Committee for Risk Assessment (RAC)
Committee for Socio-economic Analysis (SEAC)

Opinion

on an Application for Authorisation for

Industrial use of 1,2-Dichloroethane as a solvent for the synthesis of Polyepichlorohydrin used as a precursor in the production of Glycidyl Azide Polymer, an oligomer with hydroxyl terminations used to increase the energetic performance of propellants and explosives

ECHA/RAC/SEAC: Opinion N° AFA-O-0000006534-73-02/F

Consolidated version

Date: 26/04/2017
Consolidated version of the
Opinion of the Committee for Risk Assessment
and
Opinion of the Committee for Socio-economic Analysis
on an Application for Authorisation

Having regard to Regulation (EC) No 1907/2006 of the European Parliament and of the Council 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (the REACH Regulation), and in particular Chapter 2 of Title VII thereof, the Committee for Risk Assessment (RAC) and the Committee for Socio-economic Analysis (SEAC) have adopted their opinions in accordance with Article 64(4)(a) and (b) respectively of the REACH Regulation with regard to an application for authorisation for:

**Chemical name:** 1,2-dichloroethane  
**EC No.:** 203-458-1  
**CAS No.:** 107-06-2

for the following use:

*Industrial use of 1,2-Dichloroethane as a solvent for the synthesis of Polyepichlorohydrin used as a precursor in the production of Glycidyl Azide Polymer, an oligomer with hydroxyl terminations used to increase the energetic performance of propellants and explosives*

**Intrinsic property referred to in Annex XIV:**

Article 57 (a) of the REACH Regulation

**Applicant:**

**EURENCO**

**Reference number:**

11-2120115132-77-0000

Rapporteur, appointed by the RAC: João Carvalho  
Co-rapporteur, appointed by the RAC: Urs Schlüter

Rapporteur, appointed by the SEAC: Robert Csergő  
Co-rapporteur, appointed by the SEAC: Alexandra Mexa

This document compiles the opinions adopted by RAC and SEAC.
PROCESS FOR ADOPTION OF THE OPINIONS

On **22/02/2016** EURENCO submitted an application for authorisation including information as stipulated in Articles 62(4) and 62(5) of the REACH Regulation. On **29/04/2016** ECHA received the required fee in accordance with Fee Regulation (EC) No 340/2008. The broad information on uses of the application was made publicly available at [http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation](http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation) on **27/04/2016**. Interested parties were invited to submit comments and contributions by **22/06/2016**.

No comments were received from interested parties during the public consultation in accordance with Article 64(2)).

The draft opinions of RAC and SEAC take into account the responses of the applicant to the requests that the SEAC made according to Article 64(3) on additional information on possible alternative substances or technologies.

The draft opinions of RAC and SEAC were sent to the applicant on **10/02/2017**.

On **26/04/2017** the applicant informed ECHA that they did not wish to comment on the opinions. The draft opinions of RAC and SEAC were therefore considered as final on **26/04/2017**.

ADOPTION OF THE OPINION OF RAC

The draft opinion of RAC

The draft opinion of RAC, which assesses the risk to human health arising from the use of the substance – including the appropriateness and effectiveness of the risk management measures as described in the application and, if relevant, an assessment of the risks arising from possible alternatives – was reached in accordance with Article 64(4)(a) of the REACH Regulation on **09/12/2016**.

The draft opinion of RAC was agreed by consensus.

The opinion of RAC

Based on the aforementioned draft opinion and in the absence of comments from the applicant, the opinion of RAC was adopted as final on **26/04/2017**.

ADOPTION OF THE OPINION OF SEAC

The draft opinion of SEAC

The draft opinion of SEAC, which assesses the socio-economic factors and the availability, suitability and technical and economic feasibility of alternatives associated with the use of the substance as described in the application was reached in accordance with Article 64(4)(b) of the REACH Regulation on **15/09/2016**.

The draft opinion of SEAC was agreed by consensus.

The opinion of SEAC

Based on the aforementioned draft opinion and in the absence of comments from the applicant, the opinion of SEAC was adopted as final on **26/04/2017**.
THE OPINION OF RAC

The application included the necessary information specified in Article 62 of the REACH Regulation that is relevant to the Committee’s remit.

RAC has formulated its opinion on: the risks arising from the use applied for, the appropriateness and effectiveness of the risk management measures described, the assessment of the risks related to the alternatives as documented in the application, No comments were received from interested parties during the public consultation in accordance with Article 64(2)).” as well as other available information.

RAC confirmed that it is not possible to determine a DNEL for the carcinogenic properties of the substance in accordance with Annex I of the REACH Regulation.

RAC confirmed that there appear not to be any suitable alternatives that further reduce the risk.

RAC confirmed that the operational conditions and risk management measures described in the application do not limit the risk, however the suggested conditions and monitoring arrangements are expected to improve the situation.

THE OPINION OF SEAC

The application included the necessary information specified in Article 62 of the REACH Regulation that is relevant to the Committee’s remit.

SEAC has formulated its opinion on: the socio-economic factors and the availability, suitability and technical and economic feasibility of alternatives associated with the use of the substance as documented in the application, No comments were received from interested parties during the public consultation in accordance with Article 64(2)).” as well as other available information.

SEAC took note of RAC’s confirmation that it is not possible to determine a DNEL for the carcinogenic properties of the substance in accordance with Annex I of the REACH Regulation.

SEAC confirmed that there appear not to be suitable alternatives in terms of their technical and economic feasibility for the applicant.

SEAC considered that the applicant's assessment of: (a) the potential socioeconomic benefits of the use, (b) the potential adverse effects to human health of the use and (c) the comparison of the two is based on acceptable methodology for socio-economic analysis. Therefore, SEAC did not raise any reservations that would change the validity of the applicant’s conclusion that overall benefits of the use outweigh the risk to human health, whilst taking account of any uncertainties in the assessment, and provided that the suggested conditions and monitoring arrangements are adhered to.
SUGGESTED CONDITIONS AND MONITORING ARRANGEMENTS

Description of additional conditions and monitoring arrangements for the authorisation:

The applicant shall continue to conduct regular occupational exposure measurements. These monitoring programmes must be representative of the range of tasks undertaken where exposure to EDC is possible and of the total number of workers that are potentially exposed – especially those involved in the collection of samples and their analysis. Measurements shall be undertaken according to standard sampling and analytical methods, where possible.

The information gathered in the monitoring campaigns must be used by the applicant to review the risk management measures and operational conditions, including the effectiveness and positioning of extraction ventilation, to further reduce workers’ exposure to EDC.

The results of the monitoring and of the review of the OCs and RMMs must be maintained, be available to national enforcement authorities and included in any subsequent authorisation review report submitted.

The applicant shall implement the most appropriate risk management measure (RMM) for wastewater releases to reduce environmental exposure to as low a level as is technically and practically possible.

Future releases of EDC to waste water shall be subject to regular measurement with the results of monitoring made available to enforcement bodies on request. Measurement programmes shall be undertaken according to standard sampling and analytical methods, where appropriate.

The information gathered in the monitoring programmes shall be used by the applicant to review the risk management measures (RMMs) and operational conditions (OCs) to further reduce environmental exposure to EDC. The outcomes and conclusions of this review including those related to the implementation of any additional RMMs must be documented.

Description of additional conditions and monitoring arrangements for the review:

The results of the monitoring and of the review of the OCs and RMMs must be maintained, be available to national enforcement authorities and included in any subsequent authorisation review report submitted.

REVIEW

Taking into account the information provided in the application for authorisation prepared by the applicant the duration of the review period for the use is recommended to be four years.
**JUSTIFICATIONS**

The justifications for the opinion are as follows:

<table>
<thead>
<tr>
<th>1. The substance was included in Annex XIV due to the following property/properties:</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ Carcinogenic (Article 57(a))</td>
</tr>
<tr>
<td>☐ Mutagenic (Article 57(b))</td>
</tr>
<tr>
<td>☐ Toxic to reproduction (Article 57(c))</td>
</tr>
<tr>
<td>☐ Persistent, bioaccumulative and toxic (Article 57(d))</td>
</tr>
<tr>
<td>☐ Very persistent and very bioaccumulative (Article 57(e))</td>
</tr>
<tr>
<td>☐ Other properties in accordance with Article 57(f) [please specify]:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Is the substance a threshold substance?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ YES</td>
</tr>
<tr>
<td>☑ NO</td>
</tr>
</tbody>
</table>

**Justification:**

1,2-Dichloroethane (EDC) has a harmonised classification as Carc. 1B with H350 according to Classification, Labelling and Packaging Regulation, (EC) 1272/2008.

Based on studies which show its genotoxic potential, the Risk Assessment Committee (RAC) has concluded that EDC should be considered as a non-threshold carcinogen with respect to risk characterisation (reference to the studies examined are included in the RAC document RAC/33/2015/09 Rev.1 Final).

<table>
<thead>
<tr>
<th>3. Hazard assessment. Are appropriate reference values used?</th>
</tr>
</thead>
</table>

**Justification:**

RAC has established a reference dose response relationship for the carcinogenic effect following exposure to EDC (RAC/33/2015/09 Rev. 1 Final). Based on experimental animal data (cited in the aforementioned RAC document) a potentially increased risk of cancer occurring due to genotoxicity of the substance was noted.

In the absence of epidemiological studies on occupational exposure to EDC that would be useful in identifying any quantitative risk for humans, the dose-response estimations are based on the most relevant, robust study in experimental animals (development of mammary tumours in rats). A linear relationship between the exposure to each unit amount of EDC and the cancer risk was assumed.

The following cancer risk estimates were calculated by RAC and used by the applicant:
Table 1: Dose-response relationship for carcinogenicity of 1,2-dichloroethane established by RAC (RAC/33/2015/09 Rev. 1 Final)

<table>
<thead>
<tr>
<th>Route of exposure</th>
<th>Population</th>
<th>Cancer risk for 1 unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalation</td>
<td>Workers</td>
<td>$6.0 \times 10^{-7}$ per μg/m$^3$</td>
</tr>
<tr>
<td></td>
<td>General population</td>
<td>$3.45 \times 10^{-6}$ per μg/m$^3$</td>
</tr>
<tr>
<td>Dermal (for 50% dermal absorption)</td>
<td>Workers</td>
<td>$2.1 \times 10^{-6}$ per μg/kg bw/day</td>
</tr>
<tr>
<td></td>
<td>General population</td>
<td>$6 \times 10^{-6}$ per μg/kg bw/day</td>
</tr>
<tr>
<td>Oral</td>
<td>General population</td>
<td>$1.2 \times 10^{-5}$ per μg/kg bw/day</td>
</tr>
</tbody>
</table>

In the socio-economic analysis (SEA) the remaining human health risks are evaluated based on the dose-response relationship adopted by RAC.

Are all appropriate and relevant endpoints addressed in the application?

Cancer risk was estimated using the dose-response curve developed by RAC for all relevant routes of exposure and exposed populations. The applicant assesses both dermal and inhalation exposure for workers as well as inhalatory and oral exposure (via food) for the general population.

4. Exposure assessment. To what extent is the exposure from the use described?

Description:

Short description of the use

EDC is used as a solvent in the synthesis of Polyepichlorohydrin (PECH), a precursor subsequently used in the production of Glycidyl Azide Polymer (GAP). GAP is an energetic oligomer with hydroxyl terminations used to increase the energetic performance of propellants.

The global chemical reaction is a two-stage process, involving polymerisation of Epichlorohydrin (ECH) to Polyepichlorohydrin (PECH) followed by the conversion of PECH to Glycidyl Azide Polymer (GAP) by nucleophilic substitution with chloride azide:

- Step 1: Polymerisation of ECH to PECH is carried out using EDC as solvent.
- Step 2: GAP-diol possesses hydroxyl functional groups located at both ends of the chains and is synthesised via the nucleophilic reaction of its precursor, PECH, with sodium azide (NaN$_3$).

The use of EDC is limited to Step 1 of the abovementioned reaction: the polymerisation of ECH to PECH. Sampling and laboratory testing demonstrate the absence of EDC in the PECH at the end of the reaction, therefore eliminating any risk of exposure during the synthesis of GAP and further steps in the supply chain.

The synthesis of GAP is carried out in a batch process at a single facility on the applicant’s site in France for a total duration of less than one month per year (22 days in 2015, 15
days in 2014). The production of a single batch of the product takes two to three 8-hour shifts, with two operators involved in the process. A total of seven employees are currently employed in the production of PECH and are therefore potentially exposed to EDC. EURENCO’s use of EDC for the synthesis of PECH amounted respectively to 1.0 and 2.6 tons for the two last campaigns of 2014 and 2015.

Synthesis of PECH is carried with the following steps (Figure 1):
Figure 1: PECH synthesis process

Only those production steps in Figure 1 with a potential of exposure to EDC are briefly described below. Steps ⑤, ⑥ and ⑧ are not described, as the applicant claims that due to the enclosure of the system no exposure is possible from these steps. Step ⑩...
“Discarding of residue from distillation” is described, but the applicant claims that worker exposure is not relevant.

① Supply and storage
EDC is supplied and stored in 200 L hermetic tanks. Upon receipt, EDC is subject to sampling for laboratory quality control. The sampling is performed by opening the tank, and transferring a small amount of substance into a laboratory vessel by using a pipette. Laboratory testing is carried out in a semi-enclosed analysis fume cupboard. Except during the sampling operation, the tank is not opened. Sampling and laboratory testing are performed by laboratory staff and described as WCS-1 and WCS-6.

② Pre-production run
The facility is not used exclusively for this synthesis. Therefore, at the beginning of each production campaign (i.e. once a year for three to four weeks), a pre-production run is carried out with 200L of EDC, in order to wash the overall piping and instrumentation:

- Transfer of EDC into the system is performed by operators under the same conditions as ③ “Offloading of EDC”. The exposure during this transfer is considered in WCS-7 and WCS-8;
- EDC used in the pre-production run to rinse the piping is recovered in the same way as the EDC used in the production process as described for step ⑨. The exposure during this task is considered in WCS-12 and WCS-13.

③ Offloading of EDC into the system
Before transfer into the reaction system, each EDC batch undergoes sampling and testing similarly to ① (WCS-2 and WCS-6). The transfer is performed by introducing a plunging cane in the 200L tank (outside of the production facility, with a movable capturing hood providing local exhaust ventilation (LEV)) and pumping its content to the reactor. The operator wears respiratory protection equipment (RPE) during the whole operation. After placing the plunging cane and starting of the pump (‘near field’ in exposure modelling) the operator remains at a distance of more than 1 m from the tank’s opening during the rest of this operation (‘far field’ in modelling). After pumping, EDC is automatically transferred to the main reactor through a closed circuit. The exposure during this task is considered in WCS-7 (‘near field’ modelling) and WCS-8 (‘far field’ modelling).

④ Introduction of raw materials
Raw materials are introduced into the main reactor already containing EDC via a hand-sized hole of approximately 7 cm in diameter. During this operation, a movable capturing hood, as LEV, is placed above the opening. In addition, and the operator wears RPE. The exposure resulting from this task is considered in WCS-9.
After completion of the PECH synthesis reaction, the content of the main reactor is transferred to an auxiliary reactor. This transfer is performed automatically through a completely closed circuit and does not involve manual operation. The manhole (of approximately 20 cm in diameter) of the auxiliary reactor is opened three times for:

- the introduction of bicarbonate;
- pH measurement and
- aqueous extraction of the reaction mixture.

During these operations, a movable capturing hood is placed above the manhole as LEV, and the operator wears RPE. The exposure during this task is considered in WCS-11. One sample is collected through the manhole and undergoes laboratory testing (WCS-3 and WCS-6).

Distillation of the aqueous phase is carried out automatically in a hermetically closed tank enclosure.

EDC collected after the distillation phase (step 8, not assessed by the applicant because there is no exposure potential) is recovered by pumping from a storage tank to a 1,000 L bulk tank, using a plunging cane. This task is performed once per campaign and is carried out outdoors. The operator wears RPE. The exposure during this task is considered in WCS-12 and WCS-13. Here again, different distances from the exposure source (near and far field) can be assumed for modelling.

The residue resulting from the distillation step contains traces of EDC. This residue is discharged into the nearby river Rhône. The EDC content of emissions to water are monitored. This release is considered (ECS-1).

The PECH-containing aqueous phase is pumped from the auxiliary reactor and then distilled within a completely closed system. The operator opens the system for sampling. The following laboratory testing is carried out as described above. Only sampling and laboratory analysis are considered for exposure to EDC (WCS-4 and WCS-6).

The effluents of the drying process are recovered by pumping from a storage tank to a 1,000 L bulk tank with a plunging cane. This step is carried out once per manufacturing operation, outside and the operator wears RPE. The exposure during this task is considered in WCS-12 and WCS-13. Here again, different distances (near and far field)
are considered in modelling. A sampling (WCS-5) of the effluent is carried out at the bulk tank, but the sample does not undergo laboratory analysis.

⑬ Maintenance

Piping and instrumentation may require some maintenance interventions. First-level interventions are carried out by internal maintenance staff (1 intervention in 2015 and 6 interventions in 2014 – no exposure). Second-level interventions are carried out by an external service provider (in 2015 1 intervention with potential exposure). Potential for exposure is encountered during maintenance, but the inventory of maintenance interventions shows no exposure for 2014 and 2015. The applicant chose not to provide an exposure assessment for this step.

### Table 2: WCS, synthesis steps, workers presented in the use applied for

<table>
<thead>
<tr>
<th>Scenario</th>
<th>ERC / PROC</th>
<th>Name of the scenario</th>
<th>Production step</th>
<th>Concerned workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECS-1</td>
<td>ERC 6b</td>
<td>Industrial use of EDC as a solvent for the synthesis of PECH</td>
<td>Discarding of distillate residues</td>
<td></td>
</tr>
<tr>
<td>WCS-1</td>
<td>PROC 9</td>
<td>Sampling 1</td>
<td>① Supply and storage</td>
<td>1 logistics worker</td>
</tr>
<tr>
<td>WCS-2</td>
<td>PROC 9</td>
<td>Sampling 2</td>
<td>③ Offloading of EDC into the system</td>
<td></td>
</tr>
<tr>
<td>WCS-3</td>
<td>PROC 9</td>
<td>Sampling 3</td>
<td>⑦ Introduction of bicarbonate, pH measurement and extraction of the aqueous phase</td>
<td></td>
</tr>
<tr>
<td>WCS-4</td>
<td>PROC 9</td>
<td>Sampling 4</td>
<td>⑩ Discarding of residue from distillation ⑪ Recovery of the organic phase and drying of PECH</td>
<td>1 laboratory staff</td>
</tr>
<tr>
<td>WCS-5</td>
<td>PROC 9</td>
<td>Sampling 5</td>
<td>⑫ Recovery of effluents after drying</td>
<td></td>
</tr>
<tr>
<td>WCS-6</td>
<td>PROC 15</td>
<td>Laboratory testing</td>
<td>① Supply and storage ③ Offloading of EDC into the system ⑦ Introduction of bicarbonate, pH measurement and extraction of the aqueous phase ⑪ Recovery of the organic phase and drying of PECH</td>
<td></td>
</tr>
<tr>
<td>WCS-7</td>
<td>PROC 8a</td>
<td>Offloading, near field</td>
<td>② Pre-production run</td>
<td>6 synthesis operators</td>
</tr>
<tr>
<td>WCS</td>
<td>PROC</td>
<td>Description</td>
<td></td>
<td></td>
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<tr>
<td>------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>8a</td>
<td>Offloading, far field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>8a</td>
<td>Introduction of raw materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>Loading of bicarbonate &amp; pH measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>8a</td>
<td>Extraction of the aqueous phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>8a</td>
<td>Recovery of effluents, near field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>8a</td>
<td>Recovery of effluents, far field</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Worker exposure

Three different worker profiles are identified by the applicant and linked to the exposure to EDC in different WCSs (see table 2 for a correlation of production steps and WCS):

- Logistics worker (WCS-1)
- Laboratory staff (WCS-2 to WCS-6) and
- Synthesis operators (WCS-7 to WCS-13).

RAC will evaluate the exposure and risk of these workers separately as the activities and opportunities for exposure are clearly distinguishable.

**WCS-1 Logistics worker**

The activity of one logistics worker with potential for exposure to EDC is limited to sampling of EDC from the delivery tanks for quality control. It is described as “① Supply and storage” and WCS-1.
WCS-2 to WCS-6 Laboratory staff

For most of the production steps quality control by sampling and laboratory testing is foreseen. It is the responsibility of one worker of the laboratory staff to take the samples and perform the testing. WCS-2 to WCS-5 describe the sampling at different production steps (③, ⑦, ⑪, ⑫). WCS-6 describes the laboratory testing for production steps ①, ③, ⑦ and ⑪. For production step ⑫ only sampling of the effluent is carried out for record keeping reason; these samples are not analysed in the laboratory.

Sampling activities are carried out as an open process, by using a pipette to collect the material and transfer the sample into a laboratory vessel. Laboratory testing is carried out in a semi-enclosed fume cupboard.

WCS-7 to WCS-13 Synthesis operators

Six synthesis operators run and control the production steps. During the production process, only sampling and laboratory analysis does not fall within their responsibility. Some of the activities are relatively open processes, e.g. “④ Introduction of raw materials” via a hand-sized hole in the main reactor and “⑦ Introduction of bicarbonate, pH measurement and extraction of the aqueous phase” via the manhole. In those cases a moveable LEV and RPE are used to reduce inhalation exposure. Dermal exposure is reduced by use of gloves.

Exposure estimation methodology:

A quantitative assessment was carried out for dermal and inhalation exposure for workers. The inhalation exposure concentration for synthesis operators was measured. Inhalation exposure for the logistics worker and the laboratory staff was modelled with ART v. 1.5. The applicant modelled dermal exposure using ECETOC TRA v. 3 and RISKOFDERM (on RAC’s request) for all workers.

Inhalation:

The applicant claims that measurements are performed on the site yearly during the EDC use period. These measurements are performed to verify if the exposure comply with the French indicative occupational exposure limit value of 40 mg/m³. However, the measurement values provided in the CSR only represent the 2015 campaign and are therefore of limited number and explanatory power. Five measurements represent an 8h average working day (as an 8h TWA) including WCS-7 to WCS-13. Three measurements are provided for 15-minute durations for specific short-term activities: ③ Offloading of EDC into the system, ④ Introduction of raw materials and ⑦ Introduction of bicarbonate, pH measurement and extraction of the aqueous phase.

In addition to these measurements, exposure modelling was performed using the ART model for all WCSs. The applicant reported the 90th percentile long-term exposure value for each WCS and for transparency included in an annex a comparison of the use conditions and modelling parameters in the CSR and the ART modelling reports for each WCS.
Dermal exposure:

The applicant used ECETOC TRA and (on RAC’s request) RISKOFDERM for modelling dermal exposure of all concerned workers. For modelling, it was assumed that for gloves (and protective suits) the tool’s standard protection factors are appropriate. Input parameters and outcome of the modelling are documented in detail.

However, the applicant states in the CSR (p. 72): "The risk estimated via the tier 1 approach (ECETOC), lead to a dermal risk more than 30 times above the inhalation risk which is clearly unrealistic considering the protection equipment and the physico-chemical characteristics of the EDC”. As RAC uses values of dermal exposure for the risk assessment, RAC recommended use of a tier 2 exposure assessment, RISKOFDERM for sensitivity analysis. The applicant followed that recommendation.

Additionally, the potential for actual dermal absorption of EDC is considered to be negligible, as any spills of EDC will evaporate rapidly from the gloves upon contact. The evaporation time is calculated as between 10 seconds (assuming 1 mg mass) and 50 seconds (assuming 5 mg mass) according to calculations based on Appendix R.14-1 of ECHA’s guidance. Therefore, EDC is expected to evaporate from gloves long before the penetration time is reached.

Due to the PPE used and the high volatility of EDC RAC considers dermal exposure as being overestimated by the used exposure modelling tools.

RMMs applied

The risk management measures applied by the applicant include the following:

- The system (main reactor, auxiliary reactor, storage tanks, piping) is essentially closed. However, the system is frequently opened and several open handling steps are necessary, mainly for sampling, introduction of raw materials and recovery of solvents and the final product. The applicant’s justification (provided in response to a question by RAC) for the fact that the synthesis is not carried out in fully closed system is not very convincing:

  “The following operating conditions justify for the fact that the synthesis of PECH is not carried out in fully closed system:

  - The current synthesis steps are carried out in closed reactors with vented to atmosphere treatments such as condensers;
  - The introduction of certain raw materials is carried out manually and therefore implies an open system;
  - The recovery of solvents and of the final product is carried out manually.

  To carry out these operations in a fully closed system would require to significantly modify the facility, notably for the introduction of raw materials and recovery phases, and may have an impact on the control of the process (notably regarding the pressure in the reactors).”

- During activities with greatest potential for exposure, additional technical measures like movable extraction systems (in the CSR described with 90% effectiveness, while for modelling only 50% effectiveness is considered) for the outdoors offloading operations and introduction of raw materials are in place. Laboratory testing is
performed in in a semi-enclosed fume cupboard (considered with 99% effectiveness). The effectiveness and technical level of these measures is doubtful according to photo documentation provided by the applicant.

- The applicant has an OSH System in place that on RAC’s request was described by the applicant in some detail. This includes:
  - Air treatment systems (reactors and movable exhaust systems) are systematically controlled and cleaned between production campaigns.
  - All operators follow an on-the-job training, provided by the workshop supervisor. After this training, the operators are issued a specific accreditation for each operation. This accreditation is renewed every 5 years.
  - Training sessions dedicated to safety instructions are organised (and documented) every three months for each operator, regarding general safety instructions and specific safety instructions for the PECH synthesis workshop.
  - During activities with greatest potential for exposure (i.e. open handling steps), personal protective equipment is worn. This includes a full protective suit, including supplied air respirator system and gloves. The applicant made the choice to use:
    - APF of 30 for the full mask with gas filter P3 is documented in the CSR. However, an APF of 40 was used in calculations provided as spreadsheets in support of the CSR.
    - APF of 250 for the continuous flow compressed air breathing apparatus.
    - APF of 10 for the gloves.

RAC considers the above-mentioned APF-values as standard protection factors (acceptable for the types of PPE and procedures described) for PPE in industrial settings. Documentation of the used PPE is sufficient as technical information for protective suits, gloves and RPE was provided at RAC’s request.
Table 3: Operational Conditions and Risk Management Measures

<table>
<thead>
<tr>
<th>worker profile</th>
<th>Duration and frequency of exposure</th>
<th>LEV used + effectiveness</th>
<th>RPE used + effectiveness</th>
<th>Skin protection + effectiveness</th>
<th>Other RMMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics worker (WCS-1)</td>
<td>&lt;1 min Once per year</td>
<td>Movable capturing hood (50 or 90%)</td>
<td>Full mask with P3 filters (EN 141) (APF 30)</td>
<td>Protective clothes, gloves (APF 10)</td>
<td>effective housekeeping practices, organisational measures</td>
</tr>
<tr>
<td>Laboratory staff (WCS-2 to WCS-5)</td>
<td>&lt;1 min per operation 8 – 23 times per year</td>
<td>Movable capturing hood (50 or 90%)</td>
<td>Full mask with P3 filters (EN 141) (APF 30) or Continuous flow compressed airline breathing apparatus (EN 14594) 4A/4B (APF 250)</td>
<td>Protective clothes, gloves (APF 10)</td>
<td>effective housekeeping practices, organisational measures</td>
</tr>
<tr>
<td>Laboratory staff (WCS-6)</td>
<td>50 min per operation for all samples Once per operation; 23 times per year</td>
<td>Fume cupboard (99%)</td>
<td>none</td>
<td>Protective clothes, gloves (APF 10)</td>
<td>effective housekeeping practices, organisational measures</td>
</tr>
<tr>
<td>Synthesis operators (WCS-7 to WCS-13)</td>
<td>5 – 25 min per operation /WCS, each WCS once per operation; 23 times per year</td>
<td>Movable capturing hood (50 or 90%)</td>
<td>Full mask with P3 filters (EN 141) (APF 30) or Continuous flow compressed airline breathing apparatus (EN 14594) 4A/4B (APF 250)</td>
<td>Protective clothes, gloves (APF 10)</td>
<td>effective housekeeping practices, organisational measures</td>
</tr>
</tbody>
</table>

Note: the concentration of the substance during different production steps is not provided by the applicant.

Discussion of the exposure information:

Inhalation exposure

Typical inhalation exposure measured over a full shift for synthesis operators lies in between the limit of quantification (0.105 µg/m³) and 3.39 µg/m³. Additionally, short term exposures were measured between 2.17 µg/m³ and 7.63 µg/m³. Having in mind the rather limited number of measurement values (only five) RAC used the 90th percentile 2.76 µg/m³ (corrected for frequency and duration to 0.28 µg/m³) instead of the maximum value of the full shift measurements. The duration and frequency of the
activities leading to EDC-exposure of synthesis operators is limited to less than two hours per day and 23 days per year.

For logistics worker and laboratory staff no measurements are available, but inhalation exposure was modelled. Also for synthesis operators inhalation exposure was modelled. It is, however, for several reasons questionable whether the modelling approach is very meaningful:

- Input parameters of the model (ART reports) do not match exactly the OCs and RMMs implemented at the workplace, as described in the CSR in all cases.
- Meaning of the modelling results (8 h TWA or task-specific exposure value) is not defined: the exposure values presented are averaged for the duration and frequency of the tasks.
- Corrections “outside the model” (correction for PPE, duration and frequency of the tasks) are not entirely transparent.

The logistics worker is exposed to EDC only during one sampling event per year for approximately one minute. ART-modelling and correction for PPE, frequency and duration of this activity yields an inhalation exposure of \(1.7 \times 10^{-3} \mu g/m^3\).

The duration and frequency of the activities leading to EDC-exposure of laboratory staff is limited to less than one hour per day during 23 days per year. ART-modelling of these activities, considering the frequency and use of PPE, results in an inhalation exposure of 655 \(\mu g/m^3\).

Dermal exposure

The activities with highest potential for dermal exposure are open handling steps, sampling and laboratory analysis. Dermal exposure reduction only relies on chemical protective gloves. Regarding PPE the applicant has documented (on RAC’s request) which gloves are used and how an efficiency of 90% is achieved.

Additionally, the potential for actual dermal absorption of EDC is of reduced relevance, as any spills or splashes of EDC will evaporate rapidly from the gloves upon contact. Therefore, EDC is expected to evaporate from gloves long before the penetration time is reached. In spite of the above reasoning, the applicant carried out dermal exposure calculations using ECETOC TRA and RISKOFDERM for all WCSs. RAC would consider this as being beyond a reasonable worst-case dermal exposure assessment and take forward for risk assessment the RISKOFDERM results (being more realistic or less conservative than the ECETOC TRA values) as presented in table 4.
Table 4: Exposure – dermal and inhalation

<table>
<thead>
<tr>
<th>Worker profile</th>
<th>Route of exposure</th>
<th>Method of assessment</th>
<th>Exposure value</th>
<th>Exposure value corrected for PPE**</th>
<th>Exposure value corrected for PPE &amp; frequency ***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics worker (WCS-1)</td>
<td>Inhalation</td>
<td>Modelling</td>
<td>7200 µg/m³</td>
<td>180 µg/m³</td>
<td>1.7 x 10⁻³ µg/m³</td>
</tr>
<tr>
<td>Dermal</td>
<td></td>
<td></td>
<td>Negligible compared to other worker profiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory staff (WCS-2 to WCS-6) (sampling &amp; analysis modelled separately)</td>
<td>Inhalation</td>
<td>Modelling</td>
<td>23409 µg/m³</td>
<td>6575 µg/m³</td>
<td>655 µg/m³</td>
</tr>
<tr>
<td>Dermal</td>
<td></td>
<td></td>
<td>4926 µg/kg/d</td>
<td>493 µg/kg/d</td>
<td>49 µg/kg/d</td>
</tr>
<tr>
<td>Synthesis operators (WCS-7 to WCS-13)</td>
<td>Inhalation</td>
<td>Measurement</td>
<td>2.76 µg/m³</td>
<td>****</td>
<td>0.28 µg/m³</td>
</tr>
<tr>
<td>Dermal</td>
<td></td>
<td></td>
<td>423 µg/kg/d</td>
<td>42.5 µg/kg/d</td>
<td>4.3 µg/kg/d</td>
</tr>
</tbody>
</table>

* RAC chose to use dermal modelling results generated with the RISKOFDERM model.

** For this assessment an APF of 40 for RPE (for some tasks also RPE with an APF of 250 is described by the applicant) and of 10 for gloves is used.

*** ... and duration of the task: RAC uses (in accordance with the applicant) 220 working days per year and 8h per working day for correction of the exposure.

**** This information is not relevant, as the underlying measurement value (90th percentile of five personal measurements) represents a global working day and RPE is not worn for the full shift but only for some specific tasks.

Aggregated and combined exposure

The applicant claims that the different worker profiles do not have common tasks. However different tasks (WCSs) are combined by modelling (e.g. sampling and laboratory analysis) or personal measurements (e.g. tasks of the synthesis operators) to exposure values that represent full shift-exposure of the different worker profiles. Additional combining of single exposure values is not considered reasonable.

Uncertainties related to the exposure assessment:

Although the general approach chosen by the applicant is conservative, especially as documented in the submitted modelling reports, a number of uncertainties related to the exposure assessment for workers can be identified, most of them pointing to the possibility of higher exposures. Measurements are only available for one worker profile (i.e. synthesis operator), while other worker profiles are not covered by measurements.
• Available measurements are limited to data from the last production campaign (2015) and are very limited in numbers (only eight data points are available)
• Several tasks are carried out manually and the technical RMMs are not state-of-the-art regarding enclosure of the system, movable extraction systems / movable hoods and general ventilation. Also the method of use of technical RMMs (specifically movable LEV) is not state-of-the-art.
• High effectiveness of 90% is described in the CSR for moveable hoods and even 99% for fume cupboards, with no validation.
• For several production steps, the applicant relies heavily on the effectiveness of PPE (for dermal and inhalation exposure reduction). The description of the workplace and the implemented RMMs do not comply with the hierarchy of control principles as technical options for exposure reduction were not used.
• The effectiveness of gloves (90% reduction of dermal exposure) might be underestimated.
• The effectiveness of RPE is not described consistently throughout the CSR: An APF of 30 for a full mask with gas filter P3 is presented in the CSR but an APF of 40 was used in calculations provided as spreadsheet in support of the CSR.
• The chosen modelling approach for inhalation exposure is questionable for reasons described above under “Discussion of the exposure information”
• It remains unclear why some production steps (⑤, ⑥ and ⑧) are not considered in the exposure assessment.
• Maintenance activities are not considered in the exposure assessment, however a potential of exposure is identified by the applicant.

Overall, the uncertainties noted are considered to be significant.

**Indirectly exposed workers**

The assessment of exposure of workers not involved directly in the EDC-related process is not provided by the applicant. RAC however, agrees that the risks calculated for man via the environment (i.e. the general population) should in principle cover indirect exposure to workers as well.

**Environmental releases / Indirect exposure to the general population (humans via the environment)**

Environmental releases were initially calculated by the applicant using release factors from the Technical Guidance Document on risk assessment (part II: environmental risk assessment). At the request from RAC for a more refined risk assessment, the applicant re-calculated releases based on the ESVOC spERC 4.20 v1. The latter environmental scenario was assessed by RAC to be unsuitable for the current application because this spERC is “not relevant for solvents”. Subsequently the applicant proposed that ESVOC spERC 1.1 v1: “Manufacture of substance or use as a process chemical: (industrial)” was appropriate to the substance, use applied for and the OCs and RMMs implemented on site and used the release factors described for the release estimates.

Releases to water: The residue resulting from the distillation step contains trace levels of EDC. This residue is discharged as waste water directly into the nearby Rhône river. According to the applicant, wastewater is subject to decantation and separation of solid and liquid phases prior to release to the environment (no physico-chemical treatment is
performed). Efficiency of removal of EDC is thus limited. There is no STP treatment. Waste water is thus discharged directly into the river.

EDC aquatic releases are monitored during the phases of synthesis of PECH. The applicant presented monitoring data: 10 measurements from 09/07/2011 to 27/11/2013. At RAC’s request the daily records for all of 2015 on the liquid effluent discharge at site were made available. For the 2011-2013 data the majority of samples (80%) were below a limit of quantification of 2 μg/L. The maximum concentration measured during this period was 7.2 μg/L. Within the 2015 dataset there were 21 days with emissions above “detection level” with values between 0.71 kg/day – 3.18 kg/day (EDC was detected only during periods of production). This dataset showed that for 2015, a total of 37.3 kg EDC was released into the river Rhône. Based on the 2015 monitoring dataset and the EDC tonnage for the same year RAC calculates the water release fraction to be 0.014 (37.3 kg/2.6 tonnes). However, the latter release rate was not used by the applicant in the risk assessment.

The applicant conducted an exposure assessment using the water release factor from the spERC. Taking into consideration that for this spERC release factions can differ based on the physical-chemistry properties of substances, the release fraction used in the risk assessment was 0.01 (corresponding to water solubility of EDC > 1000 mg/L).

At the request of RAC, the applicant provided the full EUSES report based on the ESVOC 1.1 v1 spERC. Despite confirmation from the applicant that the waste water is released directly to the river without treatment/STP, RAC observed that the exposure assessment was conducted assuming the presence of a municipal STP. RAC invited the applicant to provide feedback as to why the assessment was conducted in this manner. In response, the applicant re-did the exposure assessment using no STP in the EUSES model. The exposure values from the latter are presented in this DO.

Release to air:

Operational tasks conducted indoors are either conducted within closed systems, or use LEVs which are connected to a central stack. Prior to release to the atmosphere, the EDC captured in the stack undergo a filtration with activated carbon to reduce the release of EDC into the environment. Based on the manufacture’s technical specifications, the efficiency is assumed to be greater than 80%, however data on the actual efficiency while in use in this manufacturing site is not available. There are also tasks conducted outdoors which cannot be done indoors due to logistical incompatibilities. Consequently, direct air emissions to the atmosphere are possible. There are no stack emission measurements or any type of ambient air EDC measurements available. Therefore, in the absence of these data, the applicant derived a release factor of 0.05 based on the default release factor for air from ESVOC 1.1 v1, modified to assume that no RMMs were in place. The results presented in this opinion are based on the EUSES results assuming this spERC and default release factor (without RMM) submitted by the applicant in reply to the RAC’s request.

In addition, in the reply to RAC’s request, the applicant also conducted a risk assessment based only on the outdoor tasks. In this calculation, the applicant estimated the % time taken to conduct the tasks outdoors and assumed that the same % of the total EDC was released outdoors (assuming spERC ESVOC 1.1 v1). However, in this opinion document, RAC only presents the exposure assessment results based on the use of the full default
values for the spERC (submitted by the applicant on RAC’s request), since it already accounts for outdoors emissions.

Release to soil: There are no direct releases to soil. The applicant used the spERC default soil release factor of 0.0001 to assess the indirect releases.

Release of general wastes: All wastes potentially containing EDC are collected on site for subsequent treatment as dangerous wastes.

Table 5: Summary of environmental emissions

<table>
<thead>
<tr>
<th>Release route</th>
<th>Release factor or rate</th>
<th>Release estimation method and details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Release fraction: 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Release rate: 26 kg/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reference value of spERC ESVOC 1.1v1 (water solubility &gt; 1000 mg/L)</td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td>Release fraction: 0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Release rate: 130 kg/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reference value of spERC ESVOC 1.1v1 (vapour pressure &gt;10,000 Pa and assuming no RMMs in place)</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>Release fraction: 0.0001</td>
<td></td>
</tr>
</tbody>
</table>

Exposure of humans via the environment was estimated by the applicant using spERC release factors and followed by EUSES. The latter model was run based on the following assumptions:

- No STP functionality,
- 2.6 tonnes/year,
- 23 emission days/year,
- river flow rate 56,300,000 m$^3$/d (dilution factor 28,200$^1$)
- and the physicochemical and environmental fate properties of the substance.

The resulting local and regional PECs are listed in the table below.

The applicant considered both inhalation and oral routes of exposure using standard EUSES assumptions on food basket and intake rates (through ingestion of drinking water and consumption of fish, leaf crops, root crops, meat & milk).

There is no consumer exposure since EDC is only used for industrial purposes. According to the applicant, sampling and laboratory testing demonstrate the absence of EDC in the PECH at the end of the reaction, therefore eliminating any risk of exposure during the synthesis of GAP or during the manipulation of GAP by EURENCO’s customers for their applications.

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$^1$ The dilution factor (28,200) was calculated by EUSES software using as input the measured river flow rate (56,300,000 m$^3$/day) and the default value for effluent discharge rate (2,000 m$^3$/day).
Table 6: Summary of indirect exposure to humans via the environment

<table>
<thead>
<tr>
<th>Protection target</th>
<th>Exposure estimate and details (i.e. methodology and relevant spatial scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man via Environment –</td>
<td>Local PEC: 9.91 x 10^{-2} µg/m³</td>
</tr>
<tr>
<td>Inhalation</td>
<td>Regional PEC: 3.75 x 10^{-5} µg/m³</td>
</tr>
<tr>
<td>Man via Environment –</td>
<td>Drinking water</td>
</tr>
<tr>
<td>Oral</td>
<td>Local PEC: 3.16 x 10^{-3} µg/kg bw/day</td>
</tr>
<tr>
<td></td>
<td>Regional PEC: 9.52 x 10^{-2} µg/kg bw/day</td>
</tr>
<tr>
<td></td>
<td>Food consumption</td>
</tr>
<tr>
<td></td>
<td>Local PEC: 8.62 x 10^{-4} µg/kg bw/day (major contribution from root crops)</td>
</tr>
<tr>
<td></td>
<td>Regional PEC: 4.95 x 10^{-7} µg/kg bw/day (major contribution from fish)</td>
</tr>
<tr>
<td></td>
<td>Sum of drinking water &amp; food consumption</td>
</tr>
<tr>
<td></td>
<td>Local PEC: 4.02 x 10^{-3} µg/kg bw/day</td>
</tr>
<tr>
<td></td>
<td>Regional PEC: 1.45 x 10^{-6} µg/kg bw/day</td>
</tr>
</tbody>
</table>

Uncertainties related to the environmental releases / assessment of exposure to humans via the environment:

RAC considers that the ESVOC 1.1 v1 spERC is applicable to the use applied for as the accompanying factsheet states that the scope of the spERC is intended to include “use as a process chemical”. However, the substance domain of the ESVOC 1.1 v1 spERC is described for the petroleum substances (e.g. aliphatic and aromatic hydrocarbons) and petrochemicals (e.g., ketones, alcohols, acetates, glycols, glycol ethers, and glycol ether acetates). On this basis there appears to be some uncertainty regarding the applicability of this spERC to chlorinated solvents, such as EDC. This uncertainty was not addressed by the applicant when RAC invited them to provide further information on the appropriateness of the spERC to EDC. The significance of this uncertainty is discussed in relation to individual estimates of releases to air and water below.

The applicant’s estimate of release to water was based on a default release factor value of 0.01 selected from the spERC for a substance with a water solubility greater than 1000 mg/L). Based on the 2015 monitoring dataset and the EDC tonnage for the same year provided by the applicant the water release fraction can be calculated to be 0.014 (37.3 kg/2.6 tonnes). As the observed release factor is marginally greater than the one used in the risk assessment, the resulting water related PECs could be slightly greater than estimated by the applicant. However, in general, the spERC-based estimate and estimate based on measured data in 2015 appear to be in good agreement (within the same order of magnitude). Therefore, this uncertainty is considered to be minor and not affect the reliability of the indirect exposure assessment for humans via the environment, irrespective of residual uncertainties regarding the substance domain of the spERC.

RAC noticed that the waste water dilution used in the assessment was 28,200. This is well above the maximum recommended in REACH guidance of 1,000, and is thus
expected to underestimate exposure. In order to obtain a better understanding as to how much this dilution could impact exposure and compromise the overall reliability of this assessment, EUSES was re-run using a dilution factor of 1,000. The latter resulted in an overall cancer risk of $3.92 \times 10^{-7}$, hence the impact is minimal when compared to the overall cancer risk provided by the applicant ($3.90 \times 10^{-7}$).

Releases to air are based on a release factor from the ESVOC 1.1 v1 spERC, without supporting measurements. Waste air (from LEV) is subject to treatment with activated carbon prior to release to air. Based on the manufacturer’s technical specifications, the applicant assumes that the efficiency of this RMM is greater than 80%. As the ESVOC 1.1 v1 spERC assumes an RMM efficiency of 90% the applicant based their release estimates on an air release fraction of 0.05, which is associated in the spERC with releases in the absence of RMM. Although the absence of supporting measured data introduces some uncertainty to the assessment, RAC notes that the applicant has based their modelled release estimates on assumptions that are intended to overestimate emissions and corresponding environmental concentrations. In terms of the residual uncertainty regarding the substance domain of the spERC, RAC notes that the release factors for air outlined in the spERC are derived from Annex I of the ESR / NONSTGD (TGD 2003). As such, these release factors reflect the release potential of a substance relative to its vapour pressure and are not limited in applicability to petroleum substances. RAC further notes that the default release factor to air outlined in Annex I of the TGD for a substance with a vapour pressure >10,000 used in a closed system (MC=1) is 0.005.

Therefore, overall, these uncertainties are likely to result in a marginal overestimate of exposure via air and, given the OCs and RMMs described (e.g. the use of active carbon), are not considered to compromise the reliability of the applicant's exposure assessment.

**Conclusion**

RAC considers that:

- the description of use provided allows to draw conclusions related to exposure situations
- while there are uncertainties related to use of modelling tools for assessment of exposure for some of the tasks, overall the methodology used to derive exposure levels is suitable.
- the information provided related to exposure resulting from the use applied from is considered to be sufficient to use it in a risk assessment and in the risk characterisation.

5. If considered a threshold substance, has adequate control been demonstrated?

☐ YES  
☐ NO  
☒ NOT RELEVANT, NON THRESHOLD SUBSTANCE

**Justification:**

Non-threshold substance.
6. If adequate control is not demonstrated, are the operational conditions and risk management measures described in the application appropriate and effective in limiting the risk?

☐ YES
☒ NO

Justification:

Workers

Evaluation of the risk management measures

Regarding the RMMs in place, RAC concludes that the main processes, in principle, are carried out in closed systems. However, a significant number of tasks include open handling (e.g. sampling, adding substances to the reactor) and by that an increased potential of exposure to EDC is present. The applicant relies heavily on PPE to control the exposure with APF of up to 250 (continuous flow compressed air breathing apparatus) for several tasks. Additional technical RMMs (enclosure of the system, movable extraction systems / movable hoods and general ventilation) are in place, but not state-of-the-art regarding the level of enclosure they achieve (the best available option) and the way they are used. This last evaluation however is mostly based on the examination of the photo documentation provided by the applicant, where the positioning of the capturing hoods / LEV in relation to the source of emission was such that it would not provide the effectiveness assumed by the applicant (e.g. fig 7 and 8 in the public version of CSR).

Risk characterisation

Risk characterisation for workers (directly and indirectly exposed) is based on ECHA’s dose-response relationship for EDC carcinogenicity:

- Lifetime excess cancer risk (workers, inhalation): $6.0 \times 10^{-7}$ per µg/m³
- Lifetime excess cancer risk (workers, dermal): $2.1 \times 10^{-6}$ per µg/kg bw/d

Inhalation exposure for workers was measured directly for synthesis operators and modelled with ART for laboratory staff; dermal exposure was estimated using RISKOFDERM.

RAC concludes that inhalation exposure to synthesis operators of 2.76 µg/m³, corrected for PPE, frequency and duration is 0.28 µg/m³. The modelled inhalation exposure to laboratory staff has a significantly higher level of 23409 µg/m³, corrected for PPE, frequency and duration it is 655 µg/m³.

It is therefore reasonable to assume that lifetime cancer excess risk for inhalation for all workers across the site and all activities is a maximum of $3.93 \times 10^{-4}$ (lifetime cancer excess risk for inhalation for laboratory staff).

It is the applicant’s overall conclusion that dermal exposure and risk is highly overestimated due to the physico-chemical properties of EDC (fast evaporation) and the exposure control by PPE (mainly gloves). However, the results of dermal exposure
modelling were included. RAC calculated and included the corresponding dermal risk levels for synthesis operators and laboratory staff.

In terms of dermal exposure, values between 4.3 (synthesis operators) and 49 µg/kg-bw/d (laboratory staff) have been calculated using RISKOFDERM. It is therefore reasonable to assume that lifetime cancer excess risk for dermal exposure for all workers across the site and all activities with a potential of dermal exposure to EDC is overestimated with a maximum of $2.9 \times 10^{-4}$ (lifetime cancer excess risk for dermal exposure for laboratory staff).

Based on the available data it is reasonable to assume that combined, dermal and inhalation exposure to all workers across the site and all activities does not exceed an individual excess risk level for carcinogenicity of $6.8 \times 10^{-4}$.

The exposure to logistics worker is not included – as the adjustment for frequency and duration of his task resulted in an exposure of 1.70E-03 µg/m³ via inhalation, considerably lower than for the other worker profiles.

<table>
<thead>
<tr>
<th>Worker profile</th>
<th>Inhalation route Adjusted exposure (µg/m³)</th>
<th>Inhalation route Excess risk</th>
<th>Dermal route Adjusted exposure (µg/kg bw/d)</th>
<th>Dermal route Excess risk</th>
<th>Combined route excess risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>synthesis operator</td>
<td>0.28</td>
<td>$1.7 \times 10^{-7}$</td>
<td>4.3*</td>
<td>$9.0 \times 10^{-6}$</td>
<td>$9.2 \times 10^{-6}$</td>
</tr>
<tr>
<td>laboratory staff</td>
<td>655</td>
<td>$3.9 \times 10^{-4}$</td>
<td>49*</td>
<td>$2.9 \times 10^{-4}$</td>
<td>$6.8 \times 10^{-4}$</td>
</tr>
</tbody>
</table>

* dermal modelling using RISKOFDERM and corrected for PPE, frequency and duration

Indirectly exposed workers

No assessment of indirectly exposed workers is provided by the applicant. RAC however, agrees that the risks calculated for man via the environment (i.e. the general population) should in principle cover indirect exposure to workers as well.

Indirect exposure to general population (humans via the environment)

Cancer risk is estimated for inhalation and oral exposures of general population.

Exposure estimation used in the risk assessment was based on release fractions defaults from ESVOC spERC 1.1 v1, as supplied by the applicant.

Risk assessment has been made according to the RAC reference dose-response relationship for carcinogenicity of EDC (RAC/33/2015/09 rev 1 final). The following excess life-time cancer risks were used:

- General population inhalation exposure: An excess lifetime cancer risk = $3.45 \times 10^{-6}$ per µg/m³
- General population oral exposure: An excess lifetime cancer risk = $1.2 \times 10^{-5}$ per µg/kg bw/day
### Table 9: Local Assessment

| Inhalation route | Oral route |  |  |  |  |  |  |  |
|------------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | Drinking water | Food Consumption | Total oral route |  |  |  |  |
| Exposure (ug/m³) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) |
| 9.91 x 10⁻²      | 3.42 x 10⁻⁷ | 3.16 x 10⁻³ | 3.79 x 10⁻⁸ | 8.62 x 10⁻⁴ | 1.03 x 10⁻₈ | 4.02 x 10⁻³ | 4.83 x 10⁻₈ |
| Combined inhalation & oral route excess risk | | | | | | | 3.90 x 10⁻⁷ |

### Table 10: Regional Assessment

| Inhalation route | Oral route |  |  |  |  |  |  |  |
|------------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | Drinking water | Food Consumption | Total oral route |  |  |  |  |
| Exposure (ug/m³) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) | Excess risk (ug/kg bw/d) |
| 3.75 x 10⁻⁵      | 1.29 x 10⁻¹⁰ | 9.52 x 10⁻⁷ | 1.14 x 10⁻¹¹ | 4.95 x 10⁻⁷ | 5.94 x 10⁻¹² | 1.45 x 10⁻⁶ | 1.7 x 10⁻¹¹ |
| Combined inhalation & oral route excess risk | | | | | | | 1.47 x 10⁻¹⁰ |

**Conclusion**

- The RMMs and OCs implemented are not appropriate and effective in limiting the risks to workers and the general population, as evidenced by: 1) the number of manual tasks requiring an otherwise closed system to be opened, 2) the described RMMs (LEV) are not applied in a way that would ensure their effectiveness, and 3) there is an overreliance on use of RPE as evidenced by the information provided, contradicting the principles of hierarchy of control. Finally, RMMs are lacking when discharging EDC-containing waste. As a result, RAC considers that the exposure is not reduced to as low a level as is technically and practically possible.

- RAC considers the methodology used for cancer risk calculation to be appropriate and that the estimates of excess cancer risk for workers and for indirect exposure to humans via the environment are acceptable for use in health impact assessment.

- Overall, the uncertainties related to the assessment of the risk for workers are
considered to be significant.
− RAC notes that there uncertainties related to use of modelling tools for assessment of exposure of man via the environment for some of the tasks, overall the methodology used to derive exposure levels is suitable.
− Concerning the risk for humans via the environment, RAC highlights a concern regarding the absence of RMM’s for waste water.

7. Justification of the suitability and availability of alternatives

7.1 To what extent is the technical and economic feasibility of alternatives described and compared with the Annex XIV substance?

Description:
The Applicant’s use of 1,2-Dichloroethane (EDC) in 2015, amounts to 2.6 tonnes/year. 1,2-EDC is used in the synthesis of Polypeichlorohydrin (PECH), a precursor subsequently used in the production of Glycidyl Azide Polymer (GAP), an energetic oligomer with hydroxyl terminations used to increase the energetic performance of propellants, high explosives and powders used with firearms. It is noted that each synthesis batch of GAP is adapted to specific customer requirements, notably in terms of molecular weight and hydroxyl concentration, in order to comply with their applications’ requirements. GAP is used by several customers of EURENCO in two types of applications: rocket solid propellants and submarine rescue systems, applications directly related to national defence matters. The applicant is the sole producer of the specific type of GAP (GAP – diol) in the European Union. Given its performance, notably in terms of specific energy and insensitivity, GAP constitutes, according to the applicant, a very strategic product, both for the applicant and for its customers.

Summary of the analysis of alternatives undertaken by the applicant:
According to the applicant the main challenge in the development of advanced solid propellants, gun propellants and explosives lies in the pursuit of two conflicting properties: increased performance in conjunction with reduced vulnerability i.e. increased chemical stability to withstand mechanical shocks or fire, to ensure a high level of safety during transportation and handling.

Solid propellants are the most widespread solution to the aforementioned requirements of performance and insensitivity. In order to achieve such insensitivity properties, cast-cured polymers have been developed, in which the explosive ingredient is suspended in a polymeric binder. GAP is an energetic binder that has to deliver two main critical properties for the proper operation of solid propellants: provide sufficient mechanical properties for the overall applications’ requirements in terms of mechanical resistance or insensitivity as well as contribute as an energetic polymer during combustion. GAP is a highly energetic and low-molar-mass (≈ 2,000 g/mol) liquid prepolymer which was mainly developed during the last decade as an energetic binder for the preparation of highly energetic, high-burning-rate, chlorine-free smokeless solid rocket propellants. GAP offers an outstanding combination of thermal stability and insensitivity properties. Also has excellent physico-chemical properties: low glass transition temperature, low viscosity and high density compared to other prepolimers used in the rocket-propellant
technology. As of 2015, EURENCO’s GAP is used for two main strategic applications: solid missile propellants and gas generators for submarine rescue systems.

GAP is used by several defence industry companies in the development of next-generation solid propellants for missiles.

The applicant notes, that the only potential alternative supplier of GAP is located in the United States. There are, however, strong impediments to the purchase of GAP, such as quality issues and insufficient mechanical properties, high transportation costs. In addition, the US – produced GAP (GAP-triol) would require a complete redesign of the manufacture process as well as a requalification of the application. The use of GAP-triol poses a strong risk in terms of security of supply, notably due to the US ITAR (International Traffic in Arms Regulations)/EAR (Export Administration Regulation) Regulations and the respective export controls rules, due to which security of supply on a long-term basis cannot be guaranteed for European customers.

GAP is also used by one of the applicant’s customer in the manufacture of Airbus Defense & Space’s RESUS (REscue system for SUBmarines)-Solid Gas Generator. RESUS (REscue system for SUBmarines) is the standard rescue system installed aboard all German submarines as well as aboard submarines of other navies (Greece, Italy, Israel, India, Turkey and South Korea). The exact function sought-after with GAP-based RESUS-solid is to provide water-insoluble, non-toxic gases for surfacing a submarine in case of emergency, which requires the choice of a binder able to deliver nitrogen to a very high content.

As of today, two versions of the RESUS system are put on the market: RESUS-solid and RESUS-liquid, the first being an improvement of the second. Both systems are not interchangeable and bear specificities in terms of form factor, weight and quantity required per submarine. According to the applicant the only alternative to GAP based RESUS solid solution could be hydrazine based RESUS liquid which has different properties: both technical and chemical ones. RESUS solid as a final product is free of substances of very high concern. On the other hand, RESUS liquid uses hydrazine which poses significant risks for human health and the environment, according to its classification.

In addition, substitution of GAP with any potential alternative for the manufacture of the RESUS rescue systems would entail a complete redesign and redevelopment of the application. This process would require approximately 5 years and would cost € 20 M, according to the applicant. On the other hand, in case of sole modification of GAP’s synthesis solvent its final implementation on the RESUS solution would only require, in case deviations in functional properties are experienced, a new two year qualification programme, which would imply expenses in the order of magnitude of € 1M.

To identify possible alternatives, the applicant carried out a consultation of suppliers on the basis of the functional requirements for the use applied for (Use-1). But the consultation of suppliers did not lead to identify a potential alternative to EDC for the specific functional requirements of Use-1.

Then a literature review was performed on the basis of the functional requirements and hazards for human health of Use-1, on the basis of the following criteria: chemical

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properties, toxicity, expert opinion regarding risks for human health. On the basis of the aforementioned criteria (see Table 22, AfA & SEA Public version), none of the potential 17 solvents identified is deemed appropriate for the substitution of EDC.

**Table 11: Potential alternatives to EDC, literature search**

<table>
<thead>
<tr>
<th>SOLVENT</th>
<th>CHEMICAL PROPERTIES(*)</th>
<th>TOXICITY</th>
<th>EXPERT OPINION(**)</th>
<th>CONCLUSION(***):</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-bromobutane</td>
<td>Boiling point 102°C</td>
<td></td>
<td>-</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Flash point 13°C</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Auto-ignition temperature 265°C</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1-bromopropane</td>
<td>Boiling point 70/71°C</td>
<td>CMR</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>1-chlorobutane</td>
<td>-</td>
<td>Reprotoxic</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Alpha-pinene</td>
<td>Presence of double bond</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Beta-pinene</td>
<td>Presence of double bond</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Ethyl tert-butyl ether</td>
<td>Ether function</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Hexafluorobenzene</td>
<td>Potential reactivity with reagents of PECH</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boiling point 82°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flash point 10°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexamethyldisiloxane</td>
<td>Ether function</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td>-</td>
<td>CMR</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Heptfluoropropane</td>
<td>Gaseous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrofluoroethers</td>
<td>Ether function</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Limonene</td>
<td>Presence of double bond</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Methyl tert-butyl ether</td>
<td>Ether function</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Z-Methyltetrahydropyran</td>
<td>Ether function</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Perfluorohexane</td>
<td>-</td>
<td>CMR</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Tetramethylium</td>
<td>Boiling point 26.6°C</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Trifluorobenzene</td>
<td>Inert toward PECH</td>
<td></td>
<td>×</td>
<td></td>
</tr>
</tbody>
</table>

(*) In red: characteristics that are incompatible with the expected functional properties of the potential alternative to EDC; (**) = Hazardous; ▶ = positive judgement by experts; ▼ = non-hazardous; (***): × = rejected; ✓ = potentially compliant; TBD: under investigation

Through extensive research works led in partnership with its customers, EURENCO identified three potential alternative solvents to EDC: (#1d) (Alternative 1), (#1e)\(^3\) (Alternative 2) and toluene (Alternative 3).

However, taking into account the intrinsic CMR properties of these substances (all alternatives are class 2CMR substances), this substitution does not qualify as an acceptable long term option. It is considered by the applicant as a temporary solution. For this reason, EURENCO is engaged in a long-term research project described in the following paragraph.

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3 Exact name of Alternative 1 and 2 are claimed CBI.
Technical feasibility

Preliminary laboratory-scale trials of Alternative 1 demonstrated the potential technical feasibility of Alternative 1 for the synthesis of PECH. According to the applicant in terms of both functional properties and CMR properties, Alternative 1 constitutes the most promising potential alternative to EDC for the synthesis of PECH. Preliminary laboratory-scale trials of Alternative 2 demonstrated the potential technical feasibility of Alternative 2 for the synthesis of PECH. Given the difference in boiling points between EDC and Alternative 2, its implementation in the synthesis of PECH is expected to require an improved cooling capacity of the synthesis facility.

The use of toluene (Alternative 3) as a substitute to EDC in the synthesis of PECH is currently studied by an external research centre under stringent confidentiality agreements. Results of these works will be communicated to EURENCO in the first semester of the year 2017.

According to the applicant Alternative 1, Alternative 2 and Alternative 3 are at the same levels in terms of technical readiness in the context of Use-1.

The Applicant states that Alternative 1 and Alternative 2 are relatively close to EDC in terms of chemical composition and have already been subject to preliminary lab-scale testing that demonstrated their potential technical feasibility. Besides the validation of their final properties and a technical-economical study, their implementation will mainly require a process of industrialisation and qualification. The timeline of the development and implementation is provided only for alternative 1 and 2.

**Table 12: Timeline of development and implementation of Alternative 1 or Alternative 2**

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory-scale works</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical-economical study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice of an alternative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Industrial scale transfer</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formulation validation</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green light for production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualification of PAG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

On the basis of the timeline presented above, and considering both uncertainties on the technical steps and research results, as well as the period of time needed to submit a new dossier should the need arise, the future alternative to EDC is expected to be fully developed, implemented and qualified in 2021.
As of today, and taking into account the intrinsic carcinogenic properties of these substances, this substitution step does not qualify as an acceptable long-term option. It is therefore considered as a temporary solution allowing pursuing the production of GAP and satisfying the customer requirements during the period of time needed for the development of a sustainable alternative. In order to identify, develop and implement a sustainable synthesis route, EURENCO is engaged in a research project aiming at a complete reengineering of GAP’s synthesis process with human health as main criterion. Such a redesign constitutes a major innovation step and will be developed from scratch. A long-term research program was therefore validated in partnership with DGA, the French Armament Procurement Agency, which will lead to several consecutive 3-year studies. The initial research project, of an overall duration of 54 months, was notified by DGA on October 30th, 2015. The outcome of this research project is expected to be a new synthesis route for PECH or PAG, specifically developed to not involve the use of substances that are hazardous for human health and environment. The research program is expected to deliver results that can be industrially implemented in 2024 (subject to the inherent uncertainties of research projects).

This substitution timeline is in line with applicant’s commitment to the French Ministry of Defence in the framework of the long-term research program with the DGA. SEAC cannot assess this information as the long-term research program with DGA is subject to defence confidentiality. The applicant was only authorised to disclose the data that have already been provided in the application, i.e. a rather general description of the programme and associated resources as well as planning/timeline of the planning. According to the applicant this research program has been validated (i.e. commitment of EURENCO towards the French Ministry of Defence) and that resources regarding research works (doctoral or post-doctoral positions) are therefore already secured for the period of time described in the AoA (a confirmed phase of 18 months followed by a conditional phase of 36 months).

**Economic feasibility**

The applicant states that because all alternatives have technical deficiencies rendering them to be technically infeasible, quantitative analysis of economic feasibility has not been conducted. The alternatives are considered to be at a too early stage of development to assess economic impacts of their implementation in the process of synthesis of PECH.

**SEAC’s evaluation and conclusion**

SEAC points out that the analysis of alternatives, based on the literature review, has offered a limited overview of the shortcomings of the potential alternatives to EDC in terms of functional properties. The review was performed on the basis of the functional requirements and hazards for human health of Use-1, based on chemical properties (see Table 7), toxicity (impacts on human health or the environment), expert opinion (based on available bibliographic data). It is not exactly clear in all of the proposed alternatives what was the shortcoming when compared with the key functional properties of EDC. Some of the proposed alternatives (1-bromopropane, 1-chlorobutane, Hexane, Perfluorohexane) where dismissed as technically infeasible mainly due to their impacts on human health or the environment (CMR, reprotoxic).

The applicant, together with its customers, had shortlisted three alternatives (Alternative 1, 2, 3) which are considered promising in terms of functional properties. Even though
Alternatives 1 and 2 are at preliminary laboratory-scale trials and toluene is studied by an external research centre, these three alternatives are to be developed, tested and industrially implemented by 2021. SEAC does not have the means to assess if the research & development plan for the substitution by 2021 is a reasonable one.

SEAC takes into account the applicant’s conclusion that the alternatives investigated during the literature search did not provide any suitable alternative in terms of chemical properties and over all none of the seventeen analysed solvents are to be considered feasible alternatives for EDC as a solvent for the synthesis of polyepichlorohydrin.

In SEAC’s view, the applicant has provided a generic assessment of the technical feasibility of the alternatives without analysing in-depth all of the shortcomings between the critical main chemical and functional properties of EDC as a solvent in the synthesis of PECH (solubilisation of raw materials of synthesis of polyepichlorohydrin polyepichlorohydrin, chemical inertia toward reagents, controlled water content and acidity as well as non-miscibility with water and controlled boiling point) and the possible alternatives.

The applicant presented some alternatives as promising and claimed to be industrially ready by 2021. However, the applicant did not present further scrutiny of alternatives labelled as promising or provided further R&D plan in this regard.

SEAC wasn’t able to assess economic feasibility as no such assessment was performed. Potential alternatives identified in the literature review where not assessed in any way in regards of economic feasibility aspects, in the case of the three shortlisted alternatives (which appear promising in terms of functional properties, Alternatives – 1, - 2, - 3) it was claimed that alternatives at a too early stage of development to assess economic impacts.

The Applicant was unable to identify suitable alternatives, as documented in the applications, no comments on this were received during the Public Consultation, leaving SEAC to accept the claims of the applicant.

7.2 Are the alternatives technically and economically feasible before the sunset date?

☐ YES
☒ NO

Justification:

The applicant concludes that there are no technically feasible alternatives to EDS as a solvent for the synthesis of PECH used as a precursor in the production of GAP. Based on the actual status of R&D programs, alternatives are not foreseen to be commercially available for all the applications mentioned, before the sunset date.

According to the applicant the three potential alternatives appear promising in terms of functional properties and are expected to be developed, tested and industrially implemented.

The alternatives are considered to be at a too early stage of development to assess economic impacts of their implementation in the process of synthesis of PECH hence aspects of economic feasibility are not considered by the Applicant in the AoA.
Conclusion

SEAC concludes, in line with the applicant’s assessment, that no alternative to EDC seems to be available on the market currently. Technical infeasibility of the alternatives is claimed based on their shortcomings to provide key technical properties (solubilisation of PECH and of raw materials of synthesis of PECH, chemical inertia toward reagents, controlled water content and acidity, non-miscibility with water, controlled boiling point).

SEAC could not assess the economic feasibility of alternatives because the applicant did not provide an assessment that would have allowed the comparison of potential alternatives in terms of their economic feasibility.

SEAC based on the available information could not verify it to the full extent if there are possible alternatives in terms of technical feasibility and the AoA lacks transparency on certain issues (precise substance identity, further R&D plans). SEAC concludes that the applicant’s claim that potential alternatives will not be ready to be industrially implemented before 2021 due to the aforementioned technical reasons cannot be refuted and with the uncertainties attached accepts the Applicant’s conclusion that at present, available alternatives exhibit technical deficiencies and none of them can be used as drop-in alternative until the sunset date.
### 7.3 To what extent are the risks of alternatives described and compared with the Annex XIV substance?

For the alternatives identified by the applicant the following information is given

**Table 13: Risks of alternatives**

<table>
<thead>
<tr>
<th>Alternative name</th>
<th>Based on</th>
<th>Comment</th>
</tr>
</thead>
</table>
| Alternative 1<sup>4</sup> | CBI | Acute Tox.4 H302  
Skin Irrit.2 H315  
Eye Irrit.2 H319  
Acute Tox. 3 H331  
Carc. 2 H351  
Repr.2 H361d  
STOT RE1 H372  
RCR can be based on a threshold |
| Alternative 2<sup>5</sup> | CBI | Carc. 2 H351  
RCR can be based on a threshold |
| Alternative 3 | Toluene | RCR can be based on threshold basis |
| Alternative 4<sup>6</sup> (long –run) | CBI | Unknown |
| EDC | | Flam. Liq. 2 H225  
Acute Tox. 4* H302  
Skin Irrit. 2 H315  
Eye Irrit. 2 H319  
STOT SE 3 H335  
Carc. 1B H350 |

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<sup>4</sup> The substance identity of the alternative are claimed as CBI by the applicant  
<sup>5</sup> *idem supra*  
<sup>6</sup> *idem supra*
The applicant indicates that the readiness of the alternatives for direct substitution is equal and that all alternatives could be considered as real alternatives by 2021. However the applicant remains unclear regarding any preference.

- The applicant considers that for the alternative 1 a threshold approach can be based on the EU Risk assessment report and for alternative 2 – on the Opinion of the Scientific Committee on Consumer Safety. The exact reference is claimed confidential as it would reveal the substance identity of the alternatives.
- The potential of basing it risk assessment approach on a threshold approach for Toluene is based on the assessment of Tukes (Finnish Safety and Chemicals Agency –Tukes, substance evaluation conclusion document as required by REACH Article 48 for Toluene, 12 November 2013). The applicant claims it can base its approach on a 20 ppm threshold, which is a direct French occupational exposure level (no source was given).

**Evaluation and Conclusion**

RAC finds it difficult to evaluate the AoA for a direct substitution for the following reasons:

1. One alternative is poorly described and the actual content of it is not presented, even in the confidential version of the AoA/SEA
2. The applicant does not specify, which alternative will actually be chosen.
3. No evaluation has taken place whether the actual DNEL and threshold value referred to by the applicant (CSR p. 50) for one of the alternatives are appropriate for the purposes of AfA.

The only statement on which RAC can make a conclusion is the commitment of the applicant and their customer, the purchasing directorate of the French ministry of defence (Directorate General Acquisition, DGA), as documented in their contract, is their intention to exclude SVHC in the further R&D work.

RAC concludes:

Due to the reasons described above, a final and concluding assessment of the risks of alternatives described and their comparison with the Annex XIV substance is not possible.

**7.4 Would the available information on alternatives appear to suggest that substitution with alternatives would lead to overall reduction of risk?**

☐ YES
☒ NO
☐ NOT APPLICABLE

**Justification:**

There is little information available on the identified alternative(s) and the applicant has not provided a well-reasoned argument for keeping relevant information anonymized.
Conclusion

Given the classification and labelling described above, some of the alternatives might lead to an overall reduction of risk of developing cancer. However, other alternatives are also classified for carcinogenicity.

7.5 If alternatives are suitable (i.e. technically, economically feasible and lead to overall reduction of risk), are they available before the sunset date?

☐ YES
☐ NO
☒ NOT RELEVANT

8. For non-threshold substances, or if adequate control was not demonstrated, have the benefits of continued use been adequately demonstrated to exceed the risks of continued use?

☒ YES
☐ NO
☐ NOT RELEVANT, THRESHOLD SUBSTANCE

Justification:

Additional statistical cancer cases

The estimated number of additional statistical cancer cases has been calculated using the excess risk value presented in section 6 and the estimation of the number of exposed people provided by the applicant. It is noted that this approach gives a conservative estimate of the statistical number of fatal cancer cases associated with exposure durations of 40 years (for workers) and 70 years (for the general population), respectively. RAC notes that these calculations are based on the estimation of exposed populations as provided by the applicant.

Estimated additional statistical cancer cases for workers’ over the review period (4 years) is 4.6x10⁻⁶ (fatal cancer cases 2.1x10⁻⁶ and 2.5x10⁻⁶ of non –fatal cancer cases).
Table 14: Excess risk estimates for 40 years’ exposure for workers

<table>
<thead>
<tr>
<th>Worker profile</th>
<th>Inhalation route</th>
<th>Dermal route</th>
<th>Combined route excess risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted exposure (µg/m³)</td>
<td>Excess risk</td>
<td>Adjusted exposure (µg/kg bw/d)</td>
</tr>
<tr>
<td>Synthesis operator (staff of 6)</td>
<td>0.28</td>
<td>1.66 x 10⁻⁷</td>
<td>42.5*</td>
</tr>
<tr>
<td>Laboratory staff (staff of 1)</td>
<td>655</td>
<td>3.93 x 10⁻⁴</td>
<td>493*</td>
</tr>
<tr>
<td>Logistics worker</td>
<td>1.7 x 10⁻³</td>
<td>1.02 x 10⁻⁹*</td>
<td>Not assessed**</td>
</tr>
</tbody>
</table>

*This value is not taken further for monetisation

** given frequency and duration of the task as well As the corresponding monetary value corresponding of to the associated identified risk ( is below €0.01), this population is not considered to be relevant in the socio-economic assessment.

Table 15: Estimated additional statistical cancer cases due to exposure of man via environment associated with 70 years of local and regional exposure

Local Assessment (default population of 10 000)

<table>
<thead>
<tr>
<th>Inhalation route</th>
<th>Oral route</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drinking water</td>
</tr>
<tr>
<td></td>
<td>Adjusted exposure (µg/kg bw/d)</td>
</tr>
<tr>
<td>Adjusted exposure (µg/m³)</td>
<td>Excess risk</td>
</tr>
<tr>
<td>9.91 x 10⁻²</td>
<td>3.42 x 10⁻⁷</td>
</tr>
<tr>
<td>Combined inhalation &amp; oral route excess risk</td>
<td>7.25 x 10⁻⁶</td>
</tr>
</tbody>
</table>

Regional Assessment (default population of 20 000 000)

<table>
<thead>
<tr>
<th>Inhalation route</th>
<th>Oral route</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drinking water</td>
</tr>
<tr>
<td></td>
<td>Adjusted exposure (µg/kg bw/d)</td>
</tr>
<tr>
<td>Adjusted exposure (µg/m³)</td>
<td>Excess risk</td>
</tr>
<tr>
<td>3.75 x 10⁻⁵</td>
<td>1.29 x 10⁻¹⁰</td>
</tr>
<tr>
<td>Combined inhalation &amp; oral route excess risk</td>
<td>1.47 x 10⁻¹⁰</td>
</tr>
</tbody>
</table>
Costs of continued use (HH)

The applicant when assessing the costs for the human health (HH), calculated the cost of medical treatment and the cost of mortality and morbidity.

To calculate the cost of medical treatment, the applicant performed the calculations based on the medical treatment cost of cancer in France, which derived from France’s health care annual expenditures related to cancer and the number of persons covered by a health care regime. The applicant calculated the individual cancer medical treatment costs during the review period applying the cost per year per cancer case, the average survival duration of persons suffering from cancer (6 years in France) and used a 3% discount rate.

When evaluating the mortality and morbidity, the applicant used two assessments, the Disability-Adjusted Life year (DALY); years of life lost (YLL) and year lost due to disease (YLD) based on the value of a statistical life-year and the value of a statistical life (VSL), both approaches based on the willingness to pay (WTP) estimates to avoid a cancer case, as provided in ECHA’s SEA guidance. Strictly speaking, the applicant assesses the disease burden in terms of DALYs and numbers of fatal/non-fatal cases, and then monetises both using WTP estimates. In this context the DALY is a measure of effectiveness, which is then turned into an efficiency metric by multiplying by the WTP for a life year.

Monetising the YLL, the applicant based its calculations on the number of deaths (=the total excess risk of cancer), the standard life expectancy at the age of death (in years) and the central value of a statistical life-year. The total YLL (discounted by 3%) in terms of monetary value amounts to €2.8. When monetising the YLD the value of 0.75 was used for disability weight. The number of potential statistical cancer cases was estimated by multiplying the number of workers exposed and the excess of risk of cancer. The average duration of disability was obtained by subtracting the mean age of death by cancer and the mean age of diagnosis of cancer.

Complementary to the DALY approach, the applicant has conducted a human health impact assessment to characterise the cancer burden for workers and arising from inhalation exposure to EDC in the use applied for based on WTP to avoid cancer. The applicant considering that the human sites for carcinogenicity may differ from those observed in animals (as in the Nagano et al. study) and all EURENCO employees

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7 According to the French data there where 2,192,957 (Rapport de l’Assurance Maladie sur les charges et produits pour l’année 2013) persons covered by the health care regime for cancer, total expenditures for the health care system related to cancer amounted to € 11.5 Billion (= cost of € 5,244/year/cancer case; ONDAM 2010 hors MIGAC y compris IJ maternité et dépenses d’invalidité, source CNAMTS extrapolé tous régimes. In: rapport de l’Assurance Maladie sur les charges et produits pour l’année 2013.)
8 Institut National du Cancer, Epidemiologie nationale des cancers - Donnees essentielles, 2015
9 NewExt, New Elements for the Assessment of External Costs from Energy Technologies, 2003
10 ECHA, Guidance on the preparation of socio-economic analysis as part of an application for authorisation, Version 1, January 2011
12 Number of years lost 10 ((82 years (standard life expectancy)-72 years (mean age of cancer death)) x 4.6x10-6 (total excess of risk of cancer) x € 65,985 (statistical life-year)
13 WHO, global burden of disease 2004 update: disability weights for diseases and conditions, 2004
14 Institut National du Cancer, Epidemiologie nationale des cancers - Donnees essentielles, 2015
15 Idem
concerned by the AfA are males, choose to use global cancer data to characterise the carcinogenic effects of EDC.

In France incidence and mortality associated with all cancers, excluding non-melanoma skin cancer, for males, all ages is associated with a mortality rate of 46.3% and a morbidity rate of 53.7%.\(^{17}\)

To value excess cancer cases (impacts on social welfare) in monetary terms, the applicant used the reference values of the Willingness-to-pay ECHA 2011 guidance\(^{18}\) on socio-economic analysis in applications for authorisation: €0.4 million per non-fatal case and €1.05 million per fatal case. The values have been adjusted to the base year using a GDP deflator index (18.25% over the 2003-2015 period and 7.32% over the 2008-2015 period).

To ensure a complete consistency of the values with ECHA’s requirements, regarding the monetised impacts of the “applied for use” scenario the applicant also provided calculations for the 4% discount rate. In the original assessment the monetised impact of mortality, morbidity and the cost of medical treatment amounts to €3 – 4 (in both assessments, DALY and VSL based on the WTP).

As RAC re-assessed the expected lifetime risk, the estimated number of additional statistical cancer cases as reported in Tables 14 and 15 differs from the assessment made by the applicant. Hence SEAC also recalculated the monetised human health impacts for workers using via the Willingness-to-pay values recommended by ECHA guidance (€0.4 million for non-fatal cancer cases and €1.05 million for fatal cancer cases) which are adjusted to the base year using a GDP deflator index (1.01517 per year).

SEAC has also made a worst-case assessment of the health impacts of continued use based on the new WTP ECHA study\(^{19}\) using the upper value of avoiding a fatal cancer case €5 million (adjusted to the base year). Based on RAC’s risk assessment, SEAC established the monetised human health impacts due to the continued exposure to EDC based on the price-adjusted values of both the ECHA guidance document on SEA and the ECHA study. This results in monetised cancer risks of €11 300 for workers, ignoring latency periods (adjusted to the temporal scope of the analysis).

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\(^{17}\)GLOBOCAN 2012, IARC -20.1.2016

\(^{18}\)ECHA, Guidance on the preparation of socio-economic analysis as part of an application for authorisation, Version 1, January 2011

Table 16: Monetised impacts, corrected for the review period.

| Excess risk (estimated by RAC) total consisting of 46% fatal and 54% non-fatal cases | Number of workers | Total cases | Total cases over the review period | Mortality | Morbidity | Total cases over the review period | Mortality | Morbidity |
|---|---|---|---|---|---|---|---|---|---|
| 8.94E-05 | 6 | 5.36E-04 | 5.36E-05 | 125.25 € | 11.50 € | 136.75 € |
| 6.80E-04 | 1 | 6.80E-04 | 6.80E-05 | 158.78 € | 14.57 € | 173.35 € |
| 7.25E-05 | 10,000 | 7.25E-02 | 4.14E-03 | 9.573.57 € | 887.91 € | 10.551.49 € |
| 1.47E-10 | 20,000,000 | 2.94E-03 | 1.68E-04 | 392.28 € | 36.01 € | 428.29 € |
| | | | | | | 11,299.87 € |

The applicant in its initial application considered the Man-via-environment impacts to be negligible and therefore did not monetise it. The applicant presented a measure of excess cancer risk, considered that measure to be negligible and did not elaborate that measure further into an impact assessment.

Following the comments of SEAC and RAC on the methodology applied initially, the risks to indirectly exposed workers and the general population in the direct neighbourhood of the sites as well as risks to the general population in an area of 200 x 200 km around the sites were assessed (“man via environment”) by the Applicant, via a dedicated spERC and EUSES software.

The applicant has concluded that the total excess of risk for general population related to exposure via inhalation, adjusted by the use-1 review period duration is 1.37x10^-4 (for local scale) and 5.15x10^-4 (for regional scale). Furthermore, the total excess of risk for general population related to exposure via oral route, adjusted for review period duration is 0.20x10^-4 (for local scale) and 3.32x10^-4 (for regional scale).

A revised version to account for emissions to air has been submitted by the applicant indicating an increased, compared to previous, risk for general population. The applicant has concluded that the total excess of risk for general population related to exposure via inhalation, adjusted by the use-1 review period duration is 7.25x10^-5 (for local scale) and 1.47x10^-10 (for regional scale). Furthermore, total number of cases risk for general population related to exposure via oral route, adjusted by the use-1 review period duration is 7.25x10^-3 (for local scale) and 2.94x10^-4 (for regional scale). SEAC took note of RAC's new estimate (Table 10) of the number of additional statistical cancer cases of MvE and followed the same methodology as described above for calculating the workers impacts. This results in monetised cancer risks of 11,300 €, reflecting the concerns RAC has on the emission to the environment and the impact of man via the environment caused by that.
SEAC’s evaluation and conclusion

SEAC agrees in principle with the applicant’s approach to assessing the expected health impacts from the continued exposure to EDC. SEAC remarks, that even though the applicant in its initial approach used the DALY methodology to estimate the monetised health effects of the continued use, the complementary assessment based on VSL methodology resulted in similar values diverges from general SEAC approach of calculating the cost of mortality and morbidity based on WTP values, the methodology and studies used are consistent with the socio economic valuation principles for the calculation of economic welfare changes as regards to human health impacts. When compared with the general SEAC’s approach, the monetised differences are insignificant, even overestimated, the approach and assumptions used are transparent.

SEAC notes that the way the RAC dose-response functions are applied assumes that the effects occur immediately. SEAC considers this may be an overestimate, as a result of the failure to account for the latency of cancer.

SEAC considers the monetised risk for workers might be somewhat lower than assessed by the applicants as a result of the failure to account for the latency of cancer. Also, due to the fact that the dermal risk is more than 30 times above the inhalation risk which according to the applicant is clearly unrealistic, EDC is expected to evaporate from gloves long before the penetration time is reached, such that RAC considers this as being beyond a reasonable worst-case dermal exposure assessment.

Benefits of continued use (cost of non-use scenario)

In general, SEAC considers the applicant’s approach to assessing the economic and social impacts to be based on a sound methodological foundation, which correctly identifies the costs (mainly profit losses and lost investment) estimated from the perspective of the applicant. According to the applicant, the most likely “non-use” scenario is the ceasing of synthesis of PECH and a halt to the synthesis of GAP for the period of time needed to develop and implement an Alternative, i.e. during four years after the sunset date of EDC. The applicant lists the impacts of the non-use scenario as economic (applicant’s loss of profits and a loss of investments, social (potential indirect job loss for the applicant’s customers) and distributional (include a loss of investments made by the French State over the last decade in the development of GAP-based applications, a loss of market shares and revenues for defence industry companies as well as severe availability issues for armed forces relying on GAP-based applications).

According to the applicant, the direct economic impacts of the “non-use” scenario for EURENCO include a loss of revenues and a loss of investments. The assessment of the loss of profits foreseen during the review period (2017-2021) in the context of the “non-use” scenario is based on the applicant's internal financial and accounting information regarding cost price and selling price. The assessment of these costs are based on the order forecasts of GAP by the applicant’s customers. No further detail on the estimation of profit loss was provided to SEAC. The assumption is that if an authorisation is not granted the loss of profits over the 2018-2021 period amounts to €11 300 (4% discounted). The presented loss of investments is claimed to be the cumulated value of...
the equipment used for the synthesis of PECH and PAG that would be considered as of no industrial use in case of a ceasing of activity, there will be no possibility to valorise them for other processes within the applicant’s production capabilities. SEAC could not verify this claim and considers that these inventory items could be sold off in case of non-use. Applicant responded to SEAC’s question in this regard that the potential resale opportunity may not cover other economic impacts of the NUS and the resale price of such assets on the second-hand industrial market could not be precisely estimated. The applicant presented a detail of investments in amortisation, by year of last annuity starting from 2019 to 2033. The assessment is based on the identification of the investments still due for amortisation after the year 2018, as well as the precise number of amortising years remaining using the annualised costs method by a 4% discount rate. According to the applicant at least one of the alternatives (Alternative 1, 2 or 3) is expected to be developed, tested and industrially implemented in 2021, hence SEAC considers in the case of a NUS the loss of investment (amortisation still due) should be accounted only between 2017-2021 (if considered at all).(and would amount to € 29,000, 4% discounted).

SEAC cannot exclude that the loss of investment is to some extent already taken into account with the loss of profits. SEAC therefore will base its conclusion on whether the benefits outweigh the risk of loss of profit alone.

As regarding the social impact - no direct impact on employment at the applicant’s facility is foreseen in the context of the “non-use” scenario but it is assumed by the applicant that the “non-use” scenario will have an indirect impact on employment for its customers. SEAC could not verify and quantify the impact of loss of employment for the applicant’s customers (the applicant also stated that it as cannot be estimated at present time) and the contractual penalties are claimed confidential. Hence, SEAC will consider the above broader social impacts only in the qualitative assessment of the “non-use” scenario.

The applicant also describes qualitatively the wider impacts of non-authorisation: there will be a loss of investments for the French State for the development of a new generation of GAP-based tactical missiles (if not considered as sunk cost), will lead to a loss of revenues for companies involved in the development and commercialisation of GAP-based applications, most notably for Bayern Chemie (producer of RESUS) and will impact on submarine forces over the world.

SEAC considers that the derived estimates could be overestimated (e.g. the annual sales between 2019 and 2021 are based on a preliminary forecast, machinery equipment if considered of no use at applicant’s site could be sold off). Nevertheless, SEAC considers the cost assessment of the non-use scenario is provides an adequate analysis and an appropriate order of magnitude estimate of the total cost of “non-use” of EDC, in the range of several hundred thousand of euros over the 4-year period assessed. Therefore, it can be used for comparison with the economic burden of health impacts.

Conclusion

As described by RAC in part 6, the sole health endpoint considered in the quantitative health impact assessment is the number of excess cancer cases. SEAC is unaware of any other relevant human health endpoints or environmental concerns.

Concerning the estimation of economic welfare losses associated with the number of excess cancer cases, the applicant uses the cost of medical treatment and the monetised value of a cancer case. To determine the monetised value of Disability-Adjusted Life
A value of a life year lost was used (£ 65,985), based on the NewExt of £55,800 in 2003 price levels. Willingness to Pay (WTP) value of £1.24 million to avoid a fatal cancer case and £0.47 million for a non-fatal cancer case.

According to the applicant, the benefits of continued use of EDC outweigh the monetised risk to human health (160 000 : 1) for the requested review period.

SEAC considers that the information provided by the applicant is sufficient to assess both the benefits and health impacts of the use applied for.

SEAC has reassessed the economic impacts based on additional information about profit ranges and lost investment. SEAC has also made a worst-case assessment of the health impacts of continued use based on the new WTP ECHA study\(^\text{20}\) using the upper value of avoiding a fatal cancer case £5 million (adjusted to the base year i.e. 2017, the values used by the applicant for the non-fatal cancer cases are in line with the value in the new ECHA study ~ £ 400,000).

In conclusion, SEAC find that the approach and assumptions used to derive the health cost and benefits are on the whole clear and transparent. SEAC considers the conclusion (based on profits alone, high values of WTP) that the benefits outweigh the risks by far to be robust.

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<th>9. Do you propose additional conditions or monitoring arrangements</th>
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<td>❑ YES  ❑ NO</td>
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The applicant shall continue to conduct regular occupational exposure measurements. These monitoring programmes must be representative of the range of tasks undertaken where exposure to EDC is possible and of the total number of workers that are potentially exposed – especially those involved in the collection of samples and their analysis. Measurements shall be undertaken according to standard sampling and analytical methods, where possible.

The information gathered in the monitoring campaigns must be used by the applicant to review the risk management measures and operational conditions, including the effectiveness and positioning of extraction ventilation, to further reduce workers' exposure to EDC.

The results of the monitoring and of the review of the OCs and RMMs must be maintained, be available to national enforcement authorities and included in any subsequent authorisation review report submitted.

The applicant shall implement the most appropriate risk management measure (RMM) for wastewater releases to reduce environmental exposure to as low a level as is technically and practically possible.

Future releases of EDC to waste-water shall be subject to regular measurement with the results of monitoring made available to enforcement bodies on request. Measurement

programmes shall be undertaken according to standard sampling and analytical methods, where appropriate.

The information gathered in the monitoring programmes shall be used by the applicant to review the risk management measures (RMMs) and operational conditions (OCs) to further reduce environmental exposure to EDC. The outcomes and conclusions of this review including those related to the implementation of any additional RMMs must be documented.

Description of additional conditions and monitoring arrangements for the review:

The results of the monitoring and of the review of the OCs and RMMs must be maintained, be available to national enforcement authorities and included in any subsequent authorisation review report submitted.

Justification:

RAC acknowledges that the applicant already has a monitoring regime for workers in place and that they have indicated that this will be continued. However, additional measurements are necessary for synthesis operators and laboratory staff as the dataset submitted with the application was limited to a single year monitoring results, with a relatively small number of individual measurements. The applicant claims to have an advanced OSH-system in place (including technical, organisational and personal measures) to protect workers. However, a significant number of tasks include open handling (e.g. sampling, adding substances to the reactor) and by that an increased potential of exposure to EDC is present, the applicant relies heavily on PPE to reduce the exposure. Additional technical RMMs (enclosure of the system, movable extraction systems / movable hoods and general ventilation) are in place but these are not used in a way that would provide optimal effectiveness as evidenced by the photo documentation provided by the applicant. Therefore exposure is not reduced to as low a level as is technically and practically possible and could be reduced by more advanced enclosure or appropriate positioning of LEV.

The waste water is discharged directly into the nearby Rhône river without RMM (no physico-chemical treatment). The 2015 dataset shows 21 days with emissions above “detection level” with values between 0.71 kg/day and 3.18 kg/day (EDC was detected only during periods of production), equivalent to a total annual release of 37.3 kg EDC to the river Rhône.

To reduce environmental exposure to as low a level as is technically and practically possible, appropriate RMM to wastewater releases must be implemented.
10. Proposed review period:

- Normal (7 years)
- Long (12 years)
- Short (4. years)
- Other:

Justification:

RAC’s advice:

RAC has no advice on the length of the review period.

In identifying the review period SEAC took note of the following considerations:

- The applicant has demonstrated that the main socioeconomic benefits (related to the avoidance of profit and investment losses), from the use of EDC outweigh the risks.
- The applicant has presented three alternatives that according to the applicant are promising for substituting EDC. Potential alternatives appear, according to the applicant, promising in terms of functional properties but are not expected to be developed, tested and industrially implemented before 2021, thus a short review period of four years would be necessary and appropriate as well.
- SEAC finds that the analysis of alternatives is not sufficiently thorough and lacks in depth a comparison between the critical main chemical and functional properties of EDC and the possible alternatives. Based on the limited information SEAC agrees with the applicant’s opinion that alternatives are at a too early stage of development to assess economic impacts of their implementation in the process of synthesis of PECH. SEAC concludes that none of the alternatives are currently regarded feasible from a technical point of view.

Based on the available information SEAC concludes, at present, that available alternatives exhibit technical deficiencies and none of them can be used as drop-in alternative until the sunset date. SEAC also concludes that the potential alternatives will not be ready to be industrially implemented before 2021 due to the aforementioned technical reasons. SEAC also agrees with the applicant that the above substitution step does not qualify as an acceptable long-term option, as all three alternatives are class 2 CMR substances. The application of any of the above alternatives, starting from 2021, is therefore considered as a temporary solution allowing the production of GAP and satisfying customer requirements during the period of time needed for the development of a sustainable alternative, which will be based on the complete reengineering of the synthesis process of GAP by 2024. SEAC cannot assess this information as the long-term research program with DGA is subject to defence confidentiality.

However, SEAC finds the time review requested by the applicant reasonable so as to follow a two-step substitution strategy which as claimed will not only secure the production of GAP but will also eliminate the risks for human health and the environment related to the use of EDC in the long term.

Taking into account these points, SEAC recommends a 4-year review period.
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<th>11. Did the Applicant provide comments to the draft final opinion?</th>
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<th>11a. Action/s taken resulting from the analysis of the Applicant’s comments:</th>
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