SOCIO-ECONOMIC ANALYSIS

Legal name of applicant(s):	Rolls-Royce plc
Submitted by:	Rolls-Royce plc
Date:	21 August 2020
Substance:	Bis (2-ethylhexyl) phthalate (DEHP) *EC: 204-211-0 CAS: 117-81-7*
Use title:	The processing of a stop-off formulation containing DEHP during the diffusion bonding and manufacture of aero engine fan blades
Use number:	1

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FIGURES

None included

LIST OF ABBREVIATIONS

Annex XIV	List of chemicals requiring Authorisation to be used in the EU
AoA	Analysis of Alternatives
bw	Body weight
CLP	Chemicals Labelling and Packaging
CSR	Chemical Safety report
DB/SPF	Diffusion bonded / super plastically formed
DEHP	bis (2-ethylhexyl)phthalate
DNEL	Derived No Effect Level
DSD	Dangerous Substances Directive
EASA	European Aviation Safety Agency
EAL	Environmental Assessment level
ECHA	European Chemicals Agency
EQS	Environmental Quality Standard
H360	Hazard Statement – May damage fertility or the unborn child
HS&E	Health, Safety & Environment
HSE	Health and Safety Executive
IUCLID	International Uniform Chemical Information Database
MOS	Margin of Safety
MSB	Materials Stewardship Board
NOAEL	No Observable Adverse Effect Level
OES	Occupational Exposure Standard
PPE	Personal protective equipment
PSIS	Pre-Submission Information Session
RCR	Risk Characterisation Ratio
REACH	Registration, evaluation, authorisation (and restriction) of chemicals
SEA	Socio-Economic Analysis
SP	Substitution Plan
Stopyt-62A	Bonding stop-off agent containing DEHP
Stopyt-62G	Bonding stop-off agent containing Glycerol
Stopyt-62PL	Bonding stop-off agent containing Triethylene glycol bis (2-ethylhexanoate)
SVHC	Substances of Very High Concern
TWA	Time weighted average
WCFB	Wide-chord fan blade

DECLARATION

The Applicant is aware of the fact that evidence might be requested to support information provided in this document.

Also, we request that the information blanked out in the "public version" of the Socio-economic analysis is not disclosed. We hereby declare that, to the best of our knowledge as of 21 August 2020 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: 21/8/20

Date, Place: 21 August 2020,
Barnoldswick,
Lancashire,
UK

David Pease
Chief of Manufacturing Engineering
Wide Chord Fan Blade

1. SUMMARY OF SOCIO-ECONOMIC ANALYSIS

The previous Authorisation for the use of Stopyt-62A demonstrated that Adequate Control of risks has been achieved in the WCFB manufacturing process, and this was agreed by the regulator as evidenced by the review period granted of 7 years. Unfortunately, the alternatives development work was not successful and so we are seeking a further Authorisation.

The aim of this Socio-Economic Analysis (SEA) is to re-examine, and if appropriate re-validate, the evidence previously provided to support the case for authorisation of DEHP in the Rolls-Royce fan blade manufacturing process.

Fan blade manufacture at Rolls-Royce's Barnoldswick UK site supports our global civil and defence aero-engine businesses, which had a combined turnover in excess of £10 billion in 2019 and employed over 29,000 people in total.

Each Rolls-Royce engine type undergoes a rigorous development and validation programme in order to obtain approval from the European Aviation Safety Agency (amongst other aircraft safety regulatory bodies) which provides type-certification of aircraft and components. Stopyt-62A, which contains DEHP is used in the precision manufacture of the fan blades for Rolls-Royce engines. The process to develop, test and validate DEHP-free alternatives to Stopyt-62A requires an extensive programme of work, which, in the previous submission, was estimated to take 5-7 years and involve research and development costs of up to £14 million. Although every effort was made to expedite this process and approve an alternative product (Stopyt-62G) for use, the formulation trials were unsuccessful and the formulation failed the engine certification testing programme relatively late in the approval process, even after the manufacture and trial of test components. This was due to unanticipated effects of the formulation on material fatigue life.

The total quantity of DEHP imported to the UK by Rolls-Royce and used in the fan blade manufacturing process is less than 1 tonne per annum. The life-cycle for DEHP terminates at the Rolls-Royce UK site where DEHP is ultimately is removed from components by the very high temperature fan blade forming process. Based on the monitoring data presented in the Rolls-Royce DEHP CSR, the risks to human health and releases to the environment from the Rolls-Royce processes were agreed to be acceptable (based on the risk management measures in use and the extremely low risk ratios achieved). There are likely to be no human health or environmental benefits from removing DEHP from the process. Under the 'applied for use' scenario, Rolls-Royce continued to apply the risk management measures set out in the CSR to ensure that there are no negative impacts on human health or the environment from the use of DEHP and will continue to do so while this stop off formulation is in use.

Rolls-Royce considers that the negative economic and social impacts of the 'non-use' scenario would be severe and would result in no health or environmental benefits. Reauthorisation under REACH for continued use of DEHP in Stopyt-62A beyond the expiry date of the current review period is a business-critical requirement for Rolls-Royce. Whilst the Company remains committed to approving and transferring manufacture to an alternative (DEHP-free) formulation, failure to obtain authorisation would result in major disruption to our global aircraft engine manufacturing output, with the possibility of all UK DB/SPF WCFB manufacturing being relocated to Singapore or the United States. Both of these would require considerable expense and use of natural resources to implement and result in a significant interruption in deliveries to both civil and defence customers.

2. AIMS AND SCOPE OF SEA

2.1. Aims and scope of SEA

Rolls-Royce plc wish to apply for a re-authorisation for the continued use of bis (2-ethylhexyl) phthalate (DEHP) beyond the previously authorised review period expiry of February 2022, as permitted under the REACH Regulations.

In the Rolls-Royce Chemical Safety Report (CSR) for DEHP it has been demonstrated that Adequate Control of human health and environmental risks is achieved in the aero-engine fan blade manufacturing process, which uses a formulation containing DEHP.

The aim of this Socio-Economic Analysis (SEA) is to provide further evidence to support the case for authorisation of DEHP use in the Rolls-Royce fan blade manufacturing process.

2.2. Market and business trends including the use of the substance

Manufacturing of fan blades is carried out at Rolls-Royce sites in the UK and Singapore. During 2019, just over 7300 titanium DB/SPF fan blades were manufactured at this UK site, using DEHP in the process. Fan blade manufacture supports our global civil businesses which had a turnover of £8.1 billion in 2019 and employed 26,100 people. It also made a significant contribution towards our defence aero-engine business for which the UK site is the single source for critical components.

The total quantity of DEHP imported to the UK by Rolls-Royce and used in the fan blade manufacturing process is less than 1 tonne per annum. With regards to the REACH legislation the life-cycle for DEHP terminates at the Rolls-Royce UK site where DEHP is removed from components by the very high temperature fan blade forming process. A number of risk management measures (RMMs) are employed by Rolls-Royce to protect human health and the environment from the potential risks of DEHP use. Based on the monitoring data presented in the Rolls-Royce DEHP CSR, the risks to human health and releases to the environment from the Rolls-Royce processes are considered to be acceptable (based on the RMMs in use and the extremely low risk ratios achieved). Consequently, there are likely to be no human health or environmental benefits from removing DEHP from the process.

Fan blades are safety critical components of aero-engines and any change to their design or manufacture requires extensive research, testing and regulatory approval. The attempt to develop alternatives to DEHP has to date incurred significant research and development (R&D) costs for Rolls-Royce. Although it was originally estimated that this would take 5-10 years to complete, trials on the most promising alternative were expedited with the intention of completing them within the original 7-year Authorisation review period. These trials however, were unsuccessful and the formulation failed the engine certification testing programme relatively late in the approval process, even after the manufacture and trial of test components. This was due to unanticipated effects of the DEHP-free formulation on WCFB metallic material fatigue life.

A technically viable alternative to use of the DEHP-containing formulation is therefore still not available, however the test programme is continuing with another potential alternative formulation at this time. The testing to date on the promising alternative candidate (Stopyt-62PL) has progressed well and is encouraging that an alternative material to DEHP will prove suitable.

2.3. Definition of "applied for use" scenario

The 'applied for use' scenario is that, in the case that our current alternative candidate formulation does not pass the final testing to demonstrate equivalence to the DEHP-containing formulation, that Rolls-Royce obtains authorisation for continued use of DEHP beyond the expiry of the current review period in February 2022 until such time that a new alternative is developed and validated.

Under this scenario it is expected that the R&D activities needed will require an additional 5 to 7 years to deliver a viable alternative to DEHP. As per the Company's current experience the successful introduction of a particular formulation cannot be guaranteed.

2.4. Definition of "non-use" scenario

The 'non-use' scenario is that if authorisation for the continued use of DEHP by Rolls-Royce is not granted, and the current alternative being tested proves not to be successful, then fan blade production in the UK would cease completely by the authorisation expiry date of February 2022, leaving Singapore as a single source in the immediate future.

This would also compromise a significant defence aero-engine project where that work could not currently be undertaken outside the existing UK facility, and would necessitate considerable expense of relocating manufacture to the USA. Whilst the Company remains committed to approving and transferring manufacture to an alternative formulation, failure to obtain authorisation would result in major disruption to our global aircraft engine manufacturing output, with the possibility of all UK DB/SPF WCFB manufacturing being relocated to Singapore or the United States. Both would require considerable expense and use of natural resources to implement, grossly outweighing the HS&E benefits of continuing to use DEHP-containing Stopyt-62A for an interim period.

2.5. Information for the length of the review period

Although it is envisaged that an additional 5 to 7 years will be required to deliver a viable alternative to DEHP, the Company's current experience has demonstrated that the success of an individual programme cannot be guaranteed. An extension of a further 7 years is therefore requested to allow a further iteration of the alternatives development and testing should this be required.

3. IMPACTS OF GRANTING AUTHORISATION

The following assessments are based on the assumption that the relevant manufacturing operations on civil WCFB would be transferred to the existing facility in Singapore, and that a new facility would be required in the USA for military blades. For both product ranges, it would be impractical to maintain the subsequent manufacturing operations at the UK facilities, and therefore transfer of the whole product manufacture would be required commercially.

The replacement product under development is cost neutral and therefore the product cost considerations are additional transport, equipment relocation, new build requirements and product validation trials for the new locations. Due to the industry and component certification trials required, these product validation trials form significant amounts of the relocation costs. These costs give no further benefit to the Company and could not be passed on to the customer, and so increase the cost burden on the Rolls-Royce business against very fierce international competition.

3.1. Human health and/or environmental impacts

Table 1: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	Applied for Use Scenario	Non-use Scenario	Commentary
Human Health	Adequate Control using risk management measures - no health impact	Adequate Control using risk management measures - no health impact	No health benefit arising from non-use scenario

3.1.1 Number of people exposed

The table below is an estimate of the number of personnel potentially exposed to Stopyt-62A, using 2019 as the baseline year.

Table 2: Number of People Exposed

Year	Directly Exposed (Manufacturing Operators)	Potential For Indirect Exposure on Site (technical support staff, supervision, waste handlers, cleaners etc.)	Potential For Indirect Exposure off Site (waste disposal, laundry etc.)	Total
2019	30	12	8	50

3.1.2 Impact on the environment

Table 3: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	Applied for Use Scenario	Non-use Scenario	Commentary
Environment	Small quantity of hazardous waste. R&D materials and energy use for alternatives development	Small quantity of hazardous waste. Significant materials and energy use for relocation of production to outside the UK and Europe. Additional impacts for Rolls-Royce staff travel and transport of around 9,000 finished fan blades per year back to the UK for final assembly	Environmental impact of relocation of production is likely to be significant

Table 4: Summary of additional statistical <endpoint> cases:

	Excess <endpoint> risk	**Number of exposed people**	**Estimated statistical <endpoint> cases**	**Value per statistical <endpoint> case**	**Monetised excess risk per year**
Workers					
Directly exposed workers	N/A	30	N/A	N/A	N/A
Indirectly exposed workers	N/A	20	N/A	N/A	N/A
Sub-total	N/A	50	N/A	N/A	N/A
General population					
Local	N/A	0	N/A	N/A	N/A
Regional	N/A	0	N/A	N/A	N/A
Sub-total	N/A	0	N/A	N/A	N/A
Total	N/A	50	N/A	N/A	N/A
Latency (years)	N/A – due to minimal exposure as per monitoring				

3.2. Economic impacts

Table 5: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	**Applied for Use Scenario**	**Non-use Scenario**	**Commentary**
Economic	Significant R&D costs for Rolls-Royce to develop alternatives. Potential production cost savings from alternatives development RR able to continue to fulfil Customer engine orders until an alternative is proven	High relocation costs for Rolls-Royce. Up to 350 direct job losses in the UK plus many more supply chain job losses. Benefit outside of the UK in terms of jobs and GDP. Significant investment in new production plant outside the UK is required. Customer engine orders not fulfilled with financial penalties for Rolls-Royce. Major negative impact on Rolls-Royce share price and investor confidence. Competitors will have	The economic impacts of non-use are very high and could affect Rolls-Royce's competitiveness and investor confidence. Production leakage to outside of the UK would occur if authorisation is not granted and this is not the intention of REACH when the risks are already adequately controlled.

		an advantage over Rolls-Royce as they are not affected. Up to 0.6% of UK GDP would be at risk based on value of Rolls-Royce engine production that could be affected during the period of relocation of fan blade production.	

3.3. Social impacts

Table 6: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	Applied for Use Scenario	Non-use Scenario	Commentary
Social	Continued provision of highly skilled jobs at UK manufacturing site. Continued support and jobs for an extensive UK and European engine supply chain.	Loss of high skilled jobs at UK manufacturing site. Potential closure of UK manufacturing site and deskilling of workforce. New jobs created outside of Europe.	There is a need to protect UK and European manufacturing jobs from further decline

3.4. Wider economic impacts

Table 7: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	Applied for Use Scenario	Non-use Scenario	Commentary
Wider Economic	The Compressors internal business unit of Rolls-Royce, containing fan blade manufacture, is a significant contributor to GDP.	These may include impacts on European and UK GDP for the non-use scenario and economic benefits for countries outside of Europe.	The wider economic impacts of non-use may be significant

Table 8: Socio-economic benefits of continued use

Please note that the values provided in table 8 are not annualised but instead we report the estimated one-off costs that would be incurred for each major impact quantified.

Description of major impacts	**Quantification of impacts** **One-off costs € (£)**
1. Benefits to the applicant(s) and/or their supply chain	
1.1 Avoided profit loss due to investment and/or production costs related to the adoption of an alternative	€0 (£0)

1.2 Avoided profit loss due to ceasing the use applied for	Blank #1
1.3 Avoided relocation or closure cost	Blank #2
1.4 Avoided residual value of capital	€0 (£0)
1.5 Avoided additional cost for transportation, quality testing, etc.	Blank #3
Sum of benefits to the applicant(s) and / or their supply chain	Blank #4
2. Quantified impacts of the continuation of the SVHC use applied for on other actors	
1.1 Avoided net job loss in the affected industry	350
1.2 Foregone spill-over impact on surplus of alternative producers	N/A
1.3 Avoided consumer surplus loss (e.g. because of inferior quality, higher price, reduced quantity, etc.)	N/A
1.4 Avoided other societal impacts (e.g. avoided CO_2 emissions or securing the production of drugs)	N/A
Sum of impacts of continuation of the use applied for	Retention of 350 highly skilled jobs in EU / UK based on 2019 production
3. Aggregated socio-economic benefits (1+2)	Blank #5

4. COMBINED ASSESSMENT OF IMPACTS

4.1. Comparison of impacts

Table 9: Summary of Comparison of Impacts for Rolls-Royce DEHP Scenarios

Impact	Applied for Use Scenario	Non-use Scenario	Commentary
Overall Comparison	Rolls-Royce's current DEHP risk management measures are shown to protect human health and the environment. The negative impacts of the applied for use scenario are considered to be relatively small and manageable.	The negative impacts of the non-use scenario are considered to be extremely high and may result in production leakage to non-UK countries. Rolls-Royce would suffer major financial damage and up to 350 EU / UK job losses may occur. Up to 0.6% of UK GDP could be at risk during the period of relocation of fan blade production.	The SEA results are provided to support the case for DEHP authorisation for Rolls-Royce fan blade manufacture in the UK

Table 10: Comparison of socio-economic benefits and risks of continued use

Please not that annualised values presented in table 10 are based on the total costs being annualised over a review period of 7 years.

Socio-economic benefits of continued use		**Monetised excess risks associated with continued use**	
Benefits to the applicant(s) and/or their supply chain [annualised to € million per year over 7 year review period]	Blank #6	Monetised excess risks to workers directly exposed in the use applied for [annualised to € million per year]	€0 (£0)
Quantified impacts of the continuation of the SVHC use applied for on other actors	€0 (£0)	Monetised excess risks to the general population and indirectly exposed workers [annualised to € million per year]	€0 (£0)
Additional qualitatively assessed impacts	€0 (£0)	Additional qualitatively assessed risks	€0 (£0)
Aggregated socio-economic benefits [annualised to € million per year]	Blank #7	Aggregated monetised excess risk [annualised to € million per year]	€0 (£0)

Table 11: Benefit/ risk summary

Net benefits (€)	Blank #8
Benefit/monetised risk ratio	Not calculable

4.2. Distributional impacts

The main impact of non-authorisation is to disrupt production in the short term, with knock-on operational (delivery) impacts on customers, and on employment in the region where the Barnoldswick site is based. There is no known HS&E upside to non-authorisation due to the level of exposure/release being below the limits of detection. The distributional impacts of authorisation reflects these points.

Table 12: Distributional impacts

Affected group	Economic impact	Health and environmental impact
Economic operator		
Applicant	---	N/A
Suppliers of alternatives in the EU	N/A	N/A
Suppliers of alternatives outside the EU	N/A	N/A
Competitors in the EU	N/A	N/A
Competitors outside the EU	+	N/A
Customer group 1 (Airframe manufacturers)	--	N/A
Customer group 2 (Defence customers)	---	N/A
Public at large in the EU (identify)	N/A	N/A
Geographical scope		
Region or Member State (UK – Northwest England)	--	N/A
Within the applicant's business		
Employers/Owners	---	N/A
Exposed workers	-	N/A
Non-exposed employees	-	N/A

4.3. Uncertainty analysis

The SEA is based on 2019 data due to the widespread disruption and business interruption in 2020 due to COVID-19.

The on-going production costs of changing to a new formulation of Stopyt are minimal, due to the new formulation being a like-for-like replacement with no additional processing, and purchase costs are unlikely to be affected. The business costs are therefore associated with the testing and validation of the new formulation, and these costs and timescales are difficult to precisely predict due to the potential for validation failure and re-test.

The costs of relocating manufacture are broadly estimated as the business future is uncertain on the required capacity and capability of alternative plants to accommodate the UK manufacturing quota, without additional investment in plant and buildings. It has been assumed that only plant and validation costs will be required to move civil blade manufacture to Singapore.

Defence blade manufacture will require the construction of a new facility outside the UK and EU, and almost certainly in the USA. Costs for this facility are estimates based on the relocation of UK plant where suitable for transfer.

5. CONCLUSIONS

In the 'applied for' use scenario, Rolls-Royce has demonstrated that Adequate Control of human health and environmental risks is achieved in the aero-engine fan blade manufacturing process which uses a formulation containing DEHP. Rolls-Royce will continue to apply the risk management measures set out in the CSR to ensure that there are no negative impacts on human health or the environment from the use of DEHP. Rolls-Royce is nearing the end of testing of a promising alternative, however success is not guaranteed at the time of submission of this review report. Should the alternative fail, then Rolls-Royce will need to progress development of further alternatives, which will require 5 to 7 years beyond the current DEHP Authorisation expiry date to be fully validated and implemented and so remove DEHP from the fan blade production process.

Rolls-Royce considers that the negative economic and social impacts of the 'non-use' scenario would be severe and would result in no health or environmental benefits. The SEA results are provided to support authorisation for continued used of DEHP in the fan blade manufacturing process until an alternative is available. Rolls-Royce believes that a further 7 years authorisation review period is required so that a technically and economically viable alternative can be developed and validated in the case that the current alternative candidate is not successful.

6. REFERENCES

None included