ANNEX XV RESTRICTION REPORT

AMENDMENT TO A RESTRICTION

SUBSTANCE NAME: CHRYSOTILE

IUPAC NAME: Chrysotile

EC NUMBER: -

CAS NUMBER(S): CAS No 12001-29-5 and 132207-32-0

CONTACT DETAILS OF THE DOSSIER SUBMITTER:

EUROPEAN CHEMICALS AGENCY
Annankatu 18, P.O. Box 400, 00121 Helsinki, Finland
tel: +358-9-686180, www.echa.europa

VERSION NUMBER: 1.0

DATE: 17 January 2014

Contents

Tables

Page

Abbreviations

AAK	AarhusKarlshamn Sweden AB
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (Federal Institute for Occupational Safety and Health, Germany)
CSTEE	Scientific Committee on Toxicity, Ecotoxicity and the Environment of the European Commission
Dow	Dow Deutschland Anlagengesellschaft mbH
ECHA	European Chemicals Agency
EU	European Union
€m	million euros
€bn	billion (thousand million) euros
GSA	Gesellschaft für Schadstoffanalytik mbH
GSD	Geometric Standard Deviation
KEMI	Kemikalieinspektionen (Swedish Chemicals Agency)
LP	low pressure
NaOH	Sodium hydroxide (a.k.a caustic soda)
NPV	Net Present Value
PPE	Personal Protection Equipment
PTFE	polytetrafluoroethylene

AMENDMENT TO A RESTRICTION

About this report

Entry 6 paragraph 1 of REACH Annex XVII covers six types of asbestos fibres. The entry prohibits the manufacture, placing on the market and use of the fibres, and of articles and mixtures containing these fibres added intentionally. The entry also gives a possibility for a Member State to exempt the placing on the market and use of diaphragms containing one of the fibres, namely chrysotile, for existing electrolysis installations until they reach the end of their service life, or until suitable chrysotile-free substitutes become available, whichever is the sooner. In 2011 Member States making use of the exemption reported to the Commission on the issues affecting the needs for the exemption.

In January 2013, the Commission requested ECHA to prepare an Annex XV restriction report with a view of prohibiting the placing on the market and use of diaphragms containing chrysotile. In the restriction report special attention should be on assessing risks to human health and environment, on availability of alternatives, and on the socio-economic impacts.

This restriction report proposes a modification to the existing entry such that the existing derogation is modified and extended for the two named companies until 2025, and that those companies need to annually report their use of and risks related to the use of chrysotile. Due to the very targeted focus on the two electrolysis installations currently relying on this exemption – AarhusKarlshamn Sweden AB (AAK), a hydrogen production facility in Karlshamn, Sweden and Dow Deutschland Anlagengesellschaft mbH (Dow), a chlor-alkali installation in Stade, Germany – ECHA has consulted with these two companies extensively in 2013. This restriction report is largely based on the information received through that consultation. Based on these information and data, the exposure to chrysotile in their processes is minimised by process design and appropriate working practices.

AAK has already decided to adopt a chrysotile-free production method for hydrogen within the next 5-10 years. After that, it has no further need for diaphragms containing chrysotile and it would not need further exemption for the use of import of such diaphragms. Based on the entry 6, Germany has granted a national (not a company specific) exemption allowing “the manufacture and use of diaphragms containing chrysotile” ..”including the asbestos-bearing raw materials needed for their manufacture, in systems existing on 01.12.2010 until end of their use” (Bundesgesetzblatt, 2010). The only company using this exemption in Germany is Dow. It is currently undertaking production level testing using chrysotile-free diaphragms in its current installation. Subject to favourable results from the production level testing, Dow will be able to make a decision during 2015 to adopt the chrysotile-free diaphragms into its process. The full adoption would take about ten years, until 2025.

Compared to the situation in 2005 the number of electrolysis installation still needing to use chrysotile in their production process has decreased in the EU. Both pressure from the regulation and the changing business environment are causing companies to replace chrysotile where possible. As the risks appear to be controlled in AAK and Dow, continuing or ending the possibility for exemptions would not affect risk levels. For AAK, already planning to end the chrysotile use, there appears to be no additional costs due to regulation. Rather the costs can be interpreted as normal costs of renewing aging machinery. For Dow, the move away from chrysotile would have additional costs of €70 million – or €5.8 million per annum – when calculated up to 2030 and assuming that the transfer to chrysotile free technology takes place without problems. Should this not take place, the costs could be higher, even €355 million, or €29 million per annum. This restriction report proposes a modification to entry 6, which offers further incentives targeted to the two companies to find alternatives to chrysotile in a proportionate manner.

A. Proposal

A.1 Proposed restriction(s)

It is proposed that that entry 6 Paragraph 1 of Annex XVII in the REACH Regulation is modified to read as follows (text to be deleted is stroked out and new text is underlined):

A.1.1 The identity of the substance(s)

IUPAC name: Chrysotile

EC no: -

CAS no: 12001-29-5, 132207-32-0

A.1.2 Scope and conditions of restriction(s)

6. Asbestos fibres (a) Crocidolite CAS No 12001-28-4 (b) Amosite CAS No 12172-73-5 (c) Anthophyllite CAS No 77536-67-5 (d) Actinolite CAS No 77536-66-4 (e) Tremolite CAS No 77536-68-6 (f) Chrysotile CAS No 12001-29-5 CAS No 132207-32-0	1. The manufacture, placing on the market and use of these fibres and of articles and mixtures containing these fibres added intentionally is prohibited.~~However, Member States may exempt the placing on the market and use of diaphragms containing chrysotile (point (f)) for existing electrolysis installations until they reach the end of their service life, or until suitable asbestos-free substitutes become available, whichever is the sooner.~~ ~~By 1 June 2011 Member States making use of this exemption shall provide a report to the Commission on the availability of asbestos free substitutes for electrolysis installations and the efforts undertaken to develop such alternatives, on the protection of the health of workers in the installations, on the source and quantities of chrysotile, on the source and quantities of diaphragms containing chrysotile, and the envisaged date of the end of the exemption. The Commission shall make this information publicly available.~~ ~~Following receipt of those reports, the Commission shall request the Agency to prepare a dossier in accordance with Article 69 with a view to prohibit the placing on the market and use of diaphragms containing chrysotile.~~ 2. By way of derogation, paragraph 1 shall not apply until 31 December 2025 regarding the placing on the market and use of diaphragms containing chrysotile (point (f)), and placing on the market and use of chrysotile fibres used exclusively for the purpose of including such fibres in diaphragms, to electrolysis installations in use on 17 January 2013, if placing on the market or use were exempted by a Member State in accordance with the restriction on asbestos fibres as initially codified by Regulation (EC) No 1907/2006 of 18 December 2006 (OJ L 396, 30.12.2006). Without prejudice to the application of other Union provisions on the protection of workers from asbestos, any manufacturer, importer or downstream user benefiting from the derogation shall:

	i) minimise exposure to asbestos fibres placed on the market or used in compliance with the derogation of this paragraph, ii) prepare an annual report per calendar year giving the amount of chrysotile placed on the market and used in diaphragms, in compliance with the derogation of this paragraph, iii) send the report specified in para 2(ii) to the relevant Member State giving the exemption and the European Commission, with a copy to the European Chemicals Agency, including a translation into English in case the original report is drawn up in another official language than English, by 31 January of the following year. The relevant Member States giving the exemption may set a specific limit value for fibres in air or a monitoring regime for ensuring compliance with paragraph 2(i). If a monitoring regime is required, the results of the monitoring of exposures from the use of diaphragms and any fibres used should be included in the report specified in paragraph 2(ii). If a party granted a exemption concludes that the exemption needs to be extended because the relevant electrolysis installation has not reached the end of its service life and technically or economically viable asbestos-free substitutes are not yet available, they shall submit a report by 31 December 2020 to the Member State granting the exemption and the European Commission. The report shall include a risk assessment, including any relevant Exposure Scenarios describing the measures to minimise the risks, an Analysis of alternatives, and any information relevant for a socio-economic analysis related to the need for a further derogation. [3.]….. [4.]…..

A.2 Targeting

The proposed modification relates only to entry 6 Paragraph 1 of REACH Annex XVII, and to the need to assess whether to further restrict placing on the market and use of chrysotile i.e. whether it should be allowed to continue use of chrysotile in already existing electrolysis installations.

Currently, only the two companies are still making a use of the exemptions granted by the Member States in accordance with the provisions of paragraph 1 of entry 6 of Annex XVII. AAK was given an exemption to apply chrysotile in one refurbishment/use of its electrolysis unit, and it made the refurbishment 2010-2011 (Swedish Chemicals Agency, 2011). Germany, has granted a national (not a company specific) exemption allowing “the manufacture and use of diaphragms containing chrysotile” ..”including the asbestos-bearing raw materials needed for their manufacture, in systems existing on 01.12.2010 until the end of their use” (Bundesgesetzblatt, 2010). These exemptions are discussed in more detail

in E.1.1. A Polish company earlier utilizing the exemption closed down its operation in December 2012 and no longer uses chrysotile (Polish Ministry of Economy, 2013).

As requested by the Commission, the main emphasis in this restriction report is on assessing risks to human health and environment, on availability of alternatives, and on the socio-economic impacts in view of a prohibition. In practice, this means the focus is on the two electrolysis installations currently relying on the exemptions.

A.3 Summary of the justification

A.3.1 Identified hazard and risk

The hazard related to chrysotile is well established. Therefore, this section focuses on estimating the exposure, and analysing the risk.

AAK

AAK uses chrysotile in two high-pressure electrolysis units for hydrogen production. Chrysotile is used in the gaskets and in the diaphragms in these units. Chrysotile is located within the cells and thus, not accessible to AAK employees. The cells are prepared by the chrysotile supplier (IHT[1], Switzerland) and only whole sealed cells have been imported to the AAK site. Therefore, although chrysotile is in continuous use in the electrolysis units, no chrysotile is handled at the site. As a result, there are no apparent points of exposure in the standard process activities at the site. Furthermore, the volume of chrysotile in the electrolysis units is relatively low totalling to about 7.5 tonnes.

Chrysotile containing cells within the blocks are replaced with cells with new chrysotile-containing diaphragms during refurbishment of the equipment every 10 to 15 years. There is no exposure to the chrysotile during these refurbisment activities, because only the sealed cells are handled at the site, not the chrysotile or the diaphragms themselves.

The latest refurbishments for the two machines were done in 2006 and 2010. No chrysotile containing blocks have been imported to the site since 2010. AAK has decided to transfer to a new technology and therefore there is no need for further refurbishment of the electrolysis units in the future. The refurbishment (mounting and dismounting the cells, for the transportation of new and used cells containing diaphragms), and any handling of chrysotile prior to that is done in Switzerland by IHT Switzerland. The same company takes care of the waste handling of diaphragms containing chrysotile after the refurbishment. No chrysotile is handled at the AAK site. As a result, based on the information on the process design provided by the company, the risk from chrysotile use at the AAK site is negligible.

Dow

At Dow the process consists of two subprocesses i.e., use of diaphragms containing chrysotile and use of chrysotile fibres to maintain the diaphragms during their use in the process.

The diaphragms are in the cells such that they, and the chrysotile in them, are not accessible to employees. Furthermore, inside the diaphragms, the chrysotile fibres are embedded into a plastic matrix and operated as a wet process, which prevents chrysotile

[1] IHT, Industrie Haute Technologie SA, located to Monthey, Switzerland, is the supplier of equipment and service for high-pressure electrolysers of Lurgi design.

fibre release. The potential points of exposure are managed by the process design and where needed (e.g. maintenance activities), by the use of personal protective equipment (PPE).

Bulk chrysotile is brought to the site as dry fibres. As exposure to dry fibres is considered dangerous all handling of the dry chrysotile fibres is fully automated. The dry fibres are mixed with brine in an automated process to produce slurry, which is used to maintain diaphragms in cells while in operation. The process design i.e., automation and the use of robots, minimises the exposure. Furthermore, PPE is used where needed e.g. during any periodic cleaning or maintenance tasks.

When diaphragms are worn out and need to be replaced, the chrysotile is washed out from the cells and the waste is heat-treated in a special oven, such that the fibre structures are destroyed. Dow reports the resulting waste to be non-hazardous and usable as filler in construction.

According to the annual monitoring carried out by Dow, the workers exposure to chrysotile is mostly below 100 fibres per m^3 and meets the requirement of Article 17 of the Hazardous Substances Ordinance of Germany (Bundesgesetzblatt, 2010)[2]. The compliance with the German requirement is due to the automated process design and due to the use of PPE during periodic cleaning and maintenance activities. The results of the monitoring support the conclusion.

A.3.2 Justification that action is required on a Union-wide basis

The existing entry 6 of REACH Annex XVII applies across the EU. Any modification to the entry clearly needs to be made on a Union-wide basis.

A.3.3 Justification that the proposed restriction is the most appropriate Union-wide measure

In the case of AAK, there is no exposure for chrysotile in the use of the electrolysis units and thus potential risks from existing use of chrysotile are considered negligible. AAK has already decided to move away from chrysotile in the next 5-10 years. The potential risks would not be affected by earlier removal of chrysotile from the production system. On the other hand, the earlier removal would be costly as transfer to chrysotile-free technology requires several years.

In the case of Dow, exposure is minimized due to the risk management measures implemented and supported by the monitoring data, and potential risks from the use of chrysotile are controlled. ECHA has not received any information to suggest that the replacement of chrysotile-based technologies should be taking place faster than currently planned by the company.

Dow is currently testing a possibility for an alternative substance to be used instead of chrysotile in its operation. However, the alternative requires still further production level testing. The decision about adopting the substitute can be made 2015. If this alternative proves to be technically and economically feasible, the adoption could be completed by 2025. According to Dow the adoption would cause an additional cost of €70 million (or €5.8

[2] Bundesgesetzblatt (2010) stipulates that the maximum concentration can be 1000 fibres/m3 for chlor-alkali electrolysis processes.

million per annum) to the company. This cost is a result of Dow's effort under the current legislation. The proposed amendment to entry 6 would not change this cost.

Given the overall objective to phase out use of chrysotile in the EU and the uncertainties related to the viability and timing of alternatives to chrysotile an amendment to entry 6 is proposed. This is described in Section A.1. This proposal is simple and transparent, and it gives a clear end date for the derogation based on the best current knowledge about the substitutes. The proposed end date is based on the best information at the time of writing of this report. As that the restriction process (up to decision) will take up to two years, the end date in the entry can easily be modified before adoption of the entry, should important new information become available. Such information would in particular be Dow's results on the viability of the alternative that it is testing at the time of writing of this report. The proposal for the amendment of entry 6 is considered to be the most appropriate Union-wide measure.

B. Information on hazard and risk

B.1 Identity of the substance(s) and physical and chemical properties

B.1.1 Name and other identifiers of the substance(s)

IUPAC name: Chrysotile

EC no: -

CAS no: 12001-29-5, 132207-32-0

B.1.2 Composition of the substance(s)

Not relevant for this proposal as the current substance identification is not being changed.

B.1.3 Physicochemical properties

Not relevant for this proposal.

B.1.4 Justification for grouping

The existing entry 6 in REACH Annex XVII is concerned with several forms of asbestos, and this restriction report is only concerned with one of them, chrysotile, which has a specific derogation in the entry. There is no intention to affect the other members of the group with the modification proposed in this report.

B.2 Manufacture and uses

B.2.1 Manufacture, import and export of a substance

Currently, only two legal entities are making a use of exemptions granted by Member States in accordance with the provisions of paragraph 1 of entry 6 of Annex XVII, namely, *AarhusKarlshamn Sweden AB (*AAK) and *Dow Deutschland Anlagengesellschaft mbH (*Dow). The Polish company mentioned in the Commission's request no longer uses chrysotile containing diaphragms (Polish Ministry of Economy, 2013). The companies do not manufacture or export any chrysotile fibres or produce or export chrysotile containing articles.

AAK is a relatively small user of chrysotile as it has only a total of 7.5 tonnes of chrysotile in its two electrolysis units and no on-site maintenance of the diaphragms containing the chrysotile is required. Given the periodic replacement of diaphragms about every 15 years, it would need to import about 3.8 tonnes of chrysotile in diaphragms for one of the units every 7-8 years. However, no further imports are expected , as the company has decided to transfer to chrysotile-free production technology in the next 5 to 10 years.

Dow currently imports diaphragms from the US which contain chrysotile, as well as chrysotile fibres from Brazil for the on-site maintenance of the diaphragms. On average, the total volume imported per year is about 71 tonnes (21 tonnes within diaphragms and 50 tonnes as bulk chrysotile fibres in sealed bags).

B.2.2 Uses

The two companies operate two different electrolysis processes:

- AAK produces hydrogen by means of the electrolysis of water. The electrolytic decomposition occurs by conducting an electrical current through an electrolyte of potassium hydroxide. The plant uses two electrolysis units containing chrysotile diaphragms; each electrolysis unit consists of four cellblocks each containing 135 cells, having in total 540 individual cells per unit. See annex 1 for further details.

  The main role of the diaphragm containing chrysotile is to keep hydrogen and oxygen separated during the process. If the barrier were to fail, hydrogen would diffuse and blend with oxygen in order to form an explosive gas mixture at normal working pressure 32 bars. In case of ignition of the explosive gas mixture at this pressure, a 9-10 fold increase in pressure to about 300 bars could develop, with the potential to cause significant damage.

  In addition, a gasket component of the diaphragm, consisting of chrysotile encased in PTFE acts as a tightening material and electrical insulator between the hydrogen and oxygen sides of the electrolysis cells. If this connection is not completely tight, this could again lead to the formation of explosive gas, or the electrolyte - concentrated potassium hydroxide at 90°C and at high pressure – could be released into the production room with a risk of injury to employees and damage to machinery.

  Chrysotile is in continuous use in the electrolysis process, in the form of diaphragms, but no chrysotile fibres are handled or brought to the site. During replacement, cells containing chrysotile are brought to the site, and the old one removed, by the diaphragm supplier. The used cells containing the diaphragms are replaced and the diaphragms themselves are never handled at the site. No chrysotile has been imported to the site since the last refurbishment in 2010; no further imports are expected due to the closure of the current process.

- Dow uses chrysotile in the production of chlor-alkali, which in turn is used as a feed stock/raw material in an integrated production system at the site. The process produces chlorine (approximately 1 million tonnes/year[3]), (low concentration) sodium hydroxide and a small amount of hydrogen. Dow's electrolysis cells are operated at very low current density levels, thus consuming less energy; according to Dow, there are no technical alternatives for chrysotile in low current density production systems.

  In the Dow process, an hydraulically-permeable, microporous chrysotile diaphragm in the cells separates the anolyte and catholyte compartments and prevents the explosive reaction of hydrogen or sodium hydroxide with chlorine. In the process, the feed brine flows into the catholyte compartment and mixes with sodium hydroxide solution. Operating conditions in the chlor-alkali electrolysis process are severe (e.g. pH ranging from 2 in the anolyte to 12 in the catholyte compartment, temperatures up to 90°C, and the presence of sodium hypochlorite and chlorate). Chrysotile is suitable for such harsh conditions.

  Dow replaces the diaphragms in 8-10 % of the cells every year. Additionally, Dow annually uses 40-50 tonnes of chrysotile fibres for the maintenance of the diaphragms. The fibres are mixed with brine to prepare a wet slurry, which is frequently added to the

[3] This is about 5% of the global and over 60% of the European annual capacity of chlor-alkali diaphragm installations (A German Member State "Report on the derogation for diaphragms containing chrysotile pursuant to point 6 of Annex XVII to the REACH Regulation" (European Commission. 2011)).

cells to maintain the diaphragms and to prolong their lifetime. The fibres are stored at the site in sealed bags in a dedicated storage area (see exposure scenarios in the annex 2 for more detail). Dow recently imported a large amount of chrysotile from Canada in advance of the closure of Canada's last asbestos mine (Jeffrey Mine) in 2012 (Righton Canada, 2012). Thus, Dow currently has an inventory of 540 tonnes of fibres, which would last for 10 years at the current rate of consumption.

The chrysotile which is not destroyed in the course of the harsh electrolysis process is evacuated from the installation and transported to the incineration system on site. Similarly, wet chrysotile is removed mechanically from the used diaphragms and incinerated. The residue is used as an inert closing layer and construction material in waste disposal landfills.

B.2.3 Uses advised against by the registrants

Not relevant for this proposal.

B.3 Classification and labelling

B.3.1 Classification and labelling in Annex VI of Regulation (EC) No 1272/2008 (CLP Regulation)

Table B. 1 - Classification of chrysotile

Index No	International Chemical Identification	EC No	CAS No	Classification		Labelling		Notes
				Hazard Class and Category Code(s)	Hazard statement Code(s)	Pictogram, Signal Word Code(s)	Hazard statement Code(s)	
650-013-00-6	Asbestos	—	132207-32-0 12001-29-5	Carc. 1A STOT RE 1	H350 H372 **	GHS08 Dgr	H350 H372 **	
650-013-00-6	Asbestos	—	132207-32-0 12001-29-5	Carc. Cat. 1; R45 T; R48/23		T R: 45-48/23 S: 53-45		E

Source: Annex VI of the CLP regulation (EC 2008)

B.3.2 Classification and labelling in classification and labelling inventory / Industry's self-classification(s) and labelling

There have been 24 notifications made to the Classification and Labelling Inventory for chrysotile all using the harmonised classification.

B.4 Environmental fate properties

Not relevant for this proposal.

B.5 Human health hazard assessment

B.5.1 Toxicokinetics (absorption, metabolism, distribution and elimination)

Not relevant for this proposal.

B.5.2 Acute toxicity

Not relevant for this proposal.

B.5.3 Irritation

Not relevant for this proposal.

B.5.4 Corrosivity

Not relevant for this proposal.

B.5.5 Sensitisation

Not relevant for this proposal.

B.5.6 Repeated dosed toxicity

Chrysotile has the potential to induce non-neoplastic lung damage (IPCS (1998) Environmental Health Criteria 203). The prime concern is asbestosis, generally implying a disease associated with diffuse interstitial pulmonary fibrosis accompanied by varying degrees of pleural involvement. Asbestotic changes are common following prolonged exposure of 5 to 20 fibres per millilitre. This is equivalent to 5,000,000 and 20,000,000 fibres per m^3. CSTEE stated there is uncertainty and debate regarding whether the two pathological end-points of asbestosis and lung cancer are independent or whether fibrosis is a necessary pre-requisite for cancer (CSTEE 1998).

B.5.7 Mutagenicity

Not relevant for this proposal.

B.5.8 Carcinogenicity

CSTEE (1998 and 2002) was of the opinion that chrysotile is a human carcinogen causing both mesotheliomas and lung cancer. In rats, chrysotile has produced mesotheliomas and lung carcinomas after inhalation and mesotheliomas after intrapleural administration.

IARC (2012) is of the opinion that there is sufficient evidence in humans for the carcinogenicity of all forms of asbestos (including chrysotile). Asbestos causes mesothelioma and cancer of the lung, larynx, and ovary. Also positive associations have been observed between exposure to all forms of asbestos and cancer of the pharynx, stomach, and colorectum. There is sufficient evidence in experimental animals for the carcinogenicity of all forms of asbestos (including chrysotile). All forms of asbestos (including chrysotile) are carcinogenic to humans (Group 1A).

B.5.9 Toxicity for reproduction

Not relevant for this proposal.

B.5.10 Other effects

Not relevant for this proposal.

B.5.11 Derivation of DNEL(s) / DMEL(s)

Not relevant for this proposal.

B.6 Human health hazard assessment of physicochemical properties

Not relevant for this proposal.

B.7 Environmental hazard assessment

Not relevant for this proposal.

B.8 PBT and vPvB assessment

Not relevant for this proposal.

B.9 Exposure assessment

B.9.1 General discussion on releases and exposure

B.9.1.1 Summary of the existing legal requirements

Entry 6 paragraph 1 of REACH Annex XVII prohibits the manufacture, placing on the market and use of chrysotile and of articles and mixtures containing those fibres added intentionally.

The entry gives a possibility for a Member State only to exempt the placing on the market and use of diaphragms containing one of the fibres, chrysotile, for existing electrolysis installations until they reach the end of their service life, or until suitable chrysotile-free substitutes become available, whichever is the sooner.

Two companies are currently relying on such Member State exemptions in order to be able to use chrysotile in their electrolysis installations (see Section E.1.1).

In addition, *Directive 2009/148/EC of 30 November 2009 on the protection of workers from the risks related to exposure to asbestos at work* applies to activities where workers are or may be exposed to dust arising from asbestos or materials containing asbestos. Employers must carry out a risk assessment to determine the nature and degree of the workers' exposure and to ensure compliance with the relevant limit values. Qualified personnel shall regularly measure asbestos-in-air concentrations against a maximum limit value for airborne concentration of asbestos, which is 0.1 fibres per cm^3 (i.e. 100,000 fibres per m^3) as an eight-hour time-weighted average (TWA). If it is foreseeable that the limit value cannot be achieved by technical measures the employer shall ensure protection by providing proper personal protective equipment, putting up warning signs and preventing the spread of asbestos dust. Employers shall also provide appropriate training for workers. Work areas with any potential for exposure shall be demarcated, indicated by warning sign and access shall be forbidden to those who are not required to enter. The Directive further requires that each worker's state of health must be assessed, including a specific chest examination, prior to exposure to asbestos, and subsequently at least once every three years during exposure.

B.9.1.2 Summary of the effectiveness of the implemented operational conditions and risk management measures

AAK

The use of chrysotile only in enclosed diaphragms, which are supplied to and taken from site by a specialist company (who are also responsible for disposal) means there is no expected exposure and no specific risk management measures required for protection of AAK workers (see section B.9.3 Uses below for further details). No exposure data is available.

Dow

Operational conditions and risk management measures implemented at Dow Stade plant are described in the table B.3 and in further detail in the Annex 2 based on the information provided by Dow.

Table B. 2 - Overview of recommended and implemented measures to control asbestos risk in Dow

General Measures	
Recommended according to Table E.3-1 (Guidance on IR&CSA part E (ECHA 2012)	**Implemented in Dow**
Very high level of containment required, except for short term exposures e.g. taking samples	All processes are conducted in fully closed systems and as much as possible by remote and mechanical handling to minimise manual work. Where certain activities cannot take place fully in closed systems (e.g. dismantling of cells; coupling/decoupling of hoses), the equipment or equipment parts which could contain or be contaminated by asbestos fibres are wetted or fully submerged, thereby preventing any asbestos fibres from becoming airborne. When flexible hoses are applied for product transfer, hoses are flushed/purged with brine to ensure all asbestos has been flushed into the cells before the decoupling of the hoses. All contaminated water is directed to a closed water treatment system for removal of asbestos (refer to the description of waste handling in the exposure scenarios).
Design closed system to allow for easy maintenance	The cells with the diaphragms are designed in such a way that during service life no maintenance in the cell itself is needed. Maintenance and cleaning is done on the outside of the cells; here no opportunity for contact with the asbestos is possible, as the cell is a closed system. The equipment in the asbestos handling room requires very little maintenance.

	During maintenance and cleaning activities, operators have to comply with very strict Standard Operating Procedures (refer to the description in exposure scenarios).
If possible keep equipment under negative pressure	All critical working rooms/areas are ventilated and under negative pressure to prevent dispersal of fibres to other working areas. All critical equipment with openings to the surrounding environment are under local extraction ventilation. All extracted air is filtered through HEPA filters before release to the environment. All used filter materials are disposed of by incineration (for details on the waste handling, refer to the description in the exposure scenarios).
Control staff entry to work area	The total site is fenced and access controlled. The Stade site has an admission procedure is in place as well as a separate admission procedure for cell services. Access to the cell services building is controlled via the control room. All employees have to sign in and obtain a work permit or are working according to safe working procedures. A limited number of dedicated employees is allowed to enter and to work in the dry asbestos handling room.
Ensure all equipment well maintained	A management system is in place in the form of the 'Preventive Predictive Maintenance' (PPM) programme. This is a documented computer system to ensure that all maintenance activities are carried out in a timely manner based on permits, legal requirements and supplier definitions. Maintenance employees are trained accordingly.
Permit to work for maintenance work	All activities are covered by safe work permits and company-approved working procedures.
Regular cleaning of equipment and work area	Housekeeping procedures are in place, with associated training. Special wet cleaning machines are used and regularly maintained.
Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed	Dow compiles and maintains a strict set of EH&S standards as part of its Operational Discipline Management System (ODMS) to ensure compliance with legal requirements

	and to minimise risks for employees and the community. All employees are trained in using so called: Behaviour Based Programs (BBP) Learning Experience Report (LER)
Training for staff on good practice	All operators are trained annually both to enhance hazard awareness as well as their technical and organisational capabilities to safely execute their activities. All working procedures are included in the training. If working procedures are modified, specific training is provided on the modifications.
Procedures and training for emergency decontamination and disposal	An emergency procedure is in place with associated training on an annual basis. The need for emergency decontamination is highly unlikely, due to the closed systems under negative pressure. Since start-up (1992) of this system, no emergencies have been experienced.
Good standard of personal hygiene	Regardless of the work place, employees have to use the so called black and white changing rooms (clean and dirty sides with showers in-between). Employees have to change when they enter, and shower and change when leaving the workplace. When activities in the asbestos handling room are required, an additional lock system including the shower room must be used. In this case, employees only using disposable clothing. All employees are well trained and experienced in the use of PPE.
Recording of any 'near miss' situations	Dow is registering near misses in a global system called (GIRD) Global Incidents Reporting Database (this has not been further investigated). Depending on the type and level of concern a root cause investigation is initiated to prevent re-occurrence (done via the “Apollo” methodology).
	An annual health surveillance programme is in place which includes the following: anamnesis (medical interview), physical examination, spirometry and thorax x-ray. These examinations are carried out before taking a position with Dow, and then every

	12 to 36 months, defined by the physician (including examination after the employment). The programme is carried out by the GVS (Gesundheitsvorsorge), an organisation which is part of the German Statutory Accident Insurance. This information has not been evaluated by ECHA.
	Annual workplace asbestos fibre concentration monitoring at the workplace to evaluate exposure to asbestos. This programme is carried out by the GSA, a certified provider, and it was defined under the supervision of the BG.
PPE Measures	
Recommended according to Table E.3-1 (Guidance on IR&CSA part E (ECHA 2012)	**Implemented in Dow Stade**
Substance/task appropriate respirator	When activities are undertaken, where there might be some opportunity for exposure (e.g. cleaning/maintenance activities), workers wear disposable clothing and a full face mask (Dräger Panorama Nova RA; meeting EN136 minimum requirements) with a powered air filtering unit with P3 filter cartridge (Dräger X-plore 7300 Filter TH/M3 PSL; meeting EN 12941:1998 / EN12942:1998 minimum requirements). Used cartridges/filters are disposed of by incineration (for details on the waste handling, refer to the description in the exposure scenarios).
	General personal protective measures: wearing of safety clothing and protective safety gloves. Safety clothing: Tyvek Classic Xpert cat. 3 Safety gloves: UVEX PROFAS Profi Trader cat.II, EN 388 Helmet: UVEX Safety shoes: UVEX When activities in the asbestos handling room are required, an additional lock system including the shower room must be used. In this case, employees use only disposable clothing.

Note: In the exposure scenarios for the relevant uses, measures related to the use of closed systems, other technical and organizational measures to minimise exposure and personal protective measures (e.g. use of respirators) will be referred to specifically. The implemented measures listed in the table above that are related to a good standard of

occupational hygiene and safety (controlled access, use of working procedures, training in normal and emergency situations, management supervision, good personal hygiene, exposure monitoring, and health surveillance program) are referred to as: Advanced Occupational Health and Safety Management System in place (certified according to ISO 9001 and 14001).

B.9.2 Manufacturing

Not relevant for this proposal.

B.9.3 Uses

B.9.3.1 General information

Not relevant for this proposal.

B.9.3.2 Exposure estimation

B.9.3.2.1 Workers exposure

AAK has not established specific chrysotile-related monitoring as there is considered to be negligible exposure as chrysotile is enclosed in the machinery and the fibres are never handled at the site.

Dow has provided ECHA with monitoring information. Monitoring data show fibre concentrations generally below 100 fibres per m^3 and always clearly below the German legal limit.

There are two uses of asbestos identified in Dow-Stade:

- Use of asbestos/brine slurry as reconditioning agent (closed systems)
- Use of asbestos in diaphragm cells (closed systems)

Dow has provided several exposure scenarios for the handling of asbestos fibres until they are included into the diaphragms (see Annex 2).

Table B. 3 lists all the exposure scenarios (ES) relevant for the restriction proposal.

Table B. 3 - Overview of exposure scenarios and contributing scenarios in Dow

Identifiers*	**Market Sector**	**Titles of exposure scenarios and the related contributing scenarios****	**Tonnage (tonnes per year)**
ES1 – IW1	n/a	Use of asbestos/brine slurry as reconditioning agent (closed systems) (SU3) Contributing scenarios worker: • Receival and storage of fibre packages (PROC1) • Dumping of fibres in mixing vessel (PROC1) • Formulation of slurry (PROC1) • Filling of feeding containers (PROC1) • Feeding of slurry to electrolysis cells (PROC1) • Flushing of feeding lines and (de)coupling hoses (PROC3) • Maintenance and cleaning dry asbestos handling room (PROC8b) • Waste handling (PROC8b)	50
ES2 – SL-IW1	n/a	Use of asbestos in diaphragm cells (closed systems) (SU3) Contributing scenarios worker: • Receival and storage of electrolysis cells, including diaphragms (PROC1) • Assembly of electrolysis cells (PROC3) • Installation of electrolysis cells (PROC3) • Service life of electrolysis cells (PROC1) • Disconnection of electrolysis cells from production line and intermediate storage in water pit (PROC3) • Dismantling and cleaning of dismantled parts (PROC8b) • Waste handling (PROC8b)	21

***** Industrial end use at site: IW-#: C-#, Service life (by workers in industrial site): SL-IW-#.

****** ECHA recommends the Use Descriptor system to systematically describe uses (Guidance on information requirements and chemical safety assessment; Chapter R.12: Use descriptor system); although the description of the uses and related contributing scenarios should be evident from the text itself, for consistency reasons also the Use Descriptor system has

Identifiers*	Market Sector	Titles of exposure scenarios and the related contributing scenarios**	Tonnage (tonnes per year)
been applied when describing the two uses.			

There are no validated exposure models available to estimate exposure to asbestos fibres. Where measured exposure data for activities are available, these have been used to compare with the reference value. As recommended in the "Guidance on IR&CSA, Chapter R.14" (ECHA, 2010), the 90 percentile upper confidence level is used for comparison with the benchmark value.

With respect to the available measured data, based on the permit granted by the Gewerbeaufsichtsamt (Trade Supervisory Office) and defined by the German "Berufs-Genossenschaft für Rohstoffe und chemische Industrie" a yearly monitoring programme is followed. An overview of the collected data is listed in Annex 3. A certified German service provider, Gesellschaft für Schadstoffanalytik mbH (GSA), performed the sampling and analysis. Additional information on the sampling points is provided in Annex 2.

For practical reasons (viz. the type of sample pumps used to sample the required volume of air) it is not possible to perform personal monitoring. All measured data are based on stationary measurement. However, as there are no activities performed by workers that lead to direct and local release of asbestos in the breathing zone of workers, and because the sampling points are located very close to where activities are executed by workers, these stationary data can be considered representative for workers' personal exposure. Supporting evidence for this assumption is the low variability in measurement results (Geometric Standard Deviation (GSD) varies between 1.00 and 1.56).

The measured data are of good quality. The value of 290 is 29% of the German limit and can be seen to be within fluctuation as Dow is close to the detection limit[4]. Where measurements have been carried out, in general six data points are available. According to the "Guidance on IR&CSA, Chapter R14" (ECHA, 2010), at least six data points should be presented to adequately describe the exposure of a single work activity within one company. This requirement is thereby met in most situations.

[4] The nature of the fibres measuring method (VDI guideline 3492 (DAR, 2013)) allows a certain "confidence interval" (see on page 3) resulting in a "fluctuation" of the values which are defined by the measuring method (Poisson-distribution) - therefore one may have a variation of values at the sample point given by the measuring method (According to Dow, e.g. in 2013 the value is 100 fibres/m^3 at this sample point (Dow, 2013)).

Table B. 4 - Maximum fibre equivalents from six sampling points for comparison with benchmark exposure level at Dow, Stade in 2008-12

Year	Maximum fibre equivalents fibres/m^3
2008	-
2009	100
2010	-
2011	100
2012	290

Source: Monitoring data provided by Dow (2013)

B.9.3.2.2 Consumer exposure

Not relevant for this proposal.

B.9.3.2.3 Indirect exposure of humans via the environment

Not relevant for this proposal.

B.9.3.2.4 Environmental exposure

According to industry information, there is no exposure to the environment from the use of chrysotile in the two plants.

Dow reports that all extracted air is filtered through HEPA filters before release to the environment. All used filter materials are disposed of by incineration (for details on the waste handling, refer to the description in the exposure scenarios). All contaminated water is directed to a closed water treatment system for removal of asbestos (refer to the description of waste handling in the exposure scenarios).

B.10 Risk characterisation

B.10.1 Use

B.10.1.1 Human health

B.10.1.1.1 Workers

For the purpose of estimating the risk associated with the exposure of workers to asbestos fibres in the context of this restriction report, a benchmark (maximum) exposure level based on the exposure-risk relationship assessed by the German authorities is proposed (BAuA, 2008). In deriving this exposure-risk relationship, the assessment of unit risk for fatal asbestos-induced lung cancer and mesothelioma as performed by the US EPA on the basis of epidemiological studies served as a starting point (EPA, 2013). According to the derived linear exposure-risk relationship for asbestos, a concentration of 10,000 fibres/m^3 corresponds to an excess lifetime cancer risk for workers of 4/10,000. The REACH Guidance

on information requirements and chemical safety assessment, Chapter R.8 Appendix R.8-14 (ECHA, 2012) states "that the decision point for 'acceptable' lifetime (i.e. working life of 40 years) cancer risk levels used for workers are generally around 1/100,000 but higher or lower levels have been considered to be tolerable under certain circumstances". The excess lifetime cancer risk of 1/100,000 corresponds to a concentration of 250 fibres/m^3, according to the German derived exposure-risk relationship. This concentration is therefore used as a benchmark level in evaluating the exposure of workers in the context of this restriction report.

In addition, the European Commission[5] has issued a binding European OEL of 100,000 fibres/m^3.

Table B. 5 - Type of risk characterisation

Route	Type of effect	Type of risk characterisation	Hazard conclusion (see section 5.11)
Inhalation	Systemic Long Term[6]	Semi-quantitative	No DNEL or DMEL for inhalation (systemic long term) is available for asbestos. Instead, for the risk assessment, the benchmark figure referred to above is used.
	Systemic Acute	Not required	Covered by assessment of systemic long term effects.
	Local Long Term	Not required	No hazard identified
	Local Acute	Not required	No hazard identified
Dermal	Systemic Long Term	Not required	No hazard identified
	Systemic Acute	Not required	No hazard identified
	Local Long Term	Not required	No hazard identified
	Local Acute	Not required	No hazard identified
Eye	Local	Not required	No hazard identified

5 *European Directive 2009/148/EC* (Official Journal, 2009)

6 Exposure to asbestos may lead to adverse effects of a non-malignant nature (e.g. pleural changes (pleural plaques, diffuse pleural thickening) and asbestosis) and of a malignant nature (e.g. lung cancer, mesothelioma). Both types of effects may occur after high intensity and/or long-term exposure to asbestos (although effects in general are associated with long term exposure). As the carcinogenic effects are the most critical, the assessment will focus on these effects. Although there is evidence that carcinogenic effects may be associated to short term high level of exposure, it is highly unlikely that such exposure may occur during the application of asbestos in Dow, due to nature of the application and controls in place. Therefore, this will not be addressed in this assessment, it is assumed to be sufficiently covered by the assessment for the long term systemic effects.

Comments on assessment approach and risk management related to toxicological hazard:

A semi-quantitative assessment has been carried out for long-term systemic hazards via inhalation.

Comparison with measured data

The benchmark value of 250 fibres/m^3 is compared with available exposure information and is lower in all but one case (see the Table B.5). This supports that the risk is minimised.

Qualitative assessment

In addition, a qualitative assessment has been conducted. Based on its effect (asbestos is classified as a, category 1 carcinogen), asbestos should be allocated to the high hazard band, according to Table E.3-1 (Guidance on IR&CSA; part E (ECHA, 2012)). In table B.3 a set of measures is recommended to control and minimise the risks of exposure to asbestos. The table lists these recommended measures and indicates how these measures are implemented in Dow in Stade to minimise the risk of exposure to asbestos.

There are many small tasks with a potential exposure, in which a single task takes only 1-2 hours each (such as “coupling hoses”, “preparing slurry”, “putting cells into the pit”, “cleaning the cells”). The same worker may carry out many such tasks during a single day and thus, could potentially be exposed to asbestos in several consecutive tasks during the same day. For instance, the same worker can do the following tasks consecutively during a single day:

- “coupling hoses” and “preparing slurry”,
- “ putting cells into the pit” and “cleaning the cells”
- “unload cells” and “final cell assembly”

However, this is not expected to change the outcome of the assessment as all exposures are negligible and risks are minimised.

B.10.1.1.2 Consumers

Not relevant for this proposal.

B.10.1.1.3 Indirect exposure of humans via the environment

Not relevant for this proposal.

B.10.1.1.4 Combined exposure

Not relevant for this proposal.

B.10.1.2 Environment

Neither AAK nor Dow has reported any release of asbestos to the environment. ECHA has no reason to believe that an environmental assessment is required.

B.11 Summary on hazard and risk

AAK

AAK uses chrysotile in two high-pressure electrolysis units for hydrogen production. The chrysotile is used in the gaskets and in the diaphragms in these units. Chrysotile is located within the cells and thus out of reach of AAK employees, and no chrysotile is handled at the site. As a result, there is no worker exposure to chrysotile during the standard process activities at the site. Neither is there exposure to the chrysotile during the periodic refurbishment activities, because only the sealed cells are handled at the site, not the chrysotile or the diaphragms themselves. As a result, the risk from chrysotile use at the AAK site is considered negligible.

Dow

Dow uses chrysotile via their use of diaphragms containing chrysotile and in the form of chrysotile fibres to maintain the diaphragms. The chrysotile fibres in the diaphragms are embedded into a plastic matrix, and the diaphragms are encased within the electrolytic cells. As a result, the diaphragms and the chrysotile in them are not accessible to employees. Any potential points of exposure from handling of diaphragms are minimised by the process design and where needed, by use of PPE. The dry chrysotile fibres are handled via a fully automated process, and mixed with brine to produce a wet slurry. The entire process design minimises the exposure and PPE is used where needed e.g. during any periodic cleaning or maintenance tasks. Any waste slurry and chrysotile from used diaphragms is burned in a special oven, such that the fibre structures are destroyed. The resulting waste is non-hazardous.
According to the monitoring carried out by Dow, the exposure of chrysotile to workers is generally below 100 fibres per m^3. In all but one case, this exposure level is below the benchmark exposure level proposed by ECHA and it clearly meets the current requirement of Bundesgesetzblatt (2010).

The conclusion is that exposure to chrysotile at the Dow site appears to be minimised. The air monitoring confirms this conclusion.

C. Available information on alternatives

C.1 Assessment of alternatives

AAK

AAK has outsourced all handling of chrysotile to its supplier (IHT, Switzerland). AAK has not taken part in identifying or developing an alternative substance to replace chrysotile. The task has been left to the supplier of the diaphragms. According to the supplier, no suitable alternative exist for the electrolysis equipment that are used at the AAK site

There are alternative methods to meet the hydrogen needs. AAK has identified 2-3 different methods for hydrogen production not requiring chrysotile. Separately, also the purchase of hydrogen has been assessed, however, due to e.g. large volume needs this has been found not to be a feasible option.

AAK has already decided to adopt an alternative hydrogen production methodology (not involving chrysotile), due to aging of the current machinery and other increases in maintenance costs. AAK has reviewed alternative production techniques to replace its current technology. Those include, for instance, low pressure electrolyser, steam reforming or methanol cracking.

A low pressure electrolysis is basically identical to the technology used today, however running at atmospheric pressure. No chrysotile is required in the production process. Functioning chrysotile-free gaskets and diaphragms are available for the low pressure electrolysis.

Another alternative method is steam reforming, the most commonly installed process today for hydrogen production. In a steam reforming process a carbon-based material, usually LP-gas, is chemically broken down over a catalyst at high temperature into a mixture of simple components. Following that, hydrogen is purified out of the mixture in several steps.

The third option, methanol cracking, is run at a lower temperature compared to the steam reforming process, but the process is otherwise much alike the steam reforming process.

In all three alternatives the produced hydrogen has a lower pressure than what is currently needed. Subsequently, a hydrogen compressor, a gas-turbine or a reciprocating piston is required to achieve the 32 bar pressure needed in the hydrogenation processes. This makes the process more cumbersome and causes extra costs compared to the current process, where hydrogen has readily higher pressure. However, they are technically and economically feasible solutions to be used instead of the current aging technology.

Based on foreseen future needs of hydrogen and increasing maintenance costs of the current, aging machinery AAK has already decided to adopt a new production method for hydrogen and to change its production technology to one not requiring chrysotile. The company is currently weighing alternative options. Most likely the technology would be chosen from the three aforementioned methods. After deciding upon the method, the adoption process will start. AAK estimates the process to take about 5 years, due to the technology selection and design and planning work required at the site. Administrative work in order to receive appropriate permissions for the new technology is also estimated to take up to 2 or 3 years.

In sum, AAK plans to be ready to replace its current aging chrysotile-based technology with chrysotile-free in about 5-10 years, i.e. by 2025 at the latest. As long chrysotile-free, the specific choice of the future technology by AAK does not have relevance.

Dow

Dow has designed and further developed its electrolysis machinery by itself, and has been doing R&D over the last forty years in order to find suitable alternatives to replace chrysotile in the process. However, no alternative substance or material has been found for the case of low current density technology used by and for the cells typical for Dow. Dow is currently doing a production level testing on a promising alternative to chrysotile diaphragms. The testing should provide final results during the year 2015. Both technical and economic feasibility of the alternative need to be assessed.

Other companies using a high current density technology in the EU, have already replaced their chrysotile-containing diaphragms with an alternative substance/material. However, according to Dow, those alternatives are not suitable for the Dow's low current density process.

Dow has informed ECHA that the transformation of the system to the high current density one would not be economically feasible. **If Dow could not use its low current density technology, the production of chlor-alkali and other products based on that would become unprofitable in Dow's site** (due to investment and increased energy costs) and would rather be moved elsewhere.

The chrysotile diaphragm in an electrolysis cell is the most important part for a reliable and safe operation. Besides safety, the quality of the products (chlorine, hydrogen & caustic soda) as well as the (low) energy consumption[7] and the long lifetime of the diaphragm depend on the diaphragm design and material. Suitable materials for ensuring long service life in the Dow-specific low current density chlor-alkali electrolysis process are rare due to severe operating condition of the process (e.g. pH ranging from 2 in the anolyte to 12 in the catholyte compartment, temperatures up to 90°C, and presence of Sodium Hypochlorite and Chlorate.

R&D on alternative substance for diaphragms

In the late 1970's, the Dow Chemical Company and some other chlor-alkali producing companies initiated work aiming at replacing asbestos in the diaphragms. This was driven by the interest to find efficiency improvements and innovative developments that would improve the performance and guarantee the safety requirements of the diaphragm technology. As an additional motivation, there was a desire to find substitutes in order not to be solely dependent on imports from chrysotile mining countries. This research for alternatives was continued in the 1980's due to the evidence shown of the long-term carcinogenic effects of asbestos.

Previous attempts to replace chrysotile with once novel materials e.g. fluorised plastics[8] (PTFE), ultimately failed due to the material characteristics of PTFE – particularly its water-absorbent characteristics. Other substances tested were unsuitable due to their chemical inconsistencies or their safety-related shortcomings (chlorine/hydrogen reaction hazard).

The research efforts in the mid-eighties on a potential substitute failed with regard to its workplace and environmental safety as well as its technological and economic performance. In 2011, only two remaining patents are being used at an industrial level: the Polyramix® (PMX®) diaphragm by DeNoraTech and the Tephram® diaphragm by Axiall (former PPG),

[7] Dow reports to have in place one of the lowest energy consuming chlor-alkali technologies.

[8] PTFE first became available as a new material during space travel development in the USA around 1970.

which is currently not yet being used in the EU. Both substitutes have been developed exclusively for the typical diaphragm technologies operating at high current densities. Due to the specific characteristics of the electrolysis cells and the particularly energy-efficient operational mode on the Dow site (with very low current densities), Dow has not so far been successful in applying an appropriate chrysotile-free diaphragm for long-term large-scale operations.

In the year 2009, Dow started its current, multi-year programme for testing the suitability of substitution materials for diaphragm chlor-alkali electrolysis. Laboratory tests began with small-scale diaphragm cells in 2010. Those being successful, Dow has been running tests on 12 production size diaphragms since June 2012. Dow's objective is that the substitute reaches the same performance as chrysotile diaphragms in respect of safety, energy consumption and life-time.

With the limited amount of data at the time of writing this report (January 2014) the future performance of the substitute across a total life cycle can only be projected within a range, e.g. "lowest cost" and "highest cost". In the assessment provided by Dow, the "lowest cost" scenario assumes energy consumption, production efficiency (yield of NaOH, caustic soda) and lifetime to be equal to the performance of the chrysotile diaphragms. In the "highest cost" scenario, it is assumed that the energy consumption would be 5% higher[9], production efficiency would be 5% lower and the lifetime would be only half of the actual (10 years with reconditioning) lifetime of the chrysotile diaphragm. These projections can be narrowed with ongoing test duration. Especially the yield of NaOH (caustic soda) and the actual lifetime of the chrysotile-free under Dow's unique operating conditions need to be demonstrated.

Both long service life of diaphragms and the low energy use of Dow electrolysis process are unique within the chlor-alkali industry. Shorter lifetime and higher energy consumption would result in losses in production efficiency, which would directly impact the economic performance of the plant. Cost effects of the substitute with different assumptions concerning its production efficiency have been assessed in a cost model, and are reported in Section E.1.1.

Dow expects to obtain reliable results concerning the feasibility of the substitute by 2015. Even in the event of positive results, the large installed capacity of chlorine and the full integration of the plants would require a transitional period of approximately 10 years (2015-25) to substitute chrysotile completely. According Dow, such an transition period would be required also for a smooth adoption process and to be able to refine and test the use of the substitute in the on-going process. A shorter period would increase the adoption costs. No more diaphragms containing chrysotile would need to be imported after 2015 in such a scenario.

Assessment of alternative production methodologies

Dow has also studied alternative production technologies available for chlor-alkali production. BiPRO (2006) carried out a detailed socio-economic impact assessment for the use of chrysotile diaphragms in the chlor-alkali electrolysis. According to Dow, the scenarios and consequences of BiPRO (2006) are still valid.

The study revealed, that the substitution of chrysotile diaphragms by membrane technology is economically not feasible and not advantageous for energy efficiency and environmental reasons. Conversion of chrysotile diaphragm technology would require at least €700 million investment. At the same time, this investment would result in technical, environmental and

[9] For instance 5% higher energy consumption compared to Dow's current technology would lead to about 75000 tonnes higher CO_2 emissions per year.

economic disadvantages. Operation costs would increase by about 10% and greenhouse gas emissions would increase by about 15% due to higher electrical energy demand for membranes (BiPRO 2006, page 15). The process integration and product chain at the Dow site would be disrupted. The cost efficiency of the whole Stade location would deteriorate significantly and the site would no longer be competitive for continued production of chlorine, caustic soda, and the chlorine-based downstream product chains. In sum, according to Dow, the Stade site would no longer be profitable if it would need to transfer a membrane technology.

A second option, replacing Dow's existing cells with commercially available chrysotile-free cells would only be possible in a completely new designed plant and would entail conversion costs similar to the cost of converting to membrane technology. The commercially available chrysotile-free cells would offer proven technology, but according to Dow with prohibitive costs, thus this option has not been evaluated further. Additionally, higher energy consumption due to the high current density technology would be expected. That would result in an increased energy use by more than 10% compared to the low current density operation, which in turn means about €12 million per year higher energy cost and an increase of CO2 generation by more than 150.000 metric tonnes per year at the same time.

A third option in the study was to continue using the existing cells but to switch from the current low current density technology to high-current-density Diaphragm technology with Chrysotile-free diaphragms. Compared to the previous option, the investment could be less costly as the existing cells were used. However, it is not obvious that the technology would work (and be profitable) as the cells and diaphragms have not been designed to work together. Secondly, as already mentioned Dow uses its own specially designed diaphragm technology that is optimized to operate at low current density (lowest in industry), resulting in much lower energy demand, compared to technologies available on the market or used by other companies. This technology provides the best energy performance as basis for the downstream operation (chlorohydrin process).

The cell area is the heart of the overall process and is typically comprised of a multiplicity of individual cells that are assembled into a series. A certain numbers of series are then connected electrically to each other in circuit, which terminates at a rectifier which is designed for low current density. There is no competent knowledge available how the critical cell dimensions (electrode height, width and electrode gap) would need to be changed to incorporate one-half the electrode area in a new cell design.

Dow would expect that existing rectifiers and the total electrical system would also need to be modified or replaced. Furthermore, Dow is not aware of any validated data about the operability, process safety and cell lifetime with such modifications. Due to low current density technology the cells Dow is using are much larger than other commercially available cells – switching to high current density technology would require a complete new cell design, again resulting in higher energy consuming process. Additionally the switch involving new cell design would require a research and development program over several years resulting in any case economic losses due to higher energy demand without other benefits.

In conclusion, Dow uses their own specially designed proprietary diaphragm technology that is optimized to operate at low current density resulting in low energy demand relative to others in the industry. Because of the large investment cost and higher energy consumption for a conversion to either membrane or commercially available chrysotile-free diaphragm (high current density) cell technology, Dow has informed to ECHA that these are not economically feasible alternatives and would render the operation of the Dow site unprofitable. The third option appears similarly non-feasible, as there is no proven technology available. The reason is the development and testing work (costs) required,

together with expectedly higher energy costs in the end, even if the technically feasible combination was found.

The only practical alternative appears then to be a chrysotile-free diaphragm, which can be operated at Dow's unique operating conditions. According to Dow, even in the case where a substitute was found, the conversion to asbestos-free alternative would result in additional cost to the company without concrete improvements regarding to safety and with potential disadvantages in carbon emissions. If such a conversion needed to happen in a short time frame, the costs are increased.

If such alternative is not found or if costs are prohibitively high, and further chrysotile use is not allowed, Dow has informed ECHA that the Stade chrysotile diaphragm cells and largely the integrated production process thereafter would potentially face a closure. Subsequently, the production of chemical products based on chlorine, would be subject for reallocation to the Middle East or US gulf coast.

D. Justification for action on a Union-wide basis

The existing entry 6 of REACH Annex XVII applies across the EU. Any modification to the entry clearly needs to be made on a Union-wide basis.

E. Justification why the proposed restriction is the most appropriate Union-wide measure

E.1 Identification and description of potential risk management options

E.1.1 Risk to be addressed – the baseline

The current use of chrysotile is described in Section B. This section describes the expected future use in the EU. Currently, chrysotile is used by two producers, AAK and Dow. AAK has informed ECHA that it will cease to use chrysotile-based technology in about 5-10 years, so Dow will become the only chrysotile user in the EU using the derogation given in entry 6. Therefore this section is focused on Dow, with only relatively minor attention provided to the situation at AAK.

AAK

Exemptions on use

AAK has been importing cells with diaphragms containing chrysotile as part of its production, periodically, every 10 to 15 years, for the renovation of its electrolysis units. Applying the derogation in entry 6 of Annex XVII, The Swedish Chemicals Agency approved an exemption to AAK for the replacement/use of chrysotile in the existing electrolysis units until the end of 2009 or the end of 2010 (Swedish Chemicals Agency, 2009). Based on this exemption, AAK made the renovation in 2010-2011. The envisaged date of the end of the exemption is related to the remaining service life, which is estimated to be 2020/21 for one of the electrolysis units and 2025/26 for the other (Swedish Chemicals Agency, 2011). The exemption for AAK gives an indicative date of the end of the exemption, and it does not lay out any specific monitoring or reporting requirements.

Projected use

AAK uses chrysotile in hydrogen production. Based on previous experience, it would need to refurbish its equipment and import cells with diaphragms containing chrysotile again in 2020/21. However, as a result of increasing maintenance and reliability issues, AAK has decided to replace its electrolysis-based hydrogen production with a chrysotile-free hydrogen production method. The two existing electrolysis units containing chrysotile will be used until the new production method is in place, by 2025 at the latest. There is no need for further imports of chrysotile.

Risk

At the AAK site, the risks from chrysotile use, renovation and disposal are negligible. No further renovations will take place at the AAK site prior to the final dismantling and removal of the equipment as part of the switch to a chrysotile-free alternative technology.

Costs

So long as the existing exemption granted to AAK is allowed to continue, use of chrysotile by AAK will cease by 2025 (and probably earlier), and there are no costs associated with

any restrictions on its use beyond this date. If the existing derogation in entry 6 were to be ended immediately (or prior to AAK's switchover to the alternative technology), AAK would need to suspend temporarily its operations based on hydrogenated fatty acids, or to transport hydrogen from an external supplier (which it has indicated would not be viable over anything but the shortest period). Both of these could be expected to entail significant costs which, in the limit, could mean AAK decided to close this aspect of its business at Karlshamn.

Dow

Exemptions on use

Germany granted a national (not company-specific) exemption covering "*the manufacture and use of diaphragms containing chrysotile for chlorine-alkali electrolysis, including the asbestos-bearing raw materials needed for their manufacture, in systems existing on 01.12.2010 until the end of their use, if: 1) no asbestos-free substitute substances, preparations or articles are available on the market; or, 2) use of the asbestos-free substitute substances, preparations or articles would result in unacceptable hardship, and the concentration of asbestos fibres in the air at the workplace is below 1000 fibres per cubic metre."* (Article 17, Bundesgesetzblatt, 2010).

The German exemption applies in practice currently only to Dow. It does not have an end-date and is valid as long as the specified conditions are fulfilled. Besides not setting the end-date for the exemption, the derogation by Germany appears to cover both diaphragms and raw materials needed for their manufacture. The exemption does not include any monitoring or reporting requirements.

Projected use

Dow uses chrysotile in the production of chlorine, which in turn is used as feed stock/raw material in an integrated production system at the site. The total stock of chrysotile contained within the Dow electrolysis installation is about 270 tonnes. Each year, Dow replaces about 10% of the diaphragms, containing about 21 tonnes of chrysotile, and uses about 50 tonnes of chrysotile fibres for maintenance of the diaphragms. Both chrysotile and the diaphragms containing chrysotile are imported. Dow has recently purchased a large stock of chrysotile fibres and has (at the time of writing of this report) about 540 tonnes stored at the Stade site. With current use, this stock would permit the maintenance of the existing diaphragms for over 10 years.

On 2 December 2013, Dow Chemical Company announced it would sell a bulk of its chlorine operations – a total of 40 plants around the world – as part of its continuing efforts to move away from cyclical commodity products. This sale would concern global chlorinated organics production factories in Stade (Dow Chemical Company, 2013). However, Dow representatives at Stade have informed ECHA that this would not affect chlorine production at the Dow Stade site neither substitution activity or R&D, and that current production plans remain valid. In any case, a simple change in ownership of the Dow site might not be expected to change the projected use of chrysotile. Further information is likely to be received during public consultation on this restriction report between March and September 2014.

Dow has been testing a substitute substance with a view to replacing chrysotile in its diaphragms. If successful, this would allow the continued use of the existing cells and cellblocks, and only the diaphragms would need to be changed. Production-level testing is currently ongoing. The final results are expected in 2015. If the substitute substance is found to be technically and economically viable, Dow has said that it intends to adopt it. The adoption itself would be spread over about 10 years and should be completed by 2025. This

would minimise switch-over costs and permit process development and optimization. However, as the testing is ongoing, there is uncertainty about the feasibility of the alternative, and whether it will be suitable for full-scale adoption. Due to this uncertainty two alternative baseline scenarios are developed: "Baseline A" and "Baseline B".

Under Baseline A, it is assumed that the chrysotile-free alternative is technically and economically viable and that Dow will adopt the technology over the 2015-2025 period. Adoption would follow a normal rate of diaphragm renewal i.e., 8-10% of the diaphragms containing chrysotile would annually be replaced with diaphragms containing the new, chrysotile-free substance.

The maintenance of the diaphragms containing chrysotile is assumed to remain as currently, so the need for chrysotile fibres will continue, but decrease by about 10% every year as the number of diaphragms containing chrysotile declines. Table E.1 presents the annual (declining) demand/use of chrysotile by Dow over the period 2015-25, under Baseline A.

Table E. 1 - Baseline A: Projected annual demand/use of chrysotile by Dow in 2015-25 assuming that the currently tested substitute is viable, tonnes

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	**Total**
Chrysotile within diaphragms	0	0	0	0	0	0	0	0	0	0	0	**0**
Chrysotile fibres for maintenance	50	45	40	35	30	25	20	15	10	5	0	**275**
Total	**50**	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**10**	**5**	**0**	**275**

Source: Dow (2013)

Baseline B assumes that the substitute substance which is currently being tested does not prove to be technically or economically viable and that Dow continues to use chrysotile under the existing exemption. As a result, the need for chrysotile would remain at 21 tonnes per year in diaphragms and 50 tonnes per year as fibres (assuming that the overall production activity on electrolysis in Dow remains the same). Table E.2 presents the annual demand/use of chrysotile by Dow over the period 2015-25, under Baseline B.

Table E. 2 - Baseline B: Projected annual demand/use of chrysotile by Dow in 2015-25 assuming that the currently tested alternative is not viable, tonnes

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	**Total**
Chrysotile within diaphragms	21	21	21	21	21	21	21	21	21	21	21	**231**
Chrysotile fibres for maintenance	50	50	50	50	50	50	50	50	50	50	50	**550**
Total	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**71**	**781**

Source: Dow (2013)

Costs

Dow has provided ECHA with costs estimates for Baseline A, i.e. for adopting the substitute substance, estimated using the Cost Guidelines that are used in the preparation of

restriction proposals (ECHA 2010). The Dow cost model is based on standard economic financial cost-benefit analysis methods that calculate the net present value (NPV) of additional expenditures and investments that are necessary for the new technology implementation. An equivalent annualised cost is also presented. All data used within the cost model are based on publicly available information or Dow internal information shared with ECHA.

In the cost model there are six major components affecting future costs and revenues:

1. initial investment to build the necessary infrastructure for producing and replacing chrysotile-free diaphragms;

2. higher costs of producing the chrysotile-free diaphragms technology versus the current technology;

3. the length of the adoption time;

4. losses in product sales due to lower yields;

5. higher production costs due to increased energy use; and,

6. the lifetime of the chrysotile-free diaphragms.

The period for analysis in the model is 2015–2030. The adoption period for the new chrysotile-free diaphragms is assumed to be 2015-25. The discount rate for converting future revenues and costs into present values is 4% per annum, as per ECHA guidance. Taxes and inflation are excluded from the analysis. Additionally, the cost model includes sensitivity analysis on:

1. output efficiency of the new technology (sodium hydroxide (NaOH) yield is assumed to decrease by 5%);

2. production efficiency of the new technology (electricity consumption is assumed to increase by 5%; and,

3. the durability of the new technology (the lifetime of the diaphragms containing the substitute substance is assumed to decreases to 5 years from the existing 10 years).

In the so-called “highest cost” case, all these less favourable changes are assumed to occur at the same time.

Table E. 3 - Cost for Dow of adopting new chrysotile-free technology under different scenarios over 2015-25 (€ million)

	Lowest cost scenario	Sensitivity to possibly increased costs			Highest cost scenario
		NaOH yield reduction of 5%	Energy consumption increase of 5%	Diaphragm lifetime reduction of 50%	
	(0)	(1)	(2)	(3)	(0+1+2+3)
Initial investment	18.14			13.98	32.12
Additional diaphragm cost	51.12			15.21	66.33
Propylene glycol margin	0.94			0.28	1.22
Reduced NaOH yield		204.41			204.41
Increased energy consumption			50.63		50.63
Total cost	70.19	204.41	50.63	29.47	354.70
Annualised cost	5.77	16.80	4.16	2.42	29.16

Source: Dow (2013)

In the case of full adoption over 2015-25 with no changes in overall efficiency compared with before (the "lowest cost" scenario), the total additional costs to 2030 due to the adoption would be €70m in NPV terms (equivalent to €5.8m per year over the same period). In the "highest cost" scenario, the costs would be €355m (total) and €29.2m (per year), again in NPV terms. Table E.3 gives the results from the different scenarios and breaks the costs down by different components.

When looking at the different cost elements, the largest single component in the "lowest cost" scenario is the costs of the diaphragms themselves, whereas the sensitivity analysis shows that a possible 5% reduction in NaOH yield would be by far the single most important cost element, accounting for more than 50% of total costs in the "highest cost" scenario.

Compared to the "value of output" from the integrated production system related to the chrysotile process – estimated to be approximately €1.1 bn per year[10] – the annual cost of adoption is between 0.5–3% depending on the efficiency of the diaphragms containing the substitute substance. Costs as a proportion of net earnings or profit (a better measure of the benefits of continued production) would be higher than this.

The effects of changing the assumed adoption end-date to 2019 or 2030, instead of the initial 2025, were also estimated (but are not reproduced here). As expected, the shorter time period would be more costly, partly due to higher initial investments required to be able to double the rate of introduction of diaphragms.

Dow considers that the existing entry 6 is the major driver of their search for a chrysotile substitute. It has acknowledged though that a substitute could also alleviate any potential concerns related to supply security and image associated with chrysotile use, although the majority of the compliance costs is said to result from regulatory pressure.

[10] The figure of €1.071bn is an estimate. The exact figure is subject to some variation due to the integrated nature of the process and the difficulty in assigning costs and value accurately.

Under Baseline B, production would continue as now, and there would be no additional costs due to adoption or other activities due to the regulation. Dow report that R&D would continue but at a reduced rate, and an alternative would not be adopted unless it was expected to increase company profitability overall, i.e. it would have negative net costs for Dow.

Risk

The conclusion of Section B9.11 above was that exposure to chrysotile at the Dow site appears to be minimised, which is confirmed by air monitoring data.

Conclusion on the baseline

Besides AAK and Dow, ECHA is not aware of any other installations which are using chrysotile in electrolysis operations in the EU, and entry 6 prevents any plant from starting new use of chrysotile. The projected further need for chrysotile in AAK is zero after 2025. Thus, there would be only one remaining plant in the EU, Dow Stade, potentially using chrysotile after this date. Dow's future use depends on whether it is successful in finding a viable chrysotile-free substitute. If successful, it can start adoption in 2015 and would no longer need to import diaphragms containing chrysotile. About 275 tonnes of chrysotile fibres would be needed for maintaining the remaining diaphragms over the 2015-2025 period. The estimated additional costs due to adoption of the new substitute are NPV €70 million (or €5.8 million per annum) until 2030 if the deployment is fully successful. These costs could increase up to €355 million (or €29 million per annum) depending on a number of factors. These costs represent lower-bound estimates of the costs to Dow of closing their chlor-alkali operations – if costs of switching to alternative were higher than the costs of closure, Dow would opt to shut down.

If the deployment of the substitute substance does not succeed, Dow would continue to use about 71 tonnes of chrysotile per annum or about 781 tonnes between 2015 and 2025. On the other hand, there would be no additional cost for Dow in this case. Dow has reported that it would continue to undertake research into chrysotile-free alternatives, as part of its normal R&D programme to improve business efficiency and performance and reduce risks. However, without the regulatory pressure an alternative would only be adopted if it were to result in a net improvement, i.e. a reduction in net costs.

E.1.2 Options for restrictions

There is a continued demand on the part of AAK and Dow to be able to use chrysotile-based technologies until at least 2025 (in Dow's case, possibly earlier for AAK). Risks of continued use are minimal in both cases. The costs of switching to alternatives – and the time required to undertake such a switch – are significantly positive. The costs of immediate closure are at least as big, both for the companies involved and the local and wide economies. Therefore, on the basis of a comparison of the benefits and risks of continued use, ECHA concludes that the continued use of chrysotile by these the two companies is justified, at a minimum during the introduction of the chrysotile-free technology, and indeed also if no such technology is available. Therefore, ECHA does not propose a termination of the derogation, either with immediate effect, or before such alternatives are available.

The existing entry 6 therefore appears valid as such, and thus, one option is not to amend the entry at all. This would have the advantage of having limited implications in terms of administrative and legislative burden. The main motivation for proposing options to change the current entry is to improve clarity and transparency of the existing derogation. Besides differing incentives towards the companies, the options may have somewhat different costs of regulating the remaining use. There are also some differences in how the administration of the restriction would be carried out.

ECHA considers that any modification to the entry should include the addition of a reporting requirement. Five options to modify the entry are described. None of them is designed to affect directly the costs of replacing chrysotile. However, all options create some additional incentives and regulatory pressure for replacement. The estimated impacts on human health are essentially the same (and negligible) for all options.

The proposed reporting requirement

One deficiency in the current entry 6 is that it does not stipulate any reporting requirements for those companies that are given an exemption. It is reasonable that a company receiving an exemption should report to the authorities how it is being complied with and in particular if it foresees any difficulties. This would permit better monitoring, enforcement and revision as appropriate. ECHA proposes that in the options described below there would be a reporting requirement consisting of the following:

1. An annual report giving the amount of chrysotile placed on the market and used in diaphragms, compatible with the derogation.

2. Results of the monitoring of exposures from the use of diaphragms and any fibres used should be included in the aforementioned report if a Member State has set a specific limit value for fibres in air or an applicable monitoring regime.

3. If a legal entity taking advantage of the derogation (i.e. Dow) concludes that the derogation would need a further extension because the relevant electrolysis installation has not reached the end of its service life and technically or economically viable asbestos-free substitutes are not yet available: a report by 31 December 2020 with a risk assessment, including any relevant exposure scenarios describing the measures to minimise the risks, an analysis of alternatives, and any information relevant for a socio-economic analysis related to the need for a further derogation.

For transparency and efficiency, ECHA proposes that the company sends the report to the relevant Member State Competent Authority (i.e. Germany) and to the European Commission, with a copy to the European Chemicals Agency, with a translation in English.

The above reporting requirements are not expected to impose major costs, as the reports are based on actual operations of the company that has an exemption.

Five options to regulate chrysotile

Five options have been identified to change regulate chrysotile. Four are variants of a restriction while one would be to add chrysotile to Annex XIV.

Option 1 proposes to continue the current derogation, but sets a time limit to the national exemptions granted by the Member States. At the time of writing, 10 years seems a reasonable time limit for an exemption to continue before (if necessary and justified) being renewed, as this would enable both AAK and Dow to undertake planned switch over to alternative non-asbestos technologies (in the case that they are available). The first option would be administered by a Member State, as is the case at the moment.

In Option 2, there would be an explicit derogation listed in the entry with a time limit of 2025. Thus, any use after 2025 would require amendment of the entry via an Annex XV restriction report.

The main feature of Option 3 is that it utilises a volume constraint as the basis for the exemption instead of the time limit. Under this option, it would be ECHA – not the Member State Competent Authority – that would administer the exemption.

Option 4 would end the current derogation immediately (after the necessary legislative changes have been made), and ban all existing uses of chrysotile in diaphragms. This option is included for completeness.

A further option (analysed in Section E.1.3) would maintain the current entry but require companies to apply for an authorisation for continued use under the assumption that chrysotile would be added to Annex XIV.

Options 1-3 all include a similar reporting requirement. This is not separately added into the descriptions below.

Option 1 - Continuing the current derogation with time-limited exemptions

Option 1 proposes to continue the basic form of the current derogation, but adding a time limit such that a Member State cannot give or maintain an exemption for more than 10 years at one time. Exemptions would be renewable. The derogation itself appearing in the entry would not have an end date. The exemption would also make explicit that the importation of fibres for maintaining diaphragms is allowed. The Member State would be responsible for administration of the exemption and for notifying this to the Commission. The reason for the exemption would need to be given. ECHA would receive this information from the Commission and make it publicly available on its website.

Option 2 – Derogation with a fixed end date

Under Option 2, a time limit would be set for the derogation itself such that it would end in 2025. The derogation would apply only to two companies currently utilising an exemption granted by a Member State under the entry 6, paragraph 1, not to any other companies. It would explicitly allow the importation of fibres for the maintenance of diaphragms. Section A.2.1 gives the exact wording.

The two companies would not need to apply for exemptions separately. If the companies wanted to use chrysotile after 2025, they would need to report that by 2020. The derogation would in this case, and if appropriate, need to be extended via an amendment of the entry, following the normal Annex XV restriction procedure.

Option 3 – Limiting the amount of chrysotile used

Under this option, instead of a time-limited derogation, a maximum amount of chrysotile to be used would be stipulated. The derogation would explicitly allow the importation of fibres for the maintenance of diaphragms, and it would be administered by ECHA. The derogation in the entry would not itself give an exemption or set the tonnage, rather it would assign powers to ECHA to set the permitted use amount. Under this option, a company would request a specific amount of chrysotile to be used for a given period of time, e.g. 10 years as under Option 2. The criteria could be e.g. “the concentration of asbestos fibres should be below 1000 fibres per m^3 for chlor-alkali electrolysis plants and there should be no

technically and economically feasible alternatives."[11] Such a mechanism would add flexibility in case additional time (but not chrysotile) was needed to complete substitution.

Option 4 – Immediate end of the derogation and ban on existing uses of chrysotile

This option would end the derogation in entry 6, and ban existing uses of chrysotile in diaphragms from some suitable early date. Given legislative time, the earliest possible date would seem to be 2017, but 2020 might appear more realistic.

As a sensitivity analysis, it can be assessed how costs would change if chrysotile use was to be banned by 2020. In the case of Dow, the faster adoption schedule would increase the adoption costs significantly in Baseline A. Besides the direct monetary costs of adoption, Dow reports the profitability and the safety of the plant during and after the adoption process would also suffer, as there would not be enough time to refine process efficiency during the adoption.

The faster adoption schedule does not apply to Baseline B, since by assumption no adoption is possible in this case. Therefore, this option would require Dow to cease its chlor-alkali production at Stade. A switch to a non-diaphragm technology would not be possible over this period because it would require complete reorganisation of the plant operation, which would, it is claimed, be too expensive to be justified. Dow has reported that it would shift its operations away from the Stade plant and out of the EU in this case. This would have very significant cost implications for Dow and the local and wider economy.

In case of AAK, it is unclear whether the company would have enough time to replace chrysotile with an alternative by 2020. In such a case, the costs could end up being very significant, as the whole integrated production system of edible fats and technical fatty acids would be affected, and potentially would need to be suspended until the chrysotile-free technology was implemented and operational. In the limit, the company might consider this suspension to be too costly to justify keeping the plant operational.

The risks of continued chrysotile use at AAK and Dow are already significantly controlled and effectively negligible. Thus, the benefits of any immediate closure of the two plants would also be negligible, and certainly orders of magnitude lower than the costs of closure. ECHA concludes that this option is not justified. Therefore, Option 4 is given no further consideration.

E.1.3 Other Union-wide risk management options than restriction

Requiring an authorisation for the use of chrysotile

In this option, the current entry would not be modified but ECHA would prepare an Annex XV SVHC dossier proposing that asbestos was added to the Candidate List and then prioritised. The Commission would then add it to Annex XIV and thus companies currently using diaphragms containing chrysotile would be required to apply for an authorisation for the use of chrysotile. In an authorisation-based system, a company would apply for authorisation if no chrysotile-free alternatives were technically and economically feasible, and if the benefits of an authorisation to the company would be greater than harms from the remaining risk. The applicant would incur both application costs and a fee but it would

[11] For instance, if Baseline A was the starting point for Dow, it would apply for a quota of about 275 tonnes of chrysotile to be used during 2015-25. However, if the chrysotile free technology was not successful, Dow could re-apply with a justification why it would need in total about 781 tonnes (Baseline B) of chrysotile.

have flexibility on when to adopt new technology, as long as it had been granted an authorisation.

The advantage of the authorisation requirement is that it would modify the regulatory approach assigning clear burden of proof to the company applying for authorisation. The applicant would need to demonstrate that it is minimising the risks associated with its use, that there are no technically or economically suitable alternatives, and that the (societal) benefits of their continued use of chrysotile would outweigh the (societal) risks. The authorisation would be company specific, and thus a somewhat more flexible instrument than restriction, as it would allow the company to take a decision either to substitute or to apply for an authorisation depending on the circumstances. The company would then only need to incur the costs of substitution if they were lower than the costs of applying and the risks of continued use. In principle, this would be a more cost-effective option than a restriction for those using chrysotile. This option would also have clear review periods specified. This approach would be a transparent way to regulate the remaining use of chrysotile.

The main disadvantage of this option is that the importation of diaphragms containing chrysotile would not be regulated, as the authorisation requirement does not apply to imported articles. Addressing this issue would still require a revision to the existing restriction entry. ECHA has concluded that this disadvantage is sufficient for this option to be given no further consideration.

Other options are not relevant to this report either, as the report considers whether entry 6 should be revised.

E.2 Assessment of risk management options

The 'shut-down' (Option 4) and authorisation options (Section E.1.3) were discarded from further assessment. The three remaining options (1 to 3) are compared below against Baselines A and B. Given the phase out of chrysotile in AAK, the assessment therefore focuses on impacts related to Dow.

E.2.1 Impact if the current entry is maintained

Leaving entry 6 unchanged is likely to mean it would continue to have the same impact as so far in reducing the use of chrysotile. The main impact of maintaining the current entry is that an open-ended exemption could be considered vague in a regulatory sense. Still, the current situation does not appear problematic (see Baselines A or B). ECHA considers that one problem with the current situation is that the derogation does not set any reporting requirements. This has been addressed in the section below.

Member States have had somewhat different approaches to implementing the entry 6 derogation and would have that possibility in the future if the current entry was maintained:

- As AAK is planning to adopt new chrysotile-free technology for hydrogen production before 2025, only Option 4 would significantly affect AAK.
- Dow is making use of the national exemption granted by the ordinance of Germany (Bundesgesetzblatt, 2010). If entry 6 was maintained, the ordinance would continue to apply. The current exemption by Germany does not offer any direct incentives to Dow to replace its chrysotile use. However, Dow has informed ECHA that entry 6, and the risk of a future ban on chrysotile use, are the major drivers of its current efforts to adopt a chrysotile-free alternative. The costs of (administering) the exemption appear minor. In addition, during the preparation of this report, ECHA has

not received evidence that the current restriction is not sufficient to control the risk. Thus, the current entry 6 appears to be a cost-effective approach.

As there are no changes compared with the current situation, the impact of maintaining the current situation is not further assessed here.

E.2.2 Restriction option 1 - Continuing the current derogation with time-limited exemptions

E.2.2.1 Effectiveness

E.2.2.1.1 Risk reduction capacity

This option is not considered to result in any direct changes in human health or environmental risks and impacts arising from Dow's use of chrysotile. Adding a time limitation to the exemption would improve the effectiveness of the regulation as it would give some additional incentive to the company to find a replacement for chrysotile. However, risks at Dow are already well managed so any bringing forward of the point at which Dow would cease chrysotile use would not result in significant risk reduction benefits.

The continuing need to apply for new exemptions and the reporting requirement imply effort and resources for Dow, and thus would generate additional costs compared with the current situation. In this way, the proposed time limit on the exemption and the annual reporting requirement create some additional incentive for finding an alternative and the proposed entry might be more effective in reducing the (small) risk compared with the current entry.

E.2.2.1.2 Costs

For Dow, costs under this option depend on their success in the search for an alternative. In case it has a substitute available by 2015, the adoption could happen by 2025 as described and the costs would be the same as in Baseline A.

If Dow is unable to implement a suitable substitute, chrysotile use would be as in Baseline B and there would be no additional direct costs related to chrysotile use or substitution. However, the reporting requirement would cause some moderate costs to Dow and there would be some administrative costs through the need to apply for a new time-limited exemption.

E.2.2.1.3 Proportionality

The proposed modification introduces some indirect incentives to companies to substitute away from chrysotile use sooner than in the baseline. However, the impacts are not sizable. Similarly, additional costs due to Option 1 would be minor. In sum, Option 1 is considered proportionate.

E.2.2.2 Practicality

It terms of practicality, Option 1 appears similar to the Baseline.

E.2.2.2.1 Implementability and manageability

Compared with the baseline, a time limit on an exemption seems slightly more straightforward to implement and manage given the added reporting requirement, since the requirements for implementation are clearer. However, there would be additional costs associated with renewing exemptions. Given Baseline B, Option 1 would mean that a new

exemption would need to be sought from the national authority prior to the expiration of the current one.

E.2.2.2.2 Enforceability

Compared with the baseline, a time limit on an exemption seems slightly more enforceable due to the additional reporting requirement.

E.2.2.3 Monitorability

Compared with the baseline, a time limit on an exemption improves to some extent the monitorability of the exemption due to the added reporting requirement.

E.2.2.4 Overall assessment of restriction option 1

Compared with the baseline, Option 1 would not directly affect human health or environmental risks or impacts. The cost of replacement of chrysotile depends on the success of Dow in adopting the substitute chrysotile-free technology. However, compared with the baseline, the costs would not be substantially different with Option 1 apart from the small costs related to reporting. Thus, Option 1 seems proportionate as it would slightly improve the effectiveness of the regulation and give more direct incentives to a company to find a replacement for chrysotile. At the same time, it would make it clear that continued exemptions could be given if suitable alternatives are not available, thereby improving cost-effectiveness. It would also clarify the restriction for both companies and Member States.

E.2.3 Restriction option 2: Derogation with a fixed end date

E.2.3.1 Effectiveness

E.2.3.1.1 Risk reduction capacity

Option 2 is not considered to result in any direct changes in human health or environmental risks and impacts. However, adding a time limitation to the derogation would improve the effectiveness of the regulation as it would give additional incentive to a company to find a replacement for chrysotile. However, risks at Dow are already well managed so any bringing forward of the point at which Dow would cease chrysotile use would not result in significant risk reduction benefits.

Entry 6 does not currently give any time limit for the derogation. The derogation is specified in terms of “the service life of the current equipment”, but in practice this imposes few limits, as machinery parts are continually changed or overhauled during maintenance and/or refurbishment and thus “service life” is naturally extended. Therefore, the time limit would improve clarity and give a clear end to a now open-ended derogation.

The reporting requirement requires effort and thus is costly. In that manner, the proposed time limit on the derogation and the annual reporting requirement strengthen the incentive for finding an alternative. Renewal of the derogation would be more laborious and more uncertain than receiving a new exemption under Option 1, and thus the substitution incentive under Option 2 is slightly stronger.

Recognising the existing granted exemptions and considering all the information received from the companies in preparing this Annex XV restriction report, the most administratively simple way of exempting their uses would be to assign the exemptions directly to the two companies concerned, rather than making them apply separately for exemptions which have effectively already been justified. If they were required to apply, they would simply

submit the information already given to ECHA, with (presumably) the same conclusion regarding the justification for continued derogation. This would appear to be unnecessary duplication of the efforts undertaken to compile this Annex XV report.

E.2.3.1.2 Costs

Costs under this option appear very similar to those under Option 1. However, if Dow's potential substitute is found to be unviable (Baseline B), Option 2 with the time limit for derogation (2025) could be said to be more costly – both financially and in terms of business uncertainty – since revising a restriction entry is more onerous than renewing an exemption, and could be regarded as more difficult to justify.

E.2.3.1.3 Proportionality

The proposed modification introduces some indirect incentives to companies to substitute away from chrysotile sooner than in the baseline and at least as much as under Option 1. However, the impacts are not sizable. Similarly, additional costs due to Option 2 would be minor. In sum, Option 2 is considered proportionate.

In case of Dow, proportionality depends on whether the substitute is found – if the company can adopt the substitute it is now testing by 2025 (Baseline A), the option is equally proportional as Option 1. In case no substitute is found, the company would need a continuation of the derogation in order for the option to remain proportional. Otherwise, the company would face very costly changes in a short time period, in the limit requiring the shutdown of the entire Dow operation.

E.2.3.2 Practicality

E.2.3.2.1 Implementability and manageability

A time limit for the derogation is simple to implement and manage. It does not itself incur other additional costs than those required to administer a possible continuation of the derogation. In case Baseline B materialised, Option 2 would be more laborious than Option 1.

E.2.3.2.2 Enforceability

A time limit for the derogation and the reporting requirement is simple to enforce and therefore additional costs from this would be moderate.

E.2.3.3 Monitorability

A time limit and reporting requirement are simple to monitor and do not cause significant additional costs of monitoring.

E.2.3.4 Overall assessment of restriction option 2

Compared with the current situation, Option 2 would not directly affect human health or environmental risks or impacts, and thus appears similar to the Option 1. Option 2 would clarify the restriction both to companies and to Member States. The cost of replacement of chrysotile depends on Dow's success in adopting substitute chrysotile-free technology. Assuming this is the case, compared with the baseline, the costs would not be different with Option 2 apart from the relatively small costs related to monitoring, and thus Option 2 seems proportionate. If Dow is not successful in its current efforts to develop a substitute, the proportionality of Option 2 is more difficult to assess due to uncertainties and added

costs in the extension of the derogation. Assuming the situation described in this report remains the same, it would be expected that the derogation would be extended, implying that this option would be proportionate.

E.2.4 Restriction option 3: Limiting the amount of chrysotile used

E.2.4.1 Effectiveness

E.2.4.1.1 Risk reduction capacity

This option is not considered to generate any direct changes in human health or environmental risks and impacts. However, adding a volume limit to the exemption would improve the effectiveness of the regulation, as it would give some additional incentive to the company to find a replacement for chrysotile. However, risks at Dow are already well managed so any bringing forward of the point at which Dow would cease chrysotile use would not result in significant risk reduction benefits.

The need to apply for a permitted use volume and the need to report require effort and thus entail costs compared with the current situation. In this way, the proposed volume-limit on the exemption and the annual reporting requirement create some additional incentive for finding an alternative and the proposed entry might be more effective in reducing the (small) risk than the current derogation. However, a further exemption appears more predictable i.e. less uncertain to a company if compared with extending a derogation in Option 2, which could lessen the substitution incentive.

E.2.4.1.2 Costs

The main difference between this and other options is that the volume limit gives more time flexibility to a company to restructure its process. This flexibility in turn could save company compliance costs. On the other hand, the volume limit could be more laborious to monitor and enforce than a time limit and as such it could be costlier to administer. Finally, the derogation is time-wise open-ended and indefinite in that sense.

In case adoption can be implemented by 2025 (Baseline A), the costs would be as in options 1 and 2. In case Dow is unable to adopt a suitable substitute, the costs would be close to the same as in Baseline B in Option 1, as re-application of the additional volume would bring some minor costs.

E.2.4.1.3 Proportionality

The proposed modification introduces some indirect incentives to companies to substitute away from chrysotile use sooner than in the baseline. However, the impacts are not sizable. Similarly, additional costs due to Option 3 would be minor. In sum, Option 3 is considered proportionate.

E.2.4.2 Practicality

E.2.4.2.1 Implementability and manageability

Compared with the current situation, Option 3 seems slightly more straightforward to implement and manage given the added reporting requirement. However, Options 1 and 2 appear slightly better still in this respect.

Administration by a single body, ECHA, is thought to offer more predictability and transparency on the exemptions compared with a situation where different Member States

grant different exemptions to their companies. This improves the implementability and manageability of the regulation.

E.2.4.2.2 Enforceability

Compared with the current situation, a volume limit on an exemption seems slightly more enforceable given the increased reporting requirement. However, the time limit would be slightly easier to enforce.

E.2.4.3 Monitorability

Compared with the current situation, a volume limit on an exemption improves to some extent the monitorability of the exemption due to the added reporting requirement and it is almost as convenient as the time limits.

E.2.4.4 Overall assessment of restriction option 3

Compared with the baseline, Option 3 would neither directly affect human health nor environmental risks or impacts (similar to Options 1 and 2). The cost of replacement of chrysotile depends on the success of Dow to introduce the substitute chrysotile-free technology. However, compared with the baseline, the costs would not be clearly different with Option 3 apart from the small costs related to monitoring. Thus, compared with the baseline Option 3 seems proportionate as it would slightly improve the effectiveness of the regulation as the volume limit would give somewhat clearer incentives to a company to find a replacement for chrysotile. It would also clarify the restriction both to companies and to Member States. In case of Baseline B, Options 1 and 3 would be more proportionate than Option 2.

E.2.5 Other Union-wide options

Not relevant, as the issue at hand is to whether or not to revise entry 6.

E.3 Comparison of the risk management options

The main issue determining substitution possibilities is whether Dow will be able to find a substitute to be used in its current electrolysis system. The regulatory options assessed are mainly refinements of the current situation.

The regulatory options described above are compared in Tables E.4 and E.5. In Table E.4 it is assumed that Dow will be able to adopt and implement the chrysotile free technology by 2025. This is described as “Baseline A”. The opposite is the case in Table E.5, i.e. Dow is assumed not to be able to adopt the substitute and thus it would need a further derogation (or it would need to cease the use of diaphragms containing chrysotile). For the comparison with the baseline, it is assumed that the derogation can be continued, but at a cost. All the three options are compared with the baseline level. Costs are listed as annual costs in million euros. In other categories, the levels are indicated with a plus or negative sign or with zero.

In each case, differences are small. The clearest differences stem from the practicality and monitorability relating to the improved reporting requirements. In Baseline A, where Dow adopts the chrysotile-free technology, Option 2 (ending the derogation in 2025) comes out as the preferred option. It is as costly as the others, but it is easy to implement and manage and gives stronger incentives for replacement than in other cases. Furthermore, the option provides administrative benefits as the end-date can easily be adjusted during

the REACH process (e.g. 2030 instead of 2025) without affecting the structure of the entry, and as the wording provides automatic closure to the derogation.

In Baseline B, where the potential substitute turns out to be infeasible, options 1 and 3 are about equally preferred, although Option 3 may require some more effort in implementation and management. In Baseline B, Option 2 would be the least favourable, due to the administrative work required for the amendment of entry 6. This additional effort reduces the implementability and manageability and generates additional costs. Option 3 (quantitative restriction) and Option 1 (added precision) would be equally preferred. Thus, further information about the testing results on the potential substitute will aid in the choice of the preferred option.

Table E. 4 - Comparison of the options to restrict the use of chrysotile in the EU vs. Baseline A

	Effectiveness			Practicality		Monitorability
Options	Risk reduction capacity	Annual cost million €	Proportion-ality	Implementability and manage-ability	Enforce-ability	
Baseline A	(+)	€5.8m	0/-	++	++	0
Option 1: Added precision	(+)	€5.8m	0/-	++	++	+
Option 2: End derogation in 2025	(+)	€5.8m	0/-	+++	++	+
Option 3: Quantitative restriction	(+)	€5.8m	0/-	+	++	+

Sources: Sections E1 and E2 of this report

Table E. 5 - Comparison of the options to restrict the use of chrysotile in the EU vs. Baseline B

	Effectiveness			Practicality		Monitorability
Options	Risk reduction capacity	Cost	Proportion-ality	Implementability and manage-ability	Enforce-ability	
Baseline B	0	€0m	0	++	++	0
Option 1: Added precision	0	€0m	0	+++	++	+
Option 2: End derogation in 2025	0	€0m	0	+	++	+
Option 3: Quantitative restriction	0	€0m	0	++(+)	++	+

Sources: Sections E1 and E2 of this report

Given the overall objective of phasing out the use of chrysotile in the EU, and the uncertainties related to the viability and timing of alternatives to chrysotile, Option 2 is proposed. The proposed wording of this option is described in Section A.1. This proposal is simple and transparent, and it gives a clear end date for the derogation based on the best current knowledge of the substitutes. As the restriction process (up to decision) will take up

to two years, the end date in the entry can easily be modified before adoption of the entry, should important new information become available. Such information would in particular be Dow's results on the viability of the alternative that it is testing at the time of writing of this report. The proposal for the amendment of entry 6 is considered to be the most appropriate Union-wide measure.

E.4 Main assumptions used and decisions made during analysis

The analysis in this report is based on the following main assumptions:

- Demand for chlorine of Dow remains unchanged till 2025.
- Dow Chemical's recent announcement of carving out of some of its assets, including Dow's Global Chlorinated Organics production facilities in Stade, Germany, will not have an affect of the analysis that has been carried out in this report.
- AAK will phase out chrysotile use by 2025. It is uncertain whether Dow will be able to confirm the alternative to current use of chrysotile technically and economically feasible. Due to this uncertainty two alternative Baselines A and B have been prepared. It is assumed in this report that there is a higher likelihood that Baseline A will materialise, i.e. that Dow will to be able to adopt the alternative technology starting from 2015.
- The information concerning technology, costs and potential exposure provided by AAK and Dow reflect their respective situations in a correct manner. ECHA has no reason to question this.
- Knowledge of the hazard concerning chrysotile is clear and additional new technical understanding (e.g. based on new monitoring techniques) will not change this in such a manner that it would affect the analysis of this report.

F. Socio-economic Assessment of Proposed Restriction

A separate socio-economic assessment of the proposed modifications has not been undertaken as the relevant information is provided in Section E.

G. Stakeholder consultation

During the preparation of this report ECHA has consulted extensively AAK and Dow. In addition it has consulted the competent authorities in Sweden, Germany and Poland, as well as the European Commission.

ECHA's consultation with Dow started in April 2013. Dow representatives visited ECHA on 10 April, and ECHA's staff members visited the Stade plant on 19 June 2013. The exchange continued since. The information provided by Dow clarified the use of asbestos and technology in place at the plant as well alternative substitute substances. During autumn 2013, Dow provided to ECHA exposure scenarios and exposure assessment concerning the use of chrysotile at the site.

ECHA's consultation with AAK started June 2013. AAK provided basic written information and ECHA's staff visited the plant in Karlshamn on 4 September 2013 to clarify the technological questions. AAK provided ECHA information about the use and derived demand of the chrysotile, about potential substitutes for chrysotile and about its future plans how to replace the current hydrogen production technology with chrysotile-free technology. During the exchange ECHA concluded that it would not need to request exposure scenarios from AAK.

The consultations with Member State competent authorities were infrequent and related to getting further knowledge on the way the Member State had implemented the derogation of entry 6. The consultations with the Commission were frequent and related to both the way entry 6 was implemented, to latest information on the use of chrysotile and to the finalisation of this restriction report.

REFERENCES

AAK. 2013. Information and data provided by the company and personal communications during ECHA's visit to AAK's site in Karlshamn, Sweden on 4 September 2013.

BAuA. 2008. Bekanntmachung zu Gefahrstoffen 910 "Risikowerte und Exposition-Risiko-Beziehungen für Tätigkeiten mit krebserzeugenden Gefahrstoffen". GMBl 2012 S. 717 [Nr. 40].

BBSR. 2010. Gefahrstoff Asbest; BBSR-Berichte KOMPAKT 2/2010 (in German). Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR). Bonn. Germany.

BIBRO. 2006. Review of the derogation of the asbestos ban for diaphragms used in the chlor-alkali industry. Socio-Economic Impact Assessment for the Use of Asbestos Diaphragms in the Chlor-Alkali-Electrolysis at the Stade Plant of Dow Deutschland Anlagengesellschaft mbH. (Access only for European Commission and Limitations Working Group)

Bundesgesetzblatt. 2010. § 17 Nationale Ausnahmen von Beschränkungsregelungen nach der Verordnung (EG) Nr. 1907/2006 (see page 1655) in Verordnung zur Neufassung der Gefahrstoffverordnung und zur Änderung sprengstoffrechtlicher Verordnungen. Vom 26. November 2010.

CSTEE. 1998 Opinion on chrysotile asbestos at the 5th Scientific Committee on Toxicity, Ecotoxicity and the Environment plenary meeting. Brussels, 15 September 1998.

CSTEE. 2002. Opinion on Risk to human health from chrysotile asbestos and organic substitutes Opinion expressed at the 35th Scientific Committee on Toxicity, Ecotoxicity and the Environment plenary meeting. Brussels, 17 December 2002

DAR. 2013. Measuring method – VDI-guideline 3492 "Indoor air measurement Ambient air measurement. Measurement of inorganic fibrous particles, Scanning electron microscopy method" (2013). Deutscher Akkreditierungs Rat.

Dow. 2013. Information and data provided by the company and personal communications during the meeting between Dow and ECHA in ECHA on 10 April 2013 and during ECHA's site visit to Dow's site in Stade, Germany on 19 June 2013.

Dow Chemical Company. 2013. Dow Announces Carve-Out Scope for $5 Billion of Commodity Chemicals Businesses. 2 December 2013. Available at: http://www.dow.com/news/press-releases/article/?id=6380

EC. 2008. (EC) Regulation No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation), Annex VI, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2008R1272:20110419:EN:PDF

ECHA. 2010. Calculation of compliance costs. Addendum to the guidance on socio-economic analysis (SEA) - restrictions. 27 October, 2010. Available at http://echa.europa.eu/documents/10162/13576/appendix1-calculation__compliance_costs_case_restrictions_en.pdf

ECHA. 2010. Guidance on information requirements and chemical safety assessment. http://echa.europa.eu

ECHA. 2012. Guidance on information requirements and chemical safety assessment. http://echa.europa.eu

EPA. 2013. Integrated Risk Information System. Asbestos (CASRN 1332-21-4). Available at http://www.epa.gov/iris/subst/0371.htm.

European Commission. 2011. A German Member State "Report on the derogation for diaphragms containing chrysotile pursuant to point 6 of Annex XVII to REACH Regulation (English translation) in the Exemptions to the Asbestos Restriction. http://ec.europa.eu/enterprise/sectors/chemicals/files/reach/restr-asbestos-report_en.pdf

Health Council of the Netherlands. 2010. Asbestos: Risks of environmental and occupational exposure – presentation of advisory report. The Hague: Health Council of the Netherlands, 2010; publication no. 2010/10E.

HSE. 2013. Respiratory Protective Equipment at Work; HSE publication HSG53. Health and Safety Executive. www.hse.gov.uk.

IARC. 2012. A Review of Human Carcinogens: Arsenic, Metals, Fibres, and Dusts, International Agency for Research on Cancer, Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, Vol. 14, Sup.7, 100C, 2012, available at http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-11.pdf

IPCS. 1998. Chrysotile Asbestos (Environmental Health Criteria 203), International Programme on Chemical Safety, World Health Organization, Geneva, 1998, available at http://whqlibdoc.who.int/publications/1998/9241572035_eng.pdf

Official Journal. 2009. European Directive 2009/148/EG. L 330/28. 16.12.2009.

Polish Ministry of Economy. 2013. A letter by the Ministry of Economy, Poland to European Commission dated 9 April 2013.

Righton Canada. 2012. Last Quebec asbestos mine abandons its plan to re-open. 17 October, 2012. Available at: http://www.rightoncanada.ca/?p=1591#sthash.8OLgUQeM.dpuf

Swedish Chemicals Agency. 2009. Decision by a Swedish Chemicals Agency (KEMI) on "application for a derogation to use materials containing asbestos when refurbishing electrolysers" in AAK Karlshamn. A letter to AAK Karlshamn dated 23 March 2009.

Swedish Chemicals Agency. 2011. A Swedish Member State Report on Asbestos exemption of articles in the Annex to Report on Exemption on Asbestos. 25 August 2011. http://ec.europa.eu/enterprise/sectors/chemicals/files/reach/restr-asbestos-report_en.pdf

TNO/RIVM. 2010. Praktische consequenties van het advies van de Gezondheidsraad inzake asbest 2010 (in Dutch, summary in English); TNO/RIVM report (TNO-034-UT-2010-01344; RIVM 607647001).

VMM. 2007. Metingen van asbestconcentraties in 2006 (in Dutch); Vlaamse Milieumaatschappij, Afdeling Meetnetten en Onderzoek; report D/2007/6871/006. Email: info@vmm.be

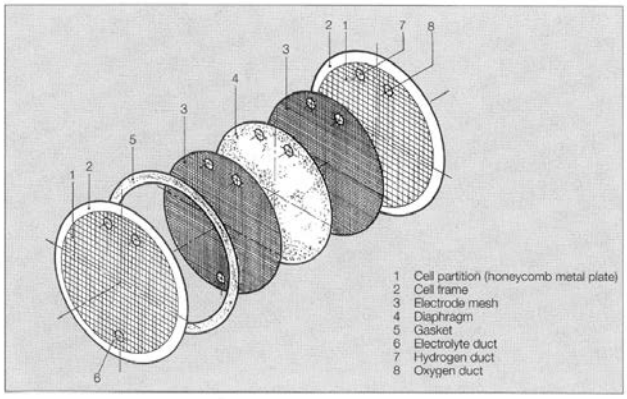
ANNEX 1 - Description of AAK hydrogen production and electrolysers

In technical terms, hydrogen is added to the double bonds of the fatty acid chains, causing reduced unsaturation in the following order: polyunsaturated → diunsaturated → monounsaturated → saturated fatty acids. A wide range of melting points can be obtained as the process can be stopped at any point. Liquid oil can be lightly hardened and still remain liquid with substantially improved keeping properties, whereas in other applications fully hardened fats are needed.

Hydrogen is produced by means of electrolysis of water yielding hydrogen and oxygen. The electrolytic decomposition is made by conducting an electrical current through an electrolyte of potassium hydroxide. The equipment used for electrolysis is two high pressure electrolysers, Electrolyser 1 (E1) and Electrolyser 2 (E2). The electrolysers were originally installed in the 60´s. The picture below shows two constructions of four cellblocks mounted together.

Four cellblocks mounted together, IHT construction on the left and AAK on the right

Each electrolyser is built from four cellblocks each containing 135 cells, in total 540 individual cells. Each cell is conductively isolated from its adjacent cells and can be defined as a small electrolysis reactor. In the cells, asbestos is used in a diaphragm and in a gasket (packing), both located inside these cells. The diaphragm and the gasket are situated in the enclosed sections of the installation. The total amount of asbestos in the two electrolysis unit is approximately 7.5 tons.



Construction of the cell

At a revision the details number 1, 3, 4 and 5 is replaced and the cell frame number 2 is carefully checked for damages by for instance corrosion and if necessary replaced. The block is reassembled and delivered as a package for reinstallation into the electrolyser frame. At start-up after the revision, a number of temperature and pressure cycles have to be run to assure full tightness to leaks of the electrolyser. The tie-rods are tightened with precise torque according a special schedule.

The estimated life length of the cell blocks prior revision are approximately 15 years, for brand-new cell blocks slightly longer. After a full revision the blocks can be operated for another interval of approximately 15 years.

When looking at the hydrogen production, The daily short term demand variations of hydrogen due to the requirements of the different hydrogenation processes have to be taken into consideration. These variations are to a smaller extent balanced by the existing buffer storage of hydrogen. The current, “normal” supply situation corresponds to a demand of about 1.5 electrolysers.

A hydrogen production facility, independent of type and technology, is an advanced piece of technology. In order to be a reliable supplier of products produced with hydrogen, a safe supply of hydrogen is needed as hydrogen is not readily available on the market. In order to assure a safe supply and enabling long-term customer contracts with reasonable commercial risk regarding penalties due to failure to deliver, hydrogen production facilities must be available at the company.

ANNEX 2 – Dow Exposure Scenarios

A2.1 Exposure scenario 1 for workers: use as reconditioning agent (closed systems)

Market sector: n/a

Sector of use: SU3

Article categories: n/a

Environment contributing scenario(s): n/a

Worker contributing scenario(s): PROC1, PROC3, PROC8b

Subsequent service life exposure scenario(s): n/a

Exposure scenario(s) of the uses leading to the inclusion of the substance into the article(s): n/a

Description of the activities and technical processes covered in the exposure scenario:

Receival and storage of fibre packages:

The fibres are always supplied to Dow in Stade directly, packed in hermetically sealed plastic packaging. The packages are delivered to the site in Dow-System-Container (DSC) containers, containing specially designed smaller containers/boxes with individual packages of asbestos; the functionality of the DSC is validated by an independent association on a regular basis. This consists of checks/maintenance of doors and door seals to ensure full containment (no opportunity for asbestos to be released to the surrounding environment). As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

DSC Container

Container in lock with open doors

Asbestos bags in boxes

The DSC containers with the boxes are stored in a dedicated storage area with controlled access (only trained and dedicated Dow employees can enter the area). From here they are lifted and transported over a short distance by means of a crane to the automated unloading system to formulate the asbestos slurry. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

Dumping of fibres in mixing vessel:

The DSCs are mechanically (remote control) transported to a dedicated working room, with a vertically sliding door. The handles of the doors are manually connected to a hydraulic system for opening the doors, after which the sliding door is closed and the room is hermetically sealed from the surrounding area. The room is ventilated and under slight

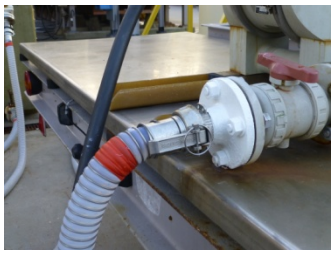
negative pressure.
The DSC is automatically opened by a hydraulic system and the fibre packages are one by one picked up by a robot arm and placed on a conveyer belt in a tunnel connected to the mixing vessel. During transport on the conveyer belt through the tunnel the fibre packages are mechanically sliced, after which the fibre material is dumped into the mixing vessel. The whole equipment (tunnel with the conveyer belt and mixing vessel) is ventilated and under negative pressure. The packaging material is collected in closed system into pre-treated bins containing the special additives to reduce the melting point of the asbestos, and incinerated in an on-site rotary oven/kiln. No employees are directly involved in the transportation and asbestos handling activities. An operator is overseeing the activities from a remote position through a window pane (control room). As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).
Note that all extracted air is filtered by means of HEPA filters after which the filtered are is emitted via a stack (refer to A2.1.1.).

Formulation of slurry:
The asbestos fibres are formulated with brine to an asbestos slurry in the mixing vessel. The mixing vessel opening is connected to the tunnel and is under negative pressure. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

Filling of feeding containers:
After mixing, the asbestos slurry is fed from the mixing tank into mobile containers (1 m^3) by means of a flexible hose. This does not require manual interference. After filling, the containers are transported and used to feed a stationary container as well as mobile containers by means of flexible hoses. Note that the chlorine production plant has two sections (ECU-1 & ECU-2), built in 1972 & 1975, and therefore having slightly different designs; one section uses a stationary, the other sections uses mobile containers).
There are two manual activities: the transport of the containers and the coupling/decoupling of hoses. Both are done 2 times per week. Except for the coupling/decoupling of hoses, all activities take place under closed conditions. Therefore this activity is considered to be a fully closed process (PROC1). The coupling/decoupling of hoses, including the flushing/purging of feeding lines, is described as a separate activity.

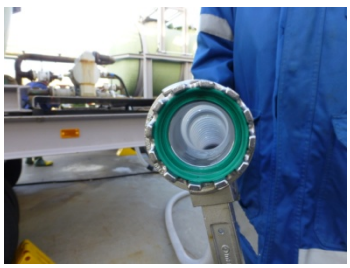

Mobile container


Connected container


Connected hose


Container with flush connection


Pumps with flush lines


Open and cleaned hose

Feeding of slurry to the electrolysis cells:
From either the stationary container (fixed line) or the mobile containers (flexible hoses), the asbestos slurry is pumped into the cells using a flush line, which is connected to the cells; the flush line is separated from the cells itself (cells are closed during operation). This activity does not require any manual handling. Except for the coupling/decoupling of hoses (refer to the next activity described), this is a fully closed process (PROC1).

Flushing / purging of feeding lines and (de)coupling of hoses:
After filling the feeding containers or feeding of slurry to the electrolysis cells, the hoses are flushed/purged with brine before decoupling the hose from the container/cell. The brine is flushed into the cells. The flushing/purging does not require manual handling. The only manual handling is the coupling/decoupling of hoses. As this takes place after flushing/purging (removal of any remaining asbestos fibres) and under wet conditions, any contact with fibres during uncoupling is highly unlikely. The flushing/purging is a fully closed process, however with some opportunity for contact when decoupling, therefore this activity is best reflected by a PROC3.

Maintenance and cleaning dry asbestos handling room:
During the asbestos/brine slurry formulation activities, no maintenance and cleaning related to the asbestos activities are undertaken. When maintenance and cleaning of the asbestos handling room and the equipment in it is done, operators that do maintenance and cleaning in this working area, have to comply with very strict Standard Operating Procedures, including:

- Use of the clean/contaminated locks for entering/leaving the working area
- Wearing disposable clothing and dedicated safety shoes when entering the working area (no other clothing is worn)
- Wearing a full face mask with powered air filtering unit (P3 filter cartridge) when in the working area
- Following a decontamination procedure in the contaminated lock (which is under negative pressure), when leaving the working area (showering, cleaning shoes, cleaning of respirator, disposing of disposable clothing). Note that the lock is decontaminated after each use (rinsing of walls and floor with shower; water is fed to the closed wastewater treatment system; the lock is continuously exhausted and cleaned with a vacuum cleaner the air is fed to the filter system (stack).

Note that all disposable clothing and used cartridges are collected into pre-treated bins containing the special additives to reduce the melting point of the asbestos, (which are sealed and disposed after each activity by workers) and incinerated in an on-site rotary oven/kiln.
Maintenance and cleaning is commonly reflected by the use of PROC8a (non-dedicated transfer activities). However, as this activity is done in a dedicated way, the PROC8b is considered to be best describing this activity.

Waste handling (note: this step is identical for both exposure scenarios):
All wet waste from the processing and cleaning activities is fed to a closed waste water treatment system. No manual handling is involved. All other waste materials (e.g. used filters, cartridges, etc) are collected in dedicated closed bins that are preloaded with treatment chemicals (in liquid form (in preparation of the thermal treatment) and transported to the rotary oven/kiln for thermal treatment. Note that the bins are stored in a dedicated and locked area.
The sludge resulting from the water treatment is mixed with special additives to reduce the melting point of the asbestos, pelletized and transported to the rotary oven/kiln for thermal treatment at 1300°C.
This is a fully closed process, not requiring any manual handling, except for the drum filling with wet pellets. where the operator put the lid on the filled bin. Exposure to fibres is

negligible as the asbestos is bonded in the pellets and the pellets are still wet. After filling the drums, they are closed with a lid and transferred to the kiln.
As this activity is related to transfer of materials and is done in a dedicated way, the PROC8b is considered to be best describing this activity.

Closed bin

Locked store area

A2.1.1 Environmental contributing scenario 1

As indicated earlier in this chapter, no environmental assessment has been conducted, as there is no release of asbestos to environmental compartments (water, air):

- All working areas and facilities (e.g. the washing facility) where the diaphragms as such are handled are ventilated and under negative pressure. The extracted air is filtered with HEPA filters before it is emitted via a stack to the outside air. Used HEPA filters are collected in dedicated waste bins for chemical and thermal treatment in a rotary oven/kiln (for details, refer to the description of the waste handling in exposure scenario 2). The HEPA filters are covered with a plastic bag before opening the filter section, thereby preventing worker exposure to fibres.

- After filtering all extracted air is emitted to the air through 2 stacks (stack 1: all 'dry' ventilation systems; stack 2: all 'wet' ventilation systems, e.g. the washing/cleaning facility).
  Stack emission measurements, as required according to the environmental permit and under supervision by Gewerbeauffsichtsamt (trade supervisory office), have been carried by a certified consultancy firm (GSA: Gesellschaft für Schadstoffanalytik mbH) in 2010, 2011 and 2013. The concentration of the fibres measured at stack 1 (2 samples) and stack 2 (1 sample) is below the detection limit (< 100 fibres/m^3) for all samples.

  In December 2013 background outdoor asbestos levels have been measured at the three gates (North, West, Southwest) and at a location at the fence line (East). All measurement results were below the detection level (< 100 fibres/m^3).
  The background asbestos concentration in outdoor air in Germany is in the range of 100 to 150 fibres/m^3[12].
  TNO/RIVM state in a recent report regarding the status in the Netherlands[13]: "In the 1980s, asbestos concentrations in outdoor air ranged on average from 100 to 1000 fibres/m^3, and up to tens of thousands of fibres/m^3 near specific asbestos sources. Since 1993, the use of asbestos has practically been banned in the Netherlands. Since then, asbestos concentrations in outdoor air have substantially decreased". Since 1987, no systematic asbestos measurements have been performed in the Netherlands. Based on

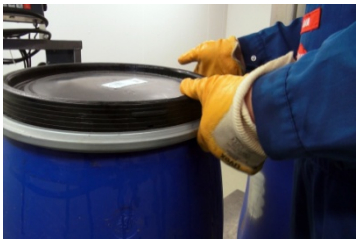
[12] *Gefahrstoff Asbest; BBSR-Berichte KOMPAKT 2; 2010 (BBSR, 2010)*

[13] *Praktische consequenties van het advies van de Gezondheidsraad inzake asbest 2010 (summary in English); TNO/RIVM report (TNO-034-UT-2010-01344; RIVM 607647001); Aug 2010 (TNO/RIVM, 2010)*

incidental measurements, performed by TNO, current background concentrations of asbestos in outdoor air are estimated to range from 20 to 40 fibres/m^3, although exposure around specific sources may be significantly higher.
In Belgium asbestos concentrations in outdoor air have been measured in 2006 by the Flemish Environmental Society[14]. Average background levels (chrysotile) in a residential area (no asbestos sources present in the vicinity of this area) amounted to 92 fibres/m^3.
In general the stack measurements and the background outdoor air measurements at the perimeter of the site are in the same range as the background levels found in Germany, the Netherlands and Belgium in rural and residential areas. Therefore it can be concluded that the extracted air emitted by Dow in Stade does not contribute to an increase of the concentration of asbestos in air in the surrounding environment.

- All wet waste and wastewater (from the water pit, from the cleaning activities, from the washing facility, etc.) is sent to a closed waste water treatment system. The waste water is pumped to a clarifier and from there to a centrifuge where the concentration of water in the waste/sludge is reduced to approximately 40%. The remaining sludge is mixed with special additives to reduce the melting point of the asbestos, and pelletized to bond the fibres in the wet pellet matrix). The pellets are collected in a drum, which, after sealing, is transported with a truck to the on-site rotary oven/kiln for thermal treatment at 1300°C (for the control of worker exposure: refer to the waste handling described in exposure scenario 2).


Pellets are collected in drums


Drum with lock ring


Pellet drum area is locked

- In this thermal treatment the fibre structure will be destroyed and the asbestos material converted into a non-fibrous, asbestos free slag. The slag is used as backfill material in caverns or as an inert closing layer and construction material in waste disposal landfills.

A2.1.2 Worker contributing scenario 1: Receival and storage of fibre packages (PROC1)

A2.1.2.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such
Amount used (or contained in articles), frequency and duration of

[14] *Metingen van asbestconcentraties in 2006 (in Dutch); Vlaamse Milieumaatschappij, Afdeling Meetnetten en Onderzoek; report D/2007/6871/006 VMM, 2007)*

use / exposure
• Frequency: 4 times per year • Duration of activity: 3 hours per day (1 technician)
Technical and organisational conditions and measures
• Containment: storage in closed system (DSC); packages are securely sealed. • Handling of materials: no manual handling, only mechanical handling of containers with crane. • General ventilation: not applicable (outdoors); good mechanical ventilation (1-3 air changes per hour) in asbestos room. • Local exhaust ventilation: no. • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoor/outdoor
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3.

A2.1.2.2 Exposure and risks for workers

Table A2. 1 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Note that the asbestos is fully sealed (no source of asbestos available).	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.
Due to the high level of containment (containers are closed; asbestos packages are sealed), there is no opportunity for contact with the chrysotile asbestos. Furthermore, all other

measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.3 Worker contributing scenario 2: Dumping of fibres in mixing vessel (PROC1)

A2.1.3.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per week • Duration of activity: 1 hour per day (1 technician in remote control room)
Technical and organisational conditions and measures
• Containment: handling in closed system (hermetically sealed inner room in asbestos room). • Handling of materials: no manual handling, only mechanical handling of containers and packages (robotic system). • Operator is separated from activities in a control room (overlooking activities through a window). • General ventilation: inner room is under negative pressure due to local exhaust ventilation • Local exhaust ventilation: yes (tunnel and mixing vessel are under negative pressure) • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3.

A2.1.3.2 Exposure and risks for workers

Table A2. 2 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	90 % Upper Confidence Level: 108 fibres/m^3	RCR = 0.11

Remarks on exposure data:

Measured data are available for the exposure of the operator in the control room (refer to A2 Annex 3).
No. of samples: 6; Geometric mean: 102 fibres/m^3; Geometric Standard Deviation: 1.04; 90 % Upper Confidence Level: 108 fibres/m^3; Exceedance fraction: < 0.1 %.

All 6 measurements were below the level of detection (approximately 100 fibres/m^3). For calculation of the statistics the level of detection as such was used as the result of the measurement. The variation in measurement results is low (as indicated by a Geometric Standard Deviation of 1.04). The 90 % upper confidence level has been used for comparison with the reference level of 1000 fibres/m^3. The 90 % upper confidence level is well below the reference level. The probability of exceedance of the reference level for this situation is < 0.1 %.

Conclusion on risk characterisation:

From the comparison of measured data with the reference level it is concluded that the level of exposure is approximately 10 times lower than the reference value of 1000 fibres/m3 (corresponding to a life-time cancer risk of $2x10^{-5}$). Consequently, this level of exposure corresponds with a life-time cancer risk of $2x10^{-6}$, which is well within the range of what is considered to be an 'acceptable' lifetime (i.e., a working life of 40 years) cancer risk level for workers.
From a qualitative risk assessment perspective, due to the high level of containment and because the tunnel and mixing vessel are under negative pressure (thereby preventing asbestos fibres to be released to the asbestos room), there is no opportunity for release of the chrysotile asbestos. Secondly, no operators are present in the asbestos room (the activities are overseen from a control room, separated from the asbestos room), therefore the risk of possible contact with asbestos fibres is further reduced. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, and based on the results of the exposure measurements, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.4 Worker contributing scenario 3: Formulation of slurry (PROC1)

A2.1.4.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: 5 %
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per week • Duration of activity: 1 hour per day (1 technician in remote control room)
Technical and organisational conditions and measures
• Containment: handling in closed system (hermetically sealed inner room in asbestos room). • Handling of materials: no manual handling, only mechanical handling (stirring of asbestos/brine slurry). • Operator is separated from activities in a control room. • General ventilation: inner room is under negative pressure due to local exhaust ventilation • Local exhaust ventilation: yes (tunnel and mixing vessel are under negative pressure) • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3.

A2.1.4.2 Exposure and risks for workers

Table A2. 3 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Workers are controlling the process from a remote position (control room).	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.
Due to the high level of containment and because the tunnel and mixing vessel are under negative pressure (thereby preventing asbestos fibres to be released to the asbestos room), there is no opportunity for contact with the chrysotile asbestos. Secondly, no operators are present in the asbestos room (the activities are overseen from a control room, separated from the asbestos room). Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.5 Worker contributing scenario 4: Filling of feeding containers (PROC1)

A2.1.5.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: 5 %
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per week • Duration of activity: 1 hour per day (1 technician)
Technical and organisational conditions and measures
• Containment: handling in closed system (mixing vessel, closed mobile container, connecting hose). • Handling of materials: no manual handling, only mechanical handling from a remote position (pumping slurry from mixing vessel into mobile container; note: the coupling/decoupling of hoses will be addressed as a separate contributing scenario, refer to paragraph A2.1.8). • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: yes (mixing vessel is under negative pressure) • Advanced Occupational Health and Safety Management System (refer to table B.3).

Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.1.5.2 Exposure and risks for workers

Table A2. 4 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Feeding/filling is a fully closed process; workers are controlling this from a remote position.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.

Due to the fact that during the filling the system is fully closed, there is no opportunity for contact with the chrysotile asbestos. Secondly, workers are controlling this from a remote position. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.6 Worker contributing scenario 5: Feeding slurry to electrolysis cells (PROC1)

A2.1.6.1 Conditions of use

Product (article) characteristics

• Concentration of substance in mixture: 5 %
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 4 times per week • Duration of activity: 2 hour per day (1 technician)
Technical and organisational conditions and measures
• Containment: handling in closed system (closed stationary and mobile containers, closed cells, connecting hose). • Handling of materials: no manual handling, only mechanical handling from a remote position (pumping slurry from containers into cells; note: the coupling/decoupling of hoses will be addressed as a separate contributing scenario, refer to paragraph A2.1.8). • General ventilation: not applicable (outdoors) • Local exhaust ventilation: not applicable (fully closed system). • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: outdoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.1.6.2 Exposure and risks for workers

Table A2. 5 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Feeding/filling is a fully closed process; workers are controlling this from a remote position.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value

has been made.
Due to the fact that during the feeding the system is fully closed, there is no opportunity for contact with the chrysotile asbestos. Secondly, workers are controlling this from a remote position. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.7 Worker contributing scenario 6: Flushing of feeding lines and (de)coupling of hoses (PROC3)

A2.1.7.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: 5 %
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per week • Duration of activity: 0,5 hour per day (1 technician); coupling/decoupling of hoses: approximately 10 seconds per coupling/decoupling.
Technical and organisational conditions and measures
• Containment: flushing: handling in closed system. • Handling of materials: manual coupling/decoupling of hoses: flush/purge hoses with brine before decoupling. • General ventilation: not applicable (outdoors). • Local exhaust ventilation: not applicable (outdoors). • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: outdoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.1.7.2 Exposure and risks for workers

Table A2. 6 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	Geometric Mean: 100 fibres/m^3 (note: Upper Confidence Level cannot be calculated as the results are identical)	RCR = 0.10

Measured data are available for the coupling/decoupling of hoses as part of the feeding/filling activities.

No. of samples: 2; Geometric Mean: 100 fibres/m^3; Geometric Standard Deviation: 1.00; 90 % Upper Confidence Level: n/a; Exceedance fraction: n/a (n/a: cannot be calculated as the results are identical).

Conclusion on risk characterisation:

Only 2 data points are available for filling of containers and feeding of cells, including the coupling/decoupling of containers. Both results were below the level of detection (100 fibres/m^3). As the results are identical, neither 90 % upper confidence level, nor the Exceedance fraction can be calculated.

The only opportunity for exposure of workers to asbestos, is when decoupling the hose. Before decoupling, the hose is thoroughly flushed/purged with brine to remove all asbestos fibres that may still be present in the hose and couplings. Only after taking this measure, the employee is allowed to decouple the hose. As the hose and couplings are wet due to the brine, any contact with airborne fibres is prevented. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1)(ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.8 Worker contributing scenario 7: Maintenance and cleaning (PROC8b)

A2.1.8.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 6 times per year • Duration of activity: 2 hours per day (1 technician)

Technical and organisational conditions and measures
• Only enter and leave the asbestos room using the clean/decontaminated lock rooms. • Comply with the decontamination procedure when leaving the asbestos room. • General ventilation: inner room of asbestos room is under negative pressure due to local exhaust ventilation • Local exhaust ventilation: yes (tunnel and mixing vessel are under negative pressure) • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• Wear a full face mask (Dräger Panorama Nova RA; meeting EN136 minimum requirements) with a powered air filtering unit with P3 filter cartridge (Dräger X-plore 7300 Filter TH/M3 PSL; meeting EN 12941:1998 / EN12942:1998 minimum requirements). Efficiency: 97.5 %. • Wear disposable clothing. • Dispose of disposable clothing in the dedicated disposal bins after entering the decontamination room. • Shower and clean respirator and safety boots as well as the shower cabin before removing full face masks. • Dispose of used filter cartridges in the dedicated disposal bins. • For other measures, refer to table B.3
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.1.8.2 Exposure and risks for workers

Table A2. 7 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. The concentration of asbestos fibres in this room is very low (refer to paragraph A2.1.3 and A2.1.4), due to the local extract ventilation and high level of hygiene; in addition workers are	

Route of exposure and type of effects	Exposure concentration	Risk characterisation
	protected by use of a powered respirator with efficiency of 97.5 %.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.

When executing maintenance and cleaning activities in the asbestos room, there is some opportunity for exposure to asbestos, although fairly limited (refer to paragraph A2.1.3 and A2.1.4). First of all, activities by employees are only allowed, when the process for formulating of asbestos/brine slurry is not operated. Secondly, during maintenance activities, the tunnel with conveyer belt to the mixing vessel is continuously under negative pressure, thereby preventing the release of asbestos fibres to the asbestos room. Finally, despite the limited opportunity for exposure, workers are required to wear respiratory protection (Assigned Protection Factor: 40 [15] ; efficiency: 97.5 %). In summary, although there is some opportunity for exposure to asbestos, with these measures in place, contact with airborne fibres is very unlikely. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1)(ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.1.9 Worker contributing scenario 8: Waste handling (PROC8b)

(note: this step is identical for both exposure scenarios)

A2.1.9.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in wet matrix of pellets
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 75 days per year

[15] *Respiratory Protective Equipment at Work; HSE publication HSG53, (HSE, 2013)*

• Duration of activity: 8 hours per day (1 technician)
Technical and organisational conditions and measures
• Containment: mainly closed system, except for the collection of wet waste pellets. • Handling of materials: only mechanical handling of wet waste, except for the collection of waste pellets (manual handling) • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: no. • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.1.9.2 Exposure and risks for workers

Table A2. 8 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	90 % Upper Confidence Level: 112 fibres/m^3	RCR = 0.11

Measured data are available for the exposure during pelletization (refer to Annex 3).
No. of samples: 6; Geometric Mean: 103 fibres/m^3; Geometric standard deviation: 1.05; 90 % Upper Confidence Level: 112 fibres/m^3; Exceedance fraction: < 0.1 %.

Remarks on exposure data:

All 6 measurements were below the level of detection (approximately 100 fibres/m^3). For calculation of the statistics the level of detection as such was used as the result of the measurement. The variation in measurement results is low (as indicated by a Geometric Standard Deviation of 1.05). The 90 % upper confidence level has been used for comparison with the reference level of 1000 fibres/m^3. The 90 % upper confidence level is well below the reference level. The probability of exceedance of the reference level for this situation is < 0.1 %.

Conclusion on risk characterisation:

From the comparison of measured data with the reference level it is concluded that the level of exposure is approximately 10 times lower than the reference value of 1000 fibres/m^3 (corresponding to a life-time cancer risk of $2x10^{-5}$). Consequently, this level of exposure corresponds with a life-time cancer risk of approximately $2x10^{-6}$, which is well within the range of what is considered to be an 'acceptable' lifetime (i.e., a working life of 40 years) cancer risk level for workers.

From a qualitative risk assessment perspective, there is very limited opportunity for contact with the chrysotile asbestos as all (wet) waste is treated in a closed wastewater treatment system. The only opportunity for exposure is during pelletization, when the pellets are discharged in a bin and the bins are manually sealed and replaced by empty bins. During the discharge the bin is connected to the discharge pipe (with only very small openings around the rim); secondly the pellets, in which the asbestos fibres are bonded, are still partly wet during discharge. Therefore, there is very limited opportunity for contact with the chrysotile asbestos. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1)(ECHA 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, and based on the results of the exposure measurements, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2 Exposure scenario 2 for workers: use in diaphragm cells (closed systems)

Market sector: n/a

Sector of use: SU3

Article categories: n/a

Environment contributing scenario(s): n/a

Worker contributing scenario(s): PROC1, PROC3, PROC8b

Subsequent service life exposure scenario(s): n/a

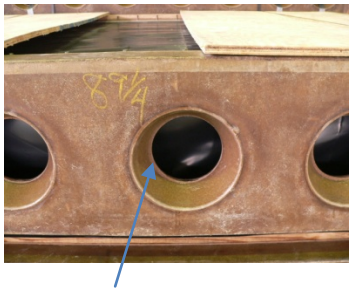
Exposure scenario(s) of the uses leading to the inclusion of the substance into the article(s): n/a

Description of the activities and technical processes covered in the exposure scenario:

Receival and storage of electrolysis cells:

The electrolysis cells consists of two pieces; the anode part (which is constructed separately and does not contain asbestos material) is already available on the site and is reused (refer to 'dismantling and cleaning of dismantled parts'); the cathode part, including the asbestos diaphragm, is delivered to the site in a cell body. The cathode part is sealed with a plastic coversheet. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

Cells received in trucks



Cathode/Diaphragm covered with black sheets

Removed sheets from cathode

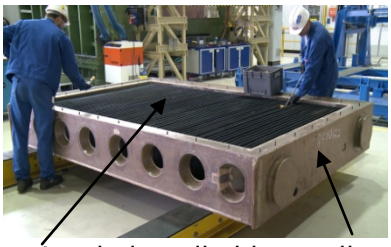
Upon receival, the cathode and anode cell parts are stored in a storage building and in a dedicated indoor area. Also after assembly the whole electrolysis cells may be stored in this area. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

Assembly of electrolysis cells:

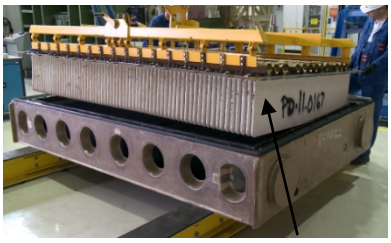
Using a crane the cathode is mounted on a frame and turned, after which the plastic cover is removed and the cathode is manually sprayed/moistened with water. Removal of the plastic cover is done mechanically, using a crane. The plastic cover is collected in a bins and disposed of by incineration in the on-site rotary oven/kiln. Consequently the anode part is mounted on top of the cathode part, using a crane and 'turning' equipment, and hermetically sealed with rubber strips. Workers are involved (see also data of SP 2) in these activities as they are operating the equipment (crane, 'turning' machine). During most of

the time no contact with the diaphragm is possible (sealed diaphragm), however after removal of the cover and till the assembly of the anode part has been finalized, there is some opportunity for contact with the diaphragm. As the fibres are completely bonded/immobilized in the diaphragm matrix and the cathode is moistened during the activity, it is still justified to consider this activity is as a closed process, best reflected by a PROC3.

Installation of electrolysis cells:
After assembly the electrolysis cells are transported to the production lines (using a crane and a truck) and connected to the inlet and outlet lines and the power supply. Except for the very short-time activity to make the connections this is a fully closed process, thus best reflected by a PROC3.



Anode installed in a cell frame



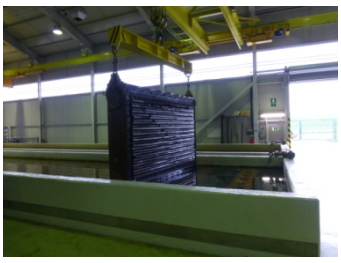
Cathode with Diaphragm

Final Assembled cell

Service life of electrolysis cells:
After connection the cells are operational and utilized in the production of chlorine. In general the service life of the electrolysis cells is at least 10 years. During the operational phase no maintenance or repairs are made to the cells, except in rare situations where single cells need reconditioning of the diaphragms; this is already covered by the exposure scenario 1. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).

Note that during service life, there is no maintenance or cleaning done to the inner part of the cells (diaphragm) as such, which might lead to exposure to fibres.

Disconnection from production line and intermediate storage in water pit:
At the end of service life the electrolysis cells, the covers are removed from the cells, using a crane transported to the storage pit, and submerged in water in the storage pit, using a crane. During the disassembly process the asbestos diaphragm is still contained within the cell. During the intermediate storage the cells are fully submerged in the water pit, thereby preventing any contact with the diaphragm. As no contact with fibres is possible, this is considered to be a fully closed process (PROC1).



Cell removed from pit

Cell Transportation

Storage Pits filled with water

Dismantling and cleaning of dismantled parts:
The electrolysis cells are lifted from the water pit and under wet conditions dismantled into

their single parts (anode, cathode with diaphragm and the cell frame). The anode and cathode (with the diaphragm) ware washed in a closed washing facility to remove residual fibres.


Wash Facility


Cathode/Diaphragm


Cell Frames


Anodes for reuse

The washing/cleaning facility is fully closed. The washing itself is done with high pressure water. This is an automated system, controlled via the process system from control room. No manual handling is involved. The washing facility is under negative pressure (exhausted air is filtered by means of HEPA filters (refer to environmental contributing scenarios 1 and 2) before emission to the environment). Wastewater from the washing facility is directed to the closed waste water treatment system in the cell services plant (refer to description of "waste handling" below). The cell frames are crushed and transferred to the rotary kiln for incineration.
The anode is reused and the cathode as metal is sent to an external high temperature oven and disposed of after washing. As this activity is related to transfer of materials and is done in a dedicated way, the PROC8b is considered to be best describing this activity.

Waste handling (note: this step is identical for both exposure scenarios):
All wet waste from the processing and cleaning activities is fed to a closed waste water treatment system. No manual handling is involved. All other waste materials (e.g. used filters, cartridges, etc) are collected in dedicated closed bins that are preloaded with treatment chemicals in liquid form (in preparation of the thermal treatment) and transported to the rotary oven/kiln for thermal treatment. Note that the bins are stored in a dedicated and locked area.
The sludge resulting from the water treatment is mixed with special additives to reduce the melting point of the asbestos, pelletized and transported to the rotary oven/kiln for thermal treatment at 1300 °C.
This is a fully closed process, not requiring any manual handling, except for the drum filling with wet pellets, where the operator put the lid on the filled bin Exposure to fibres is negligible as the asbestos is bonded in the pellets and the pellets are still wet. After filling the drums, they are closed with a lid and transferred to the kiln.
As this activity is related to transfer of materials and is done in a dedicated way, the PROC8b is considered to be best describing this activity.


Closed bin

Locked store area

A2.2.1 Environmental contributing scenario 1

As indicated earlier in this chapter, no environmental assessment has been conducted, as there is no release of asbestos to environmental compartments (water, air):

- All working areas where the fibres are handled are ventilated and under negative pressure. The extracted air is filtered with HEPA filters before it is emitted via a stack to the outside air. Used HEPA filters are collected in dedicated waste bins for chemical and thermal treatment in a rotary oven/kiln (for details, refer to the description of the waste handling in exposure scenario 2). The HEPA filters are covered with a plastic bag before opening the filter section, thereby preventing worker exposure to fibres.

- After filtering all extracted air is emitted to the air through 2 stacks (stack 1: all 'dry' ventilation systems; stack 2: all 'wet' ventilation systems, e.g. the washing/cleaning facility).
  Stack emission measurements, as required according to the environmental permit and under supervision by Gewerbeauffsichtsamt (trade supervisory office), have been carried by a certified consultancy firm (GSA Gesellschaft für Schadstoffanalytik mbH) in 2010, 2011 and 2013. The concentration of the fibres measured at stack 1 (2 samples) and stack 2 (1 sample) is below the detection limit (< 100 fibres/m^3) for all samples.

  As already mentioned in exposure scenario 1, regarding background levels:
  In December 2013 background outdoor asbestos levels have been measured at the three gates (North, West, and Southwest) and at a location at the fence line (East). All measurement results were below the detection level (< 100 fibres/m^3).
  The background asbestos concentration in outdoor air in Germany is in the range of 100 to 150 fibres/m^3[16].
  TNO/RIVM state in a recent report regarding the status in the Netherlands[17]: "In the 1980s, asbestos concentrations in outdoor air ranged on average from 100 to 1000 fibres/m^3, and up to tens of thousands of fibres/m^3 near specific asbestos sources. Since 1993, the use of asbestos has practically been banned in the Netherlands. Since then, asbestos concentrations in outdoor air have substantially decreased." Since 1987, no systematic asbestos measurements have been performed in the Netherlands. Based on incidental measurements, performed by TNO, current background concentrations of asbestos in outdoor air are estimated to range from 20 to 40 fibres/m^3, although exposure around specific sources may be significantly higher.
  In Belgium asbestos concentrations in outdoor air have been measured in 2006 by the Flemish Environmental Society[18]. Average background levels (chrysotile) in a residential area (no asbestos sources present in the vicinity of this area) amounted to 92 fibres/m^3.
  In general the stack measurements and the background outdoor air measurements at the perimeter of the site are in the same range as the background levels found in Germany, The Netherlands and Belgium in rural and residential areas. Therefore it can be concluded that the extracted air emitted by Dow in Stade does not contribute to an increase of the concentration of asbestos in air in the surrounding environment.

- All waste water generated during assembly and dismantling/cleaning activities is

[16] *Gefahrstoff Asbest; BBSR-Berichte KOMPAKT 2; 2010 (BBSR, 2010)*

[17] *Praktische consequenties van het advies van de Gezondheidsraad inzake asbest 2010 (summary in English); TNO/RIVM report (TNO-034-UT-2010-01344; RIVM 607647001); Aug 2010 (TNO/RIVM, 2010)*

[18] *Metingen van asbestconcentraties in 2006 (in Dutch); Vlaamse Milieumaatschappij, Afdeling Meetnetten en Onderzoek; report D/2007/6871/006 (VMM, 2007)*

entering a closed waste water treatment system. The waste water is pumped to a clarifier and from there to a centrifuge where the concentration of water in the waste/sludge is reduced to approximately 40 %. The remaining sludge is mixed with special additives to reduce the melting point of the asbestos, and pelletized to bond the fibres in the wet pellet matrix). The pellets are collected in a drum, which, after sealing, is transported with a truck to the rotary oven/kiln for thermal treatment at 1300 °C (for the control of worker exposure: refer to the waste handling described in exposure scenario 2). In this thermal treatment the fibre structure will be destroyed and the asbestos material converted into a non-fibrous, asbestos free slag. The slag is used as backfill material in caverns or as an inert closing layer and construction material in waste disposal landfills.

A2.2.2 Worker contributing scenario 1: Receival and storage of electrolysis cells (PROC1)

A2.2.2.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per year • Duration of activity: 4 hours per day for 5 days (4 technicians)
Technical and organisational conditions and measures
• Containment: handling in closed system; packages are securely sealed. • Handling of materials: no manual handling, only mechanical handling of cathodes (with diaphragm). • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: no. • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.2.2 Exposure and risks for workers

Table A2. 9 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Note that the asbestos is fully sealed (no source of asbestos available).	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.

As the cathode containing the diaphragm is securely sealed, there is no opportunity for contact with and no opportunity for release of the chrysotile asbestos. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.3 Worker contributing scenario 2: Assembly of electrolysis cells (PROC3)

A2.2.3.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per year • Duration of activity: 8 hours per day for 20 days (4 technicians)
Technical and organisational conditions and measures
• Containment: mainly closed system (cathode with diaphragm is sealed, till removal of plastic cover). • Handling of materials: mechanical handling of anode and cathode; manual handling during sealing with rubber strips after assembly of cathode to anode. • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: no

• Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.3.2 Exposure and risks for workers

Table A2. 10 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	90 % Upper Confidence Level: 253 fibres/m^3	RCR = 0.25

Measured data are available for the exposure during assembly (refer to Annex 3).
No. of samples: 6; Geometric Mean: 122 fibres/m^3; Geometric Standard Deviation: 1.56; 90 % Upper Confidence Level: 253 fibres/m^3; Exceedance fraction: < 0.1 %

Remarks on exposure data:

4 out of 6 measurements were below the level of detection (approximately 100 fibres/m^3). For calculation of the statistics the level of detection as such was used as the result of the measurement. The variation in measurement results is low (as indicated by a Geometric Standard Deviation of 1.56). The 90 % upper confidence level has been used for comparison with the reference level of 1000 fibres/m^3. The 90 % upper confidence level is well below the reference level. The probability of exceedance of the reference level for this situation is < 0.1 %.

Conclusion on risk characterisation:

From the comparison of measured data with the reference level it is concluded that the level of exposure is approximately 4 times lower than the reference value of 1000 fibres/m^3 (corresponding to a life-time cancer risk of $2x10^{-5}$). Consequently, this level of exposure corresponds with a life-time cancer risk of $5x10^{-6}$, which is well within the range of what is considered to be an 'acceptable' lifetime (i.e., a working life of 40 years) cancer risk level for workers.
From a qualitative risk assessment perspective, there is no opportunity for contact with the chrysotile asbestos until removal of the plastic cover of the cathode with the diaphragm. However, as the asbestos in the diaphragm is bonded to a matrix and there is no manual handling of the diaphragm itself when assembling the cathode to the anode and when sealing the anode to the cathode, the opportunity for contact with asbestos is very limited.

Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, and based on the results of the exposure measurements, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.4 Worker contributing scenario 3: Installation of electrolysis cells (PROC3)

A2.2.4.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per year • Duration of activity: 10 hours per day for 6 days (20 technicians)
Technical and organisational conditions and measures
• Containment: handling in mainly closed system (cells are closed until connection to the production line is made). • Handling of materials: mechanical handling of cells; only short manual handling for connecting to the production line. • General ventilation: not applicable (outdoors). • Local exhaust ventilation: not applicable (outdoors). • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: outdoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.4.2 Exposure and risks for workers

Table A2. 11 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Asbestos is bonded in matrix, diaphragm itself is not handled (located in the cell), so the probability of exposure is very low.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.

As the cells containing the diaphragm are fully closed, there is only opportunity for contact with the chrysotile asbestos, when the cell has to be opened on the outer side for connection to the production line. This is a short time activity. The activity takes place at the outer side of the cell (no direct contact with/access to the diaphragm). Finally the asbestos in the diaphragm is bonded in a matrix, thereby preventing release of fibres. Therefore the opportunity for contact with asbestos is highly limited. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.5 Worker contributing scenario 4: Service life of electrolysis cells (PROC1)

A2.2.5.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix (the added slurry to the electrolysis cells is also bonded into the matrix structure).
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: daily • Duration of activity: 3 hours per day (2 technician)
Technical and organisational conditions and measures

• Containment: handling in closed system (cells are fully closed). • Handling of materials: no manual or mechanical handling of diaphragm during service life (operators carry out visual inspections, process control of fully closed production line). • General ventilation: not applicable (outdoors). • Local exhaust ventilation: not applicable (outdoors). • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: outdoors
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.5.2 Exposure and risks for workers

Table A2. 12 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Cells are fully closed during service life.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.

As the cells during service life are fully closed, there is no opportunity for contact with the chrysotile asbestos or for release of asbestos fibres. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.6 Worker contributing scenario 5: Disconnection of electrolysis cells from production line and intermediate storage in water pit (PROC3)

A2.2.6.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix (the added slurry to the electrolysis cells is also bonded into the matrix structure).
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 2 times per year • Duration of activity: 8 hours per day for 2 days (2 technicians)
Technical and organisational conditions and measures
• Containment: handling in closed system (cells are submerged in water). • Handling of materials: mechanical handling of cells; only short manual handling for disconnection from production line. • General ventilation: not applicable (outdoors). • Local exhaust ventilation: not applicable (outdoors) • Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.6.2 Exposure and risks for workers

Table A2. 13 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	No exposure data are available for this activity. Cells are closed and during storage submerged in water, preventing release of fibres.	

Conclusion on risk characterisation:

As no exposure data are available for this activity, no comparison with the reference value has been made.
During this activity the cells are closed and during intermediate storage, submerged in water. The only opportunity for exposure arises when the cell is disconnected from the production line. This is a short term activity. During this activity, there is no contact with the inner parts of the cell, containing the diaphragm. Secondly the asbestos is bonded in a matrix and the diaphragm in the cell is wet. This prevents asbestos fibres to be released and become airborne. Therefore, the opportunity for contact with the asbestos is considered to be very low. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.7 Worker contributing scenario 6: Dismantling and cleaning of dismantled parts (PROC8b)

A2.2.7.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in matrix (the added slurry to the electrolysis cells is also bonded into the matrix structure).
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 75 days per year • Duration of activity: 8 hours per day (3 technicians)
Technical and organisational conditions and measures
• Containment: cathode with diaphragm is kept wet during all activities • Handling of materials: only mechanical handling of anode and cathode; no manual handling • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: no

• Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.7.2 Exposure and risks for workers

Table A2. 14 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	Disassembly: 90 % Upper Confidence Level: 235 fibres/m^3 Washing of anode/cathodes: Geometric Mean: 100 fibres/m^3 (90 % Upper Confidence Level cannot be calculated as data results are identical)	RCR = 0.24 RCR = 0.10

Measured data are available for the exposure during disassembly (refer to Annex 3).
Disassembly: No. of samples: 9; Geometric Mean: 123 fibres/m^3; Geometric Standard Deviation: 1.48;
90 % Upper Confidence Level: 235 fibres/m^3; Exceedance fraction: < 0.1 %.

Washing of anode/cathodes:
No. of samples: 3; Geometric Mean: 100 fibres/m^3; Geometric Standard Deviation: 1.00;
90 % Upper Confidence Level: n/a; Exceedance fraction: n/a (n/a: cannot be calculated as data results are identical).

Remarks on exposure data:

4 out of 9 measurements for the dismantling were below the level of detection (approximately 100 fibres/m^3). For calculation of the statistics the level of detection as such was used as the result of the measurement. The variation in measurement results is low (as indicated by a Geometric Standard Deviation of 1.48). The 90 % upper confidence level has been used for comparison with the reference level of 1000 fibres/m^3. The 90 % upper confidence level is well below the reference level. The probability of exceedance of the

reference level for this situation is < 0.1 %.

Only 3 data points for the washing of anode/cathodes are available. One result was below the level of detection, the other two results at the level of detection (100 fibres/m^3). As the data results are identical, neither 90 % upper confidence level, nor the Exceedance fraction can be calculated.

Conclusion on risk characterisation:

From the comparison of measured data with the reference level it is concluded that the level of exposure is approximately 4 times lower than the reference value of 1000 fibres/m^3 (corresponding to a life-time cancer risk of $2x10^{-5}$). Consequently, this level of exposure corresponds with a life-time cancer risk of approximately $5x10^{-6}$, which is well within the range of what is considered to be an 'acceptable' lifetime (i.e., a working life of 40 years) cancer risk level for workers.

From a qualitative risk assessment perspective, there is very limited opportunity for contact with the chrysotile asbestos as the asbestos in the diaphragm is bonded to a matrix and the diaphragm is kept wet during all dismantling and washing activities. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).

In conclusion, with these measures and conditions implemented, and based on the results of the exposure measurements, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.2.8 Worker contributing scenario 7: Waste handling (PROC8b)

(note: this step is identical for both exposure scenarios)

A2.2.8.1 Conditions of use

Product (article) characteristics
• Concentration of substance in mixture: substance as such, bonded in wet matrix of pellets
Amount used (or contained in articles), frequency and duration of use / exposure
• Frequency: 75 days per year • Duration of activity: 8 hours per day (1 technician)
Technical and organisational conditions and measures
• Containment: mainly closed system, except for the collection of wet waste pellets. • Handling of materials: only mechanical handling of wet waste, except for the collection of waste pellets (manual handling) • General ventilation: natural ventilation from windows and doors. • Local exhaust ventilation: no.

• Advanced Occupational Health and Safety Management System (refer to table B.3).
Conditions and measures related to personal protection, hygiene and health evaluation
• PPE used: safety helmet, safety glasses, safety gloves, safety work clothing, safety shoes (for details on type and materials, refer to table B.3).
Other conditions affecting workers exposure
• Process temperature: ambient. • Place of use: indoors.
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply
• Refer to table B.3

A2.2.8.2 Exposure and risks for workers

Table A2. 15 - Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, systemic, long-term	90 % Upper Confidence Level: 112 fibres/m^3	RCR = 0.11

Measured data are available for the exposure during pelletization (refer to Annex 3).
No. of samples: 6; Geometric Mean: 103 fibres/m^3; Geometric standard deviation: 1.05; 90 % Upper Confidence Level: 112 fibres/m^3; Exceedance fraction: < 0.1 %.

Remarks on exposure data:

All 6 measurements were below the level of detection (approximately 100 fibres/m^3). For calculation of the statistics the level of detection as such was used as the result of the measurement. The variation in measurement results is low (as indicated by a Geometric Standard Deviation of 1.05). The 90 % upper confidence level has been used for comparison with the reference level of 1000 fibres/m^3. The 90 % upper confidence level is well below the reference level. The probability of exceedance of the reference level for this situation is < 0.1 %.

Conclusion on risk characterisation:

From the comparison of measured data with the reference level it is concluded that the level of exposure is approximately 10 times lower than the reference value of 1000 fibres/m^3 (corresponding to a life-time cancer risk of $2x10^{-5}$). Consequently, this level of exposure corresponds with a life-time cancer risk of approximately $2x10^{-6}$, which is well within the range of what is considered to be an 'acceptable' lifetime (i.e., a working life of 40 years) cancer risk level for workers.
From a qualitative risk assessment perspective, there is very limited opportunity for contact with the chrysotile asbestos as all (wet) waste is treated in a closed wastewater treatment system. The only opportunity for exposure is during pelletization, when the pellets are discharged in a bin and the bins are manually sealed and replaced by empty bins. During

the discharge the bin is connected to the discharge pipe (with only very small openings around the rim); secondly the pellets, in which the asbestos fibres are bonded, are still partly wet during discharge. Therefore, there is very limited opportunity for contact with the chrysotile asbestos. Furthermore, all other measures and conditions of use, as recommended in the ECHA Guidance IR&CSA Part E (table E.3-1) (ECHA, 2012), are implemented (refer to table B.3).
In conclusion, with these measures and conditions implemented, and based on the results of the exposure measurements, it is highly unlikely that workers will be exposed to asbestos, and experience any adverse effects as result of it.

A2.3 RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

A2.3.1 Human health (related to combined exposure)

A2.3.1.1 Workers

Workers may be exposed to asbestos naturally present in their living environment. The background levels for the general public are in the same range as the asbestos levels measured at the Stade production facilities. It is impossible to distinguish the contribution from both sources. Therefore combined exposure is considered to be irrelevant.

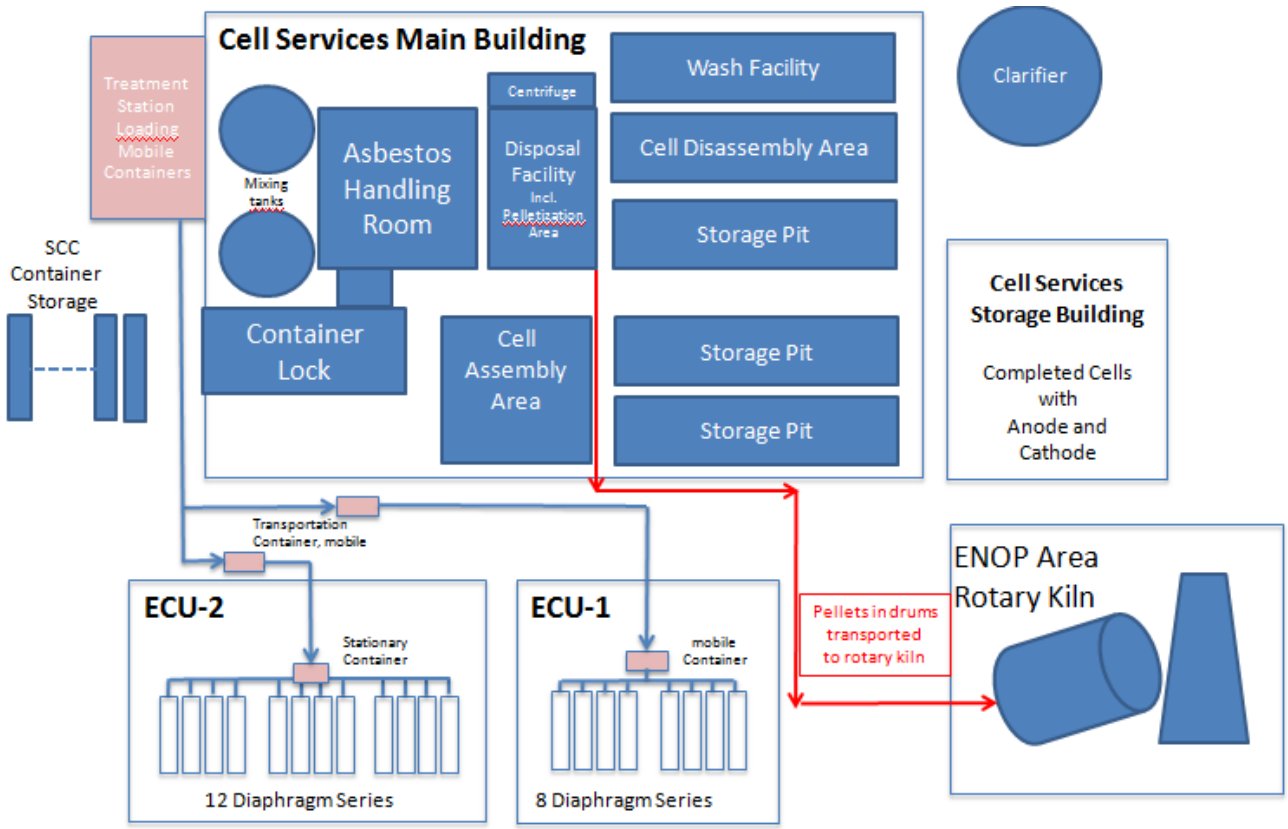
A2.3.1.2 Consumers

This is not applicable, as there is no consumer use.

A2.3.2 Environment (combined for all emission sources)

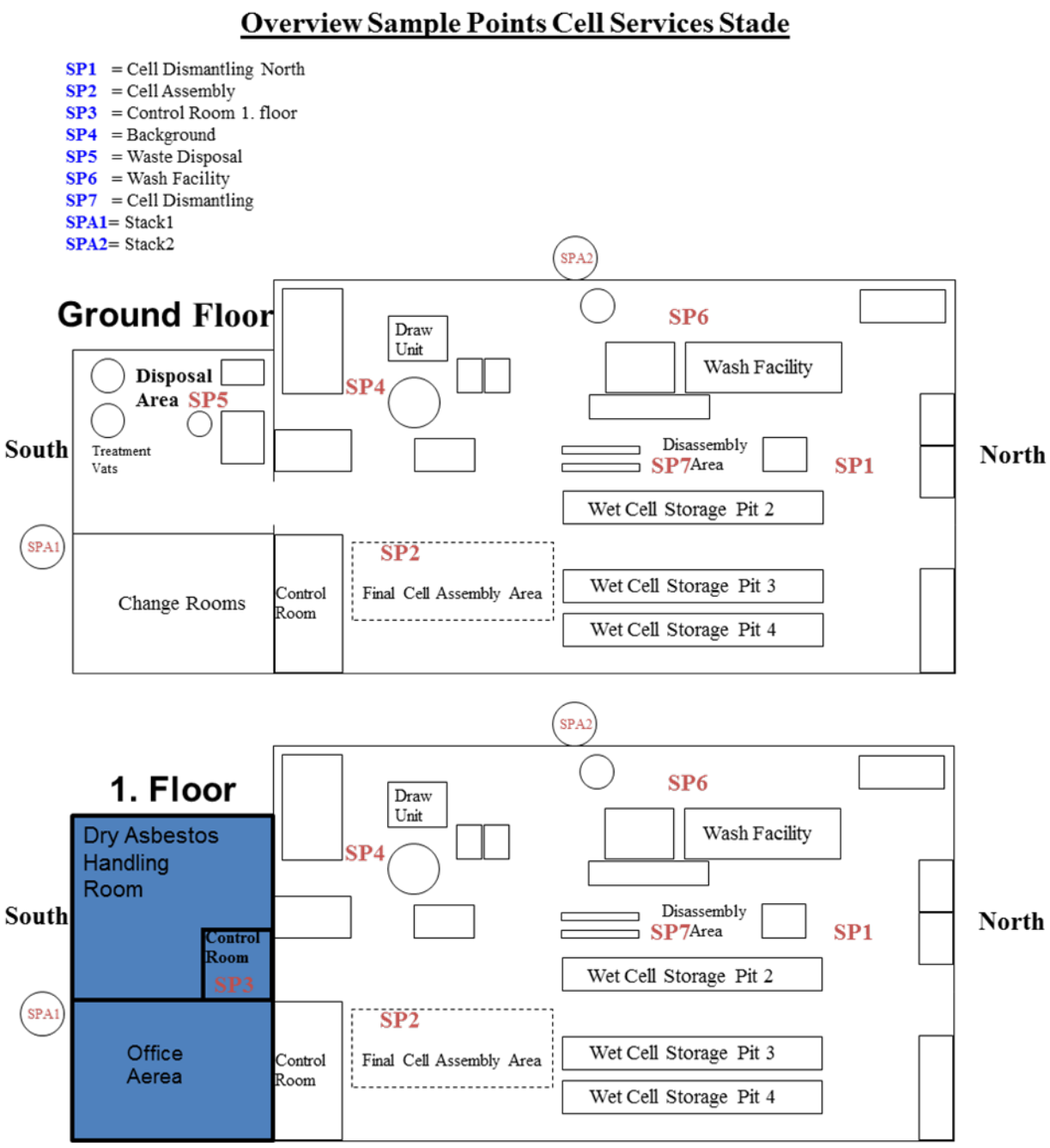
The concentration of asbestos in emitted air by Dow in Stade is comparable with what nowadays is measured as background levels in rural and residential areas. Therefore it is considered that the emission of asbestos by Dow in Stade does not contribute to an increase of the concentration of asbestos in air in the surrounding environment, nor to an increase in direct or indirect exposure of the general public.

A2 Annex 1


Cell Services Main Building
Wash Facility
Clarifier
Treatment Station Loading Mobile Containers
Centrifuge
Asbestos Handling Room
Disposal Facility Incl. Pelletization Area
Cell Disassembly Area
Mixing tanks
Storage Pit
SCC Container Storage
Container Lock
Cell Assembly Area
Storage Pit
Storage Pit
Cell Services Storage Building
Completed Cells with Anode and Cathode
Transportation Container, mobile
ENOP Area Rotary Kiln
ECU-2
Stationary Container
ECU-1
mobile Container
Pellets in drums transported to rotary kiln
12 Diaphragm Series
8 Diaphragm Series

A2 Annex 2

Sampling + analysis



A2 Annex 3

Table AA3. 1 - Results from stationary measurements during work activities (2008 – 2013)

Year	Concentration of chrysotile asbestos (fibres/m^3)						
	Control Room (SP3)	**Cell assembly (SP2)**	**Cell dismantling (SP1 + SP7)**	**Waste disposal (SP5)**	**Washing facility (SP6)**	**Filling (including (de)coupling) (SP8)**	**Background level in main hall (SP4)**
2008	<110	<110	<110	<110			<110
2009	<100	<100	100	110			<110
2010	<100	<100	<100	<100			<100
2011	<100	<100	100 <100	<100	100		<100
2012	<100	100	200 290	200	<100		<100
2013	<100	300	<100 100	<100	100	< 100 < 100	200

Note 1: Sampling and analysis according to GSA SOP-P 016 and VDI-Guideline 3942 (sampling on Nuclepore gold coated Polycarbonate filter; analysis by means of raster electron microscopy (SEM) with EDXA fibre identification)

Note 2: < xxx = below the detection limit (< FE (Fibre Equivalent): the concentration when 1 fibre would be identified on the analyzed filter surface area; corresponds with the analytical sensitivity)

Table AA3. 2 - Results from environmental measurements (2010 – 2013)

Year	Concentration of chrysotile asbestos (fibres/m^3)					
	Stack 1	**Stack 2**	**North gate**	**West gate**	**South-West gate**	**Fence line East**
2010	<100					
2011		<100				
2013	<100		<100	<100	<100	< 100

Note 1: Sampling and analysis according to VDI-Guideline 2066/3861 and 3942 (sampling on Nuclepore gold coated Polycarbonate filter; analysis by means of raster electron microscopy (SEM) with EDXA fibre identification)

Note 2: < xxx = below the detection limit (< FE (Fibre Equivalent): the concentration when 1 fibre would be identified on the analyzed filter surface area; corresponds with the analytical sensitivity)

ANNEX 3 – Dow Monitoring Data

Fiber Measurements [fibres/m3]								
Year	date of sampling	SP1 Gr.Halle, Nord	SP2 Gr.Halle, Süd	SP3 Leitstand AHR	SP4 Dia.halle CD-702	SP5 Disposalhalle	SP6 Waschhalle-Süd	SP7 M83-Demontage
2008	18.12.2008	< FA	< FA	< FA	< FA	< FA		
2009	12.11.2009	100	< FA	< FA	< FA	100		
2010	10.11.2010	stack 1: < FA						
2010	10.11.2010	< FA	< FA	< FA	< FA	< FA		
2011	14.09.2011	stack 2: < FA						
2011	14.09.2011	100	< FA	< FA	< FA	< FA	100	< FA
2012	16.05.2012	200	100	< FA	< FA	200	< FA	290
	Activity	Cell dismantling	Cell assembly	robot operation control	diaphram drawing	Disposal	diaphragm wash	cell dismantling
comment : < FA = no fiber was found, FA= fiber equivalent; SP= Sampling Point								