[redacted]

ANALYSIS OF ALTERNATIVES

and

SOCIO-ECONOMIC ANALYSIS

Legal name of applicant(s):	Centronic Limited
Submitted by:	Exosens Centronic Limited
Date:	10th April 2026
Substance:	*Chromium Trioxide* EC: 215-607-8 CAS: 1333-82-0
Use title:	Use of chromium trioxide for the electroplating of components for Geiger-Muller tubes with technical performance requirements with the purpose of creating a coating to provide specific performance characteristics and to match existing components
Use number:	1

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DECLARATION

We, the Applicant, are aware of the fact that further evidence might be requested by ECHA to support the information provided in this document.

Also, we request that the information blanked out in the "public version" of the Analysis of Alternatives and Socio-economic Analysis is not disclosed. We hereby declare that, to the best of our knowledge as of today, 10th April 2026, the information is not publicly available, and, in accordance with the due measures of protection that we have implemented, a member of the public should not be able to obtain access to this information without our consent or that of the third party whose commercial interests are at stake.

Signature: [redacted]

Date, Place: 10th April 2026
Croydon, England

1. SUMMARY

- The document presents an analysis of alternatives (AoA) and a socio-economic analysis (SEA) for the use of chromium trioxide (hereafter referred to as 'Cr(VI)') under UK REACH
- The applicant is Exosens Centronic Limited (hereafter referred to as 'Centronic' or 'the applicant'), whose manufacturing site is located in Croydon, south London
- The applicant manufactures Geiger Muller tubes (GMTs) for the detection of radiation in industrial, safety and security (defence) applications
- GMTs contain a mixture of gases, one of which creates radiation detection events and the other quenches the current generated by such events
- The quench gas is a halogen gas which is extremely corrosive
- Cr(VI) is used to provide a smooth, hard, inert metal coating which is highly corrosion-resistant; this increases the accuracy and lifespan of the detection equipment
- Ruggedness, accuracy and extended lifespan are key characteristics of the applicant's products and explain its position as the second biggest manufacturer if GMTs in the world. Their reputation for quality and reliability has been established over a period of over 50 years in the harshest environments, particularly mining and oil and gas exploration
- This use of Cr(VI) was previously covered by the CTAC authorisation under EU REACH; under this authorisation, Centronic commissioned a programme of innovative research to investigate potential alternatives to Cr(VI) for surface treatment
- In this research, chromium plating was compared against passivation and oxide-formation as alternative techniques for achieving corrosion resistance. At room temperature, these alternative treatments were found to offer broadly acceptable performance, but showed some increased bromine deposits and fall-off of voltage, indicating lower corrosion resistance and lifetime compared with chromium plating. At 125°C, however, the alternatives were found to exhibit performance degradation which suggested that, at the extremes required for Centronic's products (e.g. 125°C), performance would be unacceptable. As a result, these protective mechanisms were deemed ineffective at such temperatures
- Due to the unique performance characteristics of the applicant's products, it is concluded that there are no suitable alternatives generally available (SAGA)
- If authorisation is granted for this use, the applicant intends to establish a programme of follow-up research to understand better the role of Cr(VI) in GMT interactions, with a
- If authorisation is not granted, the applicant will close its manufacture of GMTs in the UK. It may relocate this business outside of the EU but this is not considered an easy project due to the expertise held in the UK company. In either event, profits will be lost from the UK and workers will be made redundant. The costs of these impacts are estimated at (Confidential Financial) (net present value, 3.5%)
- Residual risks to human health and/or the environment of continued use have been estimated over a 12-year period at £3,573 (net present value, 1.5%)
- The conclusion is that the costs of non-use outweigh the risks of continued use and that authorisation is justified. This result is robust to reasonable sensitivity analysis

- A review period of 12 years is requested for this authorisation. The CSR demonstrates that the risks of continued use are well-controlled, and the SEA demonstrates that the risk of continued use are outweighed by the benefits of authorisation by several orders of magnitude. The AoA explains that the use of Cr(VI) in this application has been established in the field over many decades, which means that alternatives to Cr(VI) are relatively underexplored for the applications of importance to this use. The applicant considers that this justifies a 'long' review period.

2. AIMS AND SCOPE

Centronic is the second largest manufacturer of Geiger-Muller tubes (GMTs) in the world and the only manufacturer in the UK. GMTs are used for the detection of radiation in industrial, safety and security (defence) applications. They contain halogen gas which creates radiation detection events and quenches the current generated by such events. These halogen gases are extremely corrosive, so chromium trioxide ('Cr(VI)') is used to provide a smooth, hard, inert metal coating which is highly corrosion resistant. This increases the accuracy and lifespan of the detection equipment

This application for authorisation covers the use of Cr(VI) in order to produce an electroplated coating of metallic chromium which provides specific properties and performance characteristics. The aim of the AoA is to demonstrate that no suitable alternatives to the use of Cr(VI) are currently available for this specific use. The aim of the SEA is to demonstrate that the benefits of the continued use of Cr(VI), for this specific use, far outweigh any potential risks to human health and/or the environment. The scope covers the applicant carrying out the Cr(VI)-based process and their customers, and details the societal implications of a refusal to grant an authorisation for the continued use of Cr(VI) for this specific use.

Geographic and temporal boundaries are identified in line with authorisation guidance. The principal geographic area of interest is the UK. Benefits and costs occurring within the UK are considered in scope and for potential quantification for the benefit-risk comparison. Impacts outside the UK are identified where relevant but are not quantified in the benefit-risk comparison.

The temporal boundaries reflect what is relevant for the impact in question. Emissions and exposures are estimated over the review period. The effects of exposures are expressed in terms of changes in lifetime cancer risk. The timing of impacts of the non-use scenario follows authorisation guidance. For firm closure, losses are limited to two or four years. For unemployment, costs are estimated for a period of six years after expected re-employment.

3. ANALYSIS OF ALTERNATIVES

3.1. SVHC use applied for

3.1.1. Description of the function(s) of the Annex XIV substance and performance requirements of associated products

A GMT is a gas-filled device which reacts to individual ionising events, thus enabling them to be counted. They are used to detect alpha particles, beta particles, gamma or x-ray radiation, and are a component of radiation detecting equipment/systems.

A GMT essentially consists of an electrode at a positive potential (anode) surrounded by a metal cylinder at a negative potential (cathode). The cathode forms part of the envelope or is enclosed in a glass envelope. Ionising events are initiated by quanta or particles entering the tube either through the window or through the cathode and colliding with the gas molecules. This creates positively charged ions and free electrons in the gas. The former flow towards the cathode and the electrons towards the anode, gaining sufficient energy that they initiate further ionisation events, creating what is known as an 'avalanche'. This creates a short, intense pulse of current which can be measured as a count event of a particular voltage, enabling subsequent electronic processing.

The ionising gas in a GMT is an inert gas such as argon or neon. Avalanche events can produce secondary ionisation because the particles around the cathode become highly energised and emit photons, or because the cathode itself emits electrons as a result of ion bombardment. This means the initial pulse event can be 'extended', in principle indefinitely. This prevents a new pulse event from being detected (termed 'dead time'), and reduces the accuracy of detection. For this reason, a second gas is included in the GMT to 'quench' the stream of secondary ionisation. Halogens such as bromine and chlorine are commonly used as quench gases because they readily dissociate during detection events. In doing so, they consume energy from the positive ions and cathode, thereby countering secondary ionisation and limiting dead time.

Halogen gases are the most commonly used quench gases in GMTs because they have a practically unlimited ability to dissociate and associate in response to ionisation events and therefore never 'run out', whereas alternative (organic) gases decompose. Halogens therefore give much longer equipment lifetime, which is important in uses where replacement is difficult or hazardous.

However, halogen gases are also extremely corrosive, especially in the conditions in which GMTs are commonly used (e.g. elevated temperatures). The gases interact with the conductive metallic materials from which the GMTs are made, reducing performance and lifetimes. Centronic therefore uses Cr(VI) to impart of hard, smooth and inert chrome layer to its GMTs, which is highly corrosion-resistant even in extreme use conditions. In this application, this is not due to the chromium itself but because of its tendency to oxidise rapidly on exposure to the atmosphere, with the inherent ability to self-heal.

Centronic's process involves the creation of a chrome layer on the surface of the internal metal components of the GMT which come into contact with halogens. This layer is then subject to an oxygen plasma bombardment process, which encourages the formation of a protective chromium oxide layer.

GMTs are manufactured by Centronic to recognised international standards:

- IEEE Std 309 – 1999: IEEE Standard Test Procedures and Bases for Geiger-Muller Counters (N42-3-1999 (R2006))
- IEC 60151-25 – 1971: Methods of measurement of Geiger-Muller counter tubes
- ANSI N42-1969
- IEC 134

In addition, customers generally have their own specifications consistent with their own applications and products.

3.1.2. Market analysis of products manufactured with the Annex XIV substance

GMTs are the most fundamental high-gain, gas-filled radiation detector components which are used as the sensing element of radiation instruments for the detection and monitoring of radiation, and are used in many safety and industrial uses.

GMTs can be used both to detect and measure the following types of radiation:

- Alpha particles
- Beta particles
- X-rays
- Gamma rays

Centronic produces a range of legacy products, consisting of four proven Geiger-Muller platforms for detecting the different forms of radiation (see Figure **1**):

- General purpose Alpha, Beta and Gamma
- Low dose gamma
- High dose gamma
- Contamination monitor Alpha, Beta and Gamma

The design of the tube type is dependent upon on the radiation it will be measuring as each different type of radiation has different properties. Design changes can include different material and thickness of windows to allow specific radiation to enter the tube, changes in size and length of the tube, different gases and pressures. All parameters are carefully selected to optimise performance. Chrome plating is used for all tubes manufactured by the applicant.

Figure 1 Examples of Centronic Geiger Muller tubes

Centronic only manufactures to its own designs, and has been manufacturing the same design halogenated GMTs since the 1950s. These are legacy products that customers have come to rely on for their own individual applications, many of which will be compromised should the method of manufacture change.

There are many safety and industrial uses for GMTs. Common applications include:

- Radiation protection – while working in potentially radioactive environments, it is necessary to establish whether the close vicinity is safe to occupy, check performance of shielding, ensure safety of working staff, warn of any release of contamination, record exposure levels, monitor environments near nuclear installations, detect hazards for emergency service staff
- Tracking of radiation tracers – radioactive tracers are used in many different applications, from. tracing oil in pipelines to the ingestion of radioactive substances in the diagnosis and treatment of many diseases. In all cases a radiation detector is needed to detect the tracer
- In the oil and gas well industry, Geiger counters are primarily used to measure characteristic gamma-ray signals from different rock formations. Such gamma rays are emitted due to the presence of potassium-40, thorium-232 and uranium-238 in different rock types. Because each rock type will contain different quantities of these isotopes, measuring the gamma-ray activity can identify the type of rock present. The temperatures within oil wells are typically under 125ºC, but in extreme cases, the temperatures can rise up to 175ºC.

As mentioned, Centronic is the second largest manufacturer of GMTs in the world, after LND Inc (USA). GMTs are mainly sold in the UK and EU, but also to the USA and far east. Customers include:

(Confidential market)

On average over the last four years (excluding 2020 due to Covid)) the applicant has sold (Confidential market) tubes per year with revenue of (Confidential financial). For 2025, revenue was around (Confidential financial), and the sales budget for 2026 is to increase to (Confidential financial)., with increasing market share over the next five years.

The operational ruggedness and reliability of Centronic's GMTs have been thoroughly proven over several decades and, whilst the products can be used in all applications, they are particularly suited to industrial applications such as oil and gas exploration, and oil well logging, as they offer greater stability in hostile environments, such as at elevated temperatures and pressure. In these applications the stability of the GMT is of paramount importance as changing the GMT can be costly and dangerous, e.g. in undersea applications.

3.1.3. Annual volume of the SVHC used

Use in the past has generally been 0.05–0.15 tonnes (50kgs–150kgs) per year. However, this volume is expected to rise to 0.2–0.25 tonnes (200–250kgs) per annum. Analysis in the CSR and the health quantification in the SEA are based on this higher estimate.

3.2. Efforts made to identify alternatives

3.2.1. Research and development

Centronic previously collaborated with the University of Surrey and the Institut Laue-Langevin (Grenoble, France) to investigate alternatives to Cr(VI) for corrosion protection in its GMTs. Centronic co-sponsored a programme of doctoral research by Marc Abilama for an Engineering Doctorate in Micro- and Nanomaterials and Technologies which tested GMTs coated with different finishes to performance and ageing tests. The results of this research on reported in Section 3.3. A proposal for further research is described in Section 4.1.4.

3.2.2. Identification of alternatives

As described above, Centronic's process involves the creation of a chrome layer on the surface of the internal metal components of the GMT which come into contact with halogens. This layer is then subject to an oxygen plasma bombardment process, which encourages the formation of a protective chromium oxide layer.

However, stainless steel alloys commonly contain more than approximately 18% chromium, and it has been suggested that passivation layers could be formed in stainless steels without the need for the separate plating step. This was the subject of the research discussed in Section 3.2.1. Two alternative passivation processes were identified and explored:

1. Oxygen bombardment
2. Nitric acid passivation and oxygen bombardment

Oxygen bombardment is already used as part of the Centronic treatment process to encourage the production of chromium oxide in the chrome-plated player. It was investigated to see whether oxygen bombardment alone could generate a sufficient oxide layer in the steel to provide sufficient corrosion protection.

Nitric acid passivation has been suggested to enhance the natural development of protective oxide layers in air, partially by increasing the ratio of chromium to iron present. The passivated components are then subject to oxygen bombardment to further encourage growth of Cr(VI).

Samples from the three processes (oxygen bombardment, nitric acid passivation, and the standard Cr(VI) plating process currently used by Centronic) were prepared and combined into units of one of Centronic's most popular GMT models. They were then subjected to accelerated ageing through being operated in the presence of a 6 GBq Caesium-137 radiation source in a dedicated gamma exposure room that provided gamma ray dose rates of (1.3±0.1) mSv/hr. Detectors were run at room temperature and 125°C for 24 hours a day at an operating voltage of 500V. Detectors were tested in terms of:

1. Starting voltage during ageing, as a measure of quench gas depletion
2. Plotting and examination of Geiger plateau graphs
3. Operating count rates, using Centronic's auto-test equipment
4. Measurement of operating count rates to ambient radiation
5. Surface characterisation during ageing, to identify evidence of increasing bromine content and surface roughness

3.2.3. Baseline performance of the chrome-plated detector

3.2.3.1. Starting voltage during ageing

Figure 2 and Figure 3 summarise the starting voltage of the plated detector at room temperature and at 125°C by count number.

Both cases exhibit increasing voltage initially before plateauing. This increase signifies the increased presence of quench gas in the GMT. It is suggested that the initial increase reflects a gradual outgassing of some residual contaminant which can also act as a quench gas.

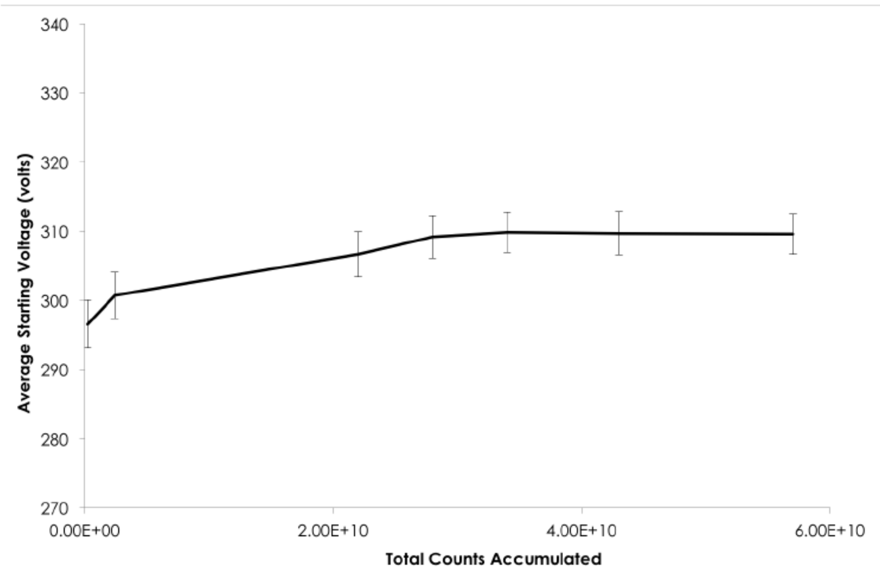


Figure 2 Starting voltage by age at room temperature for the plated detector

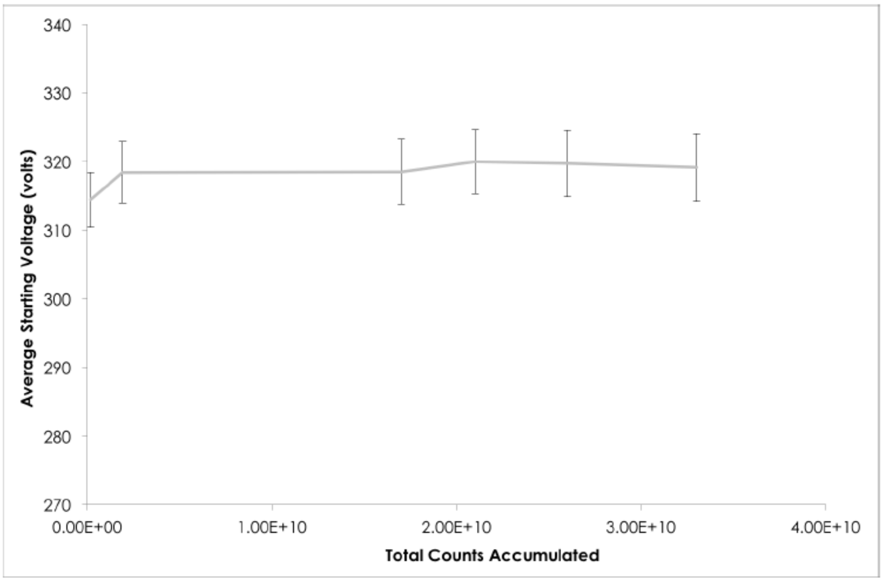


Figure 3 Starting voltage by age at 125°c for the plated detector

3.2.3.2. Geiger plateau plot measurements

Figure 4 and Figure 5 present Geiger plateau plots for the plated detectors, at room temperature and 125°C after $1.4X10^{10}$ and $5.7x10^{10}$ counts.

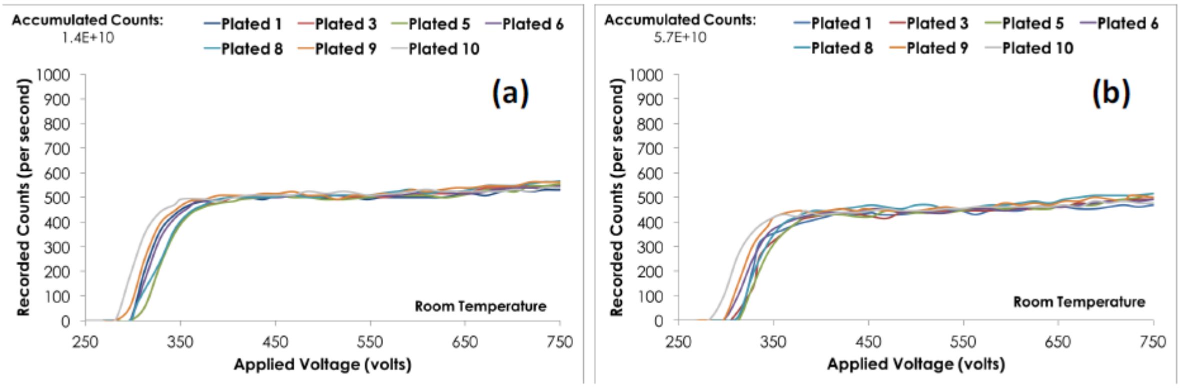


Figure 4 Geiger plateau plots at room temperature for the plated detector after (a) $1.4x10^{10}$ counts (b) $5.7x10^{10}$ counts

The quality of a plateau is measured in terms of its length and stability. All plated detectors investigated at room temperature were found to produce flat plateaux that surpassed the 750V upper limit at both ageing points.

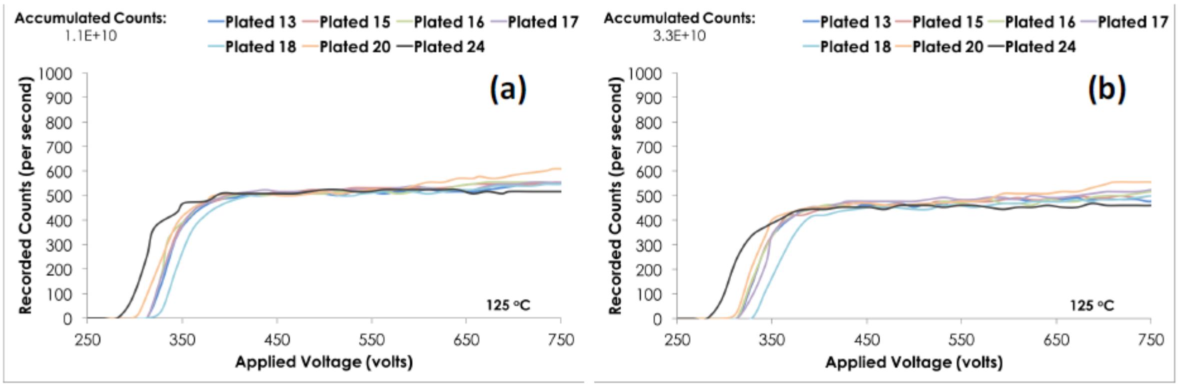


Figure 5 Geiger plateau plots at 125°C for the plated detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts

At 125°C, plots were found to exhibit visibly flat plateaux over the entire voltage range, indicating no change in performance from the elevated temperature.

3.2.3.3. Operating count rates

Figure 6 and Figure 7 present the results of operating count monitoring by age for plated detectors. At room temperature, no significant changes were found between consecutive measurements by age. This indicates that the counting stability of the GM detectors remained constant with age. This picture was replicated at the higher temperature. Some fluctuations were observed but within measurement error.

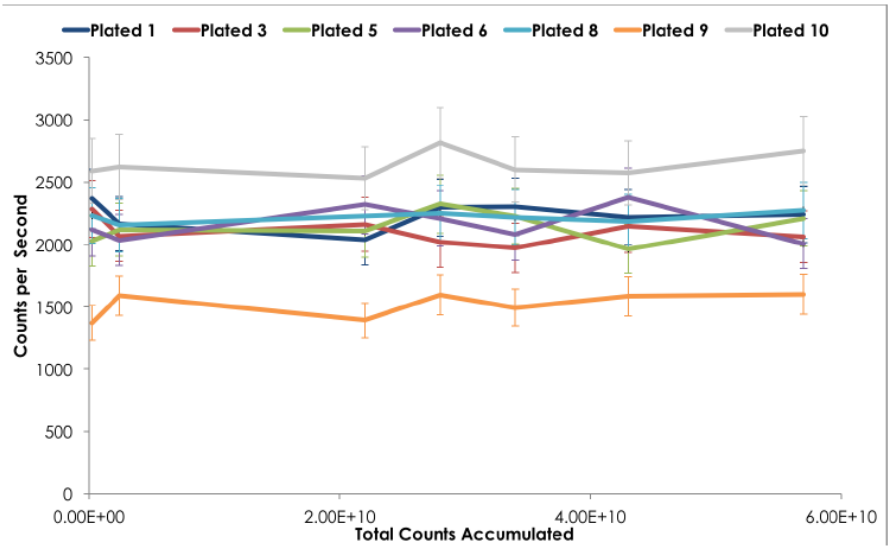


Figure 6 Operating count rate at room temperature for plated detectors

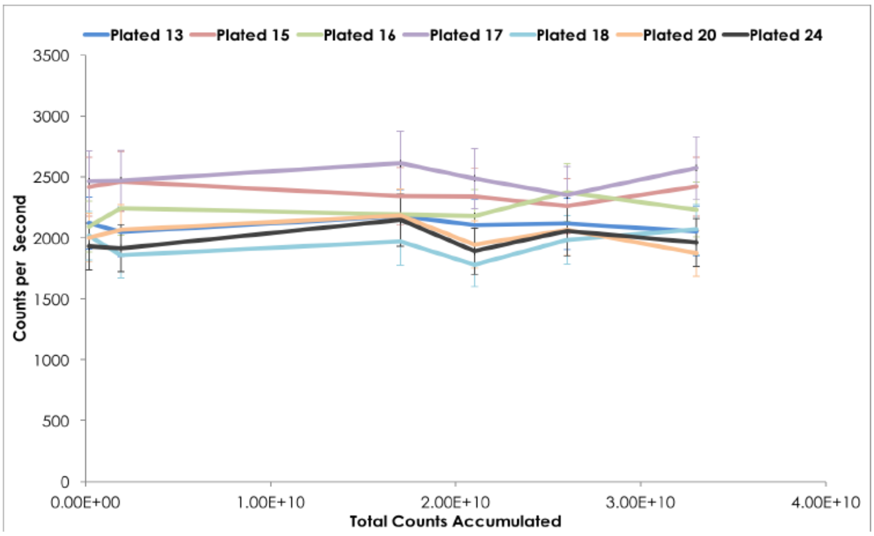


Figure 7 Operating count rates at 125°C for plated detectors

3.2.3.4. Ambient count measurements

The ambient operating count rate is an important detector parameter to consider when fault-finding Geiger counters. It is recorded by measuring the detector operating count rates in the absence of the Caesium-137 used for ageing. Such readings are typically carried out over a period of three minutes and scaled down to produce a Count Per Second (cps) value. The ambient operating count rates for all samples under investigation were determined before the start of the ageing procedure. In all cases, the detectors produced count rates of less than 1 cps.

3.2.3.5. Surface characterisation during ageing

The internal cathode surfaces were visually examined after ages. Several ageing intervals were studied, but only the initial un-aged and end-of-life results are described here. For room temperature detectors, no apparent surface change occurred over the course of the ageing process. The chromium layer did exhibit large quantities of micro-cracks, which could retain contaminants from the plating process or even small quantities of halogen quench gas. This could explain the rising starting voltage measurements described above. Similar results were observed for detectors aged at 125°C.

Elemental composition was analysed for several regions of interest. At room temperature, no bromine was detected (on average), while high levels of chromium and oxygen were observed (85.6% and 10.7% by weight respectively). The lack of bromine suggests no reactions occurred with the exposed plated cathode. Similar results were observed for plated samples aged at elevated temperature.

3.2.3.6. Note on technical feasibility

A number of remarks on the previous results are relevant.

First, the research undertaken by Marc Abilama under Centronic’s guidance was innovative, because the interactions between GMTs materials and fill-gases is historically underexplored. Accordingly, the results can only be considered preliminary when judged against the many decades of observed performance of GMTs in the field in harsh operating environments.

Second, the research was necessarily limited in scope to a small number of alternative treatments which might not necessarily reflect the best candidate alternatives out of all possible.

Third, the testing conditions were unable to mimic the true conditions which Centronic's products must be able to withstand in reality, and have been demonstrated to be able to withstand through practical use. Moreover, limitations to testing mean that real differences in performance might not have been detectable under the testing protocols employed.

As mentioned above, Centronic's GMTs have been manufactured using broadly similar techniques for many decades, and have been proven to work to the highest standards in the harshest operating conditions. This explains why Centronic is the second largest manufacture of GMTs in the world. Any deficits in performance from a switch to alternative materials or manufacturing techniques will have a direct impact on customers and markets, many of which have used Centronic products for many years because they satisfy the needs of the application and there is no need to change or improve them. Thus, the AoA is extremely sensitive to any such deficits.

3.3. Assessment of shortlisted alternatives

3.3.1. Alternative 1: Nitric passivated detector

3.3.1.1. Availability

The technique uses widely available materials.

3.3.1.2. Safety considerations

Nitric acid has a harmonised classification of Ox Liq 2 (H272), Acute Tox 1 (inhalation) (H330) and Skin Corr 1A (H314). Although hazardous, it is considered a safer alternative than Cr(VI).

3.3.1.3. Technical feasibility

Starting voltage during ageing

Figure 8 and Figure 9 present the results of the voltage ageing test for the passivated detector.

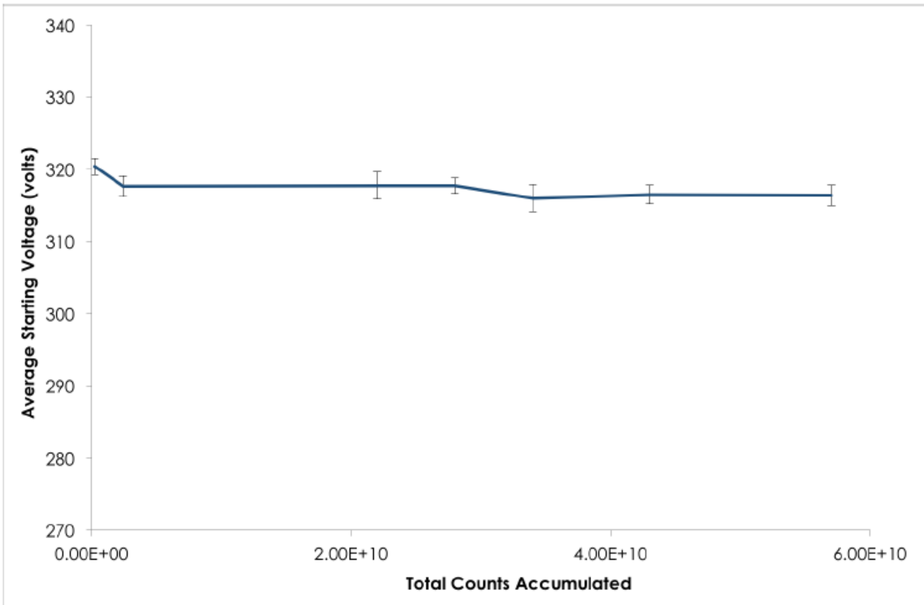


Figure 8 Starting voltage by age at room temperature for the passivated detector

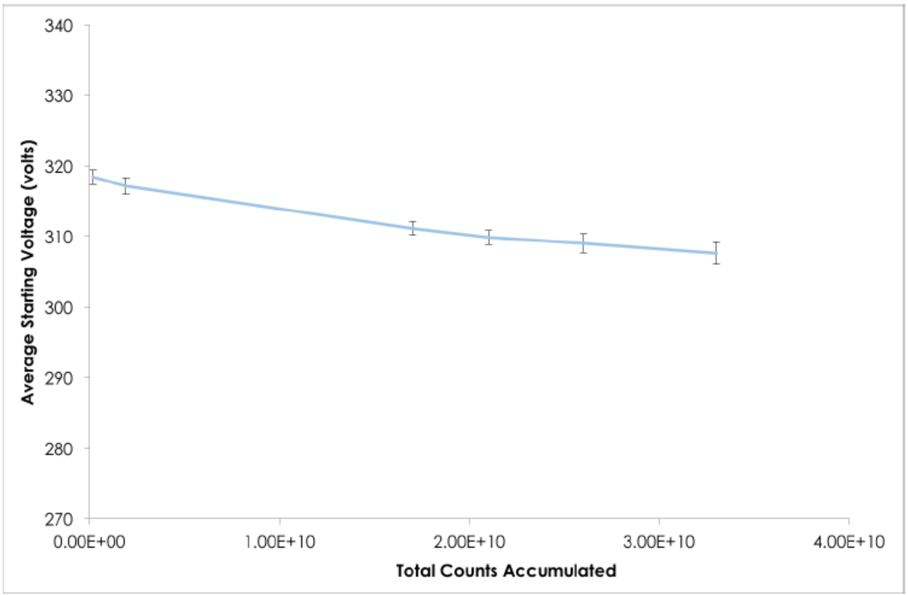


Figure 9 Starting voltage by age at 125°C for the passivated detector

At room temperature, the passivated detector exhibited some initial drop-off in voltage but was generally stable thereafter. At the higher temperature, the samples exhibited a drop of 11V on average, indicating a reduction in bromine quench gas, with no significant evidence of a cessation of the loss.

Geiger plateau plot measurements

Figure 10 and Figure 11 present Geiger plateau plots at room temperature and 125°c for the passivated detector after (a) $1.4\text{x}10^{10}$ counts (b) $5.7\text{x}10^{10}$ counts.

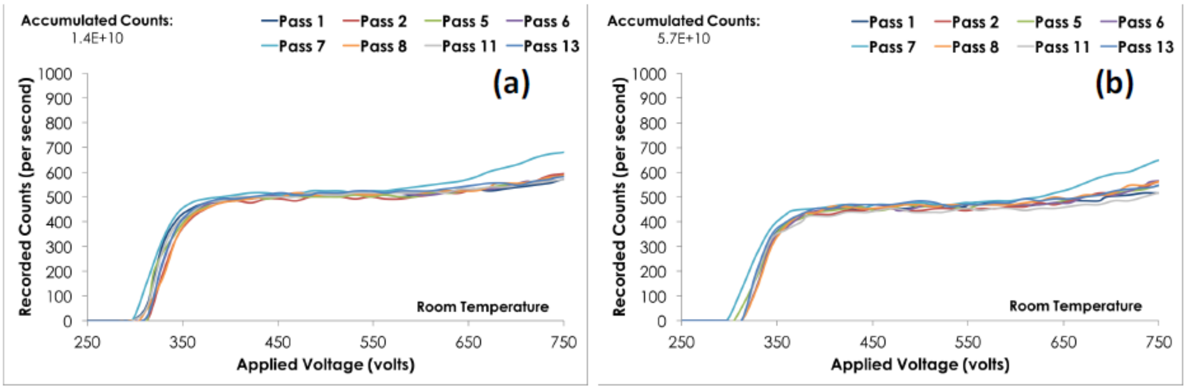


Figure 10 Geiger plateau plots at room temperature for the passivated detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts

At room temperature, the majority of detectors had flat plateaux across the relevant voltage range, indicating no visible performance degradation. This picture was confirmed at the elevated temperature at the mid-point measurement age. At the end of the ageing process, two (25%) of the sample did show signs of performance degradation. This provides some evidence of performance degradation compared with plated detectors.

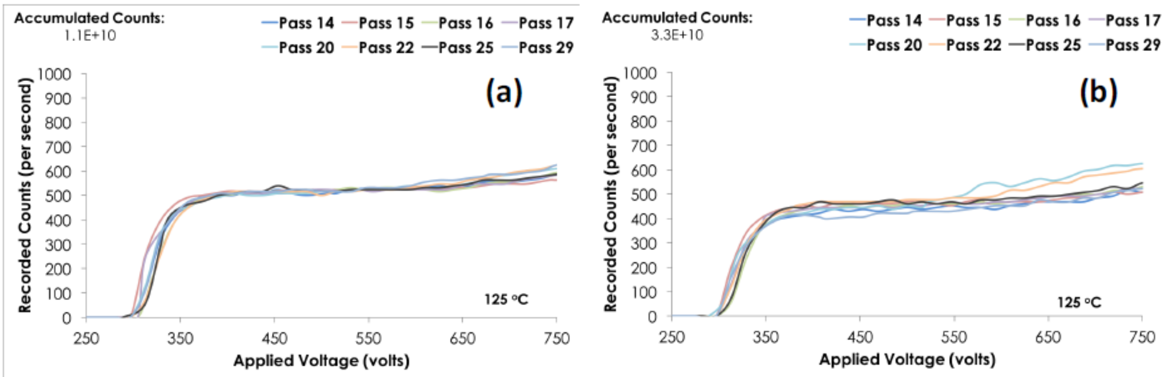


Figure 11 Geiger plateau plots at 125°C for the passivated detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts

Operating count rates

Figure 12 and Figure 13 show the results for operating count rates for passivated detectors at room temperature at 125°C.

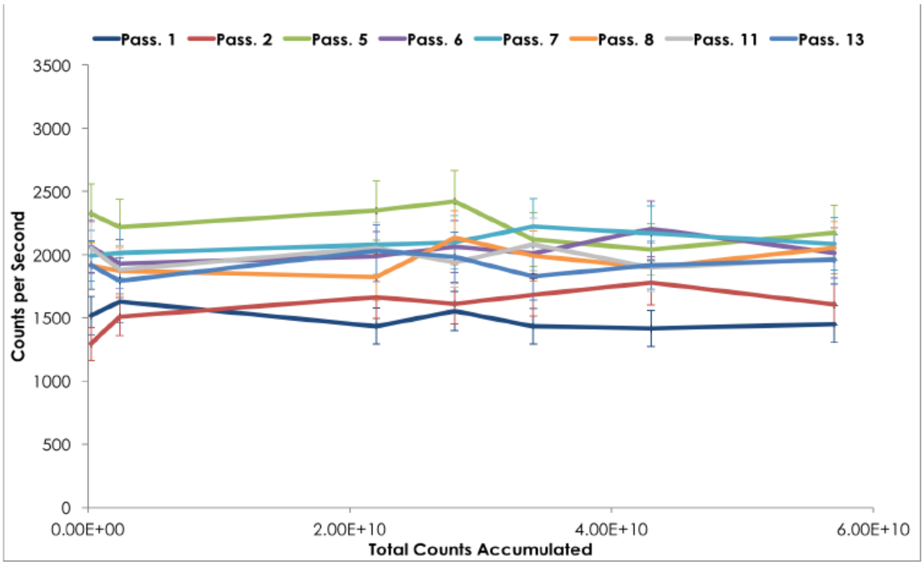


Figure 12 Operating count rate at room temperature for passivated detectors

Passivated samples aged at room temperature were found to produce operating count rate measurements which remained relatively constant throughout the ageing procedure. Some passivated samples aged at 125°C exhibited a drop in performance when judged on Geiger plateau plots (Figure 11), but this did not seem to translate into noticeable changes in operating count rates.

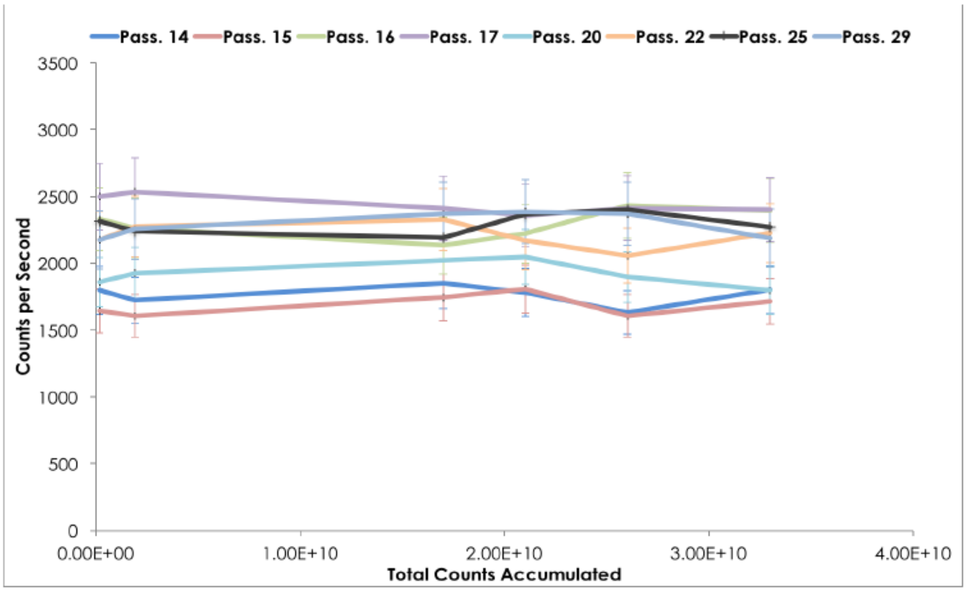


Figure 13 Operating count rates at 125°C for passivated detectors

Ambient count rates

As stated in Section 3.2.3.4, in all cases, the detectors produced count rates of less than 1 cps.

Surface characterisation with ageing

Visual examination revealed no significant changes in the cathode surface of passivated detectors at room or elevated temperature. Elemental composition analysis indicated chromium quantities of 28% by weight, much lower than observed for the plated samples. Iron made up 63% by weight, and oxygen 6%. There was some detection of bromine but below the limit of detection.

Conclusions on technical feasibility

Although performance against some parameters was judged broadly acceptable in the context of the research which generated these results, the performance on initial voltage indicated clear evidence of premature ageing and quench gas depletion, especially at 125°C, with no obvious stabilisation of these trends. There was also evidence of ageing at this higher temperature via plateau plots. As a result, this alternative is judged technically infeasible.

3.3.1.4. Economic feasibility

The alternative has been demonstrated to be technically infeasible. Therefore, an assessment of economic feasibility has not been undertaken.

3.3.1.5. Suitability for the applicant and in general

On the basis of the observed technical infeasibility, this alternative is considered unsuitable.

3.3.2. Alternative 2: Oxygen-bombarded detector

3.3.2.1. Availability

The technique uses widely available materials.

3.3.2.2. Safety considerations

The technique does not involve the use of any hazardous materials.

3.3.2.3. Technical feasibility

Starting voltage during ageing

Figure 14 and Figure 15 present the results of the voltage ageing test for the passivated detector.

At room temperature, the oxygen-bombarded detector did not exhibit any significant drop-off in voltage with age. The observed average increase of (2.1±0.7)V was within the measurement uncertainty of ±2V. At the higher temperature, the samples exhibited a drop of 4.9V on average, less than the passivated samples, but still indicating a reduction in bromine quench gas. There also appeared to be evidence of continued loss over time.

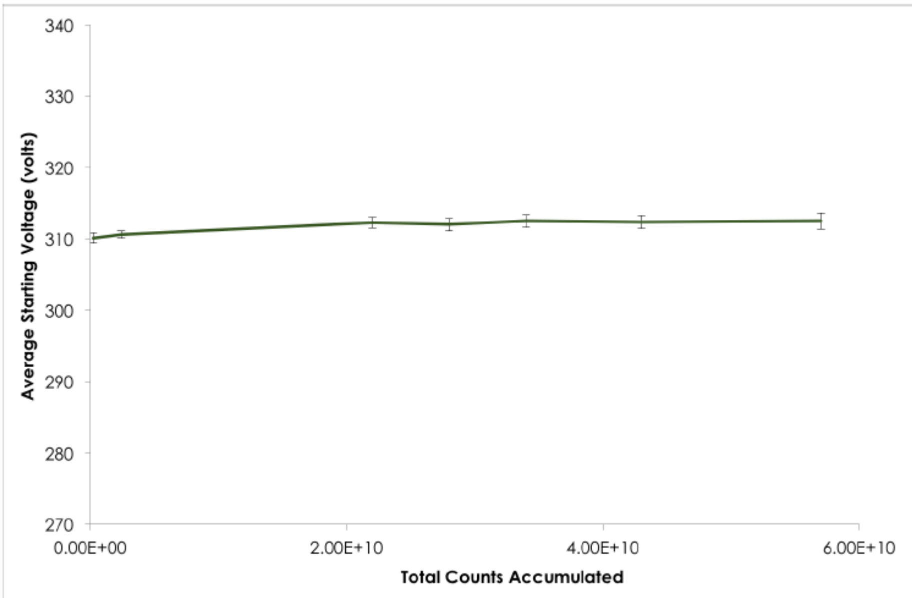


Figure 14 Starting voltage by age at room temperature for the oxygen detector

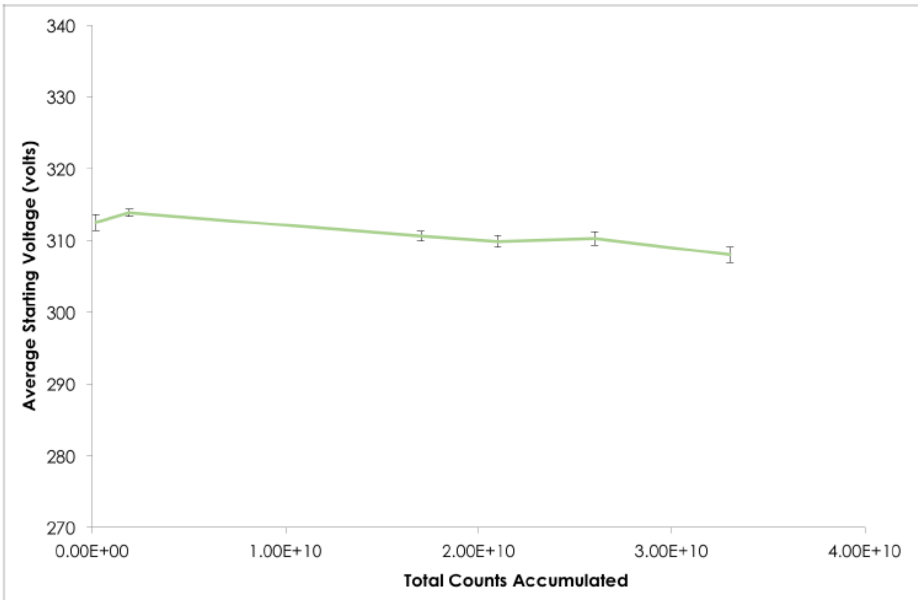


Figure 15 Starting voltage by age at 125°C for the oxygen detector

Geiger plateau plot measurements

Figure 16 and Figure 17 present Geiger plateau plots at room temperature and 125°c for the oxygen-bombarded detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts.

At room temperature, oxygen-bombarded detectors showed very similar performance, with flat plateaux across the relevant voltage range, at both age points, indicating no visible performance degradation. At the elevated temperature, performance was not as similar across samples, but no significant changes in performance were visible.

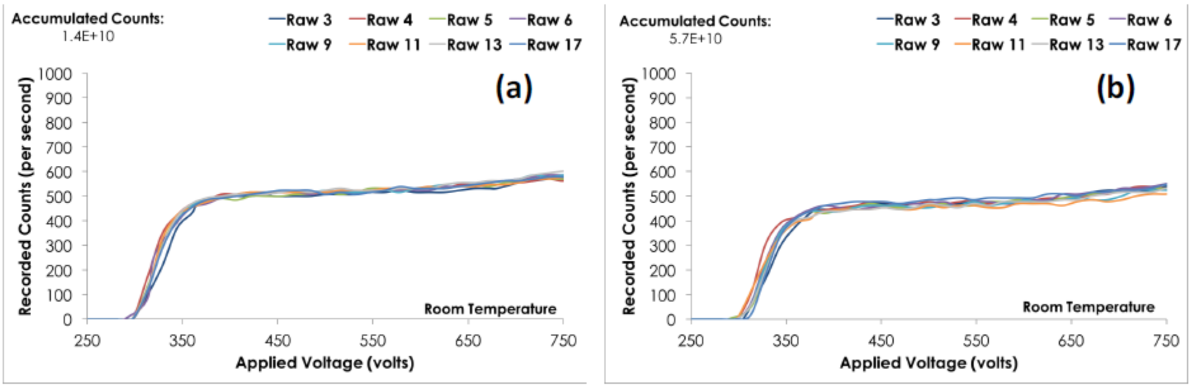


Figure 16 Geiger plateau plots at room temperature for the oxygen detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts

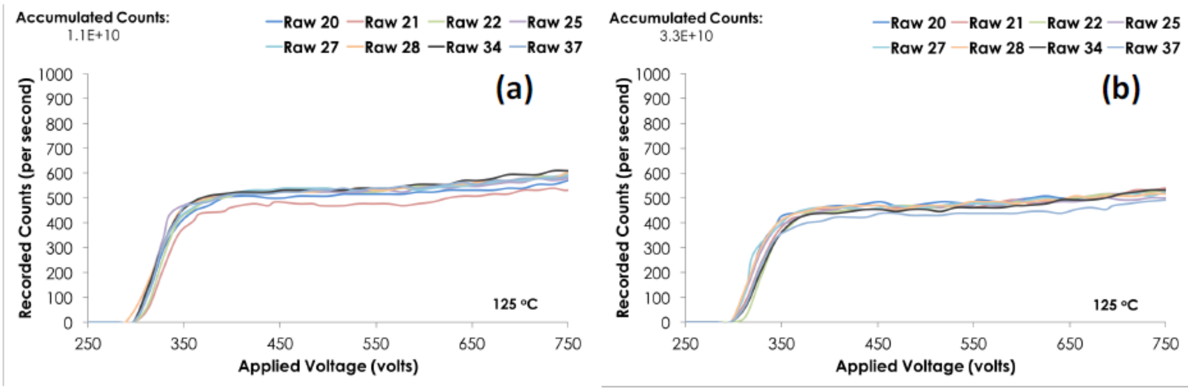


Figure 17 Geiger plateau plots at 125°C for the oxygen detector after (a) 1.4×10^{10} counts (b) 5.7×10^{10} counts

Operating count rates

Figure 18 and Figure 19 show the results for operating count rates for oxygen-bombarded detectors at room temperature at 125°C.

Oxygen-bombarded samples aged at room temperature were found to produce operating count rate measurements which remained relatively constant throughout the ageing procedure. This pattern was largely replicated for detectors aged at higher temperatures.

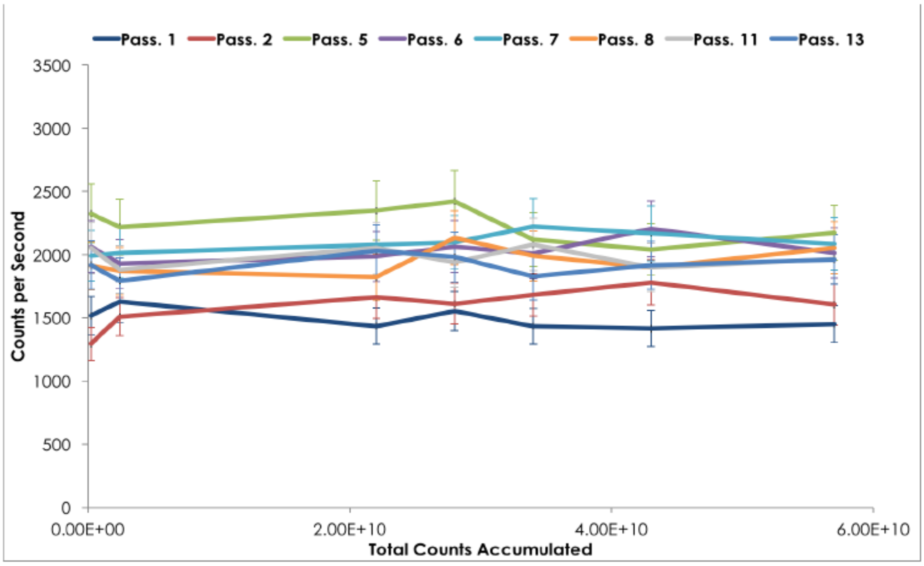


Figure 18 Operating count rate at room temperature for oxygen-bombarded detectors

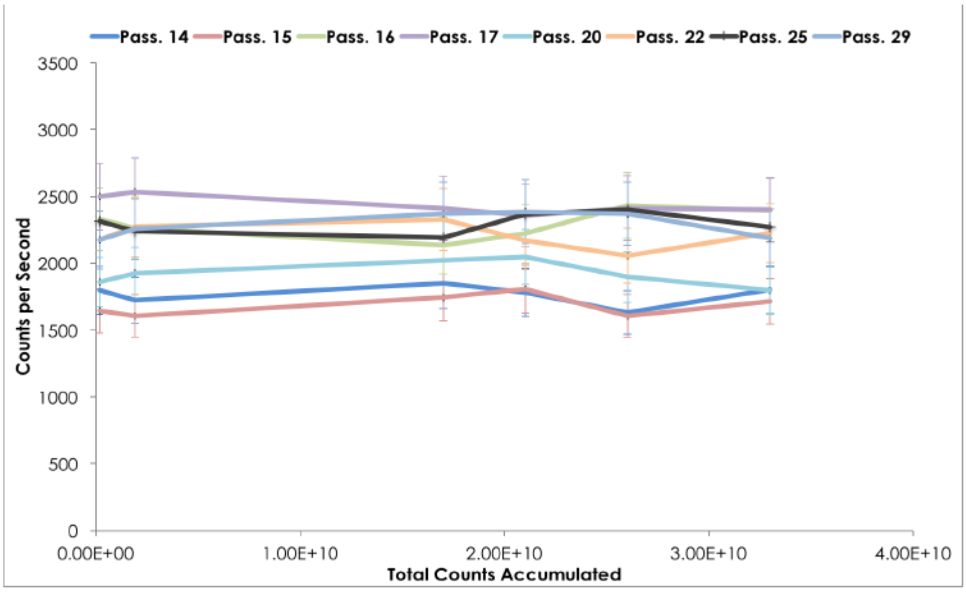


Figure 19 Operating count rates at 125°C for passivated detectors

Ambient count rates

As stated in Section 3.2.3.4, in all cases, the detectors produced count rates of less than 1 cps.

Surface characterisation with ageing

Visual examination revealed no significant changes in the cathode surface of oxygen-bombard detectors at room or elevated temperature. Elemental composition analysis indicated chromium quantities of 62% by weight, much higher than observed for the passivated samples. Iron made up 29% by weight, and oxygen 5.5%. There was some detection of bromine but below the limit of detection.

Conclusion on technical feasibility

Although performance against some parameters was judged broadly acceptable in the context of the research which generated these results, the performance on initial voltage indicated clear evidence of premature ageing and quench gas depletion, especially at 125°C, with no obvious stabilisation of these trends. As a result, this alternative is judged technically infeasible.

3.3.2.4. Economic feasibility

The alternative has been demonstrated to be technically infeasible. Therefore, an assessment of economic feasibility has not been undertaken.

3.3.2.5. Suitability for the applicant and in general

Given observed problems with technical feasibility, this alternative is judged unsuitable.

3.4. Conclusion on shortlisted alternatives

The conclusion of this AoA is that there are no suitable alternatives for the applicant's use of Cr(VI) in the manufacture of GMTs, or in general.

4. SOCIO-ECONOMIC ANALYSIS

4.1. Continued use scenario

4.1.1. Summary of substitution activities

Previous R&D work discussed above indicated that the interactions between GMT materials and fill-gases is not well understood. If this application for authorisation is granted, Centronic will establish a programme of R&D to understand these interactions better, with the intention of informing the question of what substances and technologies might be most viable alternatives to Cr(VI). This will build on the previous R&D work, which provided preliminary understanding of interactions for two alternative treatments, but was limited in terms of its explanatory power.

4.1.2. Conclusion on suitability of available alternatives in general

The analysis of alternatives demonstrates that there are not suitable alternatives available to the applicant for its use of Cr(VI) for the plating of its GMTs.

4.1.3. Substitution plan

Not relevant.

4.1.4. R&D plan

4.1.4.1. Factors affecting substitution

The key parameters governing the suitability of alternatives is the stability of GMT performance over time, and the duration of the operating lifetime. These could be interpreted as economic rather than technical parameters, since they seem to indicate that shorter lifetimes merely imply the need for earlier replacement. However, the markets and applications which are most relevant to Centronic's products are those exhibiting harsh operating conditions which make replacement difficult, hazardous and/or expensive. An example is the oil and gas market where GMTs are installed in deep water, or must be used in drilling wells at very high temperatures. This also explains why the performance deficits identified in previous R&D were seen as critical.

4.1.4.2. List of actions and timetable with milestones

An R&D plan is less concrete than a substitution plan under REACH, because of the inherent uncertainties in the research which is being proposed. Therefore, a timetable and milestones are not provided here. An indicative list of actions is as follows:

- Consolidated baseline of what, why and how Centronic achieves its chrome plating outcomes
- Understanding of what is uniquely achieved by the chrome layer, whether other layers or none could achieve an acceptable outcome
- Physical trials and analysis to support above
- Review of previous work and results
- Devics a multiple channel testing method, to enable testing of more than one product at a time, to reduce testing time and collect more data to identify a way forward. This would dramatically improve data collection to analyse future development direction
- Surface characterisation of the Geiger tube cathode:
    - Cr plated device operation

    - Cr plating process
    - Cr layer characteristics
    - Role of Cr layer in finished device
    - Alternative methods of creating Cr layer
- Experiments
    - Baseline devices
    - Devices without Cr plating
    - Devices with alternative Cr plating
- Design a successful quench gas depletion model to better understand this mechanism

4.1.4.3. Monitoring of the implementation of the substitution plan

The R&D programme will be managed internally by Centronic as a project, with agreed resourcing, actions and expected outcomes.

4.1.4.4. Conclusions

Centronic recognises that the continued search for suitable alternatives is an integral part of the REACH authorisation process. The use of Cr(VI) for plating GMTs is long established within Centronic and in the wider industry, because the substance's strong resistance to corrosion in harsh conditions make it highly suitable for this application. Nevertheless, this suitability probably means that alternatives to Cr(VI) have been relatively underexplored.

4.2. Risks associated with continued use

The CSR undertakes a calculation of the additional number of lung cancer deaths from worker exposure, based on the dose-response relationship report provided by ECHA[1]. Following the exposure scenario stated in the CSR and in accordance with ECHA (2013) ("in cases where the applicant only provides data for the exposure to the inhalable particulate fraction, as a default, it will be assumed that all particles were in the respirable size range", p4), only lung cancer is considered. The share of particles that enter the gastro-intestinal tract is assumed to be zero for the worker assessment, but is considered for 'man via environment' exposure (see below). For dermal exposure to hexavalent chromium compounds, no evidence for skin or other tumors in humans is proposed by ECHA.

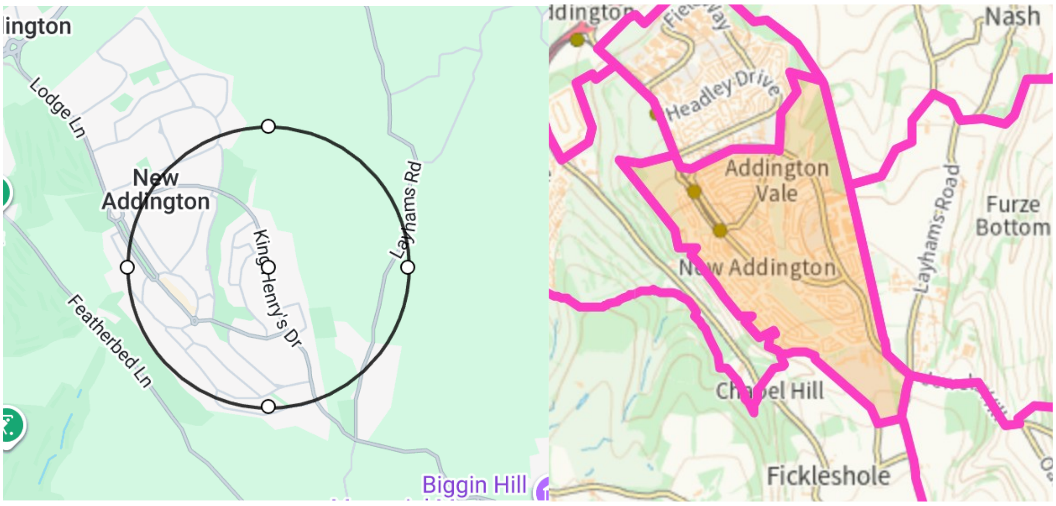
For the lung cancer calculation, Excess Lifetime Risk (ELR) is defined as the additional or extra risk of dying from cancer due to exposure to a toxic substance incurred over the lifetime of an individual. Note that developing cancer may occur during working life or after retirement. The linear exposure-risk relationship for lung cancer as estimated by ECHA (2013) is given by:

Unit occupational excess lifetime mortality risk $= 4 \times 10^{-3}$ *per* μg *Cr(VI)/*m^3

For risks to workers, this excess risk estimate is measured up to the age of 89, based on assumed exposure of eight hours per day for five days per week over a working life of 40 years. No exposure threshold is observed empirically for these cancer impacts, implying that excess risks occur at any level of exposure.

[1] http://echa.europa.eu/documents/10162/13579/rac_carcinogenicity_dose_response_crvi_en.pdf

According to ECHA guidance Chapter R.16: Environmental Exposure Estimation (Version 2.1 – October 2012), exposure to the environment should be assessed on two spatial scales: locally in the vicinity of point sources of releases to the environment, and regionally for a larger area which includes all point sources in that area. Releases at the continental scale are not used as endpoints for exposure. The end results of the exposure estimation are concentrations - Predicted Environmental Concentrations (PECs) - in the environmental compartments for both local and regional scales which have been calculated in the ES.



The $PEC_{local\ air}$ is used for the estimation of excess risk to the local population. Following ECHA (2013), risks to the local population (inhabitants) are defined in terms of lung cancer from inhalation and intestinal cancer from oral exposure (via consumption of locally sourced foodstuffs). From the figure above, it can be seen that the 1km radius around the Centronic site corresponds approximately to the electoral ward New Addington South. According to NOMIS, the latest (2024) estimate of population for this ward was 11,682.[2] There are a relatively large number of industrial and commercial premises in the area, but the working population in the area is not known. For residents' exposure via both inhalation and oral intake, this risk estimate is measured up to the age of 89, and is based on a 24-hour day for 365 days per year over an exposure period of 70 years. Therefore, the full 11,682 population will be treated as residents, which is considered a conservative assumption, since many nearby residents will in reality work outside of the area. Thus, this assumes that the daytime and nighttime populations are the same.

For nearby residents, the linear exposure-risk relationship for lung cancer as estimated by ECHA (2013) is given by:

Unit excess lifetime mortality risk = 2.9×10^{-2} *per μg Cr(VI)/m*^{3}

For residents' oral exposure and thus intestinal cancer calculations, the linear exposure-risk relationship for intestinal cancer as estimated by ECHA (2013) is given by:

Unit excess lifetime cancer risk = 8.0×10^{-4} *per μg Cr(VI)/kg bw/day.*

An estimate of daily oral intake is not presented in the CSR. For this SEA, a rule of thumb has been used of a ratio between the PEC and daily intake of 2.15, based on previous applications for authorisation.

[2] https://www.nomisweb.co.uk/datasets/pestoa2021

The individual development of cancer diseases may be fatal or non-fatal, whereas the exposure-response functions employed are defined in terms of cancer mortality (lung) and cancer (intestinal) only. Therefore, the excess risk of cancer is higher than the excess risk of cancer mortality. Non-fatal cancer is most appropriately defined in terms of survival. According to Cancer Research UK, 'disease-free survival' is defined as being alive and healthy, with no recurrence, five years after initial diagnosis.[3] Accordingly, age-standardised (i.e. all-age) five-year survival statistics for lung and intestinal cancer in England are provided by NHS England.[4] The results are presented in Table 1.

Table 1. Survival statistics for lung, intestinal and colon cancer in England and Wales

	Lung	Intestine
Relative 5-year survival rates	26.3%	56%
Non-fatal – fatal ratio	0.36	1.27

The non-fatal – fatal ratio is calculated as follows:

Non-fatal ratio = Fatal survival rate / (1 – Fatal survival rate)

The valuation of fatal and non-fatal cases of lung cancer follows ECHA (2011) guidance on SEA. ECHA (2016)[5] has published a value for avoiding a premature death of €3.5m, with a higher value for sensitivity purposes of €5m, and for avoiding cancer morbidity (non-fatal cancer) of €0.41m (2012 prices). For this SEA, all values have been converted to sterling using a 2012 exchange rate and then inflated to 2025 figures using the implicit prices deflator.[6] The resulting values are presented in Table 2. The costs of cancer treatment are not included in the estimates, but these are small in comparison with these 'human' costs, and their omission will not change the overall results significantly.[7]

Table 2. Monetary values for fatal and non-fatal cancer.

	2012	Exchange rate	GDP deflator	2025
Value of cancer morbidity (non-fatal cancer)	€410k	1.234	1.443	£480k
Value of premature death	€3,500k			£4,094k
Value of premature death (sensitivity)	€5,000k			£5,849
Value of preventing a cancer death	€3,910k			£4,574k
Value of preventing a cancer death (sensitivity)	€5,410k			£6,329k

[3] https://www.cancerresearchuk.org/about-cancer/what-is-cancer/understanding-cancer-statistics-incidence-survival-mortality#dfs

[4] https://digital.nhs.uk/data-and-information/publications/statistical/cancer-survival-in-england/cancers-diagnosed-2016-to-2020-followed-up-to-2021

[5] https://echa.europa.eu/documents/10162/13637/seac_reference_wtp_values_en.pdf/403429a1-b45f-4122-ba34-77b71ee9f7c9

[6] https://www.bankofengland.co.uk/boeapps/database/Rates.asp?Travel=NIxIRx&into=GBP, https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/ybgb

[7] See, for example, http://www.erswhitebook.org/chapters/the-economic-burden-of-lung-disease/ , where it was estimated that, in 2011, there were 292,000 cases of lung cancer and 257,000 deaths costing €11,473 per case:

4.1.1. Impacts on environmental compartments

Not relevant.

4.1.2. Compilation of human health and environmental impacts

Table 3 summarises the estimation of the excess annual risk and cost of fatal and non-fatal cancer associated with the applicant's use of Cr(VI). The total cost of all statistical cancers associated with the applicant's use of Cr(VI) is £328 per year. A 10-year latency is assumed for all cancer impacts when estimating costs.

Table 3. Costs of additional cancer risk around the applicant's plant.

Fatal lung cancer	**Excess lifetime risk**	**Number exposed**	**Cases per year**	**Value per case**	**Value per year**
Workers					
Directly exposed workers[2]	5.70E-03	1	1.43E-04	3,169,444	305
Indirectly exposed workers[3]	2.90E-08	0	0.00E+00	3,169,444	-
Sub-total	*5.70E-03*	*1*	*1.43E-04*	*3,169,444*	*305*
General population					
Local	2.90E-08	11685	4.84E-06	3,169,444	10
Regional					
Sub-total	*2.90E-08*	*11685*	*4.84E-06*	*3,169,444*	*10*
Total	**5.17E-07**	**11686**	**1.47E-04**	**3,169,444**	**315**
Non-fatal lung cancer					
Workers					
Directly exposed workers[2]	2.03E-03	1	5.09E-05	332,346	11
Indirectly exposed workers[3]	1.03E-08	0	0.00E+00	332,346	-
Sub-total	*2.03E-03*	*1*	*5.09E-05*	*332,346*	*11*
General population					
Local	1.03E-08	11685	1.73E-06	332,346	0
Regional					
Sub-total	*1.03E-08*	*11685*	*1.73E-06*	*332,346*	*0*
Total	**1.84E-07**	**11686**	**5.26E-05**	**332,346**	**12**
Fatal colon cancer					
Workers					

Directly exposed workers[2]	0.00E+00	1	0.00E+00	3,169,444	-
Indirectly exposed workers[3]	0.00E+00	0	0.00E+00	3,169,444	-
Sub-total	*0.00E+00*	*1*	*0.00E+00*	*3,169,444*	-
General population					
Local	7.55E-10	11685	1.26E-07	3,169,444	0
Regional					
Sub-total	*7.55E-10*	*11685*	*1.26E-07*	*3,169,444*	*0*
Total	**7.55E-10**	**11686**	**1.26E-07**	**3,169,444**	**0**
Non-fatal colon cancer					
Workers					
Directly exposed workers[2]	0.00E+00	1	0.00E+00	332,346	-
Indirectly exposed workers[3]	0.00E+00	0	0.00E+00	332,346	-
Sub-total	*0.00E+00*	*1*	*0.00E+00*	*332,346*	-
General population					
Local	9.61E-10	11685	1.60E-07	332,346	0
Regional					
Sub-total	*9.61E-10*	*11685*	*1.60E-07*	*332,346*	*0*
Total	**9.61E-10**	**11686**	**1.60E-07**	**332,346**	**0**
Latency (years)	10				

4.3. Non-use scenario

4.3.1. Summary of the consequences of non-use

If the applicant had to cease its use of Cr(VI) for the manufacture of GMD products, it would do so by closing the business in the UK. There would be a loss of profits for the applicant, and 15 staff directly involved in the business would be made redundant. It is possible additional administrative and support staff would also be made redundant. There would be costs for suppliers in terms of loss business, and for the applicant's customers in terms of searching for replacement products, qualifying them and dealing with lower performance.

4.3.2. Identification of plausible non-use scenarios

The analysis of alternatives presented in Section 3.3 demonstrates that there are no suitable alternatives to Cr(VI) which the applicant could adopt within any foreseeable timeframe. There is no option for subcontracting out the plating to another company in the UK or outside, because no company in the UK or the EU is authorised to take on the applicant's use of Cr(VI), or has the expertise. Therefore, the only alternatives open to the applicant to stopping its use of Cr(VI) would be closure of the business and potential relocation outside of the UK. Relocation outside of the UK is considered difficult, because the applicant's business is highly specialised, even within the broader commercial group of which Centronic is part. There would therefore be a need to transfer expertise out of the UK for this option. However, whether this particular aspect would occur is not considered material to the SEA.

4.3.3. Conclusion on the most likely non-use scenario

For the purposes of this application for authorisation, there is little distinction between total closure and closure followed by relocation outside of the UK. This is because both options would involve unemployment of UK workers and a loss of profits from the UK, which are the primary impacts of the non-use scenario valued in the SEA. In practice, therefore, the identification of the exact non-use scenario does not have a significant impact on the authorisation decision.

Therefore, the most likely non-use scenario taken forward to Section 4.4. is closure of the applicant's GMD business in the UK.

4.4. Societal costs associated with non-use

4.4.1. Economic impacts on applicants

As described in Section 4.3, if the applicant had to cease its use of chromium trioxide in 2027, it would do so by closing down its operations in the UK and exiting the market. Following the assessment in Section 4.1.2, there are no suitable alternatives generally available. Therefore, following SEAC guidance, the economic impact on the applicant comprises four years' worth of lost profit.[8] Table 4 presents figures for gross margin in the applicant's GDM business, based on the average of the company's last four years of trading, which is assumed to continue unchanged in real terms in the continued use scenario.

Table 4 Gross margin in the applicant's GDM business

	NPV (3.5%)	2027	2028	2029	2030
Turnover	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)
Materials	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)
Labour	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)
Other costs	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)
Gross margin	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)	(Confidential financial)

[8] https://echa.europa.eu/documents/10162/0/afa_seac_surplus-loss_seac-52_en.pdf

Gross margin does not include overhead costs. It is possible that some of these costs could be reduced if the GDM business was closed, but it is unlikely that they would be reduced proportionately. However, so as not to overestimate the probability that the benefits of authorisation exceed the risks, it will be assumed that all overhead costs can be avoided in the non-use scenario and hence that the overall company operating margin of 20% applies when calculating producer surplus losses. Applying this margin to the figures in Table 4 gives an estimated present value of producer surplus losses of (Confidential financial) (3.5%). This figure excludes any revenues which could be obtained from selling equipment (likely for scrap), but is assumed to be a reasonable lower bound on the true losses in the non-use scenario.

4.4.2. Economic impacts on the supply chain

Closing the applicant's GDM business would mean a reduction in sales of suppliers, and disruption for customers who would have to identify alternative products, qualify them and deal with performance deficits. It is not known how big this costs would be so they are not quantified here.

4.4.3. Economic impacts on competitors

As described in Section 3.1.2, there are few if any direct competitors in the applicant's markets, due primarily to the particular performance characteristics of the applicant's products. There will inevitably be some boost to the businesses of these companies if the applicant closes, but what few competitors there are all based outside of the UK. Moreover, any benefits to competitors have already been accounted for via the SEAC methodology for calculating producer surplus losses (fn.8). As a result, economic impacts on competitors are not considered further.

4.4.4. Wider socio-economic impacts

The principal wider socio-economic impact associated with the non-use scenario is the unemployment associated with the redundancy of 15 workers directly employed in the applicant's GMD business. The SEAC approach to estimating unemployment costs is followed.[9] Full details can be found in the confidential spreadsheet. The summary results are presented in Table 5. The total cost is estimated at (Confidential financial). (net present value, 3.5%).

Table 5 Unemployment costs of the non-use scenario

Cost component	£k (PV)
Lost output	(Confidential financial)
Reservation wage	(Confidential financial)
Search costs	8.875
Rehiring costs	91.214
Scarring	390.965

[9] https://echa.europa.eu/documents/10162/17086/seac_unemployment_evaluation_en.pdf

Total	(Confidential financial)

It is possible that other workers involved in general administrative work could also be made redundant, but this is not clear, as many of their functions are essentially overheads. As a result, the costs associated with unemployment of indirectly employed workers are not quantified and the figures in the table can be considered lower bound.

4.4.5. Compilation of socio-economic impacts

presents THE figures estimated in this section. The cost of the non-use scenario is estimated at (Confidential financial) (present value, 3.5%) over the period 2027-2039.

Table 6 presents the figures estimated in this section. The cost of the non-use scenario is estimated at (Confidential financial) (present value, 3.5%) over the period 2027-2039.

Table 6: Societal costs associated with non-use

Description of major impacts		Assessed impact
1.	**Monetised impacts**	**PV, £m, 2027-2039**
	Producer surplus loss	(Confidential financial)
	Social cost of unemployment	(Confidential financial)
	Sum of monetised impacts	(Confidential financial)
2.	**Additional quantitatively assessed impacts**	
	None	
3.	**Additional qualitatively assessed impacts**	
	None	

4.5. Combined impact assessment

Table 7 presents the estimates of the costs of the non-use scenario and risks of continued use described in the previous sections.

Table 7: Societal costs of non-use and risks of continued use.

Societal costs of non-use		Risks of continued use	
Monetised impacts (NPV £m over 12 years)	(Confidential financial)	Workers (NPV £m over 12 years)	£3,453
Additional quantitatively assessed impacts		General population (NPV £m over 12 years)	£121

Qualitatively assessed impacts		Qualitatively assessed risks	
Summary of societal costs of non-use		**Summary of risks of continued use**	£3,573

4.6. Sensitivity analysis

The ECHA (2011) Guidance on SEA proposes three levels of assessment to the approach to considering the uncertainty in the SEA:

- Qualitative assessment of uncertainties
- Deterministic assessment of uncertainties
- Probabilistic assessment of uncertainties

The ECHA guidance further states that the level of detail and resources dedicated to the assessment of uncertainties should be in fair proportion to the scope of the SEA. Further assessment of uncertainties is only needed if this is considered crucial to the overall outcome of the SEA.

The baseline results of this analysis, summarised in Table 7, are that the societal costs of non-use are around (Confidential financial)., and the costs of the risks of continued use are estimated at under £4k. The ratio of costs to risks is so high that there would need to be an extremely significant change in the calculations for the overall conclusion to change. The SEAC (2016) note on values to be attached to health risks includes an upper-bound sensitivity for premature death which is just under 50% higher than the central value used in the current analysis, which would increase the present value of the risks somewhat, but there is no other reason to believe the health costs are underestimated. It is concluded therefore that it is not feasible that the health risks of continued use would increase in value sufficiently to be anywhere close to the costs of non-use, so potential sources of variation in this value are not explored further.

The two principal sources of cost to EU society in the non-use scenario are lost profits for the applicant and the costs of unemployment for workers made redundant on closure. The latter follows the detailed methodology developed for SEAC by Dubourg (2016) so there is little justification for lowering this estimate. Thus, not only would remaining 'costs' in reality have to be opposite-signed to overturn the conclusion that benefits of authorisation outweigh the risks, but they would also have to be significant benefits, equal to millions of pounds in present value terms. However, this is not credible for lost profits, and the lost producer and consumer surplus of other stakeholders (suppliers, clients and customers) are not currently included in the estimate of costs. Thus it comes down to potential benefits which have currently been excluded from the non-use scenario. However, the non-use scenario already excludes significant costs which might be incurred but are not counted (e.g. underemployment of retained administrative workers, overcapacity of premises).

The conclusion of this discussion is that there is no potential source of variation in the estimates of the benefits and risks of continued use which would overturn the conclusion that the benefits outweigh the risks.

4.7. Information to support the review period

The applicant considers that analysis presented in this document justifies a long review period of 12 years. The CSR demonstrates that the risks of continued use are well-controlled, and the SEA demonstrates that the risk of continued use is outweighed by the benefits of authorisation by several orders of magnitude. The AoA explains that the use of Cr(VI) in this application has been established in the field over many decades, which means that alternatives to Cr(VI) are relatively underexplored for the applications of importance to this use. The scope for identifying and developing alternatives within a five-year period (to permit authorisation for seven years, allowing for the need to submit a review report) is considered negligible. Therefore, the applicant considers that this justifies a 'long' review period.

5. CONCLUSION

- The document presents an analysis of alternatives (AoA) and a socio-economic analysis (SEA) for the use of chromium trioxide (hereafter referred to as 'Cr(VI)') under UK REACH
- The applicant is Exosens Centronic Limited (hereafter referred to as 'Centronic' or 'the applicant'), whose manufacturing site is located in Croydon, south London
- The applicant manufactures Geiger Muller tubes (GMTs) for the detection of radiation in industrial, safety and security (defence) applications
- GMTs contain a mixture of gases, one of which creates radiation detection events and the other quenches the current generated by such events
- The quench gas is a halogen gas which is extremely corrosive
- Cr(VI) is used to provide a smooth, hard, inert metal coating which is highly corrosion-resistant; this increases the accuracy and lifespan of the detection equipment
- Ruggedness, accuracy and extended lifespan are key characteristics of the applicant's products and explain its position as the second biggest manufacturer if GMTs in the world. Their reputation for quality and reliability has been established over a period of over 50 years in the harshest environments, particularly mining and oil and gas exploration
- This use of Cr(VI) was previously covered by the CTAC authorisation under EU REACH; under this authorisation, Centronic commissioned a programme of innovative research to investigate potential alternatives to Cr(VI) for surface treatment
- In this research, chromium plating was compared against passivation and oxide-formation as alternative techniques for achieving corrosion resistance. At room temperature, these alternative treatments were found to offer broadly acceptable performance, but showed some increased bromine deposits and fall-off of voltage, indicating lower corrosion resistance and lifetime compared with chromium plating. At 125°C, however, the alternatives were found to exhibit performance degradation which suggested that, at the extremes required for Centronic's products (e.g. 125°C), performance would be unacceptable. As a result, these protective mechanisms were deemed ineffective at such temperatures
- Due to the unique performance characteristics of the applicant's products, it is concluded that there are no suitable alternatives generally available (SAGA)
- If authorisation is granted for this use, the applicant intends to establish a programme of follow-up research to understand better the role of Cr(VI) in GMT interactions, with a
- If authorisation is not granted, the applicant will close its manufacture of GMTs in the UK. It may relocate this business outside of the EU but this is not considered an easy project due to the expertise held in the UK company. In either event, profits will be lost from the UK and workers will be made redundant. The costs of these impacts are estimated at (Confidential financial). (net present value, 3.5%)
- Residual risks to human health and/or the environment of continued use have been estimated over a 12-year period at £3,573 (net present value, 1.5%)
- The conclusion is that the costs of non-use outweigh the risks of continued use and that authorisation is justified. This result is robust to reasonable sensitivity analysis

- A review period of 12 years is requested for this authorisation. The CSR demonstrates that the risks of continued use are well-controlled, and the SEA demonstrates that the risk of continued use are outweighed by the benefits of authorisation by several orders of magnitude. The AoA explains that the use of Cr(VI) in this application has been established in the field over many decades, which means that alternatives to Cr(VI) are relatively underexplored for the applications of importance to this use. The applicant considers that this justifies a 'long' review period.