, OR, PA.

Sjekk individuelle statlige krav.
Som tidligere nevnt i avsnitt 11 i forbindelse med redegjørelsen om titandioksid må følgende ADVARSEL inkluderes for dette produktet, ifølge den amerikanske delstaten California: DETTE PRODUKTET INNEHOLDER ET KJEMISK STOFF SOM DET I DELSTATEN CALIFORNIA VITES AT FORÅRSAKER KREFT.

KANADISKE FORSKRIFTER: Dette produktet er klassifisert i henhold til farekriteriene i Controlled Products Regulation (HLR) og HMS-databladet inneholder all informasjon som kreves av CPR. Alle kjemiske substanser i dette produktet er inkludert på eller fritatt fra den kanadiske Domestic Substance List (DSL). Amorf silika (CAS-nr. 7631-86-9) er på listen WHMIS Ingredient Disclosure List med en konsentrasjonsterskel på 1 %. Titandioksid (CAS-nr. 1344-28-1) er på listen med en konsentrasjonsterskel på 0,1 %. Titandioksid er et kontrollert produkt under WHMIS klasse D, divisjon 2, underdivisjon A, og regnes som et mulig kreftforårsakende stoff ved inhalering.

15.2. Vurdering av kjemikaliesikkerhet

AVSNITT 16: Andre opplysninger

Øvrig Informasjon:

NFPA-FAREKLASSIFISERING:
Helse 1
Brennbarhet: 0
Reaktivitet: 0
Annet: I/E

HMIS-FAREKLASSIFISERING:
Helse 1
Brennbarhet: 0
Reaktivitet: 0
Annet: Se avsnitt 8.

Sikkerhetsdatablad

Pyrogel® XTF

Revisjonsdato: 01.01.2016

Avsnitt 11, epidemiologiske referanser for titandioksid: 1) Fryzek JP, m.fl. [2003]. En kohortstudie av titandioksidproduksjonsarbeidere i USA. J Occup Environ Med 45:400-409. 2) Boffeta m.fl. [2004]. Dødelighet blant arbeidere i produksjonsindustrien for titandioksid i Europa. Kontroll av kreftfremkallere
15:697-706. 3) Sot, titandioksid, og talkum/IARC arbeidsgruppe for evaluering av kreftfremkallende risikofaktorer for mennesker (2006: Lyon, Frankrike). 4) Nåværende innsiktsbulletin nr. 63, yrkeseksponering for titandioksid, Center for Disease Control and Prevention, National Institute of Occupational Safety and Health, 2011.

Referanser til toksisitetsinformasjon for syntetisk amorf silika: Screening-datasett (SIDS) for FNs miljøprogram (UNEP), Organisasjonen for økonomisk samarbeid og utvikling (OECD), innledende hovedrapport om syntetisk amorf silika, 23. juli 2004.

Revideringssammendrag: Tillagte krav av California og ytterligere detaljer rundt diskusjonen om IARC og NIOSH
dokumenter i avsnitt 11.

ANSVARSFRASKRIVELSE: Opplysningene er presentert i god tro og antas å være nøyaktig som de effektive oppgitte data. Dog gis det ingen garantier, uttrykte eller underforståtte. Brukere oppfordres til å referere til de primære dokumentene nevnt her og vurdere dem for deres relevans i forhold til brukerens faktiske bruk av produktet. Det er brukerens ansvar å sikre at deres aktiviteter er i overensstemmelse med gjeldende føderale, nasjonale, statlige, provinsielle og lokale lover.

Dokumentspråk: NO

CERTIFICATE OF CALIBRATION AND TESTING

TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

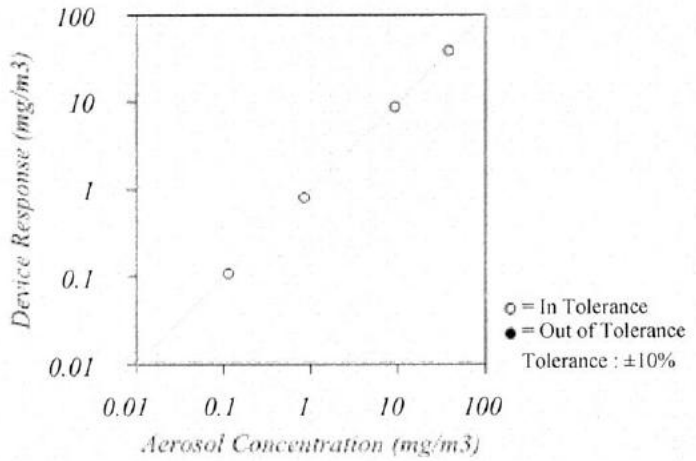
Environment Conditions		
Temperature	74.50 (23.6)	°F (°C)
Relative Humidity	46.8	%RH
Barometric Pressure	29.14 (986.8)	inHg (hPa)

Model	**8533**
Serial Number	**8533183510**

☒ As Left ☐ As Found

☒ In Tolerance ☐ Out of Tolerance

Concentration Linearity Plot



System ID: DTII01-01

FLOW AND PRESSURE VERIFICATION — **SYSTEM DTII01-01**

Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow lpm	3.0	3.0	2.85 ~ 3.15	Pressure kPa	98.8	98.8	93.87 ~ 103.75

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for optical mass measurements. Calibration of this instrument performed by TSI has been done using emery oil and has been nominally adjusted to respirable mass per standard ISO 12103-1, A1 test dust (Arizona dust). Our calibration ratio is greater than 1.2:1

Measurement Variable	System ID	Last Cal.	Cal. Due	Measurement Variable	System ID	Last Cal.	Cal. Due
Photometer	E003433	03-13-18	09-30-18	Flowmeter	E002371	03-08-18	03-31-19
DC Voltage(Keithley)	E002859	08-22-18	08-31-19	Microbalance	M001324	11-02-16	11-30-18
Temp/Humidity	E005409	10-19-17	10-31-18	Temp/Humidity	E005410	10-19-17	10-31-18
Pressure	E003440	07-24-18	07-31-19	1 um PSL	698880	n/a	n/a
3 um PSL	180387	n/a	n/a	10 um PSL	187001	n/a	n/a

Jacque Corbin
Calibrated

August 30, 2018
Date

TSI P/N 2300157

CERTIFICATE OF CALIBRATION AND TESTING

TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

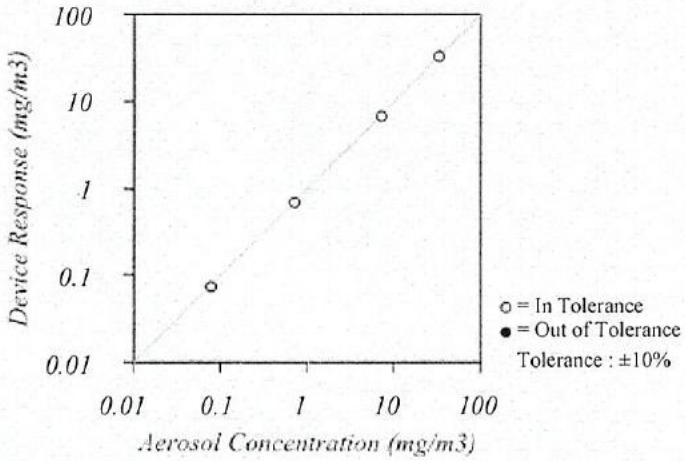
Environment Conditions		
Temperature	74.38 (23.5)	°F (°C)
Relative Humidity	20.4	%RH
Barometric Pressure	29.38 (994.9)	inHg (hPa)

Model	**8534**
Serial Number	**8534184503**

☒ As Left ☐ As Found

☒ In Tolerance ☐ Out of Tolerance

Concentration Linearity Plot



System ID: DTI101-01

FLOW AND PRESSURE VERIFICATION — **SYSTEM DTI101-01**

Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow lpm	3.00	3.05	2.85 ~ 3.15	Pressure kPa	99.7	99.7	94.71 ~ 104.68

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for optical mass measurements. Calibration of this instrument performed by TSI has been done using emery oil and has been nominally adjusted to respirable mass per standard ISO 12103-1, A1 test dust (Arizona dust). Our calibration ratio is greater than 1.2:1

Measurement Variable	System ID	Last Cal.	Cal. Due
Photometer	E003433	09-24-18	03-31-19
DC Voltage(Keithley)	E002859	08-22-18	08-31-19
Temp/Humidity	E005657	02-28-18	02-28-19
Pressure	E003440	07-24-18	07-31-19
3 um PSL	180387	n/a	n/a

Measurement Variable	System ID	Last Cal.	Cal. Due
Flowmeter	E002371	03-08-18	03-31-19
Microbalance	M001324	10-03-18	10-31-20
Temp/Humidity	E005656	03-01-18	03-31-19
1 um PSL	698880	n/a	n/a
10 um PSL	187001	n/a	n/a

Jacque Corbin
Calibrated

November 8, 2018
Date

CERTIFICATE OF CALIBRATION AND TESTING

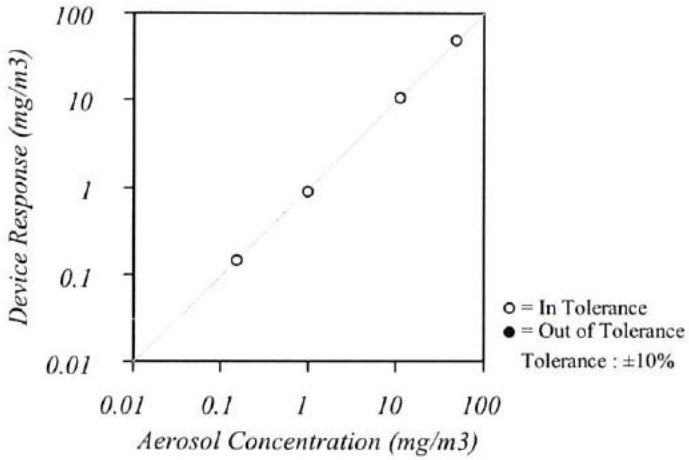
TSI Instruments Ltd, Stirling Road, Cressex Business Park
High Wycombe Bucks HP12 3RT England
Tel: (Int +44) (UK 0) 1494 459200 Fax: (Int +44) (UK 0) 1494 459700 http://www.tsiinc.co.uk

Environment Condition		
Temperature	23.0	°C
Relative Humidity	31.30	%RH
Barometric Pressure	1005.4	hPa

Model	**8533**
Serial Number	**8533103004**

☒ As Left ☐ As Found
☒ In Tolerance ☐ Out of Tolerance

Concentration Linearity Plot



System ID: DTII02-01

FLOW AND PRESSURE VERIFICATION — **SYSTEM DTII02-01**

Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow lpm	3.1	3.0	2.95 ~ 3.26	Pressure kPa	100.6	100.6	95.58 ~ 105.64

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for optical mass measurements. Calibration of this instrument performed by TSI has been done using emery oil and has been nominally adusted to respirable mass of standard ISO 12103-1, A1 test dust (Arizona dust). Our calibration ratio is greater than 1.2:1

Measurement Variable	System ID	Last Cal.	Cal. Due
Barometric Pressure	E006014	31-03-10	31-03-11
Humidity	E006014	31-03-10	31-03-11
Microbalance	UK 23403008	05-01-11	05-01-12
Pressure	E006013	31-03-10	31-03-11
2.8 um PSL	580457	n/a	n/a
DC Voltage	E003323	12-10-10	12-10-11

Measurement Variable	System ID	Last Cal.	Cal. Due
Temperature	E006014	31-03-10	31-03-11
Photometer	E003336	07-01-11	07-07-11
Flow and Temperature	E006128	02-02-11	02-02-12
1 um PSL	596913	n/a	n/a
10 um PSL	34340	n/a	n/a

Calibrated

8 February, 2011
Date

ID: 14283-4

Prosedyre for bruk av Pyrogel

Godkjent dato 15.10.2018 (Pål Elvind Lervik)

Revidert Prosedyre for bruk av Pyrogel UKE 50 Haugesund

1. FORMÅL OG OMFANG

Formålet med denne prosedyre er å sikre at bruk og installasjon av Pyrogel utføres på en sikker og trykk måte, og iht. til krav fra produsentens HMS datablad.

2. MÅLGRUPPE

Denne prosedyren gjelder for alle som er involvert i utførelse med jobber som innebærer bruk av Pyrogel XT-E eller XT-F.

3. ANSVAR OG MYNDIGHET

Formann skal legge til rette for at arbeidet utføres sikkert, og at nødvendig verneutstyr er tilgjengelig og blir brukt.
Alle i arbeidslaget har ansvar for at jobben blir utført på en trygg og sikker metode, i henhold til denne prosedyren.

4. BESKRIVELSE

4.1 Generelt

Pyrogel er et hydrofobt materiale, som benyttes som både termisk isolering (XT-E), og brannisolering (XT-F).
Produktet blir levert på rull i 5 eller 10mm tykkelse, eventuelt ferdig tilpasset.
Karakteristisk for Pyrogel, er mye støvdannelse ved bearbeiding og montering/demontering.

4.2 Faremoment

Faren ved bruk av Pyrogel er støvdannelse, og kuttskader ved tilpassing av produktet.

4.3 Verneutstyr

Påse at riktig og nødvendig verneutstyr er tilgjengelig på anlegget.
Normalt PVU benyttes, i tillegg til følgende:

- Det skal benyttes friskluftsmaske eller viftebasert maske. Bildeeksempel av airstream maske fra Sundstrøm

- Engangsdress benyttes for å redusere hudeksponering.
- Lange hansker av type nitril eller lateks benyttes utenpå kutthansker ved tilpassing. Ved montering av Pyrogel er kutthansker normalt ikke nødvendig.

4.4 Tildekking

Ved tilpassing av produktet skal dette foregå i egnet telt som er bygd for dette formålet.
Ferdig tilpasset materiell skal fraktes i lukket sekk.
Arbeidstedet skal være tildekket med stillaspressening, for å unngå støvspredning til omgivelsene og annet personell.

4.5 Før start aktivitet

- Avsperring av arbeidsstedet.
- Gjøre seg kjent med hvor nærmeste nøddusj og øyeskyllestasjon er tilgjengelig.

4.6 Under utførelse av aktivitet

- Rengjøre arbeidsplassen regelmessig for å minimere støvutvikling.
- Oppbevar materialene i emballasjen inntil det er klart for bruk.
- Ved tilpassing av produktet skal det benyttes saks eller kniv. Produktet skal ikke rives i siden dette gir stor støvdannelse

4.7 Etter ferdig aktivitet

- Vask hendene før du spiser eller drikker.
- Rengjøring av arbeidsplass skjer med støvsuger med hepa-filter. Det skal ikke feies da dette vil virvle opp avsatt støv.Større biter plukkes opp og pakkes i sekk.
- Ved arbeid på stillas, sørg for at dette er rengjort før demontering.
- At utstyr skal være rengjort og eventuelt satt til nødvendig vedlikehold.
- Ved demontering av telt skal presenningen fjernes på en måte som reduserer videre spredning av støvet.

5. AVVIK FRA PROSEDYREN

Avvik skal behandles i henhold til «Prosedyre for behandling av saker i TQM» (Id 7193).

6. ENDRINGER OG GODKJENNING AV PROSEDYREN

Prosedyren skal godkjennes av vedkommende som er registrert som godkjenner for prosedyren i TQM.

7. ENDRINGSHISTORIKK

- Fjernet fremside
- Flyttet flere punkter fra 4.1 til relevante avsnitt
- Lagt til avsnitt 4.4
- Endret tekst i punkt 4.6 og 4.7. Endret punkt som kan tolkes på forskjellige måter.

8. REFERANSER

SINTEF MOLAB

Equinor ASA
Att: Kirsti Krüger
Central Accounts Payable
PB 8500

4035 STAVANGER

SINTEF

SINTEF Molab as
Org. nr.: NO 953 018 144 MVA
Postboks 611
8607 Mo i Rana
www.sintefmolab.no

Tlf: 404 84 100

Ordrenr.:	75070-Rev.1
Rapportref.:	Totalstøv_Respirabelt støv
Bestillingsnr.:	4503707505
Antall sider + bilag:	5
Dato:	03.01.2019

RAPPORT Revidert 1

Totalstøv og respirabelt støv

***TR, 11.01.19, revisjon 1**: Revidert luftmengde i prøve 5 og 18, følgelig ny støvkonsentrasjon*

Tabell 1 Generell informasjon

	Generell informasjon
Antall prøver	42 + 50 stk.
Mottatt dato	17.12.18
Analyseparameter	42 stk. totalstøv 50 stk. respirabelt støv
Prøvested	Equinor
Ansvarlig for prøvetaking	Kirsti Krüger
Prøvetakingsutstyr	Arbeidsmiljøpumpe: Casella TUFF (utleid fra SINTEF Molab AS), flow 2,0 liter/min (totalstøv) og 2,2 liter/min (respirabelt støv) *Totalstøv:* 25 mm svart STK (standard kassett) 25 mm MCE (mixed cellulose ester) filter, porestørrelse 0,8 µm *Respirabelt støv:* SKC Plastic Cyclone 37 mm syklonkassett (SKC) 37 mm MCE (mixed cellulose ester) filter, porestørrelse 0,8 µm
Annet	Resultatene er oppgitt i mg/m^3 (konsentrasjon i luft) for totalstøv og respirabelt støv. Luftmengde for utregning av konsentrasjon er beregnet ut fra informasjon om prøvetakingstid og -flow i tilsendt måleprotokoll.

Utført av:

Tove Ravnåmo
Ansvarlig signatur

Tabell 2 Analyseinformasjon

Parameter	Metode/analyseteknikk	Deteksjonsgrense	Usikkerhet
Totalstøv	NS 4860 (gravimetri)	0,05 mg [1)]	10 % [2)]
Respirabelt støv	NS 4860 (gravimetri)	0,1 mg [1)]	10 % [2)]

1) Rapportert deteksjonsgrense (mg/m^3) avhenger av luftmengde (flow * prøvetakingstid). Ved prøvetakingstid på 8 timer vil rapportert deteksjonsgrense for totalstøv være tilnærmet 0,05 mg/m^3, og for respirabelt støv 0,1 mg/m^3. Ved kortere prøvetakingstid blir rapportert deteksjonsgrense høyere.

2) Usikkerhet for resultater nær deteksjonsgrense hhv. 40 % (totalstøv) og 56 % (respirabelt støv).

Tabell 3 Resultater totalstøv

Prøvenr.	Prøvetakings-tid (min.)	Luftmengde (m^3)	Totalstøv mg/m^3
1		0,400	5,5
2		0,441	32
3		0,390	1,1
4		0,390	0,82
5		0,350	3,4
6		0,357	2,4
7		0,431	39
8		0,431	0,90
9		0,400	3,3
10		0,379	0,84
11		0,390	1,4
12		0,884	3,6
13		0,930	22
14		0,333	0,51
15		0,420	0,90
17		0,792	0,98
18		0,479	3,5
19		1,023	20
20		0,907	0,98
23		0,884	0,90
24		0,977	1,4
25		0,769	20
26		0,731	2,7
27		0,675	0,52

Prøvenr.	Prøvetakings-tid (min.)	Luftmengde (m^3)	Totalstøv mg/m^3
28		0,713	29
29		0,646	0,57
32		0,825	0,34
34		0,627	1,2
35		0,750	2,4
37		0,461	1,5
38		0,460	0,26
39		0,917	7,9
40		0,850	0,33
41		0,813	18
42		0,294	0,24
61		0,290	< 0,17
62		0,330	0,55
63		0,297	0,17
64		0,312	0,29
65		0,310	0,52
68		0,305	1,6
69		0,320	2,3

Tabell 4 Resultater respirabelt støv

Prøvenr.	Prøvetakings-tid (min.)	Luftmengde (m^3)	Respirabelt støv mg/m^3
71		0,338	0,65
72		0,492	1,6
73		0,410	3,4
74		0,410	0,44
75		0,420	9,0
77		0,410	1,2
78		0,390	0,62
80		0,340	0,62
81		0,420	0,48
82		0,431	0,65
83		0,294	12
91		0,953	0,75

Prøvenr.	Prøvetakings-tid (min.)	Luftmengde (m^3)	Respirabelt støv mg/m^3
92		0,698	2,4
93		0,977	0,11
94		0,288	0,73
95		0,698	0,95
96		0,930	0,69
97		0,884	0,90
98		0,837	1,6
99		0,977	7,0
100		0,930	11
103		0,731	0,44
104		0,713	7,9
105		0,731	11
106		0,713	1,4
107		0,773	0,38
108		0,713	0,63
109		0,788	1,0
110		0,615	2,0
111		0,694	0,43
112		0,694	5,6
113		0,578	0,22
116		0,875	0,59
117		0,875	0,27
119		0,875	0,54
120		0,895	19
122		0,770	0,73
123		0,850	0,59
124		0,850	2,5
125		0,830	11
126		0,892	1,0
127		0,808	1,7
130		0,807	0,46
131		0,283	< 0,35
132		0,276	1,2

Prøvenr.	Prøvetakings-tid (min.)	Luftmengde (m^3)	Respirabelt støv mg/m^3
133		0,283	< 0,35
135		0,326	3,0
136		0,283	< 0,35
137		0,347	1,2
139		0,336	0,57

SINTEF MOLAB

Equinor ASA
Att: Kirsti Krüger
Central Accounts Payable
PB 8500

4035 STAVANGER

SINTEF

SINTEF Molab as
Org. nr.: NO 953 018 144 MVA
Postboks 611
8607 Mo i Rana
www.sintefmolab.no

Tlf: 404 84 100

Ordrenr.:	75070-Rev._fibertelling
Rapportref.:	Arbeidsmiljø
Bestillingsnr.:	4503707505
Rev. nr.:	1
Sider + bilag:	2
Dato:	16.01.2019

RAPPORT

Fibertelling

Revisjon 17.01.19, TR: Rettet opp tabelltekst til tabell 3.

Tabell 1 Generell informasjon

	Generell informasjon
Antall prøver	4 stk.
Mottatt dato	17.12.18
Analyseparameter	Fibertelling
Ansvarlig for prøvetaking	Equinor v/Kirsti Krüger
Prøvetakingsutstyr	Arbeidsmiljøpumpe: Tuff, flow ca. 2,0 liter/min Filterkassett: 25 mm svart, tredelt standardkassett (STK) Filter: 25 mm PC (polycarbonate), porestørrelse 0,8 µm
Diverse	Resultat for fiber er oppgitt i antall fiber registrert og antall fiber/cm^3 (konsentrasjon i luft). Konsentrasjon er beregnet ut fra informasjon om luftmengde i tilsendt følgebrev. Fiberkriterier: lengde ≥ 5 µm, diameter ≤ 3 µm, og der forholdet lengde/bredde er minst 3 : 1* **Forskrift om utførelse av arbeid* «Grunnlag for fastsettelse av administrativ norm for MMMF, direktoratet for arbeidstilsynet 2007» er lagt til grunn for vurdering av analysene.

Utført av:

Tove Ravnåmo
Kontrollert signatur

Ørjan Jamtli
Ansvarlig

Tabell 2 Analyseinformasjon

Parameter	Metode/analyseteknikk	Deteksjons-grense	Annet
Fiber	SEM (elektronmikroskop) med energidispersivt spektrometer (EDS / EDX).	0,001 fiber/ml	Undersøkelse gjøres i henhold til prosedyre utviklet etter standard VDI 3492. Analysen utføres på et filterareal tilsvarende 2 mm^2.

Tabell 3 Resultater fibertelling

Prøvenr.	Antall fiber registrert	Luftmengde (m^3)	Fiberkonsentrasjon (fiber/ml luft)	Usikkerhets-beregning* (fiber pr.ml)
75070-001	0	0,263	< 0,001	< 0,001 - 0,002
75070-002	0	0,126	< 0,001	< 0,001 - 0,004
75070-003	0	0,150 (anslått)	< 0,001	< 0,001 - 0,004
75070-004	5 (rockwool/glava)	0,207	0,005	0,001 - 0,005

*97,5 % konfidensintervall v/ 0 fiber registrert, 95 % konfidensintervall v/ 1 eller flere fiber registrert

Kommentar

Lengde/breddeforhold på registrerte fiber oppgitt i µm: 70/2, 206/8, 935/8, 345/3, 277/6.
Fibrene foreligger delvis som frie fiber.

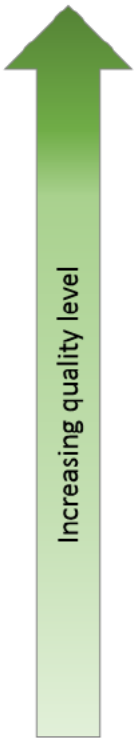
Arbeidstilsynets grenseverdier for MMMF/syntetiske mineralfiber (8 timers eksponering) *:

- Mineralull (glassull, steinull, slaggull): 1 fiber/cm^3 **

**Forskrift om tiltaks- og grenseverdier*
** 1 cm^3 = 1 ml

Appendix 7: Respiratory protection – principles and qualities

Principle	Details	Type of respiratory protection
Provide air free of pollutants from an external source		Breathing air / self contained breathing apparatus
Use the surrounding air and filter the pollutants	*Positive pressure*: Use a fan to blow the air through the filter and present the air as overpressure to the breathing zone	Fan-assisted respirator with full face mask
		Fan-assisted respirator with visor
Need an individual fit-test to verify that the mask provide a sufficient barrier. Disposable masks typically fail such test.	*Negative pressure*: Manually use the breath to draw the air through the filter to enter the breathing zone	Full face mask with replaceable filter
		Half mask with replaceable filter
		Disposable mask with integrated filter



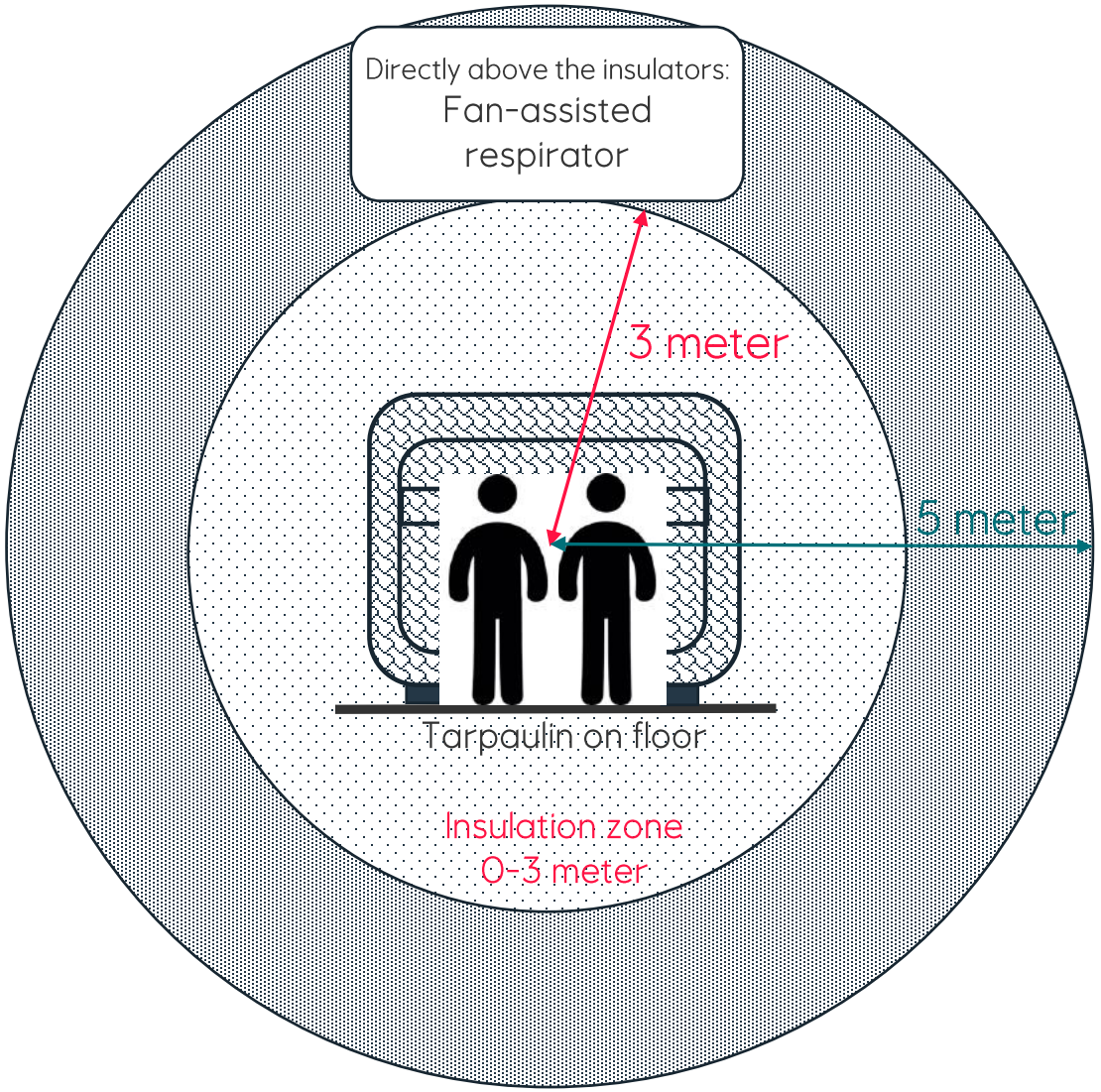
Types of respiratory protection recommended in this report

Pyrogel – recommendations for safe work

January 28, 2019

Ellen Katrine Jensen, Chief engineer Health and Working environment

Safe work with Pyrogel during mounting and demounting



Recommended risk controls (0-3 meter)

- PPE: Fan-assisted respirators with P3 filter, disposable coveralls, gloves
- Work <30 minutes: Mask with P3 filter
- Transport through area: Mask with P3 filter
- Tarpaulin on floor in work area
- Cordon off to restrict entry and indicate PPE regime

Recommended risk controls (3-5 meter)

- PPE: Mask with P3 filter
- PPE directly above the insulators: Fan-assisted respirator
- Transport through this area can be done without respiratory protection
- Cordon off to restrict entry and indicate PPE regime

Equinor occupational exposure limit (OEL):
12 hours Total dust: 6 mg/m^3 Respirable dust: 3 mg/m^3

Typical exposure level

Insulators >> OEL

Adjacent personnel above insulators > OEL

Adjacent personnel 3-5 m 10-50% of OEL

Dust sampling was done in an environment with good access shielded from outside weather. 12 hour shift.

Pyrogel information

Favourable **qualities** using Pyrogel

- reduced thickness and weight
- robust, tolerate mechanical burden
- water resistance and breathable
- very good test results for corrosion under isolation
- can be used for all Equinor insulation classes

Risk related to use of Pyrogel is **exposure to dust**. Health hazards are:

- itching, red and irritated skin, dryness and irritation of eyes and mucous membranes
- inflammation in the lungs
- chronic obstructive pulmonary disease (COPD)

Pyrogel is classified as red by Equinor. Red classification does not prohibit the use of Pyrogel. However, a **local risk assessment prior to use of the product is required** to ensure that the risk are controlled.

Consider the following parameters in the risk assessment;

- change in conditions that may **increase the dust concentration** for adjacent personnel:
  - no tarpaulin on floor below work area
  - more insulators performing work in the insulation zone
  - more condensed area (structures)
  - lower volume
  - wind blowing dust towards them
- change in conditions that may **decrease the dust concentration** and the need for respiratory protection for adjacent personnel:
  - tarpaulins on more sides around the insulation zone
  - higher volume
  - wind blowing dust away from them

Method / procedure for mounting/demounting Pyrogel is given by insulation company. Make sure to include:

- adjustment of product to take place in a suitable cutting tent
- material ready for use shall be transported in a closed bag
- the floor in the work area shall be covered with tarpaulin to prevent spread of dust to lower levels
- before starting, the insulation zone shall be blocked off
- the material shall be stored in the packaging until its ready for use
- gentle handling of material both when mounting and demounting
- work in groups (2 and 2)
- scissors or knife shall be used for adjusting the product. The product shall not be pulled since this will generate a lot of dust
- regularly vacuuming (HEPA filter) of surfaces. Note: do not sweep or use water on dust. Large pieces shall be picked up and packed in closed bags
- when demounting, the tarpaulin shall be removed in a gentle way that reduce further spread of the dust
- scaffolding: ensure that the scaffolding is cleaned prior to demounting. When demounting scaffolding, mask with P3 filter shall be used. If full shift work with demounting: fan-assisted respirator shall be used.

Report "Sampling of particles in the working atmosphere during insulation with Pyrogel XT-E", 2019

Pyrogel - recommendations for safe work

Ellen Katrine Jensen, Chief engineer Health and Working environment